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Practices and Barriers to Sustainable Urban Agriculture: A Case Study of Louisville, Kentucky

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Abstract: As urban populations increase, there is growing interest in developing innovative technologies, sustainable urban farming practices, policy measures, and other strategies to address key barriers in urban agriculture that impede improved food security and sustained urban livelihoods. We surveyed forty urban farmers and gardeners (growers) in Louisville, Kentucky, for base-level information to assess their agricultural practices and the various factors or key barriers that could influence such practices. Secondary objectives were identifying areas where practices could be improved, and identifying opportunities for research, outreach, and incentives for urban growers to transition to more sustainable and higher-yielding practices. The majority of these urban growers were white females, were more diverse than Kentucky farmers, and attained a higher degree of education than Kentucky residents as a whole. Most were engaged in urban agriculture for non-commercial reasons, and 11% were full-time urban growers operating farms for profit. Smaller farms were less likely to be operated for profit or have farm certifications than medium-sized or larger farms (Chi-squared = 14.459, $p = 0.042$). We found no significant differences among farm sizes in terms of whether growers rented or owned the land they were on (Chi-squared = 9.094, $p = 0.168$). The most common sustainable practices recorded were composting (60%), crop rotation (54%), polyculture (54%), organic farming (49%), and low or no-till (46%). The least common practices were alley cropping (5%), plasticulture (3%), and hydroponics (3%). Small farms were less likely to use crop rotation than medium-sized or large farms (Chi-squared = 13.548, $p = 0.003$), and farms responding to the survey in the latter part of the data collection were less likely to use compost than expected based on responses from the early part of data collection (Chi-shared = 5.972, $p = 0.014$). Challenges faced by these growers included limited space, accessibility to farm certification, presence of pests and diseases, and lack of record keeping and soil testing for fertility and contamination. Our study documents the need for more farm certification, education, outreach, training, research, investment, innovative ideas and solutions, collaboration among stakeholders, and better access to land through favorable urban policies and local support.

Keywords: demographics; production practices; land access and tenure; Louisville; sustainable; urban growers

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1. Introduction

As urban populations continue to increase, including in cities in the United States [1], there is growing interest in developing innovative technologies, sustainable urban farming practices, urban policy measures, and other strategies to address key barriers in urban agriculture that impede improved food security and sustained urban livelihoods. The global urban population is projected to grow to more than 6 billion people by 2050 [1]. Some urban residents in cities typified by Louisville, Kentucky, whose sociopolitical and economic under-development stems from a long history of racism, are faced with food insecurity in low-income neighborhoods that lack access to healthy and nutritious foods [2]. Some critics of the urban food movement suggest that denial of ownership and dispossession of land prevents many black, low-income neighborhoods from engaging in urban farming, and addressing this barrier will reduce urban food insecurity [2]. Like many other parts of the United States, Jefferson County, where Louisville, Kentucky, is located, saw a decline in food insecurity rates from 2017 (15.3%) to 2019 (11.7%) [3]. Food insecurity rates for 2020 are currently estimated to be 14%, with an expected decline to 12.9% for 2021 [4]. Food insecurity has adverse consequences. For example, with few grocery stores in West Louisville neighborhoods, there is a high concentration of fast-food restaurant chains, a situation that has been linked to health issues such as obesity [2]. Other studies have documented a strong association between household food insecurity and overweight status and lower psycho-social functioning in both children and adults of low-income minorities [5–10]. These neighborhoods have been further stressed by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, also called COVID-19) pandemic, which has revealed faults in the American food system [11] and highlighted the importance of urban agriculture in maintaining the urban food supply.

Approximately, 25% of the world's food is grown in urban areas, with contributions as high as 70% in some locations, and it is expected to increase as urbanization increases [12,13]. Urban farming encompasses three pillars of sustainability: social, economic, and environmental [14,15]. Promoting sustainable urban farming practices provides short- and long-term benefits in creating sustainable, resilient cities [15–17]. Urban agriculture provides a healthy and adequate food supply to the urban poor [18–20]. Gardening activities improve mental and physical health [9,10,21]. Urban farming also provides employment and income for the urban poor [22–25], creates a public good (i.e., landscape for all users) [16,25], and fosters community empowerment and development [15,26,27]. It creates a green city environment by reducing energy use and urban heat island effects, and promotes recycling and re-use of urban wastes and wastewater, limiting the urban ecological footprint [15,28–30].

In this case study based on Louisville, Kentucky, urban farming is defined as the growing of plants and the raising of animals for food and other purposes within and around a city [23,31–33]. Sustainable farming practices, including the use of cover crops, conservation tillage, crop rotation, composting, and integrated water, pest, and nutrient management, have been proposed as a component for improving soil health and crop productivity [34–37]. However, chemical fertilizer and pesticide use by urban growers could be detrimental to the urban environment and ecosystem [38,39]. Developing innovative and sustainable farming practices and sound policy measures are key to increasing urban farm productivity and enhancing food security in the food constrained world of the 21st century [40,41].

Many factors influence the adoption of sustainable urban farming, including the age and the level of education of urban farmers, their knowledge about innovative sustainable farming practices, farm size, and access to resources, tools, and data [42,43]. Land availability, which affects farm size and lack of funds to access other resources, are commonly accepted barriers to urban agriculture [44–46]. Soil contamination with heavy metals and other chemicals is considered a major health risk associated with urban agriculture [47–50], and parts of West Louisville host some chemical plants, landfills, and brownfields [51,52]. With reported chemical leaks and spills in the past [53], the soils and water resources of these neighborhoods are among the most polluted in the region and unconducive for sustainable urban agriculture.

In this study, a survey of forty urban growers in Louisville, Kentucky, was performed to assess the types of urban farming practices being used, and the factors or key barriers that could influence such practices. The main objective was to accumulate base-level information on practices in use by urban growers in Louisville and who those urban growers are. The secondary objectives were identifying key barriers and challenges, areas where farming practices can be improved, and opportunities for research, outreach, and incentives for urban growers to transition to more sustainable and higher-yielding practices.

2. Materials and Methods

2.1. Research Area

This study was conducted in Louisville, Kentucky, which has over 600,000 residents and is the most populated city in Kentucky. Louisville is next to the Ohio River and ranks among the top cities in the United States with low-income households living in food desert neighborhoods (Figure 1). Parts of Louisville, especially the West End, have many abandoned vacant properties, which are often used for dumping trash or gang activities [2,54]. Based on the postal zip codes of survey participants, 35% of the gardens/farms are in West Louisville, 23% are in East Louisville, and the remainder are in other parts of Louisville. The demand and public support for space for urban agriculture in Louisville is rising, especially in West Louisville, with many of its residents on the waiting list to be allocated land. Land development or zoning codes that specifically correlate to urban agriculture are expected to provide a meaningful impact in alleviating food access disparities in Louisville. Revising or amending Louisville's land development code, which would include promoting and regulating urban agriculture, has also been interest to the city's planners and policymakers [55].

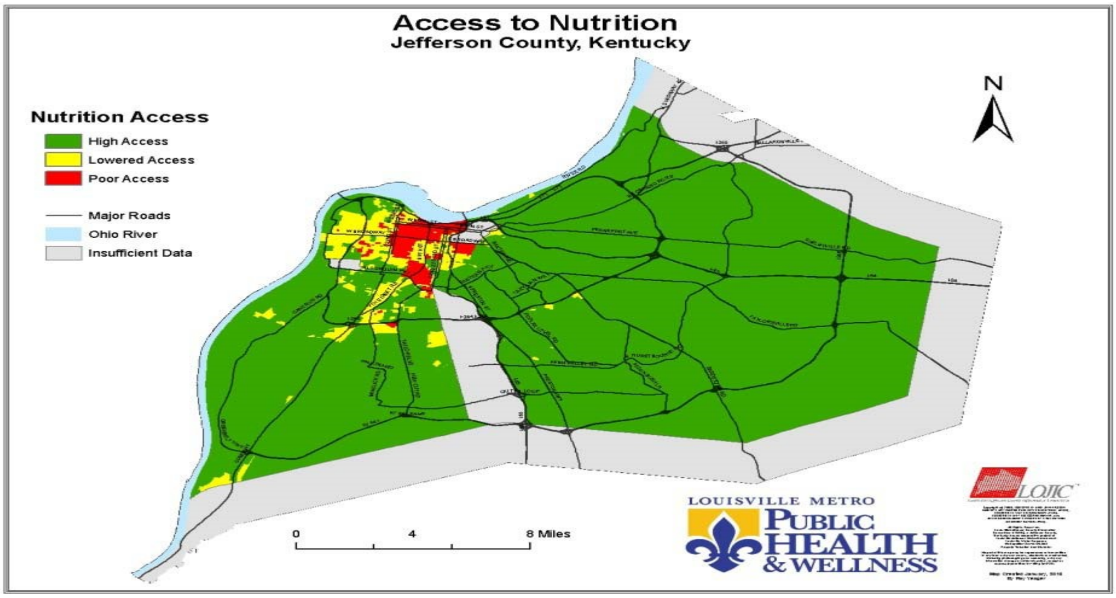

Figure 1. Food desert neighborhoods in Jefferson County, Kentucky, where the city of Louisville is located. (Source: Louisville Metro Public Health & Wellness). Scale: 0–6.4 km (4 miles).

There are several low-income neighborhoods in West Louisville, whose sociopolitical and economic under-development stems from a long history of systemic racism [2,56,57]. These neighborhoods are disproportionately faced with severe food insecurity challenges and poor health problems, which draw the attention of many public health advocates, government agencies, and grassroots and non-profit organizations [58]. To help these low-income communities sustainably access healthy and fresh food, there are over twenty-five known community urban gardens already established in Louisville alone, excluding school and backyard gardens [59]. The largest among these community gardens is the 7th Street Community Garden located in South Louisville, measuring approximately 200 m × 160 m. It is managed by the Jefferson County Extension Service, and demonstrates diversity with different participants, varieties of crops grown, and different purposes for engaging in producing food in the urban setting [59]. Producers include refugees from Africa, Asia, Latin America, and low-income and middle-income families, among others.

2.2. Data Collection and Analyses

Forty surveys (in-person and online) of urban farmers and gardeners (hereafter collectively referred to as growers) in Louisville were performed by using mixed methods (quantitative and qualitative methods/evidence). Survey participants did not self-identify as either a farmer or gardener, as definitions vary, and some used these terms interchangeably; thus, the term grower has been adopted to include both groups. Participation in the survey was voluntary and all participants were informed of how their responses would be used before agreeing to participate in accordance with Institutional Review Board Human Subjects protocols. Participants were recruited through various means, including web searches for urban farms and gardens, contact through various urban farm/garden groups and networks in the area, by the recommendation of other survey participants, attendance at events (including farmers' markets, fairs, and Kentucky State University Extension events), and the placement of flyers with a link to the online survey around Louisville. Types of urban farms included community gardens, residential backyard and school gardens, and private farms. The survey included questions about growers' demographics, farm characteristics (including farm size and location, and if the site was owned or rented), reasons for engaging in urban farming, production techniques (including sustainable practices used on the farm, number and types of crops grown, and nutrient management practices), farm expenses, pest management, and tools and resources used (Appendix A).

During the survey period (October 2017 to April 2021), forty people responded, which was a relatively small sample size considering Louisville's population of over 600,000. An overview of findings was compiled, including reporting the most common and the least common sustainable farming practices, the major challenges in the farming practices in order of least and most importance, and other findings or results based on the information given on the surveys. Data were screened and corrected for errors prior to data analysis. The screening involved checking survey responses, accounting for missing data or information, and appropriately entering the data into the statistical software. Data were reported as percent of urban growers adopting sustainable farming practices and percent of growers not adopting any or few sustainable practices.

Statistical analyses were performed using Microsoft Excel and R (The R Project for Statistical Computing, Vienna, Austria). The gender composition of survey participants was compared to that of Kentucky farmers and the Commonwealth of Kentucky as a whole using a 2-sample test for equality of proportions with an alpha level of 0.05. The age, race, education, and income of survey participants were compared to that of Kentucky farmers and the Commonwealth of Kentucky as a whole using Pearson's Chi-squared test with an alpha level of 0.05. Pearson's Chi-squared test with an alpha level of 0.05 was also used to determine if sustainable practices used differed among farms surveyed at the start of data collection and farms surveyed at the end of data collection, and to determine if sustainable practices used differed among farms of different sizes.

Some urban policy-related factors or variables, such as policies that favor or disfavor improved access to land and enhanced security in land tenure for urban farming in Louisville, were examined and discussed through the engagement with growers during the survey process. Interacting with survey participants (urban growers in this case) during the research period helped build trust, enabled us to better understand and identify the nature of tasks and functions performed by the participants at a given locality, and helped to uncover other issues or information that could have been missed during the survey design.

3. Results and Discussion

3.1. Demographics

Forty urban growers over the age of 18 in Louisville, Kentucky, participated in the survey, and the demography is shown in Table 1. Most of the survey participants were aged 26 to 35, and only 3% were over age 65; most were female (53%), mostly white (68%) with college degree, and 53% had annual household income over USD 45,000. The average farming/gardening experience among participants was 15 years, with a range of 6 months to 43 years. Survey participants differed from Kentucky farmers and the population of Kentucky in many ways (Table 1). Survey participants had a more equal gender split (Chi-squared = 5.560, p = 0.018), were younger (Chi-squared = 44.739, p < 0.001), and more diverse than Kentucky farmers, with more blacks or African American participants (Chi-squared = 607.74, p < 0.001). Survey participants did not differ from residents of Kentucky as a whole in terms of gender (Chi-squared = 0.054, p = 0.816), age (Chi-squared = 9.684, p = 0.085), and income (Chi-squared = 2.566, p = 0.633), but were more diverse (Chi-squared = 20.497, p < 0.001) and attained a higher education status (Chi-squared = 36.897, p < 0.001).

Table 1. The demography of survey participants (n = 40), Kentucky farmers (n = 123,995) (United States Department of Agriculture National Agricultural Statistics Service), and the population of Kentucky (n = 4,449,052) (United States Census Bureau). Note: Values in brackets under Kentucky farmers and the population of Kentucky represent the different age groupings used in data collection by the sources.

	Survey Participants (%)	Kentucky Farmers (%)	The Population of Kentucky (%)
Gender			
Male	47	65.4	49.3
Female	53	34.6	50.7
Age			
18–25	10	1.9 (<25)	6.8 (20–24)
26–35	27	7.9 (25–34)	13.0 (25–34)
36–45	17	12.5 (35–44)	12.4 (34–44)
46–55	20	19.5 (45–54)	13.1 (45–54)
56–65	23	26.9 (55–64)	13.3 (55–64)
Over 65	3	31.1 (>65)	16.0 (>65)
Race			
White	68	98.8	86.9
Black or African American	28	0.5	8.1
Asian	2	0.1	1.5
More than one race	2	0.4	2.2
Hispanic	0	0.6	3.7
Education			
Master's degree	25		10
Bachelor's degree	55		14.2
Some college	12		20.8
High school degree	8		32.9
Annual Income (USD)			(% of households)
<15,000	13		14.1
15,000–24,999	6		11.1
25,000–34,999	9		10.5
35,000–44,999	19		13.8
>45,000	53		50.5

Age, experience, and education play key roles in urban growers' engagement in sustainable practices [45,60,61]. Skilled and experienced urban growers are critically needed, especially in the case of low-income neighborhoods in Louisville's West End [45,60]. Past research suggests a strong correlation between age, experience, and farm productivity [45,46,60]. Better farming performance ideally comes with experience, skills, and knowledge [46]. Critical issues associated with lack of experience, knowledge, and properly implementing methods of sustainable production or management practices include chemical application, pest management, soil and water conservation techniques, proper harvest and storage of products, marketing, and record keeping [62,63].

Among the proposed benefits of urban farming are enhanced food and economic security, recreational and educational opportunities [15,22,62], beautified neighborhoods and increased property value [54,64], created public goods (i.e., landscape for all users) [16,25], strengthened community ties [22,26,54], revitalized communities and increased access to land [15,62,65], and empowered youth and women [66,67]. The most common reasons reported by survey participants (60%) for engaging in urban farming activities were for hobby/leisure, personal consumption, or non-commercial. Only 11% were full-time urban growers operating for profit. Others were involved in urban farming to provide educational opportunities to the community and to foster community and social gatherings.

3.2. Farm Size and Characteristics

Urban farms can be designed in various forms and at varying scales, depending on the objectives and available resources [62]. For the purposes of this survey, an urban farm was any area where food was grown or raised within Louisville, Kentucky. The urban growers surveyed in the study had diverse farms, including backyards, community gardens, and larger farms. Farm sizes ranged from 1.9 m^2 (0.001 acre) to 158.0 $\times$ 10^3 m^2 (40 acres). The urban farms surveyed were grouped into three size categories: small (<10 m^2), medium (10 to 2022 m^2), and large (>2023 m^2). Of the farms surveyed, 23% were small, 36% were medium, 23% were large, and 18% did not report their farm sizes. Many farms (76%) were established two or more years ago, and the oldest garden (Preston Greenhouse & Garden, in South Louisville) has existed for 42 years. Only 17% of the farms were operated for profit, and small farms were less likely to be operated for profit than medium or large farms (Chi-squared = 16.089, $p = 0.013$). Twenty-five percent of survey participants indicated that their lands were on lease contracts, and we found no significant differences among farm sizes in terms of whether they rented or owned the land they were on (Chi-squared = 9.094, $p = 0.168$). Only 10% indicated some form of partnerships or community-governed operations. Many of the farms had some form of staff: 15% of survey participants employed a dedicated staff or a farm manager, 10% employed part-time staff, and 33% had one or more regular volunteers helping with their operations. In response to whether their farms had any certifications, most of the participants (74%; Table 2) reported having no form of certification. In addition, small farms were less likely to have certifications than medium or larger farms (Chi-squared = 14.459, $p = 0.042$).

Table 2. Survey participants' responses to the question, "Does your farm/garden have any certifications?".

Available Responses	Responses (n = 40)
None	74%
USDA Organic	0%
Certified Natural	5%
GAP (Good Agricultural Practices) *	10%
Kentucky Proud **	8%
Others	3%

* Good Agriculture Practices (GAP) is a third party certification used to verify that fruits and vegetables have been produced, packed, handled, and stored to minimize the risk of microbial food safety hazards. ** Kentucky Proud is a marketing program for agricultural products born, raised, grown, manufactured, or processed in the Commonwealth of Kentucky.

3.3. Sustainable Farming Practices/Production Techniques

Most of the participants (67%) grew vegetables and culinary or medicinal herbs, and 60% produced compost. Crops grown included vegetables (mainly broccoli, garlic, tomatoes, artichoke, and peppers), herbs (mainly basil, chives, oregano, rosemary, and thyme), leafy greens (mainly arugula, cabbage, lettuce), fruits (mainly apples, grapes, and pears), nuts, and ornamental flowers. Eighteen percent of survey participants mentioned keeping records of their crop yields (Figure 2). Record keeping, even on small backyard gardens, is beneficial for tracking which crops or varieties perform well in the local conditions, and in larger operations, it helps track how sales and farm production match [68]. Additionally, record keeping is critical for many certification programs.

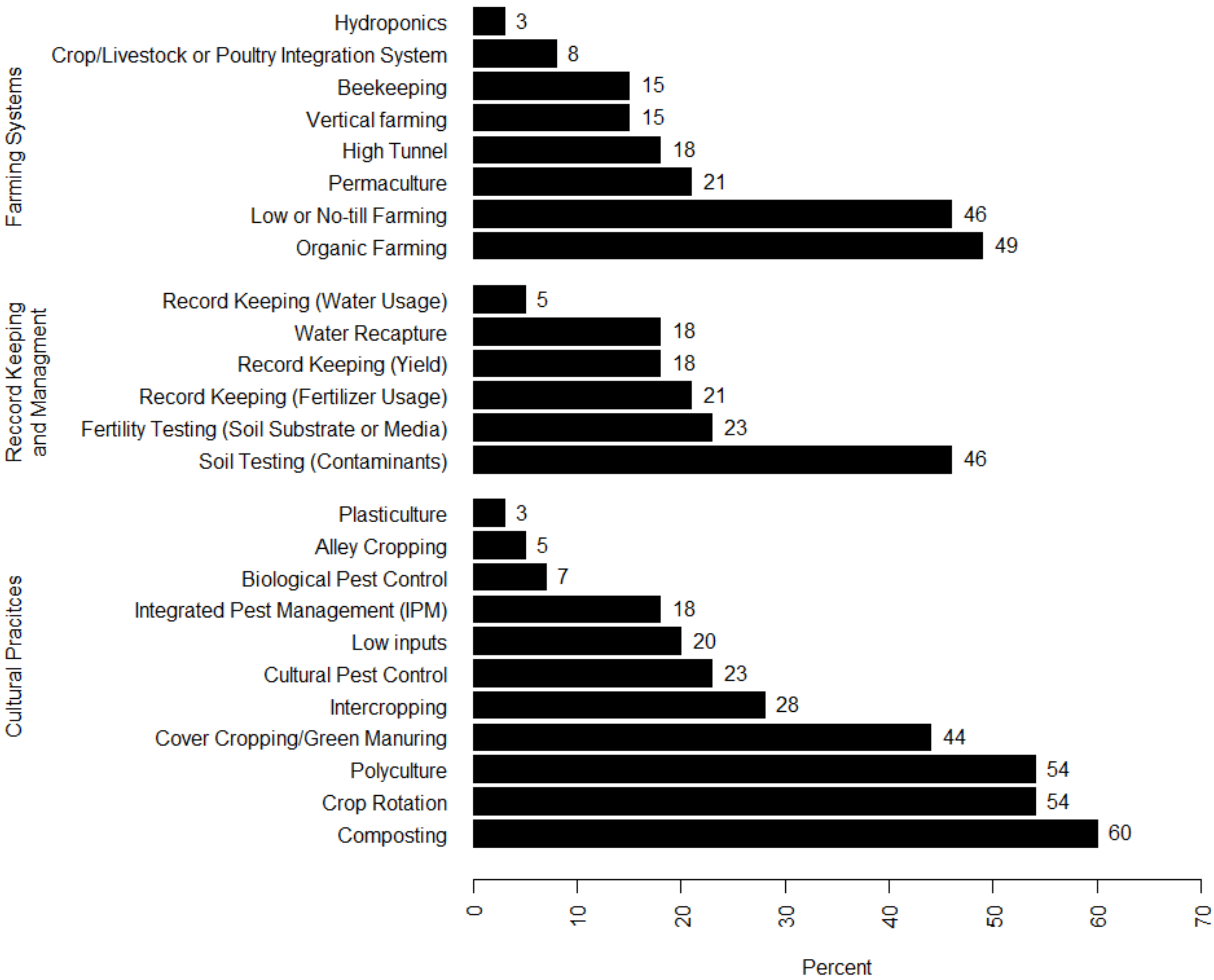

Figure 2. Sustainable urban farming practices/production techniques performed by survey participants (n = 40). These practices are not mutually exclusive.

Only 8% of survey participants kept livestock or poultry on their farms/gardens, with some keeping chicken and goats, and 15% having beehives on their farms; one farm had as many as fifteen beehives. Besides crops, and despite hygienic imperatives and environmental concerns, integrating livestock or poultry in urban farms could be sustainable and beneficial [16,32,69]. Integrating livestock production such as goats, rabbits, pigs, and chickens in urban farming (mixed crop–livestock farms) could enhance urban food and nutrition security, provide additional sources of income and recreation, and help to protect and maintain the biodiversity of cities [15,16,46,70]. In addition, nutrient cycling is enhanced through mixed crop–livestock urban farms [69,71].

Farm management or production practices/techniques—such as crop selection and planting methods, nutrient management, irrigation, and pest and disease management—could affect the sustainability of urban agriculture [43,46,63,70,72]. Adopting sustainable urban farming practices, including the use of compost, is critical to ensure urban food and water security, and make cities more climate resilient [73–75]. Composting, which is the most common sustainable practice among survey participants when asked about the production strategies they used (60%; Figure 2), entails the recycling of urban liquid and solid wastes for urban farming and can close the nutrient gap and increase urban sustainability [43,69].

Polyculture farming, or mixed cropping, which is the second most common sustainable practice alongside crop rotation (54%; Figure 2), is a sustainable farming practice in which two or more crops are planted concurrently on the same plot (for example, maize and a legume). It has multiple benefits, such as enhancing soil fertility through nitrogen fixation, minimizing risks, providing food and income, and saving money for urban growers who do not need to purchase synthetic fertilizers [71,76]. Urban growers who are more involved in this practice are likely to be more profitable, and they diversify their farms by adding high-value or short-season crops [71]. Intercropping, on the other hand, entails planting two or more crops simultaneously on the same field and in proximity and leads to greater resource use efficiency and higher crop productivity [71,77]. Adopted by 28% of our survey participants (Figure 2), intercropping has several benefits, such as improving soil fauna activities, suppressing weeds, adding nutrients and organic matter to the soil, lowering soil temperature, and reducing evaporation, water runoff, soil erosion, and chemical fertilizer use [71,77,78].

Organic farming, practiced by almost half of the survey participants (49%; Figure 2), provides local organic food to urban residents and is considered cost-effective and more sustainable than conventional farming at the city level, with multiple short- and long-term benefits [16,71,79]. Organic farming supports the local economy, biodiversity, and pest management, and it reduces the use of chemical fertilizers and pesticides, which are detrimental to the urban environment [71,79]. The practice reduces environmental risks in an urban setting, especially in polluted neighborhoods such as West Louisville, with its concentrated chemical industries and wastes storage facilities. Only 20% of participants used commercial non-organic or conventional fertilizers, and a small number (5%) mentioned using commercial pesticides, showing an inclination toward organic or sustainable practices by urban growers. Promoting organic farming as a sustainable practice by supporting local initiatives for the certification and marketing of organic foods, promoting additional "green labels," and more training and education for urban growers on organic and ecological farming practices could strengthen that trend.

Low or no-tillage, adopted by 46% of survey participants (Figure 2), is a sustainable management practice aimed at minimizing the frequency or intensity of tillage operations and is adopted by many urban growers in the United States and other parts of the world [80,81]. It is also used as a method to prepare for planting and soil compaction, while minimizing mechanical operations and soil disturbance [71]. No-till has multiple benefits, including preventing soil erosion, retaining soil moisture, reducing the risk of runoff and pollution of surface waters, raising carbon sequestration, improving nutrient cycling, and reducing plant pests, diseases, and production costs [80,81].

For the most common sustainable practices, there were no significant differences among farm sizes for use of compost (Chi-squared = 1.847, $p = 0.605$), polyculture (Chi-squared = 6.778, $p = 0.079$), low- or no-till farming (Chi-squared = 3.967, $p = 0.265$), organic practices (Chi-squared = 6.725. $p = 0.081$), and use of cover crops or green manures (Chi-squared = 12.586, $p = 0.182$). However, small farms were less likely to use crop rotation than medium or large farms (Chi-squared = 13.548, $p = 0.003$).

Pest, weed, and water management techniques and applications, including the use of efficient irrigation systems, and cultural and biological practices such as organic pest control and the use of aquatic vegetation to reduce nutrients in urban wastewater, can sustain urban farming [33,46,82]. Because pests, diseases, and weeds negatively affect productivity, participants were asked about their presence in farms/gardens and whether they used biological or cultural pest control to address their prevalence. Most admitted the presence of pests and weeds such as aphids, beetles, rodents, leafy weeds, and grass weeds; 10% reported not having pest problems or related diseases. Overall, 7% and 23% of survey participants used biological and cultural pest control methods, respectively (Figure 2). Methods employed included eliminating the host crop, crop rotation, manual uprooting, removal by handpicking, using a mixture of ingredients (such as spices/herbs with water and cayenne powder), deer fencing, etc. We found no significant differences among farm sizes and use of IPM (integrated pest management) (Chi-squared = 6.019, $p = 0.111$).

Urban agriculture, which could consume considerable amounts of water, also poses risks to water resources. Urban growers who have access to irrigation facilities are also more likely to adopt sustainable farming practices (such as soil management) than their counterparts who do not [83]. In the case of Louisville, education about adopting more efficient irrigation systems would be a good start. Participants were questioned about the irrigation methods used on their farms/gardens (Table 3), water sources, and whether they recaptured runoff on their farms to use for irrigation and kept records of the amount of water used. Survey participants named various water sources, and most (85%) depended on municipal city water lines for irrigation, using different techniques/methods such as manual irrigation (using hoses and watering cans) and sprinklers. Only 5% of survey participants kept records or had an idea of the amount of water they used, and 18% reported water reuse through recapture from runoff (Figure 2). Only 24% of participants reported using micro-emitters or drip systems that are more water efficient (Table 3). Water management practices did not differ among farm sizes in terms of use of automation (Chi-squared = 4.878, $p = 0.559$), micro-emitters (Chi-squared = 3.421, $p = 0.331$), garden hoses (Chi-squared = 1.429, $p = 0.699$), sprinklers (Chi-squared = 1.061, $p = 0.86$), or watering cans (Chi-squared = 5.282, $p = 0.152$). Small farms were less likely to use drip line or tape (Chi-squared = 8.777, $p = 0.0324$) than medium or large farms. Water sources did not differ among farm sizes for city water (Chi-Squared = 2.928, $p = 0.403$) or rainwater (Chi-squared = 4.571, $p = 0.206$).

Table 3. Survey participants' responses to the question, "How do you supply irrigation water to your farm?".

Available Responses	Responses % (n = 40)
Micro-emitters	3%
Garden hose	38%
Drip line/tape, or soaker hose	21%
Sprinkler	10%
Watering can	31%
Others	6%

Fertility and contaminants testing on soil, substrate, or media are sustainable practices that prevent food contamination, minimize expenses on fertilizers, improves nutrient management by maximizing the efficiency of nutrients, and hence improve crop productivity [36,37,84]. Twenty-three percent of participants had fertility testing performed, and 21% reported keeping records of the amount of fertilizer, amendments, and other additives they used on their farms (Figure 2). This represents an area of improvement to ensure more sustainable farming; efficient nutrient management practices depend on soil testing and careful application of nutrients with record keeping. This is especially true because 40% of survey participants reported soil amendments and fertilizers as among their top three expenses. In addition, more than half of the survey participants (54%; Figure 2) reported having no soil testing performed for contaminants on their sites and 20% indicated that soil remediation was necessary. Participants were also asked if they grew in native or imported soil. Fifteen percent responded that they use imported soil, a suitable alternative to soil remediation if contamination is suspected. Interestingly, we found no significant differences among farm sizes when looking at fertility testing (Chi-squared = 6.144, $p = 0.407$) and soil testing for contaminants (Chi-squared = 14.209, $p = 0.288$). Other surveys of urban agriculture have also found that growers are not following sustainable practices as far as nutrient management is concerned. Over-application of nutrients is common and can substantially exceed crop needs [85,86] and sometimes local regulatory limits [87]. This can lead to nutrient buildup in the soil [85,86] and nutrient runoff [88]. Parts of Louisville, especially in the West End, host many chemical plants, landfills, and brownfields [51,52]. With reported chemical leaks and spills in the past [53], the soils and water resources of these neighborhoods could be polluted, making the area unconducive for sustainable urban agriculture. This makes the practice of soil testing in Louisville especially important, to ensure that the soil is healthy for urban farming and the food being produced is not contaminated.

Because surveys were collected over an extended period, an analysis was performed on the most frequently selected sustainable farming practices to determine if changes took place with time. Farms responding to the survey in the latter part of data collection (2019–2020) were less likely to use compost than expected based on responses from the early part of data collection (2017–2018) (Chi-shared = 5.972, $p = 0.014$). As there were no policy changes regarding composting made in the Louisville metropolitan area, and most groups providing education in the area promote the use of compost, this difference may be a result of the relatively small sample size ($n = 40$). There was no significant difference among urban farms surveyed early in the data collection period and those surveyed later in the data collection period in the use of cover crops (Chi-squared = 1.577, $p = 0.209$), organic practice (Chi-squared = 2.186, $p = 0.141$), crop rotation (Chi-squared = 0.116, $p = 0.733$), polyculture (Chi-squared = 0, $p = 1$), or low- or no-till farming (Chi-squared = 0.116, $p = 0.733$).

3.4. Tools and Resources

There are many factors that influence adopting sustainable urban farming, including the level of education of urban growers, their knowledge about innovative sustainable farming practices, farm size, and access to tools, resources, and data or information [42,43,61,89]. Survey participants were asked to list the farming/gardening tools or implements they use on their sites. The lists include shovels, hoes, rakes, spades, shears, tillers, rain barrels, hose, watering cans, and other hand tools. Only 3% of participants mentioned the use of heavy equipment (tractors), and this could be attributed to the fact that most participants are operating on a small scale with small plots. Eighteen percent of survey participants listed farm tools and implements as among the top three major expenses of their farms.

In response to the question about which resources (such as books, web sites, experts from government or non-profit agencies) they used to make decisions about their farming operations, 64% of participants said they rely on the internet or web, 46% mentioned Cooperative Extension Services, and 33% depend on other resources (Figure 3). In addition, resource use did not differ among farm sizes for two of the most-commonly selected resources: internet (Chi-squared = 3.234, $p = 0.357$), and Cooperative Extension Services (Chi-squared = 1.285, $p = 0.733$). The selection of other resources may show a trend of being less likely for small farms than medium or large farms (Chi-squared = 7.571, $p = 0.0557$). Collaboration among growers to make farming decisions was 36%, and this could indicate that resource sharing and collaboration among urban growers in Louisville could be improved. Some participants mentioned the lack of trust with state and federal agencies for assistance and the burdensome or bureaucratic process they must deal with to obtain a farm loan, grant, or other forms of assistance.

Resources such as research publications or farming data on the web and technical advice from experts representing government and other agencies can be beneficial or supportive to urban growers in overcoming some of the challenges faced in adopting sustainable farming practices. For example, technical assistance and funding from agencies such as the United States Department of Agriculture (USDA) and the Jefferson County Cooperative Extension Service in Louisville are contributing to the success of urban farming in the United States [59,60]. Government or city authorities can sometimes use their powers of legislation and regulation to establish urban policies that are favorable to urban farming, such as promoting or controlling the use of vacant and abandoned properties for urban farming and incorporating urban farming guidance in cities' land development code amendments. We have seen the rise of grassroots and farming movements across cities, helping to facilitate collaboration among stakeholders and coordinating efforts and programs to promote urban farming. For example, Louisville Grows, a non-profit organization found in 2009, and Sustainable Agriculture of Louisville (SAL) have been providing technical and financial assistance, training, and other resources and tools to some communities in Louisville with the aim of building a more just and sustainable city through urban farming. However, some of the survey participants were not aware of the presence of such agencies or organizations to take advantage of their support.

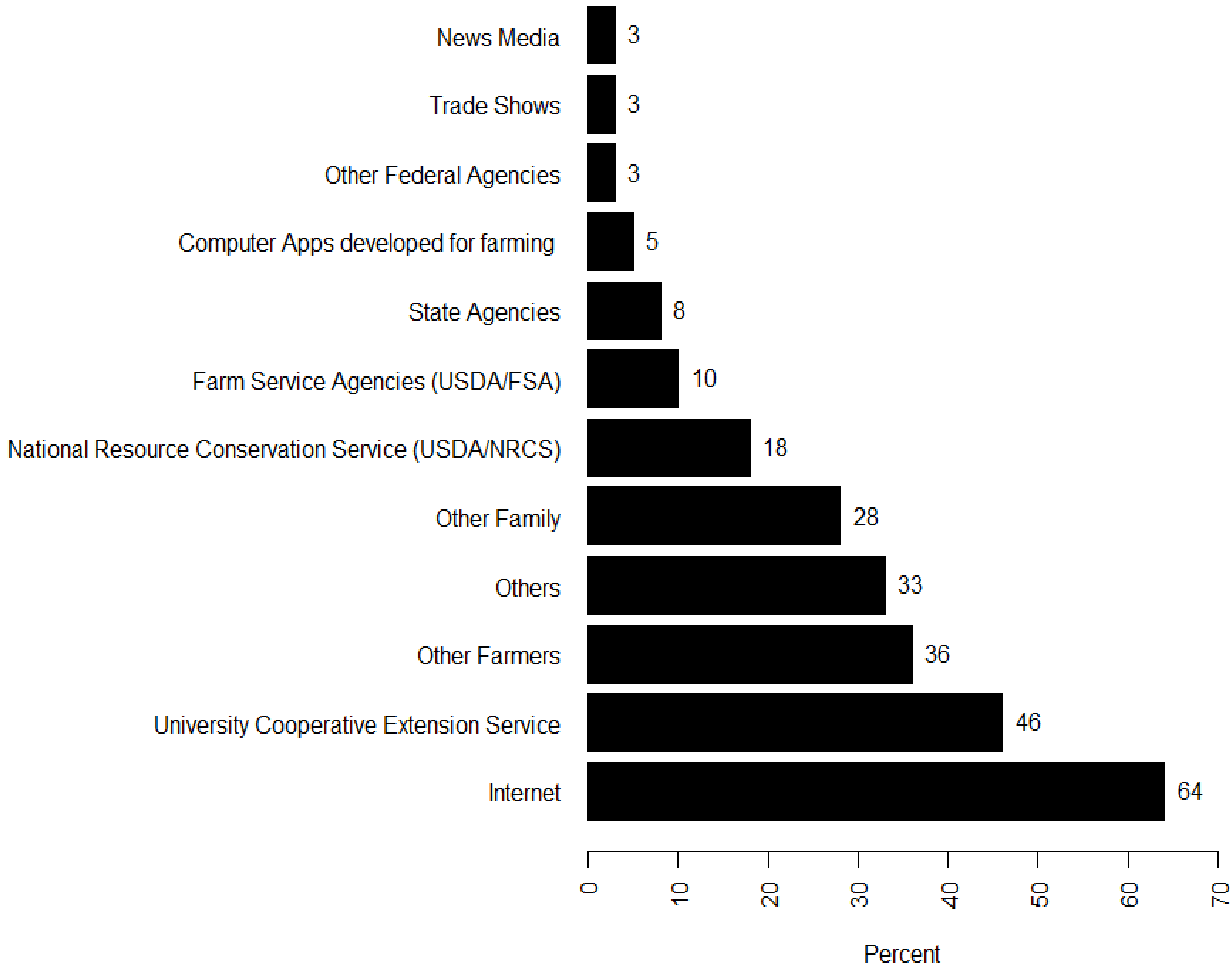

Figure 3. Resources used by survey participants to make decisions about their farming operations (n = 40). The internet category excludes web-based resources that fall under another listed category.

3.5. Challenges and Opportunities

Despite its many benefits, there are also challenges or constraints associated with urban farming practices. One of the greatest challenges mentioned by some of the survey participants is limited access to land and lack of tenure on land for urban farming. Those most affected are the marginalized groups and minorities who have the greatest need to engage in urban farming [15,46,62,63,90]. Lack of tenure is a common concern and land for urban farming in some areas is usually controlled by private interest groups, developers, or public agencies [16,62,63]. Twenty-five percent of survey participants indicated their farm or garden lands are on lease contracts, meaning that most have some form of control over or ownership of their land. However, for some of those who lease their land, they could be at risk of losing their contracts; therefore, any investments made in their farms or gardens are subject to changes made by the landowners, such as raising the rental fees or changing other terms of the rental agreement. Parts of Louisville in which there are many abandoned vacant lots and other public lands could be a potential opportunity for Louisville growers or those interested in urban farming. Demand and public support for space for urban agriculture in Louisville are on the rise, as stated by some of the participants. With many residents on the waiting list to be allocated a plot, favorable urban policies such as establishing land development or zoning codes that specifically correlate to urban agriculture are needed to alleviate food access disparities in Louisville. Revisions or amendments to the Louisville's land development code, which would include regulations to promote urban agriculture, have been of interest to urban planners, policymakers, and other stakeholders [55].

Even when land is accessible, the land that is accessible is often of poor quality or contaminated, which could lead to low productivity or pose a health risk associated with urban farming. Most of the survey participants (54%), including some in West Louisville, reported having no soil testing performed for contaminants. This is not sustainable, especially taking into consideration that Louisville is among the top polluted cities nationwide, with its many chemical industries and waste facilities [51,52]. Other studies have documented similar observations of poor urban soil quality and low soil testing performed by growers as an impediment to the sustainability of urban agriculture [91–93]. Soil testing should be given a high priority among urban growers in Louisville, especially those operating their farms/gardens in West Louisville, as these soils may need some form of remediation before use. Some of the reasons for the small number of participants testing their soils for nutrients and contaminants could be attributed to the costs involved, and lack of awareness of soil testing programs or incentives offered by key stakeholders such as the Jefferson County Soil and Water Conservation District. The agency provides incentives to cover soil tests with a cap on the number allocated to each resident. This is a good start, but it needs to be paired with outreach, communication, training, and education to encourage more Louisville growers to perform testing on their soils on regular basis.

Lack of financial resources or support is another major challenge to urban farming because the operations associated with the practice could be difficult to initiate and maintain once established [45,46,60,62]. The cost of seeds, labor, equipment, water, storage facilities, capital to buy or rent land, insurance coverage, and converting vacant parcels into urban gardens can be a daunting challenge to urban growers or to those interested in engaging in the practice [45,46,60]. A broad range of farm expenses were reported by survey participants, and the top three major expenses were the cost of seeds or seedlings (85%), fertilizer (40%), and utilities (35%). Others documented the cost of supplies and equipment, labor, farm chemicals and pesticides, permits, and buildings and other infrastructures as one of their top three expenses. Many individuals or groups that engage in urban farming with limited income depend on partnerships and outside donors for funding [46,60]. Measures to improve urban growers' access to financial resources/capital, including the revision of loan conditions with lower interest rates, creating micro-credit schemes, and providing subsidies or incentives, boost urban farming potentials and changing urban livelihoods [46,60]. In Louisville, agencies such as the Jefferson County Cooperative Extension Service and non-profits such as Louisville Grows have been helping urban growers offset some of the costs/expenses associated with their operations. These measures include providing growers with seeds, gardening tools, maintenance of equipment, infrastructures such as raised beds, water supply, volunteer work, and grants.

Water is not only one of the most important resources for urban farming, but it is also in high demand, growing scarce in some regions and becoming more expensive [15,45,46,94]. Even though some of the survey participants did not mention water as a challenge, some did say that water was provided free for them, indicating a dependence on others for city water. This means that outside groups or organizations bear the cost of higher water bills, bringing into question the economic sustainability of that system. Most of the survey participants had no idea or record of the amount of water they use on their sites, which is counter to sustainable urban farming practices. Without records, it is possible that some urban growers who have gained free access to city water though a third party represent a greater financial burden to those organizations than others. Water use, management, and storage, such as water harvesting, which is an efficient water conservation technique practiced by 33% of survey participants, could be promoted among Louisville growers. In addition, sound policies and planning are needed to regulate water runoff. Runoff from urban farms could be a source of contamination affecting water quality in urban areas.

How much water quality could be affected would depend on nutrient management and irrigation practices, both of which are not well monitored by urban growers in Louisville.

The presence of pests and diseases, as reported by 90% of survey participants, could be a challenge for urban farming [13,16]. In addition, climate-related factors, such as rising temperatures and excessive rains in many cities, have increased plant and animal diseases, damaged crops, reduced soil quality, and reduced urban farm productivity [16,41,79,95]. Climate change, which is adversely affecting food systems and supply, plays a key role in changing the patterns of disturbance from certain native pests and pathogens through physiological changes in the host crop and increases the population and survival of certain non-native species [95]. In addition, the use of pesticides is prohibited by city authorities in some urban areas due to the health risks associated with the practice [13]. As a result, there is a need to enhance the natural control of pests and diseases through more research, training, education, and extension services [13,16].

Farm certification could be a barrier to urban agriculture because the practice is a knowledge-based exercise [46,94], and adds values to urban growers' produce, increases farmer access to markets, encourages specialization, and enhances food safety [94]. Our analyses revealed that lack of farm certification and training on sustainable production practices is a challenge, with 74% of survey participants having no form of farm/garden certification (Table 2). There are many reasons for the low farm certification among participants, including lack of access to, or knowledge about, local and national or federal agencies trainings, the availability of training workshops, and the bureaucratic hurdles, politics, and costs to obtain farm certification. As a result, further inquiry should assess Louisville growers' understanding of the benefits of farm certification and training and how barriers to access could be removed.

4. Conclusions

Urban farming can be practiced sustainably with great productivity potential despite the challenges it faces. As Mougeot [32] puts it, urban farming "must be viewed not as a problem, but as one tool contributing to sustainable urban development". However, planning for sustainable urban farming requires considering many factors, including the economic, social, ecological, technical, political, geographical, and institutional drivers and constraints associated with it. This can be illustrated in the survey results for Louisville, Kentucky, where urban growers do not use sustainable practices in some areas but have the potential to become more sustainable and increase production capacity if they did. Examining which urban farming practices cities should adopt, considering their multidimensional impacts, warrants further investigation [96]. Some cities could promote organic farming as a sustainable practice and set it on their political agenda. There is a need to include urban farming in urban land use planning, and to develop more evidence-based policies and regulations for urban farming. Cities need to design land inventories and allocation tools in their plans and provide institutional support by creating partnerships with communities and other stakeholders to boost the potentials of urban farming [13,62,97]. Given the complex relationship between urban farming and urban policies (e.g., poverty alleviation), future research needs to evaluate policy measures, especially their outcomes in relation to benefitting the urban poor or marginalized communities.

Due to the increasing awareness of the key roles urban farming could play in the sustainability of cities, there has been remarkable success among urban growers adopting sustainable farming practices throughout the nation with the help of key stakeholders (including local and state agencies) [93,98]. Some of the key stakeholders such as extension service agents should continue to raise awareness of the benefits of farm certification and soil testing among urban growers, create more opportunities through training and education, and reduce the barriers associated with obtaining a farm/garden certification. There are also opportunities for innovation to improve the accessibility and awareness of soil testing for contamination, which could ensure that food produced does not present a health risk. Future research should also focus on evidence-based and science-based approaches to urban farming for a better understanding of the sustainability of innovative urban farming practices, the relationship between urban farming and the urban environment, urban farming and urbanization, and how urban policies continue to influence urban farming. More research is also needed on the distribution and accessibility of food produced in the cities, the impact of livestock production and management in urban farming, and the impact of urban farming on climate change adaptation and mitigation, as cities vulnerable to climate change are continuing to experience floods, droughts, hurricanes, and loss of farm productivity [41,79].

5. Limitations and Assumptions

The first major limitation of this study is the small number (n = 40) of survey participants. Second, the surveys were collected over an extended period. This extended time scale was due to the difficulties associated with locating smaller scale urban growers for participation. We assumed that the responses of survey participants are truthful and answered to the best of their knowledge and experience.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of Kentucky State University (protocol code 18-001 originally approved on 17 August 2017 with modifications approved on 10 July 2019).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Consent for publication of the deidentified data generated by this study was obtained when subjects as part of the informed consent process.

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Appendix A. Survey Questionnaire

For the purposes of this survey, a farm is any area where food is being grown or raised, and this includes backyard gardens, community gardens, school gardens, and larger farms.

Appendix A.1. Description of the Farm

This section of the survey contains questions about the farm. The first set of questions are on general farm characteristics such as size, location, and number of employees.

Appendix A.1.1. Farm Details

1. What is the name of the farm or business that operates the farm?
   ____
2. What city is the farm located in?
   ____
3. What is the zip code where your farm is located?
   ____
4. How old is the farm? ____________ ☐ Years ☐ Months ☐ Do not know
5. How big is the farm? Please indicate the units.
   __________________________ ☐ Square feet ☐ Square meters ☐ Acres ☐ Hectares ☐ Do not know

6. Does your farm have any certifications? Check all that apply.

☐ None
☐ LEED
☐ USDA Organic
☐ Certified Natural
☐ GAP (good agricultural practices)
☐ Greenmarket
☐ Animal Welfare Approved
☐ Hormone Free/rBGH free
☐ Antibiotic free/no antibiotics
☐ Grass fed
☐ Pasture raised/free range
☐ Do not know
☐ Other:

7. Do you operate the farm for profit? ☐ Yes ☐ No ☐ Do not know
8. What is your type of farm operation?

☐ Sole proprietorship
☐ Partnership
☐ Family held corporation
☐ Corporation (not family held)
☐ Cooperative
☐ Trust or estate
☐ Institutional
☐ Community governed or operated (not a cooperative)
☐ Do not know
☐ Other:

9. Does your organization have staff that work on the farm? Check all that apply and indicate how many if known.
   ☐ Full time employees ____________________________
   ☐ Part time employees ____________________________
   ☐ Volunteers____________________________________
   ☐ Seasonal workers______________________________
   ☐ A dedicated manager____________________________
   ☐ Do not know___________________________________
10. What are your farms major expenses? Please select the top three and number them 1 being the biggest and 3 being the third biggest expense for your farm.
   ____Fertilizer, lime, soil conditioners, and compost
   ____Other chemicals (like pesticides and herbicides)
   ____Livestock purchases
   ____Utilities (electricity, water, and fuel)
   ____Seeds, sets, plants, transplants, trees, and nursery stock
   ____Feed and veterinarian expenses
   ____Crop insurance
   ____Other expense including professional farm management services, property tax, and insurance for equipment and machinery
   ____Permits, business licenses and business fees
   ____Mortgage/loan/rent payments for land or equipment.
11. What are your goals for the farm? Check all that apply.

☐ Personal use/enjoyment
To provide food for:
☐ Residents
☐ Donation
☐ Food service
☐ Institution
To sell crops through/to:
☐ CSA
☐ Farmers markets
☐ Distributor
☐ Institution
☐ Food service
To sell value added products through/to:
☐ Farmer's market
☐ Distributor
☐ Institution
☐ Food Service
☐ Foster community and host social gatherings
☐ Educational opportunities for the community
☐ Do not know
☐ Other:

12. Are you able to meet those goals?
☐ Yes, all of them. ☐ Yes, some of them ☐ No ☐ Do not know
13. Is your farm or garden at your place of residence? ☐ Yes ☐ No ☐ Do not know
14. Does the farm rent or own the site?
☐ Rent ☐ Own ☐ Some land used is owned and some is rented ☐ Do not know

The next set of questions is on the production techniques used by the farm.

Appendix A.1.2. Production Techniques

15. What percentage of the farm is used for vegetable and herb production? Check one.

☐ 0–10%	☐ 11–20%	☐ 21–30%	☐ 31–40%	☐ 41–50%
☐ 51–60%	☐ 61–70%	☐ 71–80%	☐ 81–90%	☐ 91–100%
☐ Do not know				

16. What growing strategies to you use on the farm? Indicate all that apply.

☐ Seed saving	☐ Seed starting	☐ Low input
☐ Intensive agriculture	☐ Low or no till farming	☐ Organic
☐ IPM ☐ Permaculture	☐ Intercropping	
☐ Polyculture (more than one crop in the same bed or field at the same time)		
☐ Alley cropping (crops growing in alleys formed between trees or shrubs)		
☐ Crop rotation	☐ High tunnel	☐ Season Extension
☐ Plasticulture	☐ Aquaponics	☐ Aquaculture
☐ Hydroponics	☐ Vertical farming	☐ Rooftop farming
☐ Do not know	☐ Other:	

17. How do you structure your growing beds? Indicate all that apply.
☐ Containers ☐ Raised beds ☐ In ground rows ☐ Mounds ☐ Hydroponics/aquaponics ☐ Do not know ☐ Other:
18. If you grow in containers, raised beds, or mound, how deep are they? Indicate units.
___☐ Feet ☐ Centimeters ☐ Inches ☐ Millimeters ☐ Meters ☐ Do not know
19. Have you ever tested the soil for contaminants? ☐ Yes, soil remediation was necessary ☐ Yes, soil remediation was not necessary ☐ No ☐ Do not know
20. Do you grow in the soil was at the site when you started the farm (native soil) or in soil/mix/media that was brought to the site (imported soil)?
☐ Native soil ☐ Imported Soil ☐ Both ☐ Do not know

Appendix A.2. Farming Practices

This section of the survey asks more specific questions about your farming practices.

Appendix A.2.1. Crop Selection

21. Indicate all of the following crop plant varieties that you grow on your farm:

☐ No crop plants				
Vegetables				
☐ Artichoke	☐ Asparagus	☐ Bean	☐ Beet	☐ Broccoli
☐ Broccoli	☐ Carrots	☐ Cauliflower	☐ Celeriac	☐ Celery
☐ Corn	☐ Cucumber	☐ Eggplant	☐ Garlic	☐ Gourd
☐ Ground cherries	☐ Horseradish	☐ Kohlrabi	☐ Melons	☐ Okra
☐ Onion	☐ Parsnip	☐ Peas	☐ Peppers, sweet	☐ Peppers, hot
☐ Potatoes	☐ Potatoes, sweet	☐ Pumpkin	☐ Radish	☐ Rhubarb
☐ Rutabaga	☐ Shallots	☐ Soy	☐ Squash, other	☐ Tomatillo
☐ Tomato	☐ Turnip	☐ Watermelon	☐ Yams	☐ Zucchini
Herbs				
☐ Amaranth	☐ Anise	☐ Basil	☐ Bay leaves	☐ Borage
☐ Chamomile	☐ Chives	☐ Cilantro	☐ Coriander	☐ Dill
☐ Fennel	☐ Ginseng	☐ Herbs, other	☐ Hyssop	☐ Lavender
☐ Leek	☐ Mint	☐ Mustard	☐ Oregano	☐ Parsley
☐ Poppy	☐ Rosemary	☐ Rue	☐ Sage	☐ Tobacco
☐ Tarragon	☐ Thyme	☐ Vicks		
Leafy greens				
☐ Arugula	☐ Brussels sprouts	☐ Bok choy /Pak choi	☐ Cabbage☐ Chard	
☐ Collard greens	☐ Cress	☐ Endive	☐ Greens, other	☐ Greens, mixed
☐ Kale	☐ Lettuce	☐ Micro mix	☐ Mustard	☐ Sorrel
☐ Spinach	☐ Root vegetable greens			
Fruit				
☐ Apples	☐ Apricot	☐ Avocado	☐ Berries	☐ Cherries
☐ Grapes	☐ Citrus☐ Peaches	☐ Pears	☐ Plums	
☐ Pomegranate☐ Nuts	☐ Ornamental flowers	☐ Ornamental trees	☐ Grains☐ Other:	

22. Do you keep records of crop yields? ☐ Yes, for all crops ☐ Yes, for some crops ☐ No ☐ Do not know
23. Please list any crops you have stopped growing on your farm and your reasons for no longer growing them:

	Crops you have stopped growing:	Reason(s) you stopped growing the crop:
01		
02		
03		
04		
05		
06		
07		
08		
09		
10		
11		
12		
13		
14		
15		

24. Do you grow mushrooms for sale? ☐ Yes ☐ No ☐ Do not know
25. Do you produce hay for sale? ☐ Yes ☐ No ☐ Do not know
26. Do you produce compost on your farm? ☐ Yes ☐ No ☐ Do not know
27. Do you keep bees on your farm? ☐ Yes. We maintain hives ☐ Yes. We work with a beekeeper to get bees onto our farm. ☐ No ☐ Do not know
28. Do you keep any poultry on your farm? Check all that apply. ☐ Chickens ☐ Ducks ☐ Turkey ☐ Quail ☐ Pheasant ☐ None ☐ Do not know ☐ Other:
29. Do you keep any other livestock on your farm? Check all that apply.

☐ Alpaca/llama	☐ Cow	☐ Goat	☐ Horse	☐ Pig
☐ Rabbit	☐ Sheep	☐ Fish	☐ None	☐ Do not know
☐ Other:				

30. Do you use cover crops or green manure on your farm? ☐ Yes ☐ No ☐ Do not know
31. Do you produce value added products for sale? ☐ No ☐ Do not know ☐ Yes. We produce the following value-added products:

Appendix A.2.2. Nutrient Management

32. Have you ever done fertility testing on your soil, substrate, or media? ☐ Yes ☐ No ☐ Do not know
33. Do you use any of the following to supply nutrients to your crops?
    - ☐ Commercial conventional fertilizers
    - ☐ Commercial organic fertilizers
    - ☐ Commercial amendments or additives other than fertilizers
    - ☐ Non-commercial amendments or additives such as manure
    - ☐ Compost
    - ☐ We do not add anything to the soil
    - ☐ Do not know
    - ☐ Other:
34. Do you keep records of how much fertilizer, amendment, and other additive you use?

    ☐ Yes ☐ No ☐ Do not know

Appendix A.2.3. Irrigation

35. How do supply irrigation water to your farm? Check all that apply.

Automated irrigation on a timer:		
☐ Drip/trickle irrigation	☐ Micro-emitters	☐ Sprinkler
Manual irrigation:		
☐ Sprinkler	☐ Manually operated garden hose	☐ Watering can
☐ Do not know	☐ Other:	

36. What is your irrigation water source? Check all that apply.

☐ Surface water ponds, creeks, or streams	☐ Aquifer or well
☐ City water line	☐ Wastewater (lagoon water, animal waste)
☐ Other:	

37. Do you keep a record of the amount of water applied to the farm by your irrigation method?

    ☐ Yes ☐ No ☐ Do not know
38. Do you recapture runoff from your farm to use for irrigation?

    ☐ Yes ☐ No ☐ Do not know

Appendix A.2.4. Pest/Disease Management

39. What pests/diseases have you experienced on your farm? Check all that apply.

☐ Aphid	☐ Bacteria	☐ Beetle	☐ Caterpillar	☐ Fungus
☐ Grub	☐ Mite	☐ Rodent	☐ Slug	☐ Thrips
☐ Virus	☐ Grass weed	☐ Leafy weed	☐ Tree weed	☐ Do not know
☐ None	☐ Other:			

40. What did you do/use to get rid of the pest problem(s)?
41. Have you ever used biological pest control (using natural enemies of pests) or cultural pest control (modification of cultivation practices such as using trap crops, sanitation, planting and harvesting date variation) on your farm?

☐ Biological pest control	☐ Cultural pest control	☐ Both
☐ Neither	☐ Do not know	

Appendix A.2.5. Tools and Resources

42. Please list the farming/gardening tools or implements you use on your farm:
43. What resources, such as books, web sites, or talking to experts, do you use to make decisions about your farm and farming practices?

☐ National Resource Conservation Service (USDA/NRCS)	☐ Farm Service Agencies (USDA/FSA)
☐ University Cooperative Extension Service	☐ Other Federal Agencies
☐ State Agencies	☐ Farm Dealer
☐ Crop Consultant	☐ Other Farmers
☐ Other Family	☐ Trade Shows
☐ Computer Apps developed for farming	☐ News media
☐ Internet	☐ Other:

Please use the space below for any additional comments you want to share about your urban farm or farming practices.

Are there other urban farms or farmers you think we should contact about participation in this survey?

Thank you for your time and cooperation in filling out this survey. We really appreciate your assistance with this project.

Appendix A.3. General and Demographic Information

44. What is your age? ☐ 18 to 25 ☐ 26 to 35 ☐ 36 to 45 ☐ 46 to 55 ☐ 56 to 65 ☐ over 65
45. What is your gender? (Check one) ☐ Female ☐ Male ☐ Other
46. Are you Hispanic, Latino, or Spanish origin? ☐ Yes ☐ No
47. What is your race or ethnicity? (Check one)

☐ American Indian/Native American	☐ Asian
☐ Black/African American	☐ Native Hawaiian/Pacific Islander
☐ Mixed race or ethnicity (non-Hispanic)	☐ White/Caucasian
☐ Other: ____________________	

48. What is your political affiliation? (Check one)

☐ Democratic party	☐ Green party	☐ Independent
☐ Libertarian party	☐ Republican party	☐ Other:

49. What is the highest level of education that you have completed? (Check one)

☐ No degree ☐ High school diploma ☐ Vocational training/trade school
College/University degree:
☐ BA/BS ☐ Master ☐ Professional ☐ Doctorate
Field of study:
____

50. Which best describes your farming experience?
☐ Full-time farmer ☐ Part-time farmer ☐ Hobby/resident/life-non-commercial
51. How long have you been farming?
____
52. How long have you been making farming decisions?
____
53. In what range was your annual household income for last year from all sources, before taxes? (Check one)

☐ Less than $15,000 ☐ $15,000–24,999 ☐ $25,000–34,999
☐ $35,000–49,999 ☐ $50,000–74,999 ☐ $75,000 or more

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