The Public Health and Environmental Benefits of Urban Agriculture:

An Analysis of Stakeholder Perspectives

Prepared by:

Nicholas H. Begley

Advisor:

Dr. Andrea Stone

Second Reader

Dr. Jody Early

University of Washington

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Abstract

The potential public health and environmental benefits of urban agricultural systems are widely accepted to produce outcomes that can improve the overall health of individuals, communities and the environment. However, professionals, academics, and policy makers may disagree regarding what those potential benefits are, or they may place different values on the importance of such benefits. There are substantial economic, political, and physical barriers that will have a significant impact on the future development of urban agricultural systems, and the efficacy of each individual urban and peri-urban food system is difficult to measure. Attempting to quantify a value for healthy environments and communities versus economic activity and the need for affordable housing is problematic. Stakeholders in the field of agriculture may provide valuable insights into the reality of a hyper-localized food systems and offer a suitable starting point to discuss the future policy implications. This study obtained data through qualitative interviews that supports the idea that stakeholders in the field of urban agriculture share similar perceptions on the potential public health and environmental benefits—while also dispelling some previous assumptions and expanding on new research topics. Any public health or environmental benefits that may be achievable through urban agriculture will only happen when the political, economic and social barriers are addressed.

Keywords: urban agriculture, food systems, environment, public health, food policy

1. Introduction

Discussions surrounding climate change and food security are becoming more and more prevalent in our daily discourse, which in turn increases the need to evaluate the potential public health and environmental benefits of a hyper-localized, urban food system. The term urban agriculture (UA), or urban farming, encompasses the concept of growing food products in

densely populated areas on rooftops, within community sponsored gardens, vacant lots, backyards, as well as indoors, using synthetic lighting systems in controlled environments (A.1). The term peri-urban (PU) agriculture is similar in concept but refers to much less densely populated areas in the outer bands or suburbs of a city or town (A.1). Urban farming conducted indoors often incorporates methods such as hydroponics, aquaponics, and vertical growing techniques to maximize space. Various farming techniques can be incorporated into the urban or peri-urban models, but the choice is often determined by existing physical, political, and/or economic barriers associated with urban spaces. Physical barriers such as lot size, or whether there is existing soil in place, political barriers such as water and land use capabilities and restrictions, economic barriers such as the cost of space and energy, or even access to subsidies are all hurdles the modern day urban farmer faces.

Farming and agriculture have been adapting and evolving for over 10,000 years to meet the caloric demands of growing populations. The traditional rural agriculture model relies heavily on fertile land, local water sources, sunlight and fossil fuels to produce, harvest, process, transport, and distribute food to urban populations. The green revolution—a period between the 1940s to 1970s, in the United States—ushered in pivotal advancements in technologies, education, and science in the field of agriculture. The term industrial agriculture often refers to large scale mono-cropping with some combination of synthetic fertilizers, herbicides, and pesticides, and genetically modified seeds (but may not include all inputs). In recent years, there have been increasing concerns about the sustainability and environmental impact of the industrial agricultural model—due to climate change, dwindling water reserves, soil degradation, and a heightened consumer demand for organic food. The current food production system in the United States alone uses 50% of the country's total available land mass (Borchers & Nickerson, 2012),

80-90% of the consumable water supply (Schaible & Aillery, 2017) and 17% of the fossil fuel energy consumed per year by all industries (Canning, Rehkamp, & Waters, 2017). Global warming will continue to play a major role in determining crop yields, and according to the Intergovernmental Panel on Climate Change (IPCC), for every 1° Celsius that global average temperatures rise, there could be a corresponding 5-10% decrease in the overall yields of crops (IPCC, 2014). Rising temperatures will also increase the need for water resources, yet crops may still struggle to produce the recommended nutritional needs of a growing human population, which is projected to reach 9 billion people by 2050.

Rapid population growth and the expansion of cities place an increased burden on both food production and food access, which will grow to be a critical public health concern related to food security. Many urban and rural areas across the United States are already affected by this phenomenon by way of food deserts—areas where the prevalence of convenience stores and fast food restaurants offering calorie-dense but nutritionally deficient food far surpasses the accessibility of fresh fruits and vegetables. There is an established correlation between populations residing in food deserts and higher rates of food-related diseases such as obesity, heart disease, and diabetes (Krukowski, Smith West, Harvey-Berino, & Prewitt, 2010). The United States Department of Agriculture (USDA) estimates that 14.1% of households in the United States are living with food insecurity and malnourishment—roughly equal to 50 million people (Coleman-Jensen, Gregory, & Rabbitt, 2017). In particular, diseases such as diabetes can be linked to populations in areas that have a higher concentration of the cheaper, higher calorie food that is typically found at fast food restaurants and convenient stores (Hilmers, Hilmers, & Dave, 2012). According to the Centers for Disease Control and Prevention (CDC), 29.1 million people living in the United States are currently living with diabetes, with an additional estimated

86 million who are pre-diabetic (Centers for Disease Control Prevention, 2014), a condition which has a dramatic effect on the quality and length of life. Increasing rates of malnourishment, as well as diseases associated with the over consumption of cheap, calorie-dense foods is already a burden on the healthcare system and could continue to grow.

Water scarcity and increased periods of draught have a negative impact on agricultural production and could worsen if new technologies and systems are not explored. Traditional agricultural methods are heavily water-dependent, while alternative methods like hydroponics and aquaponics (A.1) could use water more effectively and increase the amount of food being grown by a significant factor (Despommier, 2011), due to the ability to maximize space vertically, with closed-loop (A.1), drip irrigation (A.1) or N.F.T **(**A.1**)** systems. Hydroponics is a method of growing plants without soil (but possibly using a medium like coco coir, rockwool, or perlite) by saturating the root systems in a nutrient-rich medium, either with a synthetic solution or fish waste as in an aquaponics system. Growing plants hydroponically indoors can decrease water consumption by 98%, the amount of fertilizers by 60%, and pesticides by 100%, while at the same time maximizing crop yields per square foot (Dunbar, 2006). Hydroponics allows for more control over watering cycles and recaptures the same nutrient-rich and oxygenated water to be flushed through the system repeatedly. As more new technologies arise, and methods such as hydroponics are refined, indoor farming could become more widely accepted as a sustainable growing method with multiple positive benefits for the population and the planet.

This paper analyzes the views of stakeholders working in the field of urban agriculture to determine their perceptions on its potential public health and environmental benefits. By conducting personal interviews this study highlights emerging and conflicting themes. The perceptions and input of stakeholders who participate in urban agriculture (or any industry,

profession, or community) are particularly crucial when influencing future policy decisions. The themes that were originally expected to be shared among the stakeholders, relating to public health (PH) included: the ability to increase access to fresh, locally grown foods, the ability to suppress the negative health effects of food deserts (e.g., increased rates of diabetes and obesity) (Robinson, 2014), and possible social benefits like community interaction and physical activity. Access to fresh, local, nutritional food is shown to be a public health benefit with many positive outcomes (Centers for Disease Control Prevention, 2017), particularly within economically vulnerable populations. The expected themes from the stakeholders regarding potential environmental benefits (EI) included: the ability to decrease the distance fresh food travel to consumers, a decrease the in demand on water resources through collection and recycling, and the ability to mitigate the impacts of storm water runoff. Hyper-localized urban and peri-urban farms could make a sizable impact on the carbon footprint associated with the transportation of agricultural products by decreasing the distance between production and the end consumer. Reducing food miles—a measure of how far food travels before getting to the consumer— by buying locally grown food products could reduce greenhouse gasses by around 4-5%, due to the large amounts of both CO2 and non-CO2 emissions created during the production and transportation of food (Weber & Matthews, 2008). Urban farms can filter storm water runoff, which may include a number of pollutants such as heavy metals, pharmaceuticals, pesticides, and paving materials (e.g. roads and roofs). Runoff composition is a major concern, as it may serve as a major source of pollution to local, natural water systems (Ferreira, Walsh, & Ferreira, 2018).

Urban agriculture may be a positive asset to both public health and the environment, while being able to provide alternatives to an over-burdened food system that will be straining to meet the needs of future generations equitably and sustainably. The urban agricultural model, in

its many forms, could never fully replace traditional, rural, industrial agriculture as the future of our food system, however, increasing the amount of localized urban and peri-urban systems could have positive impacts on society's resiliency to dramatic environmental changes and population growth. Consumer demand for locally grown produce and a heightened awareness of the impacts of climate change place both urban agriculture, and research relating to its potential benefits, as a public policy priority. The urban landscape and the built environment allow for the ability to grow crops on rooftops, or within existing buildings, vacant lots, public or donated land—and directly within proximity to population dense spaces. Developing strategies to increase access to healthy, nutritious food for schools, communities and individuals should be a paramount undertaking for any municipality, but the social capital and value of "green spaces" directly conflicts with the economic and political need to create more housing and businesses to serve growing populations. If consumers are able to supplement their weekly grocery purchases with vegetables and greens from their local urban and peri-urban farms—that would dramatically change the way food is currently being grown, distributed, purchased and consumed in the United States. Policy decisions to utilize public, urban lots for the development of localized food systems, and deciding to support those systems through grants and tax incentives, rather than use those lots for housing complexes, will require political fortitude with strong community involvement.

2. Methods

The data gathered for this analysis was obtained during seven semi-structured interviews, averaging 30.59 minutes in length (shortest = 19.07 and longest = 44:46), with various stakeholders working in the field of urban agriculture. Subjects were selected by two main criteria: having currently or previously participated in urban agriculture in some capacity (e.g.

worker, volunteer, teacher, farm manager; educational background), willingness to be recorded via an audio device and sign an interview release for their statements. The semi-structured interview consisted of ten prescribed questions (B.1), two of which were follow-up questions that would provide an explanation as to why respondents answered yes or no to question numbers four and/or six (B.1). The interview was semi-structured in format to maintain a conversational flow with the interviewee while permitting enough flexibility in phrasing to allow for any follow-up questions. The purpose of each interview was to gain insight into the stakeholder's perspectives on urban farming and attempt to synthesize them correctly and appropriately. The stakeholders provided responses to questions aimed at soliciting any evidence of the hypothesized themes, as well as to gather any conflicting testimonies. There were no attempts to lead stakeholders to devolve certain themes or conclusions, and no prior conversations took place about expectations to devolve certain themes. Ethical integrity was maintained to ensure that the perceptions of the stakeholders were valid and unprompted, and any clarifying or follow up questions that led interviewees to provide evidence relating to the project was purely coincidental. All comments made by the interviewees were made under their own volition and no prompts were given as to ascertain a certain response.

2.1 Data collection and analysis

The seven interviews were audio recorded on a portable device and the files were uploaded to an online transcription service provided by Temi.com. The transcriptions were then checked by hand and revised a second time for increased accuracy and detail. Each of the interview questions were analyzed and coded individually and then compared to the answers of other stakeholders to examine any similar or conflicting themes or statements. Further analysis was later completed to detect any supplemental and/or supporting statements that may have been

made prior to the corresponding question, or later in the interview during the open comment section, which allowed stakeholders to speak freely. Each interview began with the same opening statement (B.1) read to them aloud before beginning the questions. All interviews were completed in one attempt and without interruptions—minus small background noises for three of interviews that were conducted in public spaces. The analysis of the interviewee's responses has been categorized into four distinct result sections: public health, the environment, incentives and barriers, and the future of urban food systems.

2.2 Stakeholders/ participants

Stakeholders were recruited from throughout the United States via networking events, recommendations from peers and colleagues, and through previous business, personal, and volunteering interactions. A minimum of five and a maximum of ten stakeholders were anticipated for this study, with a final group of seven participants. The stakeholders' roles and titles were self-identified during the interview, and a brief description is listed to identify their level of involvement with the field of urban agriculture:

- Stakeholder A- Co-owner/ head farmer of a small urban farm/café and market place
- Stakeholder B- Director of operations at a sustainable agriculture education center
- Stakeholder C- Farm manager of a student farm/incubator for beginning farmers
- Stakeholder D- Connects farmers with chefs on an e-commerce platform
- Stakeholder E- Educator who develops farm sites in the African American community
- Stakeholder F- Regional sales manager for agricultural products relating to hydroponics
- Stakeholder G- Farm manager for controlled environmental agriculture system

2.3 Procedures

For this study, the concepts of public health and environmental benefits were divided in to separate questions. Environmental health is considered by many to be a public health topic, but it is important to note that some public health benefits do not always provide environmental benefits. The intended purpose of separating environmental health and public health was to ensure that each topic could be discussed individually, and with the stakeholder's own interpretation of those concepts. The third question (B.1) of the interview asked respondents to provide a working definition for urban agriculture. After careful consideration, this question was included to serve as a study inclusion question, aimed at probing for any inconsistencies that may decrease the stakeholder's credibility, making the results given invalid. For this research topic, urban agriculture, such as in backyards, for personal consumption, was excluded. The perceptions of public health and environmental benefits of urban agriculture, as it relates to this study, are limited to for-profit and non-profit entities with the intent to produce and distribute food, and/or provide education to the public.

3. Results

The term "urban agriculture" has been loosely applied to almost all agriculture practices within areas of higher population densities, as in a city or town, and includes growing environments ranging from rooftops to backyards to warehouses. The ambiguity of this definition does little to provide clarity as to what constitutes, or more importantly, what *should* constitute as urban agriculture. The stakeholders interviewed for this study were asked how they would define urban agriculture in their own words, and as expected, the answers presented a wide range of perceptions—some complimentary statements and yet, some statements conflicted with one another. For example, Stakeholder D made the distinction that urban agriculture, for

personal use, is simply gardening, while Stakeholder C thought that specific type of production would qualify as urban agriculture, taking more of a holistic approach. The stakeholder's definitions were similar in terminology like distance to urban populations, but Stakeholder G rejected the idea that all types of urban farming, particularly models like community gardens, should be considered urban agriculture because the term "agriculture" itself suggests a higher production model. How urban agriculture is defined, and what qualifies as urban agriculture, will have a direct impact on an individual and/or organization's ability to obtain certain grants, or tax incentives, but also licensing requirements, safety and health regulations, and may encounter city ordinance barriers, all depending on how urban agriculture models are defined and classified in the future.

The analysis of the stakeholder interviews and their perceptions on public health and environmental benefits of urban agriculture confirmed several of the previous hypothesized themes. Also, details provided by the stakeholders expanded the potential benefits beyond the original purview of this study. The analysis demonstrates that the benefits of urban agriculture do exist. Additionally, an overwhelming agreement on persistent barriers emerged. There was concurrence among the stakeholders that economic, political, and social barriers may stifle the advancement of a thriving urban agriculture as a mainstay in our food system. The results of the analysis are broken down into five categories: public health, environment, incentives, and barriers, the future of urban food systems, and unexpected results.

3.1 Public Health

Public health is an expansive field that can encompass many topics relating to individual, community, environmental, and economic health (among others). Extracting information specifically about food access, food deserts, as well as social and physical health, predicated

separating it from environmental health. While some of the expected public health themes were mentioned, there was also some level of rejection to practical public health impacts when trying to overcome barriers like profitability and community support. When asked if there was a public health benefit to urban agriculture, there was a consensus among stakeholders that theoretical benefits may exist. For example, two stakeholders mentioned a specific benefit regarding food insecurity and the ability to increase access to members of vulnerable populations (e.g. minority, elderly, lower socio-economic), including Stakeholder A who stated:

"I think that increasing access to really fresh food is a public health service, especially in areas that are food deserts…also the opportunity to show people what food looks like and how beautiful it can be, might encourage them to eat more fresh food and therefore provide some public health support."

Stakeholder D also noted the potential public health benefit of bringing urban agriculture to food insecure spaces, and then built on the idea that people in those communities may come to appreciate the value of fresh items that are often not available in food deserts by stating:

"Public health benefits include increasing the access to fresh, locally grown good, that is picked when ripe and when ready to eat…you know, fresh and easily accessible to large swaths of people, especially those within possibly food insecure communities"

Aside from the benefit of providing access to fresh food to food insecure communities, another sub-theme that developed as a potential public health benefit pertained to the benefit of engaging in outdoor activities, as noted by Stakeholder E:

"I think finding time to be outside and doing physical activity is important for physical health in terms of just to get cardiovascular health, getting outside and also socio-emotional health in terms of just being able to spend a little time cultivating something else, working in the soil, it takes you away from your problems, I think there's also a therapeutic piece of that."

The benefit of engaging in outdoor activities was also noted by Stakeholder B, who built upon this benefit by noting the connection between being in open spaces and being a part of the community itself as a benefit by stating:

"The public health benefits correspond to open space, they correspond to community members who are peripherally or directly involved with the food growing….and that opportunity to involve oneself is a big deal."

The best way to fully understand the public health benefits of urban agriculture is to measure overall health outcomes of communities and any changes that may occur of time. The stakeholders interviewed for this study were optimistic about the potential to change those outcomes for the better, but with some level of hesitation was shared among the group. Many of the stakeholders interviewed believed that achieving better public health outcomes is difficult to quantify in the short term, and therefore does not advance a policy agenda as swiftly.

3.2 Environment

Questions pertaining to environmental health (as it relates to this paper) were specifically looking for indications that urban agriculture would have potential environmental benefits. For example, harmful chemicals and heavy metals from urban storm runoff can have a severe effect on wildlife habitats and water resources, and UA can mitigate those effects. Also, greenhouse gasses from the food miles associated with the distribution of agricultural products are exacerbating the effects of climate change. Water management, and the ability to decrease demand on water resources by recycling and recapturing water in closed loop systems were all mentioned by the stakeholders. Urban agriculture systems also can transform pavement and roof tops into greenspace, which could mitigate heat island effect (A.1), a point that was made by Stakeholder A, who stated:

"Maintaining green space is good for the local environment, and I know in denser cities more concrete laden in cities, heat island effect has been shown to be mitigated…it stands to reason that if we were a parking lot we would be generating a lot of heat, but maybe being a green space, we are mitigating some of that, and we are helping absorb storm water"

Stakeholder A mentioned that mitigating and absorbing storm water runoff was an environmental benefit of urban agriculture, and that claim was also supported by Stakeholder C who said this about storm water and carbon sequestration.

"When you are talking the environmental side, for every garden plot that's permeable, that allows rain to filter through, you're decreasing runoff from the city into the rivers or the stream and protecting marine species, and if you're talking about rooftops, that can provide carbo sequestration."

The impact that transporting food has on the environment is an important theme to discuss when considering urban agriculture's proximity to dense populations, and Stakeholder E posited that:

"*If we can reduce some of the carbon footprint of our food systems, that's definitely one way to do it. And the fact that you can grow naturally organically, whether its certified or not, in a place that's close to folks so they can get some fresh food that they know is first, very fresh but also didn't go through a lot of transportation miles to get to them is a benefit*"

The perception that urban agriculture is an environmentally sustainable practice was shared among the stakeholders, but an unexpected statement about biological diversity was mentioned by Stakeholder D, who said:

"In my experience, urban agriculture typically follows sustainable practices, and when most people are referring to urban agriculture, they are thinking it's in the purview of the sustainability movement. But after that, I think there is a huge range of benefits, from replacing impervious surfaces, to providing habitats for a variety of small animals and insects, which increase biodiversity and improves storm runoff."

The environmental benefits of urban agriculture may be easier to understand by a larger audience because the logic and reasoning behind the benefits are something most people can visualize when they think of chemicals in the river, or trucks on the highway. The value of a healthy environment, biological diversity or heat island effect often falls down the priority list when it comes to policy decisions in support of short term economic gains.

3.3 Incentives and Barriers

The responses given by the stakeholders did not reveal any incentives that would make urban agriculture a desirable business venture, and it can be deduced that the only incentive would be to help communities and the environment. If profit and economic viability are the driving forces to starting an urban farm, then that path will be difficult. Organizations whose mission is to improve public health and environmental outcomes—as a non-profit might do—who can supplement their workforce with volunteer and student labor, are in a better position to survive economically. Labor and labor costs associated with urban farms can be the biggest barrier, as mentioned by Stakeholder G:

"It can't be overstated enough that the complexity of the market and how much it's changed with labor costs going up, mostly because of pressure to raise minimum wages and it creates so much pressure, and it makes it very difficult to operate a business which requires a steady supply of labor that may or may not need high levels of education."

Further themes relating to labor costs continued to come up among the stakeholders who also mentioned the high costs associated with urban space, which can include higher rents, and possibly higher utility costs, in addition the cost of urban labor, as mentioned by Stakeholder B:

"If we are talking about urban agriculture, we have to talk about labor. One of the nice things about large conventional farms being in rural areas is that it's less expensive typically to live in those rural areas. There's manual labor that has to happen in some aspects of growing food, but right now if you're trying to pluck people from the labor force in an urban setting, there's no urban setting that's cheap to live in."

The costs associated with infrastructure, development, labor, and resources were mentioned by almost all stakeholders, but other barriers were mentioned that related to more holistic ideas such as creating value for green space versus development in the same parcel of land, as mentioned by Stakeholder C:

"The value you put on a piece of land in a city is crazy and the problem is the value for development is much more immediately a cash worthy investment. So, in the short term, without a vision, people are seeing a garden plot or a tiny little pocket park that has grown tomatoes, but

that could be a multimillion dollar skyscraper. Longer term when your greenways and your farms are in cities, it can only increase the value of the property surrounding them."

The long-term vision and planning of a perspective urban farmer can have a huge impact on their ability to be economically sustainable or provide any sort of public health or environmental benefits for communities, as mentioned by Stakeholder F:

"Often people have good intentions, but then they don't create the change that they hoped, and they're using more resources, using more money, more of their own time, and it ends up not helping anyone. The other side is that there are a lot of people acting like we're already at the finish line and that we can completely transition everything over to a model that's only urban based, or only indoor based, and we have a lot to learn, and a lot of growing to do—literally."

The most prominent barriers that stood out among the stakeholders related to the economics of urban agriculture systems and the ability to sustain a labor force, however there were also some underlining cultural and social barriers as well, which could indicate that simply having a large capital investment and the desire to be an urban farmer may not be enough for an urban farm to be a feasible proposition.

3.4 The Future of Urban Food Systems

According to the stakeholders interviewed for this analysis, urban agriculture will not be replacing traditional, rural agriculture systems anytime soon—if ever—but stakeholders believe that the built environment will play important role in the future of our food system. There was no evidence given by the stakeholders that would suggest that urban agriculture will be the dominant form of agriculture in the future, but there was a consensus between the stakeholders that it will persist. A hyper-localized food system that can reach populations faster and stay fresher longer would mitigate the tremendous responsibility placed on rural farmers, and should be treated as a viable option to improving public health and environmental outcomes.

3.4 Conclusions

As expected, the responses gathered during this study supported the idea that there is a public health and environmental benefit to urban agriculture, which was not much of a surprise. What was enlightening however, was that although the stakeholders were from many different educational and career backgrounds, various experience levels, and from different parts of the United States, the responses were all very similar to one another's. Some of the stakeholders articulated the public health benefits more clearly, others were more well-versed in environmental benefits, while some seemed to have a firm grasp on the barriers relating to UA. There were no major inconsistencies or absolute rejections to any themes across the stakeholder's responses and the evidence collected suggests that the narrative of urban agriculture being good for communities and the environment is well supported.

4.Discussion

A qualitative analysis of stakeholders' views will offer only a glimpse of the potential benefits of urban agriculture, and without further quantitative data, coupled with research and evidence of change over time—achieving new policy solutions will be difficult. Understanding the nuances of different growing systems, having the business acumen required to be profitable in urban agriculture, comprehending the social impacts on communities, and advocating for the value of sustainability and the environment, will take multidisciplinary approach. This study targeted industry professionals, researchers, and policy makers, and implores them to create more avenues and incentives for research and development surrounding urban and peri-urban food systems. Implementing economic and political strategies geared towards improving the overall well-being of individuals, communities, and the environment cannot be accomplished with

singular efforts. Advancing a policy agenda that reshapes the way we produce, distribute, and consume food is a monumental task that will take a diverse group of stakeholders and coalitions.

4.1 Policy Implications

Maintaining the status quo is neither an option, nor a solution, and the political barriers that are preventing the profitability and economic sustainability of urban food systems should be addressed. The land and space needed for urban agriculture is limited, and for many municipalities across the United States, comes at a premium. Traditional rural agriculture relies heavily on a lower wage labor force, and in some instances, can provide seasonal housing for farmworkers. The urban farm operator has similar obstacles to growing food and being profitable as the rural farmer, however the availability of agriculture subsidies is often limited, if not non-existent, and the ability to obtain preventative safeguards like crop insurance and tax exemptions—all of which minimize risk—are disproportionately skewed towards large scale industrial farmers.

The desire to undertake an urban farm project is admirable, but current policy barriers such as existing city ordinances may ultimately determine the types of business that can operate there. The urban farmer faces economic hurdles such as higher prices for energy, water, and rents, while at the same time, facing restrictions on profit due to a market price ceiling set by the rural farmer, who is often receiving subsidies and other incentives. From a financial perspective, it is difficult to compete. Limitations on the amount of water that can be used, trash disposal requirements, as well as vehicle and noise restrictions, all create more barriers. Upon conclusion of the analysis, this paper posits that there are five critical areas of policy that will need to be addressed before urban farm systems can thrive:

- Grants: Federal, state and local institutions should support the development of urban and peri-urban agriculture through grants—for both profit and non-profit organizations.
- Subsidies: The availability of subsides that could minimize both the costs and risk is disproportionately skewed in favor of the traditional rural and industrial farmer who is often growing commodity crops like sugar, wheat, soy and cotton. Subsidies for urban and peri-urban agriculture should be developed.
- Tax incentives: Creating tax incentives that allow urban farms to apply for agricultural classifications, incentivize the types of crops that are grown, or create a tax write off for food that is donated.
- City ordinances: Many municipalities are lacking the proper guidance to adequately classify urban agriculture systems in their urban spaces, often classifying them as manufacturing or industrial businesses, which make it impossible to receive any of the financial assistance listed above.
- Certifications: Creating a more inclusive policy for small scale farmers, and particularly hydroponics and aeroponic growers, by loosening the restrictions on current organic standards and decreasing the costs associated with maintaining organic certification would clear a major hurdle for prospective urban farmers.

While there are some favorable policies already in place in certain urban areas, the recommendations proposed in this paper serve to provide a foundation for policy change, and open the discourse that may lead to overcoming many other public policy obstacles. Promoting an agenda that supports urban agriculture will require many incremental changes on a local, state and federal level, and the policy "categories" outlined are broad and far reaching. There are organizations around the United States utilizing grants and becoming organic certified, as well as

local public health agencies and coalitions that are working together to pull urban agriculture out of the periphery and into the center of the conversation of sustainability.

4.2 Limitations

It is important to note that while there were many corresponding themes among the stakeholders, the sample group was small, and they were all proponents of urban agriculture. This study fails to bring rural, traditional farmers into the conversation, and a more enriched conversation and set of themes may have emerged if one or two of the stakeholders felt differently about the benefits, considering their connection to a more traditional model. The themes discussed in this paper and the recommendations presented are only a very broad overview and introduction to urban agriculture. Each of the corresponding sections in this paper (public health, environment, and barriers) present their own set of complex social, political, economic and research challenges and opportunities.

4.3 Future Research Directions

This research represents a much-needed catalyst for future research directions and outlines some of the policy areas which need to be addressed. A combination of interdisciplinary sciences, hard data, and studies like are one may move the conversation closer to creating a social constructed and research supported value for health communities and the environmental to offset the short term economic gains argument.

Appendices:

Appendix A.1

Glossary	Definition
Aeroponics	(*Also see Hydroponics*) The method of growing plants in a soilless culture with a controlled mist, which aerates the water, over the plant's root system.
Aquaponics	(*Also see Hydroponics*) A combination of hydroponics and aqua (fish) culture, which utilizes the nutrients from fish waste to fertilize the plants in a closed-loop system.
Controlled Environment Agriculture	A growing environment that can manipulated to desired conditions to isolate environmental barriers like temperature, humidity, pest control.
Closed Loop	Refers to the concept that all parts of a system are connected from start to finish or that the whole system is contained and sustainable.
Drip Irrigation	A method of watering plants consistently during the grow cycle by allowing water to "drip" from irrigation hoses or some form of piping near or on the plants roots.
Food Desserts	Areas where the prevalence of fast food and convenience store options outnumber the locations to purchase fruit, vegetables, and whole foods, usually associate with impoverished areas.
Heat Island Effect	Urban areas that are hotter than the surrounding rural areas, which is caused by the lack of trees, the amount of built structures, and roads, which absorb heat.
Hydroponics	The method of growing plants without any soil, combined with a nutrient rich solution to fertilize plants. (may use other mediums other like coco coir, or perlite)
N.F.T. (Nutrient Film Technique)	(*Also see Hydroponics*) Nutrient Film Technique is a method of hydroponics in which the roots are saturated with a nutrient rich water flow, rather than completely immersed in water.

Peri-urban Agriculture	Describes the area just outside of a major populated area, on the outer fringe of a city, closer to suburban and rural populations as a viable location for agriculture production.
Urban Agriculture	Describes the area of greater population density being used for agriculture production in the form of backyards, rooftops, warehouses, and community gardens.
Vertical Farming	A method associated with indoor production that can increase the production in a given space by stacking structures or utilizing other technology to grow vertically.

**The definitions listed above are synthesized from numerous sources, including the United States Department of Agriculture, The Environmental Protection Agency and "Plant Factory: An Indoor Vertical Farming System for Efficient Quality Food Production", a textbook on Indoor Farming.*

Appendix B.1

Interview Questions:
What is your role/title/job/occupation?
Why do you participate politically, as an academic, as a consumer, or as your career in urban agriculture, what motivates you to do this?
Describe to what urban agriculture means to you? Define it in your own words?
Do you believe that there is a public health benefit to urban agriculture? Yes or No and please explain?
Do you believe that there is an environmental benefit to urban agriculture? Yes or No and please explain?
Describe some of the challenges you see relating to urban agriculture?
Do you feel that urban or peri urban agriculture is the future of our food system? Why or why not, please explain?
Is there anything you would like to say, or something that was missed?

References

Borchers, A., & Nickerson, C. J. (2012). How Is Land in the United States Used? A Focus on Agricultural Land. *Amber Waves*, (1 March), 1–2.

Canning, P., Rehkamp, S., & Waters, A. (2017). The Role of Fossil Fuels in the U.S. Food System and the American Diet, (January 2017), 2007–2008.

Centers for Disease Control Prevention. (2014). Diabetes 2014 Report Card. *Cdc*, *TTY*, 232–4636. Retrieved from www.cdc.gov/diabetes/library/reports/congress.html

Despommier, D. (2011). The vertical farm: Controlled environment agriculture carried out in tall buildings would create greater food safety and security for large urban populations. *Journal Fur Verbraucherschutz Und Lebensmittelsicherheit*, *6*(2), 233–236. http://doi.org/10.1007/s00003-010-0654-3

Ferreira, C. S. S., Walsh, R. P. D., & Ferreira, A. J. D. (2018). Degradation in Urban Areas. *Current Opinion in Environmental Science & Health*, *5*, i–iii. http://doi.org/10.1016/j.coesh.2018.04.001

Hilmers, A., Hilmers, D. C., & Dave, J. (2012). Neighborhood disparities in access to healthy foods and their effects on environmental justice. *American Journal of Public Health*, *102*(9), 1644–1654. http://doi.org/10.2105/AJPH.2012.300865

IPCC. (2014). Climate Change 2014 Synthesis Report Summary Chapter for Policymakers. *Ipcc*, 31. http://doi.org/10.1017/CBO9781107415324

Krukowski, R. A., Smith West, D., Harvey-Berino, J., & Prewitt, T. E. (2010). Neighbourhood Impact on Healthy Food Availability and Pricing in Food Stores. *Journal of Community Health*, *35*(3), 315–320. http://doi.org/10.1007/s10900-010-9224-y.Neighborhood

Kozai, T., Niu, G., & Takagaki, M. (2016). *Plant factory: An indoor vertical farming system for efficient quality food production*. Amsterdam: Elsevier.

Robinson, K. G. (2014). Seeking effective agri-tecture: An urban farm design that nourishes a food desert, 192. Retrieved from http://search.proquest.com/docview/1618963201/abstract?%5Cnhttp://media.proquest.com/media/pq/classic/doc/3477280501/fmt/ai/rep/NPDF?hl=&cit:auth=Robinson,+Kelley+G.&cit:title=Seeking+effective+agri-tecture:+An+urban+farm+design+that+nourishes+a+food

Weber, C. L., & Matthews, H. S. (2008). Food-Miles and the Relative Climate Impacts of Food Choices in the United States. *Environmental Science & Technology*, *42*(10), 3508–3513. http://doi.org/10.1021/es702969f