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

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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.

Key Words: *urban hydroponic farming, Meru town, Meru county, Kenya*

INTRODUCTION

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, Ratta & Nasr, 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, 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, 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, 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 psychologist with an extensive education in the classics.

Fahey (2012) indicates that 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, 2012)

Onanuga (2013) indicates that 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, 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 and Oebker, 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, 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 and Belevi (2001) observe that 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 et. al., 2012).

According to Ayele 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.

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, 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, 1960). Hydroponic farming is the fastest growing sector of agriculture, and it could very well dominate food production in the future (Butler & Oebker, 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 & Koul, 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 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 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.

GENERAL OBJECTIVE

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

SPECIFIC OBJECTIVES

1. To identify how availability of capital influence the adoption of urban hydroponic farming

2. To identify how access to water influence the adoption of urban hydroponic farming
3. To establish how farmer awareness on hydroponics influence the adoption of urban hydroponic farming
4. To establish how type of crops grown influence the adoption of urban hydroponic farming

THEORETICAL REVIEW

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 & 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. 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).

RESEARCH METHODOLOGY

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).

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.

Sampling Design and Procedure

The formula below adopted from Watson (2001) was 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.

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

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.

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.

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.

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.

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.

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.

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.

RESEARCH RESULTS

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 R2, 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 1 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 1: 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.

DISCUSSION

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. 2,895 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. 3,024.

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. 3,008. 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. 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).

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. 6,979 while 45.3% did not irrigate the crops and the average income they generated per season was Kshs. 2,915. 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 .

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.

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. 2,904 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. 3,055 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. 3,013 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. 2,920 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.

CONCLUSIONS

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.

RECOMMENDATIONS

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.

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