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Geo-sustainable Practices in Urban Agriculture: A Study of Sustainable Land Use and Natural Resource Conservation at Household Level

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This study explores urban agriculture as a solution to food insecurity in Lahore, Pakistan, amid rapid urbanization and declining agricultural productivity. Using a mixed methods approach, the research assesses the current state of urban agriculture, community willingness to adopt such practices, and the factors influencing this adoption. Data was collected from households in Johar Town and Faisal Town through surveys, complemented by a literature review of global urban agriculture policies. The findings reveal limited practice of urban agriculture but significant willingness among residents, driven by factors such as self-reliance, high food prices, and health concerns. However, barriers like lack of access to land, guidance, and time hinder widespread adoption. The socio-economic profile of respondents indicates varied interest and awareness based on age, income, and household size. The study emphasizes the need for policies promoting urban agriculture, including community gardens, vertical farms, and wastewater reuse. Educational campaigns and professional training are essential to raise awareness and build skills among urban dwellers. The research concludes that urban agriculture can enhance food security and sustainability in Lahore with robust policy support and community engagement. Future research should expand the study area, use more nuanced data collection methods, and explore the economic viability of urban agriculture initiatives. Such efforts aim to advance urban agriculture practices and policies in Lahore, making the city more self-sufficient and resilient in food production.

1. Introduction

Agriculture is a key component of Pakistan's economy, supporting a large portion of the population living in rural areas and relying on farming for their income (Ministry of National health services, 2018). The urbanization rate in Pakistan is currently at 2.7, the highest in Southeast Asia. As of the 2017 Census, 63.4% of the population resides in rural areas while 36.4% are based in urban centers (UNHabitat, 2023). According to projections by the UN, by 2050, over two-thirds of the global population will reside in urban areas. This trend is evidenced by a significant increase in the number of cities with populations exceeding one million, rising from 371 to 548 cities worldwide between 2000-2018. Notably, Pakistan hosts 11 of these cities (UNDESA, 2018). This rapid trend towards urbanization has resulted in shrinking agricultural lands and heightened food insecurity due to their conversion into non-agricultural purposes such as roads, residential spaces, and industrial zones including commercial establishment and office complexes (Ibrahim & Ahmad, 2023a; Kukde et al., 2024).

The proximity of agricultural land to urban centers is a result of historical settlement patterns and urban expansion. This ensures access to fresh produce and supports local food supply chains(De Bruin et al., 2021). The way land is organized, based on zoning and economic interdependence, impacts the social and environmental aspects of urban-rural landscapes, supporting both urban growth and agricultural sustainability. (De Bruin et al., 2021; Kukde et al., 2024). Rapid urbanization in developing countries is disrupting this supply chain mechanism as the prime agriculture land being rapidly converted for other purposes. The World Bank (2015) reported that urban growth has resulted in the yearly loss of approximately 2 million hectares, with around three-quarters of this being agricultural land.

Alongside the decrease in farmland, there is also a reduction in skilled and unskilled workers within the agricultural sector due to rural-to-urban migration (Datta & Rajan, 2024). This decline in farmland and labor force has led to a decrease in food availability (Giller et al., 2021) and an increase in prices within urban areas, particularly affecting those who are economically disadvantaged (Akaeze & Nandwani, 2020).

Pakistan's transition from an agriculture-based economy, where agriculture once contributed 65% to GDP in 1950-51, to a sector comprising 22.6% of GDP in 2022-23, reflects a shift towards industrial development at the expense of agriculture[1]. Despite more than 40% of the labor force being engaged in agriculture, declining productivity, exacerbated by rural-to-urban migration, has heightened food insecurity and price volatility, particularly impacting low-income communities (Akaeze & Nandwani, 2020). According to the Nutritional Survey of Pakistan 2018, 36.9% of households in the country are food insecure. Furthermore, malnutrition among children under five is alarmingly prevalent, with 4 out of 10 suffering from stunted growth and 17.7% experiencing low weights for their heights. This double burden of malnutrition, compounded by a

rising prevalence of overweight children, underscores the need for comprehensive interventions to improve food security and nutrition outcomes in Pakistan (Ministry of National health services, 2018). The situation is reflected in table 1.1 below:

Table No 1.1: Child Malnutrition Data by National Nutrition Survey of 2018

	Stunted	Wasted	Underweight	Over-weight
Total	40.2%	17.7%	28.9%	9.5%
Urban	34.8%	16.2%	24%	9.6%
Rural	43.2%	18.6%	31.6%	9.4%

This food insecurity is further aggravated with the changing weather dynamics because of climate change (Waseem & Rana, 2023). Severe floods have been experienced in last couple of decades in Pakistan. These floods have destroyed agriculture land and greatly effected agriculture yield, making people more vulnerable to increasing and fluctuating food pricing. According to 'the state if food security and nutrition in the world 2020' report the global south is experiencing unequal spread of food insecurity which is steadily increased from 1.63 billion to 2 billion from 2014 to 2019 (FAO, IFAD, UNICEF, 2020).

This is a hinderance in achieving Sustainable Development Goal 2 to "end hunger, achieve food security and improve nutrition, and promote sustainable agriculture" (Kong et al., 2024; Steenkamp et al., 2021). Delocalization is required to decrease food miles to prevent food insecurity globally and minimize the effects of urbanization in the developing world.

Considering increasing climate change impacts and implications on industrialized agriculture, there is a clear need to establish shorter, more sustainable agricultural production practices and food supply chains. Urban agriculture is proposed as a potential method of intervention for planners to support sustainable food production and supply chains. Urban agriculture has been defined as "the production of agricultural goods by urban residents" (Zezza & Tasciotti, 2010). It has also been defined as "an industry located within (intra-urban) or on the fringe (peri-urban) of a city or metropolis, which grows or raises, processes and distributes a diversity of food and non-food products" (Mougeot, 2000).

According to Food and Agriculture Organization of the United Nations (FAO), "Urban Agriculture is an industry that responds to the nutritional demands of a city, from within that city, with the use and reuse of that city's resources while acknowledging economic and resource use does not settle aspects of regional health, food security, and application of grassroots organizations" (Hoornweg & Munro-Faure, 2008, p. 12).

A diverse array of urban agriculture practices enriches urban landscapes, including Container Gardening, Patio or Balcony Gardening, Backyard gardening, Rooftop Gardening, Cultivation of Vacant Lots, Vertical or sky farming, Animal Husbandry, Aquaponics, Community gardening, Greenhouses, Urban Beekeeping, and more (Kukde et al., 2024). These practices not

only contribute to food security but also foster a sense of community and belonging among urban dwellers (Steenkamp et al., 2021). By bringing people together to cultivate healthy, locally-grown food, urban agriculture promotes sustainable living and enhances the well-being of communities. It ensures that nutritious food is readily available and accessible, fostering a culture of respect for both food and community.

In Pakistan initiatives have been taken to promote urban agriculture but these are still in the infancy stage. Pakistan Agriculture Research Council (PARC) have formulated a vision regarding kitchen gardening to grow vegetable and herbs at household level in order to make a considerable contribution to food security of the poorest class. The objectives of this project are to create awareness about kitchen gardening, develop skills for growing fresh and safe vegetables without usage of any pesticides, grant complete set of production technology including quality seedlings and potted plants of summer and winter vegetables, establish "Kitchen Gardener's Clubs (KGC)" to provide advisory facilities at door step.

Horticultural Research Institute (HRI) through its Kitchen Gardener's Club will provide trainings, seedlings, and potted plants for their kitchen gardens. Kitchen Gardener's Club members will be encouraged to become service provider or entrepreneurship for the members. There is a need for clear and agriculture-inclusive local ordinances in Pakistan which provides direction for local farming in urban areas along with implying urban agriculture as a primary or accessory use in zoning regulations

With the increase in growth population and growth consumption in Pakistan, there is a dire need to increase practice of urban agriculture with its awareness to ensure food security. This research was conducted to find,

- How to promote urban agriculture in order to cater food insecurity?
- What is the existing situation of urban agriculture practices at household level?
- What are the drivers and barriers of urban agriculture?
- Is the community willing to adopt urban agriculture in the study area?

2. Literature Review

2.1 Rural Economy

In developing countries, a significant proportion of the population resides in rural areas where agriculture forms the backbone of the economy. This sector contributes substantially to economic value, adding about 25% in many developing nations (Satterthwaite et al., 2010). Historically, the urban-to-rural population ratio was approximately 6.7:1 in 1990, but this ratio is projected to shift to three urban dwellers for every two rural dwellers by 2025 (Satterthwaite et al., 2010). In economies heavily reliant on agriculture, low productivity and output per capita mean these countries often produce just enough for immediate consumption. Populations in such economies, whether in 17th-century Europe or 19th-century Africa, frequently live under the

constant threat of harvest failures or diseases, leading to high mortality rates (70 to 100 deaths per 1,000 people).

Pakistan exemplifies this rural dependence, where agriculture supports a large portion of the population, especially those living in rural areas who rely on farming for their livelihood (Ministry of National Health Services, 2018). Despite the rapid urbanization rate of 2.7%, the highest in Southeast Asia, 63.4% of Pakistan's population still resides in rural areas according to the 2017 Census (UNHabitat, 2023). This rural majority underscores the critical role of agriculture in sustaining the country's economy and food security.

Figure No 1: Rural Economy of Pakistan

Source: https://www.newscottage.com/how-to-revitalize-pakistans-agricultural-sector-and-rural-economy/

2.3 Urbanization and Agricultural Land

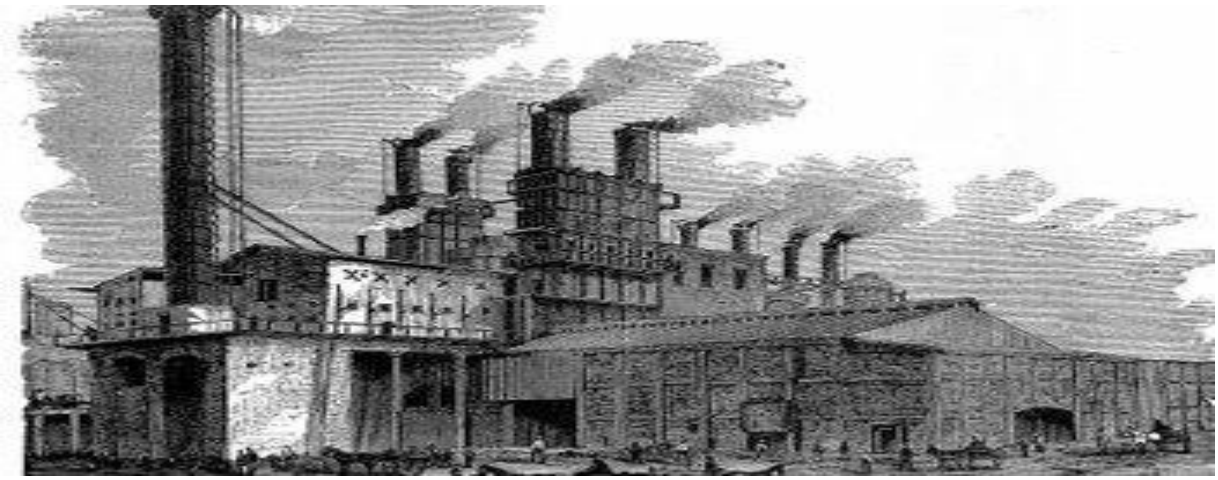
The rapid urbanization trends globally, and specifically in Pakistan, have led to a significant reduction in agricultural lands. Urban growth has resulted in the annual loss of approximately 2 million hectares of agricultural land, as reported by the World Bank (2015).

This trend is further exacerbated by the migration of skilled and unskilled labor from rural to urban areas, diminishing the workforce available for agriculture (Datta & Rajan, 2024). The conversion of agricultural land into non-agricultural uses such as roads, residential spaces, and industrial zones, including commercial establishments and office complexes, has significantly contributed to food insecurity (Ibrahim & Ahmad, 2023b).

The proximity of agricultural land to urban centers has historically ensured access to fresh produce and supported local food supply chains (De Bruin et al., 2021). The way land is organized, based on zoning and economic interdependence, impacts the social and environmental aspects of urban-rural landscapes, supporting both urban growth and agricultural sustainability (De Bruin et

al., 2021; Kukde et al., 2024). However, the rapid urbanization in developing countries disrupts this supply chain mechanism as prime agricultural land is rapidly converted for other purposes.

Figure No 2: Industrial Revolution of America



Source: https://education.seattlepi.com/

2.4 Urban Agriculture Practices

Urban agriculture has been proposed as a sustainable solution to address food security challenges in rapidly urbanizing areas. It encompasses a variety of practices such as container gardening, patio or balcony gardening, backyard gardening, rooftop gardening, cultivation of vacant lots, vertical or sky farming, animal husbandry, aquaponics, community gardening, greenhouses, and urban beekeeping (Kukde et al., 2024). These practices not only contribute to food security but also foster a sense of community among urban residents by promoting the cultivation of healthy, locally grown food (Steenkamp et al., 2021).

Urban agriculture has been defined in various ways. Zezza & Tasciotti (2010) describe it as "the production of agricultural goods by urban residents," while Mougeot (2000) defines it as "an industry located within (intra-urban) or on the fringe (peri-urban) of a city or metropolis, which grows or raises, processes, and distributes a diversity of food and non-food products." According to the Food and Agriculture Organization of the United Nations (FAO), "Urban Agriculture is an industry that responds to the nutritional demands of a city, from within that city, with the use and reuse of that city's resources while acknowledging economic and resource use does not settle aspects of regional health, food security, and application of grassroots organizations" (Hoornweg & Munro-Faure, 2008, p. 12).

In Pakistan, initiatives like the Pakistan Agriculture Research Council's (PARC) vision for kitchen gardening aim to enhance food security by promoting the cultivation of vegetables and herbs at the household level. The Horticultural Research Institute (HRI) supports this through the Kitchen Gardener's Club, providing training, seedlings, and advisory services. These efforts are

still in their infancy, indicating a need for more comprehensive local ordinances to support urban agriculture, integrating it into zoning regulations as a primary or accessory use.

Figure No 3: Rooftop Gardening

Source : https://homesteading.com/roof-garden-transformation-ideas/

Figure No 4: Vertical Farming

Source : https://ssir.org/articles/entry/feeding_the_future_of_agriculture_with_vertical_farming

2.5 Policy Analysis

The literature review in this study helps identify the drivers and barriers of urban agriculture globally. By analyzing best practices from around the world, the study aims to develop strategies to promote urban agriculture in Pakistan. This involves understanding both the facilitators and obstacles to urban agriculture, thereby enabling policymakers to craft supportive frameworks. Such policies should include clear and agriculture-inclusive local ordinances that recognize urban farming as a primary or accessory use in zoning regulations, ensuring urban farmers do not face legal or logistical hurdles (Kukde et al., 2024).

2.6 Socio-Economic Implications

Urban agriculture not only addresses food security but also offers employment opportunities and enhances urban sustainability. However, the practice faces significant barriers, including limited access to land, lack of guidance, and time constraints for urban residents. Understanding these socio-economic dynamics is crucial for developing effective urban agriculture policies. The socio-economic profile of respondents in the study indicates varied interest and awareness based on age, income, and household size, emphasizing the need for targeted educational campaigns and professional training to build skills and awareness among urban dwellers.

In addition to economic benefits, urban agriculture promotes social inclusion by engaging diverse groups of people in collective gardening activities, thereby fostering a sense of community and shared purpose. This can be particularly beneficial in urban settings where social isolation and lack of community engagement are common issues (Steenkamp et al., 2021). By bringing people together to cultivate healthy, locally-grown food, urban agriculture promotes sustainable living and enhances the well-being of communities.

2.7 Environmental Benefits

Urban agriculture also contributes to environmental sustainability by reducing the food miles associated with transporting food from rural areas to urban centers. This reduction in transportation distances can lower greenhouse gas emissions and reduce the carbon footprint of food production and distribution (Kukde et al., 2024). Additionally, urban agriculture can improve urban microclimates by increasing green spaces, which can help mitigate the urban heat island effect and improve air quality.

Moreover, urban agriculture practices such as composting and rainwater harvesting can promote sustainable resource management. By reusing organic waste and conserving water, urban agriculture can reduce the environmental impact of food production and contribute to a more sustainable urban environment (De Bruin et al., 2021).

2.8 Food insecurity in Pakistan

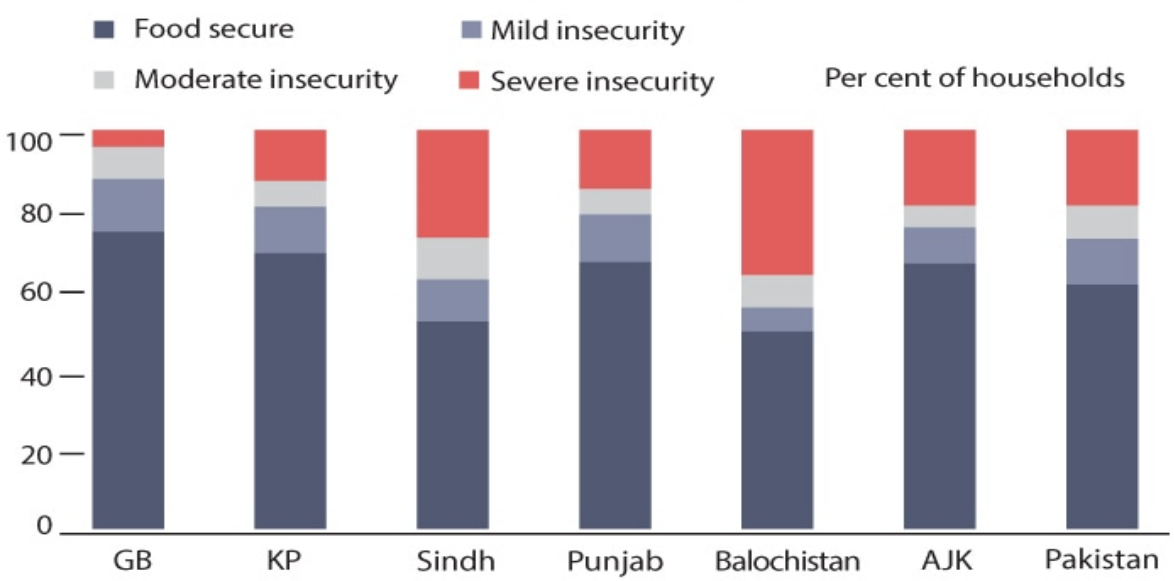
Pakistan is witnessing an exponential growth in its population. According to the latest census figures, the total population of Pakistan in 2017 was 200.2 million people. Looking back, in the year of 1960, Pakistan had a population of 45.9 million people. The increase in population causes an increase in urbanization. 17% of the population were reported to be living in urban areas in 1951. 32.52% people resided in urban centres in 1998. 36.44% people were living in urban centres during 2017. 50% of the total population of Pakistan to be projected in urban areas by 2025 (Ishrat Hussain, 2014; Pakistan Bureau of Statistics, 2017).

In Pakistan, 4 out of 10 children under five years of age are short as compared to their ages while 17.7% have low weights for their heights. The double burden of malnutrition is becoming increasingly apparent, with almost one in three children underweight (28.9%) alongside a high

prevalence of overweight (9.5%) in the same age group. The prevalence of overweight among children under five has almost doubled over seven years, increasing from 5% in 2011 to 9.5% in 2018.

According to Nutritional Survey of Pakistan 2018, 63.1% of the households of Pakistan are food secure whereas 36.9% remains insecure. 75.6% of GB, 70.9% of KP, 52.9% of Sindh, 67.6% of Punjab, 52.3% of Balochistan and 68.9% of AJK is food secure while 3.7% of GB, 11.8% of KP, 26.0% of Sindh, 14.2% of Punjab, 35.3% of Balochistan and 18.1% of AJK is severely insecure. Province-wise household food security is shown in the Figure 2.14.

Figure No 5: Household Food Security in Pakistan by Province/ Region



Source: National Nutritional Survey 2018; Ministry of Health and UNESCO

3. Methodology

In the pursuit of comprehensively understanding the dynamics and potential of urban agriculture adoption in Pakistan, this research adopts a mixed methods approach. While the primary aim is exploratory, encompassing a qualitative exploration of existing literature to inform policy frameworks, the inclusion of quantitative data is essential for assessing the current landscape and gauging community receptiveness towards urban agricultural practices. By integrating both qualitative and quantitative methodologies, this study ensures a holistic examination of the subject matter, enabling a nuanced analysis of both the prevailing conditions and the inclination of individuals towards urban agriculture.

3.1 Study Area

Lahore is capital of Punjab province and second largest city of Pakistan. It lies between 31° 15' and 31° 43' North latitude, 74° 10' and 74° 39' East longitude. The city consists of a total area of 156 square miles (404 square kilometers). 36% of the land which is 63,800 hectares

constitutes urban areas which comprises of roads and buildings of any form. It is second most populous city with population of 11,126,285 according to the census conducted in 2017. Annual growth rate of the city is 4.07 since 1998. 47.64% of the population is female while 52.35% is male and only 0.01% is transgender(GoP, 2017) . Lahore is facing a high migration rate from suburbs and other cities because of proportional growth of industry and economy, causing conversion of massive agricultural land into built-up urban land(Ashraf et al., 2015) .So, there is a dire need to introduce urban farming among the inhabitants of the city to ensure food security in the area.

The two societies taken for data collection are Johar Town and Faisal Town, Lahore. Johar town lies near important inter-city Canal Bank Road and is divided into two phases. These both phases are further feature many blocks. Phase 1 is sub-divided into A, B, C, D, E, F, G blocks whereas Phase 2 is divided into H, I, J, K, L, M, N, O, P, Q, R blocks. Residential plots in this area range from 3 Marlas to 2 Kanal. Faisal town is a relatively small society which is divided into 4 blocks: A, B, C and D. Faisal town is one of the neighboring districts of Lahore located at the south of the city center, right near the University of Punjab campus and newly planned district, Model town. It has a total of six mosques and 4 parks. One of the parks is huge and has 2 lakes. Residential plots in this society ranges from 5 Marla to 1 Kanal.

3.2 Data Collection

In order to assess the willingness of urban dwellers to pursue urban agriculture and evaluate the existing situation of urban agriculture practices in the area, a household level survey was conducted. Also, with the help of literature review of published books and article, strategies were formulated to promote urban agriculture practices in Pakistan.

Table No 1: Detail of the questionnaire

Indicator	No. of items
Motivators	5
Interest/Willingness	3
Awareness	5
Affordability	4
Covid-19	4
Barriers	8

Primary data was acquired through survey of households in few areas of Lahore which may or may not practice urban agriculture to evaluate the existing situation of urban agriculture practices. It calculates how famous urban agriculture is among the residents. It also determines the willingness of urban dwellers to adapt urban agriculture in the future. The tool used to obtain primary data is a questionnaire which revolves around specific indicators like “income, age, household area, number of members of household, willingness, interest, water availability, time

availability, knowledge, advantages or subsidies given by government, accessibility of seeds of plants mainly food, water availability, accessibility to market, among others".

First part of this research focuses on the policies of urban agriculture. It studies all the policies made in the world to promote urban agriculture and will help make policies to promote urban agriculture in Pakistan as well. So, basically secondary data is obtained through literature review of published surveys, books, and articles. This data was used to perform content policy analysis and evaluate the existing conditions of urban agriculture throughout the world. Specific tables and charts taken from online sources.

Quantitative data was analyzed using linear regression, ANOVA and other descriptive statistics were also applied on the data including mean, median, mode and various other techniques. Data analysis along with literature review will help create strategies to promote urban agriculture. These strategies will be correlated with existing policies at the end of the study. Policy content analysis was performed through literature review which helped identify drivers and barriers of urban agriculture throughout the world. Literature review will mainly focus on best practices of urban farming throughout the world.

This will help formulate a framework of strategies to promote urban agriculture in Pakistan. Literature review will create better understanding of urban agriculture for the experts so that they can implement the strategies used by other countries in Pakistan. It will help make policies which will support and uphold urban farming in the country. It will make the understanding of both drivers and barriers easy for the experts so that they can overcome the risks and use drivers at their best to promote urban agriculture in the area. Strategies are formulated at the end of the study which will be recommended to be incorporated in policies of related organizations.

These strategies would be inferred from best practices of urban farming in the world obtained through literature review, drivers and barriers obtained from primary data of household survey. These strategies were formulated after complete analysis of ways and models used in the world from time to time to promote urban agriculture while keeping in mind the existing conditions and problems of the urban dwellers of the study area.

4 Results and findings

4.1 Socio-Economic Profile of Respondents

The data is collected from areas of Lahore where most of the houses are small and there are fewer big houses. Plot sizes range from 3 Marlas to 2 Kanal. The respondents belong to both genders with ages ranging from 20 to 50 years. The respondents belonged to a variety of fields shown in table 2. Most of the respondents of the survey are undergraduates. Majority of the respondents were living in rented houses for jobs because of high market prices of the land. Maximum number of the respondents are living in these houses for 1-9 years. Monthly income of

my respondents ranges from 35,000 PKR to 4 lac per month, so that response of all economic classes could be analyzed properly. The details are mentioned in table 3.1 and 3.2 below:

Table No 2: Socio-Economic Profile of Respondents

Respondent's profile	Category	Frequency	Percentage
Gender	Male	61	44%
	Female	79	56%
Age	Less than 20	44	1%
	20-24	59	24%
	25-29	8	71%
	30-34	27	28%
	35-39	6	7%
	40 and above	44	11%
Field of work	Civil Engineering	18	13%
	Software engineering and computer science	6	4%
	Urban planning	14	10%
	Architecture	8	6%
	Business and management	6	4%
	IT and telecommunication	8	6%
	Medical	22	16%
	Teaching	11	8%
	Fine arts and fashion designing	4	3%
	Research	1	0.70%
	Student	7	5%
	None	33	24%
Years of Education	Intermediate	19	14%
	Undergraduates	69	49%
	Postgraduates	52	37%
Monthly income in PKR	Less than 50000	8	6%
	50000 to 95000	42	30%
	100000 to 145000	41	29%
	150000 to 195000	14	9%
	200000 to 250000	21	15%
	> 250000	15	11%

Table No 3: Living Situation of the Respondents

Respondent's Profile	Category	Frequency	Percentage
House ownership	Rented	83	58.00%
	Homeowners	58	41.00%
Living since	>1 year	4	3%
	1 -4 years	41	30%
	5-9 years	41	30%
	5-9 years	30	22%

	10-14 years	14	6%
Household members	1-5 members	62	45%
	6-10 members	73	53%
	>10 members	3	2%
Household area	0-5 Marlas	44	31%
	6-10 Marlas	53	38%
	11-15 Marlas	8	6%
	16-20 Marlas	27	19%
	>20 Marlas	8	6%

4.2 Urban Agriculture and Self-Sufficiency

Self-sufficiency or self-reliance in food was measured using more than two variables which identified whether people were producing enough fruit and vegetables to meet their daily requirements. The major trend found in Lahore was that people would rather buy food items from market than plant it at home. So, most of the population of the survey was found not to be self-sufficient in food. As the result show in table 3.3 only 24% were growing enough fruits that could meet their daily requirements and 30% were growing enough vegetables that would usually meet their daily consumption needs. By computing means of both variables, we found out the self-sufficiency of the respondents which was only 27%. We have not taken meat and dairy into account for this particular analysis. Following table shows our findings.

Table No 4: Self-Sufficiency of Respondents in Food

Variable	Minimum	Maximum	Mean	S.E	Percentage
Growing fruits meeting daily requirements	1	3	1.2	0.089	24%
Growing Vegetables meeting daily requirement	1	4	1.5	0.076	30%
Self-sufficiency	1	3	1.35	0.049	27%

However, if urban agriculture is practiced in cities of Pakistan, it can easily become self-sufficient in food products. On top of that, high prices of food would no longer increase poverty ratios in the country.

4.3 Drivers of Urban Agriculture and Gender Participation in the Study Area

Upon asking the respondents, we came to know various factors which motivates them to engage in urban agriculture which were self-reliance, high prices in food market, lack of nutritious food available, health concerns, mental well-being, love for gardening, finding a healthy hobby, aesthetics, natural beauty, fresh air, spending time with nature, religious obligations, reducing climate change impact and enhancing household's income by selling the produce. 80% of the women were motivated by self-reliance in food while 74% of men were encouraged to do urban

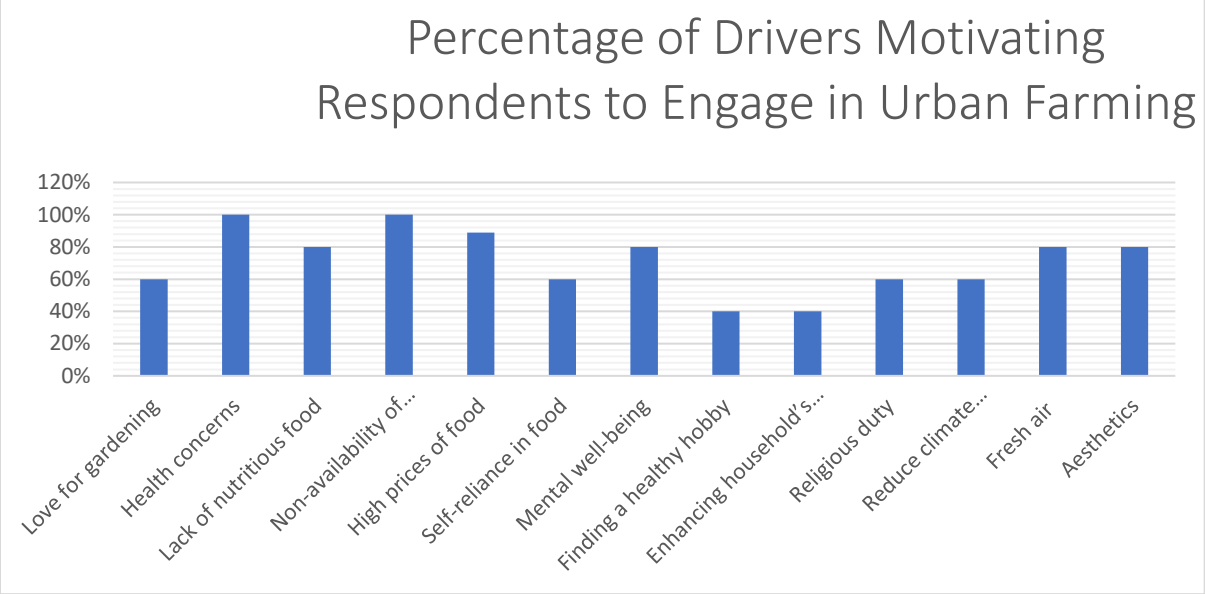
farming for the same reason. 70% of men and 80% of women were motivated due to high price of food in the market. 75% of men were motivated due to non-availability of fresh food whereas 79% of women were also encouraged to engage in urban farming for the same reason. 81% of men and 90% of women wanted to grow fruits and vegetables at home because they had health concerns.

85% of men and 92% of women were interested in urban farming because of their mental well-being. 79% of men and 85% of women were more willing to persuade farming at home because of their love for gardening. 80% of men and 70% of women wanted to engage themselves in a healthy hobby. 80% of men and 85% of women wanted to plant trees as it is one of religious obligations of Islam. Most of the respondents belong to Muslim community. In total a 50% of men and 60% of women wanted to increase their livelihood by selling home-grown fruits and vegetables. Following table 5 and figure 6 reflects the key drivers of urban agriculture.

Table No 5: Drivers/Motivators of Urban Agriculture

Drivers of Urban Agriculture	**Percentage**
Love for gardening	60%
Health concerns	100%
Lack of nutritious food	80%
Non-availability of fresh food	100%
High prices of food	89%
Self-reliance in food	60%
Mental well-being	80%
Finding a healthy hobby	40%
Enhancing household's income by selling the produce	40%
Religious duty	83%
Reduce climate change impact	60%
Fresh air	80%
Aesthetics	80%

Figure No 6: Percentage of Drivers Motivating Respondents to Engage in Urban Farming



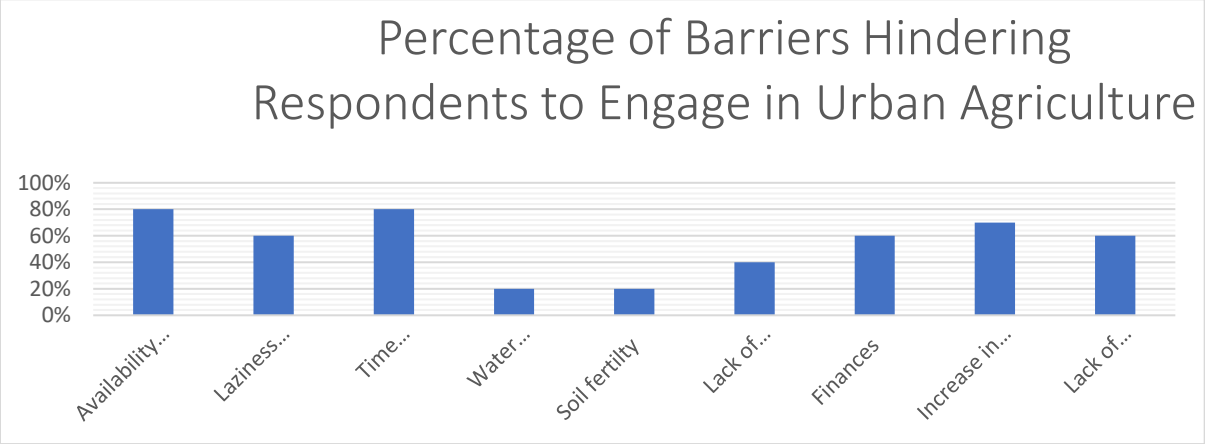
4.4 Barriers of Urban Agriculture in the Study Area

The barriers which were hindering the urban dwellers to engage in urban agriculture practices were access to land, lack of time availability, lack of interest, increase in mosquitos and other insects, lack of guidance and training, lack of finances, water availability and soil fertility. Most of the people living in slums and rental houses, do not have access to land available which makes it difficult for them to engage in urban farming activities. There is no guidance or almost no professional trainings available which could help people grow their own food items. Although now internet has taken over and anyone who wants to learn gardening can easily learn through online workshops and videos.

Table No 6: Barriers of Urban Agriculture

Barriers of Urban Agriculture	Percentage
Availability of land	80%
Laziness and procrastination	60%
Time Availability	80%
Water Availability	20%
Soil fertility	20%
Lack of interest	40%
Finances	60%
Increase in Mosquitos and other insects	70%
Lack of guidance	60%

Figure No 7: Percentage of Barriers Hindering Respondents to Engage in Urban Agriculture



People also fear that if they start growing plants everywhere like on their walls and roof, their houses might be too much contaminated with insects. Respondents don't want too many mosquitos at their homes mostly because of the fear of dengue fever. Time availability is also one of the major factors hindering urban dwellers to do urban gardening as life has become so fast and with 9-5 office timings which extend to 7-8pm off timings due to long distances, it becomes difficult for working people to focus on gardening as shown in table 6 and figure 6. Hence, instead of planting anything on their own and taking care of the plants, they just go to a nearby market and buy all the necessary food items.

4.5 Willingness of Respondents to do Urban Farming

Willingness of respondents to engage in urban agriculture was computed using four variables. Most of the respondents were found somewhat willing to do food gardening. Willingness was plotted against age, income, field of work, household size, household area, house ownership and the following results were found. Respondents belonging to age group 20-29 years and above 40 years were found to be extremely willing to engage in urban farming whereas 30-34 years age group was also willing, and 35-39 years were somewhat willing. Residents with 1-10 household members were extremely willing whereas more than 10 members household were a little less willing to practice urban agriculture. People who were living in their own house were extremely interested in urban farming whereas those living in rented houses were also very interested provided they had access to land.

There was no evident difference in people's interest and willingness with respect to the income groups they belong. Low income groups wanted to increase their livelihood by planting and selling food, middle income groups wanted to save money by not spending on food and higher income groups mostly wanted to eat nutritional food and save money. 77% of the respondents were willing to be trained by professionals and 70% were willing to pay for training. 60% would

let their women to be trained by professionals. 47% of the urban dwellers had two days off , 21% had only one off day whereas 27% had none who weren't working now. 58% of the respondents were willing to spend their off days on food gardening while 42% had other activities planned or simply wanted to rest for the weekend.

The respondents were asked questions about their willingness to adopt urban agriculture. They were asked questions whether they would engage in urban farming if financial assistance was provided to them. The variable index of willingness was made in SPSS and was divided into the higher, moderate, and lower levels reflected in table 7.

Table No 7: Willingness Index Variable of Urban Agriculture

Willingness index variables	Range	Percentage
Low	1.01-2.51	22%
Moderate	2.52-3.65	38%
High	3.66-5.0	40%

4.6 Awareness of Urban Agriculture

To evaluate the awareness level of the respondents of both societies about urban agriculture, different questions were asked. The variable index was divided into the higher, moderate, and lower levels. Lower awareness meant that the individual had almost zero knowledge about concept of urban agriculture, its forms and how it could benefit them as an alternative survival strategy. Moderate awareness meant that the individual gave a mild response. High awareness meant a complete awareness.

Table No 8: Awareness Index Variable of Urban Agriculture

Awareness index variables	Range	Percentage
Low	1.10-2.50	32%
Moderate	2.51-3.62	43%
High	3.63-4.33	20%

As it is reflected in the table 3.7 overall, 59% of the respondents were aware about the types of urban agriculture like micro-farming in and around the house, community gardening, vertical farming, rooftop gardening, backyard gardening, animal husbandry, urban beekeeping. 60% of the respondents knew about the kinds of plant that grow in different seasons of the year. 40% of the people were familiar with ways a crop is planted. 80% knew where to get the seeds from. 35% of the respondents were interested in food gardening, 39% were interested in ornamental gardening 20% were interested in both and 6% were interested in none. Only 20% of

the respondents are willing to farm on walls and rooftops. Most of them worry about seepage issue and strength of their rooftops.99% of the respondents are not growing enough fruits and vegetables at home to sell.

4.7 Urban Farming and Water Availability

Water is an essential requirement for farming whether it is carried out in rural areas or urban areas. But unfortunately, water consumption has increased over the years in comparison to its availability. To do urban farming sustainably, we need to think of smart ways to utilize water. So, for this purpose, reuse and recycling of wastewater is important. The increase in demand of water for irrigation has produced a discernible rise in the reuse of treated or untreated wastewater throughout the world. Industrial or municipal wastewater use in agriculture is a usual practice in many parts of the world (Gashaye, 2020; Hussain et al., n.d.; Jaramillo & Restrepo, 2017) Rough estimates indicate that at least twenty million hectares in 50 countries are irrigated with raw or partially treated wastewater (Hussain et al., 2001; Ruma & Sheikh, 2010)

In this survey, 60% of respondents think that water availability would not be an issue for food gardening. 60% would use water supply for irrigation, 30% were not sure and 22% were not going to use it. 67% were willing to invest in rainwater harvesting at their homes while 16% were somewhat interested and 15% did not want to do anything with it. 27% were willing to use recycled water for their produce while 58% were not sure. Although 14% did not want to use recycled water for irrigation purposes. 34% were interested in installing a recycling plant at their homes for watering the plants whereas 29% were not sure and 28% did not want to install a recycling plant at their home due to various reasons. The reasons were installation costs, maintenance cost and its life which according to public is not very long. The growing demand of water for irrigation has produced a marked increase in the reuse of treated and/or untreated wastewater worldwide.

4.8 Urban Farming and Affordability

On a scale of 1 to 5, most of the people think that the cost associated with farming fruits and vegetables ranks at 2. 30% think that growing fruits and vegetables would increase their household income and others think it would just help them save some money (see table 3.8). Affordability of the respondents was computed using 4 variables which was later recoded into affordability index. These four variables were affordability of seeds, affordability to buy gardening equipment, affordability of plantation cost and affordability to buy fully grown plants. The index was divided into three ranges: low, medium, and slightly high.

Table No 9: Affordability Index Variable of Urban Agriculture

Affordability index variable	Range	Percentage
Low	.1-1.5	50%
Medium	1.51-2.0	29%
Slightly High	2.01-5	21%

4.9 Urban Agriculture and post Covid-19

Due to covid-19, there is a massive decrease in wages throughout Pakistan. Most of the people have gone jobless especially due to the pandemic. It was reported in a study by Hussain (2020) that there are almost 5 million people in Pakistan who live just at or below the subsistence line and there are tons of unqualified people for instance waste recyclers, construction workers, labors and domestic workers who reply on daily wages to meet their needs. Around 4 million people are working on daily wages in Karachi alone, and it is estimated that almost 4 million belong to daily wagers group in Punjab.

Then there are small and medium enterprises such as textile and apparel industry were badly affected due to imposition of lockdown. Agricultural sector is no exception when being hit by covid-19 is being discussed. For example, wheat harvesting usually began in late March until mid of June in Sindh and Punjab, but due to non-availability of labor and transport, this sector had to face numerous problems. Same is the case with the transport sector, most of the drivers of local transport, taxi, rickshaw have been out of jobs since the pandemic entered the country (Worldbank,2020b).

According to table 3.9, if a person is jobless due to the covid-19 lockdown, he has more spare time, but he is not still willing to spend the time on healthy and productive activity like growing food. The reason of this situation is that people are frustrated and don't want to spend their left over money on a risky business like urban farming as no one is sure if their food would grow out perfectly due to lack of awareness and training in this area. Moreover, most of the people do not want to spend money in the situation like this as they are already making their ends meet difficultly.

Table No 10: Correlation Matrix of Variables of Impact of Covid-19 on Urban Agriculture

	Joblessness due to Covid-19	**Spare time due to covid-19**	**Willingness to spend time in a healthy and productive activity**	**Willingness to grow food because of the free time**
Joblessness	1.000	.808	.197	.088
Spare time	.808	1.000	.109	.073
Willingness to spend time in a healthy and productive activity	.197	.109	1.000	.667
Willingness to grow food because of free time	.088	.073	.667	1.000

18% of people are jobless now a days because of covid-19 lockdown. 26% are working from home. So, most of the people have extra time to spend on urban food gardening. 36% of the respondents had spare time due to covid-19 pandemic as people have lost jobs and also, they cannot move as

freely as they used to before the pandemic began. 66% wanted to spend their spare time in doing a healthy and productive activity. 61% think that buy food from food vendors is risky in this situation and 39% think that it is not at all risky but convenient. 78% wanted to grow food because of the free time they got in the pandemic. However, post pandemic things have changed and they may not be much interested any more.

4.10 Reliability Analysis

Reliability analysis (shown in table 3.10) was only performed on computed variables. These variables were computed using mean of more than 2 variables. Initially, there were 12 factors called as motivators but after conducting reliability test, only 5 items' data is found to be significant. The value of Cronbach's Alpha for motivator is 60.8%. For affordability, there was 6 but 4 are found reliable after the reliability test. For awareness and impact of covid-19, all the items were found reliable. Whereas for barriers, initially there were 9 but 8 are used. All items of the variable "Willingness" were found to be reliable according to its Cronbach alpha value.

Table No 11: Reliability Analysis of Variables

	Cronbach's Alpha	No. of items
Motivators	0.608	5
Interest/Willingness	0.759	3
Awareness	0.743	5
Affordability	0.710	4
Covid-19	0.651	4
Barriers	0.623	8

4.11 Effect of Various Variables on Willingness

To determine effect of various variables on willingness, linear regression model is applied. The independent variables are age, income, household size, number of household members, time spent in the house, knowledge about UA, motivators, barriers, affordability, covid-19 and interest of the respondents in food gardening whereas willingness is taken as a dependent variable. In Table 3.11, it is evident that interest is more likely to predict willingness of respondents to adopt urban agriculture.

Before adding interest and barriers to the equation, motivators were the biggest predictors of willingness as shown in table 3.12. Awareness of the respondents about urban agriculture and its types also had somewhat impact on the predictability of willingness. Affordability of respondents also had a lot to do with predicting willingness as evident by table 2. Age and number of household members are the factors who have very less impact on the willingness of respondents because almost same response was found in all age groups. The lower age groups of 20-24- and 25–29-year-olds were the most interested in engaging in urban agriculture activities. No matter what the number of household members were, people were generally interested in the idea of growing fruits and vegetables. Time spent in the house and household area had a little impact on

the significance of the model but not too much. Covid-19 had a little something to do with the willingness as people were desperate to look for income options but mostly people were not willing to take the risk as they already have not enough savings left. Barriers, of course, had an inverse relationship with willingness as they were doing nothing but hindering the respondents from engaging in urban agriculture activities. The significance of the model is defined as $F(11,128)=46.724; p=.000$. Our final equation becomes:

$$Willingness = -.342 + .102(Awareness) + .061(Affordability) + .115(Motivators) + .087(Covid) + .010(Time\ spent\ in\ the\ house) + .034(income) - .009(Household\ Members) + .019(Household\ Area) - .007(Age) + .818(Interest) - .083(Barriers) + \epsilon$$

Table No 12: Linear Regression Analysis of Willingness, Awareness, Affordability, Motivators, Covid-19, Time Spent in The House, Income, Household Members, Household Area, Age, Interest and Barriers

Variables	**Coefficients**		**Model Summary**		
	B coefficient	Standard Error	Estimate	F change	Sign F. Change
Awareness	.102	.047	.803	46.724	.000
Affordability	.061	.055			
Motivators	.115	.056			
Covid-19	.087	.043			
Time Spend in the house	.010	.038			
Income	.034	.034			
Household Members	-.009	.039			
Household Area	.019	.026			
Age	-.007	.027			
Interest	.818	.061			
Barriers	-.083	.091			

Table No 13: Linear Regression Analysis of Willingness, Awareness, Affordability, Motivators, Covid-19, Time Spent In The House, Income, Household Members, Household Area, and Age

Variables	**Coefficients**		**Model Summary**		
	B coefficient	Standard Error	Estimate	F change	Sign F. Change
Awareness	.072	.073	.518	15.281	.000
Affordability	.227	.084			
Motivators	.541	.072			
Covid-19	.038	.067			
Time Spend in the house	.134	.057			
Income	.045	.052			
Household Members	.013	.061			

Household Area	.006	.040
Age	.041	.041

5. Conclusions and Recommendations

5.1 Conclusions

Urban farming is often considered as an alternative source of income in times of hardships and war. In our case, our country Pakistan is facing serious economic problem. The need of the time is that households of Pakistan will have to change its survival strategy and engage themselves in alternative income producing activities. Urban Agriculture is one of the time-proven strategy to increase household income in hours of need. Urban agriculture is still a new concept in Pakistan and very few people are utilizing this strategy to increase their incomes.

Urban horticulture is given preference in Pakistan but it is lacking in policies related to urban agriculture. Urban agriculture is not introduced in zoning regulations but no one has made an issue out of it because people are not really aware about it benefits. Inhabitants of urban areas need to be educated about urban agriculture as awareness of urban agriculture was found very low. Willingness of the respondents is most determined by motivators/drivers of urban agriculture and interest of the respondents whereas time spent in the household also has a mildly significant impact.

The Pakistan Institute of Development Economics estimated a loss of 18 million jobs in this year. So, there is a massive need to engage people in something that will yield them some income or at least make them save money. According to the Pakistan Labor Force Survey (2017-18), the unemployment rate in the country was 5.8% which is expected to reach 8.1% during the economic year 2020-2021 (Pakistan Bureau of Statistics, 2019).Therefore, there is a massive need to engage citizens of Pakistan in urban agriculture activities which will make them less dependent on the rural areas and would save them a lot of money which was else going to be spent on buying food items. It would make the cities self-sufficient in food and the citizens would rely less on the rural produce. This pandemic has taught us nothing else but to make our cities sustainable and urban agriculture can play a major role to achieve that. It would also play a major role in decreasing the food miles and hence, the carbon footprint of the cities. On the other hand, the added benefit is that it is making the cities greener and cooler.

5.2 Recommendations

Urban agriculture can play a key role in making cities self-sustainable and food secure. Although urban agriculture is an old concept in most parts of the world but in Pakistan, mostly people are not aware about its advanced types and techniques. Concept of roof gardening, greenhouses and z-farming, its benefits for the environment and how they are not unsafe are also not known.

1. First step should be creating as much awareness as possible among the urban dwellers. Learning how to plant crop should be made a compulsory activity in schools. Social media can also be used for spreading awareness among the adults. Media campaigns along with posters, cookbooks, motivational phrases, and television ads can also help achieve awareness among the common people.
2. Second step should be training by professionals on how to plant seeds and take care of the plants and how to utilize minimum space for food gardening. These trainings were although arranged by PARC in the past, but proper information and advertisement was missing.
3. Third step should be creating community gardens or allocating space for community gardens in areas where the plot sizes are small and access to land is the major issue. Community gardens should be looked after by an association which runs by specific rules and regulations. Almost all the disputes among the urban farmers are to be handled by this association. Specific areas with boundaries will be allotted to each farmer, so that less problems occur among the farmers.
4. Establishment of vertical farms should be the fourth step towards achieving self-sufficiency in food. Vertical farms would not take much space and would feed millions of resident's food on comparatively low prices. Vertical farms can provide crops throughout the year as they are not adversely affected by the weather. It would create employment for the poor. Also, it would be a step towards eradicating poverty. Vertical farms are environment friendly and they also reduce the use of water.
5. Water used for urban agriculture should be reused and recycled. Wastewater should be treated and used in urban farming, so that water availability no longer remains an issue for urban agriculture. Rainwater harvesting should also be given priority in urban areas. Small rain harvesting units should be installed in the houses so that rainwater does not get wasted at all. All these steps would ensure make urban farming sustainable.
6. Land for urban agriculture should be regarded as primary or accessory use in zoning regulations of Pakistan and there should be clear and agriculture-inclusive local ordinances in Pakistan which promote local farming in urban areas. So that urban farmers do not face issues while farming on vacant lots, designated community gardening plots or even vertical farms. Also, this would make urban farmers not feel reluctant while investing in lands, building or equipment used for urban agriculture.

5.3 Limitations

While the mixed methods approach adopted in this research facilitates a comprehensive understanding of urban agriculture adoption in Lahore, Pakistan, several limitations warrant consideration. Firstly, the study area, limited to Johar Town and Faisal Town, may not be fully representative of the diverse socioeconomic and cultural contexts within the city, potentially limiting the generalizability of findings. Moreover, the reliance on household surveys for primary

data collection may introduce response biases, as respondents may provide socially desirable answers or lack accurate knowledge about urban agriculture practices.

Additionally, the literature review conducted to inform policy frameworks may suffer from selection bias, as it relies on published sources that may not fully capture the breadth of urban agriculture policies and practices worldwide. Furthermore, while the proposed recommendations offer valuable insights into promoting urban agriculture, their implementation may face challenges related to resource availability, institutional support, and community engagement. Thus, while the mixed methods approach offers a holistic examination of urban agriculture dynamics, these limitations underscore the need for cautious interpretation and further research to ensure robust policy formulation and implementation.

5.4 Future Research

Moving forward, future research endeavors in the realm of urban agriculture in Lahore, Pakistan, should strive to address several key areas to enhance the effectiveness of policy formulation and implementation. Firstly, expanding the study area beyond Johar Town and Faisal Town to encompass a more diverse range of neighborhoods and communities within Lahore would provide a more comprehensive understanding of urban agriculture practices and preferences across the city. Additionally, future studies should consider employing more nuanced data collection methods, such as in-depth interviews or focus group discussions, to capture a deeper understanding of the socio-cultural factors influencing urban agriculture adoption.

Furthermore, there is a need to conduct longitudinal studies to track changes in urban agriculture practices over time and assess the long-term impacts of implemented policies and interventions. This longitudinal approach would provide valuable insights into the sustainability and scalability of urban agriculture initiatives in Lahore. Moreover, future research should explore innovative strategies for promoting urban agriculture awareness and engagement among urban dwellers, including leveraging social media platforms, community outreach programs, and educational campaigns.

Additionally, efforts should be made to strengthen institutional support for urban agriculture, including the establishment of regulatory frameworks that recognize and support urban farming activities. Collaboration between government agencies, academic institutions, and non-governmental organizations is essential to develop and implement effective policies that facilitate the growth of urban agriculture while addressing potential challenges related to land access, water availability, and waste management.

Furthermore, research focusing on the economic viability of urban agriculture initiatives, including cost-benefit analyses and assessments of income generation potential, would provide valuable insights for policymakers and stakeholders. Finally, exploring opportunities for integrating urban agriculture into urban planning and development processes, such as incorporating green infrastructure and food production zones into city design, can further enhance

the resilience and sustainability of urban food systems in Lahore. Overall, these future directions aim to build upon the existing research and contribute to the advancement of urban agriculture practices and policies in Lahore, Pakistan.

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