Distribution, Benefits, Challenges, and Recommendations of Urban Agriculture in New York City

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Abstract

Urban Agriculture (UA) is a widely considered food policy strategy to address local food issues. A heated discussion is ongoing among city politicians, farmers and gardeners, community members and other stakeholders about whether the benefits of UA outweigh its challenges, and whether to develop or abandon a comprehensive UA plan. Employing a two-step, quantitative-qualitative method at the macro and micro scales, this study attempts to make a meaningful contribution to this debate through a full-range evaluation of UA distribution and sustainability in New York City (NYC), which has the largest number of urban agriculture projects in the nation. First, this study explored the spatial pattern of citywide UA distribution, conducted a descriptive analysis of UA performance, and examined the statistical association between UA sustainable development and 25 influential indicators in terms of demography, environment, economy, and equity. Second, it investigated two case studies, the individual urban farm and community garden, to provide in-depth insights into UA benefits and challenges.

This study concluded that UA's distribution in NYC had specific spatial clustering patterns in the South Bronx and northern Brooklyn. Citywide UA made contributions to society through its mature Community-Supported Agriculture networks, its huge green-industry educational programs, and its high eco-value circulation systems. The city was faced with UA challenges in terms of immigrant separation, non-significant economic contributions, land shortage, health imbalance, and crime occurrence. For future UA development and regulations, the recommendations were to construct an accurate and complete UA database, amend the UA zoning ordinances, promote citywide cooperation, ensure a multiple-stakeholder process, and address the land demand conflicts between UA and other land use activities.

Keywords: urban agriculture, health justice, food security, urban resilience, green education, community supported agriculture, land use, zoning

Acknowledgements and Dedication

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Thank you as well to all interview participation, which includes (but are not limited to) the 100 Quincy Community gardeners, the Youth Farm managers and volunteers, the fourth Annual Farming and Food Justice Career panelists, the Urban Food Policy Forum guest speakers, and all the UA previous researchers. Their rich information and generous support made this paper possible. Moreover, a big thank you is due to UP vision, who organized the urban farm volunteer activities and initially inspired my interest in the urban agriculture. Also, I would extend my special appreciation to Dolly R. Setton, whose suggestions and kindness greatly helped me to write this paper academically, systematically, and rationally. Thank you to my parents, family, and friends who continue to support me in all of my academic endeavors. Their love and help allow me to put my heart into this thesis and pursue the highest quality education at GSAPP.

This study is dedicated to those who interact with, contribute to, and benefit from the UA system in NYC. In face of the heated discussion about UA legislation, recognizing the relative benefits and challenges is of great importance to prop up a better future vision for UA sustainable development. I strive to extend the UA dialogue with its environmental, economic, and ethical impacts on all the New Yorkers, and hope that this paper contributes to the never-ending pursuit for a more beautiful, green, equitable, and harmonious future of the Big Apple.

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iv. List of Abbreviations

DCP	Department of City Planning
DOE	Department of Education
DOHMH	Department of Health and Mental Hygiene
DPR	Department of Parks & Recreation
GIS	Geographic Information Systems
HSPS	High School for Public Service
NYC	New York City
NYCHA	New York City Housing Authority
MUP	Multi-Stakeholder Process
OPS	Mayor's Office of Operations
PHWL	Public Housing Waiting List
RS	Remote Sensing
UA	Urban agriculture

Chapter 1. Research background

1.1 The Definition of Urban Agriculture

Human settlements are categorized into two parts, urban areas (such as cities and towns) and rural areas (such as villages and hamlets). One of the differentiation between these two gathering morphologies is their internal production systems. Agriculture and cultivation are the primary means of living in the rural areas while non-agricultural work is the prime source of employment for urban people, such as commerce and service industries (Pateman, 2011). However, land uses for different industries are not mutually exclusive in urban and rural areas. They "exist on a continuum of community types that are increasingly interconnected" (Mylott, 2009).

Urban agriculture (UA) is making this type of difference - breaking boundaries between urban and rural areas from the perspective of self - sufficiency. UA is defined as "the growing, processing, and distribution of food and other products through plant cultivation and seldom raising livestock in and around cities for feeding local populations" (United Nations, 2015).

UA can be generally classified into two main categories – urban farms and urban gardens. More specifically, it has a wide range of UA categories (Appendix B), from community gardens to commercial farms, from ground-based farms to rooftop farms, from indoor greenhouses to vertical farms, from balcony gardens to backyard farms, and from traditional-tech agriculture to aquaponics or aeroponics cultivation (Chumbler et al., 2015). All these types of UA involve local citizens or agencies to utilize urban lands and community resources, providing different types of crops, animals and non-food products (United Nations, 2017), such as vegetables, fruits, eggs, honey, and flowers. UA is considered as an efficient local food security and justice strategy since it offers fresh, affordable and low-carbon food with the reduced food miles, the distance between food producers and market consumers.

1.2 Urban Agriculture Development

As the population increases, food supply is an everlasting and crucial topic in the global society. The challenges are not only to satisfy the basic survival needs of the growing population, but also to integrate a robust food network and to improve the food industry efficiency. According to World Urbanization Prospects (United Nations, 2014), 70 percent of the world population will live in urban areas by 2050. Different with traditional agricultural transportation – plantation in countries but consumption in cities, UA makes a difference to shortening the distance between agricultural production and food market and to reconciling the unbalanced regional consumption between urban and rural areas.

Under the influence of "agricultural transformation, urbanization and industrialization" (Warner and Durlach, 1987), UA originally derived from the European system of "allotment gardens" (Muellenberg, 2017). It first came into being around the peri-urban areas in Europe in the 18th century and was spontaneously and sporadically evolved to meet the food needs for locality and to beauty the urban eyesores with greenery across the world.

UA has recently gained renewed attention for its vital role on resource utilization and social development and has become the newly-developing industry in many countries, such as Mexico (Losada et al., 2000), Canada (Huang and Drescher, 2015), and Australia (Guitart et al., 2014). According to the Food and Agriculture Organization (United Nations, 2014), this urban self-supported system is producing an astonishing 15 to 20 percent of the world's food.

In the United States, many cities lead the way toward UA development and ordinances, such as Detroit, Portland, Austin, and Boston (Popovitch, 2014). For instance, due to the long history of being an industrial city, Detroit possessed a large quantity of abandoned industrial areas (Atkinson, 2012). After converting these vacant lots into local growing projects, urban farms have watered Detroit's food desert with the production potential of more than 30 percent of vegetables for Detroiters (Ngumbi, 2017).

As the growth of UA industry, several UA programs have been developed and popularized among the U.S cities. Growing Power (1993-2017) set an example to achieve UA extra social values beyond food production, through hands-on workshops, on-site tutorials, and green-job training (Winne, 2010). Later, a variety of UA projects were promoted to pursue prominent environmental and social effects.

1.3 Urban Agriculture in New York

The earliest form of UA in New York City (NYC) can be traced back to the livestock, gardens, and farms kept by local residents during the early 19th century. At that time, most areas were covered by agriculture except the urbanized Lower Manhattan (Angotti, 2015). Later, under the influence of military supply and wartime depression, UA waned because of the transition into large-scale food production and the expansion of highly-mechanized agricultural systems (Lawson, 2005). However, liberty gardens and relief gardens, such as "Gardens for Victory", came into being in the city center, expanding the UA ideology beyond the scale of food production (Saldivar-Tanaka and Krasny, 2014). Encouraged by the contemporary community gardening movements, the postwar re-emergence of UA was the grassroots efforts as a response to the economic recovery and social changes in NYC (Reynolds and Cohen, 2016).

Currently, NYC has the largest UA number in the United States (Cohen, 2016). Its UA system has gradually given way from individual farming and gardening activists to institutional projects led by multi-disciplinary teams. According to Five Borough Farm report (Altman et al., 2014) and the historical documents of NYC's parks (NYC Department of Parks and Recreation, 2018), more than 700 UA operates in NYC, including around 400 community gardens, three commercial farms, more than ten community farms, four indoor farms, and around 350 institutional farms and gardens.

More than fifteen non-profit government agencies and institutions support the formation, development, and management of UA in NYC. Among these urban gardens, 592 gardens are registered and assisted by the GreenThumb program throughout the five boroughs (Department of Parks and Recreation, 2017). This program also offers assistance and support to more than 20,000 garden members. 545 out of 1,800 public schools have registered garden projects with the Grow to Learn NYC program since 2011 (Ackerman, 2011). NYC Housing Authority (NYCHA) supported around 250 community gardens, 117 public school gardens, four farms, and an 8,000 square feet rooftop greenhouse in NYC (NYCHA, 2017). This UA system has the wide public participation of over 14,000 farmers and gardeners (Saldivar-Tanaka and Krasny, 2014).

Most recently, the first urban agriculture bill (Int. No. 1661) was proposed by the Council Member and Brooklyn Borough President to the New York City Council, aiming at drawing up a comprehensive urban agriculture plan; however, the first attempt failed. On December 11th, 2017, the City Council passed the second attempt – Int. no. 1661-A, which sought the cooperation of different city organizations to develop an UA website. The pass of this first-ever UA bill might wishfully open the future attempts to amend UA regulations and customize development agenda for the city.

Chapter 2. Research Statement

Under the current trend of promoting UA development and regulation, this study investigated UA distribution, analyzed UA benefits and challenges, and justified the UA policy recommendations, to provide in-depth insights into the future visions of UA in the city. Firstly, this study examined the citywide UA locations, distribution, and spatial patterns, which quantitatively tested the spatial patterns of UA in NYC for the first time. Secondly, it aimed at a multifunctional evaluation of UA benefits and challenges with the most complete coverage of influential indicators, based on a statistical regression from the perspectives of the environment, economy, equity, and demography. Additionally, two UA cases dug into the evaluation of the relative UA benefits and challenges through UA modeling and interviews. It also incorporated, for the first time, the Farming Concrete dataset to extract UA records in NYC. Based on the multifunctional assessment of the UA system, this study presented policy recommendations for better urban agriculture development in the future.

Chapter 3. Literature Review

3.1 Urban Agriculture Benefits and Challenges

Urban Agriculture is a widely considered food policy strategy to address local food issues. In addition to ensuring food security, some supporters of UA see it as a solution to an array of urban problems (Reynolds and Cohen, 2016). UA deserves recognition for its multiple positive contributions – increasing green space, improving urban recreation, cultivating green-job skills, fostering community relationships, providing affordable food, and enhancing neighborhood safety.

However, debate exists about whether the challenges of UA outweigh the benefits. Opposition to UA rests on the concerns that UA might cause soil contamination, bring virtual zoonosis, and threaten public health (Flynn, 1999). In addition to natural resource pollution and negative environmental impacts (Bowyer-Bower and Tengbeh, 1997), it intensifies housing crises due to the land shortage (Friedersdorf, 2017). These risks raised by UA will cast a shadow over the future UA decision-making.

The previous literature debated the relative UA benefits and challenges mainly from the perspective of sustainable development. The chapter below reviews this discussion based on the three-legged framework of sustainability - environment, economy, and equity.

3.1.1 Environmental Aspect

UA contributes to urban areas by mitigating or addressing a set of environmental issues. UA, as a self-sufficient system in urban settings, can improve energy efficiency and conserve environmental resources, through rainwater management (Hammer, 1989), waste compost (Drechsel and Kunze, 2001), and air quality improvement (Agrawal et al., 2003). Deelstra and Girardet (2000) published an overall discussion about UA and environmental sustainability. They emphasized that vegetables in UA can adjust humidity, temperatures, dust, gases, and solar radiation. Also, preserving urban soils, promoting waste - nutrient recycling, increasing urban biodiversity, and improving environmental awareness were identified as UA ecological functions. In addition, a study (Lindemann-Matthies and Brieger, 2016) showed that UA contributed to the “attractiveness of urban areas” even though its environmental aesthetic values were perceived unequally among different social-demographic groups.

However, other researchers, such as Mougeot (2000) and Egoz et al. (2006) believed that UA aggregated soil erosion, increased visual unitedness, expedited resource depletion, and indulged mosquito breeding.

3.1.2 Economic Aspect

Economic benefits or risks caused by UA activities have a tremendous impact on the future trends of UA policy decisions. UA activates local food networks, creates more green-job opportunities, and reduces food transporting costs. Zezza and Tasciotti (2010) examined the potential of UA in addressing poverty based on a sample of developing countries. Their study demonstrated that UA provided "a substantial share of income" and constituted "an important source of livelihoods" for the urban poor. A review that summarized the findings from 35 academic research papers focusing on UA and food security, suggested UA made household income contribution though those returns were low.

Moreover, research (CoDyre et al., 2015) based on 50 backyard gardeners in Guelph, Canada, empirically evaluated the food production revenues and the costs of land, capital, and labor. They concluded that there were increased economic benefits gained from backyard gardens with larger cropping areas and better green skills. Voicu and Been (2008) inspected the effects of community gardens on the neighboring property values using a hedonic regression model. They discovered the positive impacts of high-quality community gardens and neighborhood property values, especially for those neighborhoods with low economic levels.

3.1.3 Ethical Aspect

As discussed in Chapter 1.2, UA was originally initiated and developed to diminish the distance between farming producers and food consumers. Thanks to its low food miles, UA has great potential to enhance food security and health justice under policy interventions or promotions from the government or non-profit organizations (Armar-Klemesu, 2000). For instance, according to Hardman and Larkham (2014), UA was successful in building sustainable local food systems in Birmingham as a key element of a "food charter" which customized a set of principles to bring together all the participants in the food industry.

Brown and Jameton (2000) pointed out that physical exercise in gardening ensured an improvement of personal wellness and public health. A meta-analysis among eight subgroups, conducted by Soga et al. (2017), proved the positive effects of UA on health implications, such as body mass index, reductions in depression and anxiety, and increase in life satisfaction. Also, community farms and gardens invited members or volunteers from the neighboring communities to maintain the gardens and farms, reducing their labor cost, and offering affordable food for local low-income families.

However, some studies have argued that UA's health justice and food security benefits have been overstated. For example, Badami and Ramankutty (2015) explored the association between UA and food security and concluded that there was only a weak potential for UA to address food security issues in low-income countries, where agriculture should be most useful and focal.

3.2 Urban Agriculture Research

Before developing the methodology for this study, a wide range of previous literature was reviewed in terms of different time, space, and methods, to inspire the most suitable methodological design.

3.2.1 Historical Urban Agriculture Research

The first UA relevant research was published about Central Africa in the 1960s, in a French geographical account (Mougeot, 2000). Since that study, scattered studies (Egziabher et al., 1994) have conducted research on UA systems locally and globally. In 2000, Mougeot provided a landmark discussion about UA's definition, potential, risks, and policy challenges, bringing UA from the disconnected case studies to a mature conceptual framework. In addition to the discussion of UA presence, he emphasized the roles of UA in large urban food systems and argued UA's importance in terms of the urban development, public health, environmental impact, and social profit fronts. Mougeot's paper was cited as a key reference for the essential understanding of some UA-related concepts in this study.

3.2.2 Urban Agriculture Studies in New York City

UA was investigated and discussed by various researchers and intuitions. Three leading studies by non-profit institutions or government agencies were highlighted owing to their ambitious goals and persuasive findings. New York State Energy Research and Development Authority (Ackerman et al., 2013) examined the urban land inventory for potential UA by evaluating city vacant lots and offered the recommendations of urban agricultural techniques from the engineering perspective. Five Borough Farm project, operated by the Design Trust for Public Space in partnership with Added Value, conducted its three-phase research on UA. They ended up with the publication of UA impact analysis reports and UA data collection toolkit which was cooperated with Farming Concrete. Moreover, Greenthumb program published annual reports to summarize their citywide cooperation and seasonal progress with community gardens.

In addition to these three citywide UA research projects by academic institutions or administrative agencies, some individual researchers investigated different aspects of the UA system in NYC. A case study of Latino community gardens explored the relationship between neighborhood open space and civic agriculture (Saldivar-Tanaka and Krasny, 2004). Campbell (2016) answered the question of why local food policies and sustainability plans would attach tremendous importance to UA practices when facing planning, policymaking, and governance challenges. Different from these studies with the positive conclusions, Angotti (2015) wrote an essay to discuss the potentials and limitations of UA based on the lessons from urban farms in Brooklyn.

A recent book, called *Beyond the Kale* (Reynolds and Cohen, 2016), discussed the relationship between UA and social justice activism in NYC. This comprehensive investigation drew a full picture of the UA system and underlined its significance for social justice development.

Standing on the shoulders of Reynolds and Cohen's work, this study refined the research scope from the large concept (social justice) to the multifunctional assessment (benefits and challenges).

In addition, a series of food reports were useful for the analyses between UA and local food supply network, such as annual Food Matrix reports. Urban Food Policy Institute in the City University of New York (Freudenberga et al., 2017) reviewed and synthesized the objectives, challenges and recommendations of the food policies during the last ten years.

3.2.3 Urban Agriculture Research Methods

The UA research methods can be mainly classified as the quantitative or qualitative associational investigation between UA and different influential factors.

3.2.3.1 Qualitative Research

The previous studies employed mail surveys, questionnaires, field investigation, and behavioral observation to explore different aspects of UA (Hara et al., 2013; McClintock, 2016). For instance, a policy discussion (Vallianatos et al., 2004) offered insights of UA's educational benefits and healthy values, based on the comparison and summary of different "farm-to-school" programs in the U.S. Dieleman (2016) discussed the different dimensions of UA and its balance between ecological, economic, and social value. Dieleman's research set a good example of how to discover in-depth UA insights from a case study. A systematic review based on UA literature was conducted (Warren et al., 2015) to evaluate the relationship between UA and food security, dietary diversity, and nutritional status among the 11,192 potentially relevant research.

Moreover, some qualitative methods were combined with quantitative analyses in order to offer an in-depth and accurate study. Field investigation and participants interviews for urban farms in Metro Manila were adopted in parallel with Remote Sensing (RS) image analysis techniques to calculate and visualize vegetable production and consumption balance (Hara et al., 2013). McClintock et al. (2016) similarly combined spatial mapping and spatial regression with mail surveys to evaluate the motivations of urban gardeners in Portland. It opened up the application of spatial autocorrelation analysis based on local Moran's index in the field of UA research.

3.2.3.2 Quantitative Research

More recently, several researchers turned to quantitative research on the evaluation of the UA system. One of the hot topics for these studies was the spatial mapping of UA. For instance, they employed RS and Geographic Information Systems (GIS) methods to map spatial patterns of different UA systems, such as private and public spaces of UA in Chicago (Taylor and Lovell 2012), ground level and rooftop UA in Boston (Saha and Eckelman, 2017), and UA in Rome (Cavallo et al., 2016; Pulighe and Lupia, 2016).

In addition to spatial mapping, some studies concentrated on quantitative assessment of UA. Peng et al. (2015) constructed Analytic Hierarchy Process models for Beijing's UA through selecting ten social, ecological, and economic assessing indexes. A brief paper proposed a causality combination of utility, existence, and scarcity factors for the community esteem value calculation, in order to evaluate UA's "social appreciation expressed by the community" (Miccoli et la., 2016).

Moreover, statistical regression models were adopted to test and assess the relationships between UA and a set of certain indicators, such as UA and dietary diversity (Zezza and Tasciotti, 2010), and UA and aesthetic quality among different socio-demographic subgroups (Lindemann-Matthies and Brieger, 2016). These quantitative methods were a great support of prior experience to develop the spatial analysis techniques for this research.

3.2.3.3 Influential Factor Selection

To evaluate the performance of UA, the influencing factors from diverse aspects were determined before data collection and research analyses. Sustainability was projected into three dimensions – environment, economy, and equity (Kaiser et al., 1995; Isaksson and Garvare, 2003). A case study of UA in Mexico City examined the balance between these three dimensions and symbolic values (Dieleman, 2017).

Notably, among these previous research, different demographic inputs have various influences on the association of UA and these three sustainable dimensions (Maxwell 1995; Lindemann-Matthies and Brieger, 2016). Therefore, considering an additional demographical dimension or re-projecting data into different demographic subgroups is necessary to achieve the complete coverage of all influencing factors and to ensure the comprehensive investigation of UA benefits and challenges.

Chapter 4. Research Design

This research investigated UA in NYC through the combination of quantitative and qualitative methods. Both secondary open data obtained from NYC's institutions and third-party agencies at the macro scale and first-hand primary information collected during interviews and case studies at the micro scale were employed to support this study.

4.1 Study Site

The City of New York, the study area for this research, is the most populous city and has the largest UA system in in the U.S. Its five boroughs witnessed a recent population gain and reached an estimated total population of 8,622,698 in July 2017 (DCP, 2017). In addition, NYC has a wide range of accessible datasets with different subjects at different urban scales. The statistical analysis of this study focused on the 55 Public Use Microdata Areas (PUMAs) in NYC.

4.2 Data

The data utilized in this study contained three categories of datasets. First of all, the spatial investigation of UA distribution needed an integrated and completed NYC's UA dataset. Second, secondary open datasets, such as demographic, environmental, economic, and ethical data, provided a basic description of the influencing factors or outcomes for UA in NYC. Also, this numeric information allowed for a better understanding of the status quo before going into the case studies in detail. Third, primary facts and information towards NYC's UA benefits or challenges were collected through the interviews with the urban farmers and community gardens during the case study.

4.2.1 Urban Agriculture Dataset

UA descriptive datasets were the foundation for all the analyses in this study; however, there was no integrated and comprehensive dataset with complete coverage of all the urban farms and community gardens in NYC. Therefore, extracting and combining data and information from the datasets listed in Table 1 was an important step to gather and integrate all the UA and their basic information, such as locations, founders, sizes, and jurisdiction, for further research.

Greenthumb program, NYCHA development, and the Five Borough Farm program provided citywide UA data from different aspects; therefore, extensive efforts were required to check the coverage and clean the redundancy between different datasets. The Farming Concrete dataset allowed for a small quantity of open resources about individual UA behavioral records since 2013, regarding crop, harvest, compost, landfill, participation, rainwater collection, market sales, food donations, and health data. However, this newly-published dataset is limited in usefulness due to the incomplete and inconstant updates. No previous studies have attempted to utilize this dataset to evaluate UA performance.

Table 1: UA Datasets from Different NYC's Projects and Data Processing Methods

Dataset source	Data unit	Data format	Processing methods	Usage purposes	Usage limitations	Update year	Publication agency
NYC Greenthumb Community Gardens	Point	CSV files	Geocode	Mapping and gaining deep insights into community gardens	Incomplete coverage	2017	DPR
NYCHA Developments	Point	Shapefiles	Filter	Mapping NYCHA garden development projects	Missing detailed garden or farm information	2017	NYCHA
Five Borough Farm Report	Point	Paper reports	Digitalize; Geocode	Mapping and gaining deep insights into urban farms and gardens	Lack of metadata for urban agriculture	2017	Design trust for Public space
Farming Concrete	Point	CSV files	Aggregate	Providing detailed information regarding individual garden or farm	Unstable data updates	2018	Farming Concrete

* Sources: See Appendix B

4.2.2 Secondary Data

In addition to the integration of UA dataset, a variety of appropriate data or informative indexes offered an overview of demography, environment, economy, and equity facts related to UA. Table 2 as below listed all the potential datasets employed in this research at the scale of PUMAs.

Table 2: Secondary Open Data Related to Urban Agriculture

Dataset source	Data unit	Data format	Processing methods	Update year	Publication agency
Demographic, Social, Economic, and Housing Profiles by PUMA	PUMA	CSV files	Data clean	2018	DCP
Social Indicators Report Data	Community Districts	CSV files	Convert from CD levels to PUMA levels	2017	OPS
School Point Locations	Point	Shapefiles	Geocode	2017	DOE

American Community Survey (ACS)	Community Districts	CSV files	Convert from CD levels to PUMA levels	2016	DCP
Community Health Profiles	Community Districts	Shape-files	Convert from CD levels to PUMA levels	2015	DOHMH
Community District Profiles	Community Districts	Websites	Web scrape; Convert from CD levels to PUMA levels	2017	DCP
Primary Land Use Tax Lot Output	Lot	Shape-files	Aggregate land lots into PUMAs	2017	DCP

* Sources: See Appendix B

4.2.3 Primary Information

Though these secondary datasets listed and discussed above have great potentials of delineating the basic information of UA and other UA-related factors, more data and facts in this study were collected by the in-depth interviews during the case study. The emphasis of interviews was the collection of UA information toward organizational mechanism, community engagement, and policy impacts.

4.3 Methods

This study will conduct research on the performance of UA using quantitative and qualitative methods, respectively at the macro and micro scales (Figure 1). This two-step research first investigated the spatial pattern, overall performance and influential factors of UA based on the citywide urban farm and garden datasets. After these quantitative evaluations of UA, two case studies through UA modeling and interviews were adopted to seek deeper insights into an individual urban farm and an individual community garden. In this chapter, the combination of these quantitative and qualitative methods will be introduced in detail.

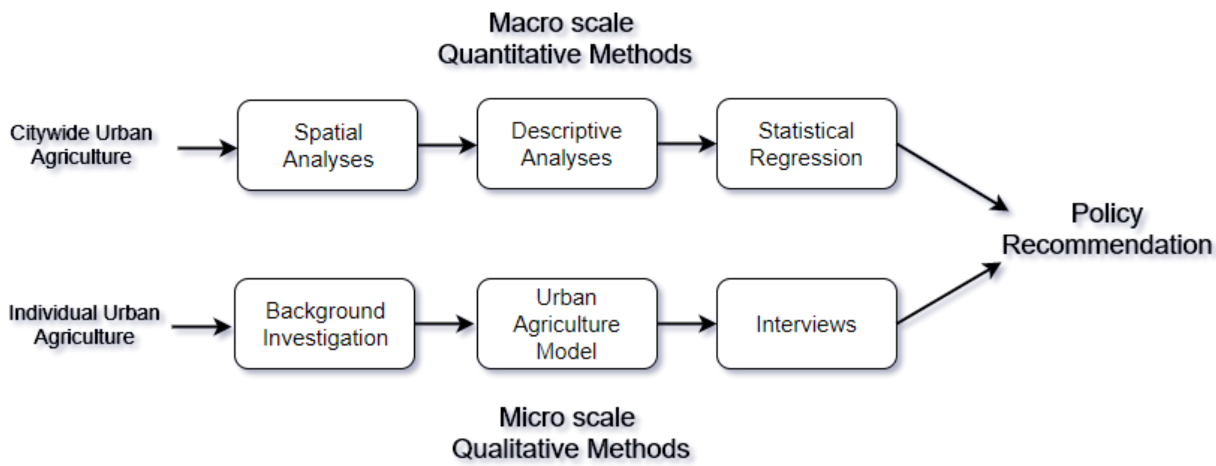


Figure 1: Work Flow for Methodology

4.3.1 Quantitative Methods

Although the majority of the UA previous studies tended to conduct research through qualitative methods (Smit, Nasr, and Ratta, 1996), this study gave the best efforts to perform the quantitative evaluation with the limited UA datasets. Location mapping and spatial research based on cluster and hotspot analysis were employed in this study, as an attempt to explore the more quantitative methodological possibilities. Additionally, the Farming Concrete dataset was first extracted to provide descriptive of UA performance. Regression models were adopted to discuss the benefits and challenges of the citywide UA system.

4.3.1.1 Spatial Analyses

Mapping the locations of UA was the first step to quantify the spatial distribution of urban farms and gardens in NYC. It allowed for spatial pattern recognition and spatial relationship exploration of the UA system for the next step. Since there is no universal and complete UA dataset for NYC, this step should clean up all the datasets from different agencies in Table 1 and integrate them into a unified UA data shapefile for mapping. In addition, the UA jurisdiction map was generated to present the current cooperation among different UA organization.

After acquiring UA location map, this study first examined the spatial autocorrelation of the UA system using the Moran's index (Lindemann-Matthies and Brieger, 2016), and investigated the spatial pattern of UA distribution using the cluster and outlier analysis and the optimized hot spot analysis. If there was a specific spatial pattern of UA under the observation of these primary spatial analyses, further statistical exploration provided deeper insights into the existence of UA mechanism.

4.3.1.2 Descriptive Analyses

Pulling UA records from the Farming Concrete dataset allowed for a basic understanding of the typical individual UA cases, before jumping deeper into statistical analysis and case studies. These UA records were manually evaluated, selected, and summarized based on their integrity, authenticity, and rationality. Only those UA records that were verified by the certain farm or garden names and locations were included in the descriptive analyses. After extracting the data records for specific UA cases, classification and summation were applied to calculate the UA performance from different aspects.

Furthermore, an overview of the gardening or farming activities in the farms or gardens with available records in the Farming Concrete database was generated to delineate and evaluate the current development and activities in the case study sites. Some of these farms and gardens did not claim themselves by entering their names or locations; therefore, the only way to identify them was to track the unique garden or farm IDs.

4.3.1.3 Statistical Regression

To investigate the multiple functions of UA, a series of simple linear regression models were used to test the significance of the relationship between UA and all the potential influencing UA factors in NYC. Before constructing and testing the regression models, the pivotal step in this process is to ensure the complete coverage of external UA factors. As discussed in Chapter 3.2.3.3, community sustainable development can be evaluated in terms of the three-dimension matrix of the environment, economy, and equity (Isaksson and Garvare, 2003). In addition, examining the UA- demography association might disclose the demographic influences and social drivers of UA. Therefore, in this study, a variable set with 25 influencing indicators (Table 3) was selected on the basis of the combination of demographic, environmental, economic, and ethical dimensions.

From the perspective of demography, overall population, age, education, culture, and housing were taken into consideration when exploring the social environment of UA. Air quality and park access were chosen as the important indicators to examine the environmental impacts of UA. UA will also alter or be altered by its economic settings; therefore, the economic association was investigated based on agriculture labor, median household income, unemployment rate, poverty population, supermarket footage, and assessed land value. Last but not least, promoting UA development plays a vital role on the pursue for food security and health justice. It is reasonable to include the indexes of food demand (fruit and vegetable consumption) and health status (obesity rate, diabetes rate, Nutrition Assistance program participation, and physical exercise) of New Yorkers in the linear regression models.

Table 3: Variable Selection of 25 Influential Indicators for UA

Normative framework	Evaluation aspect	Selected indicator	Yea r	Dataset
Demography	age	Life expectancy	2015	Community Health Profiles
		Population with age below 17	2015	Community Health Profiles
		Population with age 65 +	2015	Community Health Profiles
	Population	Overall population	2016	American Community Survey
	Education	School location counts	2017	School location points
		Percentage of population with education of college or higher	2015	Community Health Profiles
	Culture	Percent of individuals 5 years and older who report that they speak English "less than very well"	2015	Community Health Profiles
		Percent born outside the U.S. or U.S. territories	2015	Community Health Profiles
		Percentage of population that are white	2015	Community Health Profiles
	Housing	Total Number of Families on the Public Housing Waiting List	2015	Social Indicators Report Data
		Percentage of households spend 35% or more of their income on rent	2015	Demographic, Social, Economic, and Housing Profiles by PUMA
	Crime	Number major felonies were reported in 2016	2016	Community District Profiles
Environment	Air quality	Annual average of micrograms of fine particulate matter (PM 2.5) per cubic meter	2015	Community Health Profiles
	Park access	Percentage of residents live within walking distance of a park or open space	2016	Community District Profiles
Economy	Agricultural jobs	Number of labor in the industry of agriculture, forestry, fishing and hunting, and mining	2016	American Community Survey
	Supermarket areas	Supermarket square footage per 100 population	2015	Community Health Profiles
	Household income	Median household income (dollars)	2016	American Community Survey
	Unemploy-ment	Percent of the civilian population 16 years and older that is unemployed	2016	American Community Survey
	Poverty	Percent of individuals living below the federal poverty threshold	2016	American Community Survey
	Land Value	The average tentative assessed land value	2017	Primary Land Use Tax Lot Output
Equity	Health Jus-tice	Age-adjusted percent of adults that is obese (BMI of 30 or greater) based on self-reported height and weight	2015	Community Health Profiles
		Age-adjusted percent of adults that had ever been told by a healthcare profes-sional that they have diabetes	2015	Community Health Profiles
		Age-adjusted percent of adults reported getting any exercise in last 30 days	2015	Community Health Profiles
	Food justice	Age-adjusted percent of adults that reported eating at least one serving of fruits or vegetables in the last day	2015	Community Health Profiles
		Total Supplemental Nutrition Assistance Program recipients	2015	Social Indicators Report Data

In this case, all the variables were re-projected, re-calculated, and re-aggregated consistently at the level of Public Use Microdata Areas (PUMA). The total number of UA in each PUMA was employed as the dependent variable. Its relationship with every assumptive independent variable was tested by a simple regression model separately. Notably, instead of applying these regression models into the future prediction of UA occurrence, these models were more importantly used to testify the significance of the relationships between UA occurrence counts and its influential indicators. Therefore, the focus of these regression tests was the outputted p-values and positive-or-negative coefficients, rather than the coefficient values themselves.

4.3.2 Qualitative Methods

Due to lack of constant and complete information directly relevant to individual UA economic-social factors in the open datasets, more information collection was conducted via qualitative methods. Constrained by the time, location, and financial support of this research, a case study was employed as the primary qualitative method. It examined the in-depth "purposive samples" to describe the current situation of UA in NYC. Two case studies through the background investigation, UA modeling, and interviews were considered as an important component of this research.

4.3.2.1 Background Investigation

One urban farm (the Youth Farm) and one community garden (100 Quincy Community Garden) were selected as the typical cases to discuss the UA management, community engagement, and policy outreach. Before entering into interviews, background investigation offered the basic understandings of these two UA, as listed in Table 4.

Table 4: The Introductive Summary of Urban Farms and Gardens Case Study

Name	Detail	Year Found	Organization in-volvement	Neighbors	Community District	Website
The Youth Farm	Ground-based ed-ucational urban farm	2010	BK Farmyards; HSPS; Farm School NYC	Wingate, Brooklyn	Community District 9	http://www.theyouth-farm.org/
100 Quincy Commu-nity Gar-den	Ground-based self-sufficient community gar-den	2012	Greenthumb pro-grams	Bedford, Brooklyn	Community District 3	https://100quincy.wordpress.com/about/

The Youth Farm was selected due to its education-oriented pursues beyond food production. Its educational programs included not only the ground-based farming activities for high school students but also the hands-on skill training programs for citywide green-job hunters. It began with an initiative educational project between the High School for Public Service and NYC Department of Education in 2010 and later was developed into an education-focused production farm accessible by its community and the society.

100 Quincy Community Garden represented a different picture of UA in NYC. It was a typical Community Supported Agriculture (CSA), which was strongly supplied by the community, and returned the harvests to the community. Its founding process was triggered and supported by its neighboring community people. Currently, it is managed and maintained by a group of garden members and volunteers from the community. This community garden was chosen as a case study spot due to its active garden status, including the constant data updates into the Farming Concrete database.

Reading and summarizing the reports and studies relevant to these two farms and gardens in terms of historical development and current conditions facilitated further and deeper discussion about the role, functions, and mechanism of UA when entering into in-depth interviews.

4.3.2.2 Urban Agriculture Model

Through background reviewing and site investigation, an UA model came into being to generalize the internal interactions and external effects of the UA system. In Figure 2, this model highlighted the four key elements of the UA system and simplified the interactions among these four elements, which supported the internal cycling and promoted the external outputs of UA. It was applied to summarize the whole pictures of these two UA case study sites.

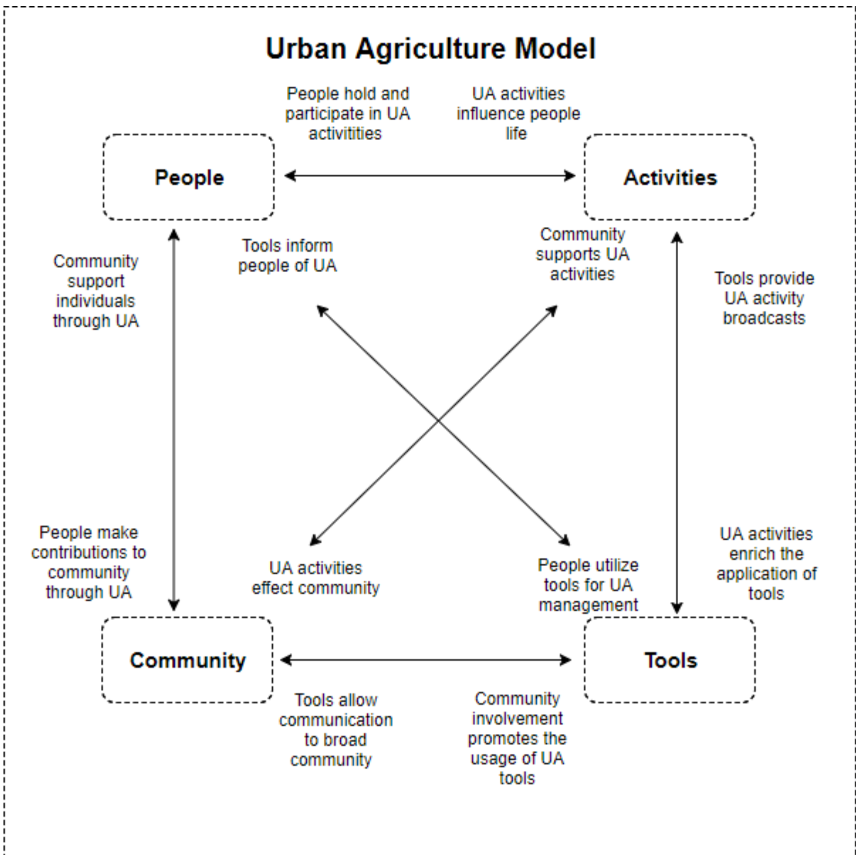


Figure 2: Urban Agriculture Modeling

4.3.2.3 Interviews

Meeting with anyone who has been involved in NYC's urban farms or community gardens assisted the setup of a direct and effective communication channel with UA's stakeholders. They were farmers, gardens, community people participated in UA, funders for UA, staff in any

UA supporting organizations, officials from the government agencies, and academic researchers in UA or other related fields. By attending a series of food justice panels, garden kick-off meetings, and farming volunteer days, four interviewees were selected based on a snowball sampling method where the previous interviewees recommend names of their partners who can be interviewed. The interviews were semi-structured and conducted in person. The majority of interviewees had a tight connection with the selected case study sites – the Youth Farm and 100 Quincy Community Garden.

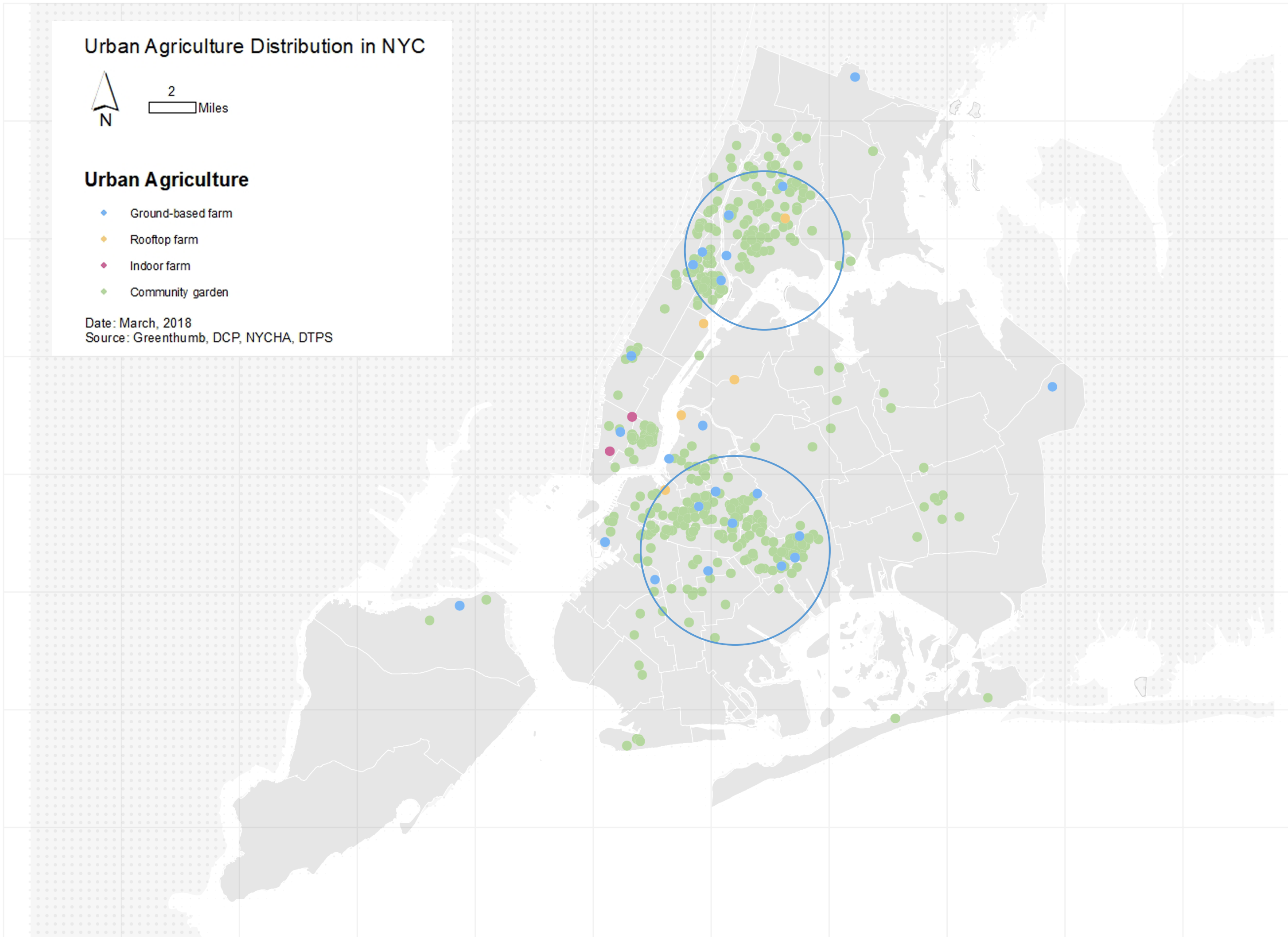
Chapter 5. Results

Based on the methods proposed in Chapter 4, the study results were discussed from two angles, the citywide urban agriculture system, and individual urban agriculture case study.

5.1 Citywide Urban Agriculture System

5.1.1 Spatial Analyses

Map 1 presents UA locations within the five boroughs in NYC. Community gardens are spread widely across the city and tend to aggregate in the two areas highlighted in the map – Harlem and the South Bronx, and the northern part of Brooklyn. The majority of urban farms are ground-based farms, mainly distributed across Manhattan, Bronx, and Brooklyn. Also, there are several indoor greenhouse farms and rooftop farms operating in the city. Queens and Staten Island have a relatively low amount of UA, compared to other boroughs. This uneven UA distribution implies the existence of a spatial pattern, which suggested the next step of deeper spatial analyses.



Map 1: Urban Agriculture Location Map in NYC

In Map 2, the jurisdictions of community gardens registered in Greenthumb program in NYC have a wide range of governmental institutions and agencies. Department of Parks and Recreation (DPR) has the largest number of jurisdictions – 278 community gardens while Department of Education (DOE) administered more than 100 community gardens. Less than these two organizations, the Trust for Public Land (TPL) and New York Restoration Project (NYRP) have jurisdiction over 71 and 47 community gardens, respectively. Notably, some community gardens are under the jurisdiction of multiple governmental agencies.

Examining the spatial autocorrelation of UA distribution in NYC, Moran's index (Figure 3) shows a z-score of 4.136. It indicates that there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

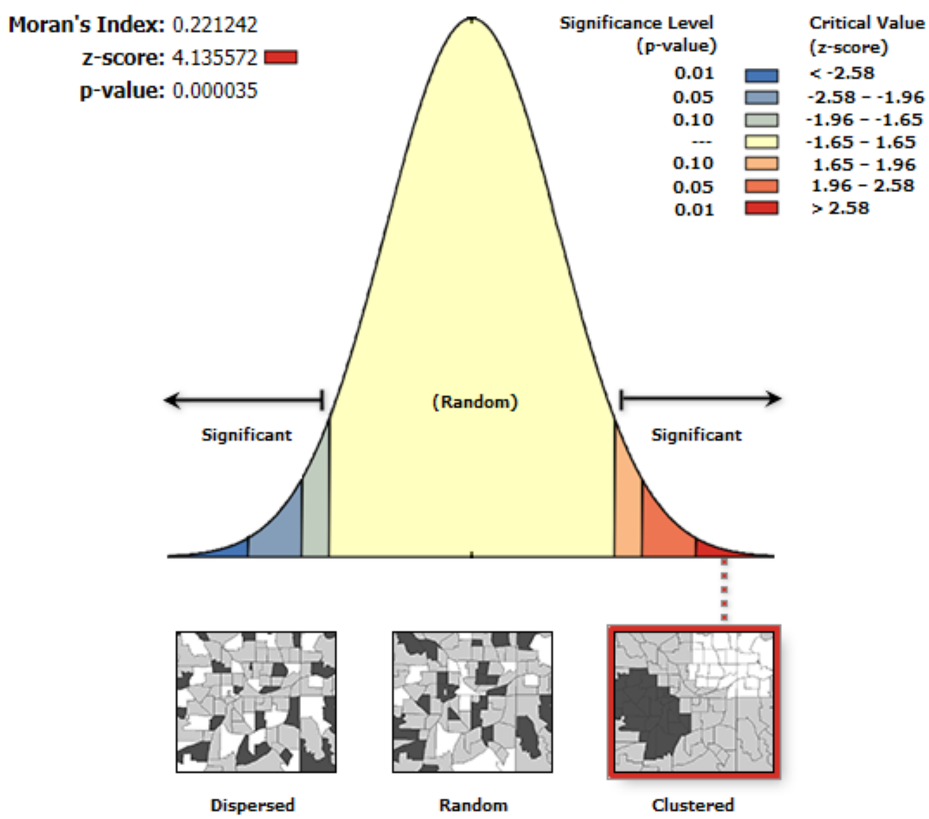
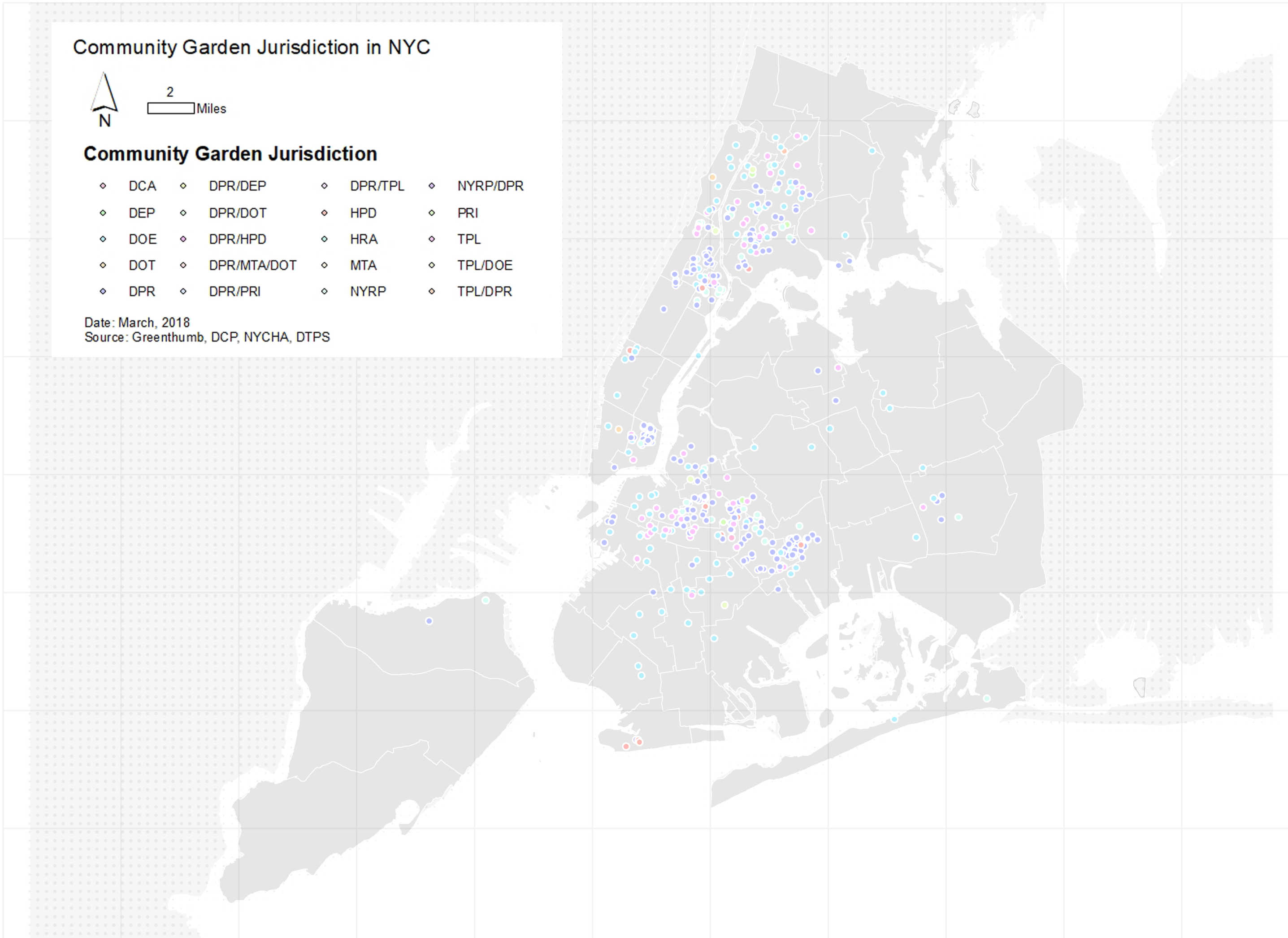


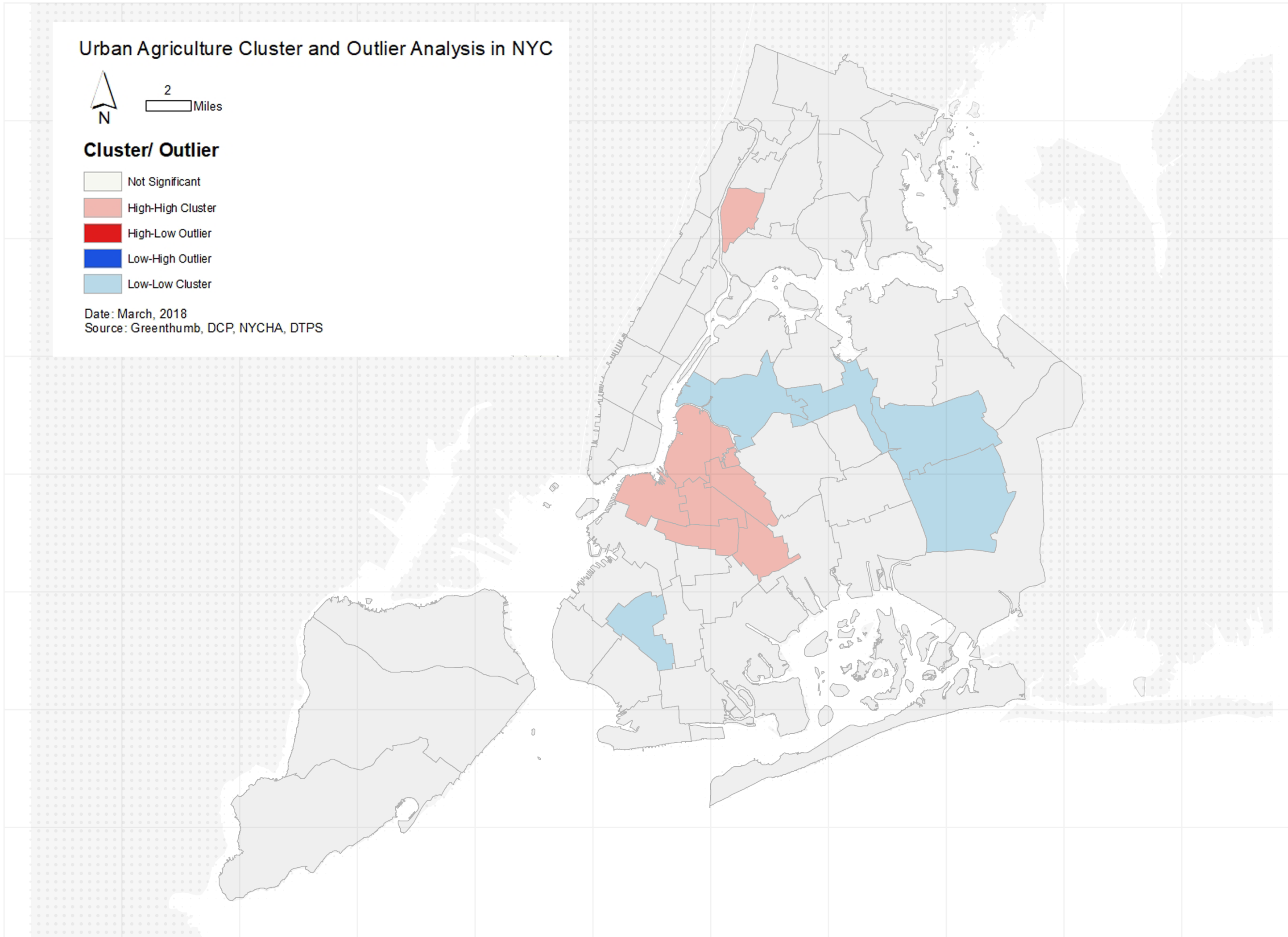
Figure 3: Spatial Autocorrelation Statistics for UA



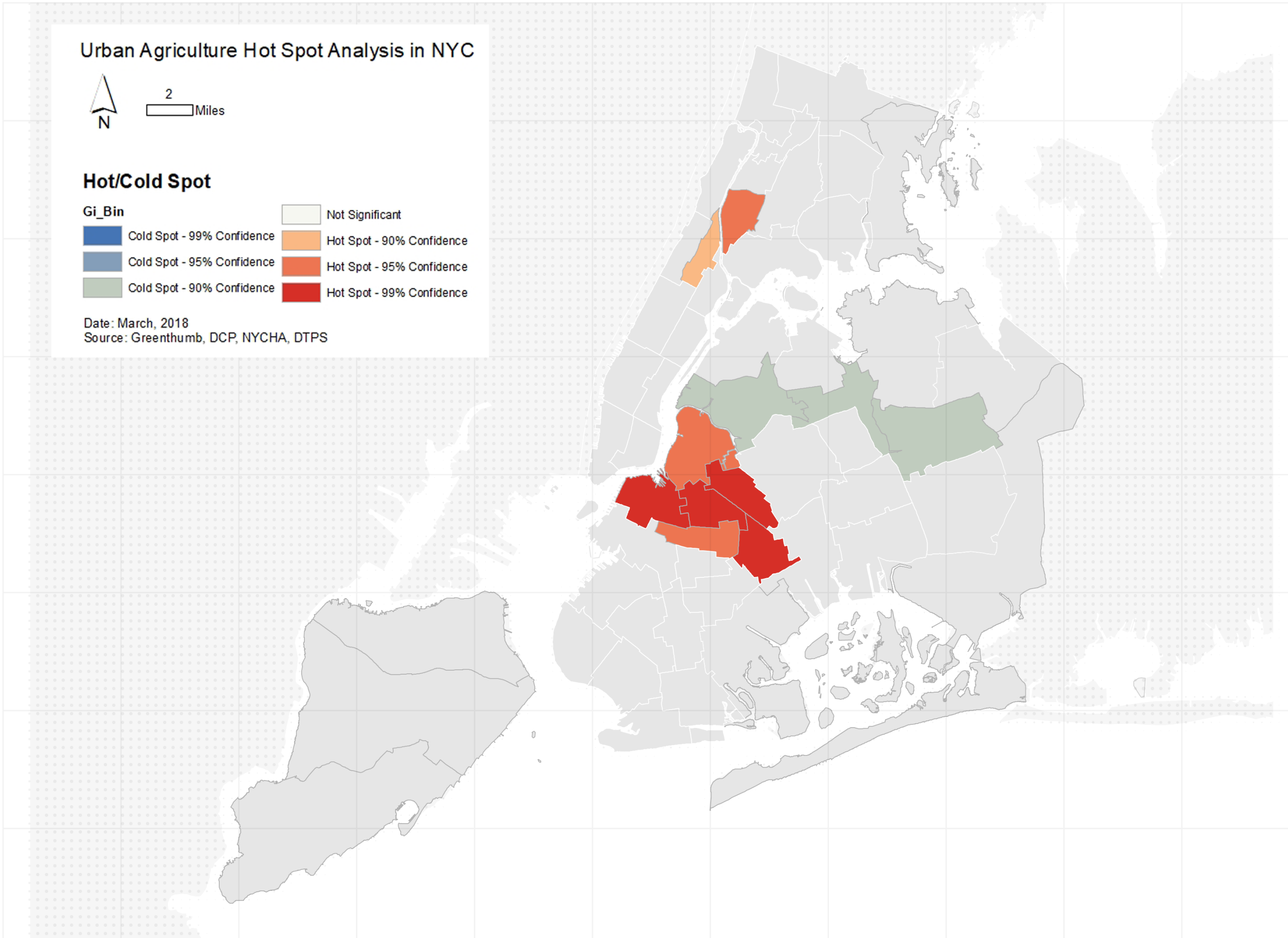
Map 2: Community Garden Jurisdiction in NYC

Based on this conclusion that UA has a certain, non-random, spatial distribution pattern, cluster and outlier analysis becomes meaningful and useful to explore the spatial clusters and outliers. Map 3 indicates that the PUMAs located in the South Bronx (including Concourse Village, Melrose, and Highbridge) and northern Brooklyn (including Brooklyn Heights, Bedford, Crown Heights, Bushwick, and Brownsville) have clustered trends. They are the PUMAs with rich UA spots, and also surrounded by other PUMAs with large UA spot numbers.

This result is consistent with the findings from the hot spot analysis shown in Map 4. A cluster of UA at a 99% significance level is found in the north area of Brooklyn (including Brooklyn Heights, Bedford-Stuyvesant, Crown Heights, Bushwick, and Brownsville). At the same time, the PUMAs located in central Harlem and the South Bronx (including Concourse Village, Melrose, and Highbridge) share a UA hotspot at a 90%-95% confidence level. Differently, the wide-area UA cold spots are located in Queens, including Long Island City, Sunnyside, Woodside, Rego Park, Richmond Hill, and Jamaica.



Map 3: UA Cluster and Outlier Analysis in NY



Map 4: UA Hot and Cold Spot Analysis in NYC

5.1.2 Descriptive Analysis

This study employed the Farming Concrete dataset to perform a descriptive analysis relevant to UA activities for the first time. Due to the coverage restrictions of this dataset, only those reliable and integral records of the urban farms and community gardens were extracted and summarized to sketch the current UA practices. An environmental contribution was reflected by the rainwater harvesting, compost production, and landfill waste diversion by UA. Harvest counts and market sales were the useful indicators to estimate the economic activities of UA production. This dataset also provided potentials for discussing the participant mood change when entering into and leaving out of UA spots.

5.1.2.1 Environmental Aspect

The urban farms and community gardens adopt the rainwater collecting using barrels, tanks, or cisterns as a routine activity. The purposes behind rainwater harvesting are not only to reuse rainwater for irrigation but also access the small stormwater management grants from the city agencies. Due to the restricted access to water during the dry season in 2001, the Water Resources Group was founded by GrowNYC and GreenThumb to encourage water preservation in the citywide UA system.

At present, among over 140 community garden rainwater collection systems, more 1.5 million gallons of rainwater was harvested annually in NYC (Grow NYC, 2018). Extracting the rainwater collection records from the Farming Concrete dataset, Figure 4 presents the efficiency of rainwater collection among the urban farms and community gardens, some of which are encoded by numbers due to missing name information. The annual rainwater harvesting efficiency from all these urban farms and community gardens shares an average value of 5.73 gallons per roof square feet.

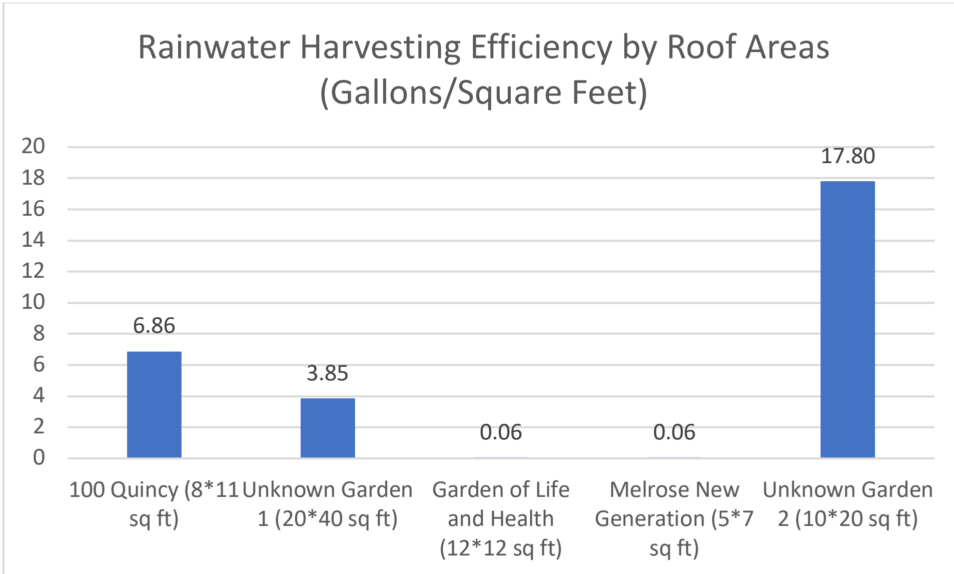


Figure 4: Rainwater Harvesting Efficiency Comparison

The urban farms and community gardens contribute to the communities by accepting compost materials and providing compost production. They collect and accumulate their own composting materials, such as dry leaves, dead sticks, and nongrowing plantings and invite local residents, community neighbors, and cooperative restaurants to drop off kitchen scraps, yard clippings, and other organic material for composting on-site.

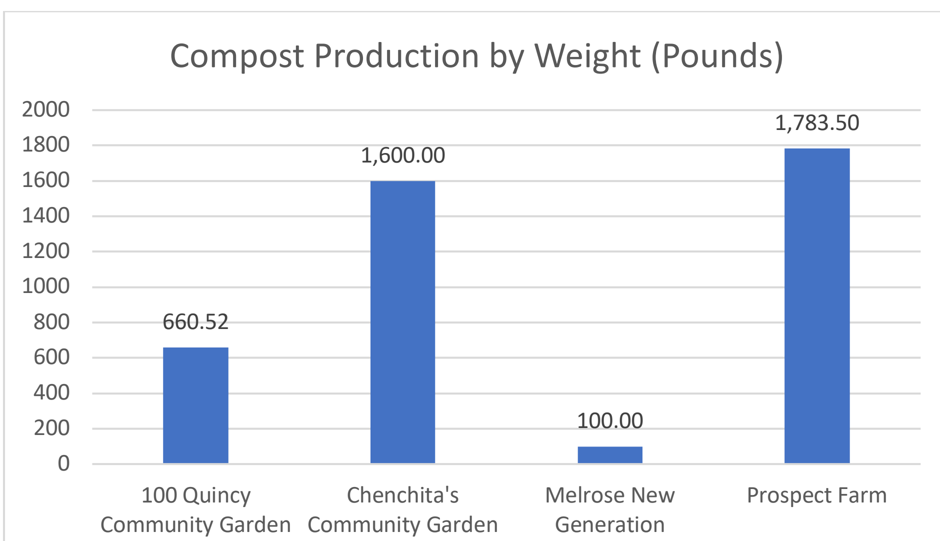


Figure 5: Compost Production Comparison

However, there is no composting amount aggregation of the UA system at the city level. Figure 5 offers the preliminary statistical pictures for those urban farms and community gardens recorded by the Farming Concrete dataset. It indicates that the compost production from the farm and garden sample has a wide range, with an average value of 1, 036 pounds.

These compost drop-off programs in the urban farms and community gardens help to reduce the amount of trash that goes into landfills. Calculating the landfill wastes diverted per year provides a better understanding of its environmental impacts on the community sustainable development. No previous surveys conducted research on the total amount of the city's landfill waste diversion in the NYC's farms and gardens. Therefore, this study attempts to describe their landfill waste diversion through a sample of farms and gardens. Figure 6 demonstrates the landfill waste diversion provided by urban farms and community gardens. This community garden sample shares an average of 4431.84 pounds.

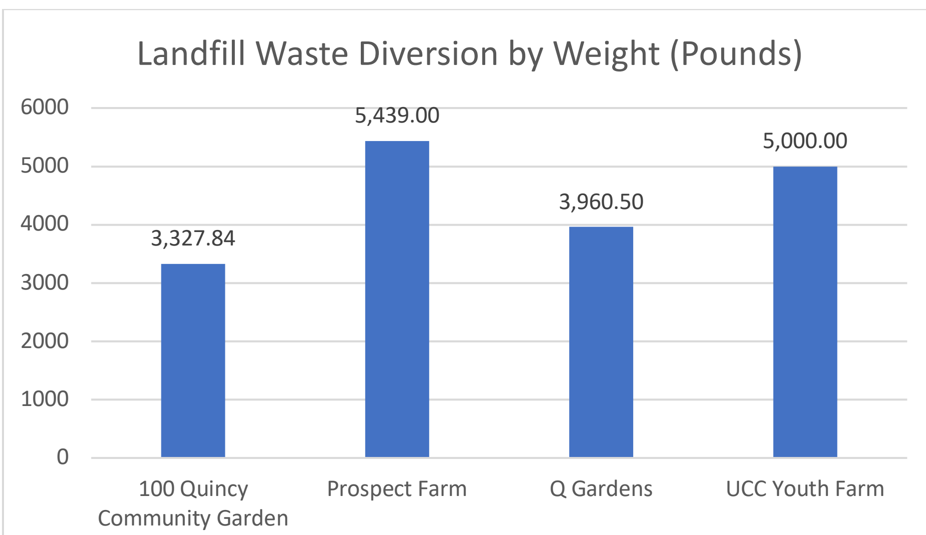


Figure 6: Landfill Waste Diversion Comparison

5.1.2.2 Economic Aspect

Economic activities were measured using the UA harvest counts and market sales. Figure 7 indicates the wide range of all types of harvest total counts per year among eight urban farms and community gardens. They averagely gained a harvest weight of 726.69 pounds. It reflects that the current UA has not achieved the high food production and significant economic values.

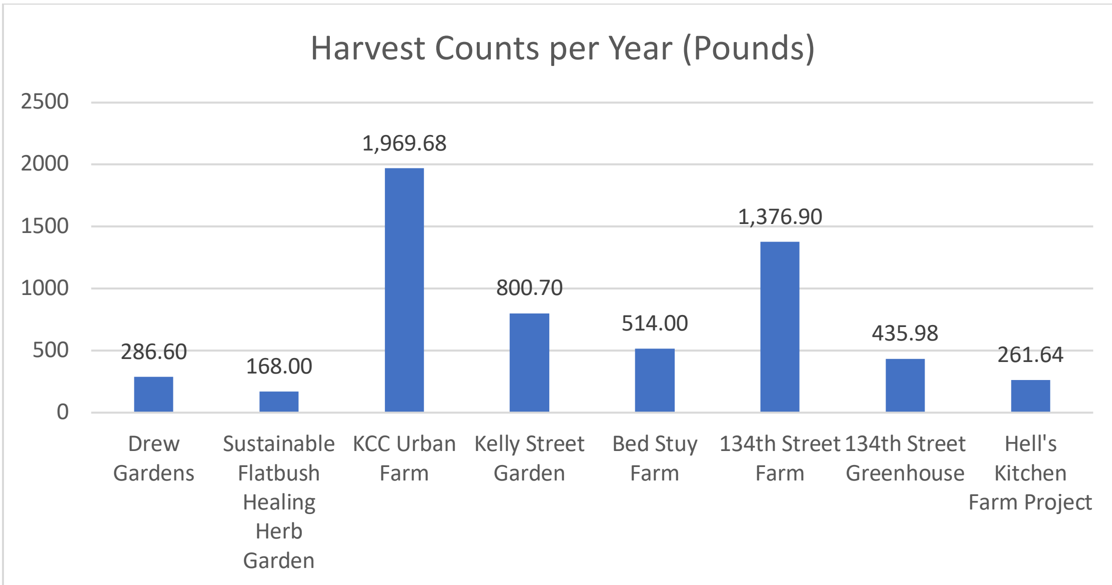


Figure 7: Harvest Counts Comparison

Similar to the harvest counts discussed as above, Figure 8 shows that the market sales of community gardens per year make no significant contributions to the city food trading market. Notably, the market sales range from hundreds to thousands of dollars, which implies the differences between the production scale and output channels among these community gardens.

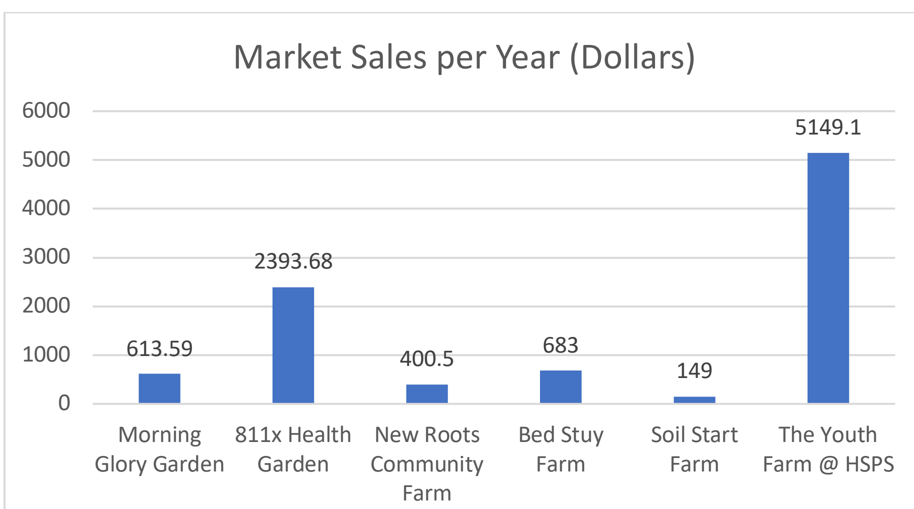


Figure 8: Market Sales Comparison

5.1.2.3 Ethical Aspect

A few community gardens, such as the Center for Family Life Garden and the Healthy Choice Garden, recorded their participant moods when they entered into gardens and left out of gardens. These records support the argument that farming activities in the UA environment make a difference to the human moods. Figure 9 and Figure 10 present the obvious emotional change from more anxious and angry attitudes to more happy and peaceful attitudes.

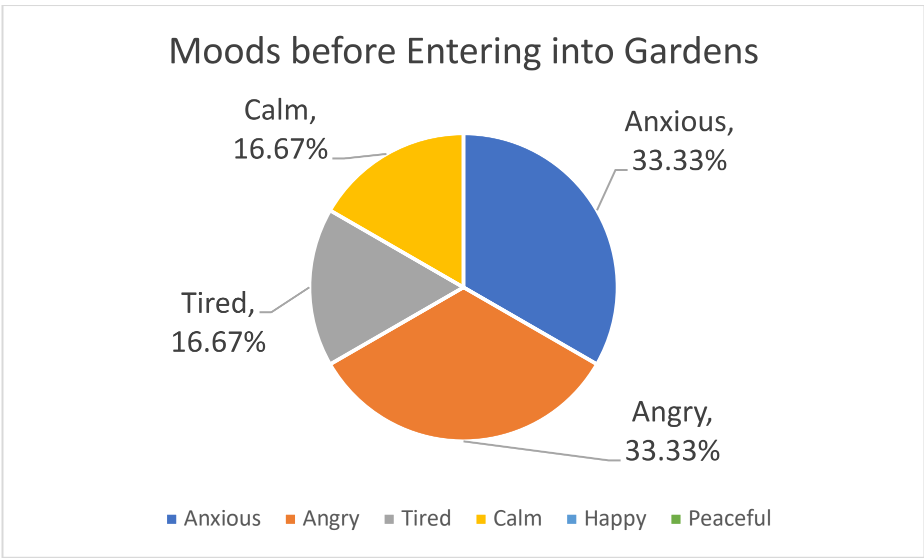


Figure 9: Participant Mood When Enterig into Gardens

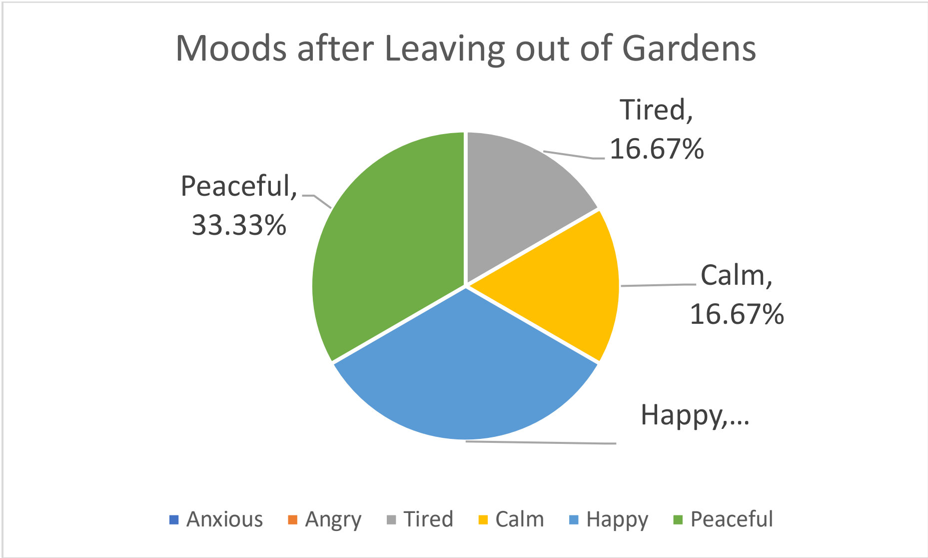


Figure 10: Participant Mood When leaving out of Gardens

5.1.3 Statistical Regression

The main findings from linear regression models are listed in Table 5, 6, 7, and 8. They illustrate that there are significant relationships between UA counts in PUMAs and these influencing variables – demography dimension (life expectancy, senior population, high education attainment, resident cultural background and race, public housing application, and crime incidents), environment dimension (walking distance to open space), economy dimension (median household income, unemployment rate, and poverty rate), and equity dimension (nutrition assistance program engagement, diabetes rate, and fruit and vegetable consumption). This study does not further explore the degree of relationships disclosed by coefficient values but includes a brief discussion about their influencing trends denoted by the positive or negative coefficients.

5.1.3.1 Urban Agriculture and Demography

The results in Table 5 suggest that UA has a significantly negative association with life expectancy, similar to the conclusions of the senior population impacts on UA counts (with the age of 65 and larger). In contrast, there tends to be less UA if the population is more foreign-born and less white. The statistical results also indicate a significantly positive relationship between UA and school numbers in the PUMAs. Moreover, the number of families on the Public Housing Waiting List (PHWL) has a negative association. The more families on PHWL, the less UA cases in the PUMAs. The total number of major felonies has a positive relationship with UA spot numbers, as suggested by the regression models.

Table 5: Correlation between UA and Demographic Indicators

Evaluation aspect	Selected indicator	Relation-ship	P-value	Signifi-cance
Age	Life expectancy	-	0.000	***
	Population with age below 17	+	0.092	
	Population with age 65 +	-	0.002	***
Population	Overall population	-	0.195	
Education	School location counts	+	0.000	***
	Percentage of population with education of college or higher	-	0.083	
Culture	Percent of individuals 5 years and older who report that they speak English "less than very well"	-	0.421	
	Percent born outside the U.S. or U.S. territories	-	0.01	***
	Percentage of population that are white	-	0.002	***
Housing	Total Number of Families on the Public Housing Waiting List	+	0.000	***
	Percentage of households spend 35% or more of their income on rent	+	0.696	
Crime	Number major felonies were reported in 2016	+	0.009	***

5.1.3.2 Urban Agriculture and Environment

From the environmental perspective, two indicators, air quality, and park access have a different potential impact on UA. As shown in Table 6. The increase of UA numbers has a positive relationship with resident park access. Unlike park access distance, the linear regression model determines a non-significant correlation between air quality and UA counts.

Table 6: Correlation between UA and Demographic Indicators

Evaluation aspect	Selected indicator	Relation-ship	P-value	Signifi-cance
Air quality	Annual average of micrograms of fine particulate matter (PM 2.5) per cubic meter	+	0.103	
Park access	Percentage of residents live within walking distance of a park or open space	+	0.000	***

5.1.3.3 Urban Agriculture and Economy

As examining economic activities (Table 7), median household income results in a negative impact on UA development while unemployment and poverty rates have positive contributions to UA occurrence. It is unforeseen that the number of labor in agricultural and other relevant fields, the supermarket footage per 100 people, as well as the assessed land values have a non-significant influencing role in UA numbers.

Table 7: Correlation between UA and Economic Indicators

Evaluation aspect	Selected indicator	Relationship	P-value	Significance
Agricultural jobs	Number of labor in the industry of Agriculture, forestry, fishing and hunting, and mining	-	0.521	
Supermarket areas	Supermarket square footage per 100 population	+	0.488	
Household income	Median household income (dollars)	-	0.002	***
Unemployment	Percent of the civilian population 16 years and older that is unemployed	+	0.001	***
Poverty	Percent of individuals living below the federal poverty threshold	+	0.000	***
Land Value	The average tentative assessed land value	-	0.598	

5.1.3.4 Urban Agriculture and Equity

By shown in Table 8, the obesity rate and diabetes rate positively influences UA practices. For food justice, the number of Supplemental Nutrition Assistance Program (SNAP) recipients narrates a positive relationship with UA counts. Meanwhile, the negative association between UA spots and daily fruit and vegetable consumption is presented in the regression models.

Table 8: Correlation between UA and Ethical Indicators

Evaluation aspect	Selected indicator	Relation-ship	P-value	Signifi-cance
Health Justice	Age-adjusted percent of adults that is obese (BMI of 30 or greater) based on self-reported height and weight	+	0.050	***
	Age-adjusted percent of adults that had ever been told by a healthcare professional that they have diabetes	+	0.001	***
	Age-adjusted percent of adults that reported getting any exercise in the last 30 days	+	0.964	
Food justice	Age-adjusted percent of adults that reported eating at least one serving of fruits or vegetables in the last day	-	0.006	***
	Total Supplemental Nutrition Assistance Program recipients	+	0.000	***

5.2 Urban Agriculture Case Study

After citywide investigation of UA distribution and functions, narrowing down to individual UA case studies provides detailed and in-depth insights into the UA system.

5.2.1 Background Investigation

Some preliminary analyses based on the Farming Concrete dataset present the current conditions and production status of the UA case study sites. The Youth Farm only entered its 2015 market sales in the database, while 100 Quincy Community garden kept yearly records for various farming activities since 2015.

In Figure 11, the top six production types of market earnings tell the commercial attempts of the Youth Farm. Referring to Figure 8, the Youth Farm has an annual income of over 5,000 dollars which highly exceeds the average value around 1,500 dollars.

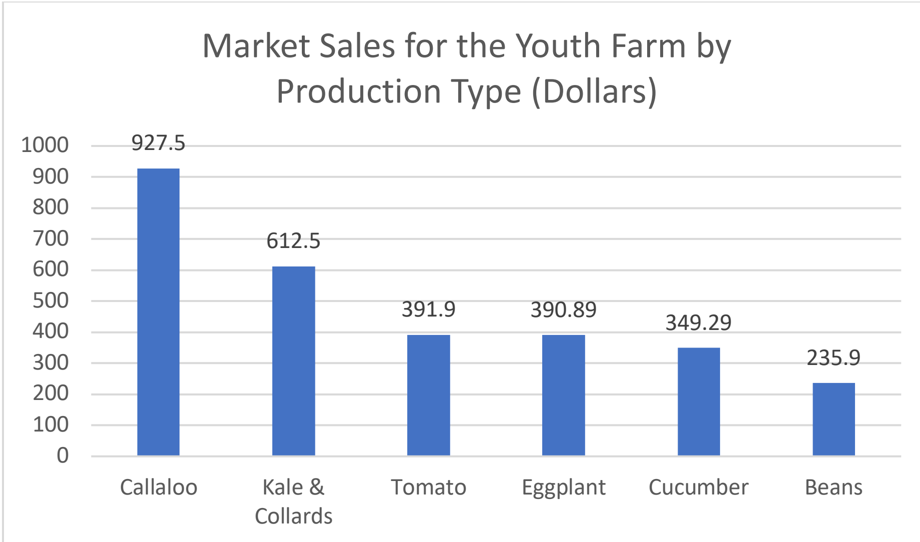


Figure 11: The Youth Farm Market Sales by Production Type

Thanks to the three-year updates from 100 Quincy Community Garden, it is feasible to investigate its historical and current conditions in terms of rainwater harvest, landfill waste diversion, and compost production. Figure 12 records the annual volume of rainwater collection using its 8 feet *11 feet roof from 2015 to 2017. Compared to of other gardens, some of which are encoded by numbers due to missing name information, 100 Quincy Community Garden reaches a relatively high annual rainwater harvesting efficiency (Figure 4 in Chapter 5.1.2.1).

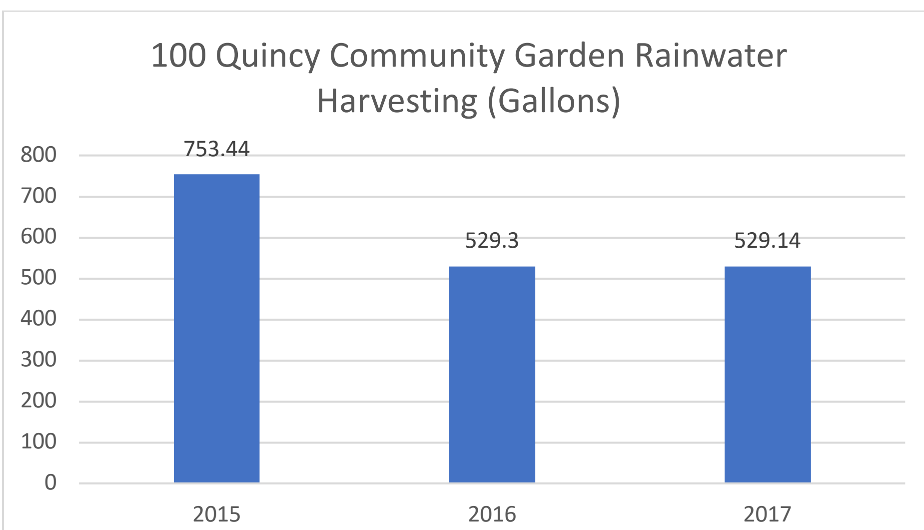


Figure 12: 100 Quincy Community Garden Rainwater Harvesting

Figure 13 shows that 100 Quincy Community Garden remains a constant annual compost production ranging from 400 to 900 pounds during the period from 2015 to 2017. Compared to other community gardens with an average of 1161.167 pounds of compost production, 100 Quincy Community Garden achieves a relatively low amount of compost production weight. However, standardizing the compost production by garden surface areas, as an estimate of composting capacity for each garden, realizes composting efficiency calculation and comparison. 100 Quincy Community Garden remains a medium value of compost production efficiency (Figure 14).

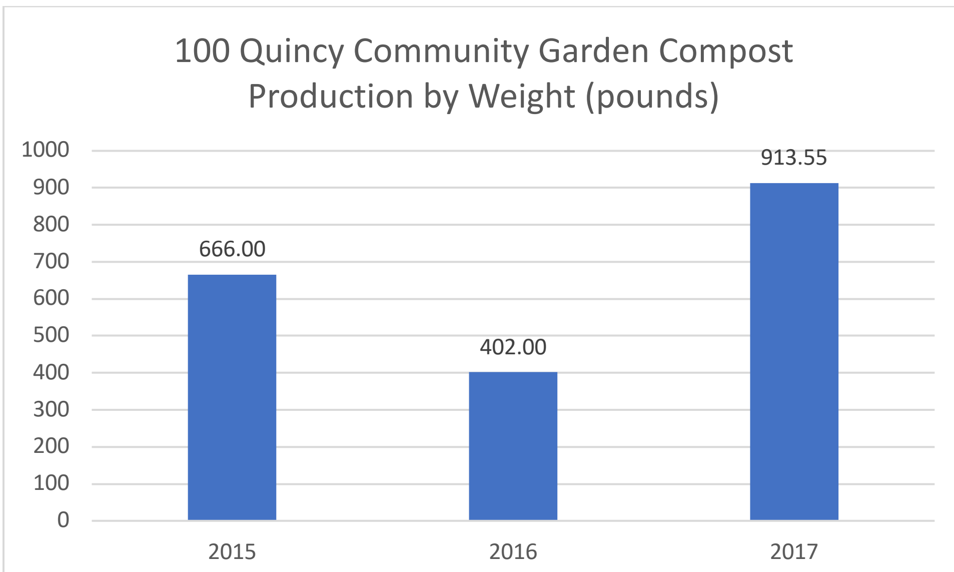


Figure 13: 100 Quincy Community Garden Compost Production by Weight

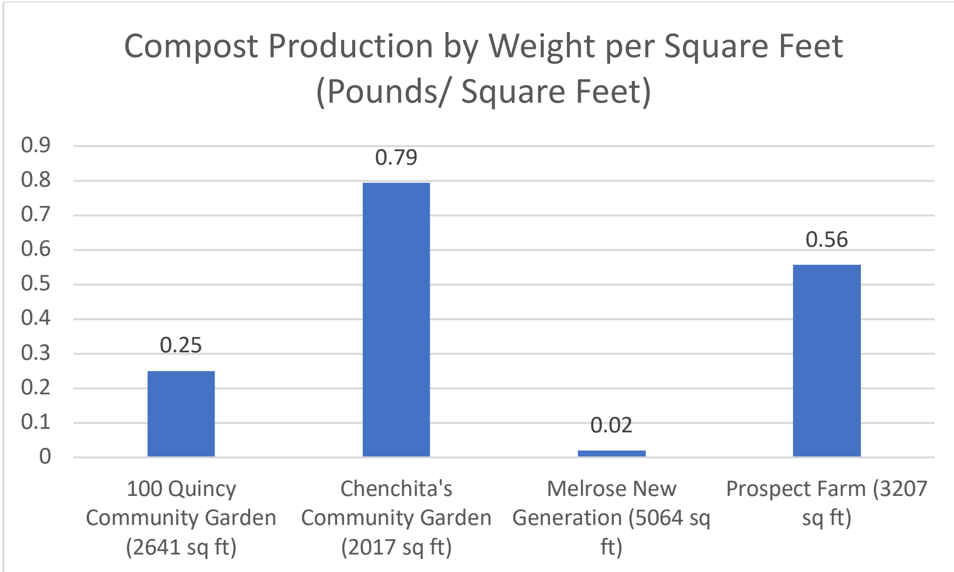


Figure 14: Compost Production Comparison by Weight per Square Feet

Figure 15 presents a significant increase of landfill waste diversion for 100 Quincy Community Garden from less than 1000 pounds in 2015 to more than 7000 pounds in 2017. Due to the limited size of the garden, it arrives a relatively low value of total landfill waste diversion when comparing it with other gardens. After an adjustment by garden areas, 100 Quincy Community Garden realizes a relatively high value of landfill waste diversion efficiency (Figure 16).

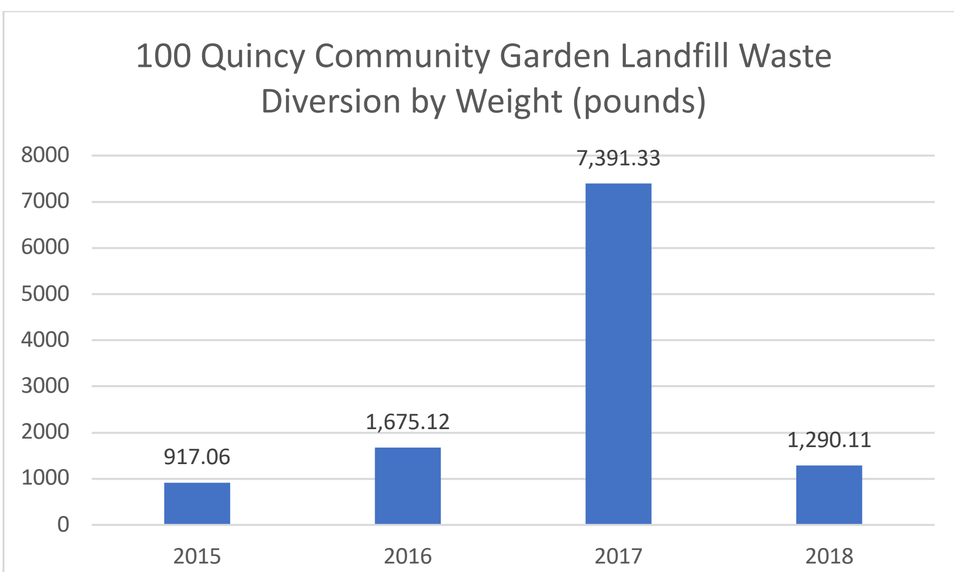


Figure 15: 100 Quincy Community Garden Landfill Waste Diversion

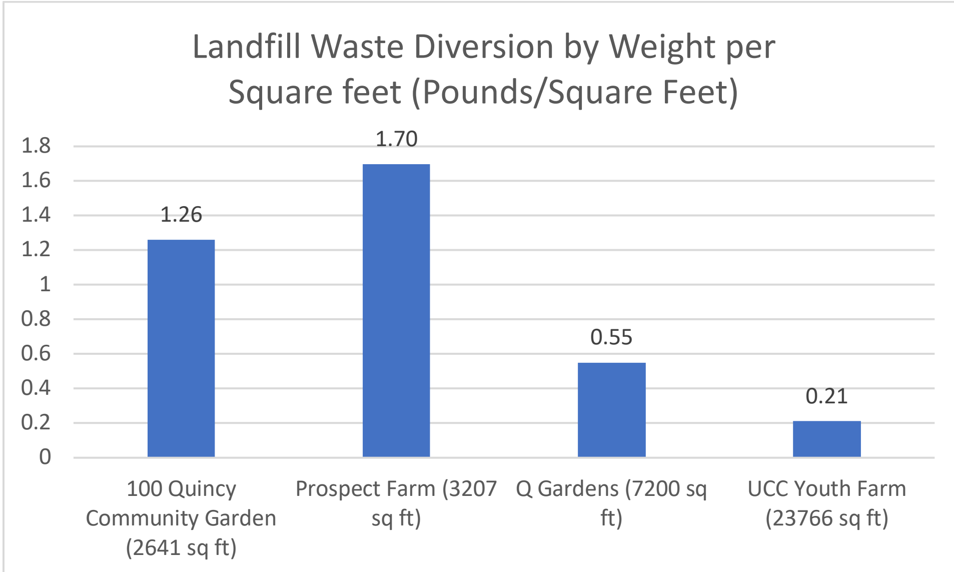


Figure 16: Landfill Waste Diversion Comparison

5.2.2 Urban Agriculture Modelling

On the basis of the UA model and interviews (Figure 2), the key characteristics of the Youth Farm and 100 Quincy Community Garden are summarized and documented in terms of people (primary actors/ stakeholders), activities (farm/garden activities), environment (community interactions), and tools (communication tools) in Table 9. Through documenting these UA elements and the interactions among them, this chapter aims at a detailed description about these two case studies, in order to delineate the functions, mechanism, participation, and operations of the typical UA cases in NYC. The in-depth discussion of the relative UA benefits and challenges will be only constructed based on a full understanding of the UA practices.

Table 9: Key Characteristics of Two Case Studies based on UA Model

Feature categories	Key characteristics	The Youth Farm	100 Quincy Community Garden
Primary actors /stakeholders	Managerial broads	BK Farmyards	Community gardeners in the Block Association
	Land owners	NYC Department of Education	NYC Department of Parks and Recreation
	Partnership organizations	The Brooklyn Greenhouse, Farm school NYC, High School for Public Service, NYC Department of Education, and Green Guerillas	Greenthumb program, Brooklyn Botanical Garden, Brooklyn Queens Land Trust, Citizens Committee For New York City, Bedford Stuyvesant Early Childhood Development Center
Farm/garden activities	Farming/gardening activities	Weeding, Planting, watering, harvesting, tidying up, composting, landfilling, building/ fixing	Weeding, Planting, watering, harvesting, tidying up, composting, landfilling, building/ fixing, raising chickens, rainwater collecting
	Product types	Vegetables, fruits, flowers, and composts	Vegetables, fruits, composts, eggs, and flowers
	Educational activities	Go Green! Class, the Farm Intensive Certificate program, and Professional Development for Teachers	School plots Children and student site visits
	Marketing activities	Sales to members, farmer's markets, and restaurants	Free to members and small food donations to community
	Volunteer activities	Open hours / Volunteering days	Open hours
	Social activities	Community volunteer participation	Community BBQ days and community notice board
	Other garden connections	Resource sharing and workshop attendance	Resource sharing and workshop attendance
Community interactions	Membership responsibility	Purchasing farming products	Maintaining the garden during weekly working shifts, and planting crops in their own plots as need
	Membership cost	$525 for vegetable shares and $215 for flower shares per season	Free
	Nutrition Assistance	Accepting EBT, Women, Infants, and Children (WIC), Health Bucks, and Senior Farmers Market Nutrition program coupons	NA
	Volunteer involvement	Citywide students and youth people	Community neighbors
	Social donations	Online donations available	Private donations with small amounts
Communication tools	Websites	Well-designed and active website	Website active before 2014
	Social media	Facebook Page, Instagram, blogs, and Twitter	Blogs (inactive before 2013), Facebook Page, Instagram, google group for membership

Chapter 6. Discussion

This chapter will widely discuss UA distribution, benefits, and challenges based on the results listed in Chapter 5. Also, policy recommendations toward UA development and regulation will be proposed to balance UA distribution, promote UA benefits, and overcome UA challenges in the current urban settings of NYC.

6.1 Urban Agriculture Distribution

Based on spatial analyses, the findings suggest an uneven UA distributive pattern. Central Harlem, the South Bronx, including Concourse Village, Melrose, and Highbridge, and the northern part of Brooklyn, including Brooklyn Heights, Bedford-Stuyvesant, Crown Heights, Bushwick, and Brownsville, are fruitful in urban farms and community gardens. This geographically uneven distribution can be justified in terms of agricultural history, urban fabric, and food security across the five boroughs.

Historical factors contributed to this uneven distribution. In the 1970s, a large number of lots were abandoned due to the financial crisis, especially in Manhattan neighborhoods, including Harlem and the Lower East Side. The Green Guerillas, a non-profit grassroots program, started to convert vacant lots into urban parks, gardens, and farms.

The regional differences of urban fabrics and dominant industries led to the UA spatial clusters as well. After decades of urban and economic development, Downtown and Midtown Manhattan were transformed into high-rise commercial districts under the influence of capital investment. The economic development in the South Bronx and Harlem lagged, currently remained a high unemployment rate and a high poverty rate. The relatively less-density urbanization in these areas conserved some community gardens, such as Robert L. Clinkscales Playground and Community Garden, Elizabeth Langley Memorial Garden, Woodycrest Community

Garden, Neighborhood Advisory Committee Community Garden, and Anderson Avenue Community Garden.

In addition, the clustered emergence of UA resulted from food security concerns. Brooklyn, one of the most productive agricultural areas in the nation in the 19th century, reached a food insecurity rate of 20 percent. According to the FoodBank NYC report in 2016, it became the only borough which increased this indicator since 2009. As the rising concerns of food insecurity, the food advocates, educational institutions, and communities in Brooklyn cooperated to convert vacant lots in the communities and rooftop spaces in the manufacturing areas for organic and affordable food production, such as the Youth Farm, 100 Quincy Community Garden, and Brooklyn Grange. This popular vacancy-to-UA conversion aggregated the UA prevalence and facilitated the UA resource sharing, which resulted in the emergence of UA clusters in Brooklyn.

6.2 Urban Agriculture Benefits and Challenges

The descriptive analyses and statistical regression of UA justified the UA multifunctional impacts on the city. This chapter explores the relative UA benefits and challenges based on the findings from Chapter 5 and discusses the future trends of UA development in NYC.

6.2.1 Urban Agriculture Benefits

This study supports that UA makes tremendous contributions to the city when functioning as a community public space, a farming educational site, and an urban ecological-circulation system, regardless of the other findings of UA concerns or challenges.

6.2.1.1 Community-Supported Agriculture

In the UA model, people and community are two primary elements to promote the UA internal interactions and to gain the direct UA beneficiary. UA involves a large wide of actors and stakeholders, from different levels of government institutions to non-profit agencies, from community gardeners and urban farmers to community residents, and from academic researchers to private business owners. The formation and development of UA cases attaches importance to these people and communities

The bottom-top process of 100 Quincy Community Garden sets an example of the multi-stakeholder process for the formation and management process of UA. In 2012, the garden location was a vacant lot owned by DOHPD. Several community people, driven by a shared interest of expanding community green space, grouped together. They held internal meetings to open the discussion of the vacant space future design, distributed online questionnaires giving ear to community opinions regarding vacant lot development, and voiced their proposals to attract more attention in Community Board meetings. Finally, with the help of 596 Acres, the ownership of this vacant lot was transferred to DPR. It was finally converted into a community garden and was registered under the GreenThumb program.

Currently, the neighboring people from the Block Association and the garden members from the community take the responsibilities of managing and maintaining the garden. Different levels of public and private organizations, such as Brooklyn Queens Land Trust, Brooklyn Botanical Garden, Citizen Committees, GreenThumb program, and Grow NYC, participate in the garden development, management, and maintenance.

Figure 17 narrates the community participation actions in the formation process of 100 Quincy Community Garden. The wide-range and multiple-dimensional community participation encourages the garden formation, maximizes the management support, ensures the public interest, and meets the community needs. As the returns, the garden answers the exact personal needs for all the garden members, in terms of planting, feeding, harvesting, recycling, greening, and recreating, and shapes the public space for the whole community to communicate, cooperate, message, socialize, and unite.

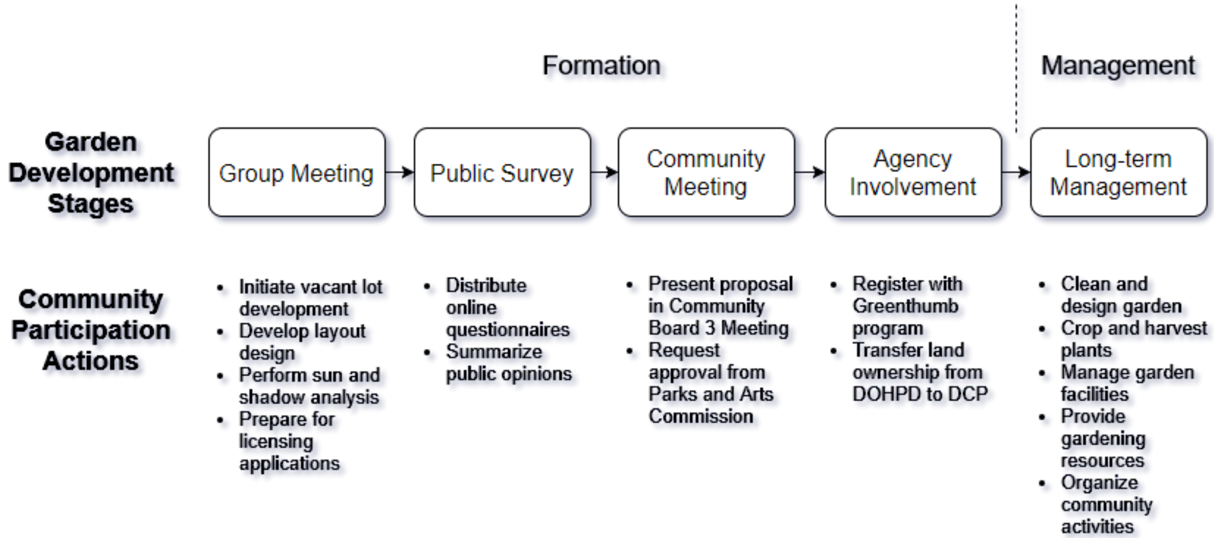


Figure 17: Community Participation Actions for 100 Quincy Community Garden Formation

Slightly different from 100 Quincy Community Garden, the Youth Farm was founded in a top-bottom process. In 2010, it was a joint program initiated by DOE, the High School for Public Service (HSPS), and Green Guerillas. Later, BK Farmyards took over the farm management role and built the wide cooperation with different agencies and programs, including Grow to Learn, the Brooklyn Greenhouse, New York Cares, Repair the World NYC, DOE, the NYS Department of Agriculture and Markets, the NYS Department of Health, and Cornell University Department of Crop and Soil Science. These cooperative opportunities bridged the communication between the farm and different social entities and enriched the farm activities and functions as a public space in the city.

Figure 18 draws the picture of the community connection network in the development process of the Youth Farm. Community people, educational institutions, and commercial entities input land, labor, donations, and resources, including cropping, composting, and landfill materials and tools into the farm. The farm exports farming vegetables and flower products, a green-skill experiment base, and a community public space, as the production outputs to the community. These two-way interactions in the farm build a robust community-supported system, which also activates and promotes the community communication, connection, integration, and harmony.

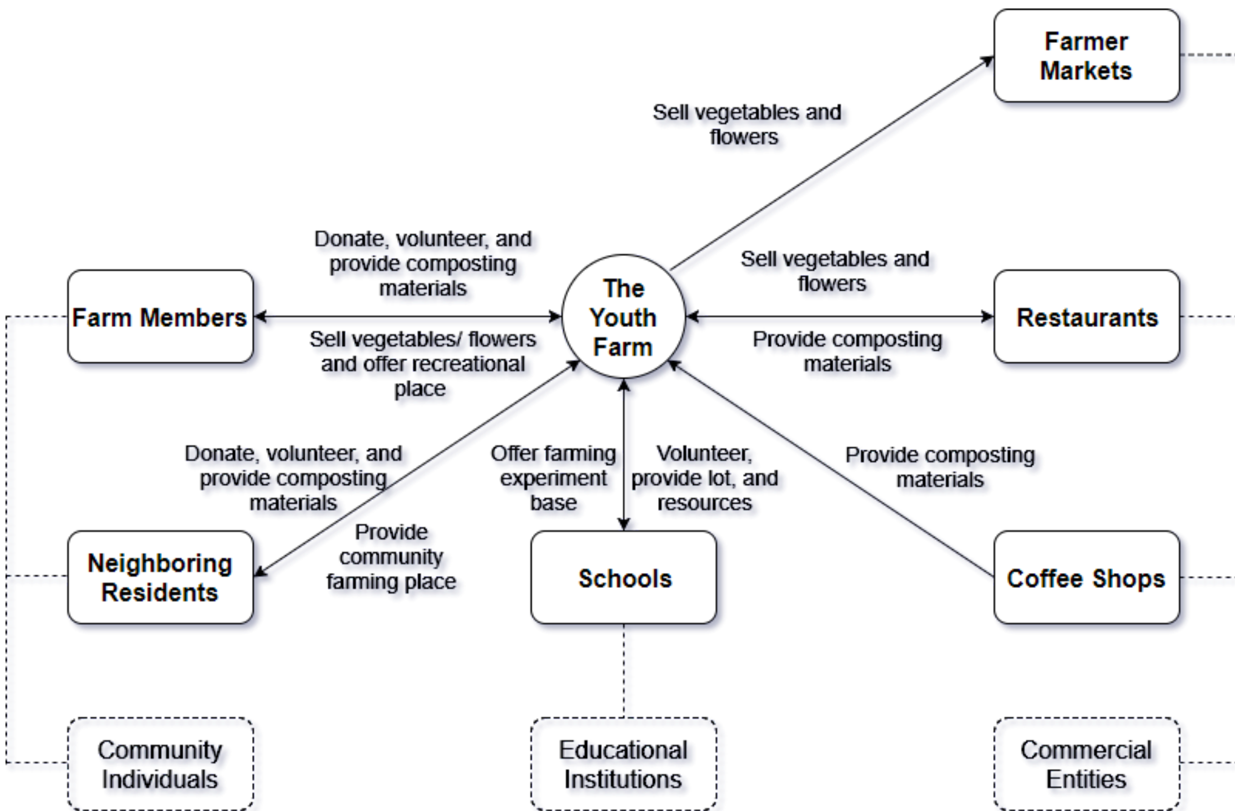


Figure 18: Community Connection Network for the Youth Farm Development

6.2.1.2 Green-industry Education

Based on the statistical regression models, the PUMAs with more schools tend to possess more UA locations. This relationship can be explained by the fact that some of the community gardens and urban farms cooperate with schools in terms of organizational management, land leasing, and agricultural education. NYC has the wide-range school gardening and farming programs. One example of these programs, Grow to Learn NYC, assists 545 public schools to connect with the garden projects since 2011 (Ackerman, 2011). These farm-to-school programs provide a cooperative platform for schools to nourish farming-skill training workshops and youth-leadership educational programs. In addition to program cooperation, some schools provide lands, resources, capital, and labor for UA development and management. Figure 19 summarizes the educational purposes of the Youth Farm programs for different target population with different time duration.

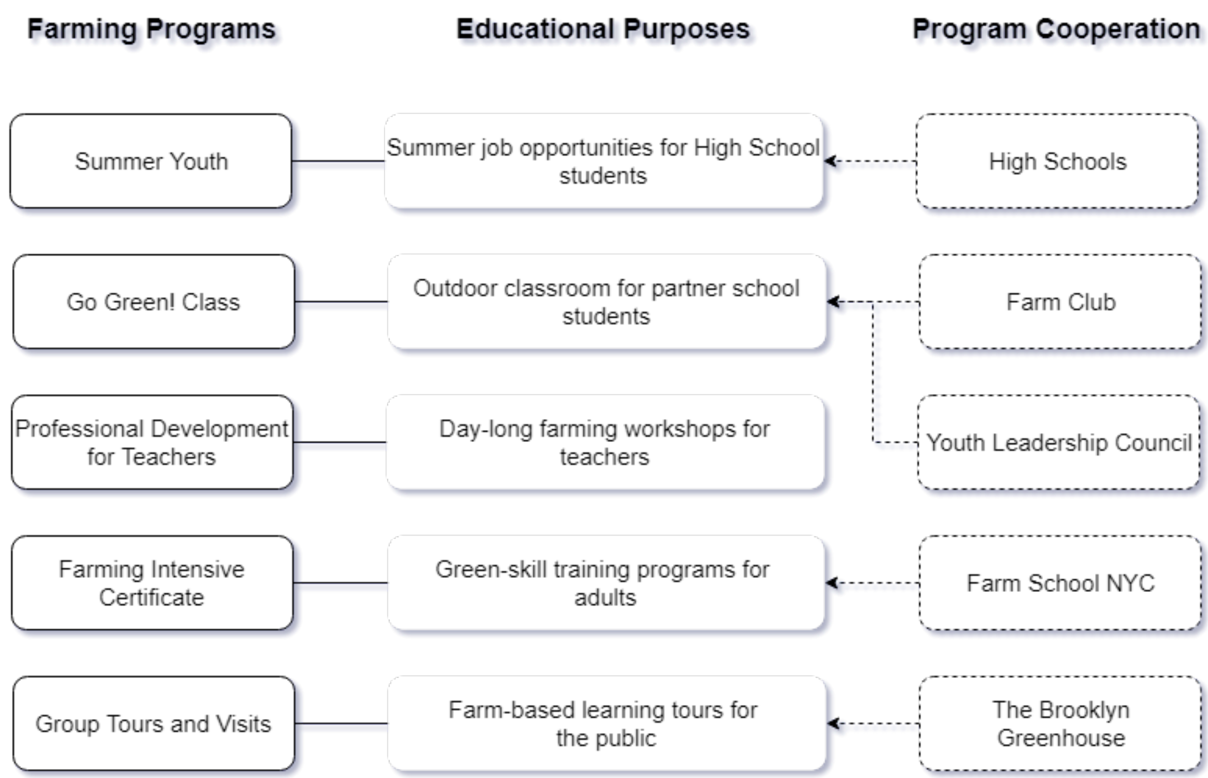


Figure 19: Different Levels of Educational Programs at the Youth Farm

6.2.1.3 Ecological-Circulation System

In addition to the benefits of community integration and green-industry education, the citywide UA system makes contributions to the city through creating green spaces, promoting ecological circulation, and improving participant moods. The regression models show a positive association between UA counts and the percentage of residents living within walking distance of a park. This phenomenon is logical since UA can be considered as a productive urban park or open space to some degree. In addition, the descriptive analyses of rainwater harvesting, composting production, and landfill waste diversion (Figure 4 – 6 in Chapter 5.1.2) explain the ecological cycling systems behind UA. The comparison of participant emotion before entering into gardens (Figure 9) and after leaving out of gardens (Figure 10) together emphasizes the ethical values of UA green activities. Figure 20 simply draws the UA ecological circulation system summarized from the two case studies.

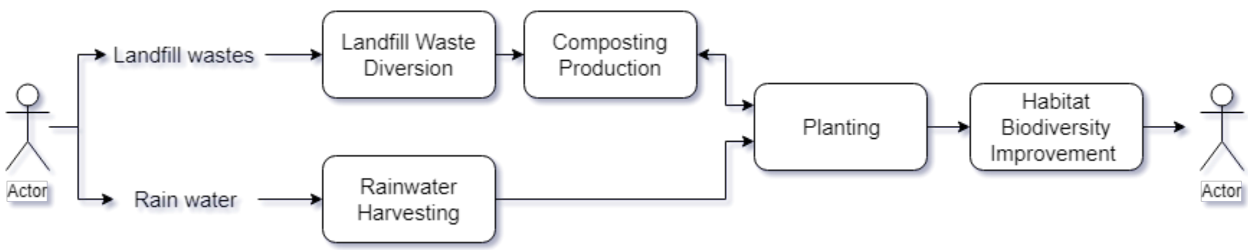


Figure 20: Typical Ecological Circulation System for Urban Agriculture

6.2.2 Urban Agriculture Challenges

6.2.2.1 Immigrant Separation and Race Inequity

Some evidence from literature review implies that color population and cultural identity promote UA formation, development, and activeness in some cases, such as Latino community gardens in NYC fostering the immigrant cultural heritage (Saldivar-Tanaka and Krasny, 2004) and commercial urban agriculture in Canada creating an inclusive community environment (Beckie and Bogdan, 2016). However, these case studies examined the typical and reputed immigrant UA projects, which cannot represent the citywide UA-and-race distributive balance.

In the statistical regression, the relationship between UA and the foreign-born and non-white population indicates that immigrant integration and race equity remain unbalanced across the UA in the city. This partial distribution might be explained by two driving factors - neighborhood relationships and public consciousness. The immigrant population usually tended to root in and earn a living in the cheap rural areas, which have the short urban development history. Their relative superficial neighborhood relationships and insufficient public consciousness resulted in the deficient UA practices in these areas. It is a challenge for the current UA system to achieve more social impacts when adapting to the immigrant environment of NYC.

6.2.2.2 Insignificant Economic Contribution

From the regression findings, there are more UA spots if the PUMAs have a lower median household income, a higher poverty rate, and a higher unemployment rate, concluding that the current UA system makes little contributions to the economic development of these communities. Also, at the level of individual farms and gardens, the descriptive analyses toward harvest counts and market sales in Figure 7 and Figure 8 suggest their limited economic incomes.

However, due to the small amount (only three) of commercial farms and gardens accounting for the whole UA dataset, the results in Chapter 5 mainly describe non-commercial farms and gardens. To discuss the economic contribution of UA, it is justified to separate the commercial UA from non-commercial UA. The former aims to achieve high economic incomes, which requires the sophisticated models of UA business, while the latter targets more social impacts, which highlights the balanced budget of UA projects. Therefore, how to support the different development focuses and needs of commercial and non-commercial UA and how to emphasize the smart growth of commercial UA will be one of the main challenges of UA economic improvements in the future.

6.2.2.3 Land Shortage

The high-dense urbanization and crowded population in NYC lead to land shortage issues for several decades. Investigating the association between UA numbers and affordable housing applications in the PUMAs indicates a future challenge for UA practices. The regression models offered a new investigation of the positive relationship between UA counts and the number of families in the PHWL. This result, to some degree, demonstrates the urban land use conflicts between affordable housing and UA.

To address the housing shortfall in the city, a hot debate was to raze vacant or low-utilized lots into potential affordable housing development sites. Twelve city-owned community gardens faced this taking challenge (Nir, 2016). Some farmers and gardeners insisted that the green space obtained from UA would be the public wealth of the city while the taking of UA faced the risks of injustice affordable housing access. For instance, urban farmers, local residents, and health food activists protested construction plans that would dig the Green Valley community farm out to build up to 20 units of affordable housing. They argued that the planned houses were not actually affordable but truly reduced urban green space. It is vital to develop land use strategies that maintain the land balance between affordable housing demands and UA development needs.

6.2.2.4 Non-significant Health Justice and Food Security Improvement

UA has been widely praised owning to its potential on promoting health justice and food security. However, the results from regression models suggest that the current UA system in NYC does not witness this promising vision. The PUMAs with a higher obesity rate, a higher diabetes rate, a lower fruit and vegetables daily consumption rate, shorter life expectancy, less senior population, and more SNAP recipients, might have more UA.

These findings demonstrate that there is still a practical gap of adopting UA programs as a direct public health and food security strategy. The challenges are how to improve the UA system efficiency in order to maximize the advantages of the shortened food miles, how to cooperate with the UA upstream-downstream industries in order to construct a robust food network using the existing local resources, and how to orient the UA target population in order to serve the most vulnerable people with affordable and healthy food.

6.2.2.5 Crime Occurrence

The regression model emphasizes a positive relationship between UA numbers and crime rate in the PUMAs. It drew a different conclusion from common sense that UA might decrease the occurrence of crime events (Reynolds and Cohen, 2016). This standpoint came into being based on the phenomenon that UA provides a brighter and nicer built environment after the conversion from the previous dark vacant spots. However, in NYC, the high-dense urban environment and strongly-modernized street views might mitigate the security influence from the vacancy-to-UA conversion. Therefore, it was arguably to consider UA as an effective strategy to improve urban security.

6.3 Urban Agriculture Policy Recommendations

In order to pursue better UA performance and a robust UA network, some policy recommendations are proposed to blueprint the UA development agenda and legalize UA planning regulations.

6.3.1 Integrating Urban Agriculture Dataset

The accuracies of the UA studies are extremely constrained by the data integrity and reliability. Same to this study, especially these heavy data-driven sections - location mapping, spatial analysis, descriptive analysis, and statistical regression. Currently, there is no uniform, complete, accurate, comprehensive, and all-in-one UA dataset for NYC. Only some governmental agencies (DPR and NYCHA) and research institutions (Five Borough Farm program) provide simple UA subsets from different aspects. Even though the Farming Concrete dataset, as a final deliverable of the Five Borough Farm project, attempts to offer a platform for gardeners and farmers to document and analyze their own records, it still remains a series of data issues – incomplete coverage, inaccurate inputs, and inconstant updates. The construction of UA datasets can benefit not only community gardeners and urban farmers, but also the policy makers, capital investors, and academic researchers in this field.

It is promising that the city has passed Int. No. 1661-A to involve different agencies together to build an active UA website by July 2018. However, building a website is far not enough for the future UA development. There are abundant key challenges, such as developing effective and efficient UA data collection rules, customizing constant and robust UA data update strategies, and specifying comprehensive and explicit institutional supervisory roles. It is highly recommended to invite both UA managers and functional departments to update, maintain, and supervise the UA database.

6.3.2 Legislating Urban Agriculture Practices

Different from other states that have legislated UA practices, such as California, Hawaii, Colorado, District of Columbia, and New Jersey, New York State lacks UA legislation. In al-most-4,000-page NYC zoning ordinance, the only word relevant to UA – "agriculture" is mentioned only a few times. The margin of UA legislation impedes UA development from different aspects. For instance, the UA practices face a challenge from zoning restriction that it is prohibited to grow and sell UA products in the same lots, which forces the isolation of production and sales location. Also, NYC's rooftop farms are currently located in the industrial and manufacturing (Brooklyn Grange at the Navy Yard), transportation and utility (Brooklyn Grange at the Long Island City), and commercial and office buildings (Eagle Street Farm and Gotham Greens). They are prevented in residential zones, where have a huge suitable space inventory that meets the criteria of building height, sunlight, and roof flatness for UA initiatives. Moreover, the indoor farming is ambiguous in zoning codes.

To encourage UA practices and support local food production, other states took different measures – creating UA Incentive Zones, such as California (AB 551, 2013), Missouri (HB 542, 2013), and Louisiana (HB 761, 2015), and granting UA tax credits, such as Maryland (HB 1062, 2010), Utah (SB 122, 2012), and Kansas (SB 280, 2015). Following these state examples, it is recommended to enact legislation that allows UA initiatives in the wide-range residential and other conditional zoning areas, or amends property tax law to appraise UA development in NYC.

6.3.3 Promoting Citywide Cooperation

Some states pushed the establishment of UA committees, departments or programs to enhance citywide cooperation, such as Missouri (HB 1848, 2010 and HB 2006, 2016), Texas (2011), District of Columbia (B 677, 2015), and Minnesota (SB 191, 2016). Greenthumb program has been well reputed as the largest community gardening program in the nation. However, the incomplete coverage of all the community gardens and the exclusion of urban farms limits the Greenthumb program's citywide management and cooperation. It is recommended to found citywide departments, agencies or committees to lead UA development, supervise UA management, encourage industrial communication, facilitate citywide UA cooperation, and offer abundant UA resources.

6.3.4 Designing Multi-Stakeholder Process

In order to "address the needs and priorities of the different stakeholders", MUP is a smart strategy to achieve extra benefits, such as ensuring the justice when decision making, increasing the likelihood of implementation, serving for the widest population, and involving the maximum capital, labor, techniques, and resources (Dubbeling and Merzthal, 2006). The case studies from 100 Quincy Community Garden and the Youth Farm narrated the bottom-top or top-bottom MUP, suggesting an advanced and successful model of UA formation, development, and management. Minnesota (SB 5a, 2015) enacted legislation to direct the convenience of interested stakeholders to promote UA development. This MUP is recommended to the city as a sophisticated model to promote UA formation and development.

6.3.5 Balancing Urban Agriculture Development and Land Shortage Crises

Some farmers and gardeners held a concern that the UA spots in the city-owned lots will be taken to meet the land demand of other land use purposes, such as affordable housing development. It is vital to balance UA development aligning with other land development purposes.

Some strategies have the potential of keeping the balance between these two-end needs. For example, Hawaii (HB 560, 2013) authorized the incentives of housing development projects that incorporate UA programs. In NYC, some high-tech farming mechanisms have potentials to achieve high production-to-area ratios, such as indoor greenhouses, vertical farms, aquaponics, and aeroponics. In addition, there are extensive flat rooftop areas with appropriate daily sunlight, available and suitable for farming or gardening.

However, the site selection of potential urban agricultural places is a complicated and limited process, especially facing environmental challenges. For environmental concerns, soil contamination and water resources determine the UA site suitability in general. In NYC, many farms and gardens adopt soil replacement to mitigate soil remediation and increase farming production. Rainwater collection and storm management are widely adopted as the useful water management strategies.

Current vacant lots are the primary source for future UA sites from a realistic point of view. According to Pawlowski (2016), the rooftop spaces remain unused summing up to 14,000 acres in NYC and has a potential ability to feed 20 million people. But this number would necessarily be reduced to meet UA site selection criteria - flat and sufficient spaces allowing for farming or gardening activities, limited building heights facilitating the transport of products, tools, and resources, legislated locations in industrial, commercial, and transportation zones. Ackerman (2011) published a comprehensive report to propose the potential urban areas for UA. Among the five boroughs, about 5,000 acres of vacant areas were identified after examining the open space, NYCHA property, parking lots, green streets, backyards, and rooftops.

Chapter 7. Conclusion

In an era of urbanization, there is a constant debate about whether it is worthwhile for cities to take a step back from the intense promotion of capital development to the self-sufficient system of agricultural production. Developing a robust and suitable UA network requires careful weighing of benefits and challenges. This study suggests that NYC should support UA development owing to the tremendous benefits of community development, farming education, and green values. There is no denying the potential challenges to promoting UA sustainable development, including immigration and race separation, the non-significant contribution to economic development, the shortage of land inventory, the insignificant improvement of health injustice and food security, and the occurrence of crime incidents. However, looking forward to the future, integrating an all-in-one UA dataset, legislating UA practices, promoting citywide cooperation for UA development, designing a multi-stakeholder process, and balancing land use among different urban activities will push forward the flourishing UA development and the vision of a beautiful future propelled by UA in the city.

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Appendix A

Criteria	Category
General	Farms, Gardens
Purposes	Community, Institutional, Commercial, Individual
Locations	Ground-based, Rooftop, Balcony, Backyard, Indoor greenhouse
Techniques	Traditional, Vertical, Aquaponics, Aeroponics

Appendix B

Full links for different dataset sources

Variable category	Dataset source	Full link
Urban agriculture	NYC Greenthumb Community Gardens	https://data.cityofnewyork.us/Environment/NYC-Greenthumb-Community-Gardens/ajxm-kzmj
	NYCHA Developments	https://data.cityofnewyork.us/Housing-Development/Map-of-NYCHA-Developments/i9rv-hdr5
	Five Borough Farm Report	http://designtrust.org/publications/five-borough-farm-ii/
	Farming Concrete	https://farmingconcrete.org/mill/
Influencing variables	Demographic, Social, Economic, and Housing Profiles by PUMA	https://data.cityofnewyork.us/City-Government/Demographic-Social-Economic-and-Housing-Profiles-b/kvuc-fg9b
	Social Indicators Report Data	https://data.cityofnewyork.us/Social-Services/Social-Indicators-Report-Data-By-Community-Distric/nvqd-aa32/data
	School Point Locations	https://data.cityofnewyork.us/Education/School-Point-Locations/jfju-ynrr
	American Community Survey (ACS)	https://www1.nyc.gov/site/planning/data-maps/nyc-population/american-community-survey.page
	Community Health Profiles	http://data-nycdohmh.opendata.arcgis.com/datasets/fa12249f3af74d628af48c2be12501f4_0
	Community District Profiles	https://communityprofiles.planning.nyc.gov/
	Primary Land Use Tax Lot Output	https://www1.nyc.gov/site/planning/data-maps/open-data/dwn-pluto-mappluto.page