

Cultivating Youth Interest in Sustainability through Agricultural Education

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Introduction

Agriculture stands at the crux of civilization, enabling humans to transition from a roaming hunter-gatherer lifestyle to developing planned cities and large settlements. The desire to find and maintain arable land has driven quests for territorial expansion, robust monetary policies, and in the hopes of creating more efficient and productive ways to produce food, innovation. As the global climate crisis reshapes the world with rising sea levels and temperatures, it threatens existing forms of agriculture as well. Arable land is decreasing and some estimates suggest that existing farmlands could be cut in half by 2050, despite an unprecedented expected population of 10 billion people¹. Climate change is increasing the number of consumers maintaining plant-based diets. This coupled with the decreasing physical footprint of farmable land necessitates an urgent need to rethink food production practices. Emerging agricultural technologies are transforming the possibilities and scope of farming, especially in urban contexts. While urban farming at one time seemed restricted to gardens, the development of spatially conservative agricultural techniques such as vertical farming and hydroponics have made the possibilities of urban agriculture more realistic.

Vertical farming, also referred to as Z-farming, refers to zero-acreage farming, meaning farms take up minimal space to produce multiple acres worth of food. Food is grown upright, such as in towers or on a plant wall. Hydroponics is a farming technique where plants are grown without soil, generally relying on the recycling and reuse of water, thereby conserving water usage. Container farms, generally a result of repurposed shipping containers, use vertical farming and hydroponics to grow up to 2.5 acres worth of food annually in towers². These shipping containers are functional in extreme climates and confined spaces, so long as a water and electricity connection remain available, challenging existing limitations to farming. They utilize a temperature controlled environment, featuring ultraviolet light as a substitute for direct sunlight and have an automated water system that recycles water not consumed by the plants. While the primary purpose of these farms is to produce fresh produce in urban areas, many schools have also taken interest in these as a tool for education. The utilization of such farms by schools provides students with a hands-on learning experience to complement their education, providing first hand exposure to environmental science, agriculture, and the importance of sustainability.

For my undergraduate senior thesis at Barnard College, I studied the viability of container farming as a tool for expanding agricultural education in urban schools. My research examined five public high schools in the United States in which students were studying agriculture through container farms or traditional, horizontal methods. These schools collectively offered a mix of college preparatory curricula as well as career and technical education (CTE),

¹Jon Heggie, "How Can We Farm Our Unfarmable Land?," Science, March 18, 2019, <https://www.nationalgeographic.com/science/article/partner-content-how-farm-our-unfarmable-land>.

²"Our Mission," Freight Farms, 2023, <https://www.freightfarms.com/company>.

demonstrating the versatility of agricultural science in the classroom across a broad spectrum of students. While my methodology included the analysis of websites, school reports, and data collected by the company Freight Farms, the primary manufacturers of container farms, the main focus of my research was ethnographic. I conducted six interviews of educators and administrators, as well as a former agricultural student and an employee from Freight Farms. The research also included a site visit to John Bowne High School in New York City.

It is from this research that I have drawn the focus of this paper, in which I examine how the study of agriculture at the secondary level introduces students to sustainable food practices, increasing potential interest in sustainability at large. Developing such interest early on is essential to the future labor market and sustainable careers, as well as creating consumers more aware of the impact of food production on climate change. This paper focuses specifically on John Bowne High School (Queens, New York City, New York) and Mountain Vista High School (Highlands Ranch, Colorado). John Bowne offers an agricultural science based career and technical education program using traditional farming methods. Through my analysis of the John Bowne program, I demonstrate the benefits of agricultural education and its impact on students. Mountain Vista High School utilizes a container farm as a case study for an agribusiness course. In looking at Mountain Vista's successful usage of a container farm over six years, I present a path toward expanding agricultural education in urban areas. My focus on these two schools is supplemented by my research on W.B. Saul High School (Philadelphia, Pennsylvania; agricultural CTE), Boston Latin School (Boston, Massachusetts; container farm, college preparatory), and Montachusets Regional Vocational Technical High School (Fitchburg, Massachusetts; container farm, CTE). My research and prior studies suggests that expanding agricultural education is essential to driving interest in agricultural careers and upskilling the labor force for a sustainable future.

Urban Farming and the Economy

Advances in agricultural technology are foundational to sustaining the world's growing population. Though vertical farming is promising in terms of producing more food in less space, there are a number of environmental costs that must be understood as well. Container farms use an HVAC system that requires a high level of energy consumption, meaning they do not currently produce food in a way that is more energy efficient than traditional agricultural techniques (Van Gerrewey; Peyen et al. 2018; Kaur and Chawla 2021). However, this does not exclude such techniques from future potential, especially as renewable and nuclear energy sources develop. Because container farming aims to produce food in a spatially conscious way, researchers have also studied what limitations exist to this form of food production. Though they yield significantly more leafy greens than traditional counterparts, when looking at other types of crops, vertical farming was either on par or less successful than traditional techniques³. Despite the current high energy consumption and minimal variety of crops capable of being produced in a container farm, there are many positive environmental impacts as well. Vertical farming uses only 5 percent of the water used in traditional farming. This coupled with the small spatial needs maximizes crop yield⁴. An investigation into just how much food can be produced vertically

³ Florian Thomas Payen et al., "How Much Food Can We Grow in Urban Areas? Food Production and Crop Yields of Urban Agriculture: A Meta-Analysis," *Earth's Future* 10, no. 8 (August 2022), <https://doi.org/10.1029/2022EF002748>.

⁴ Gaganjot Kaur and Paras Chawla, "All about Vertical Farming: A Review," *Turkish Journal of Computer and Mathematics Education* 12, no. 2 (2021): 1–14.

reveals that a container farmer can grow an estimated 12 cycles of lettuce per year as a result of a climate controlled environment not dependent on weather. The ability to grow food year round significantly adds to the crop yield of these farms⁵. Another study of vertical farming suggests that indoor vertical farms can yield 10 to 100 times that of traditional farms⁶. The production of food in such a space would qualify as a grey space, meaning an artificial controlled space with minimal acreage⁷. Grey spaces may hold the key to future food production, especially given that food demand will rise between 57 and 98 percent by 2050⁸, creating a sense of urgency surrounding neo-agricultural techniques.

Even though such technologies are essential to future food production, they sometimes face negative social perceptions. Farming generally involves dirt, and most container farms utilize hydroponic techniques, meaning the food is grown without soil. Though there is no nutritional difference between soilless crops and those grown with soil, many are hesitant to purchase hydroponically sourced produce due to a belief that they are less healthy⁹. One easy solution to this is to educate the market to decrease consumer misinformation. Agricultural education provides students with necessary facts to make determinations about the nutritional value of food, which could in turn increase the demand and labor force, resulting in a growing industry and the need for an expanded labor base¹⁰.

New technologies and farming techniques hold lots of potential to solving issues of food scarcity, but only if there is a labor force to support it. The industry of vertical farming can be broken into four different groups: crop growth, supply, research and education, and consultancy, each of which creates a labor market. Potential job opportunities include farming, technology, project management, marketing, staffing, and promoting. While there seem to be ample opportunities, there currently is not a proper workforce to fill these needs¹¹. Though vertical farming is not too different from traditional methods in the sense that both aim to produce a crop output, it is a different set of skills that necessitates a workforce trained specifically in hydroponic and vertical farming techniques. A staffing gap such as this one could potentially be filled by the incorporation of agricultural education into secondary school curricula. Creating agricultural education programs does not just benefit the labor market but also the students partaking in such programs, as agriculture draws on a variety of fields, such as, engineering, management, marketing and environmental science.

Experiential Learning and Secondary Agricultural Education

Agricultural education gives students a hands-on-learning experience, allowing them to explore what they have learned in the classroom through experiential learning. Experiential learning is both a method for students to gain knowledge through a skills based approach and also as a lens by which individuals can approach the world as life-long learners¹². It ascertains that students can better understand a concept through concrete experience, reflective observation, abstract conceptualization, and active experimentation¹³. In creating agricultural education opportunities, students gain access to this type of learning, enhancing their academic

⁵ Payen et al., "How Much Food Can We Grow in Urban Areas?"

⁶ Tom Gibson, "Room to Grow," *ASEE Prism* 27, no. 7 (2018): 26–31.

⁷ Payen et al., "How Much Food Can We Grow in Urban Areas?"

⁸ Kaur and Chawla, "All about Vertical Farming."

⁹ Gerrewey et al., "Vertical Farming."

¹⁰ Gerrewey et al., "Vertical Farming."

¹¹ Gerrewey et al., "Vertical Farming."

¹² Robert W. Clark, Mark D. Threeton, and John C. Ewing, "The Potential of Experiential Learning Models and Practices In Career and Technical Education & Career and Technical Teacher Education," *Journal of Career and Technical Education* 25, no. 2 (December 1, 2010), <https://doi.org/10.21061/jcte.v25i2.479>.

¹³ Alice Y. Kolb and David A. Kolb, "Learning Styles and Learning Spaces: Enhancing Experiential Learning in Higher Education," *Academy of Management Learning & Education* 4, no. 2 (2005): 193–212.

experience. The academic enhancement stemming from both a construction of knowledge and disciplined based inquiry has benefits that extend beyond the classroom, equipping students with strong competency surrounding problem solving and task completion¹⁴. In that same sense, students are better equipped to make informed decisions as consumers, and with regards to agriculture, promoting interest in sustainable practices.

Though not much research has been done on the postgraduate outcomes of agricultural ed students, one significant study, Pantleo et al., does exist to support the idea that agricultural education leads to related careers. This study analyzed student outcomes from 2015-2019 in Missouri. These students were all CTE students concentrating in agriculture. Pantleo et al. argue that agricultural education extends beyond creating an experience that develops career skills as it prepares students to address modern agricultural programs, unlocking hundreds of career paths. Pantleo et al. found that 75 percent of agricultural CTE students who graduated between 2015 and 2019 went on to employment relating to agriculture, a direct result of their CTE training, suggesting success in agricultural programs in recruiting students to agricultural careers. Another study, Esters 2007, examined the declining enrollment colleges and universities have seen in their agriculture programs as a result of 80 percent of the US population living in urban areas where there are fewer opportunities to engage in agricultural work prior to college, therefore limiting exposure. Investment into the expansion of agricultural education could introduce more students to post-secondary agricultural study, potentially connecting students to more careers in the field¹⁵. Another study found that respondents to a survey about urban agricultural education perceived it as a chance to teach students about communication, leadership, and decision making, as well as subjects such as bio-science, technology, and global affairs¹⁶. Additionally, Russ and Gaus (2021) argue that urban agriculture contributes to several areas of public life, such as, food security, economic development, public health, and community revitalization. Teaching urban students about agriculture can serve as a way to introduce them to these essential life-long topics and connect them to careers interests in sustainability. Urban agricultural education programs have the potential to prepare students for post-secondary, filling the labor gap discussed by Kaur and Chawla (2021).

Data and Discussion

Introduction

Though I examined five sites, each offering different connections to the study of agriculture, I have chosen to focus on just two for this paper. John Bowne High School in New York City has an agricultural CTE program, offering students a chance to graduate high school with a certification in agriculture. John Bowne has a total of four acres that they use for both plant and animal science. Their program is focused on traditional farming methods, using large fields to grow crops. I also studied W.B. Saul High School in Philadelphia, which had 100 acres, used for both plant and animal science as well. Saul is an entirely agricultural high school, with students focusing on one of four tracks: animal science, horticulture, food science, or environmental science. While W.B. Saul is the country's largest agricultural high school, I've chosen to focus on John Bowne, as its students are not exclusively agriculture students, demonstrating that for students to study agriculture, it does not necessarily need to be the only program a school offers. The second school of focus, Mountain Vista High School, uses

¹⁴ Neil A. Knobloch, "Is Experiential Learning Authentic?," *Journal of Agricultural Education* 44, no. 4 (December 2003): 22–34, <https://doi.org/10.5032/jae.2003.04022>.

¹⁵ Levon T. Esters, "Factors Influencing Postsecondary Education Enrollment Behaviors of Urban Agricultural Education Students," *Career and Technical Education Research* 32, no. 2 (January 1, 2007): 79–98, <https://doi.org/10.5328/CTER32.2.79>.

¹⁶ Donn Harry Russell, "Perceptions of Urban Agriculture Education Stakeholders toward Curriculum" (Ph.D., United States -- Iowa, Iowa State University), accessed December 20, 2022, <https://www.proquest.com/docview/304511624/abstract/FF17A6D3B2514CD7PQ/1>.

container farming in conjunction with an agribusiness course. The final two sites, Boston Latin School and Montachussetts Regional Technical High School (Monty Tech) have container farms, but do not utilize them directly with a course. Boston Latin's farm was used for extracurricular purposes with students growing produce to donate to food pantries and school community. Monty Tech obtained their farm to teach students about the importance of locally sourced produce and have been using in conjunction with their culinary program. Nevertheless, these schools also offer insights into the applicabilities of agricultural education. My focus on Mountain Vista is to demonstrate the plausibility of using a container farm in direct relation to school curriculum. While the case of John Bowne provides an example of how the study of traditional agriculture in an established CTE program benefits student interest in agriculture and sustainability, the Mountain Vista case provides an example for how a container farm can also inspire interest in those fields and serve as a viable curricular tool. The two schools together offer insight into how educators and policy makers can encourage agricultural education at the secondary level and in doing so fill gaps in the labor market for agriculture, while creating a generation of young adults with a skillset designed for sustainable thinking.

Agricultural Education — John Bowne High School

Located a short bus ride from the heart of Flushing in New York City is John Bowne (JB) High School. A New York City public school, JB has a total enrollment of 3,279 students from across New York City. JB offers students seven specialized academic programs¹⁷, among which are two CTE options— their Agriscience Institute and the Bowne Law Institute¹⁸. Between freshman and sophomore years, agriculture students are required to participate in a summer work program during which they are each given a plot of land to grow food on. They are responsible for maintaining the land and harvesting it. They can sell their produce or take it home. In my research, I met with Assistant Principal Patrycja who oversees the agriculture program and received a tour of the school's facilities from a student to whom I have assigned the pseudonym Mark. Patrycja described the summer program as essential for giving students a set of foundational agriculture skills so that they are ready for more advanced study throughout the rest of high school. Mark and Patrycja noted that many students return after that summer to take on supervisor positions where they mentor the underclassmen in a paid role. Mark said that students ages 14 and older are eligible to get paid for their summer work through the New York City Summer Youth Employment Program, introducing a direct link between agricultural education and employment.

Students in the agriculture program take courses in both plant and animal sciences their freshman and sophomore year, before choosing a specialization for their remaining two years. The program culminates with the completion of a 30 page original research paper in their area of specialization along with the administration of a CTE skills assessment. Students who pass the skills assessment then earn a CTE seal on their diploma. Students in the agriculture program participate in the Future Farmers of America (FFA) organization and complete work experience as part of their graduation requirements. The John Bowne case study offers insight into what a robust CTE program can offer students in terms of both the study of agriculture as well as post-secondary interest in the subject.

When I asked Patrycja specifically about container farms as a tool for expanding agricultural education, she replied that she thinks "every school should have some sort of ag [*sic*] component to it whether in the curriculum or in a science classroom. In urban spaces it's

¹⁷ "Offered Programs," John Bowne High School, accessed April 19, 2023, <https://www.johnbowne.org/?x=true>.

¹⁸ "CTE Program Directory," New York City CTE, accessed April 19, 2023, https://cte.nyc/web/cte-nyc-schools-and-programs-search?field_cte_program_industry_tid=All&field_cte_career_pathway_tid=All&field_cte_school_borough_tid=19&field_cte_school_district_tid=All.

especially hard to have the done. Use of rooftops or container gardens or container growing is the future and it's where a lot of the urban areas are moving toward", highlighting an industry shift in farming and an increasing availability of urban farm opportunities. While John Bowne has four acres of farm space, the reality is that this is unachievable for the average urban school. Nevertheless, schools can utilize newer technology, such as container farms, to offer agricultural education programs where it was previously not physically possible.

Agricultural education also connects students to related work experience, bringing high schoolers into the agriculture labor market. At John Bowne High School, Patrycja emphasized the work experience as one of the primary benefits of the agriculture program. She said for a lot of students, the summer work program is their first job. They are expected to clock in and out, like any other job. When asked about the JB's goal for students, Patrycja said of JB graduates, "they already have a resume with their experience on there. We want them to be highly desirable employees and college candidates and also have an appreciation of agriculture". She added that whether or not students continue with agriculture post graduation, "they know how to grow their own food, the science behind it, have a familiarity with animals, civic engagement, and productive citizenship". The case of John Bowne High School illuminates how training youth in high school to develop interest and knowledge in agriculture creates a more food conscious group of graduates, demonstrating one path to upskilling the future labor market for sustainable careers.

Container Farms as a Curricular Tool — Mountain Vista High School

Located in Highlands Ranch, Colorado, 30 minutes from Denver, is Mountain Vista High School. Mountain Vista offers a wide range of courses with AP and CTE offerings. It has a total minority enrollment of just 23 percent and only six percent of its students qualify as low income. Mountain Vista has a graduation rate of 97 percent with reading and math proficiencies at 84 and 65 percent respectively¹⁹. The school acquired its Freight Farm in 2017 and has had great successes with it²⁰. The Mountain Vista farm functions as a for-profit farm and is integrated into the school's curriculum. Students at Mountain Vista must take a technical elective to graduate and the agribusiness course fulfills this requirement. The course covered a wide range of topics, including food safety, product development, sales management, and customer service, among others. Each of these topics was discussed using the container farm as a model. Students learned business skills while simultaneously learning how to navigate the farm by mastering harvesting protocols and the care of plants. Examining the syllabus also revealed that the curriculum covered both social and natural sciences. It contained a unit on different types of leadership, such as autocratic versus democratic, as well as the differences between market versus command economies. The natural science units looked at the study of natural resources and ecosystems. The Mountain Vista syllabus highlights the multitude of academic connections that can be made from the use of container farms in conjunction with traditional academic instruction.

Though the John Bowne case suggests the benefits of agricultural education in inspiring youth interest in farming and sustainability, it does so through traditional farming methods. The case of Mountain Vista High School suggests pathways to increasing agricultural education through new farming technology — container farms. Container farms, though useful for expanding access to agricultural education, are expensive to purchase and maintain. Securing funding is essential to exploring agricultural education through these tools. I am unsure how

¹⁹ "Mountain Vista High School," US News and World Report, 2022, <https://www.usnews.com/education/best-high-schools/colorado/districts/douglas-county-school-district-no-re-1/mountain-vista-high-school-4106>.

²⁰ "Mountain Vista High School Agriculture Program," Freight Farms, January 24, 2023, <https://www.freightfarms.com/case-studies/mountain-vista-high-school>.

Mountain Vista purchased their farm, but both Boston Latin and Monty Tech obtained theirs through grants. Farms could also be purchased through private donations. However, there is another way to purchase and maintain the farms through federal funding for career and technical education through the Perkins Act. In 2018, President Trump signed the most recent iteration of the bipartisan Perkins Act into law, Perkins V. Perkins is responsible for much of the funding of CTE programs, such as the one at John Bowne. In order to receive the funding, a school must have a certified CTE program. Certification is gained through a review process in which industry professionals examine the curriculum and make changes so that it reflects the most up to date practices of the field. CTE programs must have work-based learning in which students gain work experience through internships or job placement to practice the skills learned in the classroom. Students must also pass a skills-based assessment upon program completion. The final component is that the program must have a financial management aspect for students to gain familiarity with different types of bank accounts and financial planning. Should a school receive certification, they could then offer agricultural education through container farms, potentially increasing interest in agricultural careers and sustainability.

Getting a CTE program certified requires that the school have a set curriculum. Designing a curriculum is not as easy as it sounds, but in an interview with Freight Farm's Director of Events and Partnership, Caroline, I learned that Freight Farms is working to develop a curriculum to make their farms easier to use in conjunction with education. This seems in line with the requirement for an industry vetted curriculum. Mountain Vista's agribusiness course also demonstrates the feasibility of designing a course of study built on container farms, and suggests one route educators can take to connecting container farms to learning. The farm at Mountain Vista stands as proof that a school can successfully integrate a container farm into the classroom year after year, harvest after harvest, demonstrating continuity and feasibility should others wish to follow, suggesting that agricultural education can occur in places with limited space.

Conclusion

Agricultural education offers connections to non-traditional learning experiences for students. As both prior research and my research reveal, there is ample evidence supporting the benefits of agricultural education, however these opportunities are greatly limited by a school's space and the ability to develop agricultural programs within that space, making it difficult for students in urban schools to access agriculture as a formal aspect of their education. In studying both traditional-based urban agriculture education programs in conjunction with container farms, I demonstrated the impact agricultural education has on students while examining the challenges of such education within urban spaces. Though container farms are limited to the study of plants and do not provide for the study of animals, they still offer a viable tool to expand agricultural education to urban schools that would not otherwise have the space to offer such courses.

This paper offers a way for schools to integrate traditional academic subjects with the study of plants. Due to the small physical footprint of a container farm—at just 320 square feet—most urban schools would have the space to add such a device to the campus. Additionally, due to the climate control offered by container farms, schools in any type of environment can successfully utilize container farms to offer agricultural education year-round, making it more accessible to students from areas not traditionally associated with farming or food production. The most recent iteration of Perkins calls for greater integration between academics and technical training. Container farms offer a way to further connect agriculture to the classroom, bringing it to more students, and making it easier to study agriculture in urban schools and could lead to the increase of available and interested workers for green careers. At the very least, expanding agricultural education will create more informed consumers who can make sustainably minded choices.

The study of agriculture is intrinsically linked with education. Career and technical education today can be traced back through legislation to the Morrill Acts and the funding of agricultural education programs by the US government in the 19th century. It has consistently been recognized as a valuable investment. As the global population continues to grow and farmable land shrinks, it is more and more important to think critically about how food, particularly fresh produce, is produced, the distance it travels, and its accessibility. Teaching students about agriculture from a young age connects classroom skills to real-world issues of sustainability and food mileage and production and will result in an upskilled labor force. Introducing agricultural education encourages students to examine where their food is coming from and to understand the value of fresh produce and nutrition. Moreover, as there is a greater push for the linking of education to sustainability, the study of urban farming techniques makes these connections more visual and real for students.

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