

Growing Sustainability: Hydroponic Cultivation of Food Sovereignty in Canada

by

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### **Author's Declaration**

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## **Abstract**

This research aims to understand attitudes held by communities towards controlled environment agriculture (CEA) as a pathway to building resilient local food systems across Canada, particularly in northern and Indigenous communities. Local controlled environment agriculture projects such as hydroponics and aquaponics are gaining appreciation across Canada as new agriculture techniques for vegetable production, as they offer potential benefits such as reduced emissions from the transport of foods, lower food prices, creation of local jobs, and reduced vulnerabilities to changes in global food markets. Despite early research showing the validity of CEA in reducing food insecurity, there is minimal research showing the sustainability and sociocultural impacts of CEA. Many CEA units in Canada lack community support and are facing challenges in the continuity of programs, despite their potential effectiveness in building capacity and resiliency in the wake of climate change. Through a partnership with Growcer Hydroponics Inc., interviews were conducted with CEA community actors to understand patterns, behaviours, and sentiments related to the governance and culture of CEA and local food systems. A mixed methods approach was used to understand the current perceptions and values held by community members and how these correlate to the success of the farms in addressing communities' sustainability, food security, and food sovereignty needs. Responses were analyzed through sustainability, food justice, and respectful research frameworks. This research found that the desire for more accessible fresh and healthy foods is the primary motivation for the implementation of CEA in remote communities in Canada. CEA units are well supported if the community members' values include food, nature, relationships, education, equality, culture, and self-reliance. A considerable finding of this study is that although it was previously believed that CEA may have minimal benefits as the foods grown are not socially nor culturally relevant, community members have found ways to connect CEA to cultural and traditional practices and teachings.

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## **List of Abbreviations**

AFN: Alternative Food Network

CEA: Controlled Environment Agriculture

DFT: Digital Farming Technology

EDO: Economic Development Officer

GHG: Greenhouse Gas

IRM: Indigenous Research Methodologies

IT: Information Technology

IUA: Innovative Urban Agriculture

UEA: Uncontrolled Environment Agriculture

UA: Urban Agriculture

VF: Vertical Farming

## Chapter 1 - Introduction

Controlled environment agriculture (CEA) is gaining new appreciation across Canada as a way to preserve old teachings with new agriculture techniques (Steiner & Neathway, 2019). These techniques include hydroponics, aquaponics, aeroponics, vertical farming, LED growing and more (Kozachenko, 2020). CEA claims to offer many benefits to communities reliant on global food systems, such as reduced emissions from the transport of foods, lower food prices, the creation of local jobs, and reduced vulnerabilities to changes in global food markets (Wilkinson et al., 2021; Stecyk, 2018; Gott et al, 2019). CEA is also being promoted as a tool to reduce and adapt to the impacts of climate change, especially in northern and Indigenous communities, where the changing climate has exacerbated already disproportionate food insecurities (Stecyk, 2018). As a result, CEA is expected to grow significantly in the coming years (Wilkinson et al., 2021). The aim of this research is to understand attitudes held by communities towards controlled environment agriculture as a pathway to building resilient local food systems across Canada, particularly in northern communities, and to uncover whether there are any barriers to their adoption.

While some research claims CEA can contribute to improved global food security (Cowan et al., 2023; Currey et al., 2018; Goddek et al., 2023), others claim it to be only a partial solution (Benis & Ferrao, 2018) with a lack of empirical research to support such claims (Goodman & Minner, 2019). Critics also point out that despite all the positive claims of CEA, their environmental sustainability remains contested (Cowan et al., 2022) and there is a lack of research into their sociocultural impacts (Gan et al., 2023; Mina et al., 2023).

By uncovering these sociocultural impacts through the values and attitudes of communities, CEA can be utilized to empower communities to take control of food systems by fostering agency and building capacity (Wilkinson et al., 2021). Many CEA units in Canada lack community support and face challenges of continuity of programs, despite their

potential effectiveness in addressing the impacts of climate change (Wilkinson et al., 2021; C. Ellis, personal communication, November 2022).

Through a community-based participatory research partnership with Growcer Hydroponics Inc., semi-structured interviews were conducted with CEA farmers, employees, and community actors to understand patterns, behaviours, perspectives, and sentiments as they relate to CEA and local food systems (Rocker et al., 2022; Ruzol et al., 2017; Jernigan et al., 2012). This research utilized a mixed methods approach inclusive of qualitative and quantitative methods. The qualitative analysis used thick description themed analysis through NVivo (Cox, 2015) as well as a quantitative frequency analysis of themes (Sorensen, 2008). Utilizing qualitative and quantitative methods in conjunction allows for a quantification of results as well as the emergence of underlying stories of norms, decision-making, interactions, sociocultural impacts and conceptualizations of nature, community, and food systems (Rocker et al., 2022).

### **1.1 Food Systems and Sustainability in Canada**

Controlled environmental agriculture is the cultivation of food within a system that is not exposed to the outside environment, meaning all aspects of the system, from temperature, water, and nutrients are controlled within the system (Szopinska-Mularz, 2022). This form of innovative and technologically reliant agriculture takes many forms, such as aquaponics, hydroponics, and aeroponics (Gomez et al., 2017). Though not essential, many of these methods take the form of vertically stacked trays for growing, known as vertical farming (VF) (Van Gerrewey et al., 2021). Figure 1 shows the inside of a hydroponic unit utilizing a stacked farming configuration. This thesis focuses on hydroponic cultivation, which is the soilless growth of plants in water infused with all the nutrients needed for the growth of plants (Agriculture and Agri-food Canada). The nutrients added often include phosphorus,



Figure 1: Inside a hydroponic farm with a stacked farming configuration. Source: Mitchell, 2021

nitrogen, and potassium (Growcer.ca). Containerized hydroponic units from Growcer as well as other companies operate containers resembling shipping containers, as seen in Figure 2, most often in new containers rather than converted/recycled ones. A majority of the vegetables produced in greenhouses in Western nations are grown utilizing hydroponic methods (Agriculture and Agri-food Canada). Figure 3 shows the roots of a bok choy plant grown

Growcer Hydroponics Inc.

(Growcer) is one of many for-profit hydroponic companies that



Figure 2: Growcer farm resembling a shipping container. Source: Lynde-Smith, 2023



*Figure 3: Roots of bok choy plant grown hydroponically. Mitchell, 2021*

operate in Canada and is headquartered in Ottawa. Growcer is part of the containerized gardening industry, as they develop, build, and supply hydroponic farms within shipping containers. The price for a Growcer unit starts at \$200,000 and includes the cost of ongoing support from Growcer through the purchase, implementation, and operation of the farm. One sold, the purchaser is in charge of the operation of the unit and sale of the produce, however Growcer

does provide support as needed. Figure 4 shows a graphic provided by Growcer with the steps to get started with a hydroponic project (Growcer.ca). Growcer operates roughly 75 farms across the country (Blake, 2023); however, it is estimated that at any time, roughly one-third are not in operation, resulting from various factors (C. Basler, personal communications, October 26, 2022). This research aims to understand these factors. Figure 5 shows a map of the locations of Growcer farms across Canada published on the Growcer Hydroponics Inc. web page (n.d).

Controlled environment agriculture exists within multiple problem contexts, as it claims to address issues within various disciplines (Januszkiewicz & Jarmusz, 2017). Figure 6 shows this research situated within the broader context of climate change, reconciliation,



Figure 4: Container Farming 101 – Getting Started. Source: Growcer.ca

food security, and food sovereignty. The growth of, access to, consumption, and connections facilitated through food all relate to these four categories. Firstly, climate change will greatly impact access to safe and affordable foods (Blom et al., 2022; Brown & Funk, 2008). The creation of local food systems can help mitigate these impacts while reducing agricultural contributions to climate change (Rothwell et al., 2016). The changing climate and resulting changes in weather patterns threaten aspects throughout the entire food supply chain, including production (Habib-ur-Rahman et al., 2022; O’Riordan et al., 2013). Although a warming climate may lead to longer growing seasons, creating the potential for increased

crop yields in some regions, this may also test soil productivity and lead to increased rainfall (Agriculture Canada, 2020). As global populations continue to rise, so too does the unsustainable use of resources for food production, furthering the need to rethink our food production systems (O'Riordan et al., 2013). Some of the anticipated negative impacts on food systems of a warming climate are being seen today, with farmlands experiencing severe drought, extreme weather events, and increased pests and diseases, to list a few (Agriculture Canada, 2020). In the north, where many CEA projects are being implemented (Benis & Ferrao, 2018; Blake, 2023; Kozachenko, 2020; Steiner & Neathway, 2019), the climate is warming at an accelerated rate as compared to the south (Blunt, 2023), and the communities in these areas are often more sensitive to climactic changes (National Collaborating Centre



*Figure 5: Map of locations of Growcer hydroponic units in Canada. Source: Growcer.ca, 2024*

for Indigenous Health, 2022). Many people in northern Canada and Indigenous peoples rely upon the health and productivity of the lands for cultural and physical sustenance, health, and well-being (National Centre for Indigenous Health, 2022), including through traditional food procurement such as hunting and fishing (Kozachenko, 2020). Populations of flora and fauna used for food have been significantly reduced as a result of climate change, which in conjunction with the loss of traditional hunting practices as a result of colonization, has led to an increased reliance on imported foods (Kozachenko, 2020; National Centre for Indigenous Health, 2022).

Although there are fewer farms in northern Canada as a result of a short growing season and long harsh winters, the number of farms and farmlands in the north is decreasing

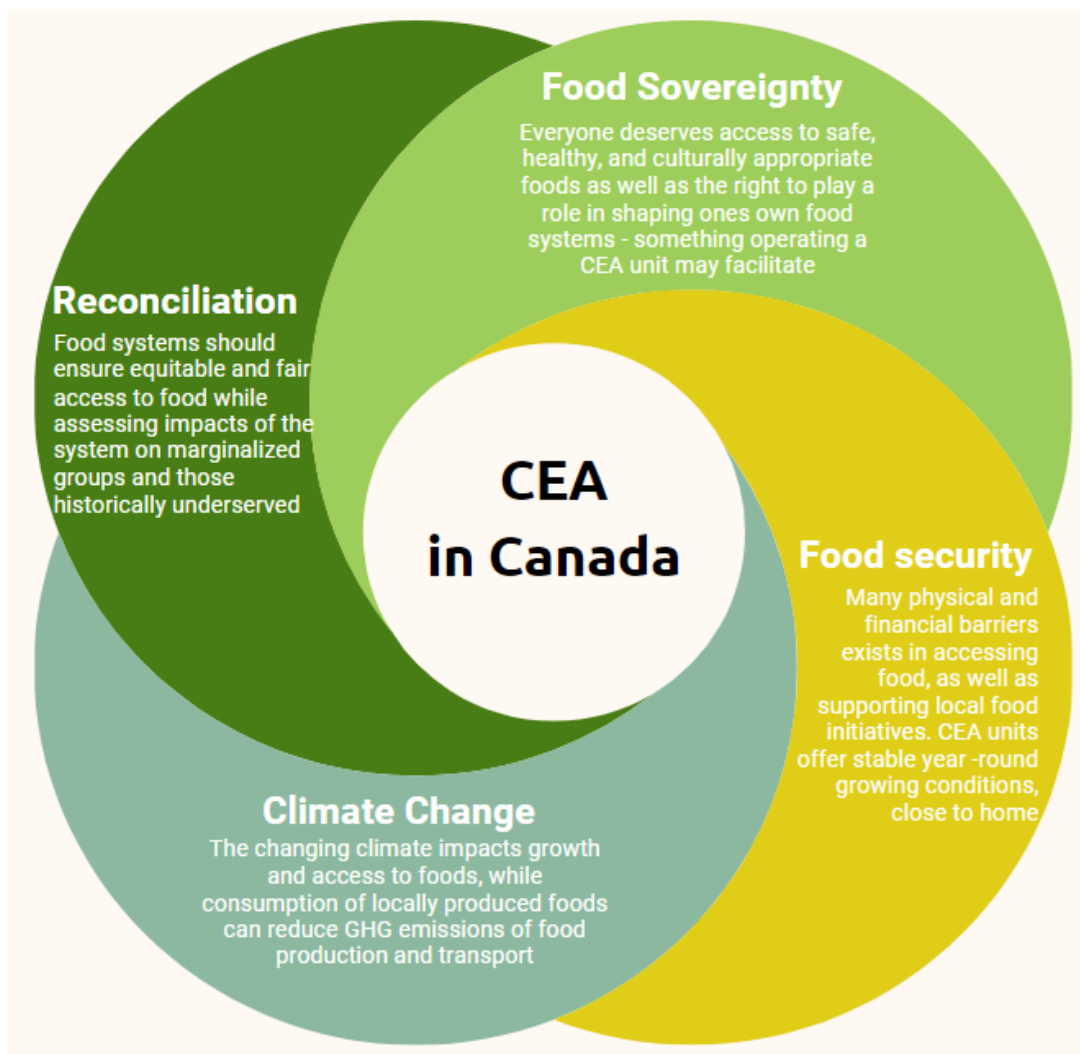


Figure 6: Research Nexus Diagram. Source: Mitchell, 2024



annually at an ever-accelerating rate (Statistics Canada, 2022). In contrast, the number of greenhouses in the north increased by 56% between 2016 and 2021, significantly higher than the rate of increase across Canada over the same time period (Statistics Canada, 2022). Additionally, farms in the north are utilizing agricultural technologies and creating renewable energy more so than compared with the Canadian average (Statistics Canada, 2022). Climate change impacts in the north are expected to be magnified and accelerated when compared with global averages, despite northerners often playing a smaller part in contributions to climate change (Natural Resources Canada). This may be an explanation for the increase in the prevalence of innovative urban agricultural (IUA) techniques in the north, including CEA.

Modern agricultural methods also play a role in contributing to climate change (Lynch et al., 2021), with 26% of GHG emissions globally resulting from food, 50% of the world's habitable land being used for agricultural purposes and 70% of freshwater withdrawals used for agriculture (Poor & Nemecek, 2018). Further, of the food that is imported into Canada, 40% is from outside of North America (Statistics Canada, 2009), leading to significant greenhouse gas (GHG) emissions from transportation (Rothwell et al., 2016). It is estimated that nearly 20% of total food system emissions are a result of transportation (York University, N.d.). Reducing emissions from transportation is believed to be the most promising method to reduce GHG emissions resulting from food (MacRae et al., 2013). Localization of food production can not only reduce GHG emissions (Gan et al., 2022) but also contribute to food security as well through improved physical access (Rothwell et al., 2016).

Hydroponic projects in Canada emerged in the 90's (Chiu, 2020), partially to address these changes in the reduced productivity and increased vulnerability of agricultural lands, while also reducing agricultural contributions to climate change (Blom et al., 2022), and lessening northern communities' reliance on expensive imported goods (Steiner & Neathway,

2019). Local CEA operations claim to produce fewer greenhouse gas emissions and utilize less energy and land when compared with conventional agriculture, while also reducing transportation and, therefore, emissions as well (Armanda et al., 2019; Kozachenko, 2020). These projects also emerged to address difficulties in accessing and growing food in northern and remote parts of Canada (Blom et al., 2022).

## **1.2 Food Justice in Canada**

According to Statistics Canada, over 10% of Canadians cannot access an adequate quantity or quality of food due to financial barriers (Statistics Canada, 2020). This number doubles in northern parts of the country and increases significantly in northern Indigenous communities (Leblanc-Laurendeau, 2020). Northern communities experience additional barriers to accessing food as a result of the remote nature of communities and consequent transportation costs, with food insecurity rates being amongst the highest in Indigenous communities without year-round road access (Leblanc-Laurendeau, 2020; Skinner et al., 2013). Among northerners, Indigenous communities experience greater difficulties in attaining food security as a result of socioeconomic inequalities, historical injustices, and legacies of colonialism (Leblanc-Laurendeau, 2020).

Food security and food sovereignty are listed separately in Figure 6 as the differences in the two concepts are significant, yet both carry importance. They differ in many ways, but the primary difference is the acknowledgement of the cultural importance of foods and a community's participation in their food system (Moragues-Faus & Marsden, 2017). Food sovereignty is a movement slowly increasing in popularity since its inception in the late 90's, which materialized to address issues that influence food security but were not encompassed in its current definition (Jones et al., 2015). Food security has more of a focus on physical and financial access to nutritious foods, whereas food sovereignty recognizes that food is often more than simply nutritional sustenance and can play a role in connection to the land, to

others, to cultural traditions, and to health and wellness (Moragues-Faus & Marsden, 2017). Food sovereignty also recognizes that people have a right to play a role in shaping and creating their food systems because of the ways in which food interacts with various community functions and relationships (Hammelman et al., 2022; Jones et al., 2015). In Canada, food and its production have historically been used as a tool to advance colonialism (Hibbert, 2018; Malli et al., 2023), which must be recognized in food sovereignty programs (Robin et al., 2023).

Reconciliation is an important aspect to consider in every research project (Murdoch, 2018), as many agricultural lands exist on treaty territory, and many Indigenous Peoples in Canada are impacted by food insecurity as a result of historical injustices and ongoing colonial practices (Leblanc-Laurendeau, 2020). It is crucial to ensure equitable access to culturally appropriate foods, those with historical and cultural importance and often acquired through means that support identities and social networks (Sowerwine et al., 2019), while also creating programs that support reconciliation efforts and empower Indigenous peoples (Murdoch, 2018). This research exists at the junction of these four problem contexts described here.

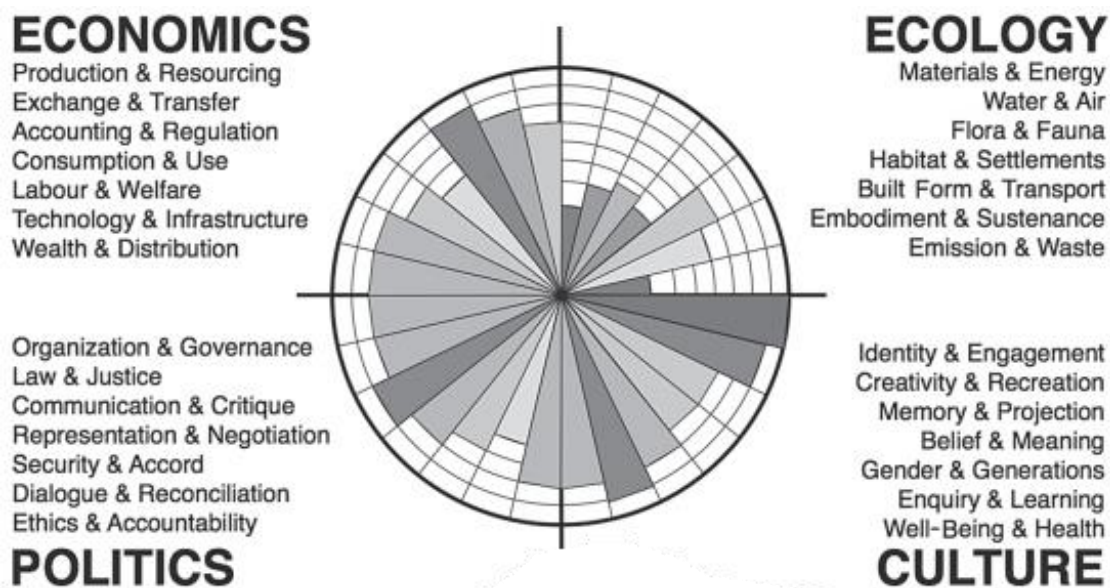
### **1.3 Theoretical Framework**

The theoretical frameworks laid out here were used throughout this research to guide inquiry, inform arguments, and provide context for conclusions drawn (Bennett et al., 2021).

#### **1.3.1 Sustainability**

The three pillars of the sustainability framework, first used in 1987 by E. Barbier, has become ubiquitous in research in the environmental field and others, yet sustainability remains loosely defined (Gan et al., 2023; Purvis et al., 2019). As a result of the ambiguity, the aspects that make up the term are contested (Purvis et al., 2019), and importance is placed

on some characteristics over others (Mina et al., 2023). The sustainability framework most commonly utilizes three main categories (also known as pillars): people, profit, and planet (Ottaviani et al., 2023; Purvis et al., 2019). These are also commonly referred to as environmental, economic, and human pillars (Purvis et al., 2019), or economics, ecology, and culture (James, 2015), as seen in Figure 7.



*Figure 7: Four Pillar Sustainability Framework developed by James (2015)*

The pillars conception is a framework for sustainability that is multidisciplinary and solution-oriented (Clune et al., 2018). This framework has become prominent through discussions and analysis centring on sustainability throughout the past 40 years, as sustainability has been of increasing concern for the public, within scientific research, (Purvis et al., 2019; Schoolman et al., 2012), and within agricultural realms (Moragues-Faus & Marsden, 2017). However, a fourth category has occasionally been added by some authors, practitioners, and researchers as of late to address flaws and gaps in the three-pillar framework (El Mekaoui et al., 2020; Ottaviani et al., 2023; Circles of Sustainability, 2022). As shown in Figure 7, James (2015) adds a fourth category of ‘politics’, which encompasses various aspects such as governance,

law, justice, accountability, and ethics. This fourth pillar is also adopted in Figure 8, labelled governance and encompassing policies, conditions, and services (El Mekaoui et al., 2020). Throughout this thesis, the fourth pillar will be adopted as the three main categories often fail to translate concepts into more comprehensive understandings of sustainability (Ottaviani et al., 2023; Purvis et al., 2018), and sociocultural aspects (El Mekaoui et al., 2020). To fully assess the value of CEA within Canadian applications, we need to expand the notion of sustainability beyond the notion that has been laid out by prior scholars through the three-pillar approach (Purvis et al., 2019). This is not to discredit the three pillars, but rather build on them. One of the contributions of this thesis is the expansion of the previous pillars to provide greater clarity within the application of Canadian communities. The Politics pillar in this thesis will encompass the characteristics described by James (2015) in figure 7, and El

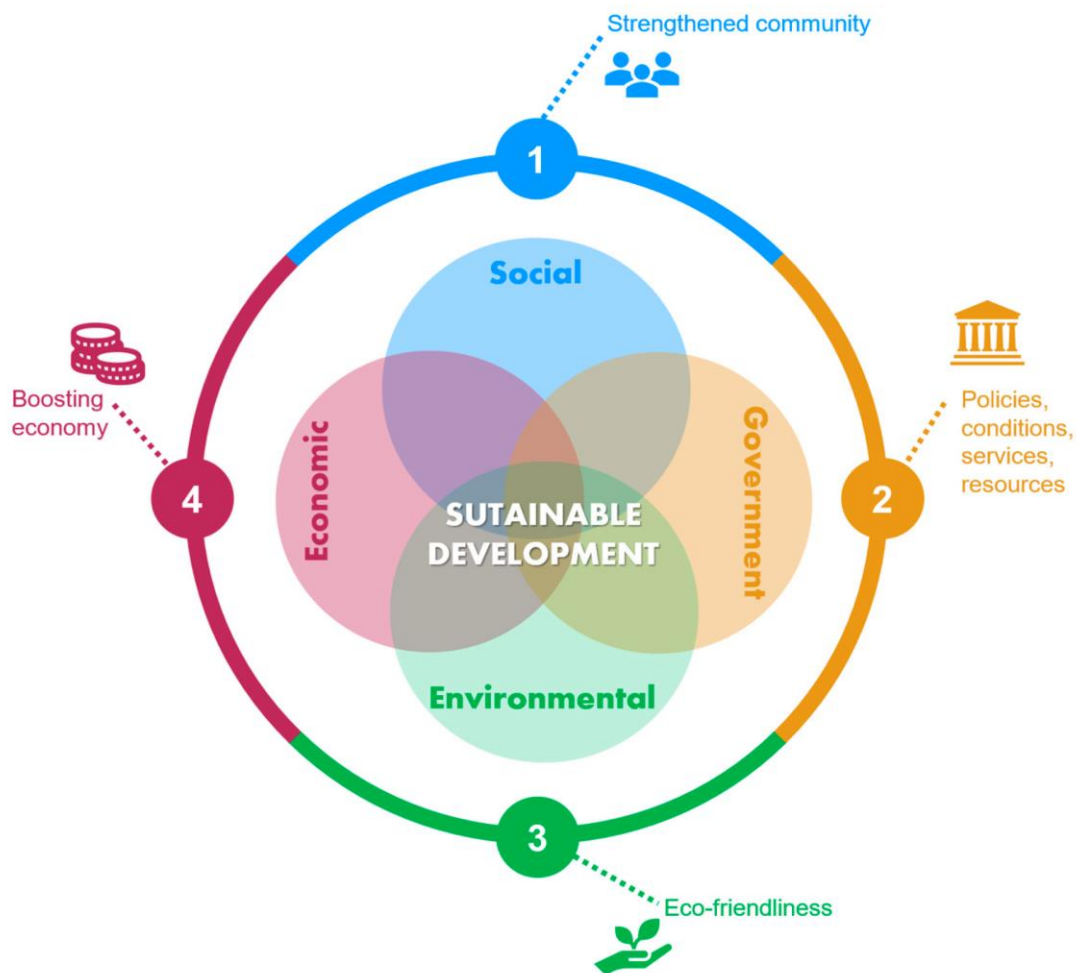


Figure 8: Four pillars of sustainability conceptualization (El Mekaoui et al., 2020)

Mekaoui et al., (2020) in figure 8, but will also include the topic of reconciliation, as it has ties to justice and ethics, and is impacted by government actions and policies (Sterritt, 2020). Many of the topics held within this fourth pillar are integral to discussions on food security and greatly influence the other categories (Moragues-Faus & Marsden, 2017). Societal needs and cultural considerations are rarely taken into account throughout research on and implementation of CEA (Gan et al., 2023; Mina et al., 2023). However, the successful adoption of CEA is reliant on the system being able to address each facet of sustainability (Broad et al., 2020; Gan et al., 2023). The sustainability pillars framework will be used to guide analysis, both through the systematic literature review conducted as well as in the research, and to generate applied solutions (Clune et al., 2018).

### **1.3.2 Sociocultural Sustainability**

Within the sustainability framework, the aspect most studied is the environmental pillar (Schoolman et al., 2012), which is also true for the context of agricultural research (Boogaard et al., 2011; Gan et al., 2023). Although culture is occasionally included as a pillar of sustainability, Osman (2022) argues that culture is the glue that holds the other pillars together and enables development. For instance, agriculture is a social practice, and culture is produced through social practices (Soini & Huttunen, 2018). Although the definitions of each pillar vary, and even the number of pillars of sustainability (James, 2015; Soini & Huttunen, 2018), social sustainability generally is agreed to mean the ability of a social system to maintain social objectives (Boogaard et al., 2011). These objectives include “social cohesion, social mobility, empowerment and equity, institutional development. It also refers to values and norms which are important fundamentals of a culture” (Boogaard et al., 2011, p. 1459). It is recognized that although some research does aim to understand all aspects of sustainability, the social and cultural components are often neglected (Gan et al., 2023), and when they are

considered, society is viewed only based on consumption patterns, implying citizens express their behaviour solely through consumptive practices (Boogaard et al., 2011). Farming is inherently linked to social and cultural practices, as recognized by Soini & Huttunen (2018):

Agricultural practices shape both the farming environment and the farmers' values and appreciations through mutual adaptations. In that way, agriculture is essentially a mixture of different components of culture such as worldviews, materials and symbols, institutions, and dynamic spatial and temporal processes inherently connected with nature. (p. 35)

This quote exemplifies the importance of including sociocultural sustainability within agricultural research, as they are inextricably linked. Cultural sustainability is also ambiguous within the literature but has been used to refer to the continuation of cultural knowledge, practices, and traditions (Gan et al., 2013; Simon, 2023), and greatly influences all other pillars of sustainability (Gan et al., 2023; Soini & Huttunen, 2018). Despite the correlation between social and cultural influences on sustainability, as well as agriculture, these connections have rarely been investigated. "Compared with the environmental and economic benefits, the social effects of CEA have been discussed and evaluated less often, and the cultural perspective of sustainability relating to CEA is barely discussed at all" (Gan et al., 2023, p. 9). This conclusion is drawn by multiple researchers (Kozachenko, 2020; Cowan et al., 2022; Mina et al., 2023).

Perceptions and community values are the points of interest in this research, as values underpin actions and individual and community identities, and play a role in integration within a community (Leal Filho et al., 2022). It is believed that values such as individualism and anthropocentrism have contributed in many ways to the current environmental crisis (Leal Filho et al., 2022; Kopnin et al., 2018), and therefore, values relating to well-being and

community support contribute to sustainable development (Leal Filho et al., 2022). These include justice values supporting equity and inclusion, environmental values including the connection of humans to the natural world and transformation and resilience values that encourage critical thinking, activating change, and overcoming social norms (Scharmer, 2018). Social values are commonly linked to the sustainable development of community projects, however, they are seldom considered (Leal Filho et al., 2022).

### **1.3.3 Food Justice Theories**

The theoretical frameworks discussed here of political ecology and food geographies underpin research and question design, as well as the interpretation of results. A political ecology framework helps to expand upon definitions of the natural environment that includes the consideration for social, political, and cultural processes in local environments (McMahan & Nichter, 2011). Political ecology acknowledges the interconnectivity of politics, geographies, ecology, and in this case, food, and how these factors shape a landscape (Moragues-Fause & Marsden, 2017). Moragues-Faus & Marsden recognize the typical exclusion of political influences within agri-food research and policy creation by stating:

this dominant framing serves to reduce and marginalize the social, spatial and political basis of food production, processing and consumption to questions of public and consumer acceptability to the onset of more novel scientific techniques in ‘solving’ the food security and sustainability problems. (2017, p. 284)

These framings described by Moragues-Faus & Marsden, such as the social and spatial basis of food production, are also common considerations within food geographies: connections, issues, patterns, and relationships between food producers and consumers in relation to place (Hammelman et al., 2020). Hammelman et al. propose a food geography theory that takes



into account power and structures of oppression related to food (2020). The framework then considers:

interconnectivity between places and movements, relationality between land and people, the flows of people, environmental resources, ideas, and culture, and the diverse approaches to achieving justice-oriented objectives. In order to build more equitable and sustainable food systems, it is essential to engage with these geographic realities in deeply theoretical and action-oriented ways. (Hammelman et al., 2022, p. 211)

Both food geography and political ecology frameworks recognize the uneven distribution of environmental resources, including food, stemming from geographic and political conditions (Hammelman et al., 2022; McMahan & Nichter, 2011). A food geography framework further recognized that the agricultural space itself serves as a medium for the sharing of knowledge, the creation or strengthening of social connections, and a place for learning and enjoyment (Park et al., 2022). Previous research finds that by utilizing frameworks that prioritize the health and nutritional aspects of food while overlooking the educational and connective potential discussed here, programs and policies are developed that inadequately address community and individual needs (Park et al., 2022). By utilizing this holistic framework for food, a deeper understanding of sociocultural impacts can be achieved, which can be used to implement programs that better suit community needs by educating, raising awareness, and then shifting this awareness to action.

#### **1.4 Conceptual Framework**

To fully grasp the sociocultural impacts of local food systems, an understanding of all of the diverse inputs, outputs, and influences must be considered. Therefore, food systems and research on such systems must recognize the interplay between environmental, social,

and economic spheres (Christensen & O'Sullivan, 2015). This analysis includes the interconnectivity of humans and nature as well as other societal influences and processes. Research on alternative food networks (AFN) tends to focus on individuals as actors within a capitalist market, rather than analyzing the processes and flows between actors, which reinforces a division between nature and humans (Christensen & O'Sullivan, 2015). Figure 9 shows an example of a food system based around the walrus, with the boxes representing topics that could be analyzed independently in this food system. However, if done so, the relationships represented by the dotted lines would be unexplored (Behe, 2016). Analyzing relationships allows for the critical evaluation of correlations between components of the system, such as the environmental health of food sources, and human well-being (Behe, 2016).

These relationships between food, people and our environments mean that food holds the potential to do more than nourish people. Some broader sociocultural effects that have been identified in previous food studies research include strengthened values, increased pleasure, relationship building, education, and more sustainable ways of life (Park et al., 2022, p. 15).

As Ostrom notes, the key to understanding the viability of a socio-ecological system is not oversimplifying it (2009). It is imperative to identify and understand the nuanced connections between various levels of the system, across different spatial and temporal scales (Ostrom, 2009). These connections include the consideration of aspects traditionally outside of a food system, such as non-market actors and non-market-based solutions, as programs implemented to address food security concerns will be influenced by broader societal and environmental factors (Christensen & O'Sullivan, 2015).

Figure 10 offers a non-linear framework developed for this research to understand the broad inputs, impacts, and relationships within complex local food systems. Flower frameworks have previously been utilized in Indigenous research methodologies, as they centre on Earth and the interdependence of all aspects of an ecosystem (Absolon, 2022). In this framework, the flower is an individual community, surrounded by their characteristics which were divulged through interviews such as values, beliefs, and perceptions.

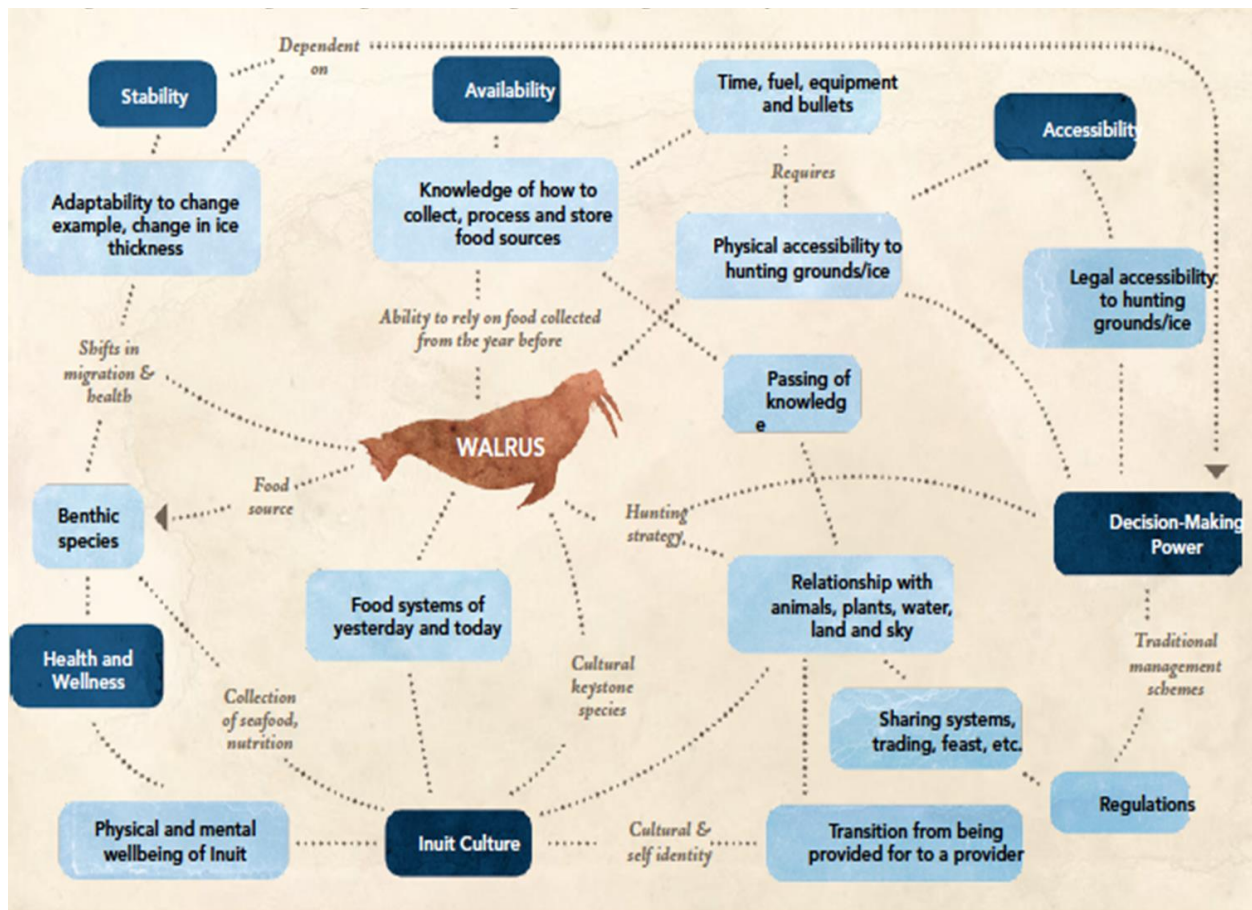


Figure 9: Indigenous research methods food system relationship analysis (Behe, 2016)

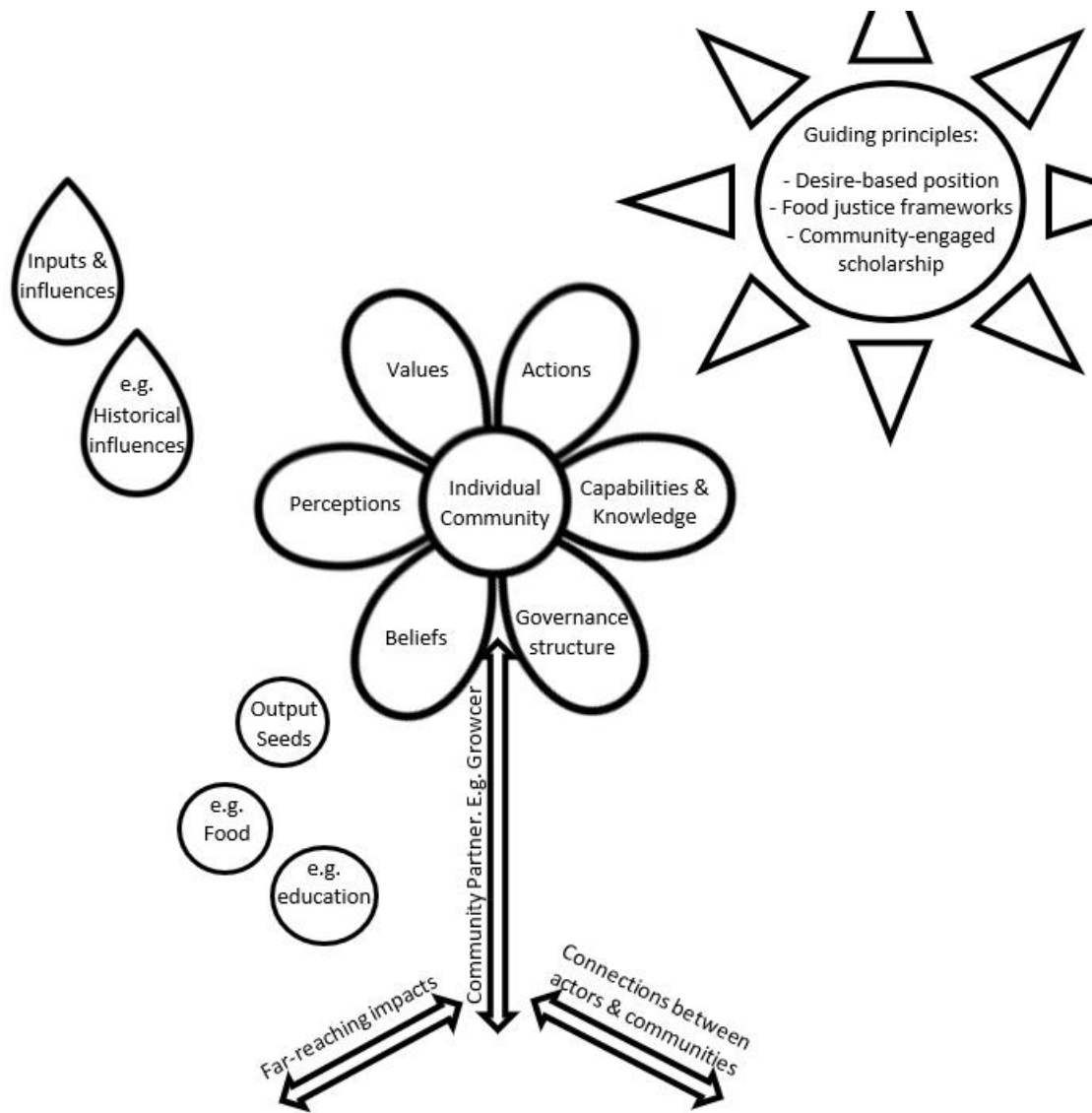


Figure 10: Flower conceptual framework. Mitchell, 2024

The rain symbolizes inputs that influence and shape actions, perceptions, and beliefs, such as historical influences, worldviews, cultures and place-based values (Leal Filho et al., 2022). Sustainability solutions are not one-size-fits-all and must take historical injustices and other extraneous factors into account, as various populations experience and view the environment differently and are adversely impacted by it (Bennett et al., 2021).

The roots are the far-reaching impacts of the programs and the ways in which the community connects with other actors and communities. Just as roots are often unseen, so too are these broader potential benefits such as the shaping of community values, capacity building, knowledge sharing, strengthening livelihoods, more viable social-ecological systems, and increased equity (Park et al., 2022). The stem of the flower is the backbone in many ways, but not the focus. In this research, Growcer Hydroponics was a community partner who was integral to project implementation and offered continued support but did not govern the system.

The seeds are outputs of the system, or what the actor is giving back. Food is an evident physical output, but others may include job creation and educational opportunities (Mina et al., 2023). Park et al., (2022) define “eating as a pedagogical act” (p. 14) meaning that food can be used as a tool for learning about food systems, understanding the political economy of food, and teaching food justice. The sun symbolizes the guiding principles that influence all aspects of the system and will guide my understanding of the food system, including community-engaged scholarship (Gaudry, 2015) and desire-based positionality, which avoid the placement of Indigenous communities in Western standards leading to a common view of communities being damaged (Tuck, 2009), as well as the theoretical framework outlined above that guides my arguments, analysis, and understanding.

Further, similar to local communities, flowers also show changes in development and expression as they grow and evolve in response to environmental factors. People and places play a significant role in shaping the needs of a community as well as the current structure of their food systems: “[f]or the local food network to flourish and to provide a real alternative, agrifood networks must build and rely upon social relations that are embedded in a particular place” (Christensen & O’Sullivan, 2015, p. 116). The framework must also allow for

different flowers and differently structured flowers, that grow in relation to the people and place it is nourishing and takes nutrients from. These complex interactions between peoples and their ecosystems may be difficult to quantify but are necessary for moving forward sustainably (Bennett et al., 2021).

The analysis of food systems must also consider the ways in which food is viewed in a community. Agribusiness financialization has led to food being seen as a means to make a profit rather than a tool to nourish body, mind and spirit, with the potential to connect individuals to their communities, nature, knowledge, and cultures (Clapp & Isakson, 2018). By understanding the petals of the flower, or, the values and beliefs held by community members concerning food, whether it is a tool for economic profit, food sovereignty, or general nourishment, steps can be taken to improve local food systems. The value of food may be changed, might fall as a seed, and eventually fall as rain to shape the system in a different way. The flower also always has the potential to grow. As recognized by Absolon, flowers are a useful symbol in Indigenous research methodologies, as they are living beings (2022). More petals can be added, more seeds can be dropped, and more roots and connections formed. Throughout this research, a few participants shared that if their organization were to someday shut down, the knowledge and empowerment they imparted upon the community would allow the project to continue and the community to still see benefits. In other words, if the flower were to die, it would continue to nourish the soil.

### **1.5 Research Aims and Objectives**

This research aimed to collect beliefs, values, and perceptions related to the operation, benefits, challenges, uses, and governance of hydroponic gardens to answer the following research questions:

- How are hydroponic units in Canada addressing food security and sovereignty, particularly in northern and Indigenous communities?

- How are hydroponic units impacting communities beyond access to food (i.e. sociocultural sustainability)?
- How do community members perceive and value i) local food systems & food more broadly ii) nature & sustainability, iii) current governance & operations of hydroponic unit(s) in the community?
- What barriers exist to hydroponic units receiving large-scale community support, and what factors support hydroponic units' success in Canada?

These questions aim to fill a gap in the current CEA literature on perceptions of CEA, which largely focus on consumer perceptions of the products grown, rather than the broader ways in which a CEA garden may impact a community (Gan et al., 2023). The perceptions sought through this research were those of community members who requested the implementation of a unit in their community, those who work(ed) for the company that develops hydroponic farms, as well as those who work(ed) in controlled environment farms. Some questions were also asked to speculate on the perceptions of the broader public to assess this as well. The semi-structured interview questions were developed from the research questions listed above. The methods used to assess these questions described here are detailed in Chapter 3, and the ways in which these questions were addressed through this research are discussed in Chapters 5-8.

The thesis is structured as follows: It has first outlined the research questions and the frameworks through which the research was created and analyzed. Following these explanations, previous work in the field will be discussed in the form of a systematic literature review, followed by a description of the methods and methodology utilized in this work. A discussion of the results of the research conducted will follow, including a discussion linked to the research questions posed in the following section, as well as

recommendations for future implementations of CEA, and food sovereignty projects. Lastly, limitations, recommendations for future work, and desired outcomes will conclude the thesis.



## Chapter 2 - Literature Review

In recent years, there has been increasing interest in and publications on indoor farming, and controlled agricultural methods (Gan et al., 2023; Mina et al., 2023). However, the publications in this domain have focussed primarily on biological aspects and technical functions of the system (Mina et al., 2023; Vatistas et al., 2022). There exist a few articles that do analyze the applications of CEA in cross-cultural settings, but they leave much of the reasoning behind the impacts up to speculation (Ares et al., 2021; Jaeger et al., 2023). As a result of the lack of research concerning the social and cultural impacts of CEA, the following research question was developed: How does the literature define sociocultural transformations associated with the adoption of controlled environment agriculture practices?

We recognized that due to the novel nature of this topic, a more in-depth analysis of the current literature as compared to what is typically presented in a master's thesis was required. Therefore, this chapter presents a systematic review of empirical research published on the social and cultural implications of CEA globally.

### 2.1 Methods

Following the definition of the problem context, the first phase of assembling publications is the identification and acquisition of relevant literature (Mina et al., 2023). This step was done utilizing the following research terms identified as themes within the problem context (Bramer et al., 2018): “Controlled Environment Agriculture” OR “Hydroponic” AND “Food Security” OR “Perception” OR “Social” OR “Cultur\*” OR “Climate Change”, from the databases OMNI, Scopus, Web of Science, and Google Scholar. This search included the research inclusion and exclusion criteria identified in Figure 11. The following steps were the assessment of studies, evidence synthesis, and interpretation of findings (Khan et al., 2003).

The inclusion criteria stated that only studies offering empirical data were included, which is a common component of systematic literature reviews (Aromataris & Pearson, 2014;

Lasserson et al., 2023). This parameter was set because there is a growing body of review literature stating the perceived benefits of CEA, which are either theory-based, cite almost exclusively other articles published by the authors, cite primarily grey literature and news sources, or cite the same few empirical research studies. 41 articles were identified and did just that, and although they fit within the research inclusion criteria, they were opinion pieces, lacked empirical research, or review articles utilized that did not produce new data sets. This assessment to ensure quality and inclusion criteria of studies was done through abstract reviews (Mota et al., 2021). After the elimination of non-empirical studies, 27 articles were found to fit the inclusion criteria and present empirical research. The social, cultural, economic, and political sustainability impacts and implications of CEA are the primary focus of this review. Therefore, articles related to the four pillars of sustainability, as described in Table 1, were included here. Additionally, because environmental sustainability tends to be the only pillar considered in CEA research, articles that reviewed environmental sustainability without the consideration of any of the other pillars were also excluded (Gan et al., 2023; Mina et al., 2023). This left topics such as socio-environmental impacts and connection to nature to be included within the planet pillar.

*Table 1: Pillars of Sustainability*

<b>Sustainability Pillar</b>	<b>Definition</b>	<b>Source</b>
People	Encompasses identities, relationships, and social values	(Gan et al., 2022; James, 2015)
Profit	Discusses economic viability and development, and the impact economic growth may have on society	(Gan et al., 2022)

Planet	Generally understood following its original definition by the Brundtland Commission. This definition centres on the idea of environmental resiliency and longevity through appropriate human use	(Purvis et al., 2018; Gan et al., 2023).
Politics	Addresses the governmental actors and policies that shape the economic, environmental, and social spheres of sustainability	(El Mekaoui et al., 2020)

The focus of this review is the sociocultural impacts of CEA globally, however, the majority of articles published and reviewed here are from North America and Europe.



Figure 11: Literature review methods. Mitchell, 2024

Once identified, the Raul Pacheco Vega Conceptual Synthesis Excel Dump (CSED) method was utilized for the synthesis of evidence (Pacheco Vega, 2016). The CSED involves the use of Excel, a practical tool commonly used in the systematization of analysis (Mota et al., 2021), to identify, track, and manage study concepts, quotations, ideas, relation to other studies and topics, and citations (Pacheco Vega, 2016). These studies were then imported into

the NVivo software for thematic analysis (O'Neill et al., 2018). To do so, researchers first familiarized themselves with the data through the CSED, then identified important topics and texts and simplified them with a code (Nowell et al., 2017). Sections of text may be assigned multiple themes, or changes throughout the process, as coding is an iterative process (Cernasev & Axon, 2023; Nowell et al., 2017). Once all studies had been coded, the resulting codes were collated and placed into groups of common themes (Nowell et al., 2017). This review utilized the pillars of sustainability as the predetermined themes, as they are commonly used to categorize characteristics of socioeconomic systems (Purvis et al., 2018)

The identified themes were then placed into the pillars of sustainability for further analysis as deductive themes can provide rich and detailed insights (Nowell et al., 2017). Inductive and deductive coding was used as a hybrid approach can be beneficial (Creswell & Creswell, 2023; Delve & Limpaecher, 2023), as inductive analysis helps identify themes and concepts not previously considered by researchers, whereas deductive analysis facilitates comparisons between similar studies as well as the testing of previous theories (Delve & Limpaecher, 2023). The strengths of inductive coding; the analysis of data without restricting the findings to fit within preexisting frameworks or preconceptions are combined with the strengths of utilizing deductive themes which connect the data to the research questions (Braun & Clarke, 2006). Nvivo was also used to create frequency charts of the codes and themes created through qualitative analysis, which allows for the quantitative review of results (Dhakai, 2022; Sorensen, 2008).

## **2.2 Limitations**

This review article sources only articles available online with empirical evidence. Each of these filters may contribute to a publication bias (Haddaway et al., 2015). Other filters included articles published in English, which may have resulted in a bias for articles published in English-speaking nations. This review also analyzed solely peer-reviewed

sources. However, other sources such as books and government data can provide insightful information (Dsouza et al., 2023). Additionally, this review focused on CEA, whereas there exist other technologically reliant and innovative forms of agriculture that involve similar applications, the analysis of which would prove useful to move forward sustainably (Casey et al., 2022). Lastly, as identified by Gan et al. (2023), a limitation of research on social and cultural sustainability is the lack of a consistent scale used to measure such topics, making comparison and analysis difficult.

### 2.3 Results

The analysis of the 27 articles included within this review provided thought-provoking insights, nevertheless, even before exploring the subject matter, an overview of the types of publications and topics studied, geographic location, and timeframe reveal important indicators of sustainability contexts under CEAs. Figure 12 shows the number of articles referencing each subthemes noted. The subthemes in blue relate to the *People* pillar of sustainability. Orange is the *Planet* pillar, grey is *Politics*, and yellow is *Profit*. A significant portion of the articles reviewed utilized interviews to understand consumer perceptions and acceptance of CEA, which relied upon their prior awareness and education in relation to farming and innovative farming, or education provided to them through the research. As a result, two of the most commonly discussed subthemes, as shown in Figure 12, are *Perception & Meaning*, and *Education & Awareness*. The subtheme referenced in the most articles is *Environmental Sustainability*, with 18 of the 27 articles discussing the topic throughout the research. Previous reviews conducted in this field show that behind biological and technical aspects, environmental sustainability is the most commonly studied aspect (Dsouza et al., 2023; Mina et al., 2023). These findings align with this research which also

shows a focus on environmental sustainability. Because this review excluded research on biological and technical aspects, the environmental aspects came to the forefront.

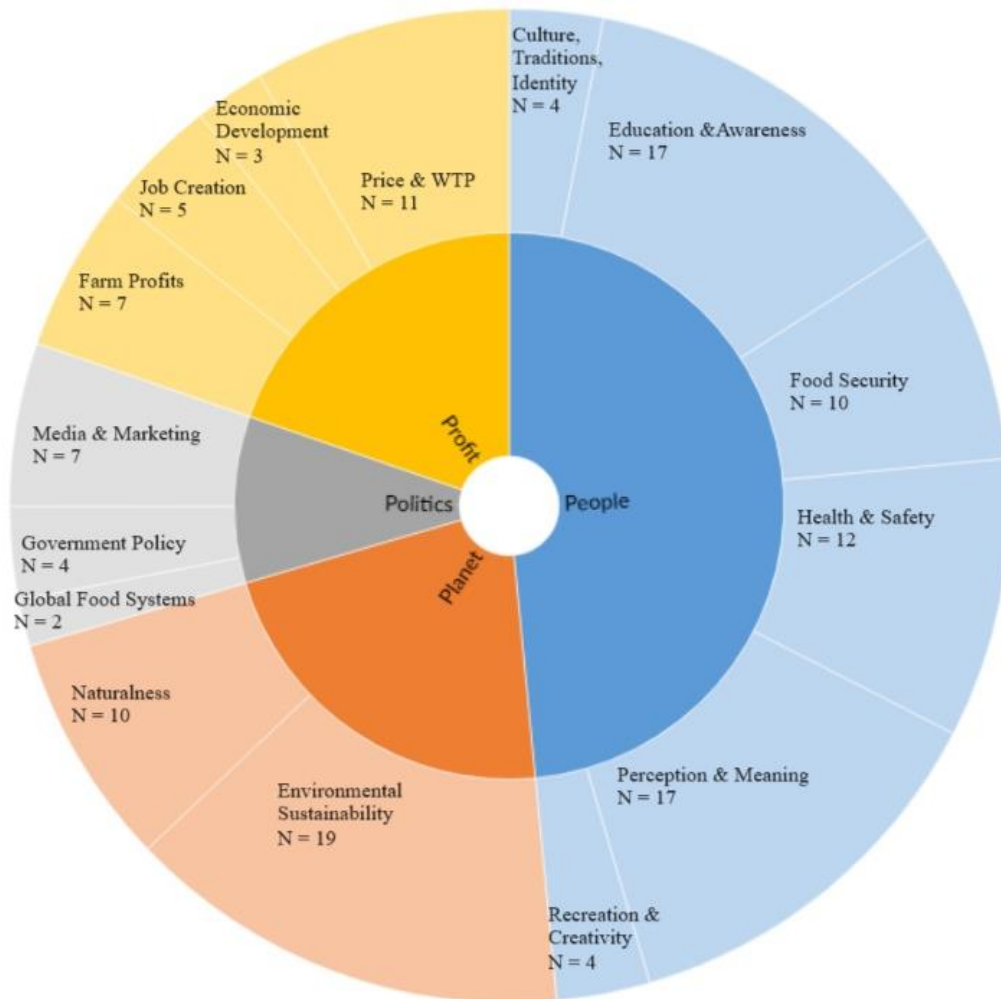
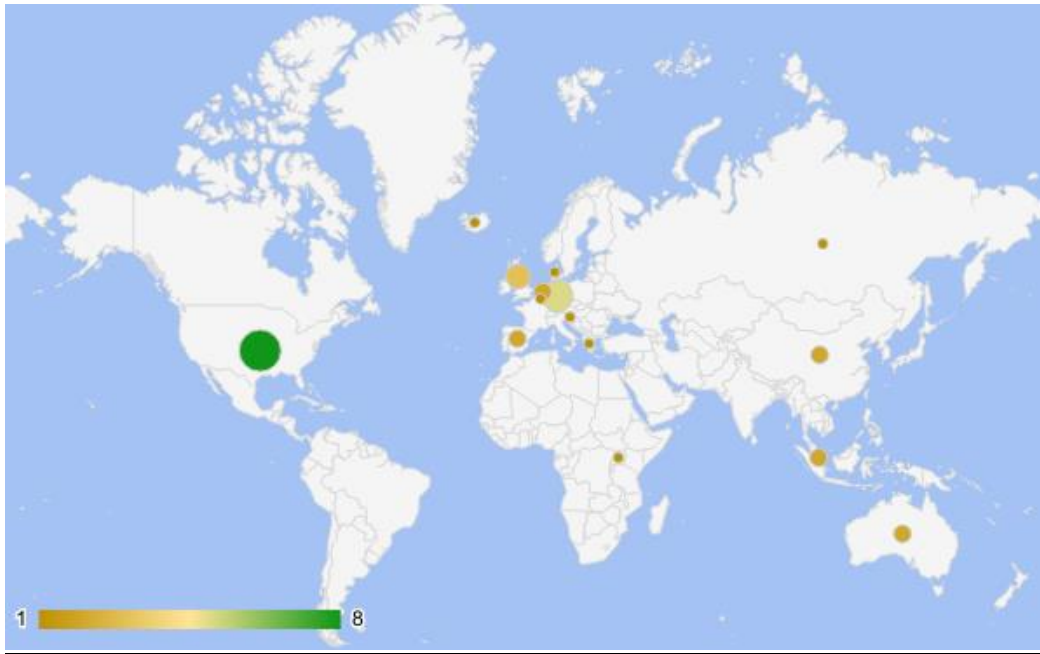


Figure 12: Number of articles discussing each sub-theme. Mitchell, 2024

In addition to the topics and themes prevalent in the research reviews, the location in which the research was conducted was also analyzed. Figure 13 shows a map of the research locations from the 27 articles that were reviewed.



*Figure 13: Map of publications research locations. Mitchell, 2024. (Note: some articles conducted research in more than one location, therefore  $N >$  number of articles reviewed)*

Most articles situated their research in the United States of America (US) (N=8). The next most common location is Germany (N=5) followed by the United Kingdom (UK) (N=3). Australia, Netherlands, China, Spain, and Singapore each had two studies conducted in that location. Belgium, Greece, Iceland, Slovenia, Russia, Uganda, Denmark, and Canada each had one study originating from that country. This map may indicate a bias of articles with study sites situated in Europe and the US because this review only evaluated articles published in English. Other research also concludes that the US and multiple European countries such as the UK, Netherlands and Germany are among the top locations where research is being conducted (Dsouza et al., 2023; Mina et al., 2023). These findings are significant because, as Dsouza et al. (2023) note, “empirical studies investigating the contributions and prospects of improving CEA's ability to address location-specific social and economic issues are imperative to understand the broader impact of CEA on people, livelihoods, economy, employment, and food security” (p. 10). It is essential that local food

systems take place-based needs and nuances into account to be effective (Moragues-Faus & Marsden, 2017).

Nonetheless, these topics may be further investigated in the future as interest in the topic is increasing, and the number of publications in the field is rising annually, as seen in Figure 14. Figure 14 shows an increasing focus on CEA in academic literature with empirical research on social sustainability starting in the year 2015. Mina et al. (2023) found that the first article discussing any social impacts of CEA was published only one year prior, in 2014, and that research has steadily and rapidly increased since then. Although research on biological and technical aspects of CEA have been analyzed prior to 2014, interest increased exponentially after 2010 (Dsouza et al., 2023). Public interest was also piqued in 2010 alongside the publication of the seminal book on vertical farming by Despommier (Benke & Tomkins, 2017). Additionally, Figure 14 shows a reduction in empirical research conducted in the year 2022, however, research by Mina et al. (2023) shows a peak in any articles published on the topic in 2022, which may be a result of the COVID-19 pandemic and the resulting increase in reviews, opinions pieces and editorials (Delardas & Giannos, 2022).

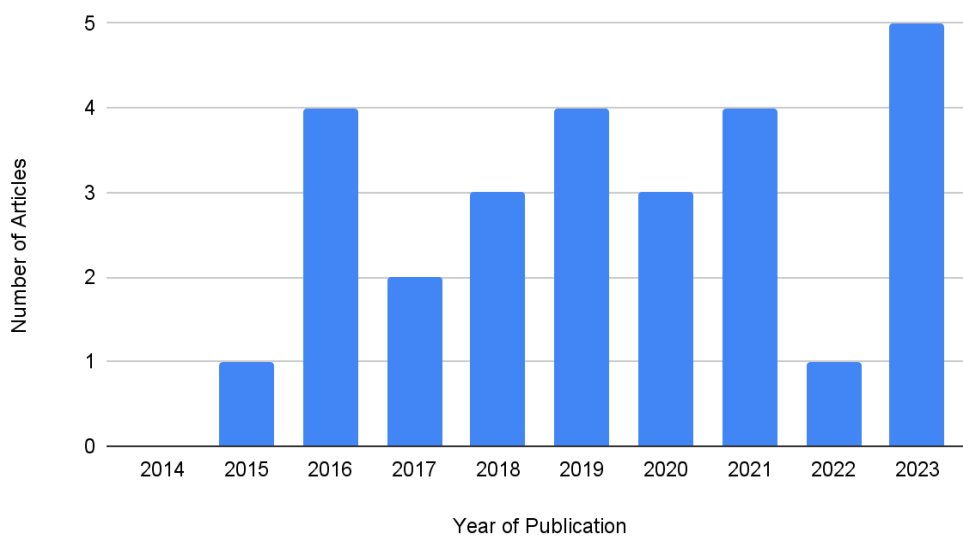


Figure 14: Graph of the number of articles published each year from 2014 – 2023. Mitchell, 2024



## 2.4 Discussion

Through thematic analysis, articles were categorized into the four pillars of sustainability based on the inductive codes generated throughout the review process. The codes categorized into each pillar are listed and defined in Table 2. This section will then discuss the findings within each pillar.

*Table 2: Definitions of codes within each theme area*

Theme	Codes	Definition	Exemplary Quote	N = Articles
People	Perception & Meaning	How people perceive, conceptualize and create meaning such as taste, food preferences, and worldviews	“When it comes to the acceptance of technology-based food innovations, specifically, Ronteltap et al. (2007) argue that distal factors (characteristics of the innovation, the consumer, and the social system in which they are embedded) influence the proximal factors (perceived costs and benefits, risks and uncertainties, social norms, and perceived behavioral control) that determine consumer intentions and decisions” (Broad et al., 2022, p. 420)	17
	Education & Awareness of CEA	Influence of awareness of CEA and education on support and opinions of CEA	“In the case of vertical farming, the public’s awareness and knowledge of the nutritional value of the food products could play an important role in their acceptance” (Perambalam et al., 2021, p. 11)	17
	Health & Safety	Health, quality, and safety of foods as well as the health of individuals	“The main concerns of consumers were related to food safety, heavy metal contamination, the use of organic practices in soilless production and the social impact of [rooftop agriculture]” (Ercilla-Monserrat et al., 2019, p. 387)	12
	Food Security	Physical and financial access to food and utilization of food	“Urban agriculture can contribute to food security in these impoverished areas by improving availability and access to nutritionally dense foods. In addition to traditional food production methods in urban areas, food crops produced hydroponically in controlled environments can result in food that is accessible and of high quality” (Currey et al., 2018, p. 543)	10
	Recreation & Leisure	Broader community impacts of food such as for recreation, leisure, of creativity	“Most of the respondents reported a preference for the uses of green and open space that allow for recreational and leisure activities. More generally, preferred uses of urban spaces involved those that integrate recreational functions while remaining open to the general public or surrounding neighborhood, as can be found in public parks and gardens or in agricultural production sites with events for members of the public (e.g., maize/labyrinth paths, educational trails, or demonstration plots)” (Specht et al., 2016, p. 6)	4
	Culture & Identity	Relationship between food, culture and identity, including	“This study concluded that the largest impact of climate change on the traditional food source has been the need for a change in the mechanisms (such as hunting and fishing) of how food is procured, which will ultimately lead to a	4

		relationships between how food is sourced and culture and identity.	change in cultural identity” (Kozachenko, 2020, p. 17)	
Profit	Price & Willingness to Pay	Cost of produce, willingness to pay (WTP), willingness to buy (WTB) and purchasing habits	“WTP for hydroponics increased significantly for groups informed about environmental, clean, or local benefits of hydroponic growing. This could be because consumer perceptions toward hydroponics actually improve after receiving information” (Gilmour, 2018, p. 37)	11
	Farm Profits & Costs	Start-up costs, costs incurred by CEA farms, CEA farm profits and stocks	“The high costs and expertise associated with [hydroponic farming] such as: green house construction, installation and usage of climate monitoring systems limits its enormous adoption among most African countries” (Gumisiriza et al., 2023, p. 2)	7
	Job Creation	Jobs created by CEA industry and job stability	“This suggests that while it is virtuous for Institutional Farms to teach CEA to youth, the likelihood of their finding high-paying jobs in the CEA industry in the NY-NJ Metropolitan region is debatable” (Goodman & Minner, 2019, p. 167)	5
	Economic Development	The improvement of a community’s tax, revenue, and job base	“Only very recently has [high-yield commercial-scale urban farming] been promoted as a means of generating economic value from otherwise unutilized urban space, like rooftops or decommissioned industrial or commercial sites, by turning them into productive spaces that can contribute to vitalize local economies” (Benis & Ferrao, 2018, p. 34)	3
Planet	Environmental Sustainability	Impact of traditional and CEA farming on the environment, including transportation	“Creating climate resilient pathways for a developed city such as Sydney may therefore require a multi-faceted approach to food production involving: decarbonisation and shortening of supply chains by retaining local commercial horticulture as a complement to regional production networks; implementing local, high technology production methods, where renewable energy sources and technological innovation can be optimally leveraged” (Rothwell et al., 2006, p. 228)	19
	Naturalness	Artificialness of produce grown utilizing CEA and of units themselves	“The concept of artificialness in the farming process remains unclear for consumers, which results in generally being sceptical and perceiving VF as “Frankenfoods”” (Perambalam et al., 2021, p. 6)	10
Politics	Media & Marketing	Food labelling, advertisements, media (news, social media etc.), and marketing in-store	“The media has paid considerable attention to this technology as a possible solution to the challenge of food security in Northern Canada. While media articles tend to highlight the opportunities afforded by CEA, further academic research is needed to determine the relationship between CEA and Northern food security” (Kozachenko, 2020, p. 20).	7
	Government Policy	Policy related to farming and food	“New York City’s elected officials have passed legislation to stimulate the use of public land and buildings for UA production generally, though not CEA specifically. These policy initiatives include Local Law 48, which helps the public find City-owned and leased (COLP) space to farm; Local Law 50, which encourages City agencies to purchase produce from New York State vendors; and the Zone Green Text Amendment, which relaxes zoning to allow for higher	4

			FAR for rooftop greenhouses” (Gooman & Minner, 2019, p. 170)	
	Global Food Systems	Distribution of food through global food systems and access to global foods	“Many of these tweets also used sensationalist language, appearing to promote a sense of uncertainty in global food systems. For example, among the five most frequently retweeted posts, vertical farming is variously described as: ‘the green solution to the growing global food crisis’” (Waller & Gugganig, 2012, p. 595)	2

### 2.4.1 People

Social sustainability, or the People pillar, is one of the less understood and more ambiguous categories (Boyer et al., 2016). Nonetheless, it is generally understood to encompass identities, relationships, and social values (Gan et al., 2022; James, 2015). In this review, the topics coded to this theme include Perception & Meaning, Education & Awareness, Health & Safety, Recreation & Leisure, Culture & Identity, and Food Security. These themes, as they were presented in the literature, will be discussed in depth throughout this paper. Many of the topics coded within this theme relied upon human recounts of personal perceptions.

The way that consumers perceive produce grown through CEA systems is influenced by a number of characteristics such as taste, quality, and freshness (Broad et al., 2022; Gilmuor, 2018), which impact purchasing habits, perceived utility, and therefore the successful adoption of CEA technology (Ercilla-Montserrat et al., 2019; Hoesterey et al., 2023). CEA is viewed positively across Europe (Ercilla-Montserrat et al., 2019; Jaeger et al., 2023), in the US (Coyle & Ellison et al., 2017; Perambalam et al., 2021), and particularly strong support is found in China and Singapore (Ares et al., 2021; Jaeger et al., 2023). Research shows conflicting evidence on the impact of gender, income, socioeconomic status and age on perceptions and support for CEA. Some studies find a positive influence of income on increased support for CEA (Ercilla-Montserrat et al., 2019; Yano et al., 2021), some find greater support from women (Balqiah et al., 2020), others conclude with greater support from men (Ares et al., 2021; Pfeiffer et al., 2021), whereas other research shows no

impact on support for CEA based on demographic information (Chen et al., 2020; Miličić et al., 2017). The research shows a tendency that consumers who value these goods, are those who typically value organic, local produce (Broad et al., 2022; Miličić et al., 2017).

Consumer support comes from a belief that units are environmentally friendly, utilize undesirable spaces (Specht et al., 2016), stabilize access to foods, provide fresher produce, create higher yields, and a greater diversity of foods (Ares et al., 2021; Broad et al., 2022; Ercilla-Montserrat et al., 2019). Research from Russia shows communities near agricultural lands show less positive perceptions of CEA (Yano et al., 2021). These perceptions of CEA are reliant upon some prior knowledge or education of what they are, their uses, and their benefits (Perambalam et al., 2021).

Public perception surveys found that participants who knew CEA before the surveys were conducted considered produce to be fresher (Ercilla-Montserrat et al., 2019), more sustainable (Jurkenbeck et al., 2019), or were indifferent to the growing method (Gilmour, 2018). However, most studies reported less than half of the participants had prior knowledge with numbers as low as 13%, and if consumers had some awareness, it was quite minimal (Gilmour, 2018; Jürkenbeck et al., 2019; Miličić et al., 2017; Perambalam et al., 2021; Pfeiffer et al., 2021). Education and increased awareness have been continually referenced as being essential to the adoption of CEA technology (Gilmour, 2018; Kozachenko, 2020; Miličić et al., 2017; Wilkinson et al., 2021), while also increasing viability through diversified revenue streams (Benis & Ferraro, 2018). Educating the public through CEA-grown produce is believed to also increase awareness of farming techniques, healthy foods, food insecurity issues and other local topics impacted by food (Broad et al., 2022; Currey et al., 2018; Goodman & Minner, 2019; Kozachenko, 2020). Ultimately increased awareness correlates to greater purchase intention (Balqiah et al., 2020; Wibowo et al., 2023). Pfeiffer et al. (2020) and Kozachenko (2020) recognize that educational materials must be tailored to the

local community's beliefs, values, and cultures in order to be appropriate and effective.

Increasing the use of these systems may also play a role in addressing food security

(Kozachenko, 2020).

Globally, local CEA initiatives are supported due to the beliefs that they provide improved, reliable, affordable, and year-round access to healthy foods and therefore promote food security (Ares et al., 2021; Cole & Ellison, 2017; Jaeger et al., 2023; Schmidt Riviera et al., 2023). Although the localization of agricultural production through CEA has the potential to improve physical access, as CEA can operate in areas not typically suitable for agriculture (Armanda et al., 2019; Gan et al., 2022; Rothwell et al., 2016; Schmidt Riviera et al., 2023; Wilkinson et al., 2021), some research questions the impacts on financial access for the public (Broad et al., 2022; Goodman & Minner, 2019) and nutrient density. The most efficient, economically feasible, and commonly grown products utilizing CEA are leafy greens and herbs which are often not calorically dense and may therefore play a minimal role in addressing food insecurity (Ares et al., 2021; Broad et al., 2022; Kozachenko, 2020). Additionally, although the availability of produce may be improved, it is often priced at a premium and therefore still inaccessible to those experiencing food insecurity (Broad et al., 2022; Goodman & Minner, 2019; Lubna et al., 2022). However, leafy greens may improve health outcomes and may still contribute to food security (Wilkinson et al., 2021).

The health of produce and consumers as well as the safety of CEA was a common concept, with 12 articles reviewed discussing the topic of health & safety related to food and its production. These are two main concerns related to produce grown utilizing CEA (Ercilla-Montserrat et al., 2019). Most found positive support for CEA as consumers believe produce to be healthy and safe to eat (Gilmour, 2018; Kozachenko, 2020; Wibowo et al., 2023; Yano et al., 2021), and particularly safer than field-grown produce (Coyle & Ellison, 2017). Health-conscious consumers showed greater support for CEA (Balqiah et al., 2020; Wibowo et al.,

2023). Consumers who are unfamiliar with the CEA techniques show some scepticism (Perambalam et al., 2021), with some believing that urban CEA products may be contaminated by pollutants (Specht et al., 2016). These results may show a need for further education on the technical aspects of the system and related safety. Education may also be addressed by increasing participation and therefore awareness through recreation and leisure activities.

Some urban CEA initiatives are being used as a locale for recreation activities, which can increase awareness, revenue, and viability of farms (Benis & Ferrão, 2018). Additionally, broader community benefits are important attractors for increased participation (Currey et al., 2018). However, farms occupying spaces that alternatively could be used primarily for recreation purposes receive lower support (Specht et al., 2016). Nonetheless, it is recognized that food is connected to many other aspects of life, which should be reflected in the food system and programs offered. These recreation activities may include educational trails and demonstration plots that would be open for public use (Specht et al., 2016).

Despite the understanding that farming and food are strongly related to cultural and social traditions and structures (Soini & Huttunen, 2018), only 3 articles reviewed discussed these relationships. Research from Ares et al. (2021) and Jaeger et al. (2023) found significant differences in perceptions and support for various aspects of CEA between countries, which they believe to be due to differences in values, worldviews, and histories. For example, countries with histories of famine may place a higher importance on local food cultivation, and countries with low information technology (IT) dependencies may be more sceptical of digital farming technologies (Ares et al., 2021). Kozachenko (2020) recognizes that although CEA technologies may be a vector for teaching the cultural importance of farming, foods grown in CEA units are not culturally relevant (Wilkinson et al., 2021), and

the units themselves may be seen as another mode of colonial oppression by Indigenous Peoples in Canada.

The article from Kozachenko (2020) is one of two articles to include a research focus on food sovereignty: the right for locals to contribute to the development of their food systems, and access to safe, healthy, sustainable, and culturally appropriate foods (Robin et al., 2023). Food systems that fail to consider the contextual, historical, and social underpinnings of food are less likely to succeed (Gan et al., 2023; Petrovics & Giezen, 2021). Such histories include the colonization of the Americas, which, through the introduction of industrialization and resulting habitat destruction and pollution reduced traditional hunting and gathering populations while also forcing cultural shifts away from traditional foods through cultural assimilation tied to colonization (Malli et al., 2023). Colonial agricultural practices were also used to force assimilation by prescribing European beliefs, practices, and ways of life (Hippert, 2018). Additionally, Watts & Scales (2015) argue that techno-centric approaches to agriculture can undermine and obfuscate local knowledge and practices while providing uneven benefits both socio-economically and spatially. Although hydroponics, vertical farming, and aquaponics have been proposed as ways to move closer toward food sovereignty (Blom et al., 2022; Sanyé-Mengual et al., 2016; Stecyk, 2020), CEA alone cannot address deeper-rooted issues that contribute to food insecurity (Kozachenko, 2020).

#### **2.4.2 Profit**

The profit pillar of sustainability discusses economic viability, and the impact economic growth may have on society (Gan et al., 2022). Within the context of this review, some emerging themes include topics of willingness to pay, farm profits, job creation, and local economic development.

Some studies find that the media tends to oversell the economic development benefits of CEA (Goodman & Minner, 2019; Kozachenko, 2020). Goodman & Minner (2019) state that the social and economic benefits that people believe will come from CEA are based on the success of non-controlled urban environment agriculture. However, these benefits have yet to be seen with CEA (Goodman & Minner, 2019). CEA farms' success relies on their ability to contribute to local economic development (Goodman & Minner, 2019). Urban agricultural systems that combine economic goals with social and ecological functions, such as community engagement or education, are believed to receive higher uptake (Gan et al., 2022), and lead to a more viable business model (Petrovics & Giezen, 2021). Following a social enterprise model that focuses on education, leisure activities, and health and well-being can broaden revenue streams and provide greater economic benefit (Specht et al., 2016; Wilkinson et al., 2021). In order for community economic development and food systems projects to be successful in reducing poverty through local empowerment, job creation and training, and improving quality of life, they must be governed by the community in a bottom-up fashion (Novek & Nichols, 2010). Ultimately, produce grown must be seen as useful, attractive, and appropriate for community members to express their support for the system and for them to express a willingness to purchase produce.

The cost, willingness to buy (WTB), and willingness to pay (WTP) for CEA-grown produce were the focus of the research in 11 articles reviewed. CEA-grown produce is typically priced at a premium (Broad et al., 2022; Goodman & Minner, 2019), which some producers justify because of the increased quality and freshness of the product (Benis & Ferrão, 2018). Though many consumers are not willing to pay a higher price (Ares et al., 2021; Coyle & Ellison, 2017; Gilmour, 2018; Wu & Kuo, 2016), some research found consumers were willing to pay higher than the market price for the same produce grown utilizing CEA (Ercilla-Montserrat et al., 2019; Miličić et al., 2017; Perambalam et al., 2021).



WTP is positively affected by perceived sustainability, lack of pesticides and herbicides, and local origins (Benis & Ferrão, 2018; Ercilla-Montserrat et al., 2019; Gilmour, 2018; Perambalam et al., 2021). The WTP and WTB of consumers are directly correlated to the profits of farms, and costs associated with production (Gilmour, 2018).

Many review articles theorize that the controlled nature of CEA systems will lead to reduced costs through stable yields and, therefore, profits (Oh & Lu, 2023), as well as fewer inputs such as fertilizer and pesticides (Gan et al., 2022). However, these theories were not discussed in the empirical research reviewed, rather the topic of farm profits and costs focused on high start-up costs associated with CEA (Al-Chalabi, 2015; Goodman & Minner, 2019; Kozachenko, 2020). Moreover, high energy demands also contribute to increased costs (Kozachenko, 2020). However, shorter supply chains are believed to reduce the costs of operations, ultimately increasing revenue (Benis & Ferrão, 2018; Gumisiriza et al., 2023).

Further, the CEA movement is driven largely by young, inexperienced farmers (Broad et al., 2022), which may lead to failing systems that operate at reduced profits or fail altogether (Stecyk, 2020). The technology used in CEA is unfamiliar to most and requires some expertise to operate, which may lead to increased costs to access the required skills, or loss of crops if the system is not maintained properly (Stecyk, 2020).

Job creation is a major claim of CEA discussed in multiple theory and review articles (Benke & Tomkins, 2017; Gan et al., 2023; Proksch, 2011) as well as the media (Kozachenko, 2020), however, this topic was analyzed in only 4 empirical research studies. Of these studies, 3 did not analyze the ability of CEA farms to provide stable jobs, rather only the perception that they might provide employment opportunities. Through this research, it was found that consumers react positively to the possibility of CEA to create local jobs (Jaeger et al., 2023; Kozachenko, 2020; Specht et al., 2016). However, research by Goodman

& Minner (2019) in New York shows that these farms create a limited number of jobs (2-3), and of the jobs created, many are entry-level positions that may pay only slightly more than minimum wage. They also theorized that many of these positions may someday be replaced by automation in order to reduce costs and inefficiencies (Goodman & Minner, 2019). However, these jobs are categorized within the green sector and are increasingly in demand particularly as awareness and interest in environmental sustainability grows (Goodman & Minner, 2019)

### **2.4.3 Planet**

Environmental sustainability tends to be the focus of conversations and research on sustainability (Boyer et al., 2016), and is generally understood following its original definition by the Brundtland Commission (Purvis et al., 2018). This definition centres on the idea of environmental resiliency and longevity through appropriate human use (Gan et al., 2023). In this review, the planet pillar encompasses the perceived environmental sustainability and naturalness (Perambalam et al., 2021) of CEA produce and operations.

The sustainability of operations compared to conventional agriculture is a major claim of CEA systems (Gan et al., 2022) and is mentioned in 19 articles, making it the most commonly cited topic throughout the articles reviewed. The common vertical format of CEA reduces the amount of land area needed for growth and increases productivity per acre when compared with conventional agriculture (Armanda et al., 2019; Goodman & Minner, 2019; Wilkinson et al., 2021). CEA operates in closed environments, which can reduce pollution, eutrophication, and soil pollution when compared to non-controlled settings (Armanda et al., 2019; Gan et al., 2022; Rothwell et al., 2016). The controlled growing conditions may also mean a reduced need for pesticides, fungicides, etc., which can be harmful to the environment (Ares et al., 2021; Gan et al., 2022). CEA can also often operate in spaces not previously

utilized, which provides a unique opportunity to optimize the use of city spaces (Armanda et al., 2019; Broad et al., 2022). CEA in urban areas reduces transportation emissions, as well as reduces emissions related to food storage and food loss during long-distance travel (Gan et al., 2022). Additionally, it is widely recognized that a shift to more plant-based diets would help to reduce global emissions from food production, and it is argued that CEA, especially when in urban areas, can play a role in facilitating and promoting this shift (Ares et al., 2021; Goodman & Minner, 2019). However, CEA critics argue that uncontrolled environmental agriculture (UEA) in urban areas can help to reduce heat islands, sequester carbon, mitigate storm-water runoff, and provide benefits for soil, wildlife, and pollinators, which cannot be said for foods grown in a controlled setting (Goodman & Minner, 2019; Sanyé-Mengual et al., 2016).

Energy consumption is responsible for the largest environmental impact in many CEA systems (Schmidt Riviera et al., 2023), and electricity use is often higher when compared with other growth methods (Goodman & Minner, 2019), but can be more efficient when it comes to soil and water use (Rothwell et al., 2016). CEA units that utilize unsustainable energy sources, such as those in northern Canada that lack sustainable energy infrastructure, are found to have a larger environmental footprint than UEA (Al-Chalabi, 2015; Rothwell et al., 2016; Wilkinson et al., 2021). CEA is reported to operate with the smallest footprint in areas where the system can take advantage of the climate, such as areas with warmer weather and longer periods of sun (Goodman & Minner, 2019). Additionally, some CEA units operate 24 hours a day, which would require significant energy use during the cold and dark periods of the day (Gan et al., 2022). Solar panels can be used in some cases, they may pose challenges in areas that do not have adequate hours of sunlight. Although the closed environment of the systems reduces the contamination of the outside environment, the discharge of untreated water from the system may induce eutrophication of waterways

(Rajesh Kumar & Cho, 2014). Armanda et al. (2019) critiques the lack of life cycle assessments of CEA systems, leading to an overestimation of the environmental benefits of CEA.

Analysis of perceptions of vertical farming held by consumers concludes that the perceived sustainability of operations is one of the main reasons for support and acceptance of the systems (Ares et al., 2021; Broad et al., 2022; Ercilla-Montserrat et al., 2019; Jaeger et al., 2023; Jürkenbeck et al., 2019; Perambalam et al., 2021; Specht et al., 2016). Further research has found that reduced carbon emissions of CEA are one of the most important influences on consumer support for vertical farming specifically (Ares et al., 2021). Despite this support for CEA, it is recognized that there is a significant disconnect between consumer beliefs and their purchasing habits, which McGirr (2021) calls a “dissonance between attitudes and actions” (p. 14). This phenomenon is often seen as consumers not participating in alternative food networks (AFN), despite expressing disdain for their current globalized agri-food system (McGirr & Batterbury, 2015). The environmental impact of food has been found to be one of the few issues that can shift consumer purchasing habits (Ares et al., 2021). However, it must be recognized that ‘sustainability’ is socially constructed and takes on different meanings for different cultures and consumers, therefore acceptance of CEA will differ in various social and cultural contexts (Jurkenbeck et al., 2019; Lubna et al., 2022). Some members of the public are also unaware that their consumption habits have environmental impacts, and they may therefore be less likely to participate in environmentally friendly food behaviours (Jurkenbeck et al., 2019). In addition, the perceived sustainability of operations and perceptions of the produce's connection to nature and the natural world were common topics.

Eight studies that were reviewed reported a significant number of consumers perceive CEA and its produce as unnatural, too artificial, or too technological (Al-Chalabi, 2015; Coyle & Ellison, 2017; Jaeger et al., 2023; Jürkenbeck et al., 2019; Miličić et al., 2017; Specht et al., 2016; Yano et al., 2021). However, in some cases, consumers still rated these products as safe and of high quality (Coyle & Ellison, 2017; Gilmour, 2018), and may still purchase the produce. Additionally, some consumers are for the promotion of CEA, despite its unnatural qualities, if agricultural land can be returned to nature (Ares et al., 2021). Research into the perception of CEA in Spain found that the public may view urban CEA projects as not real agriculture and as posing environmental risks while promoting gentrification (Sanyé-Mengual et al., 2016). These projects and the produce are viewed as being “detached from the land” (Sanyé-Mengual et al., 2016, p. 36). Similarly, consumer perceptions of vertical farming in the US show that such agricultural methods evoke less desirable images (Lubna et al., 2022) that revolve around ideas of being not natural (Coyle & Ellison, 2017). Gilmour (2018) argues that policymakers should consider, and stay up to date on public perceptions of CEA, as this plays a significant role in shaping demand.

#### **2.4.4 Politics**

Politics is a theme added by many researchers and practitioners to address the governmental actors and policies that shape the economic, environmental, and social spheres of sustainability (El Mekaoui et al., 2020). In this review, those influences were found to be media & marketing, government policy and global food systems. Research shows that media rhetoric differs greatly from the realities of CEA, as news sources claim CEA is a panacea for problems from food insecurity to agricultural contributions to climate change (Kozachenko, 2020). Social media and online marketing, respectively, are found to be the preferred marketing strategy for CEA by consumers (Wibowo et al., 2023). The most commonly shared statements related to CEA found on social media primarily originated from commercial

vertical farming (VF) operations, or stem from the book *The Vertical Farm* by Dr. Despommier, a seminal piece praising vertical farms (Waller & Gugganig, 2021). The opinions shared in this book, however, are not widely shared by the scientific community, who are sceptical of its claims (Goodman & Minner, 2019). Often the messages shared on social media either claimed VF to be a solution to vaguely defined problems or offered links to media sources as references (Waller & Gugganig, 2021). Research shows that consumers trust CEA stakeholders, and media and marketing messages should focus on providing truthful, concrete ways in which CEA solves problems (Broad, 2020; Hoesterey et al., 2023). A large portion of consumers are unable to identify CEA-grown produce in stores based on labelling (Perambalam et al., 2021), and express a desire for clearer labelling of such produce (Jaeger et al., 2023), as consumers generally mistrust current produce labelling (Broad et al., 2022). This mistrust may stem from fluctuating belief in global food systems or lack of regulation within the industry.

The rise in consumer demand for local food is prominent in the literature and discussed elsewhere in this paper in terms of increasing consumer support for local businesses, local job creation, and reduced environmental footprint. Two articles reviewed specifically addressed the wavering consumer trust in global food markets. One article analyzed multiple tweets that voiced support for CEA, as a means of diverting from the current global food system (Waller & Gugganig, 2021). Consumers have expressed their desire for CEA to operate outside of global markets, as the capitalist system tends to concentrate wealth in the hands of a few, while further marginalizing the environment as well as communities that are the most in need (Sanyé-Mengual et al., 2016). However, the increase in CEA systems that operate outside of the global market is reliant upon easier adoption at the local level.

Three articles reviewed discuss the regulatory constraints to the advancement of CEA technology. This includes local legislation limiting the use of artificial light during the evening hours (Benis & Ferrão, 2018), zoning laws restricting the use of residential buildings for agricultural purposes (Goodman & Minner, 2019; Sanyé-Mengual et al., 2016), as well as uncertainties related to agricultural tariffs (Schmidt Riviera et al., 2023). However, the inclusion of sustainable development within city policies and roadmaps, such as climate change mitigation and energy optimization, may support the implementation of urban CEA (Sanyé-Mengual et al., 2016).

## **2.5 Conclusion**

The information presented shows positive perceptions of CEA, and support based on the belief CEA holds the ability to address a wide variety of problems ranging from food security and food quality issues to climate change and the failures of the global food markets. The consumer perception surveys included here show a belief that operations can contribute to sustainability, however these surveys were largely done with university students and were conducted primarily in Europe and the United States of America, and most participants were unaware of CEA prior to their participation in the survey (See Ares et al., 2023; Broad et al., 2022; Coyle & Ellison, 2017; Jurkenbeck et al., 2019; Montserrat et al., 2019). This is to say that more research is needed with more diverse populations as CEA systems are being implemented in diverse areas worldwide (Wilkinson et al., 2021) and consumers are more likely to participate in the food system if they are meaningful and relevant to them (Moragues-Faus & Marsden, 2017).

Most articles included within this review recognize the lack of research analyzing consumer perceptions and acceptance of CEA (Gan et al., 2022), sociocultural sustainability of CEA (Kozachenko 2020; Schmidt Riviera et al., 2023; Stecyk 2020; Wilkinson et al.,

2022), socio-economic aspects (Dsouza et al., 2023) place-based nuance related to local food networks (Goodman & Minner, 2019; McGirr & Baterburry, 2015), and the perceptions of CEA in various cultural settings (Ares et al., 2021; Gan et al., 2022; Pfeiffer et al., 2020). In other words, most research into CEA considers only the environmental pillar of sustainability (Gan et al., 2022). These articles analyze the efficacy, productivity, and potential of the systems to feed a growing population in a world that is rapidly losing farmlands (see Broad, 2020; Benke et al., 2017; Despommier, 2011; Schmidt Riviera et al., 2023), and conclude with overwhelming support for CEA to address the deterioration of agricultural productivity in the wake of climate change.

This research aimed to understand what sociocultural transformations are associated with the adoption of controlled environment agriculture, as agriculture is strongly tied to social and cultural structure, function, and tradition (Soini & Huttunen, 2018). It is theorized therefore that the loss of traditional farming, and the rise of technologically reliant agriculture will have significant social and cultural impacts (Cowan et al., 2022; Watts & Scales, 2015; Petrovics & Giezen, 2021). What research has been done in this area shows that place-based histories must be considered, such as traditional reliance on agriculture (Yano et al., 2021), previous trust in technology (Ares et al., 2021), and histories of colonization tied to food production and procurement (Kozachenko, 2020).

Additionally, many articles conclude that CEA systems must be rooted in social enterprise models in order to truly provide the benefits they claim to (Goodman & Minner, 2019; Novek & Nichols, 2010; Wilkinson et al., 2021). Alkon (2013) argues that scholars and society must critically evaluate whether alternative food networks, such as local CEA systems, represent a transformation in food systems or simply another form of product differentiation and market expansion. Although many alternatives to agri-industrial food



systems claim to work towards the de-commodification of foods (Moragues-Faus & Marsden, 2017), they may inadvertently lead to the exclusion of lower-income consumers and create the potential for labour exploitation (Alkon, 2013). As further explained:

Scholars have exposed how in many cases these ‘ethical’ and ‘sustainable’ initiatives can conceal potential environmental impacts and reproduce social inequalities, and might also be fostering an infertile consumer politics by deepening individualist practices and reproducing neoliberal configurations that hinder social change.

(Moragues-Faus & Marsden, 2017, p. 277)

Food security experts are sceptical of the ability of CEA practices to address deeper-rooted causes of food insecurity and other social and environmental issues CEA claims to address (Kozachenko, 2020). Critics point out that although there are many perceived benefits of CEA, the high costs associated with its start-up and operation make it so the model would be most successful if operated by a private company, thereby making the education and social benefit pieces secondary and less impactful (Sanyé-Mengual et al., 2016).

Many of the studies in each theme presented conflicting evidence for the claims and benefits of CEA. However, it is agreed that increased education, awareness, and transparent marketing are necessary to increase positive perceptions of CEA. Because the CEA industry seems to be growing regardless of the need for more research into the holistic sustainability of operations, Gan et al. (2022) suggest that policymakers should proactively invest in resources and tools to smooth this agricultural transition.

There is a recognized lack of research into the ways different social and cultural settings use, and value CEA (Gan et al., 2022; Mina et al., 2023), and many of the articles reviewed here analyze solely perceptions rather than observed outcomes. As Gott et al. (2019) describe “hype prevails over demonstrated outcomes” (p. 393). As discussed, the

rhetoric surrounding the systems differs from demonstrated outcomes (Kozachenko, 2020), however, implementation continues (Wilkinson et al., 2021). Some researchers believe that vertical farming and CEA “tend to ‘reinvent the wheel’ unnecessarily” (Lubna et al., 2022, p. 8), and that we should rather focus on the root causes of the issues the public may be facing related to food production and procurement, such as poverty and unequal or inequitable distribution of foods (Skinner et al., 2013), rather than creating another capitalist project aimed at market expansion.

## Chapter 3 - Research Methods & Methodology

### 3.1 Positionality Statement

This research involved participants from across Canada, with various beliefs, cultures, and experiences. I am lucky to have learned from these people and recognize that my position and previous experiences will always shape the lens through which I understand and interpret this knowledge. By providing this positionality statement, I give the reader the grain of salt to take with this thesis. I identify as a settler with Indigenous ancestry and familial ties. Our traditions and cultural histories ground our ways of knowing, which in a way separates me from some of the knowledge shared through this process. This research will utilize an Indigenous studies lens, which involves the incorporation of equity, and holistic understandings, and recognizes diverse ways of knowing beyond simply what is taught in Western academic institutions (Absolon, 2022), to avoid harmful colonial research practices. Much of my insight and education has come from the lands within Treaty 1 territory, lands imbued with knowledge and cared for by Anishinaabeg, Cree, Oji-Cree, Dakota, Dene peoples, and the Red River Métis.

This research was conducted through the University of Waterloo, located on the traditional territory of the Neutral, Anishinaabeg, and Haudenosaunee peoples. The campus is situated on the Haldimand Tract, the land granted to the Six Nations that includes six miles on each side of the Grand River.

By acknowledging this, I hope to make clear my intentions to focus on amplifying the voices of Indigenous Peoples and those involved in this research, rather than speaking on their behalf.

I came to this work in 2021 when I worked on a hydroponic farm in a Northern Manitoba town on the shore of Hudson Bay with no roads in or out of town, where I became intimately familiar with the challenges of growing food in the north and feeding a diverse

population. This particular hydroponic farm was located in Churchill, Manitoba, a community that experiences high rates of food insecurity, poverty, and other challenges related to life in the north, particularly in a community comprised primarily of Indigenous Peoples who are still feeling the ongoing impacts of colonization. However, Churchill is also one of Lonely Planet's top places to visit on the globe and sees thousands of wealthy tourists flock to its shores annually. These tourists love to go to the single store in town and take photos of the extremely high grocery prices to show to their friends back home. Within this grocery store in town is also the liquor mart, where prices of alcohol are the same as down south since the price is regulated provincially by the government. When I would go to deliver our hydroponic greens to the grocery store, I would wonder to myself, if we can regulate the price of alcohol and make it affordable across the province regardless of urban, rural, or remote, why can't we do this for food? This is where my interest in the topic began.

### **3.2 Methodology**

The methodological approach delineates and justifies the research methods chosen, and how they are employed and interpreted (Kovach, 2019). This research employs tools and draws from assumptions that are common within Indigenous studies and community-engaged methodologies (Gaudry, 2015), knowledge co-production frameworks, and respectful research methods (Ban et al., 2018; Jernigan et al., 2023; Smith, 2021; Yua et al., 2022). These frameworks share a common focus on relationship building (Jernigan et al., 2023), trust and respect, and empowerment of participants to maintain an aspect of authority and autonomy within the research and the control of information (Smith, 2021; Yua et al., 2022). This work aimed to understand perceptions, beliefs, and values related to food and nature, and controlled environment agriculture more specifically, in diverse social and cultural settings in Canada. The frameworks mentioned above ensured that this research question was answered equitably, providing space for various ways of knowing and knowledge holders,

while being conducted ethically, and aiding in sovereignty efforts (Murdock, 2018; Yua et al., 2022).

Decolonial and community-engaged scholarship recognizes that many reconciliation efforts in North America undertaken by settlers operate within colonial confines to maintain and reproduce colonial power structures (Gaudry, 2015; Murdock, 2018; Smith, 2021). By employing these methods and methodologies, we hope to contribute to reconciliation and sovereignty efforts, rather than hindering them. Many of the elements of Indigenous research methodologies (IRM), community-engaged methodologies, and respectful research methods are also present in food sovereignty frameworks (Jernigan et al., 2023; Smith, 2021; Yua et al., 2022). Food sovereignty is a focus of this research and concentrates on the empowerment, and participation of locals in the creation of food systems and research (Garcia-Sempere et al., 2019). These tools for ensuring equitable, ethical, and respectful research will be the foundation for data collection and analysis and will be further explained and justified here.

The inclusion of Indigenous knowledge (IK) and methodologies in food security research puts the focus on relationships within the system (Behe, 2016). As Behe notes, “science is fantastic at eliminating variables to answer a question. IK is fantastic at using multiple variables to answer different questions. Because we need information for both questions to get a full picture” (2016, p. 7). Baker et al. support this theory that science has a tendency to break systems into their parts for analysis, providing an example in the case of land:

we render locations legible to the discourses of science—extracting information about the Latin names of species and their relative abundances—but at the same time, we obfuscate other ways of interpreting and using the land, and how it constitutes place for (especially) local people. (2019, p. 289)

By breaking down aspects of the system to understand the whole, as Baker and Behe explain, we obfuscate the relationships within the system, which are often important to its operation as a whole. Indigenous methodologies and focusing on the co-production of knowledge may force researchers to move away from the desire to translate other ways of knowing into scientific understanding or Western knowledge systems (Behe, 2016; Smith, 2021).

Partnerships with local communities through Growcer helped to bridge these knowledge systems and work towards the co-production of knowledge.

The co-production of knowledge is also a focus of respectful research methods that entails equal consideration for different knowledge productions and worldviews (Yua et al., 2022). Indigenous methodologies and respectful research frameworks prioritize the equity of knowledge, whereas Western science favours certain knowledge productions over others (Chaudhury & Colla, 2021), specifically seeing Indigenous knowledge as less than (Smith, 2021). The superiority of peoples and knowledge is inherently linked to colonialism and white supremacy, the foundations upon which Western science was built (Chaudhury & Colla, 2021; Smith, 2021). These characteristics are often unintentionally reproduced and reinforced by well-intentioned science (Liboiron, 2021). By recognizing assumptions that have developed from these colonial linkages, and actively working to decolonize research, scientists can work to dismantle the inequity that can be perpetuated through harmful research (Chaudhury & Colla, 2021; Liboiron, 2021; Smith, 2021). To avoid harmful productions of knowledge that favour those of Western science, the methods chosen in this research utilized tools common within knowledge coproduction frameworks: equity, intentionality, trust & respect, relationships, capacity, decolonization, sovereignty, empowerment, reciprocity, control of information, co-production of problem definitions, questions, and methods, as well as the sharing of results (Yua et al., 2022). The use of

interviews as the main method of data collection addresses many of these concepts, and many others will be implemented throughout research creation and analysis.

Principles from Indigenous research methodologies (IRMs) were included during the data analysis process as IRM's ensure the inclusion of different worldviews, and knowledge (Smith, 2021). Some of these IRM's include taking other ways of coming to know things that are typically outside of what academia considers as truth, to be valid, such as storytelling, and through relationships (Smith, 2021). CEA operates in various communities across Canada, many of which are in Indigenous communities, and many others are located in northern, rural, and urban spaces. Whether participants identified as Indigenous or not, or as living in an Indigenous community, the inclusion of IRM's was essential throughout the research. Not only are many principles within Indigenous studies and community-engaged methodologies useful in conducting respectful research with any person they are essential to ensure the perpetuation of harmful colonial research practices and perceptions are avoided. Further, it is important to consider how CEA projects in any community impact reconciliation and food sovereignty efforts, and Indigenous Peoples more broadly regardless of what type of community they are located in (Murdock, 2018; Wong et al., 2020).

Furthermore, Indigenous methodologies focus on place-based knowledge and often do not strive for the universality of data and findings that are a common component of colonial scientific methods (Held, 2019; Liboiron, 2021). Colonial views including those on education and research are critiqued for the ways in which concepts like nature and relationships are seen as universally experienced, understood, and taught (Liboiron, 2021). Colonial education and research methods aim to be independent of the place of practice as well as universally replicable (Held, 2019; Liboiron, 2021), understood by Indigenous researchers as therefore only partial truths as they are devoid of context (Coburn, 2013). This universality can give research as well as food security programs a type of rigidity and structure that Indigenous

studies methodologies try to avoid (Smith, 2021). Each interview conducted was analyzed in relation to others, as well as independently out of the recognition that food, relationships, and nature are not synonymously experienced. Many participants were firstly asked to describe their community, so further responses could be understood concerning this, rather than in relation to my understanding of their community, or without relation to place.

### **3.3 Methods**

Climate change, food insecurity, and Indigenous sovereignty and reconciliation, the nexus of issues for this research, all stem from wicked problems (Grochowska, 2014; Lazarus, 2008; Signal et al., 2013); issues that have no single root cause nor solution and are immensely complex and ever-changing (Signal et al., 2013). While quantitative approaches are useful for understanding a portion of this wicked puzzle, qualitative methods are essential for understanding the complexity of the issue in its entirety as such approaches can uncover tacit, local, experiential, and/or Indigenous knowledge (Sutherland et al., 2017).

This research is in the realm of empirical environmental social sciences (ESS), the scientific analysis of norms and regulations that shape human perceptions of the natural world through the evaluation of human behaviours (Cox, 2015). To collect and evaluate these behaviours, virtual semi-structured interviews were conducted as they are favourable when the understanding of complex behaviours is the goal of inquiry (Young et al., 2018). Interviews help to reveal perspectives, beliefs, and values not previously aware to the researcher/interviewer (Pessoa et al., 2019; Young et al., 2018). This qualitative method is useful in gathering context-specific understandings, individual experiences, place-based power relations, and social, cultural, and political influences that underpin actions and behaviours (Moon et al., 2016). Growcer staff were consulted through research creation as



they are familiar with their network and were able to ensure research would not only be relevant and useful, but also ethical and respectful.

### **3.3.1 Sampling**

A broad population was identified for interviews to increase the diversity of opinions gathered. The inclusion criteria were as follows: i) those who operate(d) a Growcer hydroponic unit, ii) those who are or were previously employed by Growcer, or iii) those who played a role in the approval/implementation of a Growcer hydroponic unit in their community. These broad inclusion criteria allowed for an increased sample size and helped to create a more holistic view of nuances in a community's specific food system by gathering values, objectives, and potential alternative solutions from various stakeholder groups (Sutherland et al., 2018).

Sampling methods involved purposive and snowball sampling. These sampling methods were chosen as they are useful in maximizing the number of participants from a small total population, while also aiming to maximize diversity (Emerson, 2015; Moser & Korstjens, 2018). At the time of project inception, one Growcer staff estimated the total of Growcer hydroponic units in Canada is roughly 50, with around half in operation (C. Basler, Personal Communications. October 26, 2022). As shown in Table 3, overall, 11 interviews were conducted, five with those who implemented units, four with Growcer employees and three with growers (note one participant fit into more than one category). The nine interviews conducted with those who lived in the community's utilizing hydroponics (implementers and farmers) lived in the following provinces: Alberta, British Columbia, Manitoba, Ontario, and Saskatchewan. Growcer is headquartered in Ottawa, however it was not specified where the three Growcer staff interviewed were from.

**Table 3:** *Number of interviews within each category*

<b>Implementers of Growcer units</b>	<b>Growers/farmers</b>	<b>Growcer staff</b>	<b>Total number of interviewees</b>
5	4	3	11

\*Note one participant fit into more than one population

Because the total population was limited, a remuneration of gift cards was offered to incentivize participation. Remuneration was set at \$30, a price point that provides fair payment, while not enough to lead to undue inducement (Newman et al., 2021).

All potential participants were identified and contacted by Growcer via email with a provided recruitment letter (see appendix). Contacting prospective participants through Growcer was identified as an ideal method, as all people contacted will have prior relationships built with Growcer, which may encourage their participation (Numans et al., 2019). Participants were reminded in recruitment and consent letters that they should not be persuaded to participate based on a belief that their relationship with Growcer may be impacted if they chose not to. They were also reminded that participation is voluntary and anonymous.

Those who did participate were asked to identify or forward the research information to others who may be beneficial to the research and who fit the inclusion criteria for participation. This method, snowball sampling, a non-random purposive sampling method (Cox, 2015), also allowed for researchers to contact participants who may not have been identified by Growcer, as they may have not been presently employed by the organization or had changed contact information. As described by Cox (2015), snowball sampling is useful as “[g]iven the importance of social networks, trust, and reputation in human interactions, this method is frequently the most, or only, feasible way to obtain access to many remote respondents” (p. 3). Within the context of this research, many hydroponic units operate in small and remote communities, which often are characterized by tight-knit social networks that are built upon trust and human connections.

### 3.3.2 Interviews

In the case of Growcer hydroponic units, it is integral to understand the specific values and beliefs of communities, as they differ when compared to those of Growcer Inc. This dissent is evident in the fact that many units are left unused and not adopted by the community although they are seen as ideal solutions to community needs by Growcer (C. Ellis, personal communications, November 2022). Semi-structured interviews allowed for the realization of issues and solutions not previously considered by Growcer inc., as the format allowed interviewees to guide the conversation to issues and ideas they felt were the most important (Pessoa et al., 2019; Young et al., 2018), while also ensuring that certain topics that the research needed to address were investigated (Cox, 2015). Interviews also allow for flexibility, can be less time-consuming for participants than other more intensive methods, and are an accurate method of collecting detailed information (Young et al., 2018). Interviews were conducted virtually, which might have reduced the stress interviewees felt as they were able to stay in a location familiar to them, however interaction between researcher and interviewee differs between face-to-face and virtual interviews and may have limited the rapport and relationship building (Newman et al., 2021). Bias can materialize if interview questions are not well-constructed, and thus limit participants within their responses, or elicit responses desired by the researcher (Young et al., 2018). To avoid this, questions were developed in consultation with Growcer and were piloted. This research additionally received clearance from the University of Waterloo Ethics Board (File #45151. See appendix for clearance certificate).

Semi-structured interviews were selected for this thesis research as they allowed participants with various beliefs and backgrounds to share their knowledge openly (McIntosh & Morse, 2015). The semi-structured format allowed participants to guide the conversation, so it focused on topics and information most important to them while freely expressing their

beliefs, opinions, and worldviews (Young et al., 2018). The inclusion and equal consideration for different beliefs, perceptions, and value systems supports research equity, as a safe place to share is being created (Yua et al., 2022). Collecting various beliefs, and perceptions of problems and solutions from diverse groups of people can also help to untangle the web that constitutes wicked problems, such as food security and sustainability (Grochowska, 2014; Lazarus, 2008; Signal et al., 2013). As Wong et al. recognized, “complex problems can benefit from multiple ways of knowing” (2020, p. 772). The sharing of oral stories, and relationship-building through one-on-one conversational interviews may also be a method that is more culturally appropriate in many small and/or Indigenous communities (Kovach, 2019).

Trust within semi-structured interviews is important (Yua et al., 2022), as it allows for deeper conversations between the participant and the interviewer, leading to richer insights (Kovach, 2019). To focus on relationship building, and the development of trust, a partnership with The Growcer Inc., (Growcer) was sought. Growcer was selected as the research partner as they were one of the first hydroponic and container gardening food solutions on the market, starting in 2015 ([thegrowcer.ca](http://thegrowcer.ca)). Growcer was developed in response to climate change and food security issues in northern Canada and has since expanded to 50+ locations from coast to coast, partnering with farmers, retailers, communities, schools, and nonprofits ([thegrowcer.ca](http://thegrowcer.ca)). The research problem, questions, and methods were also developed in collaboration with Growcer, drawing from their relationships with partners, to ensure data collected was useful for those operating CEA systems. Relationships and trust building take time (Yua et al., 2022), which is why building on the prior, long-standing relationships between Growcer Inc., and community partners was done to allow for deeper conversations which strengthened this research.

The interview questions were developed from the research questions, which broadly aim to understand the impacts and implications of hydroponics in Canada, their role in addressing food security and other community needs, and the barriers to doing so. Consequently, the questions aimed to extrapolate the values, beliefs, and perceptions of participants in order to answer these questions.

Interviews were roughly 30 minutes long, and designed to be so, as a longer time commitment has the potential to restrict participation and lead to biased sampling (Young et al., 2018), while too short of a discussion may not have allowed for a full

expression of opinions from participants. The semi-structured

format also allowed for the inclusion or exclusion of certain questions based on the time available to the participant, which was asked at the beginning of the interview. Participants were also reminded prior to the interview that they had the option to skip questions as needed, whether for sensitivity reasons or for time commitments. Interviews were conducted between August and October of 2023.

### 3.3.3 Analysis

The analysis utilized a mixed methods approach, inclusive of qualitative and quantitative methods. Qualitative methods, and interviews more specifically, allow for the



*Figure 15: Growcer Hydroponic unit in Churchill, MB. (Mitchell, 2021)*

inclusion of emotions and stories behind the data collected (Kovach, 2019). Local food systems are very place-based, and as recognized by Brugnach et al. “the social context in which the subject is embedded, or the communities of practice in which the actor takes part, shape the way in which a problem is understood and the meaning that is given to it” (Brugnach et al., 2008, p. 5). This quote exemplifies the importance of qualitative methods within food systems research, including this research, as interviews provide context and emotion to responses through their perspectives (McIntosh & Morse, 2015). The quantification of these qualitative results through frequency analysis is useful for the analysis of relationships between codes, as well as for the comparison of themes and codes (Sorensen, 2008).

For this research, interviews were audio recorded and auto transcribed using Otter.ai software, which was then reviewed using transcription software, Inqscribe, to ensure scripts were accurate and verbatim. Transcripts were then returned to participants which ensures the trustworthiness of the data (McGrath et al., 2019), as well as provides participants with some control over their information, an important aspect of respectful research (Yua et al., 2022).

Following transcription, words, sentences, and paragraphs were then coded and organized using the qualitative data analysis software, NVivo 14. Some text segments were assigned to multiple codes for analysis. Codes were then placed into predetermined themes as categories, with subthemes being generated through the analysis of transcripts (Dhakai, 2022). Some codes made use of topics commonly found through the literature review process (Saldana, 2016). The predetermined themes are the pillars of sustainability, as they are commonly used to categorize characteristics of socioeconomic systems (Purvis et al., 2018). Inductive and deductive coding was used for interview data, as a hybrid approach can be beneficial (Creswell & Creswell, 2023; Delve & Limpaecher, 2023). Inductive analysis is helpful in identifying themes and concepts not previously considered by researchers, whereas

deductive analysis facilitates comparisons between similar studies as well as the testing of previous theories (Delve & Limpaecher, 2023).

Following the coding stage and generation of themes, thematic analysis requires the reiteration and revision of codes to ensure validity and reliability (Cernasev & Axon, 2023). Assigning data codes to theme groups is an iterative process (Cernasev & Axon, 2023), as secondary themes emerge through analysis (Dhakai, 2022). Once all interviews were coded and themed, theme groups were analyzed in relation to other theme groups, research questions, as well as previous work in the field. Additionally, anomalies and answers inconsistent with themes also provided information for analyses. Nvivo has the ability to create frequency charts of the codes and themes created through qualitative analysis, which allows for the quantitative review of results (Dhakai, 2022; Sorensen, 2008). These frequencies were also compared to assess topics the interviewees felt were the most important, and least important topics. Quantitative analysis allows for the understanding of the frequency of behaviours, whereas qualitative methods allow for the understanding of the beliefs and values that are the motivation for that behaviour (Castleberry & Nolen, 2018).

The use of NVivo was also important as it helped to manage and analyze the large quantities of data resulting from interviews (Dhakai, 2022; Houghton et al., 2017), commonly cited disadvantages of interview methods (McGrath et al., 2019; Young et al., 2018). To additionally mitigate difficulties in analyzing large data sets, it is recommended that analysis is commenced prior to the completion of all interviews to allow small amounts of data to be processed at once (McGrath et al., 2019), which was done in this research. Analyzing interviews during the data collection phase also provides the advantage of connecting emerging themes with early thoughts formed during interviews, as they are top of mind (McGrath et al., 2019).

Throughout the analysis of interviews, an interpretivist approach was taken to support the recognition of different interpretations of the world that are held by different groups (McIntosh & Morse, 2015). This epistemology, common in qualitative analysis of the human world, embraces a social construction of reality, meaning that various realities are created from interpretations of cultural, contextual, and historical influences (Moon et al., 2016). Interpretivism was fitting for analysis as the different communities utilizing hydroponics have varying cultural and historical backgrounds, which influence their connections to food, as well as their acceptance of agricultural and technological advancements (Mina et al., 2023). Social constructions of nature play a role in what is perceived as a sustainable solution (Gan et al., 2023), and may play a role in the success of hydroponic systems. By recognizing that communities where interviews were conducted may experience the world differently than the researcher or Growcer employees, a better understanding of their reasons for supporting (or not) local CEA food systems will be attained.

### **3.4 Limitations**

Although three populations were interviewed through this research, opinions and perceptions from community members not tied to Growcer were limited. For example, interviewing someone in the community who played no role in the implementation of the unit, nor works in the unit, may prove insightful. Those who work for, in, or requested a Growcer unit were likely to have positive impressions of CEA, which may differ from those outside of this network. Additionally, sampling those who did not follow through with the purchasing of a Growcer unit or are no longer in operation may also provide valuable results. This research interviewed community members with units that were in operation at the time of research, which may be a limitation by providing generally more positive results.

Although the inclusion criteria were broad to increase sample size, it can also make the generalization of findings difficult, which some may consider a limitation (Young et al.,



2018). Despite the broad inclusion criteria, the sample was still quite small which limits the insight that can be taken from this research (Vasileiou et al., 2018). Although sample size may be considered adequate when saturation is reached, the sample size is also dependent on the type of research and the richness of the data (Malterud et al., 2016; Moser & Korstjens, 2018). In other words, sampling size must value quality over quantity, and the interviews provided here were deemed to be of high value based on their depth and breadth. Lastly, snowball sampling was also used to increase the study population but is also a limitation. Snowball sampling can identify like-minded participants, leading to biased results (Emerson, 2015), nonetheless is essential when small communities and tight-knit groups make up the population of inquiry (Cox, 2015).

## Chapter 4 - Results

Eleven interviews were conducted throughout this research: four with Growcer staff, five with community members who were involved in the project design and implementation, and three with community members who worked as farmers inside a Growcer unit (Note: total equals 12 rather than 11, as one individual fit into more than one category). These interviews revealed 21 sub-themes that fit into the four pillars of sustainability.

Of the four pillars of sustainability, the people category was the most discussed in interviews (N=193) and also revealed the most codes through analysis (N=9), as seen in Figure 16. The theme people revealed nine sub-themes, whereas each of the other themes revealed four. Politics was the least discussed theme, being referenced 33 times.

Figure 16 shows each of the four pillars with their sub-themes. Indicated inside each sub-theme is the number of times it is referenced through the interviews (R) as well as the number of interviews that refer to that sub-theme (I). The sub-theme with the most references was physical access to food (R=35), followed by Jobs (R=30), Geography (R=28), and Values (R=28). Sub-themes with the fewest references included Policy (R=4), Growcer Internal Operations (R=6), Media & Communication (R=9), and Financial Access to Food (R=9).

Within the total 11 interviews conducted, there was not a single sub-theme that was discussed in every one of the 11 interviews. Physical access to food, Geography, Health & Safety, and Community Development were each discussed in 10 out of 11 interviews. The topics discussed in the fewest interviews were Policy (I=3), Media & Communication (I=4), and Growcer Internal Operations (I=4). These results show that difficulties in physically accessing safe and healthy food stemming from a community's geographic location were the primary concerns of those interviewed.

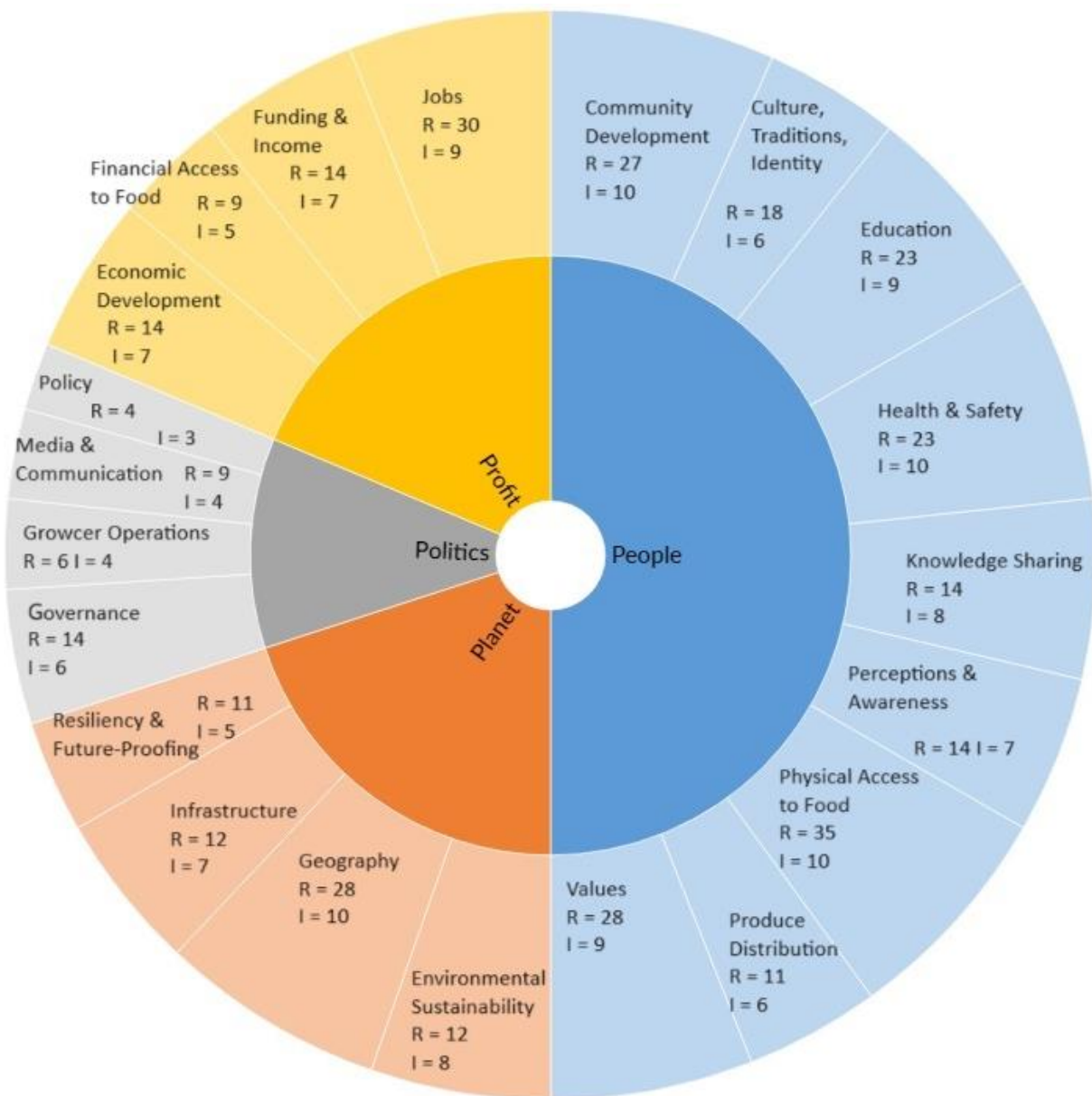


Figure 16: Number of interviews coded to each sub-theme

#### 4.1 People

(Note: the term community member is often used to refer to both those who work in Growcer farms, as well as those who were involved in the request and implementation of the unit).

The people theme/pillar touches on primarily social aspects of hydroponic units at their produce, such as perceptions, values, social benefits, and education related to the system.

Seven interviews directly discussed perceptions towards CEA, stating that the majority of people viewed CEA and its produce positively. Two participants mentioned they feel people are mostly indifferent to the growing methods so long as it can provide safe, healthy, affordable produce to their community. One community member mentioned that because leafy greens have been unavailable and inaccessible by their community for so long, many young people have not developed a palette for these healthy foods and perceive them negatively based on taste. Growcer staff believe that the technology is relatively new to the public, and it will simply take time and education before widescale adoption and normalization. Many managers of farms noted they are not concerned for the small population of people with negative perceptions, as they are often still accepting food donations, or eat at cafes using hydroponic produce, and are none the wiser.

Five of the interviews conducted touched on topics related to the distribution of the produce grown in Growcer hydroponic units. A few community members spoke of the challenges related to the food subscription model, and the benefits of being able to sell directly to a store or cafe thereby reducing efforts put towards distribution. A Growcer employee stated that marketing produce to a seller is quite separate from the gardening skills most employees have. As a result, some CEA units are producing fewer vegetables because they cannot distribute their stock. Another Growcer employee mentioned that distribution is significantly easier when the unit is located within a community of practice, where people understand the benefits. Participants from two communities mentioned that they donate left-over produce to elders or shelters, and although they recognized the need to be economically sustainable, they hoped to always be able to donate produce to those in need, as they see a large demand in their communities. In one of the communities where surplus is donated, members are still consuming the food regardless of the relevancy of the produce. As further explained an implementer of a hydroponic unit:

None of these things grew in this area before European colonization of BCs North coast. So there's that strange dichotomy that I'm always kind of struggling with. But really, what I judge is the most important factor is are people eating them or not? [...] So anything from like an elders meeting to a regalia-making workshop to a drum-making workshop, whatever it might be, we'll just donate all the fresh greens and say people can take them on their way out. There's nothing left over by the time the events done, it's all gone and the feedback is fantastic as far as quality

This participant continued by explaining that although leafy greens were not part of their traditional diet prior to colonization, food is inextricably linked to their culture, and they are able to share their hydroponic produce with their elders, which is a cultural practice. Three participants also touched on the notion that food is more than nutrition, but a mechanism that encourages sharing, gathering, and relationship building through community feasts, and family meals, and despite the new types of produce, this can again be facilitated.

This story again shows that although the method and the produce may differ from tradition, the core principles still offer some overlap.

Topics related to the culture, traditions, and identity of communities were discussed in six interviews. Although many participants acknowledged that the crops grown in CEA units are not culturally relevant to their community, nor are they foods that have been available previously and therefore many community members are not familiar with their taste or uses, a few respondents mentioned that these practices still played a small piece in reconnecting members to culture, identity, and traditions. For example, one participant noted that their community previously relied on hunting and gathering foods, and as a result, everyone knew where their food had come from, and who had foraged and prepared it. Now, many children were disconnected from their food stories and were unfamiliar with the process of growing, foraging, and preparing foods. Although the hydroponic unit itself is not a traditional growing

method, it helps children to connect again with the stories behind their food; of who is growing it, where it comes from and why it is important. One Growcer employee recounted a story he had been told by a Growcer user:

there's a chief of a First Nation in Central Manitoba who remembers his grandparents [...] farm and they had a garden and fed themselves completely from the food they produce themselves from harvesting and gardening and then, of course, hunting and fishing. And he said, you know, in the last three generations that has been completely lost. And this is a way for them to get back to those roots. No pun intended.

The sentiment of education, and connection to culture and traditions through food was shared



by many participants. Further, two Growcer staff raised the idea of integrating these foods within traditional diets creating a new fusion of Indigenous cuisine, and hydroponic greens. Figure 17 shows bok choy grown hydroponically in a Growcer unit, a vegetable many are unfamiliar with. One noted that the integration of these foods is facilitated by the increased prevalence of diabetes educators and nutritionists in communities.

*Figure 17: Bok choy grown hydroponically in a Growcer unit  
Source: Mitchell, 2021*

Three Growcer employees recognized that it is not their

place as an organization to tell people what to eat or to spearhead the research on traditional crops as a non-Indigenous company. The organization does support such work, such as through facilitating the creation of a school curriculum for hydroponics written by Canadian Indigenous leaders and is hopeful technological advancement in CEA will support a broader diversity of crops.

Two interviewees discussed the historical and continued impacts of colonization that have led to a reduction of some traditional skills and created a dependency on global food markets. One Growcer staff discussed this idea, stating:

the colonial experience for a lot of nations is a relationship of let's say, dependency that has been created for good or for bad, and a lot of communities are shifting their perspective on that and saying, like, you know, we want to get back to that time when we could feed ourselves, we could provide for ourselves, and we want that for ourselves. So, I think those, those are great, very powerful kind of objectives, that Growcer plays a small part in helping them achieve.

Having the ability to produce food was recognized as a step towards self-sufficiency and sovereignty, two recurring topics in interviews.

Self-sufficiency and sovereignty fit into the topic of the broader impact hydroponic units has, or interviewees hope will have on their community. Additionally, two Growcer staff and two community members discussed feelings of pride from the ability to produce food locally. Community development through the use of the CEA unit as a sort of educational hub was also discussed by multiple Growcer staff as well as community members. Growcer staff noted that hydroponic farms that do not have a sole purpose, whether that be to grow food, or to make money, rather they value broader community development, tend to reap more benefits. One staff remarked “we're always saying generally like the farm is

always secondary to the project. Like, this is just kind of, once again, a tool that is achieving a broader kind of objective or trying to achieve a broader goal”, another staff stated:

a lot of communities that understand that this is a component and we do have to build other sort of programs out around it and build capacity for the project to be successful, typically tend to see a lot more benefit than communities that are just sort of looking to get started in growing.

Community members discussed having garden boxes outside the unit, offering cooking classes, working with health practitioners and developing school curriculum, to facilitate broader community development.

The education of the public on topics related to CEA arose in nine interviews. One community had donated building materials to the local school for a greenhouse, to educate and connect students to food, as seen in Figure 18. Two of the people interviewed operate units attached in some way to the school in their community and felt it was providing stu



*Figure 18: Construction of a greenhouse donated by the operators of the local hydroponic unit. Source: Mitchell, 2021*



dents with knowledge related to sustainability, healthy food, and agriculture, as well as providing skills for a broad diversity of jobs not previously considered by students. A few people pointed to the benefits of teachings related to healthy food at young ages, as this may shape values for health and wellbeing, ultimately supporting healthier diets. As one community member shared:

we've seen this in, in practice that when students grow their own food, they're going to eat it and heard lots of parents say, you know, my kid never ate vegetables before this, and they're happy to eat these vegetables because they were part of growing it with their class.

Many communities were extending their education outreach beyond the classroom and educating people when they came into their store, having booths at local events, or simply starting conversations with others in their community. Every community member and CEA farmer interviewed supported the educational aspect facilitated by their unit but identified the difficulty of getting people inside the farm as being a barrier: "I'd love to do more tours in there. But it's just not possible with contamination" or, as an implementer shared:

I think the biggest bummer is the fact that you can't bring a lot of people into them to show it off, like you can, but you're gonna risk your crops at that point. So, from the outside, it's just a box. And there's not a lot that you can do to like get people engaged is not the same as a walk-around garden. You can't have people come and weed every week or volunteer, you know, you kind of need to keep it clean and, you know, so that's like, that's like the bummer about hydroponics is it's not that engaging, you have to keep it clean and controlled.

One interviewee felt as though if they were able to provide tours of the unit, they would have busloads of people lined up to see inside. Others felt that just having the unit would spark conversations in town, leading to increased awareness and education.

Education related to food and hydroponics was noted as essential not only for community members but for others outside of the community as well. Eight of the participants interviewed spoke to the importance of knowledge sharing, five of which were community members who had either already spoken with other communities wanting to implement similar systems or expressed willingness to help others. Although three Growcer staff stated that they do facilitate these connections between communities and that they are quite powerful, one staff noted that something is still missing.

So there is a community of practitioners of economic development officers and they get together once a year and they share. Here's how we opened an industrial park and how we thought about this and that like they have certifications and they upgrade their skills. [...] That sort of community of practice doesn't exist in Canada yet [...]. So kind of letting people connect and creating a group of people who all run in Growcer Farms and they can exchange skills and so I think that is one of the barriers to true full-scale adoption because then Growcer is no longer the main holder of knowledge the knowledge gets shared between people directly which is even more powerful. It creates like a snowball effect, helps people develop skills on their own we become no longer a critical part of and we're no longer needed. Like I would want to see in the future like, if Growcer were to disappear, everything keeps going. And that's kind of the intent.

This sentiment of a lack of a community of practice was shared by community members and farmers who were interviewed. A number of operators recognized that each CEA unit faces its own unique challenges stemming from the variants in communities in which they operate and that it would be helpful to have some sort of open forum between operators, such as discussed by the Growcer employee.

Although there exist variations in the communities that operate CEA units, many share the same root goals and values. One of the interview questions asked participants to discuss what they felt people in their community valued, and if these values impacted the adoption of CEA technology. Some of the values mentioned are food, nature, relationships, communication, education, equality, culture, and self-reliance. When asked if their community values nature, many noted public support for local initiatives such as nature walks and community clean-ups, with many noting the popularity of hunting and fishing locally which often correlates to values for nature. Two people noted that although they feel their community values align with the goals of CEA systems, they are seeing a rise in big-box stores and fast-food chains that don't share these values. Three interviews discussed their versions of success, which often related to what is valued in that location, and if the hydroponic unit can support those values that are present. For example, one community member noted:

they value their connections, so they value being able to make those connections and maintain those connections in healthy ways, whether that be with family or friends or even classrooms" further noting " I think they support anything that we're doing like, again, like I said, anything related to bringing healthy food into the community or anything related to bringing people together, the whole community is willing to support.

Most communities valued the health and safety of people and of produce, as this was one of the most recurring themes, arising in 10 interviews. This topic was commonly referenced as the motivation factor for the implementation of a Growcer unit in a community; better access to safe, healthy, and higher-quality produce than what is presently available. Because this produce is grown locally, there is a high likelihood that consumers know the farmer, and know how it's produced, easing safety concerns. Two people went on to further express

distrust in the global food markets, and their ability to provide what they called ‘clean food’. Additionally, being able to access foods almost immediately after harvest and creating foods with higher nutritional value were referenced as extremely valuable.

Three interviews touched on the need for more support to facilitate a transition to healthier diets. For example, one interviewee noted that although healthy produce is now available, there are no doctors or nutritionists in that community to change people's relationship with food. One interviewee shared that there are these health practitioners present in their community and they are seeing positive changes in diets as a result. Growcer employees speculated that improved access to healthy food through local CEA projects may lead to reductions in health-related diseases but noted that no empirical evidence currently exists to prove this theory.

Improving physical access to fresh and healthy foods, according to Growcer staff, is one of the main motivations for the implementation of Growcer hydroponic units in most cases. This was discussed in 10 interviews, mostly in a positive light. When asked to elaborate on motivations for the unit, one participant noted “I think it's really just getting food into the community and importantly, in our climate area, like our growing season is so short so Growcer was such an incredible solution for us to be able to grow things year-round”. Many interviewees connected their rural geography to a lack of fresh produce, pointing to Growcer as a way to increase physical access to such produce.

However, participants from two communities recognized that although fresh produce is available, people are still choosing other alternatives. One responded, “the grocery store is only, you know, 10-minute drive away [...] so it's a matter of choice. It's not, you know, so the availability is there. It's a matter of choice”. This participant acknowledged that although there is other produce physically available, it often wasn't local, of high quality, or financially accessible.

## 4.2 Profit

The profit pillar of sustainability, also referred to as the economics pillar, encapsulates issues and discussions related to money, or the lack thereof. This includes finances related to the purchasing and operating of CEA units, income, and price of foods.

Two interviewees cited the introduction of their hydroponic unit as reducing the financial barriers to healthy produce in their community, however, others noted that although physical access may be improved, financial access does not always ensue. For example, one Growcer user noted “generally speaking, even if you're cost competitive with the grocery store a lot of people who are struggling financially aren't even buying fresh greens from the grocery store. They're buying cheaper pre-made, pre-packaged foods”. This sentiment was echoed by another participant, stating that budget also influences what stores people shop at, some of which might not carry the hydroponic produce. Despite this, a few others interviewed stated that although the cost of locally grown CEA produce may be similar to alternatives, it is of better quality, and will likely last longer ultimately providing a better value for the cost. Some felt that people would also be willing to pay for hydroponic produce as it is grown locally and supports community initiatives and economic development.

However, the topic of economic development for the towns in which hydroponic units are located, emerged primarily from conversations with Growcer employees, rather than from community members themselves. These staff members discussed the creation of local businesses, diversification of local businesses, and revenues from units being used to support other community initiatives. Although increasing economic development was cited as a motivating factor for two Growcer users, they did not elaborate on the benefits seen following implementation. Another topic cited concerning economic development that was discussed more commonly was the creation of local jobs.

Themes such as job creation, diversification, staff retention, availability, and training arose in nine conversations. Firstly, Growcer staff shared that they offer specialized training and curricula to growers to support the success of their food program. One staff felt that when growers utilized this training service prior to receiving their CEA system it eliminated some confusion as to the capacity and operations of the unit. Training of staff was something Growcer staff felt confident in “I would say one thing that is a common thread across, I would say, the vast majority of projects is the skills and capacity building piece is, is definitely one of the ones we succeed at most often”. One community member identified that although the training was adequate, the time required to operate the system was greater than what they were initially told by Growcer, specifically because there are so many aspects of the job from harvesting to cleaning to distribution. Two participants associated this diversity of tasks with difficulties in succeeding in the role. One participant elaborated stating “if you are hiring someone just to operate it, well, that's one thing. But then who's going to do the ordering of the packages or the like finding places for the produce to go”. Other participants also recognized that often in small communities, which is primarily where CEA units are being incorporated, there are not a lot of people with the required expertise, are expensive, or they can experience burn-out from the workload as the only local expert. For example:

The hard part is that there is no one here with experience growing or education in growing. Which, for me, it's hard to hire and hire people. It's not like I can put a job out saying I need someone with a diploma in horticulture.

On the other hand, another grower voiced that although they did have a degree in horticulture, working indoors was not what they had envisioned doing. “I feel like a glorified janitor in a sense that I'm really what I'm doing is cleaning, cleaning, and cleaning, I'm mixing nutrients. And then I do a little bit of harvesting” continuing on to say:

when I got into horticulture, I'm just like I can't wait to just have a butterfly land on my shoulder, a dragonfly flying around and stuff right. [...] But to me I feel like I'm, in a like I'm in a lab coat. I'm in this little container, and I feel like I'm at a hospital. So, it's not like farming like you think right like, you know, with all your you know, your gloves on, your gown on.

Despite some criticism, others felt that providing training through school might open doors for students in their communities by allowing them to think of other jobs not previously considered and provide them with job opportunities locally, rather than having young talent move away. A Growcer staff member pointed out that these jobs are also safe, minimal stress, and may be suitable for people with other life commitments, elaborating:

there aren't that many of these kinds of business opportunities where this is especially suitable for say a single mom who can't work like at the mine, and fly in fly out because they have a family to take care of or a person who's nearing retirement who wants to have that job that they can do more easily. They can't do manual labour anymore, and so this is like a perfect job.

The prospect of job creation is often a factor that piques the interest of communities considering CEA projects, according to Growcer staff, although following through to the implementation stage can often be difficult.

This high cost of implementation was discussed in multiple interviews, with one Growcer staff stating: “I think one of the biggest barriers is just access to capital to deploy these projects”. Almost all of the participants interviewed who operate Growcer units recognized this and elaborated by stating that had they not been able to cover these costs through the help of grants, their units would not be in operation today. A few shared: “a lot of people do what I did, which was getting grants or funding through other organizations” and

another “grants are huge for us” or “if we didn't get funding for it, it wouldn't be happening”.

One participant located in a community reliant on the shipment of foods via rail line shared:

I think that they had already been looking at [Growcer] because of the cafeteria and the shipping costs of the food already, even before like the rail line was lost. But then, of course, this big bundle of federal funding became available to address the rail line washout, so that was a way for them to sort of expedite the process.

Although grants are essential to the operation of CEA in small, northern, and remote communities, its finding grants and accessing grants is another skill on its own.

Two participants noted that guidance with accessing grants and grant writing would be helpful. Two others recognized that although they received grants for the start-up their units are relatively new, and they will need to ensure financial stability and sustainability to stay in operation.

### **4.3 Planet**

The remote nature of many communities is often one of the main reasons a local food system is desired and difficult to access through traditional agricultural methods. Geography and infrastructure are linked as northern and rural communities often experience additional challenges in accessing food as a result of their remote nature. One user remarked:

Challenges are our location. We're remote, at the end of the road, like, so like any kind of like even just getting the Growcer unit here with a challenge. Getting fresh fruit here is a challenge, and getting human capacity here is a challenge.

Another shared the same sentiment stating:

we're at the end of the line of the highway, like the very the terminus of [the] highway. We're the last grocery stores on the whole chain. So, we're getting the worst



quality produce transported the farthest at the highest prices along the highway 16 corridor.

Most interviewed recognized that access to food and quality of food greatly varies when compared to southern cities, even if they were not greatly different, or even that far away.

Additionally, difficulties associated with temperatures and growing conditions in the North were also discussed by many. A few noted: “we're so cold here. It's hard to grow a tomato”, and “the growing season is so short and the daylights wonky and everything. So, lots of factors working against you”. Nonetheless, a few participants discussed that their geography forced them to consider nature, sustainability, and the quality of foods. One participant stated:

if you live in a place like [this] where food comes in only once a week, fresh stuff only comes in once a week, like it's something that people talk about and are aware of like, ‘oh, did you see the broccoli’ or whatever, you know like people definitely talk about food and value good quality fresh foods.

Others shared that being in northern or rural communities meant they were surrounded by nature, often spurring interest in the topic, and creating value for sustainability and sustainably farmed produce.

When Growcer employees were asked if they felt as though farm success rates varied based on geography, they all felt as though there was no correlation between location and success, rather various other factors contributed to farm success. One employee shared:

I think it's very community dependent. I feel like a bit more of the remote communities have infrastructure-related issues that might happen, or they might have

capacity issues because they just have a harder time hiring and retaining folks, but I think it ultimately comes down to the community.

This quote additionally highlights the link between geography and infrastructure, as well as the relationship between geography and food security.

The topic of infrastructure, whether that be Growcer infrastructure or the infrastructure of the community in which the unit was located, was discussed in 7 interviews. Of these conversations, many focused on the additional cost, time, and labour of site preparation for CEA units. Albeit this is something that Growcer staff also identified as being a difficulty for those who purchase units, recognizing that each location has unique needs in relation to their geography and site. Each location also has infrastructure barriers common to remote locations, such as water quality, and electricity access. One grower stated “the water quality is obviously a big deal, though, too right? So, like a lot of the towns like, if your water ain't good like, I've had to do more system flushes now because our yields were down”, another community member shared that because of the infrastructure in their town they had to be more cautious of how they disposed of water from the unit:

it was our environmental health officer, public health officer for the region. I was talking to him about it. And he goes, and I showed him the tech sheet and what's in the water and he goes, ‘yeah, that's all fine and good if you're putting it through like a drain in your house and it's going in a municipal system’ he goes ‘but that's going to degrade your septic tank in no time just because of the nutrients’ and I went okay, so we don't want to do that.

This participant continued to share that as a result the community developed a man-made wetland system to filter and absorb runoff from the system more naturally. This was done to

mitigate future impacts on their environment. This community was not the only to consider the current and future impacts of their hydroponic unit on the environment.

Resiliency and futureproofing were recurring in roughly half of the interviews conducted. Four participants identified specifically the COVID-19 pandemic, and related supply chain difficulties as motivations for the creation of a local food system. Growcer staff have noticed this shift:

I think a lot of communities too have seen with COVID they're last in line for food, right, they're at the very end of the supply chain, they're probably like, the fourth or fifth person that has, you know, handled the goods that they buy. And because of that, like when push comes to shove, and, you know, the food distributors make decisions on where they allocate the food that they have in a shortage situation, those communities often were cut off and didn't have much choice at all in the matter.

Others interviewed reference recent challenges related to recalls of lettuce, as well as climate change's impact on agriculture as benefits to having Growcer units. A grower shared that their customers appreciate the consistency of availability and pricing of local foods, stating “since the California wildfires season has really skyrocketed the cost of lettuce coming from California and the Lower Mainland” continuing to say:

So, we had a lot of people say, you know, I had the peace of mind to know, I know who's growing my food. I know I can come down every week and I know you guys are going to deliver the greens that you've promised me. Whereas if I'm going to the grocery store, I have no clue if I'm going to see anything on the shelves.

Whether it was the COVID-19 pandemic or wildfires, the increasing fragility of global food markets was front of mind for many interviewed. Although some touched vaguely on the impact of the changing climate, such as the increased prevalence of wildfires, on agricultural production, this was not discussed by many.

Environmental sustainability was not one of the most discussed themes, despite being one of the most prominent topics throughout the review of relevant literature. The sustainability aspect of this type of farming was not often a motivator for the implementation of a hydroponic unit. If those who implemented units did consider the environment, it was because their remote or northern location forced them to, or it was a much lower priority. When asked if sustainability was an important factor, one interviewee noted:

I think it's really just getting food into the community and importantly, in our climate area, like our growing season is so short so Growcer was such an incredible solution for us to be able to grow things year-round, right. So, I think it was less the environmentally friendly way to do it. And more this is the effective way to do like, where we where we are in Canada.

another said “I think we have uh some weird outages for power. We've had all of our pipes break, you can never drink our water pretty much so people are like, 'ok how can we be more sustainable' for sure”. Although environmental sustainability was a bit of an afterthought, most participants identified this aspect as resonating with customers, sharing that they believe it helps to support uptake as this is something that is valued in their community. One operator felt that although the cost of produce may still be high, consumers who value sustainability will still be willing to pay more for this product.

#### **4.4 Politics**

Government policy related to local food, agriculture, and sustainable initiatives was discussed in three interviews, one of which was an operator of a Growcer farm while the other two were from Growcer employees. The community member discussed difficulties with local governance stating, “we've got a, unfortunately like a local government that's not really I don't know [...] they're not really advocating for sustainability as much as they should be or

for, you know, promoting local locally driven business and things like that”. They referenced this as a challenge to shifting the mindsets of community members to value and purchase their hydroponic produce rather than supporting big-box stores. Growcer employees discussed the importance of local procurement policies as well as subsidies to ensure farms are economically viable. These policies would mandate grocery stores, senior centres, school meal programs, or other food initiatives to support local farms, including hydroponic farms:

instances where communities have found success is something that I've seen more in the last year or two is when leadership really lean in is local procurement mandates. So same idea, but at an institutional level, where as part of the purchase of this project, the Chief and Council say, ‘From now on, if we sell the same product, you must buy our product first, before you can buy anybody else's product from outside the nation’.

Other policy conversations came from a Growcer employee and revolved around zoning laws and building codes that limit or prohibit the use of urban spaces for agriculture, as well as problems with the inclusion of innovative urban agriculture in tax incentives:

The tax code, to some extent, prevents investment from flowing into these in a lot of ways. Because it's not considered real estate. And it's considered farming. [...] But in this case, we're not on agricultural land so we don't get the tax benefits of agricultural land. We also don't get the tax benefits of being considered equipment and machinery.

Continuing to state that redefining these codes could significantly benefit the uptake of CEA.

Lastly, as I have discussed in the infrastructure and geography sections, remote communities experience additional challenges related to these two aspects. In First Nations communities, these challenges are magnified, as elaborated by an employee:

in an Indigenous context, there's a massive infrastructure gap [...] we've had a government that's made commitments on making investments in infrastructure and holding them to those commitments, like executing on those commitments. It's a different story, right? And so the dollars are available, getting those dollars, put to work is actually the harder part often. And so, deploying capital at scale, I would say, in an Indigenous context is the gap that remains to kind of see these units for these units, or any sort of agricultural infrastructure proliferate on reserve and in small communities across the country.

As this participant stated, government commitments to increase equity in food security, and infrastructure are unfounded in some cases. Increased education and awareness of the issue, and solutions were referenced as helping to push government and policy action.

Education and awareness were also discussed by multiple participants who spoke on the importance of getting the word out about what they are trying to achieve and to help sell produce. One operator stated:

any community that you would want to drop a hydroponics unit into, you're changing people's relationship with just how they get their food unless you're selling it in the grocery stores yourself. So, how to change those hearts and minds? I mean, the best thing that we've been able to do, it's just to tell the story.

This individual continued to say “the death of local and regional media sources, the consolidation of communications has proven to be a really big challenge. [...] So for us, we find the best bang for our buck is going on Facebook”. Another participant recognized the importance of word-of-mouth in building trust for a new initiative by stating:

Most First Nation communities, very, very, very, very close-knit right? So, if Auntie Glenna, for example, got that, you know, picked that up at the garden stand, and she made this, and then she tells her 5 kids, or they have it. You know it. Just spreads like wildfire right. Which is great.

Word of mouth through online accounts such as Facebook was recognized by two other individuals as being quite impactful to the movement.

Although media outlets such as news sources were referenced in this research once as creating positive awareness for a farm, one staff member stated that there is often some confusion as to the abilities of CEA units, and this may be attributed to media outlets.

It's not going to be the silver bullet. And I think that's just human nature, as we always do. Things are always kind of binary, black and white, right? You always want something you always want to simplify the story. And maybe part of that is the journalists who try to you know, simplify things, and say things in the simplest way possible to tell a more compelling story.

Although media can be a challenge in some cases, and a benefit in others, it was widely recognized that it is necessary to have a leader to direct these campaigns, spread the word, generate excitement and awareness around the CEA unit, and oversee the project.

Most interviewees recognized that in order for projects to be successful, they needed to be spearheaded by what most referred to as champions. These champions were often described as community members acting as individuals or on behalf of a community development group, non-profit, or other organization. One Growcer staff remarked:

the operating champion, like the person running like the person that's gonna be kind of the face of the project or a group that will be the face of the project on a day-to-day

basis when the farm is implemented is 100 percent what makes a project successful or not.

When the topic of decision making, and governance of CEA units was discussed, it was often paired with the topic of community engagement. As noted by one Growcer staff member:

sometimes it feels like the leadership represent them well, then sometimes there's also like the perception that he or she is doing things with the project and then the community is left with what decisions were made without really any engagement. So, I will say what's really important is that the community is engaged, is aware of the project while the decision is happening. Before we can have final decisions made this way makes things like night and day in terms of implementation for us.

Community engagement, as noted by many participants, means ensuring the community is aware of the benefits of the project, its applications, as well as its limitations. One staff member noted that projects often fail when the community hasn't been adequately engaged and therefore have unrealistic expectations in terms of what the CEA unit can do.

One interview participant theorized there may be a potential disconnect between the Growcer sales team and the operations side, leading to some confusion about the operating systems. Aside from explanations of Growcer internal operations from employees themselves, four community members discussed this topic. Most of them shared that they appreciated the support provided by Growcer throughout the project design, implementation, and daily operations. However, one grower continued to say “they're on the emails but emails doesn't fix the tarp or doesn't fix the thing here. And if I can, you know, I felt like I'm handy enough to do that. But if people aren't confident enough to try and fix that, who are they going to get in to do that?” referring to frequent minor repairs their system required. Another appreciated this help but felt that speaking to others with first-hand experience would be beneficial, saying “with all due respect to the Growcer, what we found is that because there's



turnover with their customer support team, there's a lot of people that you're dealing with on the customer support side, that don't have experience firsthand in growing themselves". Aside from these few comments on ways they felt they could be better supported by Growcer, most spoke very highly of the aid and information they had received.

## **Chapter 5 - Canadian Food Security and Sovereignty Through Hydroponics**

The question of whether CEA, and hydroponic units more specifically, are addressing food security and or food sovereignty in Canada is multifaceted, as these are wicked issues. There exist multiple layers to food security and food sovereignty with nuanced root causes and potential solutions that may address pieces without full attainment of the goal (Grochowska, 2014; Lazarus, 2008; Signal et al., 2013). This chapter will discuss the role that interviewees felt hydroponics is playing in the attainment of food security and or food sovereignty.

Food insecurity is not only the inability to access safe, healthy, affordable, and diverse foods (Jernigan et al., 2012), but also being unable to live healthfully as a result of food, and being unsatisfied (Herrmann et al., 2021). Although food security is a piece of food sovereignty, it is not the whole puzzle (Herrmann et al., 2021). Food sovereignty can be viewed as a framework to reduce rates of food insecurity and create a more resilient food system through the implementation of projects and principles that support justice, equity, and sustainability (Blom et al., 2022). A food sovereignty approach requires a more holistic view and understanding of the local community and their needs for a healthy and fulfilling life (Blom et al., 2022). This also entails the decommodification and definancialisation of food in exchange for culturally appropriate systems that support the autonomy of local peoples and their empowerment (Feed Ontario).

Northern Canada experiences a reduction in food security as compared to the South, as a result of climate change, environmental dispossession and contamination, as well as remote and isolated locations leading to high food transportation costs (Leblanc-Laurendeau (2020). Hydroponics, vertical farming, and aquaponics have been proposed as ways to

improve access, and therefore food security, and a tool to move closer towards food sovereignty (Blom et al., 2022; Stecyk 2020; Wilkinson et al., 2021).

CEA is proposed for many Northern, remote, and Indigenous communities in Canada as a way to improve physical access to foods thereby reducing reliance on imported, often expensive and poor-quality goods (Blom et al., 2022; Stecyk, 2020; Steiner & Neathway, 2019; Wilkinson et al., 2021). It is generally agreed that local CEA systems do address the physical availability pillar of food security (Armanda et al., 2019; Gan et al., 2022; Rothwell et al., 2016; Schmidt Riviera et al., 2023; Wilkinson et al., 2021). However, physical access to food is only one of the three pillars of food security, with the other two being financial access, and utilization (Armanda et al., 2019). Although the localization of agricultural production in urban areas has the potential to improve physical access (Gan et al., 2022), some research questions the impacts on financial access for the public (Broad et al., 2022).

According to prior studies, CEA grown products are sold at a premium (Ares et al., 2021; Lubna et al., 2022) and are generally more expensive when compared to industrially grown goods (Broad et al., 2022; Goodman & Minner, 2019; Wilkinson et al., 2021). In addition, some research finds that consumers may have a lower willingness to pay (WTP) for CEA-grown produce, as they perceive a lower cost to produce it (Coyle & Ellison, 2017; Gan et al., 2022). WTP may also be lower for this produce as the greens are often not of high nutritional value (Goodman & Minner, 2019), nor calorically dense, and therefore play a minimal role in addressing food security (Ares et al., 2021; Broad et al., 2022; Kozachenko, 2020). Figure 19 shows the cultivation of kale in a Growcer hydroponic unit, one of the commonly grown crops, which is a healthy green but not calorically dense.

In contrast, a few interviewees noted that WTP for CEA is not part of the question, because consumers are indifferent to the production methods so long as they are receiving affordable and quality produce. Further, others noted that they felt WTP might be higher for

their CEA-grown produce as consumers may be more willing to financially support local businesses and initiatives compared to agrifood counterparts available in stores. It must also be noted that the prior research conducted in this field follows the assumption that consumers are offered multiple produce alternatives at the grocery store, with the option to choose



*Figure 19: Kale grown hydroponically in Growcer unit.  
Source: Mitchell, 2021*

states that CEA grown produce may contribute minimally to food security as leafy greens are of low nutritional value (Ares et al., 2021; Broad et al., 2022; Kozachenko, 2020), many participants in this research felt that CEA grown produce in their community was of much higher nutritional value than the few alternatives, such as mouldy spinach, currently available to them.

between local or global, conventional, or organic, CEA or field grown, as well as make decisions based on the quality perceived. This is not often the case in the communities where interviewees are located, as one noted “there’s been times when you walk into the grocery store, I mean, there are only three bananas, an orange, and a mouldy box of spinach”. As this participant shared, there are not always options at the grocery store, and what is available is often of low quality. Although research

The specific price of goods was not a focus of interviews conducted in this research, but many felt that produce in their community was high as a result of shipping costs to their remote or northern location, therefore removing the need for shipping through the localization of production would lead to more affordable produce. CEA-grown products are believed to be more accessible and more desirable to those of higher incomes (Ercilla-Montserrat et al., 2019, Yano et al., 2021) and research in New York found that urban CEA played no role in reducing food insecurity, despite being located primarily in low-income areas (Goodman & Minner, 2019). Although prior research shows that this produce is financially inaccessible, interviewees felt that even if the price of CEA produce is still high, if consumers understand the value the price will be justified, which the literature tends to agree with (Benis & Ferrão, 2018; Ercilla-Montserrat et al., 2019; Gilmour, 2018; Perambalam et al., 2021).

Access to food is always a concern for people in northern, remote, and Indigenous communities in Canada. As one participant shared, “food is always a topic. You know, if you live in a place like [this] where food comes in only once a week, fresh stuff only comes in once a week, like it’s something that people talk about and are aware of”. Difficulties accessing foods as a result of geography and infrastructure was one of the most common topics among interviews, with many noting that this concern has heightened in recent years as a result of climate change, fragile global food markets and the COVID-19 pandemic. Some shared that the increased prevalence of wildfires in BC and in California was impacting crops as well as access to foods, with others noting that extreme weather events stemming from a changing climate were negatively impacting the transport of goods to their community.

The increasing fragility of our food systems is well documented in the literature, stating that the COVID-19 pandemic, in conjunction with chronic food access issues such as climate change and energy crises are having increasingly negative impacts on agriculture (Oh

& Lu, 2022). Further showing that a reduction in crop yields stemming from the increased prevalence of extreme weather events, a symptom of a changing climate, will lead to increased costs incurred by farmers to mitigate these negative impacts; the costs of which are ultimately shared with the consumer (Brown & Funk, 2008; Saba, 2023). Many forms of urban agriculture and innovative farming practices such as CEA are believed to mitigate the uncertainties related to food procurement as a result of the current global state (Oh & Lu, 2022). This feeling was shared by many participants who stated that increasing resiliency in their food systems and futureproofing was one of the main reasons for the implementation of the hydroponic unit in their community.

However, these social enterprises and community programs often do not have the capacity to adequately deal with the extent of problems related to food, and food security, that their community may face (Novek & Nichols, 2010; Wilkinson et al., 2021). Researchers state that CEA should not be seen as the only solution to food security and community needs, as it cannot remedy all social or environmental problems (Goodman & Minner, 2019), and rather should be seen as a piece of the broader local food system (Petrovics & Giezen, 2021; Wilkinson et al., 2021). Additionally, as many units are implemented in the north, communities may not be able to reap all the claimed environmental benefits as they may be utilizing

Most participants shared that they felt their hydroponic unit was positively contributing to food security and the creation of a resilient local food system, and as we've shown, although the research does not always agree the context differs greatly and therefore previous research findings do not always apply. Previous studies also remain wary of the potential of CEA to address food sovereignty. According to Kepkiewicz and Dale (2019), Indigenous food sovereignty in Canada consists of the following four principles:

the necessity of maintaining Indigenous relationships with land; the ongoing work of Indigenous peoples in shaping healthy and culturally appropriate food systems; the daily maintenance of Indigenous food systems by Indigenous peoples; and the need for Indigenous influence over policies at all jurisdictional levels. (p. 984)

Although some of these principles can be addressed through local hydroponic food systems, others cannot. Looking firstly at the maintenance of relationships with the land, it is known that access to traditional lands is imperative to the attainment of food security and food sovereignty, as social functions, cultural traditions, and much more, have inherent ties to the natural world (Food Secure Canada, N.d; Kepkiewicz & Dale, 2019). Colonial practices that historically removed Indigenous Peoples from their traditional lands and therefore foods as well, are perpetuated today (Leblanc-Laurendeau, 2020). The importance of access to land was discussed in a few interviews with participants sharing support for either side of the argument. On one hand, many felt that the inability of the public to access the system is a significant barrier to the sharing of knowledge and education related to food and the systems, whereas others paired their units with gardening boxes, constructed wetlands, or other more visible environmental components which they used to engage the community and strengthen connections to the land. Despite this, it was recognized that these foods grown utilizing CEA are not culturally relevant, the second principle of Indigenous food sovereignty.

CEA systems are criticized for not being able to provide culturally relevant foods, (Kozachenko, 2020; Stecyk, 2020; Wilkinson et al., 2021), a sentiment which was common among interviews both with community members and Growcer staff. Nonetheless, many felt that the units hold the potential to contribute positively to food sovereignty, even if they cannot address the issue entirely. It must also be noted that Growcer does not claim that the operation of their units equates to the attainment of food sovereignty, which was noted by multiple staff in interviews. One shared “that's always the conversation we have to have with

people is like being the realist of saying, look, this is going to solve one particular problem. And this one's like it's a tool in a toolkit. It's not going to be the silver bullet” and another commented, “we're always saying [that] the farm is always secondary to the project”. Both these staff members shared that the Growcer units can be seen as a tool for achieving a broader goal, whether that be food sovereignty or otherwise, but this goal must also be identified and clearly defined throughout project inception and implementation.

The third and fourth pillars of Indigenous food sovereignty in Canada pertain to the governance of the food system by the Indigenous Peoples, at all levels. Many food policies and programs favour Western knowledge and laws and are made without the consultation of Indigenous Peoples which can inhibit rather than promote food security (Robin et al., 2023). Further, technocentric approaches to agriculture often favour Western scientific knowledge, and undermine the agency of farmers, as they are viewed as passive recipients of such technological agricultural innovations (Watts & Scales, 2015). This phenomenon might be particularly poignant in Indigenous communities where technological advancements are often forced upon communities, inhibiting local agency, and reinforcing power structures (Kozachenko, 2020). This topic was not common in interviews. Growcer staff did note that Indigenous people should be the ones to lead research on the development of culturally relevant crops, and cultural education related to CEA, and that Growcer would gladly support these initiatives rather than lead them. Others also mentioned that systems achieved more success when they received stronger community support and had a consistent champion in the community who led the project through inception, implementation, and operation.

Food sovereignty requires that governance of the food systems is driven by the local community so that specific contextual and historical factors are considered within the creation and implementation of the system (Epting, 2018). Although research is limited, one study on food sovereignty in Canada through CEA finds that the development of CEA food



systems without the input of local Indigenous communities holds the potential to perpetuate harmful colonial power structures, ultimately leading to a reduction in food security and sovereignty by inhibiting agency and self-sufficiency (Kozachenko, 2020). Food sovereignty, by definition, must be driven by the community in need, however, local communities, particularly Indigenous Peoples, are often left out of consultations when new food programs are being developed (Robin et al., 2023). Another component of food sovereignty is the consideration and inclusion of traditional acquisition and food preparation and processing techniques (Miltenburg et al., 2022), which may be difficult for hydroponics to address considering it is not a traditional technique.

Ongoing processes of settler colonialism inhibit the attainment of the four principles of Indigenous food sovereignty described by Kepkiewicz & Dale (2019). For example, standard definitions of food security typically utilize a Western lens, taking solely economic indicators into account, without considering the importance of foraging, hunting, growing and other traditional foods and medicines (Bratina, 2021). Another example as explained by Kozachenko (2020) is the operation of CEA systems within a capitalist market system. Because capitalism has inherent ties to colonialism and the oppression and extraction of labour and resources from those of lower socioeconomic status, CEA may hinder the agency of Indigenous Peoples, and offer benefits only to those in densely populated, primarily white, northern centres (Kozachenko, 2020). Additionally, education has been continually referenced as being essential to the adoption of CEA technology (Coyle & Ellison, 2017; Kozachenko, 2020; Wilkinson et al., 2021). However, teaching CEA and agriculture in school settings would be utilizing the same methods of assimilation to Western culture as residential schools and settler colonialism, and therefore the importance should be placed on the teachings of traditional knowledge (Kozachenko, 2020), and educational materials should be tailored to local values (Pfeiffer et al., 2020). Further, if the healthy foods produced by

CEA are only financially and physically available and culturally appropriate for non-Indigenous Peoples, this method may widen the gap in health outcomes between Indigenous and non-Indigenous groups, further marginalizing Indigenous Peoples (Kozachenko, 2020).

This chapter outlined the ways in which the literature and the research conducted here feel CEA may or may not be addressing food security and sovereignty. As noted, much of the previous work in this field has been conducted in America and European nations, where food security rates and the causes of food insecurity may vary as compared to Canada. As a result, the conclusions of this research do not always agree with the literature. It is agreed that CEA does improve access to healthy foods, one of the main pillars of food security (Armanda et al., 2019) and that these systems are helpful in creating stable access to foods, particularly in places where food supply is unreliable (Blom et al., 2022). Previous research shows that high cost and low WTP may be characteristics of the systems (Gilmour, 2018), however, interviewees noted that all foods are expensive where they live, and they believe consumers are willing to pay this high price for these goods that are of higher quality than the alternatives and supports local initiatives. One of the reasons why it is believed that WTP is lower for these goods is because they are not calorically dense, and therefore contribute minimally to food security (Ares et al., 2021; Broad et al., 2022; Kozachenko, 2020). Participants in this research were quick to note that often they have little to no healthy options in the stores, making CEA-grown greens a viable option. Critiques point out that these greens are not culturally relevant, therefore inhibiting food sovereignty efforts, although interviewees felt that if the projects are community-driven and could address other cultural needs, they are still of value.

## **Chapter 6 - Sociocultural Impacts and Implications of Hydroponics**

Local food systems hold the potential to greatly influence various people and aspects of life. Food systems exist within other economic, social, and natural systems, all of which involve various actors throughout production and consumption (Gaitán-Cremaschi et al., 2021). Food also holds many social functions in various communities globally (Fieldhouse, 1995). Food is part of rituals and celebrations, it is used to express concern, friendship, and care for others, mark major life events, and used as a symbol of social status (Fieldhouse, 1995). Historically food has served as a social setting, as local markets, community foraging, and hunting were often social grounds, which have been reduced or lost to supermarket culture (Petrovics & Giezen, 2021). The financialization of food has also reduced the use of food in social practices, as food is viewed as a way to make money, rather than a way to feed people (Clapp & Isakson, 2018). It is believed that local food systems can interact with these various actors and social functions when implemented in intentional ways, leading to broader community impact beyond simply access to nutrition (Novek & Nichols, 2010). This chapter outlines the ways in which interviewees felt their hydroponic units have and potentially will provide social, economic, cultural, and environmental benefits through food, and how this is supported by previous research in the field. These include both social and cultural impacts such as the promotion of feelings of pride and empowerment, facilitating social connections, revitalizing cultural practices, and the creation of jobs and training opportunities.

The localization of CEA units in the communities where food will be consumed means a separation from the global food systems. The globalized food system is increasingly being characterized as being in crisis as a result of economic factors, as we have discussed, but Keenan et al., (2023) argue that one driving factor for this crisis is the concentration of corporate wealth and control, and the financialization of food. Financialization describes the control financial institutions have on the production, distribution, and consumption of food

within the global capitalist paradigm (Epstein, 2005). This global system permeates into the everyday life of producers and consumers (Clapp & Isakson, 2018), and can exacerbate social inequalities, food insecurity and environmental destruction (Keenan et al. 2023). Needless to say, a shift from this system by producing food outside of it, may lead to positive sociocultural impacts, as the financialization of food has led to a reduction of food being used in social practices (Clapp & Isakson, 2018). The social aspects of food have been lost throughout the creation of global markets and supermarket culture (Petrovics & Giezen, 2021).

One of these intended benefits of local CEA projects includes the promotion of social connections both between community members and between consumers and producers. Urban agricultural programs and innovative farming technologies have been shown to facilitate connections between consumers and those who grow their food (Goodman & Minner, 2019; Pfeiffer et al., 2020) while helping to bridge the generational gaps in agriculture (Oh & Lu, 2023). This bridging was exemplified in a story told by a Growcer staff member, sharing that they had received feedback from a community where grandkids were connecting with their grandparents' farming backgrounds for the first time, through hydroponics.

Other participants shared that these generational connections were facilitated through the sharing of food, which is now more accessible and affordable. As stated by a Growcer staff member “food brings everyone together”. Relationality, responsibility, and reciprocity are integral to Indigenous food sovereignty in Canada and can be practiced through the sharing of food (Miltenburg et al., 2022). Initiatives that aim to support food sovereignty are found to strengthen social networks by building relationships within the community while also caring for others through the sharing of food (Miltenburg et al., 2022). Some communities are able to do this through their CEA unit, as one participant described:

it just brings the whole community together like we do have a bunch of community-based meals here and to be able to go in the garden and see the things that were harvested that are part of the meal, that they're now being able to share with their children, I think is a big step.

This participant described sharing foods through community meals with multiple generations, touching on numerous social benefits. This participant explained that sharing food became difficult as prices of imported foods rose. One Growcer staff shared a story of the connection between generations saying, “I went to a community visit to visit a community, one of the community leaders said, if we can inspire two kids to think about food differently, by seeing this project in the community, it's a win for us”. Many interviewed stated that they were able to expand their reach and benefit by sharing extra produce with food banks and planned to always donate a portion of food as a way of caring for their community. One community used their capacity and resources to grow seedlings for outdoor gardens, as seen in Figure 20, which were given out in the community.

Urban agricultural systems that combine economic goals with social and ecological functions, such as community engagement and education are believed to receive higher uptake



*Figure 20: Seedlings grown as a community outreach initiative. Source: Mitchell, 2021.*

(Gan et al., 2022), and lead to a more viable business model (Petrovics & Giezen, 2021), which is agreed upon by a significant portion of those interviewed within this research. Another way the research suggests to ease the uptake of this new agricultural technology is to increase the social and cultural significance (Stecyk, 2020).

Although, as discussed in the previous chapter, leafy greens are not culturally relevant to most people in northern and Indigenous communities in Canada, nor is hydroponic technology, aspects of the system can still be used to share traditional teachings and practices. Social gatherings and the sharing of food are some of these traditional practices that are facilitated through local food production. More than one participant shared that the rising price of imported foods forced them to limit the number of community gatherings and feasts held in their community and that by making food more accessible and affordable through CEA production, they could resume these practices again. Others shared that connecting youth to where, how, and who grew their food was another way of reconnecting with their culture. Figure 21 created by the Government of British Columbia (n.d) identifies traditional food as the metaphorical tip of the iceberg, with all of the unseen impacts in the water below. Although CEA-grown produce may not be traditional, many of those interviewed felt it could still touch on some of the aspects under the water such as gathering, teachings, and knowledge transfer. In addition, some felt that the systems would help to increase community feelings of pride and empowerment.

Not all of those interviewed felt that feelings of pride and empowerment were fostered through their food system project, but it was a topic in roughly half of the interviews conducted. One participant shared that these feelings were clear at board meetings for their organization, stating that “there's a certain sense of cultural pride in having this enterprise [...] you can see the pride just like exuding from them of how happy they are that we've made this work”. Others shared that being in a small community, they often knew the grower which

made them proud, as well as being proud of their small community for being able to produce high-quality foods through innovative and modern methods. A Growcer staff shared this idea by saying:

what we're also starting to see now in a lot of the communities, the project itself, the community project and the growing initiative itself has its own brand and identity, which I think means a lot to the communities because being able to grow something

in the community, for your community is like priceless. Research shows that local community economic development programs related to food have the potential to enhance community pride when there is a focus on community empowerment (Novek & Nichols, 2010). One participant who had seen minimal impact on their community felt as though feelings of pride were lacking as a result of poor communication and



Figure 21: Iceberg metaphor for traditional foods (Source: Gov. of BC)

awareness related to their hydroponic unit and the goals of their project. These findings support the idea that consumers must be engaged in the process to be more aware of and to receive the intended benefits. One way of directly engaging community members is through employment.

A few mentioned the positive impact of providing more jobs as well as more diverse jobs than what might presently be available in the community, although one noted that due to the automation of the system, the job is fewer hours than they had hoped for, and not very challenging. Additionally, some researchers believe that the number of jobs created will be few (Goodman & Minner, 2019), and may be subject to technological unemployment in the future (Mina et al., 2023). The systems often create low-paying jobs (Goodman & Minner 2019), and higher-paying jobs are often filled by those from outside the community (Mina et al., 2023). Although job creation in the literature focuses primarily on the number of jobs created, these interviews focused on the diversity of jobs, and the ability to provide diverse work experiences to community members, which was highly valued by participants. The increased prevalence and reliance on technology require a need for re-skilling and up-skilling (Kolade & Owoseni, 2022), which these units may provide.

This chapter touched on the many ways food has a greater impact on lives other than simply providing nutrition (Fieldhouse, 1995). The local production of food outside of the global system may allow for more social functions to be met through the CEA system, such as increased social connections, gatherings, and settings for the sharing of knowledge (Petrovics and Giezen, 2021, Pfeiffer et al., 2020). These characteristics are also important comments that help to connect Indigenous Peoples to cultural traditions, even if the food is not culturally relevant. Combining these functions of the system to ensure produce is not only feeding people but contributing to broader community development helps to ensure the public acceptance, viability, and continuity of the systems (Novek & Nichols, 2010; Petrovics &



Giezen, 2021; Stecyk, 2020). To ensure broader community benefits, such as pride and empowerment, consumers and community members must be aware and well-informed on the system and its benefits, through engagement. Although people can be engaged and involved through employment, operators of systems should ensure jobs are stable and secure and provide opportunities for growth to adapt to changes in the industry and living wages.

## **Chapter 7 - Local Perceptions of Food, Sustainability, Community, and Hydroponics**

The perceptions of sustainability solutions and values held by the community are directly correlated to a project's success (Leal Filho et al., 2022). Human values underpin actions and behaviours (Lincoln & Ardoin, 2016; Leal Filho et al., 2022), and play an important role in shaping decision-making habits, and generating support for innovative agricultural practices (Pfeiffer et al., 2021). Human values are often classified into three categories: for oneself, for others, and for the environment (Lincoln & Ardoin, 2016). Current global systems have shifted values and actions to be primarily for oneself (Kopnin et al., 2018), though it's argued that actions for others, also known as for the common good, inherently support the natural world (Christie et al., 2019). It is widely agreed that a transition to a more sustainable future would require a large-scale shift in societal values (Christie et al., 2019; Kopnin et al., 2018). Although some methods such as education can alter actions, opinions are primarily founded on values and beliefs which are deeply rooted and difficult to change (Pfeiffer et al, 2020). This chapter will discuss some of the values and perceptions present in the communities where interviews were conducted, to see if there are value trends that correlate to the success of CEA systems.

It is important to understand how people who will be participating in these local food systems, consuming the produce, and living in these communities perceive and value the system, as they should be the ones benefiting most from the projects. According to the Growcer co-founder, they believe that people using the system must perceive and value them differently than the company, as many Growcer units have been left unused (C. Ellis, personal communications, November 2022). This divergence in views is evident in the literature showing strong support for the environmental sustainability of systems, which wasn't strongly supported by this research, as well as the difference in media rhetoric.

Research done by Kozachenko (2020) found that the dominant narrative surrounding CEA is one put forth by mainstream media, which portrays CEA as an ideal solution to address food security concerns in Northern Canada and provide educational opportunities, while also not contributing to climate change. Research shows that media rhetoric differs greatly from the truth of CEA's benefits (Goodman & Minner, 2019; Kozachenko, 2020), while information regarding CEA online is dominantly immerging from CEA stakeholders such as vertical farm companies (Waller & Gugganig, 2021). As Gott et al. (2019) state in reference to the common rhetoric surrounding CEA "hype prevails over demonstrated outcomes" (p. 393). This quote is particularly poignant in this case where there is a lack of research on demonstrated outcomes on social and cultural impacts, despite food being so heavily related to social and cultural traditions and relations. Although media was not a focus of these interviews, some participants noted that media and social media could be beneficial in reaching consumers and sharing their stories. This connection was important to the participants as it put a face to the project, allowed consumers to become more familiar with who was growing their food, and connected with consumers.

Numerous interviewees who participated in this research shared that values for others were strong within their community. Christie et al. (2019) identify values that reflect the common good as including "respect for the natural environment"; 'equity and equality'; 'ethics, justice and morality'; 'altruism and sense of community'; 'consideration of all living beings'; and 'economic value as a means and not an end'" (p. 1347). Many of these values described were identified by interview participants as being prevalent in their community, and for those who stated that relationships and people were important values, it can be assumed that many of these themes identified by Christie et al. (2019), are present. Community and the common good were primary values identified in interviews, and the way that people expressed that they showed care for others was often through food.

One final question posed to participants was what they felt people in their community valued. When asked this question, one stated, “they value their connections, so they value being able to make those connections and maintain those connections in healthy ways, whether that be with family or friends or even classrooms”. The values of connections and relationships as shared by this participant were common among others. Another participant stated that “a critical driver is giving back and whether it's through our good food boxes that go out every month, or, you know, just making products more accessible [...] people feel cared for”. An important aspect to recognize is that of the community members interviewed, all but two were from either a First Nation or a community with a large Indigenous base and served largely an Indigenous population. One participant from a First Nation community shared that culture is the primary value where they live, but this inherently means values for others and for nature, a common ideology in Indigenous cultures in Canada (Gratani et al., 2016; Jensen, 2022). They stated:

the cultural value is, it's probably the top, I would think. Then from there, everything that from there, it's, you know, family is very, very important. So everyone is, everyone is related it seems like so it's one big family really.

implying that the whole community was seen as family and to be cared for. I followed this by asking how they value nature, to which this participant replied, “that's part of the culture; nature and [...] being stewards of the nature”. By responding that this community valued culture and family, also meant that the community valued nature and sustainability.

Research shows that if community members already hold values for nature and sustainability, they are more likely to support local sustainable agricultural projects (Broad et al., 2022; Miličić et al., 2017), and if consumers perceive the projects to be environmentally friendly, they are more likely to purchase the produce as perceived sustainability of operations is one of the main reasons for support and acceptance of CEA (Ares et al., 2021;

Broad et al., 2022; Ercilla-Montserrat et al., 2019; Jaeger et al., 2023; Jürkenbeck et al., 2019; Perambalam et al., 2021; Specht et al., 2016). Some participants shared that their hydroponic units were paired with garden boxes, cooking classes or nature walks to share teachings of nature and sustainability, and that these programs were welcome in their community as participants already held values for nature.

However, a Growcer staff noted that values for nature and sustainability were rarely the driver for the implementation and acceptance of CEA, in their experience. We can conclude that, as research shows, people who value others naturally value the environment, and these values support the success of local, sustainable agriculture. A large portion of research focuses on the environmental impact of CEA compared to the operations of the system (Vatistas et al., 2022), and compared to social and economic functions (Dsouza et al., 2023), although as this research shows, environmental sustainability is a much smaller concern for community members, growers, and operators. Although environmental concern may not have been a motivator for the implementation of a local food system, Growcer CEA units were generally perceived as environmentally friendly, and overall regarded positively in interviews. Research shows that perceived sustainability of produce will lead to greater willingness to pay, and intent to purchase (Ercilla-Montserrat et al., 2019; Miličić et al., 2017; Perambalam et al., 2021; Specht et al., 2016), a sentiment shared by participants. Research also shows that consumers of hydroponically grown produce often already have values for the health and safety of the environment and themselves (Broad et al., 2022).

Interview participants also noted that they felt Growcer units successfully provide safe, healthy, and affordable products that may not otherwise be available to their community. The available literature supports this conclusion that health and safety are common concerns of customers and that CEA is viewed as providing safe and healthy foods (Gilmour, 2018; Kozachenko, 2020; Wibowo et al., 2023; Yano et al., 2021). A part of these

beliefs in Growcer units and their benefits stem from strong feelings of trust in Growcer Hydroponics Inc.

Health and well-being were brought up in interviews as a motivating factor for public support and for the implementation of systems. Consumers who have values for well-being and are health conscious tend to show greater support for CEA (Balqiah et al., 2020; Wibowo et al., 2023). Health was a recurring topic in interviews, as one participant noted about the support from their community, “I think they support anything that we're doing like, again, like I said, anything related to bringing healthy food into the community or anything related to bringing people together, the whole community is willing to support”. Others noted that although they believed their community valued health and well-being, it has been so hard to access the resources needed to live a healthy life, such as healthy foods, doctors, and nutritionists, that this value is wavering. Those interviewed believed that CEA systems do provide safe and healthy foods, and they facilitate connections to others and culture, which can strengthen well-being. According to Gall et al., (2021)

An important way that the Indigenous peoples in Canada support each other and improve the well-being of the whole community is through the sharing of resources, especially food. This highlights the importance of food quality, food security and food sovereignty to the wellbeing of the Indigenous peoples in Canada. (p. 7)

Interview respondents stated that their local CEA systems allowed them to share food with their community once again, which can contribute to the well-being of the community.

Values for culture, which some interviewees reported therefore translate to values for well-being as well, as this is an important component of Indigenous cultures (Gall et al., 2021).

Although it is recognized that there is a lack of current literature analyzing the applications of CEA in cross-cultural settings, and the sociocultural implications (Gan et al., 2023), it is understood that the creation of successful food systems must consider the

historical contexts and social values related to food that are already present within a social system to be effective and relevant (Gan et al., 2023; Watts & Scales, 2015). Farming is inherently linked to social values and cultural practices, as recognized by Soini & Huttunen (2018):

Agricultural practices shape both the farming environment and the farmers' values and appreciations through mutual adaptations. In that way, agriculture is essentially a mixture of different components of culture such as worldviews, materials and symbols, institutions, and dynamic spatial and temporal processes inherently connected with nature. (p. 350)

This quote exemplifies the importance of social values in the adoption of new agricultural technologies, as agricultural practices are embedded within cultures and worldviews, which may lead to resistance in shifting away from traditional farming practices and therefore certain cultural aspects as well (Cowan et al., 2022). A few participants reported values for their culture, showing that CEA projects should be respectful of the social and cultural implications and potential changes to the ways cultures are practiced and expressed.

Participants were asked what they would change about their unit if they could, to assess these implications and potential changes, and most voiced that Growcer had done a great job thus far and had provided valuable support. Those who did have ideas for change, all involved physical changes to their units' infrastructure, or the site preparation for the system, such as difficulties with the hydro hookups, and maintenance issues. Most answers to this question sounded similar to this participant:

I wouldn't do it any other differently any other time. I think that no, I mean, honestly, I think that the way that the Growcer has been supporting us has been awesome. And if that support was lacking, then I'd of course be saying that but it's really quite good.

The support offered by Growcer was acknowledged in multiple interviews as being helpful and essential to the success of the system. Although Growcer provides the hydroponic units and continued support throughout its operations, the governance of the local food system and the hydroponic unit is ultimately in the hands of the community, a fact that those interviewed appreciated. One participant noted that self-governance was an important challenge and value and their community. One Growcer staff noted that although this model leads to empowerment and increased autonomy, if some communities lack capacity, knowledge, skill, or experience in this realm there are often challenges with the continued use and operation of the hydroponic unit.

This chapter aimed to answer the third research question of this thesis: How do community members perceive and value i) local food systems & food more broadly ii) nature & sustainability, iii) current governance & operations of hydroponic unit(s) in the community? Research and interview participants agreed that although values are deeply rooted and difficult to change (Pfeiffer et al., 2021), being able to shift values for those such as environmental sustainability, health & well-being, culture, just and equity, and for the common good, may improve the viability of local hydroponic projects in Canada (Christie et al., 2019; Gratani et al., 2016; Gall et al., 2021).



## **Chapter 8 - Successes and Barriers to the Adoption of CEA in Canada**

As we've shown in previous chapters, local food systems must be rooted in communities of practices, where the community as a whole shares the same morals and goals, and the common good is valued (Miller et al., 2022). In other words, for hydroponic units to be adopted and effective in attaining the goals set out, they must receive widespread community support. This chapter will first outline the barriers identified both in the literature and by participants interviewed through this research, including high start-up costs, infrastructure gaps, and the inexorable growth of capitalism and global food markets. Secondly, factors that lend to the adoption and effective, continuous operations of CEA, such as tailored designs of food projects will be discussed. The chapter will end with policy recommendations to ease and increase the adoption of hydroponics and CEA, urban agriculture, and innovative agriculture more broadly in northern and Indigenous communities in Canada.

The development and implementation of a local food system through hydroponics usually starts with a visionary in the community. Their dreams of affordable, safe, healthy and accessible foods are likely one of the only things that is free throughout the process of implementing a CEA unit in a community. The first real stage of the process is often feasibility studies, where a consultant is hired, or the local economic development officer (EDO) creates plans for funding and continued operations to see if the project is worthwhile and economically viable and sustainable. If Growcer is identified as being a viable option, contacting the company is also free. Growcer will also have as much contact and provide as much information to the community as requested, something one Growcer employee felt was valued and appreciated by customers, and something that may not be common among other companies. They shared:

we'll meet with you every week, for an hour if you really want to. If you show up and you come like we'll be there, you know, we're spending a lot of time with customers. So, I think that's a nice touch and when people feel supported like again, I think it contributes to success. Especially when they're in remote places.

CEA units are large purchases, and communities often do not have expertise in the area and appreciate having all of their questions answered before spending large sums of money. Once a community purchases the unit, the site where the unit will be local must be prepared, a cost that is often not accounted for. When asked what barriers existed with their project, one participant who played a role in the implementation and operation of a hydroponic unit specifically stated site preparation, sharing,

Do not underestimate the cost of site preparation. Like you really got to be honest with yourself about how much like you think just like, naively, I'm getting a shipping container and I'm gonna plot all I need is like a level piece of property. I'm just gonna plopp it down and I'm gonna get growing once I hook everything up. We're hooking everything up is like okay, well you need to dig a waterline, you need to run a data cable. You need to get an electrician to make sure you have enough power to actually do this all. So by the time we were done our site preparation, we were like \$50,000 over budget. And if we were just like a regular run-of-the-mill you know, solo entrepreneur, that probably would have sunk the whole project.

The unexpected costs associated with site preparation were spoken about by multiple community members as well as Growcer staff.

The high start-up costs associated with the CEA units are frequently referenced as one of the main barriers to implementation (Broad et al., 2022; Goodman & Minner, 2019; Kozachenko, 2020; Petrovics & Giezen, 2021). In recent years roughly only half of the container farm industry has been profitable, with many failing in the first years of operation

due to high costs, low profits, and inexperienced farmers (Armanda et al., 2019; Broad et al., 2022). Wilkinson et al., (2021) recognize that cost of delivery and operation in remote locations may lead to additional costs, especially if the cost of energy is high in that location (Kozachenko, 2020), although there may also be more subsidies and funding available specifically for these remote locations. Site preparations may be more difficult and more costly in northern and Indigenous communities in Canada, as there is a significant gap in infrastructure in northern Canada as compared to the south, which according to the National Indigenous Economic Development Board (2016) inhibits the advancement of well-being, social development, and economic development. This includes a lack of infrastructure to support reliable and affordable energy, and clean water, which may pose additional barriers to the adoption of CEA technology in Canada (Wilkinson et al., 2021). These results show a need for the consideration of local infrastructure prior to the implementation of a CEA unit, and the need for additional support to fund infrastructure developments. Growcer is aware of these barriers, as one staff noted in the interview process that all levels of Government should be held accountable for these gaps, as they lead to significant challenges in attaining food security and sovereignty.

Following the implementation of the hydroponic unit, a community must ensure they have enough interest in the project to ensure produce will be sold and used. As discussed earlier, the two themes of economic and community development go hand-in-hand. For communities to reap additional economic benefits, it is recommended that they combine a variety of functions such as leisure and educational opportunities, to not only diversify revenue streams (Benis & Ferraro, 2018; Specht et al., 2016) but to increase uptake, by raising awareness and perceived value through participation (Petrovics & Giezen, 2021).

Consumer awareness of CEA has been found to be low (Gilmour, 2018; Jürkenbeck et al., 2019; Miličić et al., 2017; Perambalam et al., 2021; Pfeiffer et al., 2021), with education

often being referenced as a viable way to increase awareness, participation and adoption (Gilmour, 2018; Kozachenko, 2020; Miličić et al., 2017; Wilkinson et al., 2021). Research supports these sentiments that increased community engagement will lead to high uptake (Gan et al., 2022; Petrovics & Giezen, 2021). Novek & Nichols (2010) also point out that for local food systems to be truly effective, they must be governed primarily by the community, rather than being implemented in a top-down fashion. This evidence supports the need for someone in the community to champion the project and community engagement. Research also agrees with the statements made by participants that education through CEA can help to teach about healthy foods, food insecurity, and agriculture (Broad et al., 2022; Currey et al., 2018; Goodman & Minner, 2019; Kozachenko, 2020). It is likely that consumer perceptions of CEA differ greatly from those of stakeholders, many of whom believe consumer acceptance to be a barrier to the adoption of innovative agriculture (Ercilla-Montserrat et al., 2019). As the literature review included in this thesis has shown, global attitudes towards CEA are generally positive, particularly if consumers perceive the units to be safe, sustainable, and provide healthy, fresh produce. Therefore, transparent communication and education on these topics are essential for adoption (Broad, 2020).

Adoption of CEA systems is also reliant on the produce to be attractive, and accessible to consumers, which includes price. It is also essential to the continued operations of CEA systems that they are economically sustainable. These two factors mean operators often must walk a fine line between being profitable and sustainable, while also ensuring produce is used firstly to feed people, rather than as a means to create profit. Research shows that the financialization of food is impacting the price, one of the most common influences on consumer purchasing habits (Broad et al., 2022), which is likely to be more important in communities that are food insecure such as those that have implemented CEA systems. These

findings support the idea that the failure of local hydroponic food systems may be a result of more systemic issues.

Although capitalist expansion is often cited as burdensome for the environment and social systems, economic sustainability is an integral piece of overall sustainability (Gan et al., 2022). However, in the context of CEA and sustainability more broadly, Gan et al., (2022) argue that we must define economic sustainability as “the ability of production systems to provide goods and services, the adaptability of economic systems to different environmental conditions, and maintaining social and cultural aspects of a community” (p. 5), which profit-driven agriculture often fails to do. Many urban vertical farms are found to focus on short-term profits, a common characteristic of the industry, leading to few profitable operations (Pertovics & Giezen, 2021).

Research finds that capitalist expansion is embedded within current food systems (Alkon, 2013). Food is not immune to westernization and capitalism, as products even as simple as lettuce grown hydroponically are subject to product differentiation and the commodification of food (Rothwell et al., 2016). Alkon (2013) argues that scholars and society must critically evaluate whether alternative food networks, such as local food systems, truly represent a transformation in food systems, or simply another form of product differentiation and market expansion (Alkon, 2013). Such schemes may lead to the exclusions of lower-income consumers and create the potential for labour exploitation (Alkon, 2013). Although many alternatives to agri-industrial food systems claim to work towards the de-commodification of foods (Moragues-Faus & Marsden, 2017), this may be a difficult task. As further explained:

Scholars have exposed how in many cases these ‘ethical’ and ‘sustainable’ initiatives can conceal potential environmental impacts and reproduce social inequalities, and might also be fostering an infertile consumer politics by deepening individualist

practices and reproducing neoliberal configurations that hinder social change.

(Moragues-Faus & Marsden, 2017, p 277)

Community-run hydroponic units are often run by non-profit organizations, and although profit may not be a focus, the food systems still exist within a capitalist economic paradigm that thrives on inequality, as explained by Moragues-Fause & Marsden (2017).

Following a social enterprise model that is less profit-driven and rather focuses on education, leisure activities, and health and well-being, such as greenhouses often do, may be a better path to success for local CEA (Wilkinson et al., 2021). This may also broaden potential funding opportunities, therefore reducing pressure for profits (Wilkinson et al., 2021). According to Fama and Conti (2022), consumers are not typically engaged with the production or distribution of food, but rather solely the consumption, therefore CEA projects should consider how community members can be engaged throughout production. One study on the acceptance of different types of urban agriculture found that programs that focused on attaining goals within each of the three pillars of sustainability, rather than solely focusing on the economic pillar, were more likely to be accepted by the public (Specht et al., 2016). Additionally, economic profit is often the only form of growth recognized in Western society, which may not be the case in northern and Indigenous communities in Canada (Kozachenko, 2020). Because CEA systems operate within a capitalist market system, which has inherent ties to colonialism and the oppression and extraction of labour and resources from those of lower socioeconomic status, CEA may hinder the agency of Indigenous Peoples, and offer benefits only to those in densely populated, primarily white, northern centres (Kozachenko, 2020).

This barrier to the growth of the CEA industry is also recognized by Petrovics & Giezen (2021) who state that within the current globalized food system, competition is favoured over knowledge sharing. Education and knowledge sharing were cited in almost

every interview as being essential to the adoption of CEA within communities. Although some researchers believe teaching CEA and agriculture in school settings would be utilizing the same methods of assimilation to Western culture as residential schools and settler colonialism, and that in Indigenous communities' importance should be placed on traditional knowledge (Kozachenko, 2020), these concerns did not arise in interviews conducted through this research. Regardless cultural sensitivity should be considered it is believed that incorporating traditional values and teachings will ease acceptance of the technology within communities (Stecyk, 2020) and that agricultural systems that are more in line with traditional agricultural practices and therefore may involve fewer technological advancements are more likely to be adopted (Gan et al., 2022). Additionally, the environmental sustainability of the systems may align with traditional stewardship practices and teachings, easing adoption (Stecyk, 2020).

Although many of the people interviewed expressed that they were aiming for many of the goals stated in this chapter, government policy or lack thereof was identified as a significant barrier in attaining goals, although this topic was discussed in a few interviews. When the topic arose it was primarily in support of government funding initiatives and policies that provided additional subsidies or funding to make the projects more feasible in the North. One Growcer staff went into detail explaining that government definitions of agriculture, and policies related to agriculture in urban space have been a significant barrier.

Difficulties associated with the incorporation of CEA in urban spaces are well documented in the literature (Benis & Ferrão, 2018; Goodman & Minner, 2019; Sanyé-Mengual et al., 2016; Schmidt Riviera et al., 2023). Assistance from governments in the form of policies and legislation that support the goals and operations of local food systems are integral factors in the success of the system (Wilkinson et al., 2020). Such legislation may include zoning laws that allow urban agriculture in its many forms or local policies that

encourage agencies to purchase foods grown locally (Goodman & Minner, 2019). Local procurement policies were also cited by a few Growcer staff as being immensely helpful in encouraging the sale of produce and therefore feasibility of operations. Research finds that although governments are generally unwilling to intervene in markets, incentivizing food choices through subsidies as well as incentives targeted at those in need are effective (Garnett et al., 2015). Research by Pfeiffer et al., (2020), found that consumers tend to support government subsidies for the adoption of more digital farming technologies and innovative urban agriculture. Despite difficulties associated with policy and the need for more research, the CEA industry is growing nonetheless, and governments should anticipate these changes and work to smooth the implementation (Gan et al., 2022). Table 4 summarizes the recommendations of this chapter. The barriers and recommendations identified were extracted from the interviews conducted and supported by the literature consulted.

**Table 4:** Summary of barriers and recommendations for CEA implementation

<b>Barrier</b>	<b>Change or Policy Recommendation</b>	<b>Actor Responsible</b>
Confusion related to feasibility realities of hydroponics	Clear, open, and honest discussions between Growcer and communities from the onset	Organizations
High start-up costs, particularly with site preparations	Offer support with finding and writing grants to start and continue projects	Organizations
Lack of infrastructure in the north making; 1) delivery of units difficult and costly, and 2) difficult and costly to access clean energy	Need for Federal and Provincial governments to retain promises of closing gaps in infrastructure such as building and maintaining road access to the North, ensuring access to potable water and affordable access to renewable energy	Government
Low consumer awareness leading to low support	Provide examples or templates of educational materials or signage that can be tailored to specific communities and their needs to be used in schools or leisure and education programs	Organizations + Operators
Difficulty marketing products and selling all units of produce to attain economic viability	Offering support, courses, or access to resources on how to run a business, rather than just offering courses on how to grow food	Organizations



Need to diversify to increase participation such as through education or leisure activities	Adjust infrastructure of CEA unit to offer viewing of operations	Organizations
Food not attractive to consumers, either in price or taste	Offer cooking classes or recipes to make produce more useful to consumers, and to justify cost	Operators
Lack of community champion to spearhead project	Help finding grants to pay community champion	Organizations
Ensure cultural and social relevance	Follow a type of social enterprise, bottom-up governance model that focuses on education and leisure opportunities and broader community development that weave in important social and cultural traditions or practices	Operators
Maintaining economic viability	Increase government funding to local agricultural projects, and broaden definition of agriculture within government subsidies to include urban projects	Government
Laws and policies restricting urban land and buildings for agricultural uses	Need for governments to reconsider zoning laws and policies to allow for urban agriculture	Government
Lack of communication between Growcer operators for knowledge and advice sharing	Creation and facilitation of meetings, town halls, open forums, or online chats between current Growcer operators as well as those interested in purchasing a unit to facilitate the sharing of best practices	Organizations
Difficulty selling all the produce grown	Local procurement policies for stores and organizations to purchase produce first from the Growcer unit before sourcing produce from outside of town	Government

The final column of Table 4 identifies who needs to enact the change described, whether it be governmental, or executed by an organization such as Growcer, or by the community operator. Although some of these changes are small, and others more significant, it is important to note that the responsibility is shared. Changes need to be made at all levels to ensure the viability of CEA projects and the attainment of local food security and food sovereignty.

## Chapter 9 - Conclusion

### 9.1 Summary of Findings

This research aimed to understand the ways that local hydroponic food systems in northern Canada are viewed and valued, to assess how they are impacting food security, food sovereignty, and broader sociocultural sustainability. Through this, factors that support the adoption and success of the units were identified.

What this research has shown is that CEA units must be governed by the community with a strong project champion, engage the community throughout the project inception and operation through local initiatives such as education and leisure programs, and aim to create a community of practice. Some barriers that were identified include the remote nature of communities leading to difficulties and high costs associated with receiving CEA units and continued operation. Whether this cost is shared with consumers or not, some research shows that produce may still be financially inaccessible to consumers, therefore contributing minimally to a reduction in food insecurity rates (Broad et al., 2022; Goodman & Minner, 2019; Lubna et al., 2022). These findings align in many ways with previous research findings but differ in others. Overall, the lack of research analyzing sociocultural impacts concerning CEA has led to much speculation in the field and conflicting evidence. It is important to note that a majority of work on this topic has previously been done in Europe and the US, and with demographics of people that have different relationships with food than those in Northern and Indigenous communities in Canada. Therefore, some previous findings may be applicable in this context, whereas others may not be.

This research agrees with previous work that people tend to have positive attitudes toward CEA (Gilmour, 2018; Kozachenko, 2020; Wibowo et al., 2023; Yano et al., 2021), especially if they believe it can contribute to providing healthier, fresher, or more environmentally friendly produce (Benis & Ferrão, 2018; Ercilla-Montserrat et al., 2019;

Gilmour, 2018; Perambalam et al., 2021). These findings also confirm that education is an extremely important piece of this work, both educating people on CEA and using CEA as a locale for teachings related to food, culture and sustainability (Gilmour, 2018; Kozachenko, 2020; Miličić et al., 2017; Wilkinson et al., 2021). Part of this education piece is the marketing and communication surrounding CEA. Although the media rhetoric differs from the results found here (Kozachenko, 2020; Waller & Gugganig, 2021) interviews and literature show that clear and honest messaging must be used to effectively communicate these topics, and this must take into consideration the vectors used to disseminate information in small communities such as Facebook.

There were also a few areas of interest where previous research differed or had not previously covered. Firstly, a significant portion of studies focus on environmental aspects of CEA, whereas this was not a concern for those interviewed here. Although participants did view systems as environmentally friendly, it was not a main contributor to their support for CEA, while it was for participants in previous research (Benis & Ferrão, 2018; Ercilla-Montserrat et al., 2019; Gilmour, 2018; Perambalam et al., 2021). One participant in this research attempted to explain this difference as they felt that food security is less of a concern in some European nations where research was conducted in comparison to Canada, and there is more of a concern over agricultural space in Europe compared to a large expansive country such as Canada. Many previous studies also found that CEA-grown produce is believed to be unnatural and separate from nature (Al-Chalabi, 2015; Coyle & Ellison, 2017; Jaeger et al., 2023; Jürkenbeck et al., 2019; Miličić et al., 2017; Specht et al., 2016; Yano et al., 2021), which was not the case here. Participants seemed almost indifferent to the growing methods, so long as they received fresh and healthy produce. Hydroponics is just a means to an end in many ways, and the end is of much more importance than the means.

Another large focus of the literature reviewed here was the price and willingness to pay for CEA-grown produce. This was not as much of a focus of participants, but the general sentiment was that the price point is still not acceptable to some, but the more important part is getting consumers to understand the value of healthy foods to justify the cost, whatever it may be. Some participants discussed the need for improved policy and government funding to decrease prices and increase accessibility. Although policy was discussed minimally in these interviews, those who did agree that government and policy can be a barrier to the adoption of CEA.

The few articles reviewed that touched on applications of CEA in cross-cultural settings acknowledged that different communities value food differently and therefore not all findings can be applied equally across geographic scales (Gan et al., 2023; Mina et al., 2023; Moragues-Faus & Marsden, 2017), which I would also agree with based on this research. Many interview participants touched on the idea that although leafy greens may not be culturally relevant to their community, CEA can be used to reintroduce various cultural practices, whether farming, community feasts, or working collaboratively towards a common goal. This was something not studied in previous literature, and a significant finding of this research.

## **9.2 Outcomes and Contributions**

Hydroponic food systems in Canada aim to address the issues at the junction of food security, food sovereignty, climate change, and reconciliation. The aspirational outcome of this work is the improved implementation of hydroponic food systems in Canada that increase food sovereignty and help mitigate, adapt to, and reduce contributions to climate change. Although this research will not directly reduce food insecurity nor stabilize the fragilities of food systems, the results can be used to improve programs that reduce barriers to accessing healthy foods. The outcomes of this research, firstly, will be the sharing of results

with Growcer Hydroponics Inc., to convey best practices moving forwards so the above future can be attained. Secondly, this research will add to the small body of literature that is currently available on CEA in Canada, the social and cultural impacts of CEA, and CEA in cross-cultural settings. Doing so may help implementations of such programs beyond just those done by Growcer. This might include recommendations for communities that chose to implement CEA, and how they can increase the project's impact, and get the most from their foods. As this research has shown, there is minimal research addressing the sociocultural sustainability of CEA, particularly in a Canadian context, and despite this lack of research, implementation continues. This research will contribute essential information on topics to consider prior to, and throughout the creation of a local food system through innovative urban agriculture.

### **9.3 Limitations and Recommendations for Future Research**

This research was strengthened in many ways through partnership with Growcer Hydroponics inc. but provided then the views of people based on this one CEA system. Additionally, interviews were conducted with community members in communities with operations units, which may also be a limitation as they all generally had positive views of their hydroponics system. This research conducted interviews with eleven participants, and although interviews with small populations are more conducive to in-depth analysis (Young et al., 2018), a small population may also be a limitation of this research (Vasileiou et al., 2018).

Recommendations for future research include conducting interviews with people in communities that have no affiliation to the CEA suppliers and conducting research with communities utilizing aquaponics, aeroponics, or other innovative urban farming techniques in addition to hydroponics users outside of the Growcer network. Additionally, empirical

research on how these systems contribute to improved health outcomes through improved food security should be conducted, as these aspects are currently limited to speculation.

Further this research only briefly touched on the historical and ongoing impacts of colonial expansion in Canada which have hindered access to foods (Hippert et al., 2018) through infrastructure developments, or lack thereof (Stanley et al., 2019), decreasing skills and access required for attaining country foods (Steiner & Neathway, 2019), and other means. Future research should consider the ways in which infrastructural developments may impact and potentially further marginalize Indigenous communities in relation to food, and how historical and continued colonial expansion impact access to and growth of food in Canada. Lastly, the communities in Canada that are utilizing innovative farming techniques are each unique with specific needs and challenges. There is a recognized lack of life cycle assessments (LCA) of CEA, particularly in these specified contexts. Future research should incorporate a LCA approach.

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## Appendix

### a. Codebook

<b>Pillar / Theme</b>	<b>Sub-them</b>	<b>Definition</b>
<b>People</b>	Values	Ones morals, ethics, beliefs, and worldviews that shape their perceptions and priorities
	Produce Distribution	The ways in which produce is distributed to the community
	Other Perceptions & Awareness	Influence of awareness of CEA and perception of it on support for CEA
	Knowledge sharing	The sharing of knowledge within a community and between communities related to CEA or otherwise
	Health & Safety	Health, quality, and safety of foods as well as the health of individuals
	Physical Access to Food	related to difficulties or lack thereof in accessing food related to physical attributes
	Education	The use of food as an educational tool as well as education on food
	Culture, Traditions, Identity	Relationship between food, culture, and identity, including relationships between how food is sourced and culture and identity
	Community Development & Social Relations	The ways in which projects create broader benefits for the community such as education and leisure or improved social relations within the community
<b>Profit</b>	Financial Access to Food	Barriers to accessing food as a result of money
	Funding & Income	Funding such as grants to support local farms, and income of the farms and the people working them
	Jobs & Training	Jobs created by CEA industry and job stability and required training
	Economic Development	The improvement of a community's tax, revenue, and job base
<b>Planet</b>	Resiliency & Future-Proofing	Developing capacity within the community to better withstand future changes such as climactic, financial or otherwise
	Infrastructure	The build environment in a particular place and how it

		impacts life there
	Geography	Issues or benefits in relation to where the community is located in Canada
	Environmental Sustainability	Impact of traditional and CEA farming on the environment, including transportation
<b>Politics</b>	Policy	Policy related to farming and food
	Media & Communications	Food labelling, advertisements, media (news, social media etc.), and marketing in-store
	Growcer Internal Operations	Related to the ways in which Growcer as a company operates and relationships with communities

**b. Letter of Support for Research from Growcer Hydroponics Inc.**

## Letter of Support for Research

Office of Research Ethics  
University of Waterloo  
200 University Avenue West  
Waterloo, ON N2L 3G1

Subject: Letter of Support for research with Growcer Inc.

To whom it may concern,

This letter will serve as authorization for the University of Waterloo that Madeline Mitchell (PI) has received consent from Corey Ellis, representing Growcer Inc., to conduct research in collaboration with the organization for the Master's thesis project entitled *New Ways, Old Teachings: Understanding Canadian Community Values for Controlled Environment Agriculture in a Changing Climate*

Through community based participatory research partnerships with Growcer Inc., interviews will be conducted with community actors to understand patterns, behaviours, and sentiments related to governance and culture of hydroponics and local food systems. A mixed methods qualitative and quantitative approach will be used to establish nodes for understanding the current perceptions and values held by community members and how they are connected across a network of actors. This analysis will allow for the mapping of underlying dimensions of interactions, norms and decision making to map values, assess sociocultural impacts, and identify best practices for the future of hydroponics in Canada.

What is expected of Growcer: to disseminate recruitment letters provided by PI to employees, operators of their hydroponic units, and those involved in the process of approving/implementing hydroponic units in their community, as well as supporting the research process through regular meetings with PI.


Benefits to Growcer: Growcer will be provided with an executive summary of findings created from the results of interviews within Growcer's network. These results will help to highlight strengths and weaknesses within current implementation and operation of hydroponic units in Canada, which may allow for the improvement of operations. This research will also contribute to the growing field of controlled environment agriculture (CEA), and highlight socio-cultural impacts of CEA not previously assessed.

What is expected of PI: Madeline Mitchell (PI), will conduct semi-structured interviews with Growcer employees/partners, the result of which will be stored securely and anonymously, and Growcer will not be made aware of participant information or identification. Madeline will produce a master's thesis from the analysis of interview results, and share the results with Growcer in the form of an executive summary. A full

copy of the thesis can be provided upon request. PI will act respectfully and professionally with Growcer and partners in interviews, and regular meetings.

Benefits to PI: PI will have the opportunity to work with and learn from a leader within the modular food industry in Canada, and will be provided access to their network of partners and farms, in order to successfully complete a master's thesis project.

Sincerely,

  
Principal Investigator (PI)

2023-02-21  
Date

  
Growcer Inc. representative

2023-02-21  
Date

### c. Recruitment Letter

To whom it may concern:

My name is Madeline (Maddy) Mitchell, and I am a Master's student in the School of Environment Resources and Sustainability at the University of Waterloo. My master's thesis research will aim to uncover community beliefs and values relating to local food systems, particularly the role that hydroponic food units play within them. Controlled environment agriculture (CEA), including hydroponics, are gaining attention across Canada for their contributions to sustainable food systems. Hydroponics offers many potential benefits to communities reliant on global food systems, such as reduced emissions from the transport of foods, lower food prices, the creation of local jobs, and reduced vulnerabilities to changes in global food markets. CEA is also being promoted as a tool to reduce the impacts of climate change in northern and Indigenous communities, where the changing climate has exacerbated already disproportionate food insecurities. Despite research showing the validity of CEA and hydroponic units in reducing food insecurity, there is a lack of research into the sustainability of these operations, and their sociocultural impacts. The aim of this research is to understand attitudes held by communities towards controlled environment agriculture, specifically Growcer Inc. hydroponic units, as a pathway to building resilient local food systems across Canada.

To evaluate the aforementioned, I would like to conduct online interviews (no more than one hour long) with i) those who operate/have operated Growcer Hydroponic units, ii) those employed or formerly employed by Growcer Inc., and/or iii) those who played a role in the approval/implementation of a Growcer unit(s) in their community. Participants will be offered a \$30 Amazon gift card as a thank you for their time.

Questions will be asked to assess perceptions of the benefits, and impacts of hydroponic units and local food systems. There are no anticipated risks of participating in this research.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board and is being conducted under the supervision of Dr. Kelsey Leonard in the Faculty of Environment (kelsey.leonard@uwaterloo.ca or at 519-888-4567 ext. 40). Your participation will be considered confidential in study results. Your name will not be included



in any paper or publication resulting from this study, however, with your permission anonymous quotations may be used and you may be referenced generally (e.g., “One community member said...”; “An operator noted that...” etc.)”. Additionally, you will be given the opportunity to review and approve your anonymized quotations prior to use in any publications.

If you are interested in being a participant in this research, please send me an email at [m7mitche@uwaterloo.ca](mailto:m7mitche@uwaterloo.ca), and I will provide you with more information, including consent forms, and scheduling info. Please feel free to contact me with any questions that you may have.

Thank you,  
Madeline Mitchell

#### d. Interview Script

##### Interview Script:

- Hi, thank you all for agreeing to participate in this study today. My name is Maddy Mitchell and I will be talking to you today about your experiences with Growcer's hydroponic food system, specifically how you feel about local food systems, and how the hydroponic unit(s) are(is) impacting your community. This will help Growcer to improve their programs and help us to understand community values relating to food, sustainability, and controlled environment agriculture.
- As a “thank you” for your participation, we are offering a \$30 Amazon e-gift card. If you would like to accept this card, it will be delivered by email. Would you like to receive the e-gift card? [If the incentive is desired, please make sure we have an email address for the participant.]
- The interview should take no longer than an hour. I have received your consent form, although can I confirm that I have your consent to participate today?
- Do I have your consent to record the session today?
- Your name will not be recorded, and please do not offer any personal information in the recordings or any information you do not wish to be included in the report. You can skip questions that you do not want to answer, and you can leave this interview anytime if you are not comfortable with the question.
- You have completed the consent form for this interview, but I just wanted to point out a couple things from that form. Of note, the information that you provide me will be only used in an anonymous fashion, you will not be identified in the study. You also have the opportunity to withdraw from the study, or not answer any of the questions. You can withdraw at any point until December 1st, 2023. If you wish to do so, please just send myself or my advisor an email via the information provided in the consent form, and I will confirm with you.
- Finally, you will receive the transcripts of this interview, and can choose to receive a short report on the results of this study.
- Do you have any questions about the study, the consent, or the interview process before we start?

## **e. Interview Questions for Community Members**

1. How would you define your community?
2. What were the motivating factors for the implementation of a hydroponic unit in your community?
3. How do you view the relationship people have with food in your community?
4. What are some flaws you feel are presented within the current food system in your community?
5. What are your views on hydroponic farms, and do you feel they are an appropriate solution to addressing the flaws you previously mentioned?
6. How do you feel the hydroponic unit is impacting your community and its members aside from simply food production (i.e. community cohesion, knowledge production, etc.)
7. If you could change the way the hydroponic unit was implemented, how it operates, how produce is sold/dispersed, what would you change?
8. What do you believe, if any, are the social and cultural impacts on your community of producing food locally?
9. What do you believe are your communities top values?
  - a. How does your community value nature?
10. What do you believe are your communities top priorities?
  - a. How does your community prioritize sustainability?
11. What do you believe are your communities top challenges?
  - a. Do you believe this plays a role in the success/failure of a hydroponic unit?

## **f. Interview Questions for Growcer Employees**

1. In what role are you employed by Growcer? For how long?
2. What do you feel are the factors that motivate a community to implement a Growcer unit?
  - a. Do you feel the unit successfully addresses these motivations in most cases? Why or why not?
3. What factors support hydroponic units' success in communities? Do you believe success rates vary based on rural vs urban communities? (south vs north?) If so, why?
4. What barriers do you feel exist to hydroponic units receiving large-scale community buy-in?
5. What changes do you feel could be made to better support the success of hydroponic units in Canada? Both in promoting food security and in addressing other community needs?
6. What do you believe, if any, are the social and cultural impacts on a community of having a local food system / hydroponic unit?

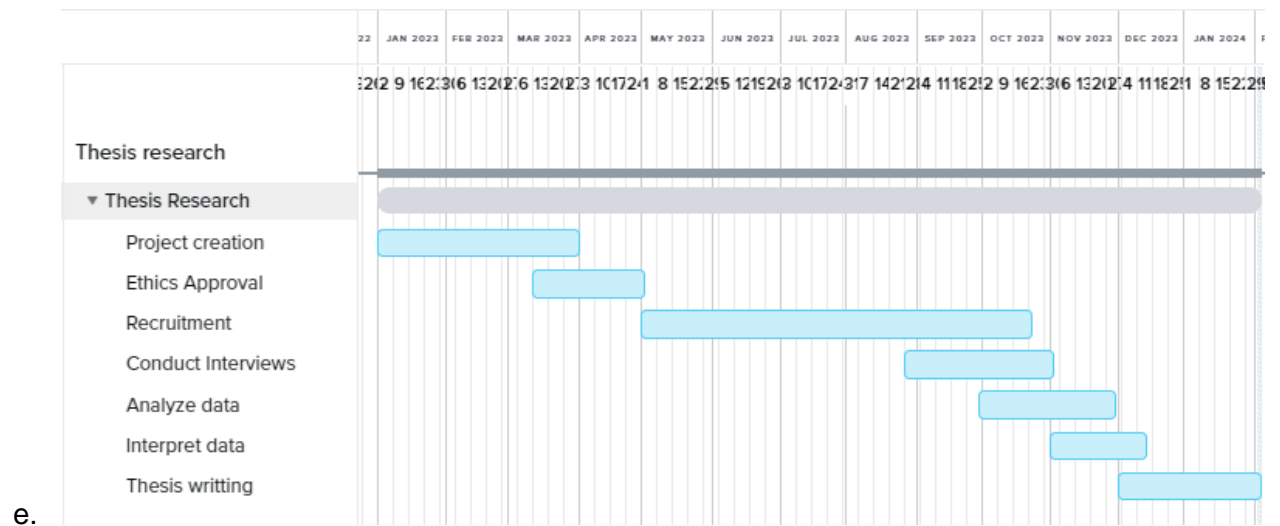
### **g. Interview Questions for Farmers / Growers**

1. How would you define your community?
2. How do you view the relationship people have with food in your community?
3. In what capacity were you involved in hydroponic farming? For how long?
4. What are some flaws you feel are present within the current food system in your community?
5. What are your views on hydroponic farming, and do you feel they are an appropriate solution to addressing the flaws you previously mentioned?
6. How do you feel the hydroponic unit is impacting your community and its members aside from simply food production (i.e. community cohesion, knowledge production, etc.)
  - a. What do you believe, if any, are the social and cultural impacts on your community of producing food locally?
7. If you could change the way the hydroponic farm was implemented, how it operates, how produce is sold/dispersed, what would you change?
8. What do you believe are your communities top values?
  - a. How does your community value nature?
9. What do you believe are your communities top priorities?
  - a. How does your community prioritize sustainability?
10. What do you believe are your communities top challenges?
  - a. Do you believe this plays a role in the success/failure of a hydroponic unit?
11. Did you feel that your work as a grower is/was respected in the community? Why or why not?

## h. Interview Closing Script

- Thank you very much for participating in this research.
- Is there anything that you were hoping that we would discuss today that we didn't?
- Do you have any questions?
- Is there anybody that you know of who might be helpful to this research, who may want to participate?

## i. Timeline



## j. Ethics Clearance Certificate

### UNIVERSITY OF WATERLOO

#### Notification of Ethics Clearance to Conduct Research with Human Participants

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Principal Investigator: Kelsey Leonard (School of Environment, Resources and Sustainability)

Student investigator: Madeline Mitchell

File #: 45151

Title: New Ways, Old Teachings: Understanding Canadian Community Values for Controlled Environment Agriculture in a Changing Climate

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The Human Research Ethics Board is pleased to inform you this study has been reviewed and given ethics clearance.

**Initial Approval Date: 05/01/23 (m/d/y)**

University of Waterloo Research Ethics Boards are composed in accordance with, and carry out their functions and operate in a manner consistent with, the institution's guidelines for research with human participants, the Tri-Council Policy Statement for the Ethical Conduct for Research Involving Humans (TCPS, 2nd edition), International Conference on Harmonization: Good Clinical Practice (ICH-GCP), the Ontario Personal Health Information Protection Act (PHIPA), the applicable laws and regulations of the province of Ontario. Both Boards are registered with the U.S. Department of Health and Human Services under the Federal Wide Assurance, FWA00021410, and IRB registration number IRB00002419 (HREB) and IRB00007409 (CREB).

This study is to be conducted in accordance with the submitted application and the most recently approved versions of all supporting materials.

**Expiry Date: 05/02/24 (m/d/y)**

Multi-year research must be renewed at least once every 12 months unless a more frequent review has otherwise been specified. Studies will only be renewed if the renewal report is received and approved before the expiry date. Failure to submit renewal reports will result in the investigators being notified ethics clearance has been suspended and Research Finance being notified the ethics clearance is no longer valid.

Level of review: Delegated Review

Signed on behalf of the Human Research Ethics Board



Erin Van Der Meulen, Research Ethics Advisor, [ervandermeulen@uwaterloo.ca](mailto:ervandermeulen@uwaterloo.ca), 519-888-4567, ext. 47046

This above named study is to be conducted in accordance with the submitted application and the most recently approved versions of all supporting materials.

Documents reviewed and received ethics clearance for use in the study and/or received for information:

file: Letter of Support for Research (signed) - V1 - 02,23.pdf

file: Email script - V2 (04\_10).docx

file: Recruitment letter - V3 (04\_23).docx

file: Growcer Employees Interview Script and Questions - V1 (02\_23).docx

file: Community Members Interview Script and Questions - V1 (02\_23).docx

file: Growers Interview Script and Questions - V1 (02\_23).docx

file: Consent form - V3 (04\_23).docx

file: Thank you Letter - V1 (02\_23).docx

Approved Protocol Version 3 in Research Ethics System

**This is an official document. Retain for your files.**

**You are responsible for obtaining any additional institutional approvals that might be required to complete this study.**

## Glossary

<b>Concept</b>	<b>Definition</b>	<b>Source</b>
Alternative Food Network	Food systems that differ from traditional supply chains that often place importance on social networks and place-based values rather than capitalist and market-based values and solutions	(Christensen & O’Sullivan, 2015)
Aeroponics	A soilless growing technique that involves the application of nutrient-rich aerosols to plant roots, often suspended in a vertical format	(Eldridge et al., 2020)
Aquaponics	An integration of fish farming with soilless plant growth. Fish are reared within the confined water source for the plants, which allows the nutrients from the fish excrements to be used to support plant growth	(Stecyk, 2020)
Climate Change	Changes to the normal temperature, precipitation, and weather patterns through human changes to the Earth’s physical, chemical, and biological biospheres	(Agriculture Canada, 2012)
Controlled Environment Agriculture	The growth of crops indoors, usually hydroponically, where most environmental aspects can be controlled, including water, lighting, and temperature	(Cohen et al., 2022)
Digital Farming Technology	The use of digitization such as sensors, automation, and robots in agricultural production	(Pfeiffer et al., 2020)
Food Geography	The recognition of foods connection to place, land, environmental resources, and the people of the place	(Hammelmann et al., 2022)
Food Pedagogy	Learning about food systems, justice, economy and other topics through food	(Park et al., 2022)
Food Security	Having limited and or unstable access to nutritious, safe, and acceptable foods	(Jernigan et al., 2012)
Food Sovereignty	“the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods and their right to define their food and agriculture systems”	(La Via Campesina, 1996)
Hydroponics	A Soilless growing method that delivers nutrients to plants, often suspended in a wool-like substrate, through water	(Gumisiriza et al., 2023)
Indigenous Community	Including First Nations, Métis and Inuit peoples on or off reserve lands	(Skinner et al., 2013)
Innovative Urban	The optimization of food production through the decrease in maintenance and increase of yield through	(Armanda et al., 2019)



Agriculture	the use of novel technologies	
Political Ecology	The acknowledgement of political, economic, and normative forces on shaping and changing human-nature relationships	(Margues-Faus & Marsden, 2017)
Reconciliation	“the ongoing process of establishing and maintaining mutually respectful relationships between Indigenous and non-Indigenous peoples in order to build trust, affirm historical agreements, address healing and create a more equitable and inclusive society”	(Government of Manitoba Reconciliation Act, 2016)
Remote Community	Areas, typically found in northern parts of Canada, that are difficult to extremely difficult to access, often with low population and density, also characterized typically by more unmet health needs and low life expectancy compared to urban counterparts	(Subedi et al., 2020)
Rural Community	An area with fewer than 1,000 inhabitants with a population density of 400 people/km <sup>2</sup> or less	(Statistics Canada, 2021)
Uncontrolled Environment Agriculture	Localization of agricultural production within city boundaries	(Astee & Kishnani, 2010)
Vertical Farming	The stacking of crops grown utilizing various greenhouse technologies, often hydroponics, inside buildings	(Despommier, 2011)