



Building a Climate-Resilient City: Agriculture and food security

KEY MESSAGES:

- Strengthening local food systems increases resilience to supply shocks from climate change impacts on international supply chains.
- Cities should protect available agricultural land both within and around municipal boundaries for food production using innovative methods such as aquaponics and vertical agriculture.
- Small-scale food production and processing can bolster food security and provide employment, thereby strengthening local food systems and community cohesion, and should be encouraged through municipal policies, including procurement.

In recent decades, Alberta has experienced significant changes in its climate as well as its economy, population and environment. Alberta's mean annual temperatures are increasing and projected to continue to rise in the coming decades—potentially by 2.0°C by the 2030s and 4.0°C by the 2060s (compared to the 1990s) — should the current rate of global greenhouse gas emissions remain unchanged. Total average annual precipitation is also projected to increase, but this change will vary between seasons;

precipitation levels are likely to increase more in the winter and decline in the summer.¹ While these shifts in average climate conditions are significant, the more profound risk of climate change lies in the expected increase in climate variability and extreme weather events such as longer heat waves and more frequent heavy rainstorms. Should global greenhouse gas emission rates decline, the change in Alberta's climate will be less severe but still significant.



These climatic changes have real implications for food security in Alberta's urban centres, including the cities of Calgary and Edmonton. More frequent extreme weather events could damage critical infrastructure required to transport food supplies to and within cities, as well as impair the capacity of citizens to access groceries. Declining summer rains and greater risk of drought would limit the availability of water needed for local food production. Higher summer temperatures will increase refrigeration needs, placing a greater demand on energy systems.

The complexity and interconnectedness of the global food system, with its long supply chains, also means that climatic impacts in major growing regions around the world have a ripple effect on local availability of some types of food and more expensive grocery bills in Alberta. This potential is illustrated by the impact of California's recent four-year drought. Declining water availability reduced yields and depleted soils, limiting exports from the state and causing fruit and vegetable prices to increase globally.² Other similar impacts are likely in the future. For example, it has been estimated that higher temperatures and changing rainfall patterns could reduce by 50 per cent the global area suitable for coffee production by 2050.³

Strengthening the resilience of Calgary and Edmonton's local food systems would contribute to building the overall resilience of these cities to climate change. A resilient city is one in which its institutions, communities, businesses and individuals have the capacity to function and are able to "survive, adapt and grow" in response to any kind of sudden short- or long-term disruption that they might experience. Such cities integrate the qualities of flexibility, redundancy, robustness, resourcefulness, reflectiveness, inclusiveness and integration into all aspects of city functions (see Box 1). These qualities of resilience are considered to be essential to preventing the breakdown or failure of a system and to enable it to take action in a timely manner.⁴

BOX 1. QUALITIES OF A RESILIENT CITY⁵

Reflective: People and institutions reflect and learn from past experiences and leverage this learning to inform future decision making.

Robustness: Urban physical assets are designed, constructed and maintained in anticipation of high-impact climate events.

Redundancy: Spare capacity is built into the system to account for disruptions and surges in demand. It also involves multiple ways of fulfilling a need or function.

Flexible: Refers to the willingness and ability to adopt alternative strategies in response to changing circumstances or sudden crises. This can be achieved through new knowledge and technologies.

Resourcefulness: Citizens and institutions are aware of climate risks, able to adapt to shocks and stresses and are able to quickly respond to a changing environment.

Inclusive: Inclusive processes emphasize the need for broad consultation and many views to create a sense of shared ownership or a joint vision to build city resilience.

Integrated: Integrated processes bring together and align city systems to promote consistency in decision making and investments. Exchange of information between components of the system enables them to function collectively and respond rapidly.

This paper examines ways to build resilience in urban agriculture and the food system as a contribution to urban resilience building. Its purpose is to identify elements of local food systems that can be strengthened, highlight best practices in the field and suggest interventions that local governments can use to build a more resilient food system. It is one of a series of papers prepared by the [Prairie Climate Centre](http://prairieclimatecentre.ca)

to provide the public and government officials with an overview of the means by which to build cities that are resilient to the impacts of climate change, drawing on lived experience and best practices.

Envisioning a Resilient Food System

A resilient urban food system is one in which citizens are food secure; that is, they have reliable access to healthy, affordable and culturally appropriate food. In addition, a resilient food system is food sovereign, meaning that people have decision-making power over where their food comes from. To build a more resilient food system, cities need to create an enabling environment within which food can be grown, processed and sold locally while also retaining access to national and international sources. This requires sufficient natural and infrastructure resources being made accessible for both personal and commercial use and protecting growing areas against pressures from development. In this way, food value chains can be shortened, simplified and multiplied. By doing this, uncertainties in the system are reduced, decreasing the risk of price spikes and shortages. These efforts should be complemented by public education and the strengthening of community networks focused on food production, processing and purchasing to enable families and neighbourhoods to build their own resilience and food security.

Although many aspects of the food system lay outside the jurisdiction of municipal governments, there are still interventions that they can implement to help build a resilient city. This potential can be demonstrated through interventions that enhance three of the qualities of a resilient city: robustness, redundancy and resourcefulness.



Building Robustness

Building robustness into an urban food system is dependent on maintaining and expanding the key natural and infrastructure resources needed for the system to thrive. This requires two things: land for traditional agriculture practices needs to be proactively allocated and protected for urban and peri-urban agriculture activities; and cities need to embrace new, diverse ways of growing food such as rooftop agriculture, aquaponics⁶ and vertical agriculture.⁷

Land-use zoning bylaws build robustness into the food system by securing space in urban environments for food production and sale from commercial and community gardens as well as encouraging the sale of home-grown produce. Urban and community agriculture zones, ordinances that allow communities to sell the



produce they grow in their yards or small market gardens, allowances for community-supported farming operations, nurseries, greenhouses and animal husbandry operations are all models that secure the natural resources necessary for urban food production. They also provide an added element of resourcefulness by providing an enabling environment for citizens to engage in local food production and distribution. Such zoning bylaws have been implemented across the United States in cities such as San Francisco, Oakland, Seattle and Philadelphia, among others. While the details of the bylaws in each city are different, they all allow for small-scale production and distribution of food at the community level, which increases the volume and types of foods being produced and sold locally and encourages people to start sustainable production models such as community-supported agriculture programs (CSAs) and community market garden co-ops.⁹

Designated greenbelt zones around city peripheries are a valuable method of conserving natural spaces and preserving peri-urban farmland—an important local source of food for cities. Greenbelts and the policies developed to protect agricultural land within their jurisdictions improve the robustness of cities' food systems by protecting productive cropland, thereby encouraging food production that can be sold locally. Greenbelt zones have been established in cities across Canada such as Toronto and Ottawa, and around the world in cities such as Beijing, China and London, England.

As most food is grown outside the city perimeter, it is important to take a broader look at the resilience of the whole region and support local agriculture. A vibrant local farming industry close to city limits encourages urban-rural linkages and understanding about how food is grown; it also shortens food supply chains, making them simpler and more adaptable to climate shocks.

BOX 2. CASE STUDY: VERTICAL FARMING IN CHICAGO, ILLINOIS⁸

Using energy-saving technology like next-generation LED grow lights, commercial indoor vertical farming operations in Chicago are emerging. Facilities are able to harvest up to 26 times a year using 85 per cent less energy, one tenth the water and eliminating pesticide and herbicide use entirely. While many of these facilities currently only grow micro and other leafy green vegetables (lettuce, micro-greens, arugula, etc.) with short crop cycles, the potential to grow more energy-intensive and conventional foods exists. Companies such as FarmedHere, a 90,000 square-foot facility—the largest in the world—have been successful in Chicago in part because of zoning amendments to urban agriculture passed by council in 2010. The new law allows provisions for hydroponics and vertical farming operations to run in all “Planned Manufacturing Districts” citywide.

Encouraging private investment in hydroponic food production can stimulate economic development by creating jobs, lowering production costs by reducing transportation needs and decreasing risk by increasing predictability in the food supply chain. Amending city zoning and bylaws to allow hydroponics and vertical farming facilities to operate is the first step toward enabling these benefits to be realized.

This means that the likelihood of food reaching tables is more probable as climatic conditions become more variable and extreme. Both Rotterdam in The Netherlands¹⁰ and the Waterloo region in Ontario¹¹ have made great strides to map out their regional food suppliers to support local food production and promote buying local produce.



Because land in cities is a scarce commodity, innovative ways of growing food without the use of soil have been developed and are now used around the world. Hydroponic and aquaponic food production can be started in warehouses and vacant buildings throughout cities. Through technology advances that reduce resource use and costs, the vertical farming model is quickly becoming a viable option for producing affordable, fresh produce within cities while using less resources than conventional farms.

Promoting Redundancy

Promoting redundancy in the food system involves increasing the amount, quality and diversity of the resources necessary for getting food from the ground to the plate. It also involves ensuring that there is spare capacity within food systems to compensate for disruptions to logistics and account for spikes in demand, making them better able to withstand the climate shocks that typically cause food and water shortages.

Municipal composting programs, such as Calgary’s recently initiated Green Cart Food and Yard Waste Program and Edmonton’s composting facility and Master Composter Recycler Program,¹² can increase redundancy in urban food systems. Diverting organic waste from landfills has many benefits. It helps to reduce physical waste and methane gas production and, once processed, the compost can be used for improving soil structure and nutrient levels for urban agriculture initiatives and green space enhancements throughout the city. When organic compost is used over the long term, overall soil structure and health are improved, which provides direct benefits in the way of increased yields and water absorption and retention—a particularly important benefit during periods of both heavy rainfall and drought.¹³

Similarly, water is a key natural resource necessary for ensuring productive yields and healthy crops. Urban farmers and gardeners rely on access to municipal water sources. In times of drought, this reliance means that water bans can result in crop failures. Improving the resiliency of the water system as a whole can

therefore support a more resilient food system. Methods of improving redundancy in a municipal water system include diversifying potable water sources to include both surface and ground water where available, adoption of smart irrigation technologies and drip irrigation systems that greatly reduce water wasted, and water collection and storage through rain barrels.¹⁴

Building resilience into other components of a city’s infrastructure, such as transportation routes and energy and telecommunications systems, also helps to alleviate stress placed on the food supply chain. For example, in the event of prolonged power failures due to an overloaded energy system or extreme weather events, supermarkets are often forced to close in order to reduce food spoilage. In a resilient system, large food distribution centres such as supermarkets and food banks, as well as commercial food processing and storage facilities, would have back-up generators. Incentives can be provided to encourage businesses to adopt these practices that build their resilience as well as the resilience of the communities they serve.¹⁵





Spare capacity in the food supply chain is also very important during times leading up to and during natural disasters, as this is when consumer demand for food and bottled water is typically highest. Given that supermarkets typically only carry three days worth of food, these spikes in demand tax food and water supplies, as seen during the Calgary flood in 2013.¹⁶ However, building redundancy, or extra capacity, into a food system can be difficult as there is a need to keep food waste to a minimum while at the same time buffering against demand shocks. One example of a way to achieve this balance is to provide water fill-up stations at public access points across the city. In times of crisis, this measure will help alleviate the potential for a bottled water shortage, ensure that citizens have access to safe drinking water and buffer the panic to purchase bottled water in stores. Considering food and water access and supply concerns in disaster preparedness plans and policies from their inception can help identify these resilience-building mechanisms.



Encouraging Resourcefulness

There are many urban agriculture models that help to increase community resourcefulness, improve natural environments and add to local food security. Individuals and groups nationwide are now using innovative marketing models and growing techniques that are tailored for urban production. Small Plot Intensive (SPIN) agriculture and permaculture are methods being used to grow food, while CSAs and farming co-operatives have been instrumental in providing a venue. Both Calgary and Edmonton have vibrant urban agriculture communities. Urban beekeeping is underway in both cities, and Edmonton launched an urban hen keeping pilot project in late 2014.¹⁷ As well, within and around each city, a number of local farms and market gardens are selling produce grown using sustainable techniques.

Such initiatives provide an opportunity for Albertans to meet their individual tastes. As cities grow and become more diverse, their food needs also change. While many exotic fruits and vegetables must be shipped from overseas, some can be grown in urban agriculture plots on the Prairies. These urban agricultural plots can meet local production needs while also providing new Canadians with opportunities to share their knowledge of growing ethnic foods. FarmStart in Brampton, Ontario has tapped into the diverse immigrant community in the Greater Toronto Area to do just this. Through their incubator farm, new Canadians test crops that are in demand in Toronto's ethnic communities. New crops mean new market opportunities for producers able to meet the needs of local restaurants and grocery stores.

Cities can further build resourcefulness into their food system and stimulate their local economies by developing policies that support growth of the cottage food industry—businesses where the product development happens in the home.¹⁸ By reducing the restrictions on how and where artisan foods are made, individuals can start their own small businesses without needing to invest in costly commercial kitchen space and



equipment. A permit structure can be established to track businesses in this category. While there are few laws in Canada, most states in the United States have laws and guidelines for cottage industry producers. The first step to enabling such an industry is to examine the potential roadblocks, risks and confusion around food safety regulations and general restrictions for entrepreneurs.

Providing public education on food issues is an essential part of creating a more resilient system. By combining resources from government public health programs and social services, not-for-profit agencies and private organizations, food literacy programs and outreach campaigns can be developed to teach families about food budgeting, nutrition, preservation, preparation and disaster preparedness, while at the same time providing people with a nutritious meal. Community Food Centres, including Calgary’s Alex Community Food Centre¹⁹ and its counterpart organizations across Canada,²⁰ can play an important role in providing the space necessary for such programs. Offering the knowledge, skills and resources to people so they are able to reduce their food budgets, provide healthy food to their families and develop small businesses close to where they live can go a long way to fortifying local food systems through strengthening connections between individuals and giving them access to the resources they need to make their own families more food secure.



BOX 3. COMMUNITY FOOD CENTRES

Community Food Centres can be food hubs to build resourcefulness among residents. They can be used for:

- Bulk food buying clubs
- Small food banks
- Community kitchens for commercial food processing
- Soup kitchens and community suppers
- Community garden plots
- CSA box distribution points
- Farmers’ markets
- Fruit share and garden share programs to connect those looking for fruit and garden space to those who have it
- Mobile grocers and produce vendors

Another effective avenue to increase knowledge and awareness about healthy food production and consumption is by partnering with local schools to build these concepts into the curriculum and provide them with the tools and infrastructure necessary to produce and eat their own food. “Green schools” are a prime example of how school infrastructure and curriculum can be designed to incorporate these concepts. When students help grow their own food, they become more connected to what they eat and are encouraged to eat healthier. This also has a multiplier effect, as it encourages families to also be more involved in growing and preparing their own food. Growing food in schools can also help to supplement breakfast programs—making them more sustainable—and provide nutritious food that may otherwise be unaffordable. To support such initiatives, grants could be given to help build necessary infrastructure and establish partnerships between school boards and local universities to develop relevant curriculum material.



Recommendations

Cities can play a crucial role in fostering resilient food systems by developing policies that reinforce and enable robustness, redundancy and resourcefulness and by supporting projects that encourage individuals and companies to seek innovative solutions to existing food insecurity. Urban agriculture and local food industry that is community-based creates jobs and fills an important role in making affordable and culturally appropriate food more accessible throughout the urban landscape.

Strategic

- Building resilience to climate impacts into the urban food system means that cities need to think regionally and support production, processing and distribution both within and outside city limits. By simplifying and shortening food supply chains, cities can stimulate the local and regional food economy and directly influence the integration of resilience principles into the system. Work in this area should build on the urban agriculture and food strategic plans developed by Calgary and Edmonton.^{21, 22}

Regulatory/Administrative

- Policy tools such as land zoning bylaws to allow for commercial agriculture within city limits and establish greenbelt zones make food systems more robust by protecting land needed for food production.
- Developing legislation requiring food distribution centres to have emergency power helps to build redundancy and can be essential in making sure people have continuous access to food as well as reducing food waste due to spoilage.
- Developing clear guidelines and standards for cottage food industry supports citizens in forming a more resourceful food system as they bring new products into the food economy.

Economic Instruments

- Small grants to start cottage industry businesses and urban commercial agriculture operations and to support food projects help grow the economy while providing more local food to cities.

Voluntary/Community Linkages

- Awareness campaigns around buying local produce, disaster preparedness and coordinated food education and resource programs can help to increase household resilience and decrease the need to purchase supplies immediately before extreme weather events. Investing in greening school infrastructure and incorporating growing food into curriculums helps to change behaviours both of students and their families.
- The above recommendations can work in tandem with each other to fortify the current sustainable food movements in Calgary and Edmonton. The most important component of building a resilient urban food system is ensuring that citizens are onboard with city efforts. Community engagement throughout decision-making processes will help to gain acceptance for and adoption of new ways of perceiving the local food system.





References

- ¹ Projections based on data generated by the Pacific Climate Impacts Consortium. The average of 12 models over a 30-year time period were used for the time frames of 2021 to 2050 (the 2030s) and 2051 to 2080 (the 2060s) against a baseline of 1981 to 2010 (the 1990s) using a business-as-usual greenhouse gas emissions scenario (Representative Concentration Pathway 8.5). Further information is available through climate profiles created by the Prairie Climate Centre for Calgary and Edmonton.
- ² United States Department of Agriculture. (2017). California drought: Food prices and consumers. Retrieved from <https://www.ers.usda.gov/topics/in-the-news/california-drought-farm-and-food-impacts/california-drought-food-prices-and-consumers.aspx>
- ³ The Climate Institute. (2016). *A brewing storm: The climate change risks to coffee*. Retrieved from http://www.climateinstitute.org.au/verve/_resources/TCI_A_Brewing_Storm_FINAL_WEB270916.pdf
- ⁴ Rockefeller Foundation. (2015). *City Resilience Framework*. Arup International Development. Retrieved from <https://assets.rockefellerfoundation.org/app/uploads/20140410162455/City-Resilience-Framework-2015.pdf>
- ⁵ Ibid.
- ⁶ “Aquaponics is a sustainable food production system that integrates aquaculture (growing fish) and hydroponics (growing plants without soil) whereby both agricultural practices mutually benefit from each other’s presence in one production unit.” From: Food and Agriculture Organization. (2014). *Gaza leads the way with rooftop aquaponics for family nutrition*. Retrieved from <http://www.fao.org/ag/agp/greencities/pdf/GGCLAC/FAO-Gaza-aquaponics.pdf>
- ⁷ Vertical agriculture uses one of three different soil-free systems for providing plants with nutrients: hydroponics, aeroponics and acuaponics. These systems can be found in homes or in large warehouse facilities. They provide continuous crop production, eliminate herbicide and pesticide use, protect from weather-related variations in crop production, conserve and recycle water, and are people and climate friendly. Source: Birkby, J. (2016). *Vertical farming*. National Centre for Appropriate Technology. Retrieved from <https://attra.ncat.org/attra-pub/viewhtml.php?id=512#intro>
- ⁸ City of Chicago. (2010). Zoning Amendment would nourish urban agriculture citywide. Press release. Retrieved from https://www.cityofchicago.org/city/en/depts/dcd/provdrs/sustain/news/2010/dec/zoning_amendmentwouldnourishurbanagriculturecitywise.html
- ⁹ Shareable, SELC. (2013). *Policies for shareable cities: A sharing economy policy primer for urban leaders*. Retrieved from <http://www.shareable.net/download-your-copy-of-policies-for-shareable-cities>
- ¹⁰ Dowding-Smith, E. (2013). *Resilient urban food systems: Opportunities, challenges and solutions*. Outcomes of the Resilient Urban Food Systems Forum. Bonn, Germany. Retrieved from <http://www.securenutrition.org/resources/resilient-urban-food-systems-opportunities-challenges-and-solutions-outcomes-resilient-urban-food-systems-forum>
- ¹¹ Region of Waterloo. (2016). The year-round guide to local food. Retrieved from http://www.foodlink.ca/index.php?p=blbf_map_locations
- ¹² City of Calgary. (2017). Green Cart Food and Yard Waste Program. Retrieved from <http://www.calgary.ca/UEP/WRS/Pages/Recycling-information/Residential-services/Greencart/Greencart-composting.aspx?redirect=/greencart>
- ¹³ Ontario Soil Crop Organization. (2016). *Evaluation of green bin derived municipal compost to improve soil health on agricultural cropland (2013-2015 Final Report)*. Retrieved from http://www.ontariosoilcrop.org/wp-content/uploads/2016/02/V12-2015CrpAdv_Gen11_Evaluation-of-Greenbin-Derived-Municipal-Compost-to-Improve-Soil-Health-on-Ag-Land.pdf
- ¹⁴ These issues are further explored in the paper focused on water and sanitation produced as part of this Building a Climate-Resilient City series.
- ¹⁵ These issues are explored in greater depth in the energy and ICT paper produced as part of this Building a Climate-Resilient City series.
- ¹⁶ Alibhai, Z. (2015). Emergency experts deny food shortage in 2013 flood. *Calgary Journal*. Retrieved from <http://www.calgaryjournal.ca/index.php/news/2807-emergency-experts-deny-food-shortage-in-2013-flood>
- ¹⁷ City of Edmonton. (n.d.). Urban Hens Pilot Project. Retrieved from https://www.edmonton.ca/city_government/initiatives_innovation/food_and_agriculture/urban-hens-pilot-project.aspx
- ¹⁸ Environmental Health. (n.d.). *Guidelines for cottage industry involved in home food production*. Retrieved from http://www.gov.pe.ca/photos/original/doh_cottage_gl.pdf
- ¹⁹ Community Food Centres Canada. (2017). *The Alex Community Food Centre*. Retrieved from <https://cfccanada.ca/alex-cfc>
- ²⁰ Community Food Centres Canada. (2017). *Growing CFCs*. Retrieved from https://cfccanada.ca/growing_cfc
- ²¹ City of Edmonton. (2012). *Fresh: Edmonton’s Food and Urban Agriculture Strategy*. Retrieved from https://www.edmonton.ca/city_government/documents/FRESH_October_2012.pdf
- ²² City of Calgary. (2012). *Calgary Food System Assessment and Action Plan*. Retrieved from <http://www.calgary.ca/PDA/pd/Documents/Calgary-Eats/CalgaryEATS-Full-Food-System-Assessment-Action-Plan-for-Calgary.pdf>

In partnership with:



©2017 The International Institute for Sustainable Development and the University of Winnipeg

The Prairie Climate Centre is a collaboration of the University of Winnipeg and the International Institute for Sustainable Development established to advance practical climate change solutions for the Canadian Prairies. The centre's mandate is to translate climate science into knowledge products, frameworks and decision-making tools that will help local governments, the private sector, civil society organizations and other practitioners implement adaptation measures.

For more information visit: <http://prairieclimatecentre.ca/>

Author: Jennifer Temmer, International Institute for Sustainable Development

