Perception and Adoption Level of Urban Horticulture Technologies, Nairobi County, Kenya

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Abstract
Recent years have witnessed a significant improvement in the adoption and promotion of Horticultural technologies among smallholder farmers world-wide and in particular, developing countries. This project was aimed at evaluating the main socio-economic factors significantly determine farmers' decision to adoption of horticultural practices and how knowledge transfer influence urban horticulture. It was found from the literature reviewed that; age is significant and has a positive relationship with technology adoption, women are mainly in charge of urban farming and the farmers are spread over all education level and the source of food is the main reason for urban horticulture. A sample of 580 respondents was used, 138 in Kasarani, 195 in Mathare and 247 in Kibera. Questionnaires were used to collect data from urban farmers and an interview schedule used to collect information from farmers. Social and economic characteristics, accesses to space, access to information, business management and governance data was collected. Frequencies and percentages were used to analyze the data using Statistical Package for Social Sciences (SPSS). The chi–square was used to differentiate different groups and conclusions. The findings show that there is a positive relationship between occupation in peri-urban andreason for adoption of urban technologies. The study also shows that there is positive relationship between age in peri-urban and technology transfer. More than 65% of the respondents were female. There is a negative relationship between education level and technology transfer. The results from this study will enable technology implementers, policy makers and local leaders to promote appropriate technologies to the residents which will lead to increased food supply, ensure food security for active and healthy life.

Keywords: Urban horticulture, food security and technology

1. Introduction

1.1 Background of the Study

Urban horticulture is the cultivation, processing, and sale of fruits, nuts, vegetables, ornamental plants, and flowers as well as many additional services (Shyr, C.L. &Reily, H.E., 2017). It also includes plant conservation, landscape restoration, soil management, landscape and garden design, construction, and maintenance, and arboriculture. The products of urban horticulture include a large variety of vegetables, cereals, flowers, ornamental trees, aromatic vegetables and mushrooms..

The significance of urban horticulture as an important and growing sector of the urban space economy can be appreciated at individual household, community, and national levels, Urban horticulture is also a source of employment, income and favors both social inclusion and reduction of gender inequalities as 65 % of urban farmers are women (Orsini et al. 2013). A key challenge is developing policy, strategies and technical support mechanisms for the sustainable management of urban agricultural systems, addressing production issues and marketing needs within a broader framework of environmental planning and management, water supply and utilization schemes, and food safety assurance (FAO, 2010).

Kenya is one of the countries in East Africa with high population growth rate of 2.11% (World Bank, 2013). Most of the people work within the agricultural sector and their households depend on the harvest (World Bank, 2008). However, food insecurity is still a major problem and malnutrition is common in urban areas (Dubbeling, 2010). Within this reality, urban agriculture/horticulture has become a key component of the survival strategies of poorer sections of the population while also providing a significant contribution to the urban fresh food supply chain (FAO, 2010). The Government of Kenya has outlined four priority areas for the next five years. These are agricultural and food security, affordable housing, increased share of manufacturing, and universal health coverage (World Bank, 2018).Techniques have been developed or adapted specifically for urban areas but there is still some research needed in order to better understand these complex agro-systems.

1.2 Statement of the problem

The world urban population is expected to surpass 8.5 billion by 2030 (UN, 2015). The urban population expansion is more pronounced in developing countries as result of emigration from rural areas, as people flock to the cities in search of food, employment and security. The trend is accelerating, and by the year 2050, it is expected that about 66% of the world's population will be living in cities (UN, 2014). More than 60 percent of the population of Nairobi lives in the numerous slums located around the city. Kibera slum is one of "the biggest slum in Africa" (Desgroppes, A., & Taupin, S., 2011). Around half million people are currently living in Kiberaandthe population is increasing daily(Gallaher et al., 2015). In the slum, land slides are frequent and the unemployment rate is very high. Most of the land is dedicated to housing, and agricultural land remains scarce

Urban dwellers face relatively high living costs from housing, transportation, health care, education, inflated food prices and cash requirements when compared to their rural equivalents (Cohen & Garrett, 2010).Such rapid urbanization and the harsh reality of urban poverty require strategies to ensure adequate food supply and distribution systems to address escalating levels of urban food insecurity. Besides the growing demand for food, malnutrition remains central issues

as poverty continues to be prevalent in many cities around the world. Specifically, it is estimated that 40% of urban inhabitants are living on less than US$1 a day, while simultaneously 70% are living on US$2 a day (FAO, 2012). Similarly, an impoverished urban household are estimated to spend 60–80 percent of incomes on food, making them more vulnerable to food price volatility (Cohen & Garrett, 2010).Information on the sociological and economic factors and constrains affecting and limiting consumption, production and marketing of vegetables in urban areas is only sparse or not available at all. Various technologies for vegetable production are available but have to be modified, adapted and tested under the special urban environments. A comprehensive research is therefore needed to address the issues.

1.3 Purpose of the study

The purpose of the study was to evaluate the social-economic factors influencing the adoption by urban horticulture technologies among urban farmers in Kenya.

1.4 Specific objectives

i. To determine the level of influence of social-economic factors among in the adoption of urban horticulture technologies.
ii. To establish how mode of knowledge/skills transmission influence the adoption of urban horticulture technologies.

1.5 Justification of the study

Technology adoption increases food production and number of people at risk from hunger could be reduced by as much as 40% and food prices could be reduced by almost half (International Food Policy Research Institute, 2014) In general the adoption of appropriate urban horticulture technology will lead to increased food supply, ensure food security for the many low income earners in urban areas thereby helping Kenya to achieve sustainable development goals (SDGs) on food security and attaining the 2030 agenda by mitigating against food insecurity.

2. Literature Review

2.1 Social Impacts

Urban horticulture create safe spaces for recreation, improve the physical space of the neighborhood, beautifies the neighborhoods, which, in return, created more local pride and attachment to the space (Nikolaidou et al., 2016).Community gardens, in particular, were cited as a place where people built trust (Teig et al., 2009).The organization of gardens range from very close-knit associations with mutual activities to loosely organized ones which only share the facilities (de Neergard et al., 2009). The areas shared for community gardens are mostly open spaces in urban areas. Urban agriculture gives immigrants an opportunity to share their cultural varieties of vegetables and fruits with neighborhood markets. This not only helped them network with other immigrants but also created shared opportunities with non-immigrant residents (Beckie & Bogdan 2010). There are also examples of cross-generation sharing between youth and seniors. Since the majority of community gardeners are seniors (Teig et al., 2009), these gardens are an ideal venue for seniors to pass on knowledge and work with youth.

2.2 Economic Impacts

The production of horticultural products is characterized by low- cost inputs and usually more supplementary than being the main source for consumption (Galhena et al. 2013). Urban horti culture also creates an 'opportunity cost' – domestic producers can either save income through the consumption of home-produced foodstuffs that are cheaper to produce than to buy from markets, and /or increase family income by selling their products(Ruth et al., 2013) (Mohammadi et al., 2014) also found that household foods production decreases family costs of purchasing foods and transportation costs. Urban farmers are of two groups; the first class includes people doing activity to meet their family needs and the second class involves people doing activity with business intention and gaining benefits (Mohammadi et al., 2014). (Gillespie et al., 2007), direct marketing strategies creates reliable markets for small famers to expand operations. Since community agriculture rely on members who value supporting local farmers, farmers are able to rely on stable and diversified income (Flora et al., 2007).It has been found that farmers markets in food insecure areas had more affordable and quality produce (Park et al., 2011) than neighborhood corner stores and supermarkets, and in some cases provided enough competition to lower supermarket prices on produce (Park et al., 2011).

2.3 Health Impacts

According to (Orsini et al., 2013), urban agriculture represents an opportunity for improving food supply and health conditions.It is also considered as a multifunctional intervention(Lovell,2010).It is part of health promotion strategies (Wakefield,2007).A significant number of studies have already attempted to demonstrate the association between urban agriculture and access to food (Rezaiet al., 2016) or its association with improved household nutrition through consumption of fresh fruits and vegetables (Alaimoet al., 2008). In addition, (Genter C., 2015) indicates that, engagement in urban agriculture may improve physical activity and contribute to well-being and health by reducing stress.

2.4 Horticultural technology adoption

According to (Loevinsohn et al., 2013), technology is a method of producing goods and services, including methods of organization as well as physical technique. Technology itself is aimed at improving a given status quo to a more desirable level. It assists the applicant to do work effectively and efficiently than he/she would have done in the absence of the technology (Thomas et al, 2017). Adoption is an integration of a new technology into existing practice and is usually preceded by a period of 'trying' and some degree of adaptation (Loevinsohn et al., 2013). Adoption is in two categories; rate of adoption and intensity of adoption. The rate adoption is the relative speed with which farmers adopt an innovation, it time as one of its elements.

Kariyasa and Dewi (2013) noted that adoption of new technologies can lead to increased food production. A study by (Jain et al., 2009) indicates thatnon-adopters of agriculture technologies can hardly maintain their marginal livelihood and are more prone to socio-economic stagnation which often results in deprivation.

The Technology Acceptance Model describe factors that determine technology acceptance, information technology usage behavior and to provide a parsimonious theoretical explanatory model (Bertrand and Bouchard, 2008). Ducey and Adam J. (2013) explains that the technology acceptance includes perceived ease of use and perceived usefulness. Teo (2013) identified

factors such as individual differences, social influences, beliefs, attitudes and situational influences as factors that promote the intention to use technology and promote the ability to accept or reject it. Teo (2013) also indicated that an individual's behavior is influenced by an intention to perform the behavior, in other words, the real performance of the behavior is heralded by a person's behavioral intention to engage in the activity.

3. Research Methodology

3.1 Location of the Study

The study was conducted in Nairobi County. The County covers an area of 695.1kilometres squared and it borders Kiambu, Machakos and Kajiado counties. According to the Kenya National Census that was carried out 2009, the number of people living in the county is approximated to be 3,138,369 making it one of the highly populated counties in the country. Nairobi, the capital city of Kenya, is located 140 kilometres south of the Equator and 480 kilometres from the Indian Ocean, at around latitude 1°S and longitude 36°E. It covers an area of approximately 690 square kilometres and has a diverse physical environment. The altitude of Nairobi ranges from an average of 1500 metres in the East to approximately 1900 metres (Makokha & Shisanya, 2010).

3.2 Research Design

The study adopted a descriptive survey design. Survey design was suitable for this study due to the fact that it allowed interviewing and asking people about themselves directly as well as getting the primary data.

3.3 Sampling procedure

Stratified sampling was used. The247respondents were selected from the 9villages (Makina, Mashimoni, Laini Saba, Kianda, Kisumu Ndogo, Soweto East, Soweto West, Gatwekera, and Silanga) in Kibera, 195 respondents were selected from the 8villages (3A, 4A, Gitathuru, Kiamutisya, Kosovo, KwaKariuki, Mabatini, Mashimoniin Mathare and 138 respondents were selected from the twoareas of Mwiki and Kasarani. The villages/ areas acted as strata where equal number of respondents was selected from each stratum.

3.4 Data collection

The study relied on primary data of qualitative and quantitative nature. A questionnaire was used to collect social –economic data such as age, gender and occupation data through interviews to collect information from urban farmers. The farmers were required to fill in the questionnaires by ticking the boxes where appropriate.

3.5 Data Analysis Procedures

After data collection, questions were coded and entered on spreadsheet in the computer for analysis. Frequencies, percentages, tables and means were calculated to give simple summary of the observations. A Chi-square test for pairs of variables was used to test the significance of the relationship between independent.

4. Research Findings and Discussion

4.1. Socio-demographic characteristics of respondents

(a) Table 2 Distribution of the respondents based on their demographic characteristics in urban areas

	Urban				Peri-urban	
	Mathare		*Kibera*		*Kasarani*	
Social-economic characteristics	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Sex						
Male	61	31.3	74	30	34	24.6
Female	134	68.7	173	70	104	75.4
Age						
Young adults	49	25.1	64	25.9	31	22.5
Middle aged	132	67.7	160	64.8	96	69.5
Older adults	14	7.2	23	9.3	11	8
Marital status						
Single	22	11.3	40	16.2	13	9.4
Married	144	73.9	170	68.8	98	71
Divorced/separated	10	5.1	10	4.1	4	2.9
Windowed	19	9.7	27	10.9	23	19.7
Education Level						
Non formal	16	8.2	23	9.3	8	5.8
Primary	26	13.3	48	19.5	16	11.6
Secondary	108	55.4	129	52.2	41	29.7
Tertiary	45	23.1	47	19	73	52.9
Occupation						
Trading	87	44.6	101	40.9	48	34.8
Farming	4	2.1	3	1.2	2	1.5
Driving	4	2.1	8	3.2	3	2.2
Civil Service	25	12.8	30	12.2	30	21.7
Barbing	2	1	5	2	1	0.7
Unemployed	28	14.4	36	14.6	16	11.6
Others	45	23.1	64	25.9	38	27.5
Level of income						
Less than 5,000	11	5.6	20	8.1	3	2.2
5,001-10,000	23	11.8	16	6.5	5	3.6
10,001-15,000	41	21	48	19.4	18	13
15,001-20,000	39	20	42	17	31	22.5
20,001-25,000	19	9.7	38	15.4	28	20.3
25,001-30,000	12	6.2	19	7.7	19	13.8
30,001-35,000	16	8.2	14	5.7	13	9.4
35,001-40,000	14	7.2	17	6.9	9	6.5
40,001-45,000	6	3.1	9	3.6	5	3.6
45,001-50,000	8	4.1	13	5.3	4	2.9
More than 50,000	6	3.1	11	4.5	3	2.2

As shown above (Table 2), it is apparent that the majority of respondents were females, for instance, in Kasarani (75.4%) were females and the remainder were males (24.6%), in Mathare (68.7%) were females and the males were (31.3%), and in Kibera (70%) were females and males (30%). The marital status of respondents as shown above, varied from single (9.4%), married (71%), separated/divorced (2.9%) to widowed (16.7%) in Kasarani. In Mathare, (11.3%) were single, married (73.9%), separated/divorced (5.1%) to widowed (9.7%) and in Kibera, (16.2%) were single, married (68.8%), separated/divorced (4.1%) and widowed (10.9%). It is indicated that most respondents were married; Kasarani (71%), Mathare (73.9%) and Kibera (68.8%).

It is clear that majority of the respondents are middle aged adults with 67.7%, 64.8% and 69.5% for Mathare, Kibera and Kasarani respectively. On the level of education, Majority (52.9%) of the respondents had post-secondary level of education in form of certificates, diplomas and degrees, followed by (29.7%) with secondary education (11.6%) with primary education and

(5.8%) had non- formal education in Kasarani area. In Mathare, the majority (55.4%) of the respondents had secondary level of education, followed by (23.1%) with post-secondary level of education in form of certificates, diplomas and degrees, (13.3%) with primary education and only (8.2%) had non- formal education and in Kibera, the majority (52.2%) of the respondents had secondary level of education, followed by (19.5%) with primary education (19.0%) with post-secondary level of education in form of certificates, diplomas and degrees and only (8.2%) had non- formal education . The average monthly income of the respondents was between Kshs. (10, 000-35,000)for most respondents.

4.2. Distribution Frequencies of Respondents by space identified for production of vegetables

Kasarani

Table 3 (i). Frequency for space identified for growing vegetables according to social-demographic groups of respondents in Kasarani

	Socio-economic characteristics	*Rooftops*	*Balcones*	*Vacant places*	*In containers*	*Along railways*	*Below power lines*	*River banks*	*School gardens*	*Road strips*	*others*
Sex	Male(n=34)	(1) 3%	(2) 6%	(6) 18%	(5) 15%	(2) 6%	(3) 9%	(9) 27%	(0) 0%	(6) 18%	(2) 3%
	Female(n=104)	(4)4%	(4)4%	(27)26%	(9)9%	(14)14%	(4)4%	(12)12%	(3)3%	(18)17%	(9)8%
	Total(n=138)	(5)4%	(6)4%	(33)24%	(14)10%	(16)12%	(7)5%	(21)15%	(3)2%	(24)17%	(11)8%
	P value					0.494					
Age	Young adults(n=31)	(1)3%	(1)3%	(7)23%	(5)16%	(3)10%	(3)10%	(6)19%	(0)0%	(5)16%	(0)0%
	Middle aged adults(n=96)	(3)3%	(5)5%	(21)22%	(9)9%	(13)14%	(4)4%	(13)14%	(3)3%	(17)18%	(8)8%
	Older adults(n=11)	(1)9%	(0)0%	(5)46%	(0)0%	(0)0%)	(0)0%	(2)18%	(0)0%	(2)18%	(1)9%
	P value					0.465					
Marital status	Single(n=13)	(0)0%	(1)8%	(3)23%	(0)0%	(1)8%	(0)0%	(1)8%	(1)8%	(4)31%	(2)15%
	Married(n=98)	(3)3%	(4)4%	(24)25%	(13)13%	(12)12%	(6)6%	(16)16%	(2)2%	(12)12%	(6)6%
	Divorced/separated(n=4)	(1)25%	(0)0%	(1)25%	(0)0%	(1)25%	(0)0%	(1)25%	(0)0%	(0)0%	(0)0%
	Windowed(n=23)	(1)4%	(1)4%	(5)22%	(1)4%	(2)9%	(1)4%	(3)13%	(0)0%	(8)35%	(1)4%
	P value					0.598					
Educational Level	Non formal education(n=8)	(0)0%	(1)13%	(3)38%	(1)13%	(2)25%	(0)0%	(1)13%	(0)0%	(0)0%	(0)0%
	Primary(n=16)	(1)6%	(0)0%	(6)37%	(0)0%	(1)6%	(1)6%	(1)6%	(2)13%	(2)13%	(2)13%
	Secondary(n=41)	(2)5%	(3)7%	(6)15%	(7)17%	(7)17%	(1)2%	(8)20%	(0)0%	(5)12%	(2)5%
	Tertiary(n=73)	(2)3%	(2)3%	(18)25%	(6)8%	(6)8%	(5)7%	(11)15%	(1)1%	(17)23%	(5)7%
	P value					0.232					
Occupation	Trading(n=48)	(4)8%	(1)2%	(9)19%	(4)8%	(6)13%	(3)6%	(7)15%	(1)2%	(10)21%	(3)6%
	Farming(n=2)	(0)0%	(0)0%	(0)0%	(1)50%	(0)0%	(1)50%	(0)0%	(0)0%	(0)0%	(0)0%
	Driving(n=3)	(0)0%	(1)33%	(1)33%	(0)0%	(1)33%	(0)0%	(0)0%	(0)0%	(0)0%	(0)0%
	Civil Service(n=30)	(1)3%	(2)7%	(6)20%	(3)10%	(3)10%	(1)3%	(8)27%	(0)0%	(3)10%	(3)10%
	Barbing(n=1)	(0)0%	(0)0%	(0)0%	(0)0%	(0)0%	(0)0%	(0)0%	(0)0%	(1)100%	(0)0%
	Unemployed(n=16)	(0)0%	(2)13%	(3)19%	(2)13%	(1)6%	(1)6%	(1)6%	(0)0%	(5)31%	(1)6%
	Others(n=38)	(0)0%	(0)0%	(14)37%	(4)11%	(5)13%	(1)3%	(5)13%	(2)5%	(5)13%	(2)5%
	P value					0.243					
Level of Income	Less than 5,000(n=3)	(1)33%	(0)0%	(0)0%	(0)0%	(0)0%	(0)0%	(1)33%	(0)0%	(1)33%	(0)0%
	5,001-10,000(n=5)	(0)0%	(0)0%	(1)20%	(0)0%	(0)0%	(0)0%	(1)20%	(1)20%	(2)40%	(0)0%
	10,001-15,000(n=18)	(0)0%	(0)0%	(5)28%	(2)11%	(0)0%	(1)6%	(4)22%	(0)0%	(4)22%	(2)11%
	15,001-20,000(n=31)	(1)3%	(2)7%	(7)23%	(2)7%	(3)10%	(1)3%	(4)13%	(0)0%	(7)23%	(4)13%
	20,001-25,000(n=28)	(0)0%	(1)4%	(8)29%	(2)7%	(4)14%	(2)7%	(6)21%	(0)0%	(4)14%	(1)4%
	25,001-30,000(n=19)	(1)5%	(3)16%	(4)21%	(4)21%	(4)21%	(1)5%	(1)5%	(0)0%	(1)5%	(0)0%
	30,001-35,000(n=13)	(1)8%	(0)0%	(3)23%	(3)23%	(1)8%	(0)0%	(0)0%	(1)8%	(4)31%	(0)0%
	35,001-40,000(n=9)	(0)0%	(0)0%	(4)44%	(1)11%	(2)22%	(0)0%	(1)11%	(0)0%	(1)11%	(0)0%
	40,001-45,000(n=5)	(1)20%	(0)0%	(1)20%	(0)0%	(0)0%	(0)0%	(1)20%	(0)0%	(0)0%	(2)40%
	45,001-50,000(n=4)	(0)0%	(0)0%	(0)0%	(0)0%	(2)50%	(0)0%	(1)25%	(1)25%	(0)0%	(0)0%
	More than 50,000(n=3)	(0)0%	(0)0%	(0)0%	(0)0%	(0)0%	(2)67%	(1) 33%	(0)0%	(0)0%	(0)0%
	P value					0.140					

`*p<0.05

The respondents were asked about the space where they grow crops. The farmers' responses were varied. The spaces are categorized into; rooftops, balconies, vacant places, in containers, along the railways, below power lines, river banks, school gardens, road strips and others to give us a better understanding on the choice of spaces for farming. About 24% respondents did

farming along the vacant places, 17% on the road strips and 15% along the water lines such as river banks and sewage lines. There was considerable variation in the choice of space for farming between farmers from different age groups (Table 3(i)). Forty six percent of Older adults (>55 years), did farming on vacant spaces compared to 23% of young adults (<35 years).The choice of space also varied significantly amongst different gender groups (p = 0.494), age groups (p = 0.465), marital status (p = 0. 598), education level (p= 0.232 occupation (n= 0.243) and level of income groups (p = 0.140).

Mathare

Table 3 (ii). Frequency of space identified for growing vegetables according to social-demographic groups in Mathare

	Socio-economic characteristics	Rooftops	Balcones	Vacant places	In containers	Along railways	Below Power lines	River banks	School gardens	Road strips	others
Sex	Male(n=61)	2(3%)	4(7%)	11(18%)	11(18%)	0(0%)	2(3%)	13(21%)	0(0%)	12(20%)	6(10%)
	Female(n=134	2(2%)	7(5%)	25(19%)	21(16%)	0(0%)	2(2%)	32(24%)	2(2%)	31(23%)	12(9%)
	Total(n=195)	4(2%)	11(6%)	36(19%)	32(16%)	0(0%)	4(2%)	45(23%)	2(1%)	43(22%)	18(9%)
	P value						0.942				
Age	Young adults(n=49)	1(2%)	3(6%)	6(12%)	17(35%)	0(0%)	0(0%)	8(16%)	0(0%)	9(18%)	5(10%)
	Middle aged adults(n=132)	3(2%)	7(5%)	29(22%)	14(11%)	0(0%)	3(2%)	33(25%)	2(2%)	31(24%)	10(8%)
	Older adults(n=14)	0(0%)	1(7%)	1(7%)	1(7%)	0(0%)	1(7%)	4(29%)	0(0%)	3(21%)	3(21%)
	P value						0.507				
Marital status	Single(n=22)	0(0%)	1(5%)	7(32%)	2(9%)	0(0%)	0(0%)	2(9%)	0(0%)	7(32%)	3(14%)
	Married(n=144)	4(3%)	9(6%)	23(16%)	23(16%)	0(0%)	4(3%)	35(24%)	2(1%)	31(22%)	13(9%)
	Divorced/separated(n=10)	0(0%)	0(0%)	3(30%)	3(30%)	0(0%)	0(0%)	1(10%)	0(0%)	2(20%)	1(10%)
	Windowed(n=19)	0(0%)	1(5%)	3(16%)	4(21%)	0(0%)	0(0%)	7(37%)	0(0%)	3(16%)	1(5%)
	P value						0.883				
Educational Level	Non formal education(n=16)	0(0%)	1(6%)	4(25%)	2(13%)	0(0%)	0(0%)	5(31%)	0(0%)	3(19%)	1(6%)
	Primary(n=26)	1(4%)	2(8%)	4(15%)	3(12%)	0(0%)	0(0%)	1(4%)	0(0%)	9(35%)	6(23%)
	Secondary(n=108)	1(1%)	7(7%)	21(19%)	16(15%)	0(0%)	2(2%)	31(29%)	2(2%)	20(19%)	8(7%)
	Tertiary(n=45)	2(4%)	1(2%)	7(16%)	11(24%)	0(0%)	2(4%)	8(18%)	0(0%)	11(24%)	3(7%)
	P value						0.328				
Occupation	Trading(n=87)	3(3%)	4(5%)	15(17%)	14(16%)	0(0%)	0(0%)	22(25%)	1(1%)	16(18%)	12(14%)
	Farming(n=4)	0(0%)	2(50%)	1(25%)	0(0%)	0(0%)	0(0%)	1(25%)	0(0%)	0(0%)	0(0%)
	Driving(n=4)	0(0%)	0(0%)	1(25%)	3(75%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	Civil Service(n=25)	0(0%)	1(4%)	7(28%)	2(8%)	0(0%)	3(12%)	4(16%)	1(4%)	7(28%)	0(0%)
	Barbing(n=2)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	2(100%)	0(0%)
	Unemployed(n=28)	0(0%)	2(7%)	3(11%)	5(18%)	0(0%)	0(0%)	7(25%)	0(0%)	7(25%)	4(14%)
	Others(n=45)	1(2%)	2(4%)	9(20%)	8(18%)	0(0%)	1(2%)	11(24%)	0(0%)	11(24%)	2(4%)
	P value						0.203				
Level of income	Less than 5,000(n=11)	1(9%)	0(0%)	4(36%)	2(18%)	0(0%)	0(0%)	2(18%)	0(0%)	2(18%)	0(0%)
	5,001-10,000(n=23)	0(0%)	1(4%)	5(22%)	1(4%)	0(0%)	0(0%)	9(39%)	0(0%)	3(13%)	4(17%)
	10,001-15,000(n=41)	0(0%)	0(0%)	6(15%)	6(15%)	0(0%)	1(2%)	12(29%)	1(2%)	11(27%)	4(10%)
	15,001-20,000(n=39)	1(3%)	6(15%)	4(10%)	3(8%0	0(0%)	1(3%)	8(21%)	1(3%)	10(26%)	5(13%)
	20,001-25,000(n=19)	2(11%)	1(5%)	4(21%)	8(42%)	0(0%)	0(0%)	2(11%)	0(0%)	1(5%)	1(5%)
	25,001-30,000(n=12)	0(0%)	1(8%)	2(17%)	1(8%)	0(0%)	0(0%)	3(25%)	0(0%)	5(42%)	0(0%)
	30,001-35,000(n=16)	0(0%)	1(6%)	5(31%)	2(13%)	0(0%)	1(6%)	3(19%)	0(0%)	3(19%)	1(6%)
	35,001-40,000(n=14)	0(0%)	0(0%)	5(36%)	5(36%)	0(0%)	0(0%)	4(29%)	0(0%)	0(0%)	0(0%)
	40,001-45,000(n=6)	0(0%)	1(17%)	1(17%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	3(50%)	1(17%)
	45,001-50,000(n=8)	0(0%)	0(0%)	0(0%)	4(50%)	0(0%)	0(0%)	1(13%)	0(0%)	2(25%)	1(13%)
	More than 50,000(n=6)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	1(17%)	1(17%)	0(0%)	3(50%)	1(17%)
	P value						0.089				

*p<0.05

The respondents were asked about the space where they grow crops. The farmers' responses were varied. The spaces are categorized into; rooftops, balconies, vacant places, in containers, along the railways, below power lines, river banks, school gardens, road strips and others to give us a better understanding on the choice of spaces for farming. About 23% along the water lines such as river banks and sewage lines, 19% respondents did farming along the vacant places and 22% on the road strips. There was considerable variation in the choice of space for farming between farmers from different age groups (Table 3(ii)). Seven (7 %) of the older adults (>55 years), did farming in containers compared to 35% of young adults (<35 years).The choice of space also varied significantly amongst different gender groups (p = 0.942), age groups (p =

0.507), marital status (p = 0. 883), education level (p= 0.328) occupation (n= 0.203) and level of income groups (p = 0.089).

Kibera

Table 3 (iii) Frequency of space identified for growing vegetables according to social-demographic groups in Kibera

	Socio-economic characteristics	*Rooftops*	*Balcones*	*Vacant places*	*In containers*	*Along railways*	*Below power lines*	*River banks*	*School gardens*	*Road strips*	*others*
Sex	Male(n=74)	5(7%)	1(1%)	11(15%)	11(15%)	6(8%)	1(1%)	18(24%)	1(1%)	15(20%)	5(7%)
	Female(n=173)	6(4%)	1(1%)	37(21%)	24(14%)	19(11%)	1(1%)	41(24%)	1(1%)	32(19%)	11(6%)
	Total(n=247)	11(5%)	2(1%)	48(19%)	35(14%)	25(10%)	2(1%)	59(24%)	2(1%)	47(19%)	16(7%)
	P value					0.904					
Age	Young adults(n=64)	5(8%)	1(2%)	10(16%)	9(14%)	10(16%)	0(0%)	13(20%)	1(2%)	11(17%)	4(6%)
	Middle aged (n=160)	5(3%)	1(1%)	31(19%)	22(14%)	12(8%)	2(1%)	41(26%)	1(1%)	13(8%)	12(8%)
	Older adults(n=23)	1(4%)	0(0%)	7(30%)	4(17%)	3(13%)	0(0%)	5(22%)	0(0%)	3(13%)	0(0%)
	P value					0.688					
Marital status	Single(n=40)	2(5%)	0(0%)	5(13%)	3(8%)	5(13%)	1(3%)	11(28%)	0(0%)	12(30%)	1(3%)
	Married(n=170)	9(5%)	1(1%)	38(22%)	25(15%)	19(11%)	1(1%)	33(19%)	1(1%)	31(18%)	12(7%)
	Divorced/separated(n=10)	0(0%)	0(0%)	1(10%)	2(20%)	0(0%)	0(0%)	4(40%)	0(0%)	2(20%)	1(10%)
	Windowed(n=27)	0(0%)	1(4%)	4(15%)	5(19%)	1(4%0	0(0%)	11(41%)	1(4%)	2(7%)	2(7%)
	P value					0.361					
Educational Level	Non formal education(n=23)	1(4%)	0(0%)	3(13%)	3(13%)	3(13%)	0(0%)	5(22%)	0(0%)	5(22%)	3(13%)
	Primary(n=48)	1(2%)	0(0%)	9(19%)	7(15%)	5(10%)	1(2%)	9(19%)	1(2%)	11(23%)	4(8%)
	Secondary(n=129)	8(6%)	1(1%)	23(18%)	20(16%)	8(6%)	1(1%)	37(29%)	1(1%)	22(17%)	8(6%)
	Tertiary(n=47)	1(2%)	1(2%)	13(28%)	5(11%)	9(19%)	0(0%)	8(17%)	0(0%)	9(19%)	1(2%)
	P value					0.727					
Occupation	Trading(n=101)	5(5%)	1(1%)	25(25%)	9(9%)	9(9%)	0(0%)	28(28%)	1(1%)	15(15%)	8(8%)
	Farming(n=3)	0(0%)	0(0%)	1(33%)	0(0%)	1(33%)	0(0%)	0(0%)	0(0%)	1(33%)	0(0%)
	Driving(n=8)	1(13%)	0(0%)	1(13%)	3(38%)	0(0%)	0(0%)	1(13%)	0(0%)	2(25%)	0(0%)
	Civil Service(n=30)	2(7%)	1(3%)	3(10%)	5(17%)	3(10%)	0(0%)	9(30%)	1(3%)	5(17%)	1(3%)
	Barbing(n=5)	0(0%)	0(0%)	0(0%)	1(20%)	1(20%)	0(0%)	2(40%)	0(0%)	1(20%)	0(0%)
	Unemployed(n=36)	1(3%)	0(0%)	4(11%)	7(19%)	5(14%)	0(0%)	10(28%)	0(0%)	6(17%)	3(8%)
	Others(n=64)	2(3%)	0(0%)	14(22%)	10(16%)	6(9%0	2(3%)	9(14%0	0(0%)	17(27%)	4(6%)
	P value					0.918					
Level of income	Less than 5,000(n=20)	1(5%)	0(0%)	4(20%)	3(15%)	4(20%)	0(0%)	4(20%)	0(0%)	3(15%)	1(5%)
	5,001-10,000(n=16)	0(0%)	1(6%)	2(13%)	2(13%)	1(6%)	0(0%)	2(13%)	0(0%)	7(44%)	1(6%)
	10,001-15,000(n=48)	2(4%)	0(0%)	11(23%)	7(15%)	5(10%)	0(0%)	14(29%)	0(0%)	6(13%)	3(6%)
	15,001-20,000(n=42)	1(2%)	0(0%)	9(21%)	9(21%)	3(7%)	0(0%)	8(19%)	1(2%)	8(19%)	3(7%)
	20,001-25,000(n=38)	3(8%)	1(3%)	6(16%)	3(8%)	2(5%)	1(3%)	12(32%)	1(3%)	8(21%)	1(3%)
	25,001-30,000(n=19)	0(0%)	0(0%)	5(26%)	3(16%)	4(21%)	0(0%)	5(26%)	0(0%)	1(5%)	1(5%)
	30,001-35,000(n=14)	2(14%)	0(0%)	2(14%)	4(29%)	1(7%)	0(0%)	3(21%)	0(0%)	2(14%)	0(0%)
	35,001-40,000(n=17)	0(0%)	0(0%)	5(29%)	0(0%)	2(12%)	1(6%)	3(18%)	0(0%)	4(24%)	2(12%)
	40,001-45,000(n=9)	1(11%)	0(0%)	0(0%)	1(11%)	0(0%)	0(0%)	3(33%)	0(0%)	4(44%)	0(0%)
	45,001-50,000(n=13)	0(0%)	0(0%)	3(23%)	1(8%)	2(15%)	0(0%)	4(31%)	0(0%)	2(15%)	1(8%)
	More than 50,000(n=11)	1(9%)	0(0%)	1(9%)	2(18%)	1(9%)	0(0%)	1(9%)	0(0%)	2(18%)	3(27%)
	P value					0.820					

*p<0.05

The respondents were asked about the space where they grow crops. The farmers' responses were varied. The spaces are categorized into; rooftops, balconies, vacant places, in containers, along the railways, below power lines, river banks, school gardens, road strips and others to give us a better understanding on the choice of spaces for farming. About 24% along the river banks such as water lines and sewage lines and19% on the road strips.

There was considerable variation in the choice of space for farming between farmers from different age groups (Table 3(iii)). Thirty (30 %) of the older adults (>55 years), did farming on vacant places to 16% of young adults (<35 years).The choice of space also varied significantly amongst different gender groups (p = 0.904), age groups (p = 0.688), marital status (p = 0. 361), education level (p=0.727) occupation (n= 0.918) and level of income groups (p = 0.820).

4.3 Reason/ benefits for adoption of technology

Table 4(i) Frequency distribution on reasons for adoption of urban-technologies according to social-demographic groups in urban areas, Kasarani

	Socio-economic characteristics	*Source of food*	*Source of income*	*Unemployment*	*Use of available water and land*	*High dependency*	*Others*
Sex	Male(n=34)	(20)59%	(7)21%	(3)9%	(1)3%	(2)6%	(1)3%

	Female(n=104)	(81)78%	(11)11%	(2)2%	(1)1%	(6)6%	(3)3%
	Total(n=138)	(101)73%	(18)13%	(5)4%	(2)1%	(8)6%	(4)3%
	P value				0.199		
Age	Young adults(n=31)	(19)61%	(5)16%	(2)7%	(1)3%	(4)13%	(0)0%
	Middle aged adults(n=96)	(73)76%	(12)13%	(3)3%	(1)1%	(4)4%	(3)3%
	Older adults(n=11)	(9)82%	(1)9%	(0)0%	(0)0%	(0)0%	(1)9%
	P value				0.34		
Marital status	Single(n=13)	(9)69%	(3)23%	(1)8%	(0)0%	(0)0%	(0)0%
	Married(n=98)	(70)71%	(12)12%	(4)4%	(2)2%	(8)8%	(2)2%
	Divorced/separated(n=4)	(3)75%	(0)0%	(0)0%	(0)0%	(0)0%	(1)25%
	Windowed(n=23)	(19)83%	(3)13%	(0)0%	(0)0%	(0)0%	(1)4%
	P value				0.439		
Educational Level	Non formal education(n=8)	(6)75%	(1)13%	(0)0%	(0)0%	(0)0%	(1)13%
	Primary(n=16)	(13)81%	(3)19%	(0)0%	(0)0%	(0)0%	(0)0%
	Secondary(n=41)	(32)78%	(2)5%	(2)5%	(1)2%	(4)10%	(0)0%
	Tertiary(n=73)	(50)69%	(12)16%	(3)4%	(1)1%	(4)6%	(3)4%
	P value				0.645		
Occupation	Trading(n=48)	(35)73%	(7)15%	(1)2%	(1)2%	(3)6%	(1)2%
	Farming(n=2)	(0)0%	(0)0%	(1)50%	(0)0%	(0)0%	(1)50%
	Driving(n=3)	(0)0%	(2)67%	(0)0%	(0)0%	(1)33%	(0)0%
	Civil Service(n=30)	(22)73%	(3)10%	(1)3%	(1)3%	(3)10%	(0)0%
	Barbing(n=1)	(1)100%	(0)0%	(0)0%	(0)0%	(0)0%	(0)0%
	Unemployed(n=16)	(13)81%	(0)0%	(2)13%	(0)0%	(0)0%	(1)1%
	Others(n=38)	(30)79%	(6)16%	(0)0%	(0)0%	(1)3%	(1)3%
	P value				P<0.05		
Level of income	Less than 5,000(n=3)	(3)100%	(0)0%	(0)0%	(0)0%	(0)0%	(0)0%
	5,001-10,000(n=5)	(2)40%	(3)60%	(0)0%	(0)0%	(0)0%	(0)0%
	10,001-15,000(n=18)	(14)78%	(1)6%	(1)6%	(0)0%	(1)6%	(1)6%
	15,001-20,000(n=31)	(22)71%	(4)13%	(1)3%	(0)0%	(3)10%	(1)3%
	20,001-25,000(n=28)	(24)86%	(2)7%	(0)0%	(0)0%	(2)7%	(0)0%
	25,001-30,000(n=19)	(11)58%	(3)16%	(1)5%	(2)11%	(1)5%	(1)5%
	30,001-35,000(n=13)	(12)92%	(0)0%	(1)8%	(0)0%	(0)0%	(0)0%
	35,001-40,000(n=9)	(6)67%	(0)0%	(1)11%	(0)0%	(1)11%	(1)11%
	40,001-45,000(n=5)	(3)60%	(2)40%	(0)0%	(0)0%	(0)0%	(0)0%
	45,001-50,000(n=4)	(2)50%	(2)50%	(0)0%	(0)0%	(0)0%	(0)0%
	More than 50,000(n=3)	(2)67%	(1)33%	(0)0%	(0)0%	(0)0%	(0)0%
	P value				0.503		

*p<0.05

The analyses of on the main reasons for adoption of urban horticultural technologies, the farmers' responses were varied. They are categorized into source of food, source of income, unemployment, use of available water and land and high dependence .About 73% respondents said the source of food as the main reason for adoption of urban horticultural technologies, followed by 'source of income' (13%), and about 6% and 4% indicated high dependency and unemployment respectively (Table4 i). Reason for adoption varied significantly amongst different social demographic groups, sex groups (p = 0.199), age groups (p = 0.34), and occupation groups (p < 0.05).

Table 4 (ii) Frequency distribution on reasons for adoption of urban-technologies according to social-demographic groups in urban areas, Mathare

	Socio-economic characteristics	Source of food	Source of income	Unemployment	Use of available water and land	High dependency	Others
sex	Male(n=61)	48(79%)	5(8%)	5(8%)	1(2%)	0(0%)	2(3%)
	Female(n=134)	101(75%)	19(14%)	2(2%)	4(3%)	3(2%)	5(4%)
	Total(n=195)	149(76%)	24(12%)	7(4%)	5(3%)	3(2%)	7(4%)
	P value				0.145		
Age	Young adults(n=49)	33(67%)	9(18%)	2(4%)	4(8%)	0(0%)	1(2%)
	Middle aged adults(n=132)	104(49%)	13(10%)	5(4%)	1(1%)	3(2%)	6(5%)
	Older adults(n=14)	12(86%)	2(14%)	0(0%)	0(0%)	0(0%)	0(0%)
	Total(n=195)	149(76%)	24(12%)	7(4%)	5(3%)	3(2%)	7(4%)
	P value				0.043		
Marital status	Single(n=22)	17(77%)	5(23%)	0(0%)	0(0%)	0(0%)	0(0%)
	Married(n=144)	109(76%)	16(11%)	5(4%)	4(3%)	3(2%)	7(5%)
	Divorced/separated(n=10)	9(90%)	0(0%)	1(10%)	0(0%)	0(0%)	0(0%)
	Windowed(n=19)	14(74%)	3(16%)	1(5%)	1(5%)	0(0%)	0(0%)
	P value				0.766		
Ed uc	Non formal education(n=16)	12(75%)	3(19%)	1(6%)	2(13%)	1(6%)	2(13%)

	Primary(n=26)	20(77%)	6(23%)	2(7%)	1(4%)	0(0%)	1(4%)
	Secondary(n=108)	85(79%)	11(10%)	4(4%)	1(1%)	0(0%)	3(3%)
	Tertiary (n=45)	32(71%)	4(9%)	0(0%)	1(2%)	2(4%)	1(2%)
	P value				0.617		
Occupation	Trading(n=87)	63(72%)	13(15%)	2(2%)	2(2%)	2(2%)	5(6%)
	Farming(n=4)	4(100%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
	Driving(n=4)	3(75%)	1(25%)	0(0%)	0(0%)	0(0%)	0(0%)
	Civil Service(n=25)	16(64%)	5(20%)	1(4%)	2(8%)	0(0%)	1(4%)
	Barbing(n=2)	1(50%)	1(50%)	0(0%)	0(0%)	0(0%)	0(0%)
	Unemployed(n=28)	24(86%)	2(7%)	1(4%)	0(0%)	0(0%)	1(4%)
	Others(n=45)	38(84%)	2(4%)	3(7%)	1(2%)	1(2%)	0(0%)
	P value				0.984		
Level of income	Less than 5,000(n=11)	8(73%)	2(18%)	0(0%)	1(9%)	0(0%)	0(0%)
	5,001-10,000(n=23)	17(74%)	2(9%)	0(0%)	2(9%)	0(0%)	2(9%)
	10,001-15,000(n=41)	34(83%)	5(12%)	1(2%)	0(0%)	0(0%)	1(2%)
	15,001-20,000(n=39)	31(80%)	3(8%)	2(5%)	1(3%)	0(0%)	2(5%)
	20,001-25,000(n=19)	16(84%)	2(11%)	1(5%)	0(0%)	0(0%)	0(0%)
	25,001-30,000(n=12)	10(8%)	2(17%)	0(0%)	0(0%)	0(0%)	0(0%)
	30,001-35,000(n=16)	10(6%)	4(25%)	0(0%)	1(6%)	0(0%)	1(6%)
	35,001-40,000(n=14)	10(7%)	1(7%)	1(7%)	0(0%)	1(7%)	1(7%)
	40,001-45,000(n=6)	4(67%)	1(17%)	1(17%)	0(0%)	0(0%)	0(0%)
	45,001-50,000(n=8)	6(75%)	2(25%)	0(0%)	0(0%)	0(0%)	0(0%)
	More than 50,000(n=6)	3(50%)	0(0%)	1(17%)	0(0%)	2(33%)	0(0%)
	P value				0.011		

*p<0.05

The analyses of on the main reasons for adoption of urban horticultural technologies, the farmers' responses were varied. They are categorized into source of food, source of income, unemployment, use of available water and land and high dependence .About 76% respondents said the source of food as the main reason for adoption of urban horticultural technologies, followed by 'source of income' (12%), and about 7% indicated unemployment (Table4 ii). Reason for adoption varied significantly amongst different social demographic groups, sex groups (p = 0.145), age groups (p = 0.043), and level of income (p = 0.011).

Table 4 (iii) Frequency distribution on reasons for adoption of urban-technologies according to social-demographic groups in urban areas, Kibera

	Socio-economic characteristics	***Source of food***	***Source of income***	***Unemployment***	***Use of available water and land***	***High dependency***	***Others***
Sex	Male(n=74)	52(70%)	9(12%)	4(5%)	1(1%)	1(1%)	7(10%)
	Female(n=173)	123(71%)	28(16%)	6(4%)	4(2%)	5(3%)	7(4%)
	Total(n=247)	175(71%)	37(15%)	10(4%)	5(2%)	6(2%)	14(6%)
	P value				0.484		
Age	Young adults(n=64)	37(58%)	17(7%)	2(3%)	3(5%)	1(2%)	4(6%)
	Middle aged (n=160)	120(75%)	18(11%)	8(5%)	2(1%)	4(3%)	8(5%)
	Older adults(n=23)	18(78%)	2(9%)	0(0%)	0(0%)	1(4%)	2(9%)
	Total(n=247)	175(71%)	37(15%)	10(4%)	5(2%)	6(2%)	14(6%)
	P value				0.499		
Marital status	Single(n=40)	30(75%)	5(13%)	1(3%)	2(5%)	1(3%)	1(3%)
	Married(n=170)	115(68%)	28(17%)	9(5%)	3(2%)	3(2%)	12(7%)
	Divorced/separated(n=10)	9(90%)	1(10%)	0(0%)	0(0%)	0(0%)	0(0%)
	Windowed(n=27)	21(78%)	3(11%)	0(0%)	0(0%)	2(7%)	1(4%)
	P value				0.665		
Educational Level	Non formal education(n=23)	16(70%)	4(17%)	0(0%)	0(0%)	1(4%)	2(9%)
	Primary(n=48)	34(71%)	9(19%)	1(2%)	2(4%)	0(0%)	2(4%)
	Secondary(n=129)	96(74%)	16(12%)	6(5%)	1(1%)	4(3%)	6(5%)
	Tertiary(n=47)	29(62%)	8(17%)	3(6%)	2(4%)	1(2%)	4(9%)
	P value				0.744		
Occupation	Trading(n=101)	72(71%)	15(15%)	4(4%)	2(2%)	3(3%)	5(5%)
	Farming(n=3)	2(67%)	1(33%)	2(67%)	0(0%)	0(0%)	0(0%)
	Driving(n=8)	7(88%)	0(0%)	0(0%)	1(13%)	0(0%)	0(0%)
	Civil Service(n=30)	18(60%)	6(20%)	1(3%)	0(0%)	0(0%)	5(17%)
	Barbing(n=5)	4(80%)	1(20%)	0(0%)	0(0%)	0(0%)	0(0%)
	Unemployed(n=36)	22(61%)	7(19%)	3(8%)	1(3%)	2(6%)	1(3%)
	Others(n=64)	51(80%)	6(9%)	2(3%)	1(2%)	1(2%)	3(5%)
	P value				0.197		
Level of income	Less than 5,000(n=20)	15(75%)	3(15%)	0(0%)	1(5%)	1(5%)	0(0%)

5,001-10,000(n=16)	10(63%)	3(19%)	0(0%)	1(6%)	0(0%)	2(13%)
10,001-15,000(n=48)	33(69%)	9(19%)	4(8%)	0(0%)	0(0%)	2(4%)
15,001-20,000(n=42)	35(83%)	4(10%)	2(5%)	0(0%)	0(0%)	1(2%)
20,001-25,000(n=38)	27(71%)	5(13%)	0(0%)	1(3%)	2(5%)	3(8%)
25,001-30,000(n=19)	13(68%)	4(21%)	0(0%)	0(0%)	1(5%)	1(5%)
30,001-35,000(n=14)	7(50%)	1(7%)	0(0%)	1(7%)	1(7%)	4(29%)
35,001-40,000(n=17)	12(71%)	1(6%)	3(18%)	0(0%)	0(0%)	1(6%)
40,001-45,000(n=9)	4(45%)	4(45%)	0(0%)	0(0%)	1(11%)	0(0%)
45,001-50,000(n=13)	10(77%)	2(15%)	0(0%)	1(8%)	0(0%)	0(0%)
More than 50,000(n=11)	9(82%)	1(9%)	1(9%)	0(0%)	0(0%)	0(0%)
P value				0.065		

*p<0.05

The analyses of on the main reasons for adoption of urban horticultural technologies, the farmers' responses were varied. They are categorized into source of food, source of income, unemployment, use of available water and land and high dependence .About 71% respondents said the source of food as the main reason for adoption of urban horticultural technologies, followed by 'source of income' (15%), and about 4% indicated unemployment (Figure 4 iii). Reason for adoption varied significantly amongst different social demographic groups, sex groups (p = 0.484), age groups (p = 0.499), and level of income (p = 0.065).

4.4. Challenges farmers face in adoption of urban farming technologies.

Table 5 (iii) Frequency distribution on challenges farmers face in adopting of urban technologies according to social-demographic groups, Kibera

	Socio-economic characteristics	Pests & Diseases	Inadequate capital	Slashing crops	security	Inadequate inputs	Inadequate Market	Any other
sex	Male(n=74)	18(24%)	6(8%)	6(8%)	46(62%)	0(0%)	0(0%)	4(5%)
	Female(n=173)	0(0%)	17(10%)	34(20%)	83(48%)	20(12%)	4(2%)	25(15%)
	Total(n=247)	18(7%)	23(9%)	40(16%)	129(52%)	20(8%)	4(2%)	29(12%)
	P value							
Age	Young adults(n=64)	7(11%)	9(14%)	8(13%)	20(31%)	5(8%)	2(3%)	13(20%)
	Middle aged (n=160)	5(3%)	7(4%)	25(16%)	91(57%)	15(9%)	2(1%)	15(9%)
	Older adults(n=23)	6(26%)	7(30%)	7(30%)	18(78%)	0(0%)	0(0%)	1(4%)
	P value							
Marital status	Single(n=40)	4(10%)	4(10%)	1(3%)	31(78%)	2(5%)	0(0%)	1(3%)
	Married(n=170)	13(8%)	10(6%)	33(19%)	79(47%)	16(9%)	4(2%)	25(15%)
	Divorced/separated(n=10)	1(10%)	5(50%)	0(0%)	4(40%)	0(0%)	0(0%)	0(0%)
	Windowed(n=27)	0(0%)	4(15%)	6(22%)	15(55%)	2(7%)	0(0%)	3(11%)
Education level	Non formal education(n=23)	6(26%)	10(44%)	1(4%)	10(44%)	1(4%)	0(0%)	0(0%)
	Primary(n=48)	1(2%)	5(10%)	7(15%)	19(40%)	3(6%)	2(4%)	12(25%)
	Secondary(n=129)	5(4%)	7(5%)	25(19%)	69(54%)	10(8%)	2(2%)	15(12%)
	Tertiary(n=47)	6(13%)	1(2%)	7(15%)	29(62%)	6(13%)	0(0%)	2(4%)
Occupation	Trading(n=101)	7(7%)	7(7%)	17(17%)	57(56%)	8(8%)	1(1%)	15(15%)
	Farming(n=3)	1(33%)	0(0%)	0(0%)	1(33%)	0(0%)	0(0%)	3(100%)
	Driving(n=8)	1(13%)	0(0%)	2(25%)	3(38%)	0(0%)	0(0%)	3(38%)
	Civil Service(n=30)	1(3%)	3(10%)	5(17%)	17(57%)	1(3%)	1(3%)	2(7%)
	Barbing(n=5)	0(0%)	2(40%)	1(20%)	1(20%)	0(0%)	0(0%)	1(20%)
	Unemployed(n=36)	0(0%)	7(19%)	4(11%)	18(50%)	4(11%)	1(3%)	4(11%)
	Others(n=64)	8(13%)	6(9%)	11(17%)	32(50%)	7(11%)	1(2%)	1(2%)
Level of income	Less than 5,000(n=20)	3(15%)	0(0%)	0(0%)	18(90%)	0(0%)	0(0%)	0(0%)
	5,001-10,000(n=16)	1(6%)	1(6%)	1(6%)	7(44%)	3(19%)	0(0%)	3(19%)
	10,001-15,000(n=51)	3(6%)	6(12%)	11(22%)	21(41%)	4(8%)	0(0%)	6(12%)
	15,001-20,000(n=42)	0(0%)	2(5%)	7(17%)	23(55%)	3(7%)	3(7%)	2(5%)
	20,001-25,000(n=47)	4(9%)	6(13%)	6(13%)	20(43%)	2(4%)	0(0%)	9(19%)
	25,001-30,000(n=20)	1(5%)	0(0%)	4(20%)	10(50%)	2(10%)	0(0%)	2(10%)
	30,001-35,000(n=15)	1(7%)	2(13%)	3(20%)	5(33%)	1(7%)	0(0%)	1(7%)
	35,001-40,000(n=17)	3(18%)	2(12%)	3(18%)	11(65%)	0(0%)	0(0%)	0(0%)
	40,001-45,000(n=9)	0(0%)	1(11%)	3(33%)	4(44%)	2(22%)	0(0%)	1(11%)
	45,001-50,000(n=13)	2(15%)	1(8%)	0(0%)	5(39%)	3(23%)	1(8%)	1(8%)
	More than 50,000(n=11)	0(0%)	2(18%)	2(18%)	5(46%)	0(0%)	0(0%)	1(9%)

N:B These responses may not add to 100%,because some respondents gave more than one response(multiple response)

Data on table 5 (iii) shows that (52%) percent of the respondents felt that security of land ownership and theft of crops was the most severe challenge for urban, slashing of crops (16%) , pest and diseases (7%) while only (2%) mentioned inadequate market for vegetables. Those, whose level of income was less than 5,000, indicated that security and pests and diseases as the main challenge at 18% and 15% respectively.

4.5.Kind of vegetables grown.

Table 6(ii) Distribution frequency of kind of vegetables grown according to social-demographic groups, Mathare

	Socio-economic characteristics	Kales	Spinach	Onions	Amaranth	Pumpkin	Green beans	Pepper	others
Sex	Male(n=61)	61(100%)	35(57%)	16(26%)	30(49%)	0(0%)	0(0%)	4(7%)	6(10%)
	Female(n=134)	96(72%)	80(60%)	33(25%)	24(18%)	41(31%)	12(9%)	5(4%)	15(11%)
	Total(n=195)	157(81%)	115(59%)	49(25%)	54(28%)	41(21%)	12(6%)	9(5%)	21(11%)
	P value								
Age	Young adults(n=49)	49(100%)	29(59%)	10(20%)	12(24%)	0(0%)	0(0%)	4(8%)	9(18%)
	Middle aged adults(n=132)	106(80%)	74(56%)	39(30%)	36(27%)	41(31%)	12(9%)	5(4%)	8(6%)
	Older adults(n=14)	2(14%)	12(86%)	0(0%)	6(43%)	0(0%)	0(0%)	0(0%)	4(29%)
	Total(n=195)								
Marital status	Single(n=22)	22(100%)	12(55%)	6(27%)	13(59%)	0(0%)	0(0%)	3(14%)	2(14%)
	Married(n=144)	124(86%)	82(57%)	42(29%)	32(22%)	41(29%)	12(8%)	6(4%)	11(8%)
	Divorced/separated(n=10)	6(60%)	6(60%)	0(0%)	3(30%)	0(0%)	0(0%)	0(0%)	5(50%)
	Windowed(n=19)	5(26%)	15(79%)	1(5%)	6(32%)	0(0%)	0(0%)	0(0%)	3(16%)
Occupation	Trading(n=87)	77(86%)	48(55%)	32(37%)	37(43%)	2(2%)	0(0%)	7(8%)	19(22%)
	Farming(n=4)	2(50%)	1(25%)	1(25%)	2(50%)	1(25%)	0(0%)	0(0%)	0(0%)
	Driving(n=4)	2(50%)	1(25%)	1(25%)	2(50%)	2(50%)	0(0%)	0(0%)	0(0%)
	Civil Service(n=25)	20(80%)	18(72%)	3(12%)	4(16%)	11(44%)	0(0%)	2(8%)	1(4%)
	Barbing(n=2)	2(100%)	1(50%)	1(50%)	0(0%)	1(50%)	0(0%)	0(0%)	0(0%)
	Unemployment(n=28)	28(100%)	17(61%)	7(25%)	1(4%)	13(46%)	6(21%)	0(0%)	0(0%)
	Others(n=45)	26(58%)	29(64%)	4(9%)	8(18%)	11(24%)	6(13%)	0(0%)	17(38%)
Level of education	Non formal education(n=16)	16(100%)	10(63%)	0(0%)	9(56%)	1(6%)	1(6%)	1(6%)	2(13%)
	Primary(n=26)	26(100%)	15(58%)	8(31%)	13(50%)	4(15%)	1(4%)	2(8%)	3(12%)
	Secondary(n=108)	89(82%)	61(57%)	37(34%)	24(22%)	29(27%)	4(4%)	6(6%)	7(7%)
	Tertiary(n=45)	26(58%)	29(64%)	4(9%)	7(16%)	7(16%)	6(13%)	0(0%)	9(20%)
Level of income	Less than 5,000(n=11)	11(100%)	2(18%)	0(0%)	7(64%)	0(0%)	0(0%)	0(0%)	5(46%)
	5,001-10,000(n=23)	23(100%)	12(52%)	5(22%)	11(48%)	0(0%)	0(0%)	3(13%)	3(13%)
	10,001-15,000(n=41)	37(90%)	26(63%)	21(51%)	6(15%)	0(0%)	0(0%)	3(7%)	4(10%)
	15,001-20,000(n=39)	24(62%)	22(56%)	7(18%)	10(26%)	20(51%)	0(0%)	2(5%)	1(3%)
	20,001-25,000(n=19)	12(63%)	15(79%)	6(32%)	3(16%)	15(79%)	0(0%)	1(5%)	2(11%)
	25,001-30,000(n=12)	10(83%)	10(42%)	4(33%)	2(17%)	3(25%)	4(33%)	0(0%)	1(8%)
	30,001-35,000(n=16)	14(88%)	8(50%)	5(31%)	2(13%)	3(19%)	8(50%)	0(0%)	0(0%)
	35,001-40,000(n=14)	12(86%)	2(14%)	0(0%)	4(29%)	0(0%)	0(0%)	0(0%)	1(7%)
	40,001-45,000(n=6)	6(100%)	5(83%)	0(0%)	4(67%)	0(0%)	0(0%)	0(0%)	2(33%)
	45,001-50,000(n=8)	5(63%)	4(50%)	1(13%)	5(63%)	0(0%)	0(0%)	0(0%)	1(13%)
	More than 50,000(n=6)	3(50%)	6(100%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	1(17%)

N:B These responses may not add to 100%,because some respondents gave more than one response(multiple response)

Data from table 6 (ii) show that 81% the respondents grow kales as a major vegetable while (59%) percent of the respondents indicated that they grow spinach, (41%) percent grow onions and 16% grow green beans. Other crops grown by respondents include tomatoes, carrots, spider plant and cabbage at (11%) (Table 6 (ii)). On gender, majority of the respondents grew kales at 72% for female and male at 100% .

4.7. Respondents by Last place of residence

Table 8 (iii) Distribution frequency of last place of residence before residing on the current place according to social-demographic groups, Kibera

	Socio-economic characteristics	Other places in Nairobi	Rural areas	Other urban areas
Sex	Male(n=74)	20(3%)	37(50%)	17(23%)
	Female(n=173)	39(23%)	84(49%)	50(29%)
	Total(n=247	59(24%)	121(49%)	67(27%)
	P value			

Age	Young adults(n=64)	17(27%)	31(48%)	16(25%)
	Middle aged (n=160)	39(24%)	75(47%)	46(29%)
	Older adults(n=23)	3(13%)	15(65%)	5(22%)
Marital status	Single(n=40)	11(28%)	22(55%)	7(18%)
	Married(n=170)	36(21%)	84(49%)	50(29%)
	Divorced/separated(n=10)	2(20%)	4(40%)	4(40%)
	Windowed(n=27)	10(37%)	11(41%)	6(22%)
Education Level	Non formal education(n=23)	7(30%)	10(43%)	6(26%)
	Primary(n=48)	17(35%)	21(44%)	10(21%)
	Secondary(n=129)	26(20%)	68(53%)	35(27%)
	Tertiary(n=47)	9(19%)	22(47%)	16(34%)
Occupation	Trading(n=101)	25(25%)	49(49%)	27(27%)
	Farming(n=3)	2(67%)	0(0%)	1(33%)
	Driving(n=8)	2(25%)	3(38%)	3(38%)
	Civil Service(n=30)	9(30%)	12(40%)	8(27%)
	Barbing(n=5)	1(20%)	3(60%)	1(20%)
	Unemployed(n=36)	6(17%)	22(61%)	9(25%)
	Others(n=64)	14(22%)	6(9%)	5(8%)
Level of income	Less than 5,000(n=20)	4(20%)	14(70%)	2(10%)
	5,001-10,000(n=16)	5(31%)	5(31%)	6(38%)
	10,001-15,000(n=48)	11(23%)	26(54%)	11(23%)
	15,001-20,000(n=42)	11(26%)	21(50%)	10(24%)
	20,001-25,000(n=38)	8(21%)	18(47%)	12(32%)
	25,001-30,000(n=19)	3(16%)	9(47%)	7(37%)
	30,001-35,000(n=14)	6(43%)	6(43%)	2(14%)
	35,001-40,000(n=17)	4(24%)	8(47%)	5(29%)
	40,001-45,000(n=9)	2(22%)	4(44%)	3(33%)
	45,001-50,000(n=13)	2(15%)	7(54%)	4(31%)
	More than 50,000(n=11)	1(9%)	7(64%)	3(27%)

As shown in Table 8 (iii) above, 49% came from the rural areas, 27% from other locations of urban areas, and 24% from other places within Nairobi. Majority of younger adults and middle aged adults came from rural areas at 48% and 47% respectively while 13% of older adults came from other places in Nairobi areas.

5. Summary and Conclusions

5.1. Respondents Characteristics

It is apparent that the majority of respondents were females. This suggests that urban horticulture is dominated by females who in most cases are married with household care giving responsibilities. This agrees with (Lee-Smith et al., 2010) who indicated that in sub-Saharan Africa, studies of urban agriculture have been limited, but those that have been done generally suggest that approximately one-third of households are engaged in some form of urban agriculture, and that two thirds of the farmers are women. Urban farming also favors both social inclusion and reduction of gender inequalities in cities as 65 % of urban farmers are women (Orsini et al. 2013). Because of the close proximity to the home, gardening can be much better combined with child care which is still seen as a woman's duty in many countries (Dubbeling et al. 2010). (Barau, A. A. and Oladeji, D. 2017) found that 69.4% of the females who were doing farming were married in Sokoto Metropolis, Nigeria.

It is clear that majority of the respondents are middle aged adults and education level ranging from informal to post- secondary. Accessing land for farming in urban areas requires energy, determination and maturity. The finding agrees with (Barau, A. A. and Oladeji, D. 2017) who found that most of the urban women farmers (38.9 %) were in the active age range and also (Teig et al., 2009) found that the majority of community gardeners are seniors. Age is also assumed to be a determinant of adoption of new technology. Older farmers are assumed to have

gained knowledge and experience over time and are better able to evaluate technology information than younger farmers (Kariyasa & Dewi, 2013). On the other hand, age has been found to have a negative relationship with adoption of technology. This relationship is explained by (Thomas et al., 2017) that as farmers grow older, there is an increase in risk aversion and a decreased interest in long term investment in the farm. While the, younger farmers are typically less risk-averse and are more willing to try new technologies. On education, it is evident from the findings that the farmers are spread all over education level. The findings outlined are in agreement with the observation in Accra, urban farmers interviewed had no particular educational pattern (World Bank, 2013).

5.2. Space identified for production of vegetables

A renovated urban farming arose worldwide as a response to a number of factors (Bohn and Viljoen 2011). In city centres, the inadequate space has been a major challenge in the diffusion of agricultural activities (Christine E. &Nazim G. 2015). In order to utilize the available vacant urban spaces as efficiently as possible, new cultivation methods are required (Christine E. &Nazim G. 2015).

As a result, the introduction of horticulture activities in available spaces in cities has recently been observed in both land-based and non-land-based vacant spaces. First, non-constructed areas (e.g., abandoned plots, green spaces or interstitial areas) are being converted into urban gardens when available and vacant. Second, innovative methods for turning concrete into urban green infrastructures for vegetable production have been developed in the recent past, ranging from vertical farms (Despommier, 2011) to the most ordinary rooftop gardens.

The study carried in Nairobi found that urban agriculture is practiced in backyard farms, on open spaces under power lines, along roadsides, along railway lines and riverbanks as well as on institutional land (World bank, 2013).Vacant spaces in cities should also be considered as possible alternative of reducing pressure from rural agriculture and to decompensate land loss (Christine E. & Nazim G. 2015), by turning vacant lots into urban vegetable gardens, food security and sustainability are increased.

Figure 8: A farmer watering sukuma wiki at Mwiki
Source: Survey, August 2017

Figure 9: A farmer attending to cowpeas at Mwiki
Source: Survey, August 2017

Gender, age, marital status, education level, occupation and level of income had non-significant to space where production of vegetables is done. This may suggest that due to limited space in urban areas for farming, farmers have no choice other than using the available space.

5.3Reason for adoption of urban technologies

Golden (2013) found that urban dwellers can benefit from urban farming through accessing land, community development, cross-generational and cultural integration, job creation, and economic savings on food. Municipal authorities can also benefit from urban agriculture through savings (Chaminuka & Dube 2017). Land for farming is limited in urban areas, urban farming creates access to land by creating space within cities for farming. Urban agriculture can benefit urban dwellers through accessing land for them to call their own, thereby creating some sense of pride through ownership of the land (Chaminuka&Dube 2017).

Food access and availability are important dimensions that constitute food security (Chaminuka & Dube 2017).Urban horticultural has been viewed as an intervention to deal with food security. It has been used as an effective means for improving food security in critical and insecure areas (Corrigan, 2011; Larsen & Gilliland, 2009). Matteson (2007) found that above 700 community gardens exist in New York City, which has increased food access and availability to urban dwellers. Apart from improving food access and availability, urban agriculture is also important in job creation.
(Hagey et al., 2012) indicates that urban agriculture that offers packaging and processing, to complement crop cultivation is capable of creating many jobs for urban residents. Metcalf and Widener (2011) argues that through Job Creation, many urban agriculture projects will engage youths to manage horticultural farms and this will provides them with income above skills training. Urban agriculture can provide savings for county government. For example, the management of vacant lots by communities in San Francisco turned into urban farming areas benefited the Department of Public Works about US$4,100 through preventing vandalism, dumping, and labor-intensive upkeep (SPUR, 2012).

Out of 6 variables studied, occupation in Kasarani, age and level of income in Mathare were significant ($P<0.05$) on adoption of horticultural technologies. Non-significant of gender, marital status and education level observed in this study may indicate that these socio-economic variables definitely do not have any bearing on the adoption of technologies. Majority of the respondents were traders, which may indicate they have flexible time to attend to their crops.

5.3. Challenges farmers face in adoption of urban farming technologies.

Limited access to land, lack of tenure on property, and insufficient infrastructure and services for urban growers are among the main restrictions of urban horticulture according to (Lovell, 2010). Land tenure affects the application of technologies for agricultural (IslamK.M. &Tuulikki P. 2009), secured land tenure gives sufficient incentives to the farmers to increase their efficiencies in terms of production. Without secured property rights farmers do not feel emotional attachment to the land they cultivate, do not invest in land development and will not use inputs efficiently (IslamK.M. &Tuulikki P., 2009). Theft of crops by non-farmers and stray animals eating crops, are other problems associated with to urban farming (Chaminuka&Dube, 2017).

Urban agriculture is occasionally practiced in public areas unsuitable for housing, such as road verges, banks of drainage channels, wetlands and contaminated sites such as scrap yards and dumpsites for solid and liquid wastes (Nabulo et al., 2008). As such the farmers' crop has at times been slashed down by authorities (Chaminuka&Dube, 2017) .

5.4.Kind of vegetables grown.

Majority of the respondents mentioned kales and spinach. The producers in urban areasgrow more green leafy vegetables, such as kale and spinach(World Bank, 2013) this also agrees with (Gallaher et al., 2013), who indicated that over the past several years, in urban areas especially, indigenous vegetables have been replaced by kale, Swiss chard, and cabbage. Kales (*Sukuma wiki) literally* meaning "to push the week". As the name suggests, low income earners can survive on it by making it a daily meal. Kales due to its low price, it keeps people going hoping for better tomorrow. The case study in Kibera, households and other institutions like the eco school cultivate crops such as kale and spinach – leafy vegetables which adapts very well to the conditions of sack farming (Erulkar&Matheka 2007).

5.5. Last place of residence

Most respondents came from rural areas as a result most households engaging in urban agriculture could be bringing to the city the rural culture of farming to urban areas. Through urban farming, migrants gets opportunity to grow food for consumption purposes and may even sell surpluses (Beckie&Bogdan, 2010), Migrants have important skills and culture which they can share with urban farmers.(Gallaheret al., 2015) found out that the majority of farmers and non-farmers (85% and 75%, respectively) have had previous experience with mixed farming in rural areas, mostly before they migrated to Kibera. A report by World Bank, 2013 indicates that most of the residents engaged in urban farming had stayed in the city the longest or always lived there.

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