DETERMINANTS OF PARTICIPATION IN URBAN HORTICULTURAL TECHNOLOGIES IN NAIROBI COUNTY, KENYA

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Determinants of Participation in Urban Horticultural Technologies in Nairobi County, Kenya

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

Signature .... Date ....

Ezra Nyakang'o Oyaro

This thesis has been submitted for examination with our approval as the University Supervisors.

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DEDICATION

This thesis is dedicated to my wife Edinah, daughter Hope, son Ethan and son Eran, my parents Joshua Sani and Gladys Oyaro.

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ABBREVIATIONS AND ACRONYMS

Df	Degree of Freedom
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
IFAD	International Fund for Agricultural Development
KMO	The Kaiser-Meyer-Olkin
NGOs	Non-governmental Organizations
SDGs	Millennium development goals
Sig	**S**ignificance
SPSS	Statistical Package for the Social Sciences
UH	Urban Horticulture
UHPT	Urban horticultural production technologies

DEFINITION OF OPERATIONAL TERMS

Complexity	The level at which a particular technology is perceived to be hard to understand
Economic factors	Factor that can affect and influence one is financial status.
Education Level	The respondent's greatest level of schooling.
Horticulture	The study of vegetables, fruits and flowers.
Income Level	All income that the respondent receives.
Participation	Taking part in an event or activity
Perception	The way urban farming is regarded, understood and interpreted.
Social Factors	Social aspects in life that affect a person's conduct and quality of life
Technology	The application of scientific knowledge for practical purposes, and for solving certain problems
The middle-aged adults	Ages between 36 (thirty-six) years and 55 (fifty-five) years
The older adults	Age above 55 (fifty- five) years
The young adults	Ages between 18 (eighteen) years and 35 (thirty-five) years
Urban	A geographical area that constitutes a town or city

ABSTRACT

Food insecurity and, poor water and sanitation issues are among the challenges that urban and peri-urban communities face more often. A number of urban households engage in horticulture to address their food insecurity needs and also for sale. However, the understanding on urban farmer's choice of existing horticultural technologies is lacking. This study sought to determine the factors that influence the farmers' participation in select urban horticultural production technologies. Data were collected from 385 respondents spread across four sub-counties in the city using a survey questionnaire. The questionnaires survey collected information on respondents' demographic characteristics, information on social-economic, institutional characteristics and information on technological awareness of the respondents. The study considered six selected technologies; rooftop/balconies, open field, vertical gardens, pallet gardening, green house and hydroponics. Descriptive statistics, principal components analysis and a multivariate probit regression model were used to analyze data. The findings indicates that there was a general low participation in roof top, greenhouse and hydroponic technologies. Multivariate probit results shows that age of the respondent was significant and positively related to open field while negatively related to vertical garden. The level of income of respondents influenced all production systems under consideration. The use of greenhouse production technology was influenced by the land ownership. Institutional characteristics and extension services are other factors that influenced participation in urban horticultural technologies. The findings are of importance to policy makers, National and County governments in identifying areas of policy innervations and various mechanisms meant to promote urban horticultural technologies for sustainable food security.

Key words: urban horticulture, determinants factors, horticultural technologies, food insecurity

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Urbanization is "the process of increase in the population of people living in urban areas" (McGranahan & Satterthwaite, 2014). Urbanization can also be defined as an increase in the population of cities due to migration from rural areas, industrial development, social aspects, and commercialization (Pawan, 2016). Population increases, and the need for people to improve their employment status and housing prospects leads to urbanization of the previously agricultural land (Veronique, et al., 2020). Urbanization results in increased demand for human wants such as food, housing for accommodation, facilities for education and other social amenities. The UN-Habitat estimates that, around 50% of the urban residents in developing countries do not have access to enough food, water and sanitation, (McGranahan & Satterthwaite, 2014). Urbanization in most cases result to high demand for agricultural outputs, changes in land use and increase the land cost (Satterthwaite, et al., 2010). The increase in land value only makes it possible for the richer population who can afford to own land and engage in activities which give them higher returns (Satterthwaite, et al., 2010).Urban areas can be determined by a number of variables, such as the size of population, the number of social amenities, administrative structures, infrastructural facilities and employment rate (McGranahan & Satterthwaite, 2014).

High level of poverty has continued to be witnessed in a number of sub-Saharan countries due to slow growth of Gross Domestic Product (GDP) (Chauvin et al., 2012). Agriculture has been found to be the major contributor to GDP in sub-Saharan countries. Despite the importance of agriculture to the economy, there is still low agricultural production in Africa and there is need to increase productivity to reduce poverty levels (Chauvin et al., 2012). Other than poverty, large population in the cities in Africa are suffering from malnutrition (Tydeman et al., 2018). Approximately close to 200 million people suffer from vitamin A and over 1.6 billion people iron deficiencies (Tydeman et al., 2018). As a result of increased population in cities, inhabitants are faced with a number of challenges such high rate of unemployment and food security among other challenges (Kuddus et al., 2020). Urban horticulture is a possible solution to these challenges facing urban dwellers in the sub-Sahara Africa (Lal, 2020).

Urban Agriculture can be defined as "an industry which is within the urban center or peri-urban of a town or metropolis which grows, processes and distributes a variety of food and nonfood products using largely human and material resources, products and services found in and around urban areas" (Koscica, 2014). Thus, urban Horticulture is part of urban agriculture that deals with horticultural crops such as vegetables, fruits and ornamental crops (Shyr & Reily, 2017). Vegetables and fruits form an essential component of horticultural crops which are rich in bioactive components, minerals and fiber. Consumption of variety of vegetables and fruits alongside with staple foods is necessary for balanced nutrition. Most of the urban residents suffer from the deficient of vitamin A, Zinc, and iodine, (Tenkouano, 2011).

Urban horticulture offers a chance to use abandoned spaces, rooftops, and open spaces in cities to grow food (Heather, 2012). The addition of green spaces in urban areas provides many benefits that may lead to sustainable urban growth development. Badami and Ramankutty (2015) mentioned that horticultural benefits are wide-ranging: urban horticulture provides employment opportunities to many younger generation, generates income for urban farmers, improves food security, whereas Llorach-Massana et al. (2017) indicated it reduces gender disparities, contributes to mental and physical health of the residents and it eliminates social exclusion. Urban horticulture takes various forms of production systems which are carried on the available spaces within the urban areas. The available spaces in urban areas include; house backyards, below power lines, along the roads, near the riparian land and unutilized land (Cofie et al., 2008). The nature of the horticultural activities engaged in peri-urban and urban areas depends on location of the land, its size and the land tenure (Pearson, 2010). Urban technologies offer massive opportunities for limited spaces or places with 'no spaces' (Specht et al., 2014).

Policy development, the technical support on urban horticultural systems sustainability, marketing issues, food protection measures and water supply, FAO, (2010) are some of the obstacles that impede the advancement and implementation of horticultural production techniques. It is estimated that approximately 800 million people are engaging in urban farming for food production in various urban settings. (Lawson, 2016). In Kenya, majority of people work in agricultural related sectors and their daily living depends mainly on the farm harvest (World Bank, 2008). Due to the decrease of spaces for farming in the urban areas, vegetables are the most common crop grown (Hamilton et al., 2013). Various production systems have been practiced in various urban areas to grow vegetables. These production systems result to high yield and fewer pests attacks (Truong et al., 2012). Participation in any technology depends on its physical performance, cultural and the social- economic factors (Glover et al., 2016). Socioeconomic standing of a person determines their ability to invest their resources and time in the perceived urban technologies and also take the chances to deviate from their conventional practices to new innovations (Martey at al., 2013).

1.2 Horticultural Technologies Practices in Urban Areas

Globally, various urban horticultural practices which utilize open spaces such as, backyards, roof tops, balconies, along the roads and water lines are being practiced (Dubbeling et al. 2010). The urban horticulture practices include: home gardens, vertical farming, rooftop farming, balcony farming, hydroponic farming and open space farming. Home gardening is the most common form of urban horticulture, (Cousins et al., 2015). Home gardens are characterized by it is closeness to homes, cultivation of different types of vegetables, and use of low-cost inputs. This type of horticultural activities is regarded to many as a hobby and an opportunity for urban residents to spend time outside (Lovell, 2010). Home gardens are irrigated to achieve high yields. The source of water for irrigation includes rain water, harvested water, tap water or waste water.

Vertical farming is another common horticultural practice in urban areas. It is a concept which involves the conversion of the horizontal space into vertical space

(Beacham et al., 2019). This is an idea of cultivating crops by artificially stacking them vertically on top of each other (Banerjee C., 2014). The idea to use multistory building to produce food, was an American geologist, Gilbert E. innovation (Mancebo, 2018). The idea was advanced by Dr. Yeang, a Malaysian architect, who believed that the human activities involving horticultural production must mimic the patterns, its attributes, characteristics and the cycles of natural ecosystems (Besthorn, 2013). The concept of supplying food in urban areas is not modern, but the concept of vertical farming and 'zero-acreage farming' to produce food is modern (Despommier, 2009). These are some subsets of urban farming that are decentralized and sustainable (Thomaier, 2015). The production system does not depend directly on the climate and soils, as a result, this kind of farming can be done through the year. Urban areas with severe weather conditions and contaminated soils can grow health foods independently all year around (Despommiers, 2011).

Vertical farms can be either 'indoor farming' or 'outdoor farming'. Indoor farming is advantageous that old traditional soil-based farming. It gives room to total control of conditions for optimal survival of the crops, the growth and maturity, thus ensuring maximum yield (Despommiers, 2011). This Maximum produce involves, 'more crops per surface area due to stacking of crops in racks' (Banarjee & Adenaeuer, 2014). This can be achieved by using the advanced technological production systems such as hydroponics which ensures optimal growing and multiple harvest through the year (Gaba et al., 2015). Soil free vertical production system can increase production to 10 times as compared to the soil-based systems (Burrage, 2014). Crops grow much faster with multiple harvest in a year compared to those subjected to uncontrolled external conditions (Gaba et al., 2015).

Hydroponics can be defined as the growing of crops without use of soil, but with the use of nutrient solutions (Aires 2018). It is the production system where soils are eliminated, but instead another media is introduced to hold the plants (Aires 2018). The essential nutrients needed by plants are introduced into a solution induced into water. The water solution mixed with necessary nutrients supplies the plants vital nutrients for growth (Kibiti, 2017). Hydroponic farming can be traced to many centauries back, with early cases reported in the Chinese cultures and Aztec (Tripp, 2014). The formal studies of hydroponics started in 17th Century with the publication of the findings by John Woodward and Sir Francis Bacon (Tripp, 2014). In 1938 the scientists from California University came up with concept of hydroponic 'gardening and commercial Agriculture', Tripp (2014). The concepts by California scientists popularized the growth of crops using water solutions rather than soils and the concept was popularized through print media (Nisha et al., 2018). The United State Army, anticipating the Second World War, engaged in hydroponic farming to supply vegetables to their military personnel (Jones, 2014).

Hydroponics has been found to be coast effectively in terms of labor, it eliminates the traditional practices such as fumigation, tilling, watering and cultivation that were labor intensive (Tripp, 2014). A variety of crops such as leafy vegetables, tomatoes and cucumbers can be grown hydroponically and the yields are usually high (Okemwa, 2015). Hydroponics system conserves a lot of nutrients and water thus minimizing land and water are recycled within the system instead of being released to the surrounding environment (El-Kazzaz & El-Kazzaz, 2017). The crops are constantly fed with nutrients thus increasing productivity (Sardare & Admane, 2013). The systems are highly adjustable and they may function as a form of recreational activities to various commercial businesses to conduct urban horticulture (Barbosa et al. 2015). However, the initial cost of setting the hydroponic systems is costly. The cost of producing the nutrients solution, the pumps that run the system and the lighting and heating system makes hydroponic farming an expensive affair (Tripp, 2014).

Inadequate space for farming in densely populated urban areas is the major cause for open farming subsystem in cities. The open space tenure insecurity discourages food production for the urban poor (Lee-Smith et al., 2010). The open space in urban areas include; along the roadsides, along the water bodies, under power lines and on empty lots (FAO, 2012a).Open space gardens can be either supported through, national government, non-governmental organizations, or financed by private sponsor or donors. In other gardens, an individual or a group of individuals rent or own a private piece of land and share the spaces with other gardeners (Lee-Smith et al., 2010). Through open space farming, urban residents have an opportunity to use a subsidized land and thus enhance their nutrition and food security. Many urban areas in Argentina, Sri Lanka and Madagascar, promote school garden programs (Dubbeling et al. 2010). The Crops in open spaces are either irrigated or rain fed (Thebo et al. 2014). The open irrigated system often uses polluted water to irrigate the crops. A number of urban farmers in Dakar, Nairobi and Ouagadougou use waste water directly from city sewage (FAO, 2012b).

Green house production system has proved to be profitable than open field production systems (Despretz et al., 2018). Urban farmers have adopted the technology to improve food production and income. Green housed can be installed on the ground service or at rooftops. When placing greenhouses on rooftops, it is important that the weight-carrying capacity of the building has been examined. Therefore, it is necessary that greenhouse materials such as roof covering materials are light weight (Specht et al., 2015). Hydroponic systems are suitable for installation at rooftops compared with the convectional greenhouses (Caplow, 2009). The greenhouses are constructed using low-density polyethylene curtains and thermal screen to create a conducive heat condition in the green house (Nadal et al., 2017). The thermal screen and curtain, both works together depending on the temperature in the greenhouse. The nutrients and water that are essential for crops growth are provided by drip irrigation. Greenhouse food production system has been found to be more self-efficiency than outdoor gardening. It also improves the economic status of cities, the environment and the social-educational of urban residents (Nadal et al., 2017).

1.3 Statement of the Problem

Approximately 8.5 billion people will be living in urban and peri-urban areas worldwide by the year 2030 (United Nations, 2015). The trend of migration to urban areas is high, and it is projected that by 2050, approximately two-thirds of the global population will be living in urban areas. (United Nations, 2014). In Kenya, Nairobi County has the largest urban population of about 4 million as per the 2019 Kenya Population and Housing Census Report and over 60% of the population reside in numerous slums located within the city. The slums are characterized by continual land disputes, poor living conditions, inadequate water and sanitation facilities, poorly planned infrastructures, limited social amenities and the unemployment rate is quite high. (Kimani et al., 2014).

Residents of urban areas are also faced with a high cost of living ranging from education, health care, housing, transportation and inflated food prices as compared to the rural residents (Cohen & Garrett, 2010). Food insecurity is attributed by overdependence on the purchased food items, impact of climatic change and reduction of agricultural land (Kimani et al., 2014). Besides the increased demand for food, poverty and malnutrition also remains a challenge in a number of cities globally. It is approximated that about 40% of the urban residents live on a less than US$1 a day (FAO, 2012). Similarly Cohen and Garrett, (2010) noted that a number of urban residents spend about between 60 percent and 80% of their income on food, making them more susceptible to changes in food prices. Such harsh reality of poverty in the urban areas require both short- and long-term strategies which will ensure sufficient food supply. Large share of land in the city is dedicated for housing, and the land set aside for gardening is scarce or not available at all. A number of strategies which utilize small spaces to produce food in urban areas have been employed and the kind of strategy employed depends on the, extent, the duration of the severity and its magnitude (Kimani et al., 2014).

Several studies have investigated various factors influencing urban horticulture. Studies on the determinants have discussed policy issues in details (Pölling, 2016). Other, studies have investigated motivation of urban residents on regard to urban farming (Trendov, 2018). Tiraieyari et al. (2019) investigated factors influencing implementation of urban agriculture using data reported by agricultural professional officers and he recommended that further research should be carried to collect multi-information from urban dwellers. Limited studies have been undertaken to understand sociological - economic factors, perception of the urban farmers, knowledge dissemination and constrains limiting horticultural practices in urban areas. This study therefore sought to assess the factors associated with farmers' participation in select urban horticultural technologies in Nairobi City, Kenya.

1.4 Justification of the Study

Horticultural technologies practices increase food production and consequently, the number of people who are impacted by famine can be reduced by 40% (International Food Policy Research Institute, 2014). The implementation of effective urban agriculture techniques will lead to improved food security for a multitude of low-income individuals in urban settings, thereby contributing to the attainment of Kenya's sustainable development goals (SDGs) pertaining to food security. The information on how these technologies diffuses among the urban population and the social-economic factors that may hinder or promote urban production technologies need to be understood.

This study mainly focused on the factors influencing urban horticultural technologies practices as food security measure among urban areas in Kenya. The results obtained through the survey will be useful to agricultural officers, the findings will indicate the participation status of various production technologies, and thus based on the information they will come up with mechanisms to promote the less participated technologies. The findings also, can be helpful to the policy makers in formulating, designing and implementing policies that would create enabling environments for participation and sustainability of the urban horticultural technologies in peri-urban and urban areas.

1.5 Objectives of the Study

1.5.1 General Objective

To investigate the determinants which influence the participation of urban horticultural production technologies (UHPT) in the County of Nairobi.

1.5.2 Specific Objectives

i. To determine the status of participation of urban farmers in select urban horticultural production technologies in Nairobi County.

ii. To determine the demographic characteristics, Social-economic and institutional characteristics that influence the farmers' participation in select UHT in Nairobi County

1.6 Hypothesis

H_0^1: There is no statistical difference in participation in select urban horticultural technologies by social economic characteristics.

H_0^2: Social-economic and institutional characteristics do not significantly influence farmers' participation in urban horticultural technologies.

1.7 Scope of the Study

The scope was restricted to urban farmers of Kibera, Mathare, Roysambu and Kasarani practicing urban horticultural technologies. The areas range from spatially populated areas of medium income earners to the densely populated areas of low income. The four areas of Kasarani, Mathare, Roysambu and Kibera are among sub-countries of Nairobi County with the highest number of peri-urban and urban agricultural practices (Etikan et al., 2015).

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Urban Horticulture

Urban horticulture is the growing of horticultural crops for ornamental use and consumption within the urban areas and its surroundings (Arteca, 2015). Horticultural practices can be traced back to many years ago, its origin being the evolution of human activities from the nomadic live to the cultivating of different crops such as vegetables on a limited parcel of land around their homes or in a given plots which were visited once-in-a-blue-moon during the migrations period (Arteca, 2015).The practice of urban horticulture in Africa, Sub-Saharan countries and in Kenya has been necessitated by, among other factors, the shortage and high cost of food due to the increased population in urban cities (Gallaher et al., 2015).

A number of African countries have continued to record a strong and sustainable economic growth in the recent past (UN-HABITAT, 2013). Urban and peri urban residents require more ‘greener cities and these greener cities are mainly associated with good living standards. The UN-HABITAT (2013) has recommended well utilization of the natural resources within the cities. The increase of horticultural production activities to support growing urban population with food has led to increased utilization of the available natural resources. Consequently, numerous horticultural innovations have been embraced by actors to ensure environmental sustainability and reduced farm inputs. This is a common characteristic in a number of the East African cities, where numerous plant nurseries for vegetables and fruits can be seen along the roadside sides (FAO, 2012). In Kenya, a number of young adults have ventured into horticultural related entrepreneurship. As a result, the young people have been able to create self-employment, they have reduced food transportation costs, and they have reduced environmental pollution through recycling of the urban wastes (FAO, 2012).

Urban horticulture provides a secure environment for leisure activities, enhances the physical landscape of neighborhoods, and adds aesthetic value to the surrounding area, fostering localized pride and a deeper connection with the space (Nikolaidou et al., 2016). The community gardens plots enables the locals to build trust to each other (Teig et al., 2009). The organization of the gardens varies from tightly knit associations to more loosely organized ones, and most often the facilities are shared (de Neergard et al., 2009). Shared areas for communal farming are generally located in open spaces of urban regions. The spaces can be on the rooftops and any unutilized space in the city, the spaces can be small land sizes or the large ones. Urban farming is not only limited for food production, but also serves as an "agent of change and a potential catalyst for community development for communities (Berges, 2014).

Rooftop gardening, backyard gardens and the community gardening can boost tourism and result to the improved urban economy (Rowe, 2010). Urban gardens can attract residents and businesses which will accelerate commercial growth. Rooftop gardens in particular reduces the heating cost and cooling of buildings. They can also reduce chances of the building cracking thus saving the costs for repairing the buildings (Rowe, 2010). Vertical farming is a new production system that is under development and can be easily described as a greenhouse stacked on each other (Despommier, 2013). Like rooftops gardens, the vertical farms require a small space and they can compensate the agricultural land lost for commercial buildings.

The production of the horticultural products are characterized by low- cost inputs (Galhena et al., 2013). Urban horticulture creates an 'opportunity cost', urban farmers have opportunity to save an income through the consumption of their farm produce which are relatively cheaper to produce other than to purchase from the stall and city markets (Ruth et al., 2013). Household food production reduces the family food budget and transportation costs. Mohammadi et al., (2014), indicated that urban farmers produce food either to meet their family needs or for business intention. Agricultural related industries and job opportunities are created, either directly or indirectly as a result of participation in horticultural activities. These opportunities include the seed and fertilizer production, farm tools, processing, agricultural cooperatives, and marketing and distributing (Mohammadi et al., 2014). The direct marketing strategies enables small farmers to expand their operations easily, since community agriculture relies on the individuals who value and promote the local farmers, the farmers in turn are able to make diversified and steady revenue (Flora et al., 2007).

As per Orsini et al., (2013), peri-urban and urban farming has improved food supply and health conditions in urban areas. It is also considered as a multifunctional intervention (Lovell. 2010). It has become an important strategy to promote health issues in urban areas (Yeudall, 2007). A good number of studies have tried to demonstrate the association between urban farming and food insecurity in the urban cities or its relationship on the improved dietetics through consumption of household vegetables and the fruits (Rezai et al., 2016). In addition, Genter, (2015) indicates that, engaging in urban farming may result to the improved physical activities, reducing of stress and improved health.

The other studies done, have recorded negative effects of urban horticulture. A number of them have pointed the possibility of the heavy metals in the harvested crops or horticultural soils (Rouillon et al., 2017. Heavy metals traces in fruits and vegetables may lead to a health risk of the people who consume such farm products (Izquierdo et al., 2015). On the other hand, the health risks due to heavy metals on humans are unclear. It is not automatic that, if the soils have heavy metals, then the harvested crops have high concentration of the same metals and the consumption of those products will result to human health risks (Warming et al., 2015). Nevertheless, any potential health risk on humans as a result of consumption of urban agricultural products, need to be documented.

2.2 Horticultural Technologies Participation

As per Loevinsohn et al., (2013), technology is a method of physical technique. The main aim of technology is to improve a certain status quo to a better or even raise it to a high standard (Zmitko et al, 2017). According to Loevinsohn et al., (2013), technology participation is the blending of the perceived new technological ideas into the current practices and in most cases is preceded by a season of experimenting and some level of adaptation. The technology participation can be classified into two groups; intensity of the participation and the rate of participation. Participation rate is the speed at which a farmer accepts a perceived innovation. Intensity of participation is referred as the level of usage of any perceived innovation in any particular period (Zmitko et al, 2017). According to Zmitko et al, (2017) the first step is to consider if to participate in any particular innovation is in a 'discrete state with binary response variables or not'. As per Loevinsohn et al., (2013), the decision of a farmer's on whether to participate in the perceived new technology or not is conditioned by the circumstances, the existing conditions and the dynamic relationship between the characteristics of the technology.

Kariyasa and Dewi (2013) noted that participation in the perceived new innovations can lead to increased food production. The findings by Jain et al. (2009) indicates that those who are not willing to accept the perceived new horticultural technologies are likely to encounter socio-economic dormancy which may result to deprivation. The individuals who are perceived to be overwhelmed by some feelings of distress find it almost impossible to embrace the use of modern technologies. Selvaganapathi and Raja (2012) suggested that this kind of feeling of incompetence results to anxiety and dissatisfaction. Marangunic and Granic (2015) reported that the continuous upgrading and progression in technology development brings a lot of dilemma on whether to accept or reject the innovation. According to Rosemary and Mercy (2018), two research models can be used to explain technology acceptance. One model is the system specific, and it majorly focuses on how an innovations attributes affect the perception of an individual on technology, which in turn affects technology usage.

In the early innovation stages, social acceptance and perceptions is the key for the failure or the success of its diffusion (Specht et al., 2015). The perception of all stakeholders on the practice of farming innovations will be relevant for the success of horticultural technologies. Introduction of the perceived new technologies, in many instances is accompanied by a certain level of resistance during the initial stages. Diffusion of the perceived new technologies may fail, if the stakeholders perceive that the innovations may deliver little benefits or results to high risks to those who wish to finance the innovations, develop them or implement (Specht et al., 2015).

2.3 Determinants of Urban Horticultural Practices

The studies on factors influencing on urban horticultural technologies are increasing with the diffusion of the technologies in the cities (Pierpaoli et al., 2013). A farmer's decision on the continual practice of technology is conditioned by the dynamic interactions characteristics of the technology and the array of circumstances and conditions (Loevinsohn et al., 2013), The understanding of particular factors influencing the choice of technology is not only important to the generators of the innovation, but also to the economist studying the determinants (Mwangi & Kariuki, 2015). A study by Akudugu et al, (2012) has tried to group the factors influencing horticultural technology practices into three main categories; social, economic and institutional related factors. Although there is a number of categories of determinants for horticultural technology practices, there has been no clear distinguishing feature between variables in each category. The categorization is usually based on the current technology which is being investigated, the location of the study, the researcher preferences, and the client's needs (Mwangi & Kariuki, 2015).

The social-demographic characteristics determinants of horticultural technologies include the farmer's education level, experience, age, the family size, gender and financial factors (Pierpaoli et al., 2013). The size of the family is key in participation of any of the horticultural innovation, the family provides the necessary human labor and the general management (Asfaw, 2012). A large family is likely to participate in new technologies during their farm production effort (Idrisa et al., 2012). On the other hand, a number of researchers have indicated that gender does not influence horticultural technological rather it primary depends on easy access to the resources, and if in a particular context either gender tend to have better access to these resources, then in that context the technologies will not benefit both women and men equally. (Thomas et al., 2017).

Age also has been found by a number of researchers to positively influence the participation in horticultural technologies (Emanuel et al., 2016). The younger farmers are typically less risk-averse and are more willing to try new technologies while the older generation on the other hand, are found to be less trusting on the new innovation practices. They are said to be resistant to new horticultural technologies and instead prefer to continue with what has been tried and tested (Sodjinou et al., 2015). However, effective information on the benefit of the innovations softens the older farmers towards practicing the technologies (Emanuel et al., 2016).

Researchers have indicated that education is important determinant in the adoption of the perceived new technologies (Baumgart-Getz et al., 2012). It is assumed that farmers with more education are well informed and are able to evaluate and interpret information on innovations than those perceived to have less level of education. Education is the number of schooling years of an individual and hence a continuous variable (Alene et al., 2007). Alene et al. (2007) studied the relationship of education and improved agricultural technology Nigeria. The results showed that the education level had a significant and a positive relationship on agricultural technology adoption. The findings of (Beshir et al., 2012) on the double-hurdle method, showed a significant and a positive relationship of education level on chemical fertilizer technology adoption in Ethiopia. The farmer years' experience on farming has also been found to have a positive and significant relationship in a number of studies (Birhanu, 2018). A few studies have reported that education have insignificant effect on new innovation practices (Samiee et al., 2009).

The findings of Beshir et al. (2012) indicated a significant and positive relationship of the off-farm income and the participation in new innovations in Ethiopia. Households which are engaged in various off-farm activities have high chances of generating additional income which will enable them to purchase farm inputs. It is therefore expected that the ready and easily available off-farm income is positively related technological participation (Beshir et al., 2012). The availability of reliable information influence horticultural technology practices. Access to information enables farmers to be aware of the existence of a certain technology and it reduces uncertainties (Thomas et al., 2017). Urban residents are willing to practice horticultural technologies when extension services are offered to them. Through extension services, farmers get reliable information since the extension officers' act as link between innovators and users (Thomas et al., 2017).

The Economic factors have been found to have strong influence on people's environmental decisions making and behaviors. An individual will take into account financial considerations when making environmental decisions which are associated with a new practice (Adolwa et al., 2017). The absence of financing support to purchase farm input for urban farmers discourages the modern urban farming practices (Ehiakpor et al., 2021). The availability of adequate infrastructural support influence environmental behaviors (Ngwira et al., 2012). The infrastructural support that may influence the horticultural technologies include easy asses to land, availability of water for irrigation and availability and cheap farm inputs among others (Kassie et al.,2013). Perception on the other hand, may encourage or discourage urban residents from practicing the new innovations (Ajzen, 2011). The negative perception portrays urban farming as an activity for people of lower status in the society.

2.4 Conceptual Framework

The study used the concept of diffusion of technology theory by (Rogers, 2003). Rogers's defined adoption as the decision of the full use of a particular innovation as the only option available" and diffusion as "the process at which innovations are passed from one person to another thorough various channels over some time amongst the members of the social system". It can be seen from the definitions, innovations, channels of communications, time, and the social systems are some of the key components of the diffusion and participation of innovations.

Innovations is practice or an idea that is perceived to be new (Rogers, 2003). Technology that was invented many years ago, still can be regarded as a new technology if an individual perceives it to be new. Uncertainty is the main obstacle to the participation of various innovations and to overcome the uncertainty in the participation of innovations, the individuals need to be made aware of advantages and disadvantages of new innovations. Interpersonal communication and mass media are the main channels of communications of which technology is passes from one individual to the other. Diffusion has been found to be a social process which involves mostly interpersonal communications relationship (Rogers, 2003).

Innovations decision making process is the information seeking and the information processing process (Rogers, 2003). Innovations and decision-making process involves: knowledge transfer, persuasion, the process of making decision, its implementation, and the confirmation of technology. The process is shown in the figure below.

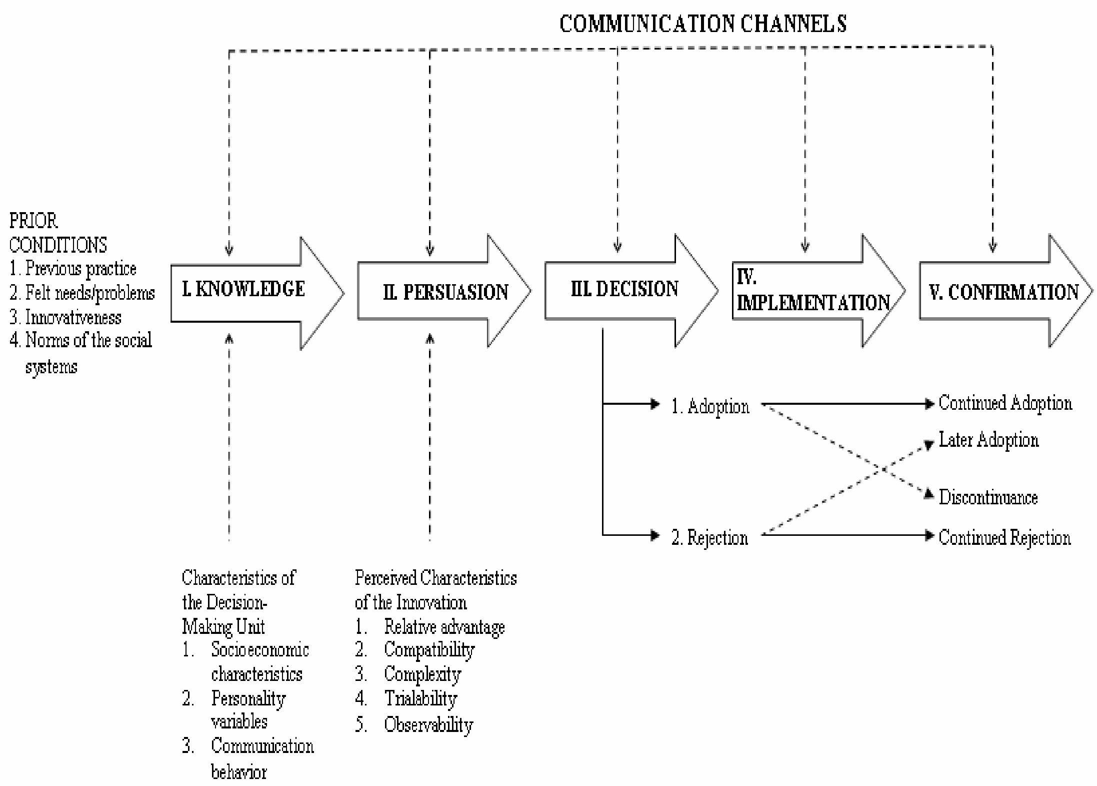

Figure 2.1: A Model to Illustrate Innovation-Decision Process Stages

(Source: Rogers, 2003)

The Figure 5 below illustrates the presumed relationship among various factors that constitute a conceptual framework. This study seeks to investigate the correlation between the variables and parameters. The researcher considered key factors influencing the participation in urban horticultural technologies. They include social-economic factors, institutional characteristics and information sources.

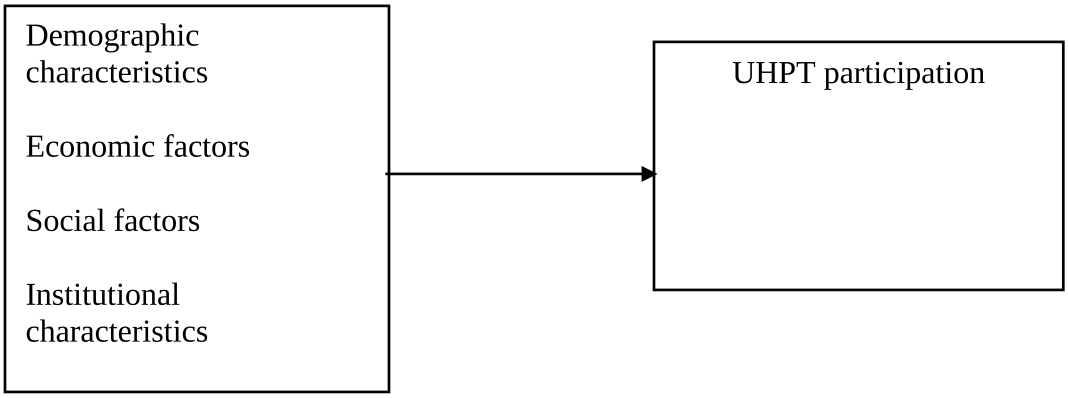

Figure 2.2: Conceptual Framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter focuses on the methodologies used for this study. It presents subsections which give detailed information on the location of study, research design, sampling size, sampling procedure, target population, data collection and data analysis

3.2 Location of the Study

The research was conducted in Nairobi County which is approximated to have an area of 695.1 Km^2 and it is surrounded by the counties of Kajiado, Machakos and Kiambu. According to 2019 Kenya National Census, the estimated population of Nairobi County is 4,397,073 people, making it the most populated county in the country. The County les between longitudes 36.817223 E and latitudes -1.286389 S at altitude of about 1,798 Metres above the sea level (Nairobi County Annual Development Plan (NCADP), 2018). Nairobi County lies at Global Positioning System (GPS) of 1017'11, 0004" S and 360 49'2.0028" E.

The County has 17 sub counties as indicate in figure 1 above. The sub counties with highest number of agricultural practices in Nairobi County, include; Starehe, Roysambu, Kasarani, Mathare, Kibra, Lang'ata, Westlands, Dagoretti North and South, Embakasi West, Central and South and Makadara (Etikan et al., 2015). The four sub- counties of Kibera, Mathare, Roysambu and Kasarani are among sub counties with the highest number of agricultural practices in Nairobi County. The four sub- counties represents a wide-ranging characteristics from spatially populated areas of medium income to highly densely populated areas of low income and urban horticultural practices have been practiced for some time now. Kibera in addition, is the largest slum in Kenya and Africa. Mathare sub county has the highest population density of 68,942/km2 and Kasarani has the largest land covers as per the 2019 Kenya Population and Housing Census. Urban farmers who were practicing horticultural technologies were identified with the assistance of agricultural officers and Nairobi residents who were practicing horticultural technologies.

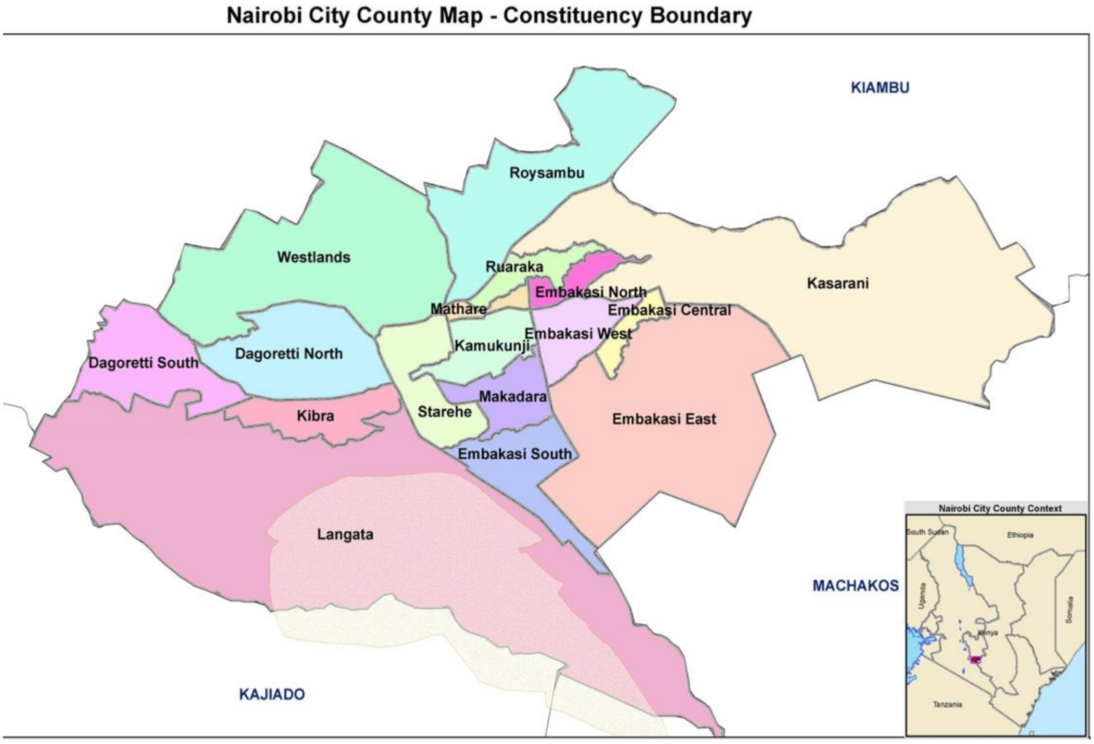

Figure 3.1: Nairobi City-County Map Showing Constituencies and Associated Boundaries

Source: Masime et al. (2013)

3.3 Research Design

This research utilized the descriptive survey design. The design was more appropriate for this study because it enabled the urban farmers to be interviewed directly, enabling us to ask them questions about themselves as well as obtaining primary data. The data collected was analyzed and presented to address the hypothesis.

3.4 Target Population

The targeted population for the study were active, visible urban farmers who were practicing horticultural technologies in Kibera, Mathare, Kasarani and Roysambu sub counties of Nairobi County.

3.5 Sample Size and Sampling Procedure

A sample size of 385 was drawn from urban farmers who were practicing horticultural technology practices. The size of sample was believed to provide the reliable data to answer the objectives of this study. The sample size was arrived by the application of Mugenda and Mugenda, 1999 formula as follows;

$$n = z^2pq/d^2$$

Where;

n = the desired sample size

z = the standard normal deviate at the required confidence level (95% is 1.96)

p= the proportion in the target population estimated to have characteristics being measured

q = 1-p

d = desired level of precision (0.05)

$$n= z^2pq/d^2 = (1.96)^2 *(0.5) * (0.5)/ (0.05)^2 =385$$

Distribution of Sample Size

The Table 3.1 shows how the sample size for each sub-County was arrived. The population for sub - counties of Kibera, Mathare, Kasarani and Roysambu is 185,777, 206,564, 262,023, 202,284 respectively as per the 2019 Kenya Population and Housing Census Report.

Table 3.1: Distribution of Sample size

Sub county	Population (As per census, 2019)	Sample size computation	Sample size	Percentage
Kibera	185,777	385*185,777/856,648	84	22
Mathare	206,564	385*206,564/856,648	93	25
Kasarani	262,023	385*262, 023/856,648	117	30
Roysambu	202, 284	385*202,284/856,648	91	23
Total	856,648		385	100

Snow ball sampling methods was used to identify 385 (Roysambu- 91, Kibera-84, Mathare-93, and Kasarani-117) respondents who were practicing horticultural technologies practices. The Nairobi County extension offices assisted to identify the active farmers also farmers identified their fellow farmers.

3.6 Data Collection

This study relied upon both quantitative and qualitative primary data. Data was collected from the urban farmers who were engaged in horticultural practices using a structured questionnaire. Questionnaire provided privacy to respondents since they responded to the questions without interference of researcher. A Pilot study of the questionnaire was done to 38 respondents to assess their comprehension and interpretation of the survey question. The revisions were done were necessary. The data which was obtained from the pilot study was used to test the internal consistency of the research instrument using Cronbach's Alpha coefficient. Questionnaires were administered via face-to-face interview and supplemented with field observations. The questionnaires helped to solicit first-hand information from the farmers. The information sought from respondents included the horticultural production technologies, perceived benefits of horticultural technologies, perceived challenged in participating horticultural technologies, UHPT information sources, kind of vegetables grown in urban areas, the spaces for growing vegetable and respondents' social-economic characteristics. The respondents' location was mapped with a Global Positioning Systems (GPS) receiver, their names and contacts were also recorded. The survey was conducted by five surveyors coordinated by supervisor and were recruited from the area of study to make work easier. The surveyors were made aware of the scope and objective of the study. The survey was carried in January and February 2023. The map below shows the location of sampled respondents in the areas of study.

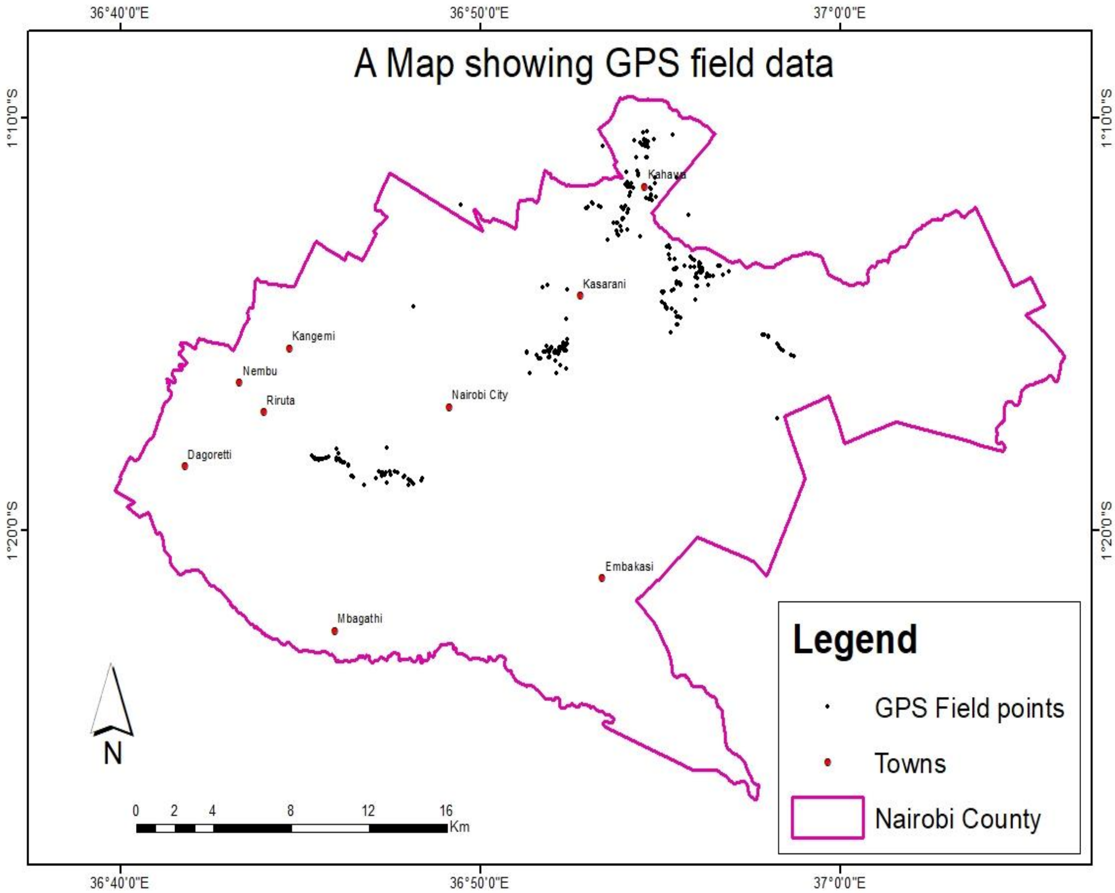

Figure 3.2: Map Showing Location of Sampled Areas of Study

(Source: Field survey Data, 2023)

3.7 Data Analysis

After data collection process, answers and questions were coded and entered on the computer spreadsheet for analysis. The demographic characteristics such as age, gender, level of income, occupation, and education were summarized using tables, frequencies, and percentages. The arithmetic mean was utilized to measure the central tendency of independent variables while the standard deviation was used to measure dispersion of social, economic and UHPT awareness statements.

The Table 3.2 and 3.3 below indicates the variables and the parameters which were measured. The variables in table 3.3 were measured in a 5-point likert scale on series of statements; 1= Strongly Disagree; 2=Disagree; 3=Neither Agree or Disagree; 4=Agree; 5=Strongly Disagree. The means were interpreted as follows: Strongly disagree in the range of 1.00 - 1.80, Disagree 1.81 – 2.60, Neutral 2.61 – 3.40, Agree 3.41 – 4.20, and Strongly agree 4.21 – 5.00 (Nyutu et al, 2021).

Table 3.2: Description of Hypothesized Variables and Units of Measurements

Variable	Definition	Measurement
Dependent variable (s)	Farmer participation in selected horticultural technologies (Open field, Greenhouse, Vertical Garden, Hydroponics Pallet gardening and greenhouse)	1= if farmer used the technology, 0= if otherwise
Independent variables		
Age	Age of the respondents in years	measured in years
Gender	Gender of household head is male	1= male 0=otherwise
Level of education	Respondents highest level of education attained (Informal, Primary, Secondary, post-secondary)	1= Informal 2= Primary 3= Secondary 4= post-secondary
Source of income	Respondents source of income	1= Employment 2= Self-employment 3= Farming 4= Rent 5 = Short term engagements 6= social benefits; 7=Others
Monthly income	Respondents average monthly household income in Kenyan shillings t	1= Less than 15,000 2= 15,001 to 30,000 3= 30,001 to 45,000 4= 45,001 to 100,000 5 = more than 100,000
Space Ownership	The respondent's ownership of space/land for growing crops	1=owned space plot/secure of land tenure 0= otherwise
Duration in Nairobi	The time in years respondents have stayed in Nairobi	1= Less than one-year 2= 1 to 5 years 3= 5 to 10 years 4= more than ten years
Place of origin	The respondents original homestead before moving to Nairobi	1= Rural areas 0= otherwise
Farming groups	The respondents belonged to farming group or not	1= Yes 0= otherwise
Trainings	The respondent has received training in the last one year or not	1= Yes 0= otherwise
Credit facility	The respondents has received credit facility or not	1= Yes 0= otherwise
Information sources	Respondents received the information on horticultural technologies from various sources	1=Print media 2 =Neighb 3=Family members 4= NGO

Table 3.3: Urban Horticultural Production Technologies Participation Variables and their Measurement Scales

Variable	Definition	Parameters
Dependent variable (s)	Farmer participation in selected horticultural technologies (Open field, Greenhouse, Vertical Garden, Hydroponics Pallet gardening and greenhouse)	1= if farmer used the technology, 0= if otherwise
Independent variables		
Social factors	Farmers social factors were measured in scale likert scale (strongly disagree, Disagree, neither agree or disagree, Agree and strongly disagree)	Family, Peer pressure, social class, social expectations Social capital
Economic factors	Economic factors were measured in scale likert scale (strongly disagree, Disagree, neither agree or disagree, Agree and strongly disagree)	Enterprises, Employment, Inflation, reinvestment, Savings

Data was analyzed using principal components analysis, factor analysis and probit regression. Factor analysis was used to test the first hypothesis 'there is no statistical difference in participation in select urban horticultural technologies by social economic characteristics. Factor analysis was used to describe the variability among the select production technologies and also to test if the production technologies were correlated. Multivariate Probit regression was done to test the second hypothesis 'social-economic and institutional characteristics do not significantly influence farmers' participation in urban horticultural technologies. Estimation of the univariate probit model for utilization of each production technology practice by farmers could result in the issue of simultaneity (Greene, 2008). To address this challenge, the multivariate probit model was employed to illustrate the interdependence among dependent variables (Taye et al., 2018).

A multivariate probit model is as shown below;

$$Y^*_{ij} = X'\beta_i + E0'_i + €_i \qquad j=1$$

$$Y^*_{ij} = \left\{ \begin{array}{ll} 1 & \text{if } Y^*ij > 0 \\ 0 & \text{if otherwise} \end{array} \right\} j=1$$

Where; j = select horticultural technologies

X' = Vector variables such as characteristics of farmers, place of origin, provision of credit facilities and trainings

β_i = Vector of computed coefficients that capture the participation of UHPT

$€_i$ = error term with multivariate normal distribution and mean of zero

The variance of the primary component for k-preserved components is calculated by;

$$\pi_j = \frac{\lambda_j}{\sum_{j=1}^{p} \lambda_j} = \frac{\lambda_j}{\mathbf{tr(S)}},$$, where tr (S) denotes the trace of S

λi is the variance (eigenvalue)

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the research findings and discussions of the study. The two specific objectives of this study were; to determine the status of participation status of urban farmers in select urban horticultural production technologies in Nairobi County and to determine the factors that influence the participation of select urban horticultural production technologies. The methods outlined in chapter three for data analysis and presentation were employed to perform the analysis.

4.2. Descriptive Statistics of Respondent's Characteristics

A range of urban farmers characteristics were examined, they include the ages, gender, level of education, level of income, space ownership, credit facilities and trainings. Table 4.1 presents the descriptive statistics for age of respondents. Age is perceived as the major determinant in the acceptance and participation in new agricultural innovations. The average age of the respondents was 37.8 years with a maximum age of 66 and minimum age of 18 years, indicating that most of the households were relatively young. The findings is consistent with Hope (2017) who stated that, the vast majority of migrants from rural to urban areas tend to be young adults Rural-urban migration in Kenya is primarily influenced by search of better employment and economic opportunities available in urban areas.

Table 4.1(i): Characteristics of Respondents

Variable	Total sample n=385		Mathare n=93		Kibra n=84		Kasarani n=117		Roysambu n=91	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Age	37.83	10.84	31.40	9.88	44.67	10.79	35.60	10.70	39.66	11.99

Table 4.1(ii) presents further results. The findings indicates that majority of the respondents were males (51.61%), (54.76%), (55.56%) and (51.60%) for Mathare, Kibra, Kasarani and Roysambu respectively. This could be that women are loaded with more house hold activities compared to men, making them to participate less in farming activities (Meseret *et al.*, 2020). About 37.9 percent of the total respondents attained post-secondary education, 41.5 percent secondary, 19.2 primary and 1.56 percent informal. It is evident from the findings that the farmers are spread across all over education levels. A study in Accra (World Bank, 2013) also found no particular educational pattern among urban farmers. Based on the survey results, none of the respondents earned more than Ksh. 100,000 per month, majority of respondents, more than 70% earned less than Ksh.15, 000 per month. More resources are needed to purchase basic materials to implement high tech innovations such as green house, vertical gardens, hydroponics and pallet gardening technology unlike open field technology. Farmers with low income are unlikely to practice high tech technologies (Blasch et al., 2020). With regard to the tenure arrangements for spaces used for vegetable production, 5.4% owned the space in Mathare, 4.8% in Kibra, 24.8% in Kasarani and 38.46% in Roysambu. Lack of land ownership discourages investment in investment in high tech technologies (Kassie et al., 2013). Most of the respondents from the results had stayed in Nairobi for more than five years.

Table 4.1(ii): Characteristics of Respondents

Variable	Total sample n=385		Mathare n=93		Kibra n=84		Kasarani n=117		Roysambu n=91	
	n	%	n	%	n	%	n	%	n	%
Gender										
Male	206	53.51	48	51.61	46	54.76	65	55.56	47	51.65
Female	179	46.49	45	48.39	38	45.24	52	44.44	44	48.35
Level of education										
Informal	6	1.56	1	1.08	0	0.00	2	1.71	3	3.30
Primary	74	19.22	2	2.15	32	38.10	19	16.24	11	12.08
Secondary	160	41.56	58	62.37	39	46.43	39	33.33	32	35.16
Post-Secondary	146	37.92	32	34.41	13	15.48	57	48.72	46	50.55
Monthly income										
Less than 15,000	293	76.10	83	89.25	71	84.52	67	57.26	72	79.12
15,001 to 30,000	72	18.70	8	8.60	11	13.10	38	32.48	15	16.48
30,001 to 45,000	14	3.64	1	1.08	2	2.38	8	6.84	3	3.30
45,001 to 100,000	6	1.56	1	1.08	0	0.00	4	3.42	1	1.10
more than100,000	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Space Ownership										
rented the space	73	18.96	16	17.20	12	14.29	26	22.22	19	20.88
owns the space	73	18.96	5	5.38	4	4.76	29	24.79	35	38.46
public/unutilized	239	62.08	72	77.42	68	80.95	62	52.99	37	40.66
Belong to farming groups										
Yes	79	20.52	35	37.63	15	17.86	24	20.51	5	5.49
No	306	79.48	58	62.37	69	82.14	93	79.49	86	94.51
Duration stay in Nairobi										
< 1 year	3	3.23	0	0.00	8	6.84	2	2.20	13	3.38
1 to 5 years	19	20.43	30	35.71	17	14.53	8	8.79	74	19.22
5 to 10 years	33	35.48	26	30.95	35	29.91	21	23.08	115	29.87
>10 years	38	40.86	28	33.33	57	48.72	60	65.93	183	47.53

4.3 Participation of Farmers in Select Urban Horticultural Production Technologies

The first objective of the study was to determine the participation status of urban farmers in select urban horticultural production technologies in Nairobi County. The results are presented in sections 4.3.1 to 4.3.6.

4.3.1 Awareness of Urban Horticultural Production Technologies

The respondents were asked if they were aware of the selected production technologies, majority of the respondents were aware of open field (94%), followed by vertical gardens (61.8%) and the least technology the respondents indicated were aware of is hydroponics at 26.2%. As expected, the majority of the respondents utilized open field technologies (60.8%), Table 4.2 below.

Table 4.2: Utilization of Urban Horticultural Production Technologies

Production technology	Aware of the production technology		Participation in production technology	
	Yes	Yes	No	No
Rooftop	251(65.2%)	134(38.8%)	16(4.2%)	369(95.8%)
Open field	363(94.3%)	22(5.7%)	234(60.8%)	151(39.2%)
Greenhouse	201(52.2%)	184(47.8%)	11(2.9%)	374(97.1%)
Vertical gardens	238(61.8%)	147(38.2%)	137(35.6%)	248(64.4%)
Hydroponics	101(26.2%)	284(73.8%)	11(2.9%)	374(97.1%)
Pallet	135(35.1%)	250(64.9%)	70(18.2%)	315(81.8)

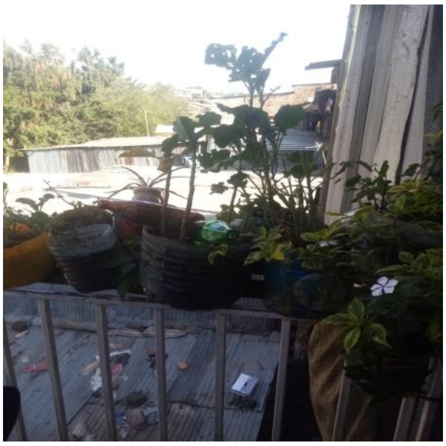

Plate 4.1: Rooftop at Kibra and Hydroponics at Kibra (Source: Author, 2023)

Plate 4.2: Open Field Farming and Greenhouse in Roysambu (Source: Author, 2023)

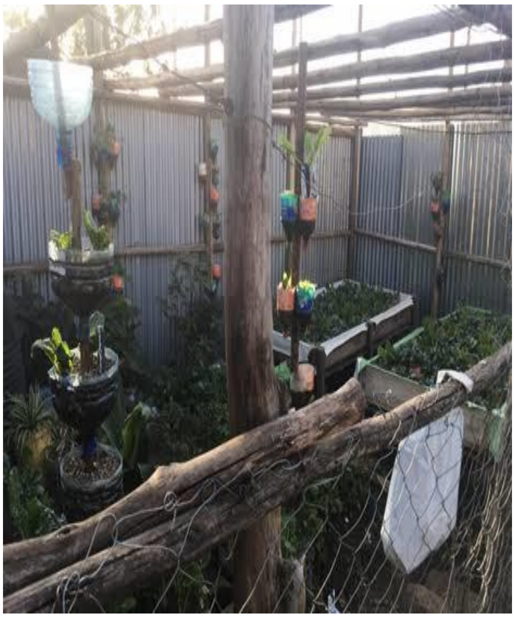

Plate 4.3: Hanging Gardens, Pallet Farming in Mathare and Open Field Production in Kasarani (Source, 2023)

4.3.2 Respondents Utilization of Urban Horticultural Production Technologies

The study investigated the main production technologies that farmers use in Nairobi County. The production technologies are; rooftop, vertical gardens, pallet gardens, green house, open field and hydroponic production technology. The results are indicated in the Tables 4.3 below.

Table 4.3: Urban Horticultural Technologies in Nairobi

Variable	**Total sample n=385**	**Mathare n=93**	**Kibra n=84**	**Kasarani n=117**	**Roysambu n=91**	**Variable**	**Total sample n=385**	**Mathare n=93**	**Kibra n=84**	**Kasarani n=117**
	n	**%**	**n**	**%**	**n**		**n**	**%**	**n**	**%**
Rooftops	16	4.16	3	3.23	4	4.76	7	5.98	2	2.20
Open field	273	70.91	38	40.86	47	55.9	70	59.83	79	86.81
Greenhouse	11	2.86	2	2.15	1	1.19	5	4.27	3	3.30
Vertical garden	113	29.35	33	35.48	43	51.19	32	27.35	29	31.87
Hydroponics	11	2.86	0	0.00	3	3.57	7	5.98	1	1.10
Pallet garden	55	14.29	24	25.81	26	30.95	14	11.97	6	6.59

The results in Table 4.4 shows that more male respondents participated in urban horticultural technologies compared to female across all production technologies other than open field. Forty eight percent of those who participated in open field production were male while 52% were female. It is widely believed that women are predominant in urban farming because they assume responsibility for providing sustenance for their households (Ngome et al., 2012). In Eastern and Southern Africa, farming is largely dominated by women (Ngome et al., 2012).The level of education varied across all production technologies, 54% of the respondents who utilized hydroponic had post-secondary education, 40% secondary education, 4% primary education and only 1% with informal education. Education is key when making decision to participate in new innovations. The expectation is that, farmers with more education are well informed and are able to evaluate and interpret information on innovations than those assumed to have less level of education. It is perceived that the farmers with high level of education are most likely to accept new technologies than the farmers with low level of education. Researchers have indicated that education is important determinant in the adoption of the perceived new technologies (Baumgart-Getz et al., 2012). The low income in urban areas has facilitated the growth of horticultural production in the immediate vicinity of cities. Majority of the respondents who participated in open field, vertical gardens and pallet gardens at 80%, 77% and 80 % respectively earned less than Ksh. 15,000. While majority of those who participated in high tech technologies such as green house and hydroponics earned between Ksh 30,000 and Ksh 45,000 per month.

The respondents either owned the space, rented or used public spaces for practicing urban horticultural technologies. The results in Table 4.4 below shows that 63% of the respondents who practiced greenhouse technology owned the space and none of the responded practiced greenhouse technology on public space. Those who utilized greenhouse technology, 63% owned the space while 36% rented the space. Space ownership is key in the participation of technologies perceived to be of high tech such as greenhouse. The absence of land ownership inhibits investment in high tech urban horticultural production technologies (Di Zeng et al., 2018). The results show that urban farming is conducted along water lines, on balconies, rooftops and in open fields. This conclusion is consistent with a similar study done in Nairobi which revealed that a sizeable proportion of urban agriculture takes place on backyard farms, roadsides, open areas, under power lines, riverbanks, railway lines and institutional land (World Bank, 2013).

The respondents were also asked to provide information on membership in farming groups. While only a small number of respondents were engaged in hydroponics (n=11), over half of them were not members of the group (63%). The results further shows that group membership across horticultural production technologies was generally low, 19% among for open field (n=46), 12% vertical gardens (n=17), 36% hydroponics(n=4) and 22% pallet gardens(n=16). According to Bizikova et al. (2020), agricultural groups enhance social connectedness by giving farmers access to horticulture information, produce markets, and financial support. Trainings are key in participation in production technologies. The respondents who participated in green house (63%) and hydroponics (54%) indicated that they had received trainings. The respondents were asked if they have received any assistance to participate in UHPT. Majority of the respondents who obtained credit facilities utilized greenhouse technology at 54% while all the respondents who participated in rooftop technology did not receive credit facility. High tech technologies such as green house and hydroponics need capital to purchase farm inputs. Credit access can provide a number of opportunities to boost agricultural production, such as getting hold of farm inputs (Khandker & Koolwal, 2014). Farmers have the potential to benefit from credit and consequently improve their quality of life. It enables farmers to get necessary capital for land preparation, planting and purchase of farm inputs (Maurer, 2014).

The farmers received information on urban horticulture from various sources such as from family member, neighbor, NGOS, print media and extension officers. 36% of those who participated in green house, received information from extension officers while 62% of those who participated in open field received information from family members. The Informal exchange of information system is the most convenient information transfer mode on the technology application. It circumvents hierarchical knowledge transfer from the researchers at the topmost of hierarchy, to the extension officer and then to the farmer at the bottom of the hierarchy hence ensuring efficiency of the information (Rossing et al., 2010). Urban farmers at times have a tendency to favor the information sources that are likely to reinforce preexisting beliefs, views and values, putting more trust in friends and family members than extension officers (Tey et al., 2017).Nongovernmental organization influenced open field, vertical gardens and hydroponics production technologies. According to studies by Sarvanan (2011), most farmers regularly access a variety of traditional information sources (television, radio, newspapers, other farmers, traders, input dealers, seed companies, and relatives) for agricultural information. The main role of agricultural extension services have been increased dissemination of knowledge regarding farmer skill development, the use of improved farm technologies, general farm management practices, and simple access to input and output markets (Wang et al., 2021).

Table 4.4: Respondents Utilization of Production Technologies

Variable	Rooftops / balconies n=16		Open field n=234		Greenhouse n=11		Vertical gardens n=137		Hydroponics n=11		Pallet gardens n=70	
	n	%	n	%	n	%	n	%	n	%	n	%
Gender												
Male	9	56.25	114	48.72	7	63.64	79	57.66	7	63.64	38	54.3
Female	7	43.75	120	51.28	4	36.36	58	42.34	4	36.36	32	45.7
Level of education												
Informal	0	0.00	3	1.28	0	0.00	2	1.46	0	0.00	2	2.9
Primary	1	6.25	50	21.37	3	27.27	6	4.38	3	27.27	6	8.6
Secondary	8	50.00	101	43.16	4	36.36	55	40.15	2	18.18	25	35.7
Post-Secondary	7	43.75	80	34.19	4	36.36	74	54.01	6	54.55	37	52.9
Monthly income												
Less than 15,000	3	18.75	189	80.77	2	18.18	106	77.37	2	18.18	56	80.0
15,001 to 30,000	6	37.50	41	17.52	4	36.36	23	16.79	5	45.45	11	15.7
30,001 to 45,000	5	31.25	2	0.85	4	36.36	4	2.92	2	18.18	3	4.3
45,001 to 100,000	2	12.50	2	0.85	1	9.09	1	0.73	2	18.18	0	0.0
More than 100,000	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.0
Space Ownership												
rented the space	0	0.00	53	22.65	4	36.36	0	0.00	4	36.36	23	32.86
owns the space	5	31.25	44	18.80	7	63.64	23	16.79	7	63.64	6	8.57
public/unutilized	11	68.75	137	58.55	0	0.00	114	83.21	0	0.00	42	60.00
Belong to farming groups												
Yes	0	0.00	46	19.66	6	54.55	17	12.41	4	36.36	16	22.86
No	16	100.0	188	80.34	5	45.45	117	85.40	7	63.64	54	77.14
Credit facility												
Yes	0	0.00	40	17.09	6	54.55	50	36.50	4	36.36	24	34.29
No	16	100.0	194	82.91	5	45.45	87	63.50	7	63.64	46	65.71
Vegetables grown												
kales	9	56.25	81	34.62	0	0.00	71	51.82	7	63.64	28	40.00
Spinach	7	43.75	64	27.35	1	9.09	37	27.01	4	36.36	24	34.29
onions	0	0.00	23	9.83	1	9.09	21	15.33	0	0.00	7	10.00
Amaranths	0	0.00	27	11.54	0	0.00	8	5.84	0	0.00	6	8.57
Pumpkins	0	0.00	12	5.13	0	0.00	0	0.00	0	0.00	0	0.00
Green beans	0	0.00	9	3.85	0	0.00	0	0.00	0	0.00	0	0.00
Green Pepper	0	0.00	5	2.14	3	27.27	0	0.00	0	0.00	4	5.71
Others	0	0.00	13	5.56	6	54.55	0	0.00	0	0.00	1	1.43

Table 4.5: Respondents Utilization of Production Technologies

Variable	Rooftops / Balconies n=16		Open field n=234		Greenhouse n=11		Vertical gardens n=137		Hydroponics n=11		Pallet gardens n=70	
	n	%	n	%	n	%	n	%	n	%	n	%
Space crops grown												
Back/front yard/upstairs	16	100.0	56	23.93	9	81.82	112	81.75	8	72.73	57	81.4
On vacant places	0	0.00	97	41.45	0	0.00	9	6.57	0	0.00	12	17.1
Along railways	0	0.00	21	8.97	0	0.00	2	1.46	0	0.00	0	0.0
Below power lines	0	0.00	8	3.42	0	0.00	1	0.73	0	0.00	0	0.0
along water lines	0	0.00	32	13.68	0	0.00	1	0.73	0	0.00	0	0.0
School gardens	0	0.00	2	0.85	2	18.18	2	1.46	3	27.27	1	1.4
Road strips	0	0.00	18	7.69	0	0.00	10	7.30	0	0.00	0	0.0
Source of water												
Piped	14	87.50	97	41.45	11	100.0	73	53.28	10	90.91	52	74.29
River/running water	0	0.00	47	20.09	0	0.00	20	14.60	0	0.00	0	0.00
wells	0	0.00	26	11.11	0	0.00	5	3.65	0	0.00	4	5.71
rains	1	6.25	25	10.68	0	0.00	18	13.14	0	0.00	2	2.86
Households recycling	1	6.25	37	15.81	0	0.00	20	14.60	1	9.09	12	17.14
Sewage/dirty water	0	0.00	2	0.85	0	0.00	1	0.73	0	0.00	0	0.00
Information sources												
Print media	2	12.50	2	0.85	0	0.00	5	3.65	1	9.09	3	4.29
Neighbor	6	37.50	67	28.63	0	0.00	21	15.33	1	9.09	10	14.29
Family	8	50.00	147	62.82	4	36.36	41	29.93	1	9.09	16	22.86
NGOS	0	0.00	4	1.71	3	27.27	31	22.63	4	36.36	14	20.00
Extension	0	0.00	14	5.98	4	36.36	39	28.47	4	36.36	27	38.57
Duration in Nairobi												
< one-year	0	0.00	7	2.99	0	0.00	3	2.19	0	0.00	3	4.29
1 to 5 years	0	0.00	43	18.38	1	9.09	18	13.14	1	9.09	11	15.71
5 to 10 years	0	0.00	97	41.45	2	18.18	12	8.76	1	9.09	8	11.43
>ten years	16	100.0	87	37.18	8	72.73	104	75.91	9	81.82	48	68.57

4.3.3 Challenges for Participating in Urban Horticultural Technologies

The respondents identified the main challenges they experience while participating in UHPT. The main challenges identified were inadequate land, inadequate water, inadequate technical skills, complexity of technologies and integrating technologies to existing environment. Inadequate land was the most mentioned at an average rating of 4.11 out of the maximum 5, with 41.6% of the respondents, a majority viewed it as an extremely high extent challenge, and 42.86% indicated it to be a challenge at a high extent. Inadequate water was mentioned second after inadequate land at mean score of 4.03 with 41.04 % of respondents describing it as a challenge at a high extent. The challenges of inadequate technical skills, integrating technologies to existing environment and complexity of technologies were scored at mean of 3.12, 3.56 and 3.24 respectively. Table 4.5 below.

The participation and diffusion of new horticultural technologies may depend on the perceived challenges. Limited access to land, inadequate infrastructure, and a lack of secure tenure for urban farmers are among the identified challenges associated with urban horticulture (Lovell, 2010). Land ownership plays an important part in the implementation of agricultural advances and technologies. (Higgins et al., 2018). Secure land tenure provides farmers with the necessary incentives to boost their production efficiency. Without secure property rights, farmers tend to become emotionally detached from the land they cultivate, often leading to a lack of long-term investment in the land and low usage of inputs in an efficient manner (Islam & Tuulikki, 2009).

Table 4.6: Challenges of UHPT Participation

Factor			**Percentage**			**Mean**	**Std. Dev**
	Not at All	**Small Extent**	**Moderate Extent**	**High Extent**	**Very High Extent**		
Inadequate land	5.2	4.2	6.2	42.9	41.6	4.1	1.1
Inadequate water	2.1	5.2	15.8	41.1	35.8	4.0	0.9
Inadequate technical skills	5.7	17.1	52.7	8.6	15.8	3.1	1.1
Complexity of technologies	1.6	19.7	47.3	15.6	15.8	3.2	0.9
Integrating technologies to existing environment	1.8	17.6	22.6	38.4	19.5	3.6	1.1

4.3.5 Assessment of Urban Horticultural Technologies

The Principal Component Analysis was done to determine the number of production technologies which accounted for most variation. The first three components have an eigenvalue of more than one and explain 74% of variation in data, Table 4.6 below. The Kaiser-Meyer-Olkin (KMO) was done to ensure data used for this study was suitable for analysis and Bartlett's Test of Sphericity was done to test the null hypothesis, 'that the correlation matrix is an identity matrix'. KMO had a value of 0.58 and since the value is more than 0.5, the sample is adequate for analysis. The $p<0.05$ indicating that the correlation matrix is significant and thus not an identity matrix, the variables are related, Table 4.7 below.

Table 4.7: Factor Analysis Results

	Initial Eigenvalues			**Extraction sums of squared loading**		
Component	**Total**	**% of variance**	**% Cumulative**	**Total**	**% variance**	**% Cumulative**
1	1.933	32.222	32.222	1.933	32.222	32.222
2	1.288	21.464	53.686	1.288	21.464	53.686
3	1.205	20.087	73.773	1.205	20.087	73.773
4	0.812	13.528	87.301			
5	0.680	11.337	98.638			
6	0.082	1.362	100.000			

Source: Survey, January and February 2023.

Table 4.8: KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of sampling Adequacy		**0.58**
Bartlett's Test of Sphericity	Approx. Chi-square	760. 215
	df	15
	Sig.	.000

4.3.6 Social and Economic Influence on Participation in Urban Horticultural Technologies

A reliability analysis test was done using principal components analysis, Table 4.8 below. The Cronbach's alpha for social (0.803) and economic (0.786). The Cronbach's alpha (s) were within the recommended range of 0.7 to 0.9, has good internal consistency (Taber, 2018). The Cronbach's alpha values more than 0.6 gives indication of a high degree of consistency (Pallant, 2011). The Kaiser-Meyer-Olkin statistic demonstrates the correlation between the various variables that measure each component. The results shows that Kaiser-Meyer-Olkin of 0.751 and p value of $p< 0.05$, indicating it was significant and therefore acceptable, Table 4.9 below.

Table 4.9: Farmers Economic and Social Influence on Participation in UHP

Statement	**Cronbach alphas**	**Component**	
		Social	Economic
Family: My family members will approve for me to practice urban horticultural technologies		0.665	
Peer pressure: People in my social cycle encourage me to practice urban horticulture		0.716	
Social class: Community around me will see me as a better person if i practice urban horticulture		0.849	
Social expectation: Most people around me think I should practice urban horticulture	0.803	0.825	
Social capital: Practicing urban horticulture enhances social interaction within the community		0.671	
Enterprises: Innovation in urban horticultural technologies can drive local business and economy			0.727
Employment: Urban horticulture can create more job opportunities			0.793
Inflation: Urban horticulture can reduce the cost of buying fresh produce			0.786
Salaries & Wages: I don’t rely on other sources of income to finance horticultural practices	0.786		0.677
Savings: By practicing urban horticulture, I have saved enough to meet other expenses			0.710

Table 4.10: KMO and Bartlett's Testa

Kaiser-Meyer-Olkin Measure of sampling Adequacy		**0.897**
Bartlett's Test of Sphericity	Approx. Chi-square	428
	df	55
	Sig.	.000

4.4 Determinants of Participation of Urban Horticultural Technologies

Multivariate probit analysis was done to determine the influence of demographic characteristics and institutional characteristics on the participation of Urban Horticultural technologies table 4.10 below.

Table 4.11: Results of Multivariate Probit Model

	Open field		**Greenhouse**		**Vertical gardens**	
	Coef.	**SE**	**Coef.**	**SE**	**Coef.**	**SE**
Age	0.130**	0.007	-0.138*	0.500	-0.023**	0.009
Gender	-0.314**	0.149	0.330	0.489	0.261	0.174
Level of education(informal)	0.073	0.102	-0.179	0.309	0.168	0.123
Level of education(primary)	0.734	0.132	0.926	0.843	0.143	0.139
Level of education(secondary)	0.769	0.345	0.141	0.925	0.592	0.628
Level of education(post-secondary)	0.242	0.174	0.600	0.843	0.080	0.302
Monthly income (less than 15,000)	-0.488***	0.174	0.305***	0.466	0.334**	0.136
Monthly income (15,001 to 30,000)	0.833	0.877	0.962***	0.240	0.417**	0.111
Monthly income (30,001 to 45,000)	0.264	0.900	0.224	0.210	0.435	0.130
Monthly income (more than 45,000)	-0.606**	0.084	0.959**	0.509	0.022	0.229
Space Ownership	0.367	0.091	0.526*	0.347	0.013	0.108
Duration in Nairobi (less than one year)	0.048*	0.010	0.341*	-0.233	0.095	0.120
Duration in Nairobi (1 to 5 years)	0.911	0.571	0.460*	0.119	0.735**	0.053
Duration in Nairobi (5 to 10 years)	0.899***	0.407	0.380	0.842	0.544	0.563
Duration in Nairobi (more than ten years)	0.424*	0.521	0.757**	0.258	0.007**	0.518
Place of origin	-0.157	0.112	-0.036	0.374	0.002	0.136
Farming groups	0.699**	0.247	0.119	0.651	-0.661**	0.267
Extension services	0.272*	0.084	0.151**	0.229	-0.338	0.117
Trainings	-0.332	0.275	0.651	0.707	0.150	0.299
Credit facility	-0.156	0.284	-0.628	0.654	0.461	0.315
Social factors	0.166*	0.253	0.548	0.612	0.055	0.190
Economic factors	0.551**	0.248	0.189*	0.637	0.565**	0.207
N	385		385		385	

Demographic characteristics plays a great role in the practice of urban horticultural technological practices. The farmer's age had influence on the practice of open field technology positively while it influenced greenhouse and vertical gardens negatively. Age is regarded as the major determinant in the acceptance and participation of the new agricultural innovations. The average age of the respondents was 37.8 years, with a maximum age of 66 and minimum age of 18 years, suggesting that most of the households were relatively young. The older respondents participated more in open field than other production systems while the younger respondents participated more in long-term high-tech production systems such as green house. The young farmers are more willing to learn and adopt high tech agricultural innovations and therefore improving farm productivity and management (Morais, 2017). The findings of Kariyasa and Dewi, (2013) indicated that, senior farmers are presumed to have acquired a significant amount of experience and insight throughout their years in the industry, and they are better equipped to assess information than their younger counterparts. As the farmers grows older and older, the interest for long term investment in farming decreases, thus they may not be willing to invest in long time innovations (Thomas et al., 2017).

The findings also indicates that gender had a negative impact on the likelihood of participation in open field technology. More male 53% participated in urban horticultural technologies compared to 47% female. More male involved in urban horticultural technologies than women could be because women are loaded with more house hold activities compared to men, making them to participate less in farming activities. They have less time to get relevant information on urban technologies (Meseret *et al.*, 2020). Monthly income had a positive income on green house and vertical gardens production technologies while it had a negative influence on open field. The respondents who earned more than Ksh 15,000 per month, were likely to participate in high tech technologies such as greenhouse compared to those earned less than Ksh 15,000. Resources are needed to purchase basic materials to implement high tech technologies such as greenhouse technology unlike the low tech technologies such as open field technology. Farmers with low income are unlikely to practice high tech technologies (Blasch et al., 2020).

The ownership of space was only significant and positively related to greenhouse technology. Green house technology, is a high-tech technology which require resource to set up and thus land tenure could be key in setting up a greenhouse. Majority of the respondents, 63% practiced greenhouse technology on their own space compared to 36% who rented the space. Lack of land ownership discourages investment in high tech innovations (Di Zeng et al., 2018). Land acquisition and land tenure security are formed in social relationships (Berry, 2018). The results indicate that farming is done a long water lines, on balconies, rooftops and open field. The findings correspond with a similar study conducted in Nairobi, which discovered that urban agriculture is performed on backyard farms, roadsides, unused areas, under power lines, riverbanks, railway lines and institutional land (World Bank, 2013).

The duration of stay in Nairobi was positive and significant with greenhouse, open field and vertical gardens technology. The respondents who had stayed more than one year in Nairobi, were likely to participate in urban horticultural technologies compared to those who had stayed less than one year. The more years one stays in Nairobi, the higher the chances of participation in UHT. Seventy two percent of the respondents who were participating in green house had stayed in Nairobi for more than ten years. Social connection, connection with the space and confidence with the space could increase with increase of the number of years one stays in place. Also, social connections could increase the chances of one acquiring space for farming (Gerard, 2022). Although it was expected that the relationship between place of origin and participation in UHPT will be positive and significant, there was no relationship between place of origin and the participation in urban horticultural production technologies. The greater percentage of the farmers pointed that they originated from the rural areas, which may indicate that most households engaging in urban farming could be bringing the rural farming culture to the city. The migrants may bring important skills they acquired in their rural areas to urban areas, which can then be imparted to city farmers. The majority of urban farmers (75%) and non-farmers (85%) had prior experience of farming in their rural areas prior to moving to Kibera (Gallaher et al., 2015). The findings of this study are at odds with those put forth by the World Bank (2013), which suggests that most urban farmers have been living in their respective city areas for an extended period of time.

Farming groups are instrumental in providing access to land for agricultural activities. The study findings suggest that there is a positive and significant relationship between farmers in groups and their participation in open field production technology. The farming groups improves social connectivity and easy access to space for farming. The findings are in line with Bizikova et al. (2020) who noted that farming groups improves social connectivity in terms of farmer's access horticultural information, markets for produce and financial assistance. Extension services was positive and significant on open field and greenhouse production technology. Extension officers provide important information new innovations and their information can be reliable. District-level extension officers take part in regular meetings to share information concerning production difficulties, the outcomes of research, technologies and suggested procedures before and over the course of each planting season (Riaz, 2010).

Social component had a positive and significant influence on open field. This study's findings are in agreement with those of Ida et al. (2017), which revealed that social environment and having a role model are some of the factors influencing involvement in urban horticulture. The finding of Albizua et al. (2020) also indicates that social networks are an important factor in disseminating horticultural innovations. This findings agrees with Dubova et al. (2020) who found out that social capital is key in the participation in urban gardens and Lam at al. (2007) who indicated that the individual is likely to engage in an innovation if they perceive the presence of higher social pressure from significant referents. Participation in urban horticultural technologies was impacted by various economic factors. High cost of living, need to create employment opportunities and need to reduce food budget were among the motivation to participate in urban horticultural technologies. Economic influenced vertical gardens and open field positively. The findings of Godwin et al., (2003) indicated that the greatest barrier for a number of farmers to participate in any production technology is the initial financial investment. The findings of Muriithi (2013) also agrees that economic factors influenced the adoption of horticulture technologies in Nakuru County, Kenya.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary, conclusions and recommendations of the research which was conducted in Nairobi County.

5.2 Summary

An investigation was done to investigate the determinants which influence the participation of urban horticultural production technologies in the County of Nairobi. A total of 385 respondents were sampled from the four sub counties of Mathare, Kibera, Roysambu and Kasarani in Nairobi County. Descriptive design was adopted to collect data from the respondents. The questionnaires were administered via face-to-face interview and supplemented with field observations. The information sought from urban farmers practicing horticultural technologies included the horticultural production technologies, perceived benefits of horticultural technologies, perceived challenged in participating horticultural technologies, UHPT information sources, kind of vegetables grown in urban areas, the spaces for growing vegetable and respondents' social-economic characteristics. Data collected was summarized using tables, frequencies, and percentages. Principal component analysis was done to test variation of urban horticultural production technologies.

Multivariate Probit regression was done to assess the relationship of urban horticultural technologies participation with gender, age, education level, monthly income, place of origin, provision of credit facilities and trainings. Majority of the respondents were males (51.61%), (54.76%), (55.56%) and (51.60%) for Mathare, kibra, Kasarani and Roysambu respectively. The average age of the respondents was 37.83 years with a maximum age of 66 and minimum age of 18 years. The least utilized production system were greenhouse, hydroponics and rooftop at less than 6%. The respondents who utilized greenhouse technology, 63% owned the space while 36% rented the space for practicing farming. Age had an influence on open field production system, greenhouse and vertical garden production systems. Monthly income was positively related with greenhouse and vertical gardens, while it negatively influenced open field production system. Space ownership had influence on greenhouse production system. The duration of stay in Nairobi influenced positively rooftop, open field and greenhouse technologies. From the findings, the farming groups related positively and significantly with open field production system while vertical gardens related negatively with farming groups.

5.3 Conclusions

The objectives of this study were aimed at determining the participation status of urban farmers in select production technologies and also to determine factors that influence the participation in urban horticultural technologies. Based on the findings of this study, it can be concluded that, participation in rooftop, greenhouse and hydroponics production technologies were low compared with open field, vertical gardening and pallet gardens. Low participation in green house and hydroponics could be due to land tenure and initial capital needed to set up the technologies. Inadequate land and water were among the challenges hindering the participation of UHPT. Individuals may not be able to invest in urban horticulture due to lack of property rights (Julia et al., 2021). Urban residents who rent households are less likely to participate in urban production technologies than those who own their homes, and they might not have enough authority to raise crops on a leased property (Julia et al., 2021).As a result of the intense competition for limited urban resources like land and water, urban horticulture fails to produce adequate food (Koscica, 2014).

The respondent's trainings and availability of credit facilities were expected to influence the participation in various production technology, contrary none influenced any production technology. Open field production was influenced by farming groups. The farming groups could assist the members to get more connection and important information on the available spaces for practicing in urban production technologies. Different players, including governments and their development partners, have paid attention to the creation and promotion of dependable farmer groups that empower farmers to increase food security (Ampaire et al., 2013). The Kenyan government unveiled its Kenya Vision 2030 blueprint in 2008, emphasizing the need to encourage the use of farmer organizations as avenues for addressing the food crisis through income- and supply-related policy initiatives (International Food Policy Research Institute [IFPRI], 2012).

The findings from this study show that respondent's demographic characteristics affected the participation in the select technologies. The results from multivariate probit model, age of the respondent was significant and positively related to open field while negatively related to vertical garden. Younger farmers are willing to try new innovations compared to older farmers (Sodjinou et al., 2015). The level of income of respondents influenced all production systems. Greenhouse and vertical gardens were influenced positively by the level of income, while open field was influence negatively. It could mean, high tech technologies require much resources to set up as compared to open field production technology. Urban households that participate in a variety of non-farm activities have a good possibility of earning extra money that will allow them to buy agricultural inputs (Beshir et al., 2012). Green house production technology was influenced by the land ownership. Participation in high tech technologies require more resources to set up and thus land tenure is key. Urban farmers are threatened by uncertain of land tenure, which in turn affects their behavior and potential future land investment (Lenka S. et al., 2020). These factors then affect urban agricultural production as producers with unstable land tenure frequently opt for low-risk innovations (Lenka et al., 2020).

The social component plays a great role in participation of urban horticultural technologies. Social component influenced open field production technology. Participating in urban gardens is mostly done for the purpose of increasing social connection (Gerard, 2022). The researchers have identified social motives, such as meeting new friends, as a rationale for participating in community gardens (Gerard, 2022). Social networks have a significant role in disseminating horticultural innovations (Albizua et al., 2020). Urban resident in USA started urban farming for social purposes, such as to make new acquaintances and interact with individuals from other cultural backgrounds (Teig et al., 2009).

The economic factors influenced open field, green house and vertical gardens production technology. Participation in urban horticulture increases household economic wellbeing, better livelihoods, generate income and foster entrepreneurship (Calvet-Mir et al., 2012). Urban farming activities can be developed into a small cottage industry, and earnings from the sale of home garden products, as well as savings from eating homegrown food. The consumption of homegrown food can result in more disposable income that can be used for other domestic purposes (Calvet-Mir et al., 2012).

5.4 Recommendations

From the findings of this study, the following recommendations can be made:

- More awareness (training, extension services) to urban and peri-urban residents on the UHPT and be encouraged to participate in technologies which require less space
- Support informal settlement farmers; new GAP (good agric practices/ methods and kits)

5.5 Further Research

- More research needs to be done to test other social factors and economic factors influencing participation in UHPT; not possible to fit all in model
- Test diverse technologies for application to urban farmer situations; space, product quality and water use efficiency
- Extend the study to other urban areas

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APPENDICES

Appendix I: Questionnaire for Horticultural Technologies

QUESTIONNAIRE FOR HORTICULTURAL TECHNOLOGIES

Topic: Determinants of participation in urban horticultural production technologies in Nairobi County, Kenya

Region		**Ward**	
Date of interview		GPS latitude	
Interview start		GPS longitude	
Interview end		Respondent name	
Enumerator name		Respondent contact	
Enumerator ID			

SECTION A: Introduction

The aim of this survey is to examine the participation of horticultural technologies in Nairobi County. Your participation to this survey will take less than 10 minutes. Participation to this survey is voluntary. Your responses will assist me to complete my research and enhance the understanding of the topic. The data collected will be confidential and only be used for the purpose of academic. Kindly give accurate information by filling in or ticking in the spaces provided. Providing your name on this questionnaire or identity is optional. Thanks in advance.

Part 1

SECTION B: RESPONDENTS BASIC INFORMATION

S.N	**Item description / Question**	**Code**	**Response**
1	Gender of respondent	1= male 0=female	
2	Age of respondent	Indicate age	
3	Highest level of education of respondent	1= Informal 2= Primary 3= Secondary 4= post-secondary	
4	Marital status	1= Single 2= Married 3= Divorced/separated 4= widowed	

5	Occupation	1= Self-employed 2= Unemployed 3= Employed 4= Farming; 5=Others (specify)….	
6	Source of income	1= Employment 2= Self-employment 3= Farming 4= Rent 5 = Short term engagements 6= social benefits; 7=Others (specify)………..	
7	Average Monthly Income	1= Less than 15,000 2= 15,001 to 30,000 3= 30,001 to 45,000 4= 45,001 to 100,000 5 = more than 100,000	
8	Space crops grown	1= Rented building 2= owned building 3= On vacant places 4= In containers 5 = Along railways 6= Below power lines 7= along water lines 8= School gardens 9= Road strips; others………….	
9	Owner for the space for growing crops	1= owned 2= rented 3= public	
10	Duration stay in Nairobi	1= Less than one-year 2= 1 to 5 years 3= 5 to 10 years 4= more than ten years	
11	Place of origin	1= Rural areas 0= other places (other places of Nairobi, other urban areas)	

SECTION C (I): INVOLVEMENT IN PRODUCTION TECHNOLOGIES

S/No	Technology	(I)Are you aware of any technology in column one?	(II)If yes in column two, which technology (s) are you aware of in column one?	(III)Which technology do you use?	(IV)How long have you practiced the technology	(V)Which major crop do you grow using the technology you have indicated	(VI)Approximate quantity you produce per month using technology you have indicated
1	Rooftops/Balconies						
2	Open field						
3	Greenhouse						
4	Vertical garden						
5	Hydroponics						
6	pallet gardening						

		Code 1=Yes 0=No	1= Rooftops/Balconi 2= Open field 3= Greenhouse 4= Vertical garde 5 = Hydroponics 6= pallet gardenin	1=Rooftops/B conies 2 Open field 3= Greenhous 4= Vertic garden 5 Hydroponics 6= pal gardening	1= Less than one-year 2= 6-10 year 3= 11- years 4= More than 15 years	1= Kales 2= Spinach 3= Onions 4=Amaranths 5 = Pumpkins 6= Green beans 7= Pepper 7= Others…….	To indicate in terms of Kilograms

SECTION C (II): INVOLVEMENT IN PRODUCTION TECHNOLOGIES

	Item description / Question	Code	Respon
1	Do you belong to any farming group	1= Yes 2= No	
2	Source of labor	1= Owner 2= Employee 3 Family/relative 4=Oth (Specify	
3	Source of water for production	1= piped 2= spring 3 river/running water 4= well 5 = rains 6= househo recycling 6= sewage 7 Others……….	
4	Main reason of practicing urban horticulture	1= Source of food 2 income 3= leisure 4= use o available resources 5=Oth (Specify	
5	Has any of your household member receive any training on urban production technologies	1= Yes 2= No	

5	If [**yes**] IN 11A above, when was the mo recent training you received?	1= Last 1-month 2= last months 3= last 1-ye 4=Other (Specify	
6	Have you received credit facility as capital f urban horticultural production technologies	1= Yes 2= No	
6	If [yes], in 12A, where was the credit facili obtained?	1= Bank 2= family/frien 3= Saccos 4= social grou 5= Government institutio 6= Others	
7	Do you sell the surplus of your vegetables fro your garden?	1= Yes 2= No	
7	If [yes], in 13A above, where do you sell your Vegetables?	1=Open air markets, 2=c site, 3=supermarket 4=online 5=other	
8	How did you learn about this urban productio technologies	1=Print media 2 =Neighb 3=Family members 4 NGOS 5= Extension office	

PART 2

D. (i) Horticultural participation status: In your own opinion, how do agree on the following statements on the participation of urban horticultural technologies?

	Strongly disagree < > strongly agree				
	SD	**D**	**D/A**	**A**	**SA**
1. I have not made any effort to participate in horticultural production technologies					
2. Am in the information search stage on urban horticultural production technologies					
3. Am in information evaluation stage on urban horticultural production technologies					
5. I have made a decision to participate in urban horticultural production technologies					
6. I am already participating in urban horticultural production technologies					

D. (ii) Horticultural participation status: In your own opinion, how do agree on the following statements on the participation of technologies

	Strongly disagree < > strongly agree				
	SD	**D**	**D/A**	**A**	**SA**
1. Rooftops/Balconies production system is easy to implement in an urban setup					
2. pallet gardening production system is easy to implement in an urban setup					
3. Open field production system is easy to implement in an urban setup					

4. Greenhouse production system is easy to implement in an urban setup					
5. Hydroponics production system is easy to implement in an urban setup					
6. Vertical garden production system is easy to implement in an urban setup					

E: Social: How do you agree with the following information on horticultural technologies**?**

	Strongly disagree < > strongly agree				
	SD	**D**	**D/A**	**A**	**SA**
1.**Family**: My family members will approve for me to practice urban horticultural technologies					
2. **Peer pressure**: People in my social cycle encourage me to practice urban horticulture					
3.**Social class**: Community around me will see me as a better person if i practice urban horticulture					
4.**Social expectation**: Most people around me think I should practice urban horticulture					
5.**Social capital**: Practicing urban horticulture enhances social interaction within the community					

F: Economic: How do you agree with the following information on horticultural technologies**?**

	SD	**D**	**D/A**	**A**	**SA**
1.**Enterprises**: Innovation in urban horticultural technologies can drive local business and economy					
2. **Employment**: Urban horticulture can create more job opportunities					
3.**Inflation**: Urban horticulture can reduce the cost of buying fresh produce					
4.**Salaries & Wages**: I don't rely on other sources of income to finance horticultural practices					
5. **Savings**: By practicing urban horticulture, I have saved enough to meet other expenses					

G: Information: In your own opinion, how do rate the following sources of information on the influence horticultural production technologies?

	Strongly disagree < > Strongly agree				
	SD	**D**	**D/A**	**A**	**SA**
1.**Neighbor**: Awareness from neighbors influences urban horticultural practices					
2.**Family members**: Information from family members influences urban horticultural practices					
3.**Non-government organization**: Information from NGO influences urban horticultural practices					

4. **Print media**: Information from media and books influences urban horticultural practices					
5. **Extension services**: Information from extension officers influences urban horticultural practices					

H. Perception: to what extent do you agree with the following statement?

	Strongly disagree < > Strongly agree				
	SD	**D**	**D/A**	**A**	**SA**
1.Practicing urban horticulture connects me to culture and nature					
2. Practicing urban horticulture makes me feel relieved and healthy					
3. I practice urban horticulture as a hobby					
4. For me, I easily practice urban horticulture					
5.urban horticulture is a solution for food insecurity					

J: Challenges: To what extent do these challenges may affect the horticultural technology practices**?**

	Not at All < > Very High Extent				
	NA	**SE**	**ME**	**HE**	**VHE**
1.Inadequate land to practice horticultural technologies					
2.Inadequate water to practice horticultural technologies					
3.Inadequate technical skills and knowledge about the technologies limit my participation in urban horticulture					

production					
4.Complexity associated with technologies limit my participation in urban horticulture production					
5.Difficulty of integrating the technologies into the existing environment					

I: In your own opinion, how do rate the following sources of information on the influence horticultural production technologies?

	Strongly disagree < > Strongly agree				
	SD	**D**	**D/A**	**A**	**SA**
1Awareness from neighbors influences urban horticultural practices					
2. Information from family members influences urban horticultural practices					
3 Information from NGO influences urban horticultural practices					
4. Information from media and books influences urban horticultural practices					
5. Information from extension officers influences urban horticultural practices					