PEER-REVIEWED PAPER

Hydroponic Shipping Container Farms: A Case Study Exploring Opportunities and Barriers to Implementation in Educational Settings

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Abstract

Hydroponic shipping container farms (HSCF) are an emerging tool used for educational purposes in schools. This case study explored key opportunities and barriers to the implementation and integration of an HSCF food education program in Western Canada. Methodology: A yearlong case study was conducted utilizing interviews and naturalistic observations. Findings: This study found that key opportunities for program implementation were partnering with a committed community champion and strong administrative support, while key barriers were the high financial costs and labor requirements of running an HSCF and an isolated HSCF teacher champion. Together, these opportunities and barriers illustrate the complex operational demands of implementing HSCFs in school settings. Research Limitations: This study focused on one school, which operated one of many different possible HSCF designs. Practical Implications: Overall, HSCF as an educational tool should be questioned due, in part, to potentially unattainable financial and labor requirements. However, more research is needed to confirm these findings and determine whether HSCFs are an appropriate tool in diverse educational settings.

KEYWORDS: FOOD EDUCATION; HYDROPONIC SHIPPING CONTAINER FARM; SCHOOL FOOD; SCHOOL FARM; SUSTAINABLE CITIES AND COMMUNITIES

Introduction

Today's food systems are unsustainable and central to many global economic, environmental, and social issues, including resource scarcity, poverty, hunger, and climate change (Araújo et al., 2023; Rockström et al., 2025). Current food systems are also perpetuating racial and social inequalities, as marginalized groups around the globe continue to suffer the largest consequences of harmful environmental and social food system externalities (HLPE, 2023). Although changes are urgently needed at all levels of the food system, research suggests that the most effective consumer-side action that individuals can take is choosing sustainable foods (IPCC, 2022; Reisch et al., 2013). Sustainable foods are those that consider environmental, social, cultural, and economic sustainability at all stages of the food supply chain (Garnett & Fischer, 2016; Willett et al., 2019). These foods are also beneficial for individual health because

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they are high in fruits, vegetables, and whole grains and low in red and processed meats (Hedenus et al., 2014; Rockström et al., 2025). Therefore, empowering individuals to choose sustainable foods is a major opportunity for a positive food system transformation and individual health improvement.

Schools are an ideal environment for incorporating sustainable food education, as young people spend a significant amount of time there. Integrating food education in schools directly connects to global agendas and several Sustainable Development Goals, particularly SDG 2 (Zero Hunger), SDG 4 (Quality Education), SDG 11 (Sustainable Cities and Communities), and SDG 12 (Responsible Consumption and Production) (United Nations General Assembly, 2015). Additionally, the intention of many educational systems is to develop an empowered and educated citizenry who are aware of their responsibility to actively participate in local, national, and global communities (Government of BC, n.d.). Schools can affect how young people engage with food and are seen as critical places for transforming knowledge into action (Hawkes et al., 2015; Story et al., 2009). Thus, learning about food systems at a young age can assist young people in moving from passive consumers of food to active participants in their food system, recognizing the health and environmental implications of their food choices (Varela et al., 2024).

Hands-on food-related learning opportunities have been shown to be effective pedagogical strategies that can have a positive impact on students' health and food choices (Charlton et al., 2021; Varman et al., 2021). Examples of these hands-on opportunities include school farms (S. Blair et al., 2023), cooking programs (Vaughan et al., 2024), farm-to-school programs (Mishra et al., 2022), and school gardens, which have an extensive body of literature supporting the many benefits students can afford. For example, school gardens have been shown to increase students' intake of fruits and vegetables (Wells et al., 2023), improve their diet (Chan et al., 2022), increase academic performance in math and science (Berezowitz et al., 2015; D. Blair, 2009; Wells et al., 2015), increase their connection with nature (Passy, 2014), and increase their knowledge about the environment and sustainability (Amiri et al., 2021). Although school gardens and other outdoor food education programs have many potential benefits, a major drawback is the seasonality of outdoor spaces. In northern countries with variable climates, such as Canada, schools are no longer in session when garden produce is ready for harvest. Therefore, there are only a limited number of months in the year in which students can be involved in garden-based learning. The use of indoor growing systems for hands-on experiential learning opportunities related to food is a promising alternative.

Nonconventional methods of agriculture have seen an increased interest commercially, as well as in community settings, because of the environmental impact of conventional agricultural methods as well as the growing demand for locally grown food (Feldmann & Hamm, 2015; Grebitus et al., 2017; Kirschenmann, 2010). Hydroponic food production is one such method (Walters et al., 2020). Hydroponic production involves the production of plants using an inert medium and adding a nutrient solution instead of the soil (Resh, 2013). Although hydroponic methods of food production were developed in the 1940s (Bouchar, 1998), and have been used in an educational context since the 1950s (Goddard, 1953), hydroponic shipping container farms (HSCF) are a more recent form of hydroponic food production within a controlled environment that is now being used both commercially and at educational institutions (Stapleton & Meier, 2022; Wagner et al., 2021).

HSCFs are shipping containers that have been converted into controlled soilless hydroponic systems. The benefits of HSCFs include the potential to meet the demand for locally produced food (Wortman & Lovell, 2013), a 70–90% reduction in water use compared to conventional agricultural methods (Raviv & Lieth, 2008), and the ability to produce food at any time of year. HSCFs are an emerging food education tool, and there is growing interest in using these units to feed and educate students at schools. Due to this increasing interest, many HSCF distributors, including the American companies *FarmBox Foods* and *Growtainers*, and the Canadian company *Growcer*, have begun marketing their products to educational institutions (Farmbox Foods, n.d.; Growcer, n.d.-b; Growtainers, n.d.).

Although studies have evaluated the potential of smaller hydroponic systems, such as hydroponic tower gardens, in educational settings (Carver & Wasserman, 2012; Jon Schneller et al., 2015; Patchen et al., 2017), there is limited research on HSCFs as educational tools (Stapleton & Meier, 2022; Wagner et al., 2020). This is a noteworthy research gap, as HSCFs represent a distinctly different educational tool when compared to smaller indoor and/or hydroponic systems because of several factors including purchasing, installation, and operating costs, size, energy and water use, production potential, and time required to operate the HSCF. Therefore, understanding both the potential drawbacks and benefits of such an investment could aid schools in deciding whether HSCF is the right tool for their specific needs.

This study aimed to explore a school's experience implementing an HSCF education program with a focus on key barriers and opportunities for program implementation and integration within the school. As HSCFs are an emerging tool used in educational institutions, it is important to investigate the process of starting and running these units, as it could provide key insights into the potential of HSCFs in educational settings. Although the educational goals and outcomes of the HSCF program are important, they are being analyzed in a separate paper and will not be discussed here. Additionally, there were several important findings related to the design of HSCF when utilized in an educational setting. These findings are outside the scope of this study and have been published separately (Edwards, 2024). Therefore, this study focuses solely on factors influencing the implementation and operation of HSCF from the perspective of program participants.

Methodology and Methods

This paper presents some of the results of a PhD dissertation (see Edwards, 2023). A case study methodology was used, which is a methodological approach that allows for an in-depth understanding of a phenomenon from the perspective of participants (Yin, 2009). Additionally, case studies are appropriate for investigating educational programs (Grauer, 2012; Hamilton & Corbett-Whittier, 2012). The purpose of this case study was not to evaluate the educational program; rather, it attempted to develop an understanding of the program and barriers and opportunities to implementation (Grauer, 2012; Hancock et al., 2021). Other qualitative case studies in the field of food and health education have used case study methodology to gain an in-depth understanding of educational programs within their specific contexts (Gisslevik et al., 2019; McHugh et al., 2021).

Ethics

Ethical approval for this study was obtained from The University of British Columbia [H21-00961]. All participants provided informed written consent to participate in the study. In the case of minors involved in the study, written informed consent was given by parents/guardians, and written informed assent was given by the student study participants themselves.

Research Site Context

This research was conducted at a middle school located in a large population center in Western Canada. At the time of the study (2021–2022), the student population consisted of approximately 800 students in grades 7 through 9 (ages 12–15) and was a mix of students coming from a variety of socioeconomic backgrounds. In 2019, the school received an approximately $250,000 Canadian dollar (CAD) grant from a Canadian charity to purchase, install, and operate an HSCF on the school grounds. This school was chosen by the charity to pilot the use of HSCFs in educational settings. The school found out about the grant through a friend of a school administrator and, through strong leadership, the support of the parent advisory group, and one teacher who was motivated to be involved put together an application and were ultimately successful in receiving the funds for the HSCF. This research project had no association with the charity or funding provided to the school.

The HSCF installed at the middle school was a 40-foot shipping container that had been retrofitted with a hydroponic growing system that could produce approximately 300 heads of lettuce per week. The unit consisted of a small front area containing the seedling chamber, a small table, the unit's water tank, and large containers of nutrient and pH buffer solutions. The main growth area was a long narrow corridor with four levels of racks on each side. Each rack had a depth of five rows of trays where the plants could grow. The unit was bought from a company that specializes in manufacturing HSCF units and is one of several possible models produced by the manufacturer.

The middle school had two overarching goals for utilizing the HSCF: educating and feeding students. However, this paper will not focus on these goals specifically, as they will be discussed in other papers that are currently being written from this research. Instead, this paper focuses on the actual implementation of the HSCF and potential opportunities and barriers for integrating these units into educational settings. Although the HSCF was installed on school property in summer 2020, the school was not able to fully utilize the HSCF in the 2020–21 school year due to the COVID-19 pandemic. Therefore, the year of the study (2021–22) was the HSCF's first full year of operation, when it was running at full production capacity and operating as an educational tool for students within the school.

Researcher Positionality

The author acknowledges that their background and experience may have impacted data collection and analysis due to researcher bias. Prior to this research, the researcher had a background in food education and spent time working in and with schools. Therefore, the choice of research methodology and interpretation of results were influenced by these experiences and the belief that all young people should be equipped with the tools and skills to be active participants in positive food system transformation. Although they had experience with food education in general, the author had no previous experience with HSCFs. Consequently, their perception of the units in educational settings evolved throughout the study and was based on the researcher's interpretation of participants' experiences. Throughout this research, the author sought to reflect on how their life experiences and privileges may unintentionally influence the research process (Dodgson, 2019).

Therefore, this study was informed by an interpretivist constructivist theoretical approach, which assumes that educational programs are shaped by the social, organizational, and material conditions in which they are implemented (Thanh & Thanh, 2015). Consistent with this perspective, the case study design prioritized understanding participants' experiences and the contextual factors influencing the implementation of the HSCF, rather than evaluating program outcomes. This theoretical orientation aligns with qualitative case-study traditions that emphasize the importance of situated meaning-making, context, and lived experience in educational research.

Research Participants

Overall, 19 individuals participated in this study. The participants included students, teachers, school administrators, community members, and charity employees. Table 1 provides a breakdown of the number of participants by type.

Table 1: Number of Participants by Participant Type

Participant Type	Number of Participants
Students	8
Lead HSCF teacher	1
School administrators	2
Teacher candidates	1
Other teachers	4
Community partners	1
Charity employees	2

Pseudonyms were used throughout the paper to identify both individuals, the school being considered in the research, and any other factors that could lead to the identification of the school and participants.

Data Collection

The data were collected between November 2021 and June 2022. Data were collected through naturalistic observations and semistructured interviews with participants (Cohen et al., 2011; Creswell, 2014). To conduct naturalistic observations, the researcher was in a school environment two to three times per week for the duration of the study. Most observations occurred within the classroom where the researcher attended and volunteered with the HSCF classes. To record observations, the researcher took physical notes on site and then later transferred them to a digital format. The extent and impact of this volunteer role will be discussed further in the Results and Discussion sections of this paper. Overall, the researcher spent more than 160 hours in school over the course of the study. Interviews were conducted both in-person and online and focused on participants' experiences with the HSCF program. Interviews were open-ended, which allowed flexibility and unique participant responses (Fontana & Frey, 2000). In total, 19 interviews were conducted with individuals both inside and outside the school, including teachers, administrators, students, and community members.

Data Analysis

Following the transcription of interviews, the interview transcripts were uploaded to NVivo software and then analyzed using Braun and Clarke's (2006) method for thematic content analysis. Although Braun and Clarke's methodology is from a psychology disciplinary perspective, it is also useful in educational research contexts and has been used in this way (Kushnir, 2025). The researcher's interpretation of the data was informed by their continued presence within the school environment and their interaction with the research participants.

Results

This section presents research findings on key opportunities and barriers regarding the implementation and integration of HSCF into Canadian middle schools.

Opportunity: Community Connections

At the onset of the study, the school had strong community connections, and several more connections were established throughout the duration of the study. Having these community connections and contributing to the community was identified as an important goal of the HSCF. For example, one school administrator said that a goal of the HSCF was:

> to make a difference in our community and share with the community. (Mark).

One important community connection was the involvement of a strong community champion. The community champion was a local grocery store owner, Sam, who became connected to the school through personal connections with school administrators and informed the school about the HSCF grant that they eventually received. This community champion was able to help the HSCF program overcome some of the most significant challenges it faced as well as initiate other community connections that led to valuable learning experiences for the students involved in the HSCF program.

For example, a major barrier faced by the HSCF program is the lack of refrigerated space. HSCF consistently produced over 300 lettuce heads per week. However, the school had the capacity to refrigerate less than half of the full HSCF harvest. Sam was able to help the school overcome this challenge by selling HSCF produced at his grocery store. The school was responsible for transporting the produce to the grocery store; however, once at the store, grocery store employees would pack, label, and sell the produce. One hundred percent of the profits generated from the produce sold at the grocery store was donated back to the HSCF program. This partnership allowed produce that could not be stored at the school to have a cool place to be stored, thereby allowing the HSCF to run at full capacity. Additionally, this connection allowed the school to generate some money from sales of HSCF produce, although not a significant amount. As Mrs. Smith, the teacher responsible for running the farm, stated:

> I think I only have about $900 CAD in the bank from sales with Sam.

The school's connection with Sam also led to several important learning opportunities for the students. Sam was a well-connected member of the community and, therefore, was familiar with several local farmers, businesses, and nonprofit organizations working in the food sector. Sam was able to connect the school with some of these individuals/organizations, which led to two important field trip learning opportunities for students involved in the HSCF class. One was a local organic orchard, and the other was a local farm that grew food to be used in a city-wide school backpack lunch program.

Establishing connections within the community was something Sam viewed as important. When describing his involvement with the HSCF program he said that he:

> connect[s] people with the right connections, allowing people to experience different things. (Sam, community partner).

Not only did Sam view his role within the community as important, but he also believed that his involvement with the HSCF program was a responsibility he had due to being a business owner in the community. This is evidenced by his assertion that:

> I believe that we have a requirement as business leaders to do what's right for the community and the environment." (Sam, community partner).

A second example of a partnership that developed over the 2021–22 school year was a local business that bred insects to be used as a source of protein in food products that would be eaten by humans. This insect farm was connected to the middle school and became interested in obtaining waste from the HSCF to be used as a source of food for the insects at their establishment. The insect farm began collecting HSCF waste/compost from the middle school weekly, at no cost to the school. This composting program was not only mutually beneficial for the school's HSCF and the insect farm, but it also initiated a school-wide composting program at the middle school. As Mrs. Smith, the lead HSCF teacher, asserted, "this is a great relationship because we do not actually compost on site and it's free for us at the school." Therefore, HSCF was able to act as a catalyst for positive school-wide initiatives related to food.

Opportunity: Strong Administrative Support

At the onset of the study, it was clear that the school had strong administrative support for the HSCF program. School administrators were instrumental in the initial application of the HSCF and were committed to supporting the HSCF's integration into the broader school environment. For example, the school administration advocated at the school district level for the initial HSCF grant application and for paid time for Mrs. Smith to attend to HSCF-related activities. One school administrator stated:

> We worked with the district and supported the modular farms. They gave us extra time to cover the work on it for the school and to cover the block of time, which was about $17,000 CAD. (James, school administrator).

The extra block of time to which James is referring is an approximately 78-minute block of time. At middle school, each class was considered one block and alternated between occurring twice per week or three times per week. Additionally, the teachers were given time to prepare for the classes they taught. Another school administrator, Mark, emphasized the advocacy needed to get this additional time when he said, "we were given one block of time, which is what I could afford from the budget. And then I was able to lobby at a district level for another block of time for Mrs. Smith."

This advocacy at the district level was a crucial first step in receiving future support for the HSCF. Mrs. Smith asserted this importance when she said:

> I think what we'll need in future, we really need our district to see this as a beneficial thing to invest in because it's a lot for me to operate, run the programs, and then also create a curriculum around it.

Therefore, it was a significant achievement that the school administration was able to secure the lead HSCF teacher some paid time for HSCF operation, and their continued advocacy underscored their commitment to the HSCF program.

Barrier: Costs

As previously mentioned, the middle school received approximately $250,000 CAD from a Canadian charity to purchase a HSCF and install it on the school property. The funding covered purchasing the HSCF unit as well as financial support for operating the HSCF for five years (originally three years but funding was extended due to the COVID-19 pandemic). Although the large amount of funding seemed to be an opportunity at the beginning of the study, financial concerns emerged as one of the largest barriers to program implementation over the course of the research. For example, despite the large amount of funding received upfront, the school still required additional financial support, which resulted in the school taking a $50,000 CAD loan from its parent advisory committee. The school administration wanted to place the HSCF somewhere on the school property where it would be visible to people passing by the school. Therefore, the loan was required to cover the expenses of extending the utilities to this location on school grounds, resulting in the school already being in considerable debt before HSCF operations commenced. Upon discussions with program participants, it was unclear whether this cost was considered when the school first decided to apply for the grant.

Regardless of the $50,000 CAD loan, finances were still a major concern for the HSCF program. Once the charity stopped funding the HSCF, the school would be responsible for the yearly operational costs of the HSCF which, according to the HSCF manufacturer, were estimated to be between $5,000 and $7,000 CAD per year. As one of the charity employees stated:

> [The charity is] committed to covering the costs of the expenses of operating the farm for five years so that the school can sort of bring their head around how they cover those expenses going forward. It could be between five and seven thousand dollars annually to operate the farm beyond the cost of the farm itself. (Lily).

The yearly upkeep costs of $5,000 to $7,000 CAD/year indicated by the HSCF manufacturer and funding charity accounted for the cost of supplies and technical support running the HSCF. This amount of money was significant for the school, and Mrs. Smith said:

> A school is not going to have $7,000 a year to put towards a program that does not necessarily impact all students … we need to find a way to bring that yearly subscription cost down.

Therefore, although the charity was committed to supporting the HSCF for five years, the school needed to find a way to make the HSCF financially sustainable so that it could continue operating after support from the charity had ended. The $5,000 to $7,000 CAD yearly upkeep costs indicated by the HSCF manufacturer may have been underestimated, as some grey literature suggests that HSCFs could cost between $8,000 and $16,500 USD ($10,045–$20,718 USD adjusted for inflation) for annual (Hicks, 2017).

The pressure to make the HSCF financially sustainable before charity funding ended had a significant impact on the way the HSCF was run. Most of the responsibility for making HSCF financially sustainable was placed on the lead HSCF teacher, Mrs. Smith. This led Mrs. Smith to operate the HSCF in a businesslike way and have less time or energy to focus on broader educational goals. Additionally, the amount of time required to operate the HSCF led to most of the class time being spent operating the HSCF.

The researcher reached out to the funding charity but was unable to receive clarification or details about exactly how all the funds were being used and by whom. Individuals within the school also did not have a clear picture of where the charity's funding was used. This lack of transparency in funding charity is potentially concerning and makes it difficult to understand the full financial costs of installing and operating an HSCF on school grounds. However, on one HSCF manufacturers' website, the cost of purchasing an HSCF starts at $205,640 plus shipping costs (Growcer, n.d.-a), whereas other manufacturers do not show pricing on their websites. The charity may have been able to obtain the unit for a lower price; however, it is likely that most of the grant money was spent on purchasing the HSCF unit itself. Additionally, the utility costs of operating the HSCF were unclear, as they were not paid for by the school itself, and Mrs. Smith was unable to get a breakdown of costs when she attempted to investigate.

Barrier: Labor Requirements

At the middle school, each class was considered one block, lasted approximately 78 minutes, and alternated between occurring twice per week or three times per week. In the 2021–22 school year, Mrs. Smith had three blocks of time to attend to HSCF operations. One block was dedicated to running the HSCF, one block was the HSCF class itself, and one block was her prep block for the other classes she taught (which she often used for HSCF tasks). Therefore, depending on the week, Mrs. Smith was given between 7.8 hours (when the HSCF class was twice a week) and 11.7 hours (when the HSCF class was three times a week) of paid time per week to operate the HSCF. This includes one block that was supposed to be dedicated to prepping for other classes and one block that was an HSCF teaching block that included students. The amount of time the HSCF manufacturer indicated would be required to operate an HSCF was at least 15 hours per week, as indicated by Mrs. Smith's statement:

> The [HSCF company] says that it is about 15 hours of dedicated time for a single person to run a farm. However, that is to grow and harvest, not the packing and distribution parts. So, that's a little under budget for that estimation I would say if you are doing it all yourself.

However, it is unclear why the HSCF manufacturer would have indicated to Mrs. Smith that labor requirements were 15 hours per week, as various HSCF manufacturer websites state much higher labor requirements. For example, Growcer states that one of its units requires 30 hours of work per week (Growcer, n.d.-a), and most other company websites do not share this information. It is important to note that these labor estimates only include the time required to operate an HSCF and not the time needed to pack and distribute produce or integrate the HSCF as an educational tool within the school. In addition, research suggests that HSCF manufacturers may underestimate the time required to run a unit. For example, in a study investigating the potential of HSCFs in commercial settings, Wagner et al. (2021) found that "running the unit was much more time consuming than promoted by the vendor" (p. 523). Therefore, despite the administration securing an extra block of time for Mrs. Smith to spend operating the HSCF, she was given nowhere near enough paid time to run the HSCF effectively. This resulted in Mrs. Smith spending many extra hours volunteering her time to run the HSCF, as well as using the time she had with students to operate the HSCF rather than engaging students in educational activities related to the HSCF.

Barrier: Isolated Teacher Champion

Although Mrs. Smith intended to share the responsibility of the HSCF with other individuals, trying to find other people within the school who were interested in assisting with operating the HSCF was an ongoing challenge. Having a teacher who is primarily responsible for HSCF is problematic. Without adequate support, the HSCF program at the middle school is susceptible to shutting down if, for example, Mrs. Smith burnt out or moved to a different school. In fact, this exact scenario occurred at the first HSCF funded by the Canadian charity. As Mrs. Smith explained:

> The first [HSCF] ran for a year. Then, the teacher had to leave because of the family circumstances. Now that the farm is sitting inactive. Nobody's running it … if I were to leave or something was to happen to me, then [the HSCF] program will not necessarily continue on.

Therefore, training additional staff on how to run HSCF is crucial for the long-term sustainability of the program. However, it proved difficult for Mrs. Smith to convince other teachers to become involved with HSCF, as this would be a volunteer task in addition to their normal teaching duties.

The charity itself recognized the large commitment required to run a HSCF and how that workload may be placed on just one individual within a school. This is demonstrated by one charity employee's statement:

> It's [food education programming] just something that people do off the side of their desk. In most cases, the work, we're so dependent on one person having a passion. And if that person moves on, those schools are without. (Lily).

Although they were aware of the unsustainability of a program when one person is primarily responsible, they had hopes that the programs they funded would be different. However, they did not provide any guidance to the middle school as to how to build such a system of support around Mrs. Smith.

Finding additional support is critical for the future of the HSCF involved in this study. As mentioned previously, the researcher volunteered in the HSCF class. This volunteer role was essential for the operation of the HSCF class. The nature of the researcher's volunteer role was to help the lead HSCF teacher when they required help throughout the year. This helped to supervise half of the class when students were working in the HSCF, assisting with HSCF chores, and transporting harvested produce to a nearby grocery store. In terms of class supervision, only four students could comfortably fit in the HSCF at one time, resulting in the other half needing to be engaged in other projects or chores outside of the HSCF while the other half worked in the HSCF. Therefore, two adult supervisors were required when the students spent time in the HSCF.

The transportation of harvested produce was also critical for the operation of the HSCF. Normally, produce needed to be stored immediately following harvest to prevent wilting. The researcher was able to quickly transport the produce to a nearby grocery store, which significantly reduced the refrigeration needs of the school. Overall, the HSCF class could not have operated in its first year without the support of the researcher; however, the researcher did not influence the actual HSCF activities, as they simply followed directives from the lead HSCF teacher. This further emphasizes the need for additional HSCF support staff at the middle school for the HSCF to continue operating in the long term.

Discussion

Through naturalistic observations and semistructured interviews, this case study and resulting thematic analysis sought to explore key opportunities and barriers to integrating an HSCF food education program into schools.

Opportunities for Implementing HSCFs in Educational Settings

Similar to a school in Wagner et al.'s (2020) study where "a public secondary school noted that the use of their HSCF on campus has enabled community building and new partnerships with the local food bank, which in turn resulted in a 'buzz in enthusiasm in the school community' " (p. 226), the HSCF program in this study fostered community building and promoted enthusiasm and a commitment to sustainability within the school community through the compost program that was initiated. The involvement of Sam, the community champion, is particularly important for the HSCF program. Sam's connection with the school highlights how a supportive community champion can facilitate strong community connections and contribute to the success of food education programs. Additionally, the visibility of the farm within the community emphasizes the potential community support that can be generated if a food education program vocalizes and promotes the presence of their program in the wider community. Community members may be excited about food education initiatives (Wickham & Carbone, 2018) and could, like Sam, see it as their responsibility to support those programs. Although other studies have shown that connecting to a wider community often happens as a last step in integrating a food education program into a school (Burt et al., 2017), this research indicates that having community support initially can provide many benefits to the program and aid in its initial integration.

Administrative support also contributed to the implementation and integration of the HSCF program in the middle school. This support primarily manifested in contributing to writing the initial grant application, advocating at the school district level for paid time to run the HSCF, and promoting the HSCF within the wider community. The administration also indicated that they wanted to build a team around Mrs. Smith to help her run the HSCF, but this mission was largely unsuccessful during the 2021–22 school year. This finding is consistent with previous studies that highlight how the support of school administration is key to food-related programming success and the ability of teachers to act as effective food, and more broadly health, educators (Esdaile et al., 2024; Skovgaard et al., 2024).

Barriers to Implementing HSCFs at Educational Institutions

While finances did not appear to be a barrier at the middle school at the onset of the study due to the $250,000 CAD in initial funding, finances were in fact the largest barrier the school faced. Although the school had full financial support for five years of HSCF operations, after that time the school would be responsible for covering a minimum of $5,000 to $7,000 CAD in yearly operating costs. This resulted in the lead HSCF teacher spending most of her time trying to make the HSCF financially viable, as the funding charity did not provide the school with any advice or modeling on how to make the HSCF financially sustainable.

Given the large upfront cost of the HSCF (likely over $200,000 CAD) and the exorbitant yearly upkeep costs (at least $5,000 to $7,000 CAD annually), it is unlikely that most schools will be able to afford to purchase and run an HSCF independently. Even if a school received initial funding for the purchase of an HSCF, the yearly upkeep costs would make the HSCF financially unviable for the school in the long run. If the primary purpose of an HSCF is for educational purposes, a school would likely be better off investing much less money in a different initiative, such as a raised garden bed or an indoor tower garden. The lack of financial transparency by the funding organization was also a concern, as it made it difficult for the school to estimate the actual operating costs of the HSCF to plan for future financial independence.

The other barriers the middle school faced, including insufficient time, resources, and staff, are common barriers to implementing food and health education programs (Bergling et al., 2022; Skovgaard et al., 2024). In terms of labor requirements specifically, when comparing this middle school's experience with Wagner et al.'s (2020) study investigating HSCFs in educational settings, one part-time employee is not sufficient to operate an HSCF, let alone attempt to use it as an educational tool. This concentrated workload on one person, or having one "teacher champion," has been shown to happen in food and health related school programming (Skovgaard et al., 2024). Although it is possible for these teacher champions to contribute to the development of well-integrated and sustainable initiatives within schools, it is critical for the responsibility to be shared among a wider group that shares a vision of the program in question. If this support system is not present, the teacher may experience burnout, which could lead to the end of the initiative. Or, if the teacher champion left the school, the program would end as there would be no one trained to take their place (Rojas et al., 2022; Skovgaard et al., 2024). In the case of the middle school in this study, there were no teachers beyond Mrs. Smith who were interested in assisting with the HSCF. Other studies have shown similar difficulties for teacher champions when trying to obtain support from other staff members. For instance, Skovgaard et al.'s (2024) study, which looked at integrating physical activity programs within schools, showed that "champions often encounter challenges, particularly when lacking active engagement and commitment from school management and colleagues" (p. 161).

This lack of interest from other teachers in contributing to the implementation of the HSCF highlights the importance of strengthening commitment to food-related learning across all subjects and teachers so that there is a broader interest in participating in these types of food-related initiatives. This could be accomplished through subject-integrated food education whereby food-related topics are included in multiple topics (Hard et al., 2024), increased focus on food-related topics within written curricular documents (Smith & de Zwart, 2017), incorporating food education into teacher education programs (Stapleton, 2022), and providing more food-related professional development opportunities for teachers (Dunn et al., 2019).

Implications

Implications for Schools and Educators

The findings of this study have several important implications for schools interested in implementing a HSCF program in their setting. First, successful implementation of a HSCF program requires substantial ongoing staff involvement, financial support, and specialized knowledge. Therefore, schools should carefully assess their existing and future labor capacity and financial resources before implementation. Reliance on a single teacher, as was the case in this study, comes with significant sustainability risks that could lead to teacher burnout or program discontinuation if there is not adequate institutional and/or community support.

Second, this study highlights the potential of HSCF programs to act as catalysts for wider community engagement in sustainability initiatives. For a school with existing community connections, a HSCF program or other well-supported initiative may serve as a driver for further community collaboration, experiential learning opportunities for students, and locally situated action at both the school and community levels.

Implications for Policy Makers and Funding Bodies

For policy makers, this study shows the importance of prioritizing food education at the district/provincial/national levels. If sustainability and informed citizenship are goals of educational systems, as they are in many instances, this goal needs to be reflected in the support and resources given to schools implementing initiatives that could contribute towards achieving this goal, such as funding opportunities that would allow a school to hire staff to operate a HSCF or lead other food-related programming.

For organizations funding school-based programming, the findings of this study underscore the importance of ensuring transparent funding models and realistic long-term cost projections to ensure the success and continued sustainability of programming.

Implications for Future Research

This study highlights the need for further research examining the feasibility of HSCFs in diverse educational settings. Studies that compare programs across geographical regions, school types, and HSCF models would allow for a clearer picture as to whether the barriers and opportunities identified in this study are widespread or context specific. Longitudinal research on HSCF programming would also be beneficial in determining whether the financial and labor demands remain stable, diminish, or intensify over time.

Recommendations

Based on this study, the following are recommendations for schools that are interested in investing in a HSCF program:

1. **Have an established and committed multi-person support team:** Schools should avoid relying on a single teacher champion and instead secure a dedicated team who are responsible for HSCF operations, curriculum integration, and community partnerships. Ideally, this team is composed of multiple actors within a school community including teachers, administrators, students, and community members. This distributed leadership structure would help ensure sustainability of the program and avoid participant burnout.
2. **Secure long-term funding prior to implementation:** Financial transparency is crucial; schools and funders should continually communicate so all parties understand initial and ongoing operating costs to ensure a long-term plan for obtaining the necessary finances to operate the HSCF.
3. **Conduct a pre-implementation feasibility and needs assessment:** An assessment that considers a school's staffing capacity, curricular alignment, site logistics, student involvement, and community interest may help determine if a HSCF is a feasible investment. Additionally, conducting a needs assessment that considers the goals of the HSCF program (e.g., educating students, feeding students) could help a school understand if a HSCF is the best option for achieving those goals.

4. **Provide professional development opportunities:** As operating a HSCF requires specialized skills and knowledge, teachers and other staff should be provided with training in hydroponic systems and relevant safety protocols. Additionally, professional development opportunities that focus on cross-curricular food related education could strengthen the educational potential of the HSCF.
5. **Leverage community partnerships:** Partnerships with local businesses, farmers, community members, and other organizations can help offset logistical challenges of operating HSCFs (such as refrigeration capacity or managing waste). Schools should map existing or potential relationships with community members early in the planning process to determine ways in which these connections could support the program.
6. **Explore lower cost or less labor-intensive alternatives when appropriate:** For schools lacking the substantial financial resources and staffing capacity necessarily for operating a HSCF, or schools that determine a HSCF is not needed to meet their programming goals, alternative growing systems (e.g., tower gardens, smaller hydroponic systems, raised garden beds) may offer similar pedagogical benefits with far lower financial and labor demands.

Study Limitations

A central limitation of this study was the small sample size of only one school. However, HSCFs in educational settings are a new phenomenon, and consequently, the total possible sample size for the study was limited. To the best of the author's knowledge, the middle school included in this study was the only non-university educational institution operating an HSCF at the time of the study. A second limitation was that the study examined only one specific model of HSCF. As several different HSCF models exist in the market, it is possible that schools would encounter different barriers and/or opportunities to implementation if an HSCF was designed differently. Finally, the COVID-19 pandemic was a limitation of this study. Due to ever-changing health orders, normal teaching and learning opportunities were disrupted many times throughout the year. This impacted the school's ability to plan and run the HSCF program as intended.

Conclusion

This study indicates that, although the implementation of an HSCF program can be supported by strong community connections and administrative support, these opportunities for successful implementation are overshadowed by significant barriers. The financial costs and labor requirements for purchasing and operating an HSCF are substantial and are likely unattainable for most schools. This study highlighted that a school would need to receive some sort of funding to initially purchase an HSCF unit and would be in a financially precarious situation following implementation if it did not have continuous external financial support to cover operating costs. The high labor requirements of the HSCF, given how this school and many others rely on teacher and community champions to run such programs, place a large burden on one or a few individuals, which could lead to burnout and program discontinuation if additional support is not provided.

Given these barriers, it is important to evaluate the suitability of HSCFs in educational settings. Depending on the goals of the school, other types of hands-on food-related learning opportunities, such as tower gardens and other indoor growing solutions, may be more appropriate and easier to implement. These units would be less intensive in terms of both financial cost and labor requirements and, consequently, would be easier for a school to initiate and have a higher potential for sustainability in the long run. Further research on implementing HSCFs in educational settings is required to confirm whether the experiences of this school are consistent across different settings. Overall, educational institutions should use caution when considering the purchase of an HSCF and ensure that they have significant school-wide support and a consistent income stream to finance operating costs before investing in an HSCF unit.

Biography

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References

Amiri, A., Geravandi, S., & Rostami, F. (2021). Potential effects of school garden on students' knowledge, attitude and experience: A pilot project on sixth grade students in Iran. *Urban Forestry & Urban Greening*, *62*(127174), 127174. https://doi.org/10.1016/j.ufug.2021.127174

Araújo, R. G., Chavez-Santoscoy, R. A., Parra-Saldívar, R., Melchor-Martínez, E. M., & Iqbal, H. M. N. (2023). Agro-food systems and environment: Sustaining the unsustainable. Current *Opinion in Environmental Science & Health*, *31*, 100413. https://doi.org/10.1016/j.coesh.2022.100413

Berezowitz, C. K., Bontrager Yoder, A. B., & Schoeller, D. A. (2015). School Gardens Enhance Academic Performance and Dietary Outcomes in Children. The Journal of School Health, 85(8), 508–518. https://doi.org/10.1111/josh.12278

Bergling, E., Pendleton, D., Shore, E., Harpin, S., Whitesell, N., & Puma, J. (2022). Implementation factors and teacher experience of the Integrated Nutrition Education Program: A mixed methods program evaluation. *The Journal of School Health*, *92*(5), 493–503. https://doi.org/10.1111/josh.13153

Blair, D. (2009). The Child in the Garden: An Evaluative Review of the Benefits of School Gardening. *The Journal of Environmental Education*, *40*(2), 15–38. https://doi.org/10.3200/JOEE.40.2.15-38

Blair, S., Edwards, G., Yu, K., Jovel, E., Powell, L. J., Renwick, K., & Conklin, A. (2023). What is a school farm? Results of a scoping review. *International Journal of Environmental Research and Public Health*, *20*(7), 5332. https://doi.org/10.3390/ijerph20075332

Bouchar, D. M. (1998). Hydroponic systems. *Horticulture Engineering*, *13*, 1–10.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Burt, K., Koch, P., & Contento, I. (2017). Development of the GREEN (Garden Resources, Education, and Environment Nexus) Tool: An Evidence-Based Model for School Garden Integration. *Journal of the Academy of Nutrition and Dietetics*, *117*(10), 1517-1527.e4. https://doi.org/10.1016/j.jand.2017.02.008

Carver, J., & Wasserman, B. (2012). Hands-On Hydroponics. *The Science Teacher*, *79*(4), 44–48.

Chan, C. L., Tan, P. Y., & Gong, Y. Y. (2022). Evaluating the impacts of school garden-based programmes on diet and nutrition-related knowledge, attitudes and practices among the school children: a systematic review. *BMC Public Health*, *22*(1), 1251. https://doi.org/10.1186/s12889-022-13587-x

Charlton, K., Comerford, T., Deavin, N., & Walton, K. (2021). Characteristics of successful primary school-based experiential nutrition programmes: a systematic literature review. *Public Health Nutrition*, *24*(14), 4642–4662. https://doi.org/10.1017/S1368980020004024

Cohen, L., Manion, L., & Morrison, K. (Eds.). (2011). *Research Methods in Education* (7th Edition). Routledge.

Creswell, J. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th Edition). Sage.

Dodgson, J. E. (2019). Reflexivity in Qualitative Research. *Journal of Human Lactation*, *35*(2) 220–222. https://doi.org/10.1177/0890334419830990

Dunn, C. G., Burgermaster, M., Adams, A., Koch, P., Adintori, P. A., & Stage, V. C. (2019). A systematic review and content analysis of classroom teacher professional development in nutrition education programs. Advances in Nutrition (Bethesda, Md.), 10(2), 351–359. https://doi.org/10.1093/advances/nmy075

Edwards, G. (2023*). Participants' Experiences Implementing a Food Literacy Program Utilizing a Hydroponic Shipping Container Farm* (K. Renwick, Ed.) [PhD]. The University of British Columbia.

Edwards, G. (2024). Using photovoice to explore students' experiences with a hydroponic shipping container farm. *Journal of Experiential Education*, *48*(3), 405-424. https://doi.org/10.1177/10538259241286496

Esdaile, E. K., Wharton, L., Vidgen, H., & Gallegos, D. (2024). Teacher perspectives on the socio-ecological barriers and enablers to food and nutrition education in primary schools: a scoping review. *Public Health Nutrition*, *27*(1), e175. https://doi.org/10.1017/S1368980024001812

Farmbox Foods. (n.d.). *Container Farms on School Campuses – Community Supported Agriculture*. https://farmboxfoods.com/container-farms-on-school-campuses/

Feldmann, C., & Hamm, U. (2015). Consumers' perceptions and preferences for local food: A review. *Food Quality and Preference*, *40*, 152–164. https://doi.org/10.1016/j.foodqual.2014.09.014

Fontana, A., & Frey, J. (2000). The interview: From structured questions to negotiated text. In N. Denzin & Y. Lincoln (Eds.), *Handbook of qualitative research* (pp. 645–668). Sage Publications.

Garnett, T., & Fischer, C. (2016). *Plates, pyramids and planets: Developments in national healthy and sustainable dietary guidelines: a state of play assessment*. FAO.

Gisslevik, E., Wernersson, I., & Larsson, C. (2019). Pupils' participation in and response to sustainable food education in Swedish home and consumer studies: A case-study. *Scandinavian Journal of Educational Research*, *63*(4), 585–604. https://doi.org/10.1080/00313831.2017.1415965

Goddard, C. (1953). Try a Hydroponic Garden. *The American Biology Teacher*, *15*(1), 12–14.

Government of BC. (n.d.). *The educated citizen*. https://bcforhighschool.gov.bc.ca/offshore/bc-curriculum-assessment-overview/the-educated-citizen/#:~:text=BC's%20Curriculum%20enables%20students%20to,critical%20analysis%20and%20independent%20reasoning

Grauer, K. (2012). A case for case study research in education. In S. R. Klein (Ed.), *Action Research Methods* (pp. 69–79). Palgrave Macmillan. https://doi.org/10.1057/9781137046635_4

Grebitus, C., Printezis, I., & Printezis, A. (2017). Relationship between Consumer Behavior and Success of Urban Agriculture. *Ecological Economics: The Journal of the International Society for Ecological Economics*, *136*, 189–200. https://doi.org/10.1016/j.ecolecon.2017.02.010

Growcer. (n.d.-a). *Frequently asked questions*. https://www.thegrowcer.ca/faq

Growcer. (n.d.-b). *K-12 Education*. https://www.thegrowcer.ca/k-12

Growtainers. (n.d.). *Container Farming: Cultivating futures through innovative learning*. https://growtainers.com/container-farming/

Hamilton, L., & Corbett-Whittier, C. (2012). *Using case study in education research*. SAGE Publications.

Hancock, D., Algozzine, B., & Lim, J. H. (2021). *Doing case study research* (4th ed.). Teachers' College Press.

Hard, L., Palojoki, P., & Larsson, C. (2024). Swedish primary school teachers' experiences of subject-integrated food education. *International Journal of Home Economics*, *17*(1), 32–47.

Hawkes, C., Smith, T. G., Jewell, J., Wardle, J., Hammond, R. A., Friel, S., Thow, A. M., & Kain, J. (2015). Smart food policies for obesity prevention. *The Lancet*, *385*(9985), 2410–2421. https://doi.org/10.1016/S0140-6736(14)61745-1

Hedenus, F., Wirsenius, S., & Johansson, D. J. A. (2014). The importance of reduced meat and dairy consumption for meeting stringent climate change targets. *Climatic Change*, *124*(1), 79–91. https://doi.org/10.1007/s10584-014-1104-5

Hicks, S. (2017, July 26). *Urban farming 2.0: From plow beams to Leafy Green Machines*. The Christian Science Monitor. https://www.csmonitor.com/Environment/2017/0726/Urban-farming-2.0-From-plow-beams-to-Leafy-Green-Machines

HLPE. (2023). *Reducing inequalities for food security and nutrition*. High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.

IPCC. (2022). *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (P. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, & J. Malley, Eds.). IPCC. https://doi.org/10.1017/9781009157926

Jon Schneller, A., Schofield, C. A., Frank, J., Hollister, E., & Mamuszka, L. (2015). A Case Study of Indoor Garden-Based Learning With Hydroponics and Aquaponics: Evaluating Pro-Environmental Knowledge, Perception, and Behavior Change. *Applied Environmental Education and Communication*, *14*(4), 256–265. https://doi.org/10.1080/1533015X.2015.1109487

Kirschenmann, F. (2010). Alternative agriculture in an energy-and resource-depleting future. *Renewable Agriculture and Food Systems*, *25*(2), 85–89. https://doi.org/10.1017/S1742170510000141

Kushnir, I. (2025). Thematic analysis in the area of education: a practical guide. *Cogent Education*, *12*(1). https://doi.org/10.1080/2331186x.2025.2471645

McHugh, C., Lloyd, J., Logan, S., & Wyatt, K. (2021). Enablers and barriers English secondary schools face in promoting healthy diet and physical activity behaviours. *Health Promotion International*, 37, daab148. https://doi.org/10.1093/heapro/daab148

Mishra, S. K., Khanal, A. R., & Collins, W. J. (2022). Farm-to-School programmes, benefits, health outcomes and barriers: A structured literature review. *Health Education Journal*, *81*(7), 781–792. https://doi.org/10.1177/00178969221119290

Passy, R. (2014). School gardens: teaching and learning outside the front door. *Education 3-13*, *42*(1), 23–38. https://doi.org/10.1080/03004279.2011.636371

Patchen, A. K., Zhang, L., & Barnett, M. (2017). Growing plants and scientists: Fostering positive attitudes toward science among all participants in an afterschool hydroponics program. *Journal of Science Education and Technology*, *26*(3), 279–294. https://doi.org/10.1007/s10956-016-9678-5

Raviv, M., & Lieth, J. H. (2008). Significance of soilless culture in agriculture. In M. Raviv & J. H. Lieth (Eds.), *Soilless Culture* (pp. 1–12). Elsevier.

Reisch, L., Eberle, U., & Lorek, S. (2013). Sustainable food consumption: an overview of contemporary issues and policies. *Sustainability: Science Practice and Policy*, *9*(2), 7–25. https://doi.org/10.1080/15487733.2013.11908111

Resh, H. M. (2013). *Hydroponic Food Production: A definitive guidebook for the advanced home gardener and the commercial hydroponic grower* (7th edition). Routledge.

Rockström, J., Thilsted, S. H., Willett, W. C., Gordon, L. J., Herrero, M., Hicks, C. C., Mason-D'Croz, D., Rao, N., Springmann, M., Wright, E. C., Agustina, R., Bajaj, S., Bunge, A. C., Carducci, B., Conti, C., Covic, N., Fanzo, J., Forouhi, N. G., Gibson, M. F., … DeClerck, F. (2025). The EAT-Lancet Commission on healthy, sustainable, and just food systems. *Lancet*, *406*(10512), 1625–1700. https://doi.org/10.1016/S0140-6736(25)01201-2

Rojas, A., Black, J. L., Orrego, E., Chapman, G., & Valley, W. (2022). *Insights from the Think&EatGreen@School Project : How a community-based action research project contributed to healthy and sustainable school food systems in Vancouver*. Canadian Association for Food Studies / L'Association canadienne des études sur l'alimentation. https://doi.org/10.14288/1.0407067

Skovgaard, T., Madsen, M. L. S., & Christiansen, L. B. (2024). Exploring the Role of Champions in the Facilitation and Implementation of a Whole-School Health Program. *Education Sciences*, *14*(2), 161. https://doi.org/10.3390/educsci14020161

Smith, M. G., & de Zwart, M. L. (2017). A perfect storm or never say die: Home Economics education in British Columbia. *International Journal of Home Economics*, *10*(1), 162–173.

Stapleton, S. R. (2022). Bringing teachers to the table: the need to teach food in teacher education. *Food, Culture & Society*, *25*(4), 740–760. https://doi.org/10.1080/15528014.2021.2012925

Stapleton, S. R., & Meier, B. K. (2022). Science education for and as resiliency through indoor agriculture. *Journal of Research in Science Teaching*, *59*(2), 169–194. https://doi.org/10.1002/tea.21724

Story, M., Nanney, M. S., & Schwartz, M. B. (2009). Schools and obesity prevention: creating school environments and policies to promote healthy eating and physical activity. *The Milbank Quarterly*, *87*(1), 71–100. https://doi.org/10.1111/j.1468-0009.2009.00548.x

Thanh, N. C., & Thanh, T. T. M. (2015). The interconnection between interpretivist paradigm and qualitative methods in education. *American Journal of Educational Science*, *1*(2), 24-27.

United Nations General Assembly. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development (Resolution A/RES/70/1)*. United Nations.

Varela, P., De Rosso, S., Ferreira Moura, A., Galler, M., Philippe, K., Pickard, A., Rageliene, T., Sick, J., van Nee, R., Almli, V. L., Ares, G., Grønhøj, A., Spinelli, S., & van Kleef, E. (2024). Bringing down barriers to children's healthy eating: a critical review of opportunities, within a complex food system. *Nutrition Research Reviews*, *37*(2), 331–351. https://doi.org/10.1017/S0954422423000203

Varman, S. D., Cliff, D. P., Jones, R. A., Hammersley, M. L., Zhang, Z., Charlton, K., & Kelly, B. (2021). Experiential Learning Interventions and Healthy Eating Outcomes in Children: A Systematic Literature Review. *International Journal of Environmental Research and Public Health*, 18(20). https://doi.org/10.3390/ijerph182010824

Vaughan, K. L., Cade, J. E., Hetherington, M. M., Webster, J., & Evans, C. E. L. (2024). The impact of school-based cooking classes on vegetable intake, cooking skills and food literacy of children aged 4-12 years: A systematic review of the evidence 2001-2021. *Appetite*, *195*(107238), 107238. https://doi.org/10.1016/j.appet.2024.107238

Wagner, N., Juarez, M., & Morrish, D. (2020). A Feasibility Study of Hydroponic Shipping Container Farms in Schools: Identifying the Influential Factors, Benefits, and Challenges. *NACTA Journal*, *65*, Nov 2020-Dec 2020.

Wagner, N., Morrish, D., & Juarez, M. (2021). Identifying the influential factors, benefits and challenges of hydroponic shipping container farm businesses: a snapshot of farmers' perceptions. *Renewable Agriculture and Food Systems*, *36*(6), 519–526. https://doi.org/10.1017/S1742170521000211

Walters, K. J., Behe, B. K., Currey, C. J., & Lopez, R. G. (2020). Historical, Current, and Future Perspectives for Controlled Environment Hydroponic Food Crop Production in the United States. *HortScience: A Publication of the American Society for Horticultural Science*, *55*(6), 758–767. https://doi.org/10.21273/HORTSCI14901-20

Wells, N. M., Myers, B. M., Todd, L. E., Barale, K., Gaolach, B., Ferenz, G., Aitken, M., Henderson, C. R., Tse, C., Pattison, K. O., Taylor, C., Connerly, L., Carson, J. B., Gensemer, A. Z., Franz, N. K., & Falk, E. (2015). The Effects of School Gardens on Children's Science Knowledge: A randomized controlled trial of low-income elementary schools. *International Journal of Science Education*, *37*(17), 2858–2878. https://doi.org/10.1080/09500693.2015.1112048

Wells, N. M., Todd, L. E., Henderson, C. R., Jr., Myers, B. M., Barale, K., Gaolach, B., Ferenz, G., Aitken, M., Hendrix, L., Taylor, C., & Wilkins, J. L. (2023). The effects of school gardens on fruit and vegetable consumption at school: A randomized controlled trial with low-income elementary schools in four U.S. states. *Preventive Medicine Reports*, *31*(102053), 102053. https://doi.org/10.1016/j.pmedr.2022.102053

Wickham, C. A., & Carbone, E. T. (2018). "just say it like it is!" use of a community-based participatory approach to develop a technology-driven food literacy program for adolescents. *International Quarterly of Community Health Education*, *38*(2), 83–97. https://doi.org/10.1177/0272684X17749572

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., … Murray, C. J. L. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, *393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

Wortman, S. E., & Lovell, S. T. (2013). Environmental challenges threatening the growth of urban agriculture in the United States. *Journal of Environmental Quality*, *42*(5), 1283–1294. https://doi.org/10.2134/jeq2013.01.0031

Yin, R. K. (2009). *Case Study Research: Design and Methods*. SAGE.