FACTORS INFLUENCING ADOPTION OF URBAN HYDROPONIC FARMING. A CASE OF MERU TOWN, MERU COUNTY, KENYA

JACOB GITOBU KIBITI

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DECLARATION

This research project report is my original work and has not been presented for examination in any other university.

Signature…………………………………………   Date……………………

Jacob Gitobu Kibiti

L50/84551/2016

This research project report has been submitted for the award of the degree with our approval as University supervisors.

Signature ………………………………   Date………………………

Amos K. Gitonga

School of Open and Distance Learning.

University of Nairobi

DEDICATION

This research project is dedicated to my beloved mother Mary Mukomunene for her moral and financial support, self-sacrifice and determination to ensure my success, also to my sister for her invaluable support during my research period.

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To all of you I say may God Bless you abundantly.

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ABBREVIATIONS AND ACRONYMS

AGROPOLIS	:	International Graduate Research Awards Program in Urban Agriculture.
CGIAR	:	Consultative Group on International agriculture research.
FAO	:	Food and Agriculture Organization of the United Nations.
IDRC	:	International Development Research Centre (CANADA).
IWMI	:	International Water Management Institute.
MDG	:	Sustainable Development Goal.
SGUA	:	Support Group on Urban Agriculture.
UA	:	Urban Agriculture
UNDP	:	United Nations Development Programme
GIAR	:	International Agricultural Research Centre
GDP	:	Gross Domestic Product.

ABSTRACT

The conversion of farm land and water sheds for residential or commercial purposes have negative consequences on food security, water supply as well as the health of the people both in the cities and in the peri-urban areas. Urban hydroponic farming has thus emerged as a complimentary strategy to reduce urban poverty, food insecurity and enhance urban environmental management. The purpose of this study was to evaluate the factors influencing adoption of urban hydroponic farming in Meru town, Meru County. The study objective were ; To identify how availability of capital, access to water, farmer awareness and type of crop influence the adoption of urban hydroponic farming. In this study descriptive research design was employed. The reason for selecting descriptive research design was that design describes the state of affairs as it exists at present; in this case the researcher had no control over the variables. The target population of this study was 1080 urban farmers who were involved in urban agriculture within Meru town. From the calculations using Waston (2001) formulae, a sample size of 150 urban farmers was selected and represented 14 percent of the target population. Data was collected by the use of questionnaires and interview schedules. Raw data collected from the field was first cleaned for errors, coded, analyzed and categorized as per the research questions in order to simplify it for presentation. Data was analyzed and presented descriptively using statistical package for social science version 20. Qualitative data was checked for completeness and cleaned ready for data analysis. Content analysis was used in processing the data and results presented in prose form. Out of this sample size, 135 questionnaires were filled and returned accounting for 90% response rate. 50.67% of the urban farmers were female while 49.33% of the urban farmers were male. This implies that both men and women are equally involved in urban farming in Meru town. 49.3% of the urban farmers had secondary education, 24.7% of the urban farmers had primary education and below, 16.7% of the urban farmers had college education and 9.3% of the urban farmers had university education. The study found out that 52 % of the urban farmers did not invest any funds acquired by credit in their urban farming and the average income they achieved per season was Kshs. 2895. Though a significant number of farmers had not received any training on farming, standing at about 53%, the result also showed an inclination in receiving training from private institutions, NGOs and the Government of Kenya. The study found out that availability of water for irrigation determined whether urban farmers in Meru town are able to produce throughout the season and thus increase in their income particularly from higher prices during the dry season. The study found that types of crops grown and number of months taken by the crop to reach to maturity determined the income that the farmers obtained. The study recommends that financial institutions that offer formal credit should be encouraged to stop categorizing urban agriculture as risky, costly and difficult investment venture that involves high transaction costs and unpredictable returns. Farmers should be encouraged to take loans while the government needs to provide farmer support services to the urban farmers. Urban farmers should be encouraged to irrigate their farms and modern irrigation methods like drip irrigation should be availed to them to avoid water wastage. The study recommends further research on the influence of urban planning on returns from urban farming. Moreover policy and practice can benefit from further analysis on the influence of farmer characteristics, particularly gender, on urban farming income and returns earned by factors of production

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The world urban population is expected to increase by 72 percent by 2050 from 3.6 billion in 2011 to 6.3 billion 2050. All the expected growth in the world urban population will be concentrated in the urban areas of the less developed countries whose population is projected to increase from 2.7 billion in 2011 to 5.1 billion in 2050 ((United Nations,2011). Although urbanization is the driving force for modernization, economic growth and development there is increasing concern about the effects of expanding cities principally on livelihoods, human health, and the environment. The implication of rapid urbanization and demographic trends for employment, food security, water supply, shelter and sanitation especially the disposal of waste that the cities produce are staggering(UNCED, 1992).

The conversion of farm land and water sheds for residential or commercial purposes have negative consequences on food security, water supply as well as the health of the people both in the cities and in the peri-urban areas. Urban hydroponic farming has thus emerged as a complimentary strategy to reduce urban poverty, food insecurity and enhance urban environmental management. It also plays an important role in enhancing food security since the costs of supplying and distributing food to urban areas based on rural production and imports continue to increase and do not satisfy demand especially of the poorer sectors of the population. (Smit, J., Ratta, A., & Nasr, J. 1996).

In hydroponic farming, plants are grown without the use of soil. Plants receive all the essential nutrients from a nutrient-rich water-based solution. There is a variety of hydroponic methods in which plants can either grow in a non-soil medium or directly in the solution. These operations are systematically controlled and therefore tend to produce higher per acre yields than conventional farming. Within the past few years this method has been used in urban environments to improve access to fresh food. Innovative entrepreneurs in New York and Montreal have utilized hydroponics to grow produce on urban rooftops. (Fahey, C. 2012).

The earliest published work on growing terrestrial plants without soil was the 1627 book Sylva Sylvarum by Francis Bacon, printed a year after his death. Water culture became a popular research technique after that. In 1699, John Woodward published his water culture experiments with spearmint. He found that plants in less-pure water sources grew better than plants in distilled water. By 1842, a list of nine elements believed to be essential for plant growth had been compiled, and the discoveries of German botanists Julius von Sachs and Wilhelm Knop, in the years 1859–1875, resulted in a development of the technique of soilless cultivation. (Mowa, E. 2015). Growth of terrestrial plants without soil in mineral nutrient solutions was called solution culture. It quickly became a standard research and teaching technique and is still widely used. Solution culture is now considered a type of hydroponics where there is no inert medium.

In 1929, William Frederick Gericke of the University of California at Berkeley began publicly promoting that solution culture be used for agricultural crop production. (Dunn, H. H.,1929). Schmeltz et al (2007). First termed it aquaculture but later found that aquaculture was already applied to culture of aquatic organisms. Gericke created a sensation by growing tomato vines twenty-five feet (7.5 metres) high in his back yard in mineral nutrient solutions rather than soil. He introduced the term hydroponics, water culture, in 1937, proposed to him by W. A. Setchell, a phycologist with an extensive education in the classics.

Fahey, C. (2012). In recent decades, the advent of new technologies and cheaper building materials has made hydroponics the preferred growing method amongst controlled environment agriculture (CEA), farmers. According to data from the 2009 USDA Agriculture Census, the sales of crops grown under protection increased from \$31.7 million in 1988 to over \$553.2 million in 2009. Of these crops grown under protection in 2009, 78% were grown hydroponically (USDA,2011). This sharp increase in sales is a clear economic indicator that there is high demand for hydroponically grown crops Most of these hydroponic crop sales are grown in large scale greenhouses spanning many acres. However, they can also be grown on rooftops in urban environments. (Fahey, C. (2012)

Onanuga, A. O. (2013). Hydroponic systems have been in use to evaluate growth and development of vegetables, fruits and flowers for decades. Recently, there has been an increased interest in hydroponics to evaluate growth and development of crops such as wheat and rice in Asia. Wheat crops absorbed more nutrients such as iron and zinc grown in hydroponic systems than plants grown in the field due to direct contact of root hairs with the nutrient solution. Hydroponic systems planted with rice genotype IR651 and cotton plants reduced osmotic and toxic effects of salinity (Nemati et al. 2011; Natalia Castillo 2011). The hydroponic medium also increased growth and yield of rice plants (Nemati et al. 2011). Hydroponic systems also make it easier to monitor nutrient uptake, root morphology, physiological development status and yield (Lynch 1995).

There has already been a great deal of buzz throughout the scientific community for the potential to use hydroponics in third world countries, where water supplies are limited (Butler, J.D. and Oebker, N.F.2006). Though the upfront capital costs of setting up hydroponics systems is currently a barrier but in the long-run, as with all technology, costs will decline, making this option much more feasible (Singh, S. 2012). Hydroponics has the ability to feed millions in areas of Africa and Asia, where both water and crops are scarce.

In South Africa, with its diverse climatic conditions and soil types, growing plants in soil is unpredictable. There is a wide range of challenges, such as variations in temperature, water holding capacity, cation exchange capacity, soils contaminated with heavy metals, available nutrient supply, proper root aeration as well as disease and pest control (du Plooy et al., 2012). Growers in South Africa are faced with the challenge of producing high yields combined with good quality, in order to satisfy local consumer demand (Maboko et al., 2011). Rarely is this demand met, mainly due to poor cultivation methods, poor cultivar choice, inadequate plant nutrition, adverse climatic conditions, or pest and disease infestation (Maboko et al., 2011).

The pioneer of commercial greenhouse crop production in South Africa, Don Bilton, adapted the 'Nutrient film technique' (NFT) in the late 1970's by using gravel in plastic lined beds instead of pure nutrient solution. The technique was named 'Gravel Film Technique' (GFT), the first commercial hydroponic system in South Africa and still utilized on a commercial scale in the country. Although vegetable production (including tomatoes) in South Africa is mainly open field cultivation; soilless cultivation in a protected environment has gained popularity due to improved yield and quality (Niederwieser, 2001; Maboko et al., 2009). Un-favorable weather conditions, such as hail and high temperatures during the summer season, have resulted in farmers trying to optimize yield and quality of tomatoes by using soilless production systems under shadenet structures (Maboko et al., 2011) while other vegetable growers are under the impression that only greenhouse (tunnels) are suitable to ensure good yield and quality (Combrink, 2005).

Baumgartner, B., & Belevi, H. (2001). Hydroponically grown vegetables are high value crops and play a major role in income generation for small scale and commercial farmers in South Africa. Two hydroponic systems are applied commercially in South Africa (open bag and closed hydroponic system), with the majority of hydroponic farmers using plastic tunnels in open bag system (OBS) for production of crops such as tomatoes, sweet pepper, runner beans and cucumber, while leafy vegetables, such as lettuce, herbs, Swiss chard and spring onion are produced in tunnels or shade net structures using closed hydroponic system. The majority of vegetables are still produced seasonally in the open field, resulting in an inconsistent availability and affordability of vegetables in South Africa. Because of the diverse climatic conditions in South Africa, production of vegetables under protection plays a major role in increasing yield, quality and availability (Maboko et al., 2009; 2011).

Farmers in Kenya have been able to adopt the art and are using it mostly to grow fodder for their animals. Farmers are able to grow fodder which is ready in 8 days after planting. This has been able to offer these farmers fodder throughout the year. Using this technology, farmers are able to yield more than 50 kilograms of fodder from a space of 20 feet by 10 feet. This method is very good for modern day farmers who have limited space to grow fodder. For example, a greenhouse which is 140 meters squared can hold up to 1800 trays which can produce approximately 1.2 tons of fodder per day using between 700-900 liters of water. However, the temperatures in the greenhouse should be controlled. Most farmers prefer to grow grains such as barley, wheat, maize, and oats although barley is the preference choice of most farmers since it has more protein nutrients which have supper results to animals. (Ayele, S., et al 2012)

According to Ayele, S., et al (2012) the hydroponic industry is expected to grow exponentially, as conditions of soil growing is becoming difficult. Specially, in a country like Kenya , where urban concrete conglomerate is growing each day , there is no option but adopting soil-less culture to help improve the yield and quality of the produce so that we can ensure food security of our country. Government intervention and Research Institute interest can propel the use of this technology.

1.2 Statement of the problem

It is in the interest of any nation to ensure that its citizens have access to economic opportunities and also sufficient nutritive food to satisfy their needs all the times. No country can be able to sustain a rapid transition out of poverty without raising productivity in the agricultural sector (Timmer, 2005). Agriculture constitutes the economic core of most low income countries and contributes 33 percent of the GDP and 52 percent of the exports and employs 60 percent of the working population (World Bank, 2005). The increasing urbanization and urban land use planning in developing countries and especially Kenya has a direct implication for food security particularly in urban areas. (GOK, 2011). Conventional crop growing in soil (Open Field Agriculture) is somewhat difficult as it involves large space, lot of labour and large volume of water (Beibel, J.P 1960). Moreover, some places like metropolitan areas, soil is not available for crop growing at all, or in some areas, we find scarcity of fertile cultivable arable lands due to their unfavorable geographical or topographical conditions. (Beibel, J.P 1960).

Hydroponic farming is the fastest growing sector of agriculture, and it could very well dominate food production in the future (Butler, J.D. and Oebker, N.F 2006). As population increases and arable land declines due to poor land management, people will turn to new technologies like hydroponics and aeroponics to create additional channels of crop production (Maharana, L. and Koul, D.N, 2011). Within the past few years this method has been used in urban environments to improve access to fresh food. Innovative entrepreneurs in New York and Montreal have utilized hydroponics to grow produce on urban rooftops.

In Tokyo, land is extremely valuable due to the surging population. To feed the citizens while preserving valuable land mass, the country has turned to hydroponic rice production (De Kreij C, et al 1999). Hydroponics also has been used successfully in Israel which has a dry and arid climate. A company called Organitech has been growing crops in 40-foot (12.19-meter) long shipping containers, using hydroponic systems. They grow large quantities of berries, citrus fruits and bananas, all of which couldn't normally be grown in Israel's climate (Van Os E A; et al 2002). The hydroponics techniques produce a yield 1,000 times greater. Farmers in Kenya have been able to adopt the art and are using it mostly to grow fodder for their animals, which is ready in 8 days after planting, offering these farmers fodder throughout the year, however here in Meru despite the many benefits of adopting this technology only 5% of farmers have adopted it, hence the need to investigate the factors influencing the adoption of urban hydroponic farming.

1.3 Purpose of the Study

The purpose of this study was to evaluate the factors influencing adoption of urban hydroponic farming in Meru County.

1.4 Research objectives of the Study

The study was guided by the four objectives as stated below

i. To identify how availability of capital influence the adoption of urban hydroponic farming
ii. To identify how access to water influence the adoption of urban hydroponic farming
iii. To establish how farmer awareness on hydroponics influence the adoption of urban hydroponic farming
iv. To establish how type of crops grown influence the adoption of urban hydroponic farming

1.5 Research questions

i. To what level does availability of capital influence the adoption of urban hydroponic farming?
ii. How does access to water influence the adoption of urban hydroponic farming?
iii. To what extent does farmer awareness on hydroponics influence the adoption of urban hydroponic farming?
iv. How does the type of crops grown influence the adoption of urban hydroponic farming?

1.6 Significance of the Study

Urban hydroponic farming can directly and indirectly contribute in pursuing several of the sustainable development goals. Urban hydroponic farming main direct contribution is to goal number two which involves Zero Hunger - End hunger, achieve food security and improved nutrition and promote sustainable agriculture. Urban hydroponic farming also enables the achievement of vision 2030 through poverty eradication as it is one of the ways to earn income from sales of produce that have better yields compared to conventional agriculture

This study is vital to urban planners as it will enable them to factor in the importance of urban hydroponic farming in the economic development of the urban governments.

This study is also of great importance to policy makers who are involved in the countries strategic plans. Urban hydroponic farming may function as a strategy for poverty alleviation, creation of employment and social integration.

1.7 Scope of the Study

This study was restricted to the sampled respondents involved in urban farming within Meru town and solicited information deemed to be representative of the situation in the urban Centre. The research was limited to the factors influencing adoption of urban hydroponic farming in Meru town with a view to identifying options to guide policy and programs in enhancing the activity. The research was carried out during the month of April and June 2017 and was restricted to the area demarcated as Meru town. It was also assumed that the sampled respondents were knowledgeable and could provide current and relevant data as per the objectives of the study.

1.8 Limitations of the Study

The study used descriptive survey design which tends to be unpopular for studies that are too detailed to be fully explained by description. The researcher has to have a clear perception of what the study intends to cover, failure to which the results may lead to inappropriate data collection. The respondents in descriptive survey design tend not to be truthful and give inappropriate answers and the assumption is that the respondents are knowledgeable and can give answers that answer the research questions. There are other intervening variables like environmental factors and moderating variables like government policy that affect the relationship between the factors influencing urban hydroponic farming thus limiting the study.

1.8.2 De-Limitation of the study

This study focused on urban farmers within the boundaries of Meru town. This study had a target population of 1080 urban farmers and a sample size of 150 urban farmers was selected. The study concentrated on few independent variables like access to capital, access to water, farmer awareness and types of crops grown. This means that there are other variables that are influential to urban hydroponic farming. During the administration of the questionnaire the sampled respondents were informed by the researcher that the information given was to be only used for research purposes and was to be treated with uttermost confidentiality. This created trust between the researcher and the sampled respondents

1.9 Basic Assumptions of the Study

The study assumed that there were no serious changes in the composition of the target population that would have affected the effectiveness of the study sample. This study also assumed that the respondents would be honest, cooperative and objective in the response to the research instruments and that they would be available to respond to the research instruments in time. Finally, the study assumed that the authorities in the area would grant the required permission to collect data from the urban farmers.

1.10 Organization of the Study

This study is organized into five chapters. Chapter one contains the introduction to the study. It presents background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the Study, delimitations of the study, limitations of the Study and the definition of significant terms. On the other hand, chapter two reviews the literature based on the objectives of the study. It further looked at the conceptual framework and finally the summary. Chapter three covers the research methodology of the study. The chapter describes the research design, target population, sampling procedure, tools and techniques of data collection, pre-testing, data analysis, ethical considerations and finally the operational definition of variables. Chapter four will present analysis and findings of the study as set out in the research methodology. The study will close with chapter five which presents the discussion, conclusion, and recommendations for action and further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section consists of the theoretical framework for the study, review of the literature on variables, the conceptual framework, and empirical review, critique of the existing section provides the theories that support the variables under investigation.

2.2 Availability of capital and adoption of urban hydroponic farming

An estimated 500 million agricultural smallholder's, farm up to two hectares of land, with 2 billion to 2.5 billion people living in these smallholders' households worldwide (Hazell 2011 and Christen and Anderson 2013). These farms feed a great number of the rural poor. According to IFC (2011), of the three quarters of the world's poor that live in rural areas, 80 percent depend on agriculture as their main source of income and employment. These smallholders also play a key role in increasing food supply, more so than large farms in poor countries, and increasingly supply large conglomerates and corporations with inputs for their products (Carroll et al. 2012). Despite their socioeconomic importance, smallholders tend to have little or no access to formal credit, which limits their capacity to invest in the technologies and inputs they need to increase their yields and incomes and reduce hunger and poverty, both their own and that of others.

Access to financial services, while not a means to an end, is critical to provide funds for farm investments in productivity, improve post-harvest practices, smooth household cash flow, enable better access to markets and promote better management of risks. Access to finance can also play an important role in climate adaptation and increase the resilience of agriculture to climate change, thus contributing to longer term food security. (Poulton, C., et al 2010).

Access to a comprehensive range of financial services is a significant challenge for smallholders, who constitute the vast majority of farmers in developing countries. There are no precise numbers on the demand for agricultural finance. A very rough estimate by Dalberg Development Advisors (2012) suggests that demand may be as high as $450 billion in financial services ($225 billion in short term finance and $225 billion in long-term finance). The percentage of smallholders with access to finance is equally difficult to quantify. According to estimates, even promising approaches to expanding smallholder lending, such as value chain finance, are reaching fewer than 10 percent of smallholders, primarily those in well-established value chains dedicated to higher value cash crops (the Consultative Group to Assist the Poor (CGAP) 2013).

The challenges to increasing access to finance are numerous and well documented. Financial institutions interested in serving this market face myriad risks and challenges associated with agricultural production and lending, including seasonality and the associated irregular cash flows, high transaction costs, and systemic risks, such as floods, droughts, and plant diseases. While these challenges apply to agricultural lending in general, they impinge on smallholder lending in particular, given the relatively higher transaction costs of provision and smallholders' limited ability to mitigate risks. (Poulton, C., et al 2010).

According to Treftz, c., & Omaye, s. t. (2016). The fixed and variable costs for the hydroponic plants compared to the soil-grown plants are one way of outlining the cost of putting up hydroponic farms. The hydroponic system has a higher startup cost compared to the soil system. It is important to note that the hydroponic system would last through multiple seasons without the need to replace the soil. The soil for the soil system would eventually have to be replaced, fertilized and other efficient management practices, such as crop rotation, would need to be considered. These are factors that could be avoided with hydroponic farming.

The soil system has a lower cost, but uses 30% more water compared to the hydroponic system. Another important factor to consider when choosing a growing system is labor costs. Soil-grown produce is more often cited for having increased labor costs because of weeding, watering, and spraying of pesticides (Resh & Howard, 2012). With hydroponic system, it is found that soil strawberries have increased weeds compared to hydroponic strawberries. However, the hydroponic system overall is more labor intensive because of the time required to check and monitor the pH and ppm of the solutions. Additionally, each month it takes about 1.5 hours to change and replace the nutrient solutions in the hydroponic buckets; the soil strawberries did not necessitate extra monthly maintenance routines.

Economic models have been developed to estimate profitability associated with hydroponic lettuce, and it has been modified to fit different scenarios (Coolong, 2012; Donnell et al., 2011). When considering hydroponic food production on a commercial scale, developing an economic model to determine cost-benefit analysis for optimum economic feasibility would aid both the commercial and small-scale farmer. A decade ago, it was assumed hydroponic lettuce and tomatoes would be the only crops to be economically feasible for hydroponic food production (Jensen, 2013); however, since then, food prices have more than doubled and the economic revenue for different crops should be investigated for the commercial and small scale farmer (Jensen, 2013).

2.3 Access to water and adoption of urban hydroponic farming

Agriculture accounts for at least 70 percent of the total global water usage and if water is not managed well in the agricultural sector food production will decrease substantially and will lead to increased food importation (Rosegrant et al 2002).

According to World Bank (2000) water needs are directly proportional to population growth and with rapid urbanization agriculture will have to compete with increasing urban water needs. In urban centers water allocation for agriculture gives way to higher value urban uses that may adversely affect food production and the reduction in water allocation for agricultural purposes in urban centers will affect food security.

According to the forum for agricultural research in Africa and NEPAD agricultural production must increase at an annual rate of 6 percent to keep up with population increase in order to achieve food security by 2015. To achieve this annual production growth rate agricultural intensification is required which involves effective and efficient use of water (FAO 2000).

According to IWMI (2000) about 60 percent of the world's agricultural production depends on rainfall availability and this makes crop production vulnerable to adequacy, reliability and timeliness of rainfall. This makes farmers reluctant to take risks and invest in inputs and improvements resulting in low levels of productivity.

Rockstrom et al (2001) argues that water harvesting can mitigate the effects of temporal and spatial rainfall and the high risks of intra- seasonal dry spells that characterize water scarcity in agricultural production. Ngigi (2002) indicates that yield and reliability of agricultural production can be significantly improved with water harvesting. Ringler et al (2000) identifies different methods of harvesting water for agricultural purposes including use of natural or artificial depression to store rain water runoff collection and flood diversion.

Shah et al (2000) indicates that ground water offers opportunity to support agricultural activities during the dry season. Simple and affordable innovations in water lifting technologies are used such as the treadle pump and the motor pump. The capital requirements to develop ground water irrigation are low and its productivity is higher than surface irrigation. Other indigenous methods of acquiring water for agriculture involves use of well construction both hand dug wells and tube wells in areas of shallow aquifers. Tapping shallow aquifer for small scale irrigation allows easy access to water sources because of low capital requirement which makes it possible for small scale farmers to invest in irrigation (Woldearegay 2002).

Urban agriculture has enabled investment in irrigation and in instances where farmers cannot afford to invest in piped water they opt to use waste water from municipal sources (Barry 2002). Sally et al (2000) points out that precision irrigation should be adopted by farmers with limited access to agricultural water. Precision irrigation involves water management practices such as use of watering cans, drip irrigation and treadle pumps.

2.4 Farmer awareness and adoption of urban hydroponic farming

Butler & Oebker, (2006) argues that if people are made aware about hydroponic farming methods and its benefits as an alternative to traditional farming methods, then they will be more likely to consume hydroponically grown food.

Soil is usually the most available growing medium for plants. It provides anchorage, nutrients, air, water, etc. for plant growth (Ellis et al., 1974). However, soils do pose serious limitations for plant growth too, at times. Some of them are presence of disease causing organisms and nematodes, unsuitable soil reaction, unfavorable soil compaction, poor drainage, degradation due to erosion etc. (Beibel, 1960). In addition, Open Field Agriculture is difficult as it involves large space, lot of labour and large volume of water (Beibel, 1960). In most urban and industrial areas, soil is less available for crop growing, or in some areas, there is scarcity of fertile cultivable arable lands due to their unfavorable geographical or topographical conditions (Beibel, 1960). Other serious problem experienced is to hire labour at regular times for conventional open field agriculture (Butler & Oebker, 2006).

Under such circumstances, soil-less culture can be introduced successfully (Butler & Oebker, 2006).Soilless culture is the technique of growing plants in soil-less condition with their roots immersed in nutrient solution (Maharana & Koul, 2004). Soilless culture systems of cultivation can be classified according to the techniques employed. It supplies fresh vegetables in countries with limited arable land as well as in small countries with large populations. It could be useful to provide sufficient fresh vegetables for the indigenous population as well as for tourists in countries where tourism plays a vital role in their economy. Typical examples of such regions are the West Indies and Hawaii, which each have a large tourist industry and very little farmland for vegetable production (Resh, 1993).

In soilless culture some cultural practices like soil cultivation and weed control are avoided, and land not suitable for soil cultivation can be used (Polycarpou et al., 2005). Plants grown by hydroponics had consistently superior quality, high yield, rapid harvest, and high nutrient content. Soilless culture could be applied to growing some popular local crops with the application of food safety standards and at a reasonable price (Paul, 2000). This system will also help to face the challenges of climate change and also helps in production system management for efficient utilization of natural resources and mitigating malnutrition

Hussain, A., et al (2014) indicate that soilless culture can provide important requirements for plant growth with equal growth and yield results compared to field soil. Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium. When the mineral nutrients in the soil dissolve in water, plant roots are able to absorb them. When the required mineral nutrients are introduced into a plant's water supply artificially, soil is no longer required for the plant to thrive. The simplest and oldest method for soilless culture is a vessel of water in which inorganic chemicals are dissolved to supply the nutrients that plants require.

Various modifications of pure-solution culture have occurred in the past. The retention of nutrients and water can be further improved through the use of spaghnum peat, vermiculite, or bark chips. These are the most commonly used materials, but others such as rice hulls, bagasse (sugarcane refuse), sedge peat, and sawdust are used sometimes as constituents in soilless mixes. Straw bales have been used as growing medium in England and Canada and rockwool (porous stone fiber) is used in Europe. (Hussain, A., et al 2014)

Soilless culture is rapidly gaining momentum and popularity and fastest growing sector of agriculture. Soilless culture is more popular and accepted in some countries, especially in commercial production of vegetables and is quickly catching on in other parts of the world. Soilless culture could well dominate food production in the future. As population increases and arable land declines due to poor land management, people will turn to new technologies like soilless culture of crop production. There has already been a great deal of buzz throughout the scientific community for the potential to use soilless culture in third world countries, where water supplies are limited. Though the upfront capital costs of setting up soilless culture is currently a barrier but in the long-run, as with all technology, costs will decline, making this option much more feasible. (Hussain, A., et al 2014)

According to Mahato, P., & Negi, A. K. (2014). In developing countries, this technique could not get popularity among gardeners till the date. The main bottleneck behind this is lack of its standard knowledge and poor dissemination of its available technologies. Although, more literature on soilless culture is available but standard, precise and authentic information's are still lacking. Since the soilless culture industry is still rather small, and there are not sufficient marketing, but for popularization of soilless culture, it is very important to provide scientific proven technology of soilless culture to gardeners and create mass awareness in potential areas at national level. Continuing research and development may lead to more cost-efficient structures and materials; to reduced requirements of purchased energy; to new cultivars more appropriate to controlled environments and mechanized systems; to better control (including improved plant resistance) of diseases and pests.

2.5 Types of crops grown and adoption of urban hydroponic farming

According to Jensen, M. H. (1997, May). It is practically possible to grow any types of fruit, vegetable, herb etc. using this technique. Hiercium pilosella, Hypericum perporatum, Arnica montana, Ocimum basilium (basil), Anethum gravel (dill), Chrysanthemum partherium, Aloe vera, Mentha spp.(mint), Rumex officinalis (French. sorrel), Rosemary officinalis (rosemary), St.john's wort, cucumber, spinach, chili, lettuce, broccoli, pepper, petunias, tomatoes, cabbage, green peas, echinacea, ginseng, thyme, tarragon, spearmint, peppermint, sorrel, sage, oregano, marjoram, mache, leman baln, coriander, chives, chervil, aurugula, potatoes, and many other are the popular choice of vegetables that can be grown using hydroponics. Similarly, fruits such as strawberries, watermelons and cantaloupes can also be grown using hydroponic gardening at home. Flowers show a better bloom when grown hydroponically. Growing plants hydroponically is not only easy but also effective in terms of end product.

Drechsel et al (2005) observes that the most common form of urban farming is background gardening where farmers practice mixed cropping and change crops according to seasonal supply and demand and market prices. Prain (2006) indicates that urban farmers adopt crop intensification strategies in their farming systems where intensification involves cultivation of high value crops which increases productivity on the same area of land and maximize the use of available resources including waste water.

Kessler (2003) analyzed different farming systems in four West African capitals (Lome, Cotonou, Bamako and Ouagadougou) and found out that different crop and inputs were adopted in different farming systems. He observed that mixed vegetable farming with watering cans and or with pumps cultivate short and long cycle vegetables such as lettuce, cabbage, carrots and onions. The short cycle crops are grown to ensure returns on inputs and salaries, while long cycle crops are used to maximize benefit and investment in infrastructure and generating family income. The profits from urban farming depended on management capabilities and farm size. Women produced mainly short cycle crops with regular cuttings to ensure regular income and high returns.

Gerstl (2001) in a study in Ouagadougou, Burkina Faso analyzed households engaged in open space vegetable production and found out that these households usually belonged to the low income groups. Production heavily depended on water availability (Gerstl et al 2002). Ezedinma and Chukuezi (1999) did a study in Nigeria and compared the returns of commercial vegetable production in Lagos with commercial floriculture in Port Harcourt and found out that commercial vegetable farming was more profitable than floriculture farming due to low investments required

Dansol et al (2002) carried out a study on costs and return analysis in urban vegetable growing in Kumasi Ghana and observed that manual irrigation needs to be carried out with high frequency and this made irrigation time consuming and expensive. Comparing net incomes of different farming systems showed that irrigated urban vegetable farming reaches three times the income earned on average in rural farming.

Fialor (2002) analyzed the profitability of various types of cropping systems around Kumasi, Ghana and concludes that regardless of the level of the cost of production, the most profitable investment is the one that yields the highest simple return on the invested amount during that year. He identified crops like plantain, cocoyam, cassava and maize to be unfeasible choice for most urban farmers because of the long maturity period and the larger land space required to achieve profitable returns. Also he identified the combination of spring onion, pepper/ garden egg to be the best choice for farmers although cabbage as the main irrigated crops yields the maximum profit among all the crops in the year.

Buechler and Devi (2002) did a study in India and compared farming systems and income between urban and rural agriculture and showed that cereal production in urban centers generated the highest annual income compared to rural areas. Moustier (2001) compared revenues generated in urban agriculture with alternative activities that require the same set skills like retailers and simple handicraft work and discovered that urban agriculture can generate enough income to cover basic house hold financial needs.

Gerstl (2001) in a study in West Africa identified 28 to 35 different vegetable species cultivated in urban farms. Most of the cultivated vegetables are perishable and often leafy such as lettuce, spring onion, spinach and cabbage. Other common vegetables are carrot onion, amaranth, eggplant, tomato, hot pepper, green beans, and cucumber (Gockowski et al 2003, Kessler et al 2004).

Endamana et al (2003) and Kessler et al (2004) argue that while most of the vegetables cultivated in urban areas are used for stews or otherwise cooked the exotic ones like lettuce, spring onion and cabbage are mostly eaten raw and hence cause concern where polluted water sources are used.

Mawois et al (2011) indicates that the land allocation among the crops inside the farm depends on several decision variables, among them are the maximum exploitable surface area, cultivable area of each crop and duration of each crop as farmers decide on the duration due to economic reasons and variation in climate. Intra urban areas are dominated by perishable leafy vegetables grown with high crop intensity due to the short duration of the crop. Cultivation of high value crops is encouraged by the near markets and high demand and possibility to produce short life and perishable crops (Dongmo et al 2005).

Mawois et al (2011) observed in Mahajanga, Madagascar that crops such as lettuce and other long cycle crops such as onion and cabbage are not grown in the intra urban areas. The diversity of horticultural crops in urban farming allows year round production; employment and income, production of leafy vegetables provide a quick return that helps families meet their daily cash requirements (Adedeji and Ademiluyi 2009).

Danso and Drechsel (2003) indicated that due to space constraints individuals or groups of farmers often specialize in 3 to 5 specific crops. Depending on seasonal supply and demand market prices vary frequently and farmers might change crops from month to month in order to grow the most profitable ones. Moustier et al (2004) pinpoints that short duration crops such as lettuce are generally preferred for immediate cash returns and are advantageous too in view of farmer's insecure tenure situations.

2.6 Theoretical Framework

Human behavior is seen as a result of the interplay of diverse forces that create a set of circumstances through the dynamic interaction of man and his environment (Albrecht et al. 1987 in; Hoffmann, 2005; Ndah, 2008). According to the psychological Field theory of Kurt LEWIN, the interaction of situational forces with the perceived environment can be described as a field of forces, a system in tension or a psychological field. Human behavior can be described as follows: A person in his subjectively perceived environment feels something is worth striving for like adoption of Agricultural best practices. They then mobilize their personal powers to achieve this goal of adoption of the best practices in farming. When something negative or undesirable occurs like a case of low production or poor quality, the person activates his personal powers in the same way to avoid the negative situation. Ways of reaching targets and avoiding negative situations can be blocked or impeded by barriers or inhibiting forces like lack of awareness, risk or uncertainty about outcome, insufficient capital, cultural practices, lack of opportunities for scaling up of farming innovation.

Inhibiting forces-forces negatively influencing behavioral change initiating the best practices in farming e.g. lack of subsidies, limited liquidity for labour hiring, buying concentrates, lack of machinery, and limited knowledge driving forces-forces conducive to positive target improved e.g. financial assistance, technical advice, training, provision of inputs, financial assistance, linkage with market outlets. Adoption of best farming practices is thus seen as resulting from the psychological field of inhibiting and driving forces hence these forces are present in a state of equilibrium or dis- equilibrium with varying degrees of tension between them.

Once such forces are identified in the farmers decision making process, the chances of diffusion can be estimated and consequences for promotion programs can be concluded (Kriesemer and Grötz 2008).

According to Rogers (2003),the determinants of adoption are: perceived attributes of the technology; comparative advantage; the degree to which an innovation is perceived better than the idea it supersedes; complexity - the degree to which a practice is perceived as relatively difficult to understand and to adopt negatively related to its rate of adoption; trial ability -degree to which an innovation like modern farming practices may be experimented at a limited basis; compatibility-degree to which sustainable practice is perceived as consistent with the existing values, past experience and needs of potential adopters.

Rogers (2003), posited that the type of innovation decision process through which an individual passes from; knowledge to attitude and finally to adopting (individual or collective, optional or authority). With the communication channels being either interpersonal or by mass media, originating from specific or diverse source social system: norms, network interconnectedness socio-cultural practices and norms that can inhibit or drive adoption. Efforts of promotion agent past and present efforts made to promote farming the government, agricultural organizations and NGOs, at national and international level. In many rural areas farming is still carried out with simple tools by traditional methods, using practices based on trial and error. The production of food is slightly increased. There is little question that changes must be done in food production methods, and new technologies are increasingly being viewed as the vehicle for solving agricultural problems. While the solutions seem to be simple, in practice it is not. Even where new technologies exist they may be inappropriate for particular agricultural settings, they cannot be transferred easily, or they collide with traditional cultural practices and preferences.

Developing agriculture by means of substituting new for existing technologies involves behavioral change on the part of the farmer. The amount of change involved will depend of the technologies and practices being promoted and the extent to which farmers current behavior is inconsistent with them (Sofranko, 1984). Strategies for bringing about change have generally focused on altering the environment in which food production is carried out, or in the direct transformation of farmers themselves (Rogers, 1969).

2.7 The conceptual framework

The Conceptual framework is an illustration of the relationships between the variables identified for the study. It shows the relationship between the independent and the dependent variables. For this particular study, the adoption of urban hydroponic farming is the dependent variable while the independent variables are the factors that in one way or the other influence the adoption of urban hydroponic farming. These factors are access to capital, availability of water, farmer awareness and the type of crops grown. These factors, either in isolation or a combination will cause or influence adoption of urban hydroponic farming. The moderating variable for this study will be the cultural issues, for example the farming system adopted by the people living in the area. The intervening variable will be Government policy that influences farming at large.

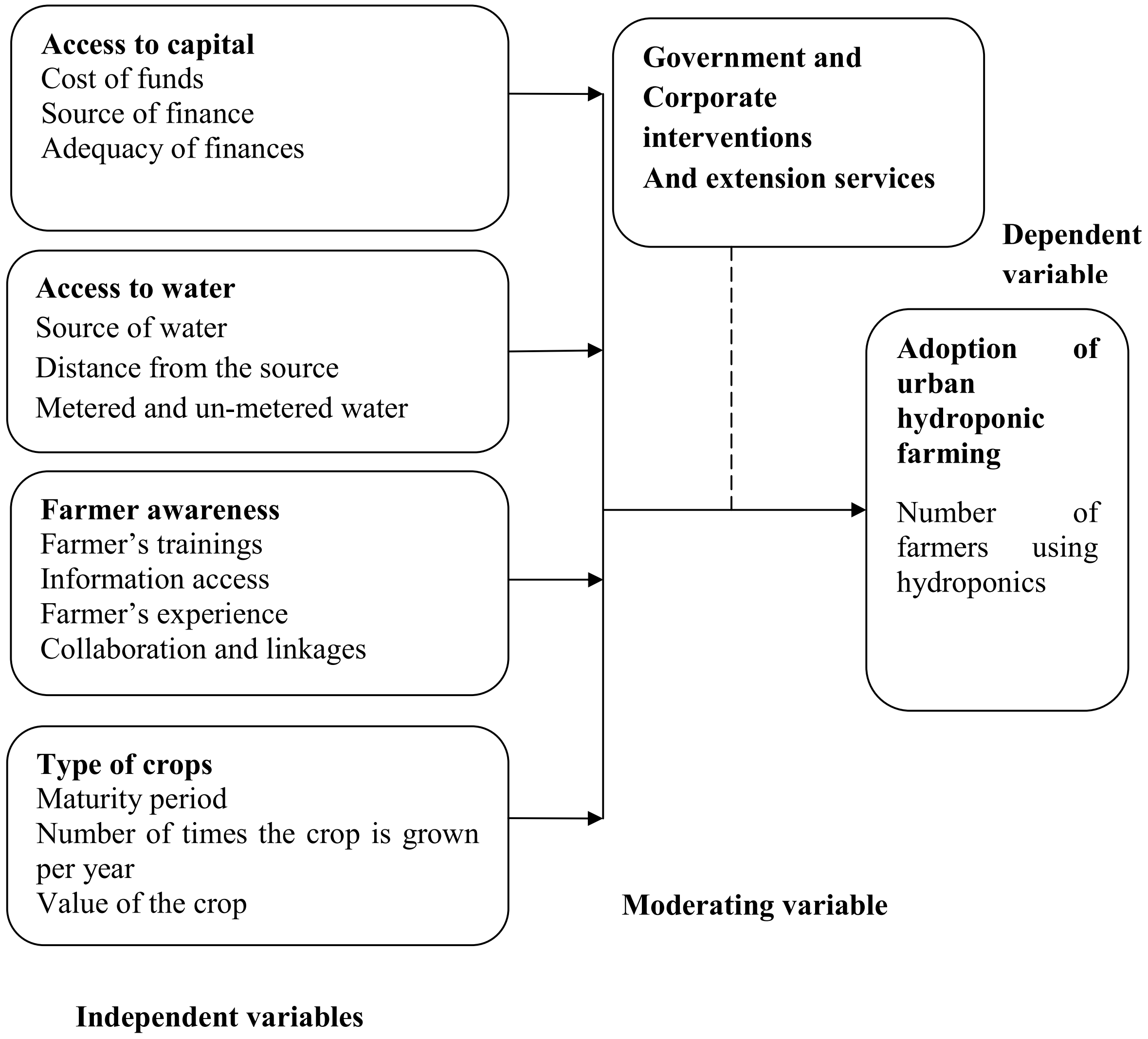

Figure 1: Conceptual framework

2.8 Summary of Literature Review and Gaps

What can we conclude from the literature reviewed above? What is the level of certainty for each of those conclusions? In order to answer these questions, it is important to appreciate that a recollection of all the literature reviewed strongly substantiates the good of hydroponic farming cannot be wished away in today's world. It is conclusive to say that from the literature review, bearing in mind the perceived gross benefits and gross costs, there are net benefits realized from the adoption of both large scale and small scale hydroponic farming.

It is however, surprising and a matter of greater concern on the reluctance of farmers and other authorities in agriculture not to adopt newer technologies for agriculture such as hydroponic farming. Bearing in mind the fundamental principles in theory of consumer behavior, the key assumption is that the consumer is rational and seeks to maximize utilities (Benefits realized from the consumption of a given commodity). On the other end of the continuum, the theory of the firms indicates that firms seek to maximize benefits and minimize costs. In the wake of these fundamental construes, farming in particularly in developing nations like Kenya seem to be defying the odds and acting in a manner that would in farming be termed as “irrational”.

It is in the purview of these inconsistencies that the basis for undertaking this study was established. The gap in knowledge was a lack of comprehension of the real issues that curtail enhanced adoption of urban hydroponic farming in developing nations like Kenya. To furnish such knowledge, this study poses the question: What are the factors influencing the adoption of urban hydroponic farming especially in Meru County amongst the urban farmers.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter identifies the research design of the study. It further highlights the target population, Sampling procedures and the methods of data collection. Also included are the measures undertaken to ensure the validity of data collected, and its reliability in this study. A summarized table at the end of this chapter is provided to highlight the operational variables and show how they are scaled.

3.2. Research design

A research design is the arrangement of conditions for collection and analysis of data in manner that aims to combine relevance to the research purpose with economy in procedure. It is the conceptual structure within which research is conducted. It stipulates the blue print for collection, measurement and analysis of data (Kothari 2003). In this study descriptive research design was employed. The reason for selecting descriptive research design is that design describes the state of affairs as it exists at present; in this case the researcher has no control over the variables. One can only report what is happening or what has happened. Also descriptive research design provides an opportunity to gather detailed data that give explanation to research questions and logically structure the inquiry into the problem of study, Marsh (1982

3.3 Target Population

The target population of this study was 1080 urban farmers who are involved in urban agriculture within Meru town. The study was confined within the boundaries of Meru town. The distribution of the respondents is per the municipal zones demarcated by the government as depicted in the table below.

Table 3.1 Target Population

Zone	Population of urban farmers
Gitimbine	152
Municipality	146
Milimani	170
Kinoru	133
Kaaga	167
Kooje	153

Gakoromone	159
Total	**1080**

Source: Ministry of Agriculture Meru.

3.4 Sampling Design and Procedure

The formula below adopted from Watson (2001) wass used to determine the sample size.

$$n = \left(\frac{p[1-p]}{\frac{\frac{A^2}{Z^2} + \frac{p[1-p]}{N}}{R}} \right)$$

Where:

n= Sample size required

N=Target population

P= Estimated variance in population as a decimal

A= Precision desired

Z= Confidence level

R= Estimated response rate as a decimal.

Thus:

N= 1080 urban farmers

P= 30 percent variance in population

A= 95 percent precision

Z= 90 percent confidence level

R = 90 percent estimated response rate.

$$n = \left(\frac{0.3[1-0.3]}{\frac{\frac{0.05^2}{1.645^2} + \frac{0.3[1-0.3]}{1080}}{0.90}} \right)$$

n= 150.228

From the calculation a sample size of 150 urban farmers was selected and represents 14 percent of the target population. According to Mugenda and Mugenda(2003), for descriptive studies 10%

or above of the accessible population is adequate for study. Therefore the desired sample size of 150 urban farmers which formed 14 percent of the total urban farmer's population in Meru town was appropriate for the study. Stratified random sampling was adopted to give the appropriate and representative sample for each urban zone. Each urban zone is used as strata for sampling. According to Fraenkel et al (2008), on occasion, based on previous knowledge of population and the specific purpose of the research investigators use personal judgment to select a sample.

Stratified random sampling is used as it gives each sampling element equal chance of selection and it also avoids clustering of selected elements in one point. The selected number in each stratum was arrived at depending on the stratums population in relation to the target population and sample size. The information is given in table 3.2.

Table 3.2 Sample Size and Procedure.

Zone	No. of urban farmers	% in relation to target population	Number of selected farmers
Gitimbine	152	14	21
Municipality	146	14	21
Milimani	170	16	24
Kinoru	133	12	18
Kaaga	167	15	23
Kooje	153	14	21
Gakoromone	159	15	22
Total	**1080**	**100**	**150**

3.5 Data Collection Methods

Data was collected by the use of questionnaires and interview schedules. A written questionnaire is a data collection tool in which written questions are presented that are to be answered by the respondents in written form. These written Questionnaires was administered to respondents via hand-delivery and collected later. Questionnaires, incorporating both open-ended and closed-ended questions items were used to gather the necessary data to conduct this study. According to Cooper and Emory (2008), the questionnaire is conveniently used because it is cheaper and quicker to administer, it is above researcher's effect and variability, and is highly convenient for the respondents as they could fill them during free times or when workloads are manageable.

3.5.1 Pilot Testing of the instrument

Ten questionnaires were administered in Nkubu town which neighbors Meru town. The respondent were selected randomly,a week before the main study. They were asked to respond to the questions as the researcher observed whether each question measured what it was supposed to measure, how long it took to interview one respondent, whether response choices were appropriate, whether the tool collected the information needed among other things. Necessary adjustments were made to the tool. To facilitate this, the researcher sought permission from local leaders, for example, the chief and assistant County Commissioner.

3.5.2 Validity of the instrument

Validity is the accuracy and meaningfulness of inferences, which are based on the research results; it is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study (Mugenda & Mugenda, 2003). To enhance validity of the questionnaires the instruments were reviewed under the supervision of the research supervisor in order to ensure they captured valid and reliable information. Also the questionnaires were pre-tested to ensure their validity. Research assistants were trained by the researcher on how to administer the questionnaires.

3.5.3 Reliability of the instrument

Joppe (2000) defines reliability as the extent to which results are consistent over time and an accurate representation of the total population under study. If the results of a study can be reproduced under a similar methodology, then the instrument is considered to be reliable.

This study espoused the test retest reliability approach as a measure of consistency. Reliability was tested using the Cronbach's alpha that was calculated from questionnaires from the pilot study that were conducted so as to assess the survey tool before the study; all the variables were found to have an alpha value of 0.7 and above and therefore were considered acceptable, and used for data collection.

3.6 Data Collection Procedure

An assistant researcher was trained in order to standardize the data collection exercise. Full lists of respondents interviewed were first prepared. The local administration office was informed of the research and an introductory letter sought from them, permission was also sought from the national council of science and technology so as to make of the study conform to the set standards. The physical location of the respondents was established for ease of delivery of the questionnaire. For illiterate respondents, a guided interview was done. With the help of the assistant researcher, all questionnaires were edited, verified and collected for analysis.

3.7 Data Analysis Technique

Raw data collected from the field was first cleaned for errors, coded, analyzed and categorized as per the research questions in order to simplify it for presentation. Data was analyzed and presented descriptively using statistical package for social science version 20. The researcher used regression analysis and cross tabulation to show the link and relationship that exist between the independent variables and urban hydroponic farming. Qualitative data was checked for completeness and cleaned ready for data analysis. Content analysis was used in processing the data and results presented in prose form. Content analysis is summarizing qualitative data that relies on the scientific method. The study used multivariate regression model. The independent variables of this study are access to capital, access to water, farmer awareness and type of crops grown. The multivariate regression model for this study is;

$$Y=A+B_1X_1+B_2X_2+B_3X_3+B_4X_4$$

Where Y is the dependent variable, urban hydroponic farming, while the independent variables X_1 access to capital,X_2 access to water,X_3 farmer awareness and X_4 type of crops grown.

3.8 Ethical Consideration

Ethical measures are principles the researcher should bind himself to in conducting the research before data collection (Macmillan and Schumacher, 1993). Initial approval was secured from the University of Nairobi. A research permit was sought from the NCST.

The respondents were assured that the information given is for the purpose of this research and was to be treated with utmost confidentiality.

3.9 Operationalization of Variables

The Operationalization of a variables means manipulating both the independent and dependent variables in such a way that they and end up having a few levels thus becoming measurable.

Objective	Variables	indicators	Data collection method	Measurement Scale	Type of analysis/Type of data
To identify how availability of capital influence the adoption of urban hydroponic farming in Meru town	Independent variable Dependent variable Urban hydroponic farming	Number of farmers who have access to capital. Number of farmers with no access to capital. Cost of acquiring capital Adequacy of capital	Questionnaire Questionnaire Questionnaire Questionnaire Questionnaire	Nominal Interval Nominal interval interval	Quantitative (regression) Quantitative Quantitative Quantitative
To identify how access to water influence the adoption of urban hydroponic farming in Meru Town	Independent variable Dependent variable Urban hydroponic farming	Sources of water Distance from the source Irrigation methods in use Cost of accessing water Quality of water for farming. Number of farmers with access to water Income generated in kshs. Annually	Questionnaire Questionnaire Questionnaire Questionnaire Questionnaire	Nominal Nominal Interval Nominal Interval	Quantitative Quantitative Quantitative Quantitative Quantitative Regression

To establish how farmer awareness on hydroponics influence the adoption of urban hydroponic farming in Meru town	Independent variable Dependent variable Urban hydroponic farming	Farmer trainings Information access. Farmer experience Collaboration and linkages Income generated in kshs. annually	Questionnaire Questionnaire Questionnaire Questionnaire	Nominal Interval Interval Interval	Quantitative Quantitative Quantitative Quantitative (regression)
To establish how type of crops grown influence the adoption of urban hydroponic farming in Meru town	Independent variable Dependent variable Urban hydroponic farming	Categories of crops grown. Maturity period of the crops. Value of crops grown. Income generated in kshs. annually	Questionnaire Questionnaire Questionnaire Questionnaire Questionnaire Questionnaire Questionnaire	Nominal Interval Nominal Interval Nominal Nominal Interval	Quantitative Quantitative Quantitative Qualitative Quantitative Quantitative Quantitative regression/

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter contains data analysis, interpretation and presentation of the findings. The purpose of the study was to analyze factors influencing adoption of urban hydroponic farming a case of Meru Town, Meru County, Kenya. The data was analyzed according to the research objectives which include; access to capital; access to water; farmer awareness and types of crops grown and how they influence adoption of urban hydroponic farming.

4.1.1 Questionnaire Response rate

The questionnaire was the main instrument used to collect data in this study targeting a sample of 150 urban farmers in Meru town. Out of this sample size, 135 questionnaires were filled and returned accounting for 90% response rate. The response rate was adequate for this analysis and conforms to Babbie (2002) stipulation that any response of 50% and above is adequate for analysis.

4.2 Demographic Information

To understand the background of the respondents participating in the study, the researcher required the respondents to indicate their gender, marital status and years of formal education.

4.2.1 Gender of urban farmers

The urban farmers were required to indicate their gender and demographic information. Demographic information is of great importance to this study as it influences some of the variables and also showing the gender involvement in urban farming.

Table 4.1: Distribution of urban farmers by gender in Meru Town (2017)

Gender	Frequency	Percentage
Male	67	49.3
Female	68	50.7
Total	**135**	**100**

Table 4.1 shows that 50.67% of the urban farmers were female while 49.33% of the urban farmers were male. This implies that both men and women are equally involved in urban farming in Meru town This finding contrasts with Maxwell (1995) who observed that urban agriculture is predominantly a woman's activity as most of the urban farmers are women and this is exemplified in most cities in sub Saharan Africa. This finding also contrasts Lynch et al (2001) who observed that in West Africa men dominate urban farming where this observation is true in respect to open space farming as compared to home gardening where women represent a higher percentage and outnumber men.

4.2.2 Years of Formal Education of urban farmers

The study sought to establish the years of formal education of the urban farmers and how it influences urban farming in Meru town.

Table 4.2: Number of years of formal education for urban farmers

Level of education	Frequency	Percentage
Primary education and below	33	24.7
Secondary education	67	49.3
College education	23	16.7
University Education	13	9.3
Total	**135**	**100.0**

Table 4.2 indicates that 49.3% of the urban farmers had secondary education, 24.7% of the urban farmers had primary education and below, 16.7% of the urban farmers had college education and 9.3% of the urban farmers had university education. This concludes that majority of the urban farmers in Meru Town are those with secondary school level of education compared to half this number who have primary school education. This contradicts the widely held belief that those involved in urban farming lack basic education.

4.2.3 Relationship between gender and years of formal education

The researcher sought to evaluate the relationship between gender and years of formal education. This was intended to unravel whether the education level of urban farmers had any bearing to the management of the farming activities.

Table 4.3: Distribution of urban farmers by gender and years of formal education

Level of education	Male	Female
Primary education and below	7.4%	17.0%
Secondary education	25.2%	24.4%
College education	11.1%	5.9%
University Education	5.9%	3.7%

Table 4.3 indicates that 25.2% of the urban farmers who had secondary education were men and 24.4% of the urban farmers who had secondary education were women. 5.9% of the urban farmers who had college education were men and 3.7% of the urban farmers who had university education were women. This is in line with Tinsley (2003) observation that women dominate urban farming due to women's comparatively low levels of education and lack of professional or other skills to effectively compete with men for formal employment.

4.3 Sources of credit accessed by urban farmers.

Credit is essential for agricultural development and is often a key element of agricultural modernization, apart from removing financial constraints it could also increase production and income and may accelerate the adoption of modern technologies (Duong and Izumuda 2002). The study sought to find out if the respondents acquire credit to improve the farming.

Table 4.4: Farmers with access to credit and average farming income per season.

Response	Frequency	Percentage	Average Income Per Season In Kshs.	Standard Deviation
Yes	65	48.0	3024	1242
No	70	52.0	2895	1253
Total	**135**	**100.0**		

Table 4.4 shows that 52 % of the urban farmers did not acquire credit to improve their farming and the average income they got from farming per season was Kshs. 2895 while 48% of the urban farmers indicated that they acquired credit to improve the farming and the average income they got from farming per season was Kshs. 3024. Income variability was the same among farmers in the two categories. This implies that farmers who acquire credit are able to improve farming by accessing farm inputs like fertilizer, quality seeds, and herbicides to control pests. Others are able to fence their plots and minimize loss of crops through theft. Credit facilities can help farmers purchase modern inputs such as high yielding varieties of seeds, fertilizers and install irrigation to increase production, (Lal et al 2003).

The study sought to find out the source of the credit. Credit sources may be formal or informal where formal sources are the institutional sources such as co-operative banks, commercial banks and agricultural financial institutions. Informal sources are the non-institutional sources such as professional and agricultural money lenders, co-operative societies, traders and commission agents, relatives and friends.

Table 4.5: Sources of the credit accessed by urban farmers

Credit lenders	Frequency	Percentage	Average Income Per Season In Kshs.	Standard Deviation
Family member's	11	8.0	2773	1183
Merry go rounds	35	26.0	3075	1403
Sacco's	39	28.7	3009	1213
Commercial banks	7	5.3	2878	1150
N/A	70	52.0	2895	1253
Total	**135**	**100.0**		

Table 4.5 indicates that 28.7% of the urban farmers got their credit from Sacco's and the average income that they got from urban farming per season was Kshs. 3,009. 26.0% of the urban farmers got their credit from Merry go rounds and the average income that they got from urban farming per season was Kshs. 3,075. 8.0% of the urban farmers got their credit from family members and the average income that they got from urban farming per season was Kshs. 2,773 while 5.3% of the urban farmers got their credit from commercial banks and the average income

that they got from urban farming per season was Kshs. 2,878. 52% of the urban farmers who did not acquire credit to improve their farming had an average income of Kshs.2895 per season.

According to Hussein (2007) informal sources are neither time consuming nor procedural but charge high interest rates. Most of the informal sources cannot meet all cash requirements of a farmer for agricultural production purposes. Formal sources are big lending sources and can meet all farming requirements of farmers (Gustavo et al 2006). Formal credit sources require specific conditions to advance loan including geographical location of the agricultural activity, climate and tied collateral with cumbersome procedure (Kabir et al 2006).

Urban farmers preferred the source of credit depending on interest charged and requirements of lender before the funds are availed. Ortmann and King (2006) observed in a study in South Africa that small scale farmers have limited access to factors of production including credit and information. Okurut et al (2004) carried out a study in Uganda and observed that demand for credit for productive investment usually comes from the poor who are risk averse and enables them to overcome liquidity constraints making it possible to undertake investment that can boost production, employment and income. Also he indicated that failure of formal banks to serve the poor is due to a combination of high risk, high costs and low returns associated with such businesses.

4.5 Availability of Water for Irrigation among urban farmers and average income per season.

The study investigated whether the urban farmers irrigated their crops during the dry season.

Table 4.6: Average income per season from irrigated and non-irrigated urban land.

Response	Frequency	Percentage	Average Income Per Season In Kshs.	Standard Deviation
Yes	74	54.7	2979	1185
No	61	45.3	2915	1299
Total	**135**	**100.0**		

Table 4.6 indicates that 54.7% of the urban farmers irrigated the crops and the average income they generated per season was Kshs. 2979 while 45.3% did not irrigate the crops and the average

income they generated per season was Kshs. 2915. Income variability was less among those who irrigated their plots than those who did not irrigate their crops. The findings imply that farmers who irrigated their crops generated slightly higher income compared to those who did not. Irrigation enables farmers to produce crops throughout the year and especially during the dry season. Urban farming has enabled investment in irrigation and in instances where farmers cannot afford to invest in piped water they opt to use waste water from municipal sources (Barry 2002). Agriculture accounts for at least 70 percent of the total global water usage and if water is not managed well in the agricultural sector food production will decrease substantially and will lead to increased food importation (Rose grant et al 2002).

The study also sought to find out the source of water for farming.

Table 4.7: Source of water used for irrigation by urban farmers.

Source of Water	Frequency	Percentage
Surface water	26	19.3
Piped water	44	32.7
Underground wells	65	48.0
Total	**135**	**100.0**

From the findings in table 4.7, 48.0% of the urban farmers got water from underground wells, 32.7% of the urban farmers used piped water to irrigate their crops, while 19.3% of the urban farmers used surface water. Rockstrom et al (2001) argues that water harvesting can mitigate the effects of temporal and spatial rainfall and the high risks of intra- seasonal dry spells that characterize water scarcity in agricultural production. Shah et al (2000) indicates that ground water offers opportunity to support agricultural activities during the dry season. Tapping shallow aquifer for small scale irrigation allows easy access to water sources because of low capital requirement which makes it possible for small scale farmers to invest in irrigation (Woldearegay 2002).

The study sought to find out the preferred method of watering the crops during the rainy season.

Table 4.8: Preferred method of watering the crops during the dry season by urban farmers.

Type of irrigation	Frequency	Percentage
Drip irrigation	14	10.7
Sprinkle irrigation	20	14.7
Manual watering cans	67	49.3
Use of treadle water pumps	34	25.3
Total	**135**	**100.0**

Table 4.8 shows that 49.3% of the urban farmers preferred manual watering cans for watering the crops during the dry season, 25.3% of the urban farmers preferred to use of treadle water pumps for watering the crops during the dry season, 14.7% of the urban farmers preferred sprinkle irrigation for watering the crops during the dry season and 10.7% of the respondents preferred drip irrigation for watering the crops during the dry season. Sally et al (2000) points out that precision irrigation should be adopted by farmers with limited access to agricultural water. Precision irrigation involves water management practices such as use of watering cans, drip irrigation and treadle pumps.

The study sought to find out the crops that urban farmers cultivated the yields in per season and the price. Irish potatoes yielded an average of 2 bags per harvest and the average price was 1200 shillings per unit. Maize yielded half a bag per harvest and the average price was 4000 shillings per unit. Beans yielded half to 1 bag and the average price was 6000 shillings per unit. Ngigi (2002) indicates that yield and reliability of agricultural production can be significantly improved with water harvesting.

4.6 Farmer’s awareness and urban hydroponic farming

Farmers’ awareness was measured by a number of factors, these include: whether or not they got regular training on farming, their main source of farming information and the number of farmers they networked with.

4.6.1 Institution offering training on farming

Summary of institutions that trained farmers on farming is illustrated in Table 4.9 below. About 53% of respondents from chose none. Government of Kenya was chosen by about 40%. As it is shown 3.4% got training from the private sector. Less than 5% got training from NGOs.

Table 4.9: Institution offering training on farming

Institution offering training	Frequency	Percentage
NGO	4	2.9
GOK	53	39.1
Private sector	5	3.4
None	73	54.6
Total	**135**	**100**

From the study capacity building on farmer is an indication of increasing awareness among them and the trainings has an effect on their farming practices. New ideas on farming receive better implementation when farmers are trained by extension staffs from either government or private sector. Result of the study reveals that a lot of farmers are on their own with no training services from either government or private sector.

4.6.2 Source of farming information on farm

Table 4.10 illustrates respondents' source of farming information in five given categories plus "none" option. About 40% of farmers stated media. Approximately 36% percent of respondents chose other farmers. About 18% farmers chose "all of the above". Approximately another 16% stated that they attended workshop and about 6% chose leaders and farmers' representatives.

Table 4.10 sources of farming information on farm

Source of information on your farm	Frequency	Percentage
Other farmers	48	35.8
Leaders and farmers representatives	7	6.4
Media	53	39.3
Workshops	18	13.3
All of the above	6	4.6
None	1	0.6
Total	**135**	**100**

From the study responses above most farmers get important farming information from the media; this can be explained by the average literacy levels in the two regions as shown in Table

4.10 where most of the farmers cannot seek information from other sources like journals thus they turn to the media and vernacular radio stations for important information.

4.6.3 Number of farmers networking with each other.

Respondents were asked the number of farmers they networked with on matters of farming and were supposed to respond in four given categories plus “none”. About 34% of respondents chose more than three, and 18% choosing two. 24% chose none. About 18% of the respondents chose two, about 12.8% of the respondents choosing three, as illustrated in Table 4.11 below.

Table 4.11: Number of farmers networking with each other

Numbers of farmers networking	Frequency	Percentage
None	33	24.4
One	13	9.9
Two	25	18.6
Three	18	12.8
More than three	46	34.3
Total	**135**	**100**

As shown in Table 4.11, majority (34.3%) of the respondents constituting of 46 respondents said that they networked with more than three farmers. The more the farmers network with other farmers the better for them since the interaction becomes an avenue for sharing challenges in farming and new experience as well as sharing ideas. Lesson leant in farming exchange hands and this brings improvement and increases awareness of new farming experiences (Muriuki et al, 2003)

4.6.4 Farmer awareness of hydroponic farming

Respondents were further asked whether they were aware of hydroponic farming and how they came to know about it, the respondent are presented in table 4.12 below

Table 4.12 Farmer awareness of hydroponic farming

Response	Frequency	Percentage
Yes	46	34
No	89	66
Total	**135**	**100**

From the finding above majority 66%of the urban farmers were not aware of hydroponic farming with those aware mentioning that they came to know about hydroponic farming through newspapers. Only 12% of the farmers had tried hydroponic farming in the area. Hydroponics is a system of agriculture that utilizes nutrient-laden water rather than soil for plant nourishment (Bridgewood, 2003). Because it does not require natural precipitation or fertile land in order to be effective, it presents people who are living in urban regions with a means to grow food for them and for profit.

4.7 Types of Crops Grown by urban farmers

Drechsel et al (2005) observes that the most common form of urban farming is backyard gardening where farmers practice mixed cropping and change crops according to seasonal supply, demand and market prices.

The study sought to find out how many months the crops cultivated by urban farmers took to be ready for harvest.

Table 4.13: Number of month's main crops take to be ready for harvest and average farming income per season.

Maturity period	Frequency	Percent age	Average Income Per Season In Kshs.	Standard Deviation
1-3 months (sukuma wiki, spinach)	57	42.0	2904	1182
3-6 months (onions, peppers, tomato Irish potatoes, cabbages)	49	36.0	3055	1552
6-9 months (carrots, peas)	23	16.7	3013	1227
1 year (bananas, fruit trees)	7	5.3	2920	1187
Total	**135**	**100.0**		

Table shows that 42.0% of the urban farmers cultivated crops that matured within a period of 1-3 months and the average income generated was Kshs.2904 per season. 36.0% of the urban farmers indicated that they cultivated crops that matured within a period of 3-6 months and the average income generated was Kshs.3055 per season 16.7% of the urban farmers indicated that they cultivated crops that matured within a period of 6-9 months and the average income generated was Kshs.3013 per season and 5.3% of the urban farmers indicated that that they cultivated crops that matured within a period of 1 year and the average income generated was Kshs.2920 per season. This indicates that fast maturing crops like sukuma wiki, Spinach, cabbage, Onions, Peppers, tomato, Irish potatoes, peas and Carrots were able to generate more income per year compared to crops that take long cycles to mature like bananas and fruit trees. According to Kessler,(2003), The short cycle crops are grown to ensure returns on inputs and salaries, while long cycle crops are used to maximize benefit and investment in infrastructure and generating family income

4.8 Regression Analysis

The researcher used a multivariate regression model to establish the relationship between independent variables (Farmer awareness, access to capital, Types of crops grown and Access to water) and the dependent variable which was urban hydroponic farming. The research used statistical package for social sciences (SPSS V 21.0) to code, enter and compute the measurements of the multiple regressions.

R-Squared is a commonly used statistic to evaluate model fit. R-square is 1 minus the ratio of residual variability. The adjusted $R^{2,}$ also called the coefficient of multiple determinations, is the percent of the variance in the dependent explained uniquely or jointly by the independent variables. 73.6% of the changes in the urban hydroponic farming could be attributed to the combined effect of the predictor variables as shown in table 4.14,an R squared value = 73.6% means that close to 74% of the changes in the urban hydroponic farming could be jointly attributed to the combined effect of the predictor variables.

The probability value of 0.003 in table 4.14 indicates that the regression relationship was highly significant in predicting how farmer awareness, access to capital, types of crops grown and access to water influenced urban farming. The F calculated at 5% level of significance was 6.937 while F critical was 2.3719. Since F calculated is greater than the F critical (value = 2.3719), this shows that the overall model was significant. The model helps us discern that the factors investigated in this study influence urban farming.

Table 4.14 Regression results showing relationship between urban farming income per season and four predictive factors

Dependent Variable	**Urban farming per season**				
R	0.8895				
R Square	0.7912				
Adjusted R Square	0.7364				
Std Error of Estimates	0.7296				
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Regression	12.223	4	3.112	6.937	.003
Residual	92.876	131	.641		
Total	115.09	135			
		Un standardized Coefficients	**Standardized Coefficients**		
	B	**Std error**	**Beta**	**t**	**Sig**
Constant	1.492	0.298		4.218	0.044
Farmer awareness	0.617	0.178	0.326	5.374	0.032
Access to capital	0.702	0.171	0.421	4.963	0.027
Types of crops grown	0.596	0.563	0.123	3.916	0.038
Access to water	0.883	.0725	0.384	4.115	0.019

The regression model above has established that taking all factors into account (Farmer awareness, access to capital, types of crops grown and access to water) constant at zero urban agriculture income will be 1.492. The findings presented also show that taking all other independent variables at zero, a unit increase in the farmer awareness would lead to a 0.617 increase in the scores of urban agriculture income and a unit increase in the scores of forms of access to capital would lead to a 0.702 increase in the scores of urban agriculture income. Further, the findings shows that a unit increases in the scores of types of crops grown would lead to a 0.596 increase in the scores of co urban agriculture income. The study also found that a unit increase in the scores of access to water would lead to a 0.883 increase in the scores of urban agriculture income.

At 5% level of significance and 95% level of confidence, farmer awareness had a 0. 032 level of significance; access to capital showed a 0.027 level of significance, types of crops grown had a 0.038 level of significance while access to water showed 0.019 level of significance hence the most significant factor is access to water. Overall, there was a positive and significant relationship between all the independent variables and the dependent variable. Access to water had the greatest effect on the urban hydroponic farming, followed by forms of access to capital, then farmer awareness while types of crops grown had the least effect to the urban hydroponic farming. All the variables were significant ($p<0.05$). The findings are consistent with Bailkey and Kaufman (2000) study in the USA who found out that urban agriculture projects were under funded, understaffed, and confronted with difficult management and marketing issues. Urban agriculture was not seen as the highest and best use of vacant inner city land by most local government policy officials. Further, Zhang-lin and Ying (2010) found that urban farming is affected by different factors as farm size, crops grown, inputs used, technology adopted, labor, age and experience on the farming activity.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter depicts the summary of the data findings on the factors influencing urban hydroponic farming among men and women in Meru town with a view to identifying options to guide policy and programs in enhancing the activity. The conclusions and recommendations are based on the study objectives. The chapter is therefore structured into summary of findings, discussions, conclusions, recommendations and area for further research.

5.2 Summary of Findings

The objectives of this study were to determine whether urban hydroponic farming was influenced by the following factors: 1) Access to capital, 2) access to water. 3) Farmer awareness and 4) types of crops grown. The summary of findings is indicated below.

The study found out that 52 % of the urban farmers did not invest any funds acquired by credit in their urban farming and the average income they achieved per season was Kshs. 2895. In contrast, 48% of the urban farmers indicated that they acquired credit to improve the farming and the average income they got from urban farming per season was Kshs. 3024. It is likely that farmers who acquire credit are able to improve farming by accessing farm inputs like fertilizer, quality seeds, and herbicides to control pests. Others are able to fence their plots and minimize loss of crops through theft. Credit facilities can help farmers purchase modern inputs such as high yielding varieties of seeds, fertilizers and install irrigation to increase production, (Lal et al 2003).

Though a significant number of farmers had not received any training on farming, standing at about 53%, the result also showed an inclination in receiving training from private institutions, NGOs and the Government of Kenya. Farmers also showed aggression in seeking out farming related information from many other sources other than from their counterpart farmers. These farmers quest for extensive information on farming was also highlighted by their expansive peer to peer networks as a majority of them were cited as having networked with more than three peers on farming related matters. The study concurs with Muriuki (2003) that the more the farmers network with other farmers the better for them since the interaction becomes an avenue for sharing challenges in farming and experience as well as sharing ideas. Also the study agrees with Walshe (1991) who urges that the lesson leant in farming exchange hands and this brings improvement and increases production.

The study found out that availability of water for irrigation determined whether urban farmers in Meru town are able to produce throughout the season and thus increase in their income particularly from higher prices during the dry season. This is confirmed by 54.7% of the urban farmers who irrigated their crops and generated Kshs.2979 as their average farming income per season compared to 45.3% who did not irrigate and generated an average income of Kshs 2915 per season. The findings imply that farmers who irrigated their crops generated twice income compared to those who did not.

The study found that types of crops grown and number of months taken by the crop to reach to maturity determined the income that the farmers obtained. More specifically the study found that 42.0% of the urban farmers cultivated crops which took 1 to 3 months to reach maturity generated an average income of Kshs2904 per season. In contrast, 36.0% of the urban farmers cultivated crops that took 3 to 6 months to reach maturity had an average income of Kshs.3055 per season.

The study also found that 16.7% of the urban farmers cultivated crops that took 6-9 months to reach maturity generated Kshs3013 average income per season. The 5.3% of the urban farmers grew crops which took 1 year to reach maturity generated lower average income of Kshs.2920 per season. This indicates that fast maturing crops like sukuma wiki, spinach, cabbage, onions, pepper, tomato, Irish potatoes, peas and carrots were able to generate more income compared to crops that take more months to mature like bananas and fruit trees. According to Kessler (2003), the short maturing crops are grown to ensure returns on inputs and wages for workers, while long maturing crops are essentially for maximize benefit and generating family income.

5.3 Discussions of Findings

This section focuses on a detailed discussion of the major findings of the study which also entails comparing the study findings to the literature in order to come up with comprehensive conclusion.

5.3.1 Access to Capital and their Influence on adoption of urban hydroponic Farming.

Credit is essential for agricultural development and is often a key element of agricultural modernization. Apart from removing financial constraints it could also increase production and income and may accelerate the adoption of modern technologies. Credit facilities can help farmers purchase modern inputs such as high yielding varieties of seeds, fertilizers and install irrigation to increase production. According to the findings, Access to credit and form of credit influences urban farming income; the study found out that 52 % of the urban farmers did not acquire credit to improve their farming and the average income they got from farming per season was Kshs. 2895 while 48% of the urban farmers indicated that they acquired credit to improve the farming and the average income they got from urban farming per season was Kshs. 3024.

Also the study found out that 28.7% of the urban farmers got their credit from Sacco's and the average income that they got from urban farming per season was Kshs. 3008. 26.0% of the urban farmers got their credit from Merry go rounds and the average income that they got from urban farming per season was Kshs. 3075. 8.0% of the urban farmers got their credit from family members and the average income that they got from urban farming per season was Kshs. 2773 while 5.3% of the urban farmers got their credit from commercial banks and the average income that they got from urban farming per season was Kshs. 2878. This implies that farmers who acquire credit are able to improve farming by accessing farm inputs like fertilizer, quality seeds, and herbicides to control pests. Others are able to fence their plots and minimize loss of crops through theft. Credit facilities can help farmers purchase modern inputs such as high yielding varieties of seeds, fertilizers and install irrigation to increase production, (Lal et al 2003).

5.3.2 Availability of Water for Irrigation its Influence on adoption of urban hydroponic Farming

Availability of water for irrigation determined whether urban farmers in Meru town are able to produce throughout the season and thus increase in their income. The study found out that 54.7% of the urban farmers irrigated the crops and the average income they generated per season was Kshs. 6979 while 45.3% did not irrigate the crops and the average income they generated per season was Kshs. 2915. The findings imply that farmers who irrigated their crops generated twice income compared to those who did not. Irrigation enables farmers to produce crops throughout the year and especially during the dry season. This observation is supported by different scholars like Rockstrom et al (2001) who argues that water harvesting can mitigate the effects of temporal and spatial rainfall and the high risks of intra- seasonal dry spells that characterize water scarcity in agricultural production, Shah et al (2000) who indicates that ground water offers opportunity to support agricultural activities during the dry season and Barry (2002) who pinpoints that Urban farming has enabled investment in irrigation and in instances where farmers cannot afford to invest in piped water they opt to use waste water from municipal sources .

5.3.3 Influence of farmer awareness on urban hydroponic farming

Though a significant number of farmers had not received any training on farming, standing at about 53%, the result also showed an inclination in receiving training from private institutions, NGOs and the Government of Kenya. Farmers also showed aggression in seeking out farming related information from many other sources other than from their counterpart farmers. These farmers quest for extensive information on farming was also highlighted by their expansive peer to peer networks as a majority of them were cited as having networked with more than three peers on farming related matters. The study concurs with Muriuki (2003) that the more the farmers network with other farmers the better for them since the interaction becomes an avenue for sharing challenges in farming and experience as well as sharing ideas. Also the study agrees with Walshe (1991) who urges that the lesson leant in farming exchange hands and this brings improvement and increases production.

5.3.4 Influence of types of Crops Grown on Urban hydroponic Farming

Types of crops grown and maturity period of the crops determined the income that the farmers got as indicated by the study findings where 42.0% of the urban farmers cultivated crops that matured within a period of 1-3 months and the average income generated was Kshs.2904 per season. 36.0% of the urban farmers indicated that they cultivated crops that matured within a period of 3-6 months and the average income generated was Kshs.3055 per season 16.7% of the urban farmers indicated that they cultivated crops that matured within a period of 6-9 months and the average income generated was Kshs.3013 per season and 5.3% of the urban farmers indicated that that they cultivated crops that matured within a period of 1 year and the average income generated was Kshs.2920 per season . This indicates that fast maturing crops like sukuma wiki, Spinach, cabbage, Onions, Peppers, tomato, Irish potatoes, peas and Carrots were able to generate three times income compared to crops that take long cycles to mature like bananas and fruit trees. According to Kessler,(2003), The short cycle crops are grown to ensure returns on inputs and salaries, while long cycle crops are used to maximize benefit and investment in infrastructure and generating family income.

5.4 Conclusions from the study

Based on the findings the study concludes that:

Credit is a key element of agricultural modernization. Apart from removing financial constraints it could also increase production and income and accelerates the adoption of modern technologies. Credit facilities helps farmers purchase modern inputs such as high yielding varieties of seeds, fertilizers and install irrigation to increase production. Farmers in Meru town preferred informal sources of credit since they are neither time consuming nor procedural but charge high interest rates. Most of the informal sources cannot meet all cash requirements of a farmer for agricultural production purposes. Small scale farmers have limited access to factors of production including credit and information. Financial intermediaries are unable to accommodate small scale farmers because their agricultural activities were considered risky, costly and difficult that involves high transaction costs.

Urban farmers should adopt crop intensification strategies in their farming systems where intensification involves cultivation of high value crops which increases productivity on the same area of land and maximize the use of available resources including waste water. The short cycle crops are grown to ensure returns on inputs and salaries, while long cycle crops are used to maximize benefit and investment in infrastructure and generating family income.

Rapid urbanization agriculture has to compete with increasing urban water needs. Water allocation for agriculture gives way to higher value urban uses that may adversely affect food production and the reduction in water allocation for agricultural purposes in urban centers affects food security. More yields were produced when irrigation was used. Relying on rainfall availability makes crop production vulnerable to adequacy, reliability and timeliness of rainfall. Urban farming has enabled investment in irrigation and in instances where farmers cannot afford to invest in piped water they opt to use waste water from municipal sources. Precision irrigation involves water management practices such as use of watering cans, drip irrigation and treadle pumps.

The study finally infers that there was a positive and significant relationship between all the independent variables and the dependent variable. Access to water had the greatest effect on the urban hydroponic farming, followed by access to capital, then farmer awareness while types of crops grown had the least effect to the urban hydroponic farming.

5.5 Recommendations from the study.

Based on the study findings the study recommended the following:

Financial institutions that offer formal credit should be encouraged to stop categorizing urban agriculture as risky, costly and difficult investment venture that involves high transaction costs and unpredictable returns.

Farmers should be encouraged to take loans while the government needs to provide farmer support services to the urban farmers

Urban farmers should be encouraged to irrigate their farms and modern irrigation methods like drip irrigation should be availed to them to avoid water wastage.

Urban farmers can use their literacy to access new technologies like greenhouse farming, hydroponic farming and hanging gardens and form farming groups which can lobby should be introduced to ensure maximum production and use of available land and space in urban center's to increase productivity.

Urban farmers should grow short cycle crops in order for farmers to generate more and continuous income to ensure returns on inputs and salaries. Also urban farmers should adopt crop intensification strategies in their farming systems to increases productivity on the same area of land and maximize the use of available resources including waste water.

5.6 Suggestion for Further Studies

The study recommends further research on the influence of urban planning on returns from urban farming. Moreover policy and practice can benefit from further analysis on the influence of farmer characteristics, particularly gender, on urban farming income and returns earned by factors of production.

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APPENDIX .1 TRANSMITTAL LETTER

JACOB GITOBU KIBITI

P.O.BOX 3279- 60200

MERU

Date 22nd March 2017

Dear sir/ madam,

RE: TRANSMITTAL LETTER FOR RESEARCH INSTRUMENTS.

I am a postgraduate student in the University of Nairobi, pursuing a Master's degree in Project Planning and Management. I am conducting a research on Factors influencing adoption of urban hydroponic farming in Meru town. You have been selected to help in this study. I do humbly request you to allow me to interview you. The information being sought is meant for research purposes only and will not be used against anyone. The researcher will ensure that a feedback reaches all those who participated.

Findings will greatly inform all stakeholders involved and will be a major boost in the adoption of hydroponic farming. Your responses will also be treated with confidence. No names of individuals or farms will be needed.

Thank you in advance.

Yours sincerely,

Jacob Gitobu Kibiti

L50/84551/2016

APPENDIX .2

QUESTIONNAIRE FOR URBAN FARMERS

Please tick and comment on the spaces provided

1. Please indicate your gender
   - Male □
   - Female □
2. Please indicate years of formal education
   - Eight years and below □
   - Between 8-12 □
   - Between 12-15 □
   - Between 15-20 □
3. Do you acquire credit to improve your farming?
   - Yes □
   - No □
4. Please indicate the source of your credit?
   - Family member's □
   - Merry go rounds □
   - Sacco's □
   - Commercial banks □
5. Please explain briefly why you prefer your choice of source of credit
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
   ……………………………………………………………………………………………
6. Do you irrigate your crops?
   - Yes □
   - No □
7. Which is your source of water for farming?
   - Surface water □
   - Borehole □
   - Piped water □

8. Which is your preferred method of watering your crops during the dry season?
   - Drip irrigation □
   - Sprinkle irrigation □
   - Manual watering cans □
   - Use of water pumps □
9. Please indicate the yields you get from your crops per season when you undertake irrigation. Also indicate the unit price of your produce?

Crop	yield	unit price
…………..	…………	………………..
…………..	………….	………………..
…………..	…………..	………………..

10. Briefly explain what should be done by urban governments to improve urban farming.
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
……………………………………………………………

11. Who offer training on farming in this region??

NGO's	□
GOK	□
Private sector	□
None	□

12. What is the source of the farm information on your farm? Tick appropriately?

Other farmer's	□
Media	□
Workshop/ seminars	□
Internet	□

13. How many farmers do you network with on matters of farming in your area or from far?

1-5	□
6-10	□
More than 10	□

14. Are you aware of hydroponic farming?

Yes	□
No	□

15. Briefly explain how you got to know about it, and whether you practice it.
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………

16. Please indicate the period you have been using hydroponic your plot.

Less than one year	□
1-2 years	□
2-4 years	□

17. What type of crops do you cultivate?
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

18. What is the maturity period of your crops?

1-3 months	□
3-6 months	□
6-9 months	□
1 year	□

19. Please indicate the crops that you cultivate, the yields in per season and the price.

Crop	yield per season	average price per unit
……………	……………..	………………………
……………	……………..	……………………….
……………	……………..	………………………
……………	……………..	……………………….
……………..	……………..	……………………….

Appendix Observation chart

Table 1: Observation Chart

Things to be observed	**Observed**	**Not observed**
Most common type of crop cultivated		
Source of water for farming		
Individuals involved in farming		
Fencing of the plots		
Use of pesticides		
Use of artificial fertilizers		
Use of organic manure		
Location of the farming plots		
Availability of extension services		
Knowledge of agricultural practices.		
Common method of watering crops		
Type of labor employed in the plots.		