Exploring Ground-level Container Gardening on the St. George Campus

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Introduction

Urban agriculture is an integral part of the sustainability community at the University of Toronto, supporting many of the institutional, city, and UN's sustainable development goals. There are a variety of staff, student, and faculty-led gardens located across the University of Toronto, including the rooftop garden on the Galbraith Building, the Anthropology Garden and Greenhouse, the in-ground UTSU Garden, and more ("Projects" n.d.). While the campus is budding with activity, there are structural and operational challenges to managing and scaling these traditional "community" gardens, including issues with visibility, physical accessibility, leaking, restrictions on participation, and infrastructure constraints (Puskar, 2020). The Sustainability Office (SO) at the St. George campus is interested in developing a more formal campus agriculture program and is exploring how ground-level container gardening might address some of these challenges based on feedback from local campus agriculture groups.

Objectives

The Project Team has been asked to explore how the SO could support existing and enable expansion of container gardening on the St. George campus, particularly for food growing, and will do so with the following research questions in mind.

1. Why and how might ground-level container gardening be used for growing food on campus? What needs to be considered? What are the best practices?
2. What are the existing campus agriculture groups doing? What is working, what is not?
3. How can the Sustainability Office support existing campus groups, enable new ground-level container gardens, and scale/promote efforts?

4. What alternatives should be considered in complement to or instead of ground-level container gardening to promote access, visibility/ engagement, and well-being with food growing on campus?

Methodology

To create a foundational understanding of our research topic and knowledge of practices within the gardening sector, we conducted a literature review. In order to gain a comprehensive perspective, our literature review included academic papers, news articles, and reports. Our literature review served the purpose of providing a thorough overview of the differences between container gardening and other types of gardening, such as rooftop and inground. This literature review aimed to determine the feasibility of container gardening on an urban campus like St. George. The literature pointed toward best and current gardening practices and how they should be applied to container gardens. Furthermore, we looked to gardening activities on other university campuses to gain insight as well, which contributed to our scan of other universities.

After we had begun our literature review and started developing our initial understanding of container gardening, we used this information to guide our questioning for our initial interviews. These interviews with gardening experts were served to deepen our knowledge and, additionally, to corroborate the data we have already collected from the literature. Three semi-formal interviews were conducted over Zoom with a staff person from the Trinity College Rooftop Garden, the farm coordinator at the UTSC Farm, and the director of McGill's Community Garden.

Finally, we created an online survey, which was sent out to groups at the University of Toronto and in the GTA who are currently involved in gardening ventures. We sent this survey to Dig In! Campus Agriculture, UTSC Campus Farm, OISE Community Learning Garden, Toronto Urban Gardeners, Community Garden Network, and Trinity College Rooftop Garden. The purpose

of this survey was to identify what groups are currently doing and further validate our literature findings. This data from this survey also served to identify gaps and opportunities for action for the Sustainability Office.

The final deliverables for this research project will be as follows:

1. **A scan** of what other universities are doing re: ground-level container gardening
2. **An inventory** of existing U of T campus group-run container gardening.
3. **A suite of recommendations** outlining how to move forward with ground-level container gardening on the St. George campus.
    a. **Infrastructure and logistics** – through the literature review, interviews and survey, a report on materials will be created consisting of what would be required for physical construction of container gardens, maintenance involved, water and sunlight along with what plants should be grown.
    b. **Staff and volunteer management –** through the data collected from interviews and surveys, best practices can be revealed from current garden operations which can be applied to improve garden operations more broadly.
    c. **Measurement & Evaluation –** current practices will be revealed to measure success of gardens which can impact further success.
    d. **Communications –** how best to promote garden efforts.

Findings: Literature Review

Literature reviews of academic and grey literature aimed to form a scan of what other urban schools are doing, and determine the characteristics of container gardens in the following areas: infrastructure and logistics, measurement and evaluation. In addition, this method has been conducted on the topic of container gardening to further develop our interview and survey questions.

Infrastructure and logistics

Abundant evidence shows that the crucial requirements for outdoor gardens' success including soil quality (Quigley, C., Tlusty, T., Hendrix, C., & Foster, A., 2015, CBC, 2020), water access (Majsztrik, John C., et al., 2017), and plant type considerations (CBC, 2020). An article from CBC that provides advice on how to grow a great garden states soil nutrition derived from a composition of nitrogen, phosphorus, and potassium is essential for plant growth. In addition, farming is traditionally a countryside event to have sufficient sunlight coverage; however, skyscrapers can easily block most of the light during the day when moving farms into cities. In other words, sunlight is essential for developing edible gardens and is a unique challenge for urban agriculture. One can argue that a container gardening approach can resolve some infrastructure challenges that other gardens face (i.e., rooftop gardens). A distinct characteristic of containerized gardens is mobility, which causes the spread of container gardens. Container gardening is lighter in weight and therefore easier to move and transport, resulting in greater operational flexibility and transportation efficiency. Different types of plants are allowed to meet their distinct environmental requirements by moving containers around without technical limitations. Mobility leads to less intensive transition management and maintenance because containers can be stored in a garage or greenhouse to avoid harsh weather during winter. Furthermore, container shipping allows growers

to sell plants year-round, regardless of soil conditions or plant growth stage, thereby increasing productivity per unit area (Majsztrik, John C., et al., 2017). Container operation can also improve water use efficiency by adequately building and maintaining irrigation systems and scheduling irrigation systems to minimize water and sediment runoff that can be used to transport pollutants.

Scalability makes container gardens cost lower than other gardens because underutilized rooftop terraces and corner plaza spaces, redundant open-air corridors, and later-used paving culverts can be used as diets for developing container gardening. The best container garden locations include flat surfaces like decks, balconies, driveways, and sidewalks (University of Maryland, n.d.). Also, different plants work best in different locations, such as boxes or hanging baskets near a window for food crops, to keep enough sunlight and fresh air, which promotes ripening. In terms of sunlight, tomatoes, peppers, eggplant, and squash need 6-8 hours of direct sunlight, while lettuce and spinach need 3-5 hours of direct sunlight. (University of Maryland, [APA], n.d.). Besides, container-grown crop producers can proactively adopt research-based best management practices to minimize the economic and environmental risks associated with limited access to high-quality water. They can be required to change by external factors such as regulations, and fines can adjust production practices over time as climatic conditions change.

Considerations pertaining to container gardens

Davis and Douglas (2020) from the University of British Columbia, discusses how containers lack adequate drainage, which affects the movement of water, air, and roots. Unlike in-ground gardens, pots in container gardens sit directly on the concrete land, which leads to the water and soil accumulation between the bottom of pots and the ground (Davis and Douglas, 2020). Davis and Douglas recommended using containers with unique “feet” design or placing containers on the strips of wooden lath or small ceramic tiles can work well for resolving the drainage problem

in container gardens. Even though containers come with open holes at the bottom for over-watering prevention, the potting soil at the bottom will still be saturated, contributing to devoid of oxygen. Potting soil is recommended to provide more air within the soil but is less stable than natural soil and associated with disease (Davis and Douglas, 2020). The complex interactions between roots and microorganisms occurring within the root zone of plants in terrestrial soil are drivers of many pathogenic root diseases. However, the complex systems have defense responses made of a rich microflora to prevent pathogens, microbial competition, and predation and restore ecological stability. In terms of container gardens, these complex systems do not exist in sterilized potting soils. The worst scenario is that while potting soils are kept too wet, a pathogenic organism is present along the side. There is no protection to keep the roots from waterborne diseases, and the damp environment will amplify the negative impacts of the pathogenic organism in the future. According to the University of Maryland Sustainability Office's experience, container gardening is the most demanding type of planting because the container size for this type of gardening is limited ("Container Gardening," n.d.).

Infrastructure alternatives

Previous literature review findings emphasize that container gardens have diverse characteristics, but they cannot complement in-ground gardens comprehensively. The hydroponic indoor farm wall at the University of Toronto Mississauga is being used for indoor gardening to solve many of the problems and adapt to an edible campus's modular nature. Master of Science in Sustainable Management (MScSM) students collaborated with Modular Farms Co., specializing in vertical farming systems, developed the hydroponic farm approach, and brought it to life. This hydroponic farm is located nearly six feet off the ground and lit by high-output fluorescent light bulbs, which grow plants hydroponically and uses a nutrient solution instead of soil. The water

nourishes the plants' roots, collects in gutters, and then circulates back to the nutrient tank, which feeds back into the hydroponic system. Seedlings in cuttings made of peat moss are initially placed in trays and then placed under a moisture dome where they germinate and are fed varying nutrients and pH levels. After a few weeks, they are ready to be transplanted into the tower. The farm wall also uses suction strips to help the water find the path of least resistance by controlling the water flow and bringing it directly to the seedlings' roots. In addition, the McGill University Community Garden uses semi-hydroponic techniques, including recycled bins, plastic sheets, and 30 cm long ABS pipes, (Bhatt, Farrah, Wolfe, & Luko, 2009). Watering is done through pipes, funnels, and cisterns, reducing watering frequency and overflow, thus preventing root rot. Furthermore, semi-hydroponic technology is being explored and adopted in school gardens because it solves a facility problem that many school gardens face today and because it is low-cost and low maintenance.

Measurement and evaluation

The produce that grows on the community garden at university of toronto scarborough campus includes tomatoes, corn, squash, cucumbers and herbs such as sage, rosemary, mint (Community Gardens, n.d.). The food that is harvested in this garden is then utilized in Farmer's Markets for free samples, food events on campus such as the Food Discussions Café, the Healthy Campus event, and also donated to food banks on and off campus.

Staff and volunteer management, and Communications

The presence of container gardening is an essential tool for increasing community involvement and collaboration among agricultural organizations everywhere, and almost all gardens employ healthy practices. Therefore, they are considered contributors to food security and sustainability (University of Dalhousie, n.d.). In addition, university gardens can provide some

assistance in increasing public volunteer opportunities for communities and community-based organizations (Edwards, 2016), as well as improving language and literacy skills (Edwards, 2016) for children, adults, and individuals. This is because it provides an opportunity to read about plants and insects, research the best plants of the season, and design for the garden. The results are mutually beneficial because the university gains practice in volunteer management, and the volunteers gain skills (Edwards, 2016). In terms of volunteer and staff management, many on-campus gardens use a seasonally phased approach to get volunteers to learn about and participate in garden activities, especially those related to infrastructure and logistics. For example, in an article by Bhatt et al. (2009), the authors discuss the Edible Campus project in Montreal and how it was created in collaboration with volunteers, researchers from two local NGOs, and university researchers. Within this project, community volunteers, as well as university staff, need to tend to the garden three times a week and spend three hours a day watering, weeding and harvesting (Bhatt et al., 2009). In addition, it is crucial to maintain the garden according to the seasons. In spring, the gardens need to be installed and planted, while in early summer, the focus is on planting activities. Late summer and early fall are harvest times; thus, this is when volunteers and staff need to devote more time to participate. In mid-autumn, after the harvest, the garden paved area will be closed and cleaned up for the winter, and the containers will be stored together for the next season. In addition, the Sustainability Office plays a vital role in volunteer management and promoting community involvement. For example, a University of Toronto Scarborough webpage on container gardening mentions that the UTSC Sustainability Office is involved in maintaining and sustaining the garden by teaching organic farming practices such as companion planting and non-toxic pest management to students who volunteer, (University of Toronto, Scarborough Campus, 2015).

A study assessing the impact of a vegetable and snack program on the home consumption of First Nations children further confirmed that container gardens increase community engagement. Children at each grade level planted and tended container gardens in their classrooms and tasted and rated the foods that could be harvested after a waiting period of about seven months. (Triador et al., 2014). Preference scores for vegetables and fruits increased over 7 months, but there was no change in household consumption. The study concludes that family engagement may be needed, along with increased availability of produce in the community, to promote household consumption. In addition to this, many university gardens seek other ways to promote community engagement; Dalhousie University's on-campus garden has a membership program to create community engagement (University of Dalhousie, n.d.). To facilitate the garden's management and maintenance, the garden is divided into 40 plots, and members are given the right to choose the crops they want to grow. In addition, members are charged a certain amount of rent for the plots, but half of this rent will be refunded to members if the plots are well managed and protected (University of Dalhousie, n.d.).

Findings: Interviews

Our interviews contribute towards an inventory of existing U of T campus group-run container gardening and the suite of recommendations in the following areas: communication, measurement, and evaluation, staff and volunteer management, infrastructure, and logistics. First, we interviewed Nathan Postma, who was involved in creating the rooftop container garden on the North House at the Munk School in 2018. Subsequently, we interviewed Beatrice Lego, who was involved with the creation of the Huron-Sussex community garden and then later, the University of Toronto, Scarborough (UTSC), urban farm. Finally, we spoke with Mitchell McLarnon, director of the McGill University Education Garden Community that cooperates with the Montreal

agriculture organization. His team has established six community gardens, which include: McGill Faculty of Education, Westmount Park Elementary School, Benedict Labre House, Dans La Rue, Studio No Bad Sound, and the Roslyn Robertson Herb and Scent garden.

Staff and volunteer management

In terms of staff and volunteer management, Nathan Postma has a paid position to manage the rooftop garden, and Beatrice Lego has a paid position to manage the UTSC farm. However, the gardens and farms are managed by volunteers, while Mitchell has six paid positions for each of the six community gardens he oversees. To get volunteers, Nathan uses a listserv by working with Digin, a campus agricultural group, and Skygarden, a campus rooftop garden on the engineering building. He also spread word of mouth at Trinity College through posters and the Trinity One program. Nathan Postma also participated in Toronto Urban Growers' city week. Volunteers at these outlets assist primarily through watering shifts. Nathan emphasized that he has no problems getting volunteers, so he does not work with the grounds and facilities staff. Beatrice tries to find volunteers to maintain the farm through social media and newsletters. She also hosts tutorials and volunteer meetings. Also, she obtains interns from May through August from the internship program coordinated by UTHSC's Master of Environmental Management. Mitchell and his team typically post job openings on the community garden website, and applications are made by emailing Mitchell directly to express interest. In addition, Mitchell regularly invites students from both the campus and the surrounding community to the Community Garden for outdoor learning, which provides many students who are interested in the Community Garden with the opportunity to practice their skills and potentially join the Community Garden. As a result of COVID-19, buildings on campus have reported limited access for maintenance staff. Since Nathan's rooftop garden is managed by student volunteers, maintenance can no longer be

performed during this growing season. Although Beatrice did not accept interns this summer, her farm is still producing food this season due to her work with the grounds crew and facilities. Mitchell's community gardens worked with local agricultural organizations during COVID-19, so the gardens are still functioning and producing food. However, due to the COVID-19, Mitchell's community gardens have become smaller than before due to reduced staff.

Infrastructure and logistics

In terms of *infrastructure and logistics*, Nathan uses commercial containers such as the biotop container - an ideal container for community gardens on the roof, ground, or mineralized surface. Biotop containers have a built-in water reservoir with a timed irrigation system. The dimensions of the container are 20cm x 32cm x 20cm. Beatrice created raised beds on her farm and mentioned that some of those beds fulfilled AODA requirements for accessibility. Mitchell's community garden uses raised garden beds for planting so that students can easily observe the plants' pollination process. Mitchell also utilized in ground beds, which he encountered difficulties due to lack of permissions to dig in the ground.

In terms of water, Nathan initially used a hose nearby and later installed a drip irrigation system that collects rainwater. The UTSC farm is near the Northside of campus, where there is no water source. For this reason, Beatrice brings water from the South campus. Right now, she has 4000 L of water on site. Beatrice recognizes this is unsustainable in terms of the environment, costs, and transportation. Therefore, she is looking to install a rainwater capture system for water support. Mitchell's community garden is irrigated mainly by hand, with the primary water source coming from the on-campus water supply. He prefers to involve students in planting and observing. However, in the future, he and his team will look for more efficient and convenient ways to irrigate the gardens for educational purposes and increase the garden's productivity.

Unlike the literature, Nathan stressed that potting soil alone is inefficient to grow edible plants. He recommended using fertilizers such as the Dosatron fertilizer. Nathan also revealed that his soil profile was at least 20 cm deep. The larger the soil profile, the more fertilizer required. For Nathan's garden, edible plants with small root profiles such as tomatoes and peppers were grown along with flowers. This is primarily because of Munk's roof weight capacity. For Beatrice's farm, Beatrice follows a crop plan depending on the season. In the winter, she even plants garlic, a hardy and cold resistant crop. For Mitchell's community garden, a mix of flowering plants and vegetables is key to increasing food production. Tomatoes, tomatoes, zucchini, eggplant, carrots, cabbage, and beets, as well as herbs such as basil, sage, and cilantro are grown in Mitchell's community gardens, and the cooperation and use of these flowering plants and vegetables has made the community gardens very productive.

In terms of the *supply chain*, Nathan's produce eventually ends up in the Trinity cafeteria. Food was not produced on a large enough scale for donations. Nathan stressed the importance of saving seeds in order to continue production of different plant varieties in the garden. From 2017-2018, Beatrice's produce went to the daycare centre on-site. In 2019, the produce was sold at UTSC's farmers market. The produce was also packaged, which increased awareness. During COVID-19, all food was donated to the food bank on campus along with the Culinaria Research Centre at UTSC. Food services at UTSC is also interested in using the produce in cafeterias. Beginning in the summer of 2017, a portion of Mitchell's Community Garden produce will be used in community kitchens and provide more than 76,000 meals per year for community members, while another portion will be shipped to local food banks and shelters as a shareable food resource to help everyone have access to healthy food.

Measurement and evaluations

Nathan and Beatrice provided key insights into *measurement and evaluation*. Nathan stated the garden was expanded to the ground level behind St. Hilda's. This allowed for production to continue on-the-ground during the pandemic as building access was restricted. Nathan highlights how funding was obtained through an alumni grant and a partnership with Charwell's initially. He mentioned that 20 containers cost around $2500-$3000 and soil, seeds, gardening materials cost $1000. The total cost was around $5000 without labor costs and the implementation of the irrigation system. In 2019, Nathan created raised beds/container gardens near St. Hilda's which cost around $218 in wood supplies. Other tools and supplies at Munk school, such as mesh, seeds, fertilizer cost around $7800. For St. Hilda's, $800 was spent. In 2019, a company called DJ Rain estimated the cost of a rainwater catcher and irrigation system at $5600 for the Munk school. Nathan utilized the SCCC grant for the rainwater catcher and irrigation system. In terms of funding, Beatrice relied on UTSC, the Greenbelt Foundation and Agrifood and Agriculture Canada, who gave her a startup fund of about $45,000 in total. Currently, Beatrice relies on University grants and local food grants, specifically Culinaria Research Centre. She also obtained funding from the City of Toronto, worth $47,000 to plant trees. Mitchell's community garden currently relies heavily on the TD Friends of the Environment Foundation, The Home Depot Canada Foundation, and Education Graduate Students' In 2016, TD Bank's TD FEF funding helped McGill expand its existing community garden and put new facilities to use, as well as initiate an on-campus community garden to be filled with a variety of plants. containers as well as raised garden beds. Also in 2016, Mitchell was awarded a grant from Home Depot that expands community gardens by using education and training as a homelessness prevention measure while providing local youth with access to post-college campuses and educational opportunities. In

addition, the McGill Graduate Student Society for Education (EGSS) provided a Solidarity Grant to fund Mitchell's community garden. This funding has made a significant impact in expanding the McGill garden space, advancing the community garden's website, and building community relationships with local stakeholders.

Findings: Surveys

Our survey questions mostly were scale questions and multiple-choice questions, which aimed to identify what they are currently doing and identify gaps and opportunities for the Sustainability office. However, we only received six responses before the deadline of the final report.

Infrastructure and logistics

When we asked about the crucial factors for setting up a garden/selecting a location, the top three of most participants are water access, sunlight, and soil quality. All six campus groups experienced and found that gardens with raised beds are the best gardening for growing plants pertaining to infrastructure and physical construction. In addition, 83% of the participants agreed on the ground-level gardens also pertaining to infrastructure and physical construction, but only half of them thought container gardening is the best solution. Over half of the participants suggested that the unique drawbacks of container gardening are meeting water needs and sourcing a location. In specific, they elaborated on container gardening has difficulties and limitations on the irrigation system, protection, and root space. In terms of the top three best benefits of ground-level container gardening, most participants selected accessibility, mobility/flexibility, and visibility as we expected. In contrast, there was one outlier, scalability, which has been presented in many articles and mentioned by other experts as advantages of

container gardens. According to question 2.4, we found a large diversity in the approximate annual costs of maintenance and operation, from $200 to above 100,000. By analyzing the background and goals of participants' gardens, we argued that the main influences of the annual cost are the garden size and labor intensiveness. Container gardening could be the best tool for learning to unban agriculture, producing food, and increasing biodiversity, habitat, and wellness was agreed by all participants. When discussing the types of plants that worked well, at least three participants recommended vegetables, pollinator species, and ornamental species. Nevertheless, two participants mentioned that large root plants were not suitable in container gardens regardless of type. From our previous literature review and interview findings, we suggested that semi-hydroponic containers can be a viable option for future campus urban agriculture. Half of the participants agreed with us, and one has a neutral opinion, whereas the other two had negative feedback. These two participants proposed semi-hydroponic containers involving more technology, complicating the maintenance requirement and increasing the operation cost.

Measurement and evaluation

Since most campus gardens serve for educational, engagement and research purposes instead of food production, the food they produce usually is donated to food banks, shelters, or other agents, used in university café and taken by volunteers for personal use. In specific, UTSC campus farms donate food to tutorials of the food studies program, whereas Dig! Campus Agriculture gave food to university cooking events. The main goal for all the campus garden groups is not making a profit out of food production; most of them did not use specific measurements of food weight to evaluate. Trinity rooftop garden and Dig! In Campus

Agriculture seeks out student involvement to give students practical learning opportunities and build a community of interested urban agriculture groups. UTSC campus farm focuses on not only the amount of food but also other statistics, for example, type of crops cultivated, amount/cost of fertilizer used, water amount/time of watering, number of volunteers involved, number of people receiving food.

Communications

All campus groups have more than one communication channel to crew staff and volunteer and spread awareness. The two most common networking techniques are sending out email newsletters or listserv and word of mouth. Creating social media, information sections on gardens' websites, and having classes and proposal submission are other feasible solutions for communicating.

According to figure 1 and figure 2, we found that at least two thirds of the campus gardens are opened to the public and offer tours to the public. However, all gardens have some kind of protection such as locks or fences, thus, the accessibility is still not flexible but not restricted as we expected. Through surveying all campus groups, we gathered all the social media feeds and websites of each garden to make a contact list.

Challenges

Hiring staff to support the operation of the garden is necessary, even with volunteers, because maintenance is essential for gardens' long-term development. However, five out of the six groups are struggling with volunteer management. In general, most gardens on St. George campus don't have a well-defined community or way of attaining membership and finding

committed volunteers. Additionally, during the pandemic, volunteers and staff need enough experience to be able to manage the gardens alone, but people come and go, so there isn't enough consistency over the years. The inconsistency and unreliable of volunteers and staff lead to small or no transition management. In contrast, Trinity Sky gardens never struggle with volunteer management because they have an existing listserv and ample volunteer labor from the TrinityONE stream.

Final Deliverables

We have constructed a series of final deliverables regarding best practices to implement and maintain container gardens to produce food. These deliverables will be in the following sections: a scan of other universities, an inventory of campus gardening groups, a suite of recommendations, and a toolkit for successful container gardening.

Scan of other universities

Our scan consists of:

McGill University

Dalhousie University

University of Toronto (Scarborough campus, Mississauga campus)

Maryland University

University of Saskatchewan

University of British Columbia

University of North Carolina

Ryerson University

University of North Carolina

York University

University of Vermont

Inventory of campus gardening groups

In appendix 1 our inventory we compiled of campus gardening groups is attached. This inventory feeds into the centralization of information and can also be used to eventually "fill in the gaps" of where a container garden can be placed and for what purpose. A contact list has been created to map existing groups out on campus; various types of gardens will be highlighted whether that is for food growing or other non-edible efforts. This can be used to eventually "fill in the gaps" of where a container garden can be placed and for what purpose.

Suite of recommendations

Our suite of recommendations will feed into the development of a formal campus agriculture program, overseen by the Sustainability Office. Recommendations will be in the following areas: infrastructure and logistics, staff and volunteer management, communications, and measurement and evaluation.

Infrastructure and Logistics

<u>Sun and Water</u>

To begin a successful venture in container gardening, mapping out locations on campus would be a crucial first step. This location needs to be inclusive of sufficient sun and water access while also considering protective aspects. For any garden to thrive, food-producing plants need to receive a minimum of 6 hours of sunlight and relatively constant watering during the

harvesting season. As stressed upon in our data, if a location does not have an easily accessible water supply, creating this infrastructure should be a top priority. Container gardens require frequent watering because their smaller soil profile leads to quicker evaporation and absorption of water. Thus, auto-irrigation systems such as drip irrigation or containers with a water reservoir are recommended to decrease maintenance time.

Soil and Fertilizer

Choosing the right material to fill the containers will play a crucial role in its future success. Ground soil should be avoided as it becomes too heavy in containers and does not provide adequate aeration and water flow. Instead, a high quality soil mix such as ProMix with mycorrhizae. A high-quality organic soil mix can also be made, consisting of compost, coarse sand, and peat moss, coir fibers, or perlite is recommended. A lightweight mix similar to this will provide sufficient oxygen supply to the roots, adequate drainage of water, and water retention. In order to ensure nutrient absorption, a drip fertigation system, or slow-release fertilizers is recommended. As supported by our research, the Dosatron fertilization system is a great choice. Furthermore, chemical fertilization should be avoided and instead an organic fertilizer should be considered.

Container Type and Location

Although our research suggested that nearly anything can be made into a container garden, we have gathered a couple of recommendations. The first being Caja garden boxes, which are constructed with recycled plastic, are food-grade, use less fertilizer, and also have a water reservoir, which would reduce the frequency of watering. The second recommendation is Smart Pots, which are lightweight, durable, come in various sizes, and affordable alternatives to

Caja boxes. In addition, up-cycled items such as milk crates lined with landscaping fabric or gallon size buckets, would be great alternatives while also reducing waste.

In terms of container depth, we recommend determining each plant's root profile and grouping them; for example, herbs with shallow roots require a minimum of 6 inches. In order to avoid runoff and groundwater depletion, containers need to have contact with the earth. To maximize environmental benefits, we suggest on-ground raised beds in tandem with other types of container gardens as raised beds would allow for water to be returned to the earth. However, with raised beds come accessibility requirements, we recommend a Toronto based company called Bufco, that creates raised beds on wheels. Additionally, small containers or raised beds on wheels can be moved through the seasons to accommodate favorable growing environments; the activity of switching locations can draw more attention than in-ground gardens.

To avoid the challenges that come with lack of protection on the ground level, we recommend fencing off the gardens and sourcing locations that are secluded behind buildings on campus. Pests need to be considered and chicken wire can also be utilized to protect the plants.

Seeds and Plant Type

Seed saving is crucial for the regeneration of food producing gardens year after year. In order to propagate these seeds, greenhouses and underground spaces can be utilized. In terms of plant type, anything will successfully grow in a container as long as its root profile is given sufficient space to grow. Grouping a variety of crops together based on root profile to avoid monocultures and reduction in soil fertility will also be beneficial in long term success.

Measurement and Evaluations

We recommend determining the final yield of produce by weight. Volunteer hours should be logged which would help determine how much additional maintenance time is necessary, in the instance of lack of engagement.

Staff and Volunteer Management, and Communications

From the weaknesses in the campus agriculture program, we have developed a few ways that the Sustainability office can begin strengthening the agriculture program on campus. We heard echoes of the University of Toronto's decentralized nature, impeding some gardening efforts' success. From this feedback, creating a central hub to attract and alert students of volunteer opportunities would be extremely beneficial for the future. A central listserv advertising volunteer needs, website signup, and connecting work-study students to gardens around campus are a few ways the Sustainability Office can play a role. The centralizing of information on gardening, in terms of network contacts and tips for starting a garden would be crucial so students can receive assistance when needed and get involved on campus. This can be done on a section of the Sustainability Office website dedicated to campus gardening activities. Furthermore, creating a database of places to apply for funding would be useful for garden groups who may not be able to receive adequate yearly funding from the University, which is necessary for maintaining the longevity of gardens. In order to fully access the community benefits of gardening, a central hub for information and increased visibility about gardening efforts on campus can increase student involvement. Community engagement will determine a garden's success because, without sufficient maintenance time, container gardens will not thrive. Finally, we recommend that the sustainability office aids in hiring at least one staff member to contribute to successful transitions within the garden group, for example, when students graduate and no longer volunteer at the gardens.

Aside from the role that the Sustainability Office can play to communicate gardening efforts, we recommend social media profiles for gardens, email newsletters, and programs like a container gardening webinar or workshop may also be created.

Toolkit for Successful Container Gardening

This toolkit should comprise a garden expert and campus garden contact lists, documents for how to care for various plant types, fertilizer and soil types, and locations best suited for container gardening.

Looking ahead and Limitations

The Sustainability Office can begin by sourcing locations abundant in concrete, which will not be hard to find on campus. These locations supplemented with container gardens will really make for a more engaging, sustainable, and livable environment for the student body, faculty and staff.

Limitations

Our research has been limited due to the coronavirus-19 pandemic as we were unable to meet in person with the group to survey campus groups and locations. Our research is also limited in knowledge about health and safety regulations. Furthermore, losing Kat after the midterm threw our group off a bit and it took longer to re-calibrate and get back on track.

Conclusion

The data that the project team has collected from our literature review of academic and grey literature, interviews, and surveys has determined container gardening on the St. George campus to be a successful venture. Container gardens can cultivate local food through sustainable methods, and community engagement through collaboration with communities, non-

profit organizations or schools. This hyper-local campus grown food has the ability to contribute to responsible consumption and production on land and alleviate soil degradation; while also contributing towards food justice and alleviating hunger around campus. The health benefits of locally grown foods are vast, as aspects of producing food supports nutritional, mental, and physical health. Container gardens can also be recognized as innovative infrastructure in urban agriculture. We have concluded that container gardening can and should be implemented in sustainable education curriculums as the benefits are vast and it will successfully mitigate barriers identified in rooftop and ground level gardening. Thus, container gardens are an accessible and effective way to expand a broader campus agriculture program.

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Appendix

Supplementary Material

Appendix 1: U of T St. George-Campus Garden Inventory Spreadsheet

https://utoronto.sharepoint.com/:x:/r/sites/fs-sustainabilityoffice-sg/_layouts/15/Doc.aspx?sourcedoc=%7B83C5CE72-DA12-466B-B39D-EA2D7CED1E7B%7D&file=U%20of%20T%20St.%20George%20-%20Campus%20Garden%20Inventory.xlsx&action=default&mobileredirect=true

Survey results:

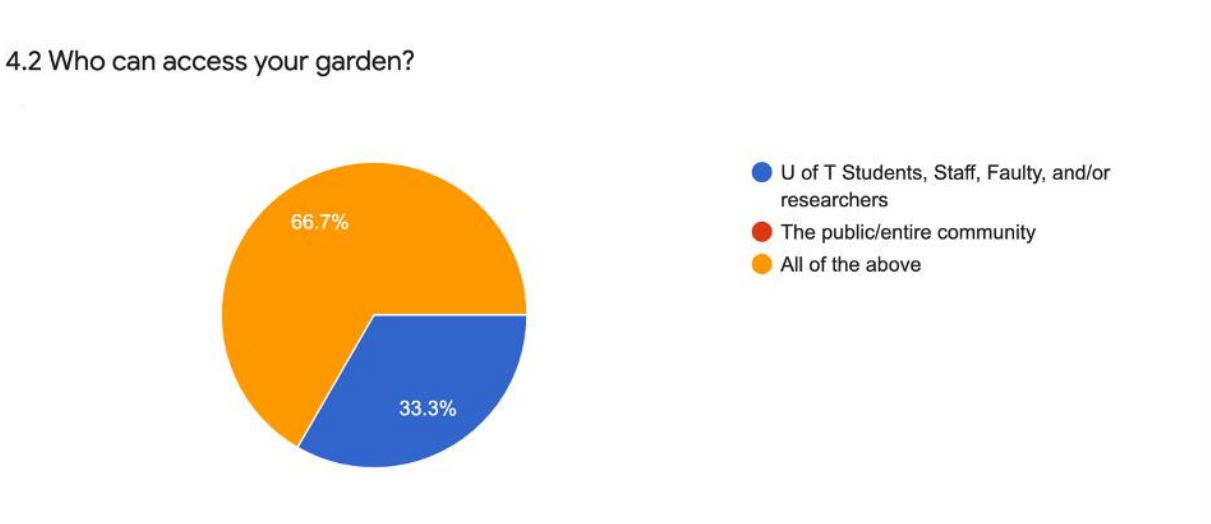

Figure 1

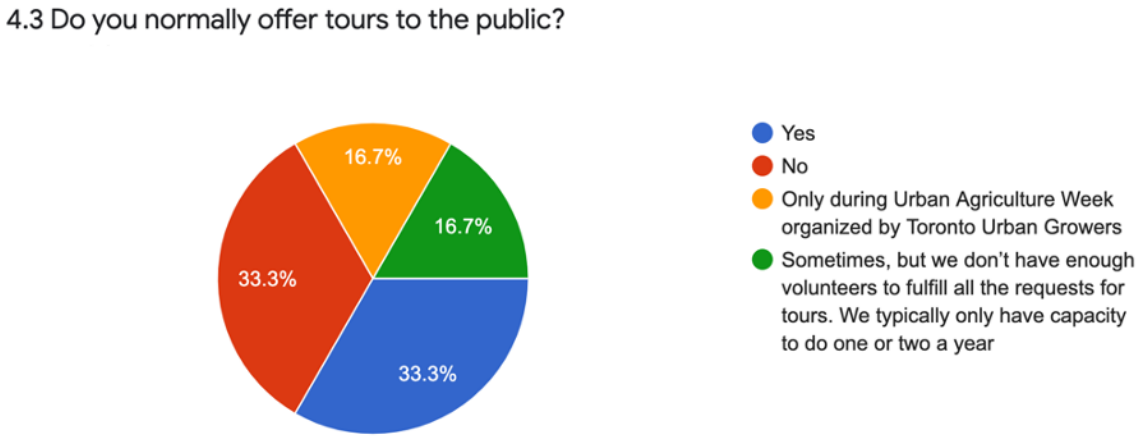

Figure 2

We have attached 4 additional files to this report for our inventory, scan, survey questions, and survey results.