THE ECONOMIC CONTRIBUTION OF URBAN AGRICULTURE TO THE LIVELIHOOD OF HOUSEHOLDS IN ZAMBIA

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DECLARATION AND APPROVAL

DECLARATION

This research thesis is my original work and it has not been presented in any university for the award of a Degree or a Diploma or other qualification.

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APPROVAL

This research thesis has been presented to the Graduate school for examination with our approval as University supervisors.

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ABSTRACT

Urban agriculture has grown tremendously in most Sub-Saharan African (SSA) countries. Increasing poverty levels and increasing food prices with stagnant incomes have resulted in household food insecurity. Urban households are resorting to urban agriculture as an alternative source of food for household consumption and for income generation. Urban agriculture has emerged as an informal entrepreneurial activity with the potential to increase household income and enhance food security. However, literature reveals that there is relatively low empirical evidence of the economic benefits of urban agriculture especially in Zambia. Thus, this study sought to empirically investigate the economic contribution of Urban Agriculture to the livelihood of households in Zambia by identifying factors that influence a household's decision to participate in urban agriculture and to determine the effect of urban agriculture on household income. The analysis was based on the 2007/2008 Urban Consumption Survey data obtained from Indaba Agricultural Policy Research Institute (IAPRI). The study covered Lusaka and Kitwe towns. The total sample size was 2682 urban households. Both Logistic regression and propensity score matching models were employed for data analyses. Logistic regression model was used to determine factors that influence a household's participation in urban agriculture because it is the appropriate regression analysis to use when the dependent variable is dichotomous. It is analogous to linear regression except that independent variable should be binary. The propensity score matching methods was used to estimate the effect of urban agriculture on household income. Propensity score matching method takes into account systematic differences in socio-economic characteristics between the treated and untreated units by matching only units from both groups with similar characteristics. This helps eliminate the problem of selection bias. In this case, the observed outcome discrepancy between the two groups can confidently be attributed to the treatment.

Results indicate that urban agriculture has a positive significant effect on household income. Household income of households that practiced urban agriculture increased by 13.7% to 19.1%. This implies that urban agriculture has the potential to improve household livelihood through enhanced income. Results also show that the age of the household head, the area of residence of the household, the marital status of the household head, the highest level of education attained by the household head, the gender of the household head, the main source of livelihood of the household head and the quantity of crops harvested in the previous season significantly influence a household's decision to participate in urban agriculture. Further results show that households in Kitwe town are more likely to participate in urban agriculture than Lusaka residents. This was used as a measure of years of experience considering that literature reveals that in Zambia, urban agriculture was first started on the Copperbelt.

From a policy point of view, these results suggest the need for the Zambian Government to recognize urban agriculture and its potential economic benefits to the livelihood of households. The Government should consider integrating urban agriculture in agricultural development policies of the country. Appropriate institutional and technical support services to urban agriculture should complement these policies.

This study will contribute to the body of literature on urban agriculture in that the propensity score matching model was used to estimate the average treatment effect to measure the effect of household participation in urban agriculture on household income. In Zambia, none of the previous impact studies on urban agriculture has applied the Propensity Score Matching methods.

Key Words*: urban agriculture, income, poverty, Propensity Score Matching, treatment effect*

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LIST OF ABBREVIATIONS

ATE:	Average Treatment Effect
ATT:	Average Treatment on the Treated
CIA:	Conditional Independence Assumption
CSO:	Central Statistical Office
FAO:	Food and Agriculture Organization of the United Nations
GDP:	Gross Domestic Product
IDRC:	International Development Research Centre
IFPRI:	International Food Policy Research Institute
KES:	Kenyan Shilling
MDG:	Millennium Development Goals
OLS:	Ordinary Least Squares
PSM:	Propensity Score Matching
PRSP:	Poverty Reduction Strategy Paper
RUM:	Random Utility Model
SAPs:	Structural Adjustment Programmes
SRP:	Social Recovery Project
SSA:	Sub Saharan Africa
UA:	Urban Agriculture
UN:	United Nations
UNDP:	United Nations Development Programme
USD:	United States Dollar
ZAMSIF:	Zambia Social Investment Fund

CHAPTER 1

INTRODUCTION

1.1 Background

Food insecurity and high prevalence of poverty are among the most significant challenges affecting development in Sub-Saharan Africa (SSA) today (FAO, 2016; UNHABITAT, 2010). It is estimated that about 42% of the Sub-Saharan African population live in poverty (Alkire *et al*., 2018). Zambia is among Southern African countries with high poverty levels. About 60% of the Zambian population lives in poverty (World Bank, 2019). Achieving poverty reduction has been a developmental agenda of the country. The Zambian government has accordingly intervened through various programs and policies in an effort to alleviate poverty. Among them are Sustainable Development Goals (SDGs), the Poverty Reduction Strategy Paper (PRSP), the Zambia Social Investment Fund (ZAMSIF) and the Social Recovery Project (SRP) (Woodbridge, 2015; Hampwaye *et al*., 2007). Recently, the Government launched the Seventh National Development Plan as the key to poverty reduction. The development plan has a strong pillar that focuses on reduction of poverty levels in Zambia (CSPR, 2017).

Agriculture has been recognized as an important sector with the potential of alleviating poverty and ensuring food security. It has become the economic backbone of the country, contributing approximately 20% to Gross Domestic Product (GDP) in 2008. In 2018, the sector's contribution to Gross Domestic Product (GDP) declined to about 2.6% (Plecher, 2018; World Bank, 2019). Agriculture is the main activity among the rural households accounting for about 80% of the rural population (CSO, 2012). Henceforth, the government in collaboration with other stakeholders has developed measures to improve agriculture production and productivity. Sustainable agriculture technologies and programs have been developed and implemented such as conservation farming practices, crop diversification, integrated livestock production, input subsidies to improve food productivity and security. The focus has been in rural areas where the activity is predominant and poverty levels are high.

However, the current global rapid rate of urbanization has posed a threat to food security in urban areas of Zambia and Sub-Saharan Africa (SSA) at large (Crush and Frayne, 2010; Stewart *et al*., 2013). During the last decade, the global urban population has become larger than the rural population. Predictions suggest that by the year 2050, around 70% of the world population will be living in urban areas (Ibrahim Game and Richaela Primus, 2015). Much of the global urban population growth will occur in developing nations. Currently about 78% of the total population in developed nations live in urban societies and only about 47% of the total population in developing nations live in urban societies (UNDESA, 2013). However, it is predicted that by the year 2050, the urban population in developed countries will increase by an estimated 0.17 billion people compared to an estimated 2.45 billion people in developing countries (Taylor and Peter, 2014) indicating a rapid increase of urban population in developing countries. In 2000, 38% of Africans lived in urban areas and it is projected to increase to 55% by 2030 (UNHABITAT, 2010).

Zambia has been reported to be the third most highly urbanized country in SSA. According to reports, about 40% of its total population is estimated to live in urban areas (World Bank, 2011; CSO, 2012). Urbanization or urban population growth in Zambia is as a result of rural-urban migration, natural population growth, economic recessions and structural adjustment programmes (Masvaure, 2013; Hampwaye, 2010). Ideally, urbanization is expected to be more of a positive than a negative phenomenon (i.e. increased economic activities). This has not been the case. Increased urban population has been associated with high unemployment levels, high food prices, food shortages, poor public services and increasing poverty levels rather than better standard of living ((Padgham *et al*., 2015; UNHABITAT, 2010). Urban households mainly access their food through purchases unlike rural households who consume from their own produce (Badami and Ramanculty, 2015). Food alone accounts for 50-80% of their disposable income (Masvaure, 2013; CSO, 2012). Increase in food prices reduces their purchasing power thus threatening food security

Although agriculture is typically thought of as a predominantly rural activity, the majority of urban households especially in SSA have resorted to farming as a coping strategy to mitigate hunger. It is reported that about 40% of the population in African cities are involved in urban agriculture (FAO, 2012). Around 800 million urban dwellers worldwide are involved in urban food sector representing about 25 -30% of the world population (Orsini *et al*., 2013). Although the actual number of people that practice urban agriculture globally remains debatable (Frayne *et al*., 2014; Lee-Smith., 2013; Stewart *et al*., 2013), urban agriculture has emerged as a source of household food supply and income generation (Warren *et al*., 2015; Stewart *et al*., 2013; Hampwaye, 2008).

The definition of urban agriculture is highly complex and is broadly defined in terms of its nature, location, scale, intentions and motivations of participants, and environment in which it is practiced. UNDP (1996) broadly defines urban agriculture as an activity that utilizes land, water and recycles urban wastes in the urban and peri-urban areas to produce a variety of crops and livestock. It is an activity which involves cultivation of land and/ or rearing of livestock on land located inside the city or on the periphery of the city using resources such as water, labor and other services available in the city.

Mougeot (2006) describes urban agriculture as the growing, processing, and distribution of food and non-food plants, trees, crops and the raising of livestock, directly for the urban market, both within and on the fringe of an urban area. From these general definitions, urban agriculture can be done on small scale or larger scale. It can be located in the boundary of the city or in urban centers. It may involve farming systems such as backyard or kitchen gardening, roadside cultivation on public or private land, livestock farming or open space cultivation (Ibrahim Game and Richaela Primus, 2015). Urban agriculture enterprises include horticulture, livestock, fodder, milk production, aquaculture and forestry.

According to various studies, urban agriculture has a significant potential to improve food security for low income households (Rezai *et al*., 2016; Frayne *et al*., 2014; Magnusson *et al*., 2014; Hampwaye, 2008). In addition, urban agriculture is seen to provide income, employment opportunities, cheap source of food and improved nutrition for poor urban households (Ayerakwa, 2016; Grewal and Grewal, 2012;

Lubinda, 2004; Lupyani, 2004). According to research, urban agriculture has been in existence throughout history. It has been an integral part of life for many urban residents (Smit *et al*., 2001; Mougeot, 1994). Recent studies in SSA have indicated an increase in the number of urban residents practicing urban farming (Frayne *et al*., 2014). However, this activity has received little or no official support in most countries. It is considered to be an illegal activity with no place in the urban setup (Oladele *et al*., 2012; Hampwaye *et al*., 2007). Despite this setback, urban agriculture has continued to grow in Africa and it has received support from many international organizations (RAUF, 2014; FAO, 2012). The International Food Policy Research Institute recognized the role of urban agriculture in eradicating hunger (IFPRI, 1996).

In Zambia, the prevalence of urban agriculture increased during the time when the country was going through an economic crisis known as Structural Adjustment Programmes (SAPs) in the early 1970s (World Bank, 2013; Hampwaye *et al*., 2007). Urban residents, especially those on the Copperbelt province were adversely affected. They resorted to urban farming as a survival and coping strategy to the harsh economic situation (Hampwaye, 2008; Simatele and Binns, 2008; Hampwaye *et al*., 2007). Since then, the activity has continued to increase and spread at a fast rate. However, the legal status of urban agriculture in Zambia still remains unclear. Incidences of crop slashing especially maize and eviction of farmers from public land still exist.

A key limitation of this study is that the dataset used is from the survey that was conducted in 2007/2008, which is more than 10 years ago. The results may not be 100% reliable and a true representation of the present situation because a number of socio-economic factors may have changed considering the long period of time since the survey was undertaken. There was lack of current dataset to use.

1.2 Problem Statement

A number of studies have been done to identify factors that influence household participation in urban agriculture (Rezai *et al*., 2016; Masvaure, 2013; Jongwe, 2013; Oladele *et al*., 2012; Asomani-Boateng, 2002; Smit *et al*., 2001; Armar-Klemesu, 2000; Nugent, 2000; Mbiba, 1999; Binns and Lynch, 1998; Lee-Smith, 1998; Mbiba, 1998; Maxwell, 1994). However, most of these studies are highly qualitative (analysis based on means and percentages). Very few studies have gone further to empirically measure the causal relationship between the factors identified and household's decision to participate in urban agriculture especially in Zambia (for example: Dossa *et al*., 2011; Onyango, 2010; Maxwell, 1995).

It was also observed that quite a number of studies have been done to determine the impact of urban agriculture on household income, (Badami and Ramankutty, 2015; Warren *et al*., 2015; Masvaure, 2013; Salcu and Attah, 2012; Kutiwa *et al*., 2010; Smit *et al*., 2001; Armer-Klemesu, 2000; Nugent, 2000; Mbiba, 1999; Mbiba, 1998; Maxwell, 1994). However, the major drawback of these studies is that analysis was done by just computing and directly comparing the outcome incomes of participants and non-participants without considering the differences in their household characteristics. This might have resulted in inconsistent and biased conclusions. According to Heckman *et al.* (1998), comparison of outcomes of observations based on non-comparable observable characteristics in impact studies might lead to biased and less reliable conclusions.

Against this background, this study employed the logistic regression model to quantitatively estimate the causal relationship between household socio-economic characteristics and the decision to participate in urban agriculture in Zambia. Logistic regression model was used because it is the appropriate regression analysis to use when the dependent variable is dichotomous (in this case urban agriculture). It is also relatively easy to apply and interpret because it is similar to linear regression except that the outcome variable is categorical. Logistic regression model uses a logarithmic transformation on the outcome variable to model a non-linear regression in a linear form. It is simply the logit of a linear.

The study further employed the Propensity Score Matching (PSM) methods to estimate the Average Treatment Effect on the Treated (ATT). The estimated ATT was used to measure the effect of urban agriculture on household income by comparing income between farming households (treatment group) and non-farming households (control group) with similar characteristics. The propensity score matching methods was used because it takes into account systematic differences in socio-economic characteristics between the treated and untreated units by matching only units from both groups with similar characteristics, thereby eliminating the problem of selection bias. In Zambia, none of the previous impact studies of urban agriculture has applied the PSM methods to estimate the effect of urban agriculture on household income.

In an effort to determine the effect of urban agriculture on the livelihood of households, this study used household total expenditure as a proxy for household income. The disadvantage of using income to measure welfare is that normally households tend to give distorted figures or inaccurate information about their income which in most cases is less than their actual income. In such cases, data collected on income tends to be unreliable and results may not give a true reflection of the impact of urban agriculture on household livelihood. In this regard, this paper examined the effect of urban agriculture on household income using household total expenditure as the outcome variable. The expenditure approach is more reliable compared to the income approach.

1.3 Research Objectives

1.3.1 General Objective

The overall objective of this study was to determine the economic contribution of urban agriculture to the livelihood of households in Zambia.

1.3.2 Specific Objectives

i) To identify the determinants of household participation in urban agriculture in Zambia.
ii) To identify the determinants of household's decision to grow maize, groundnuts or rape in Zambia.
iii) To determine the average treatment effects of urban agriculture on household income in Zambia.

iv) To estimate and compare the average treatment effects of maize, groundnuts and rape production on household income in Zambia.

1.4 Research Hypothesis

i) Household's demographic and farm characteristics significantly determine a household's decision to participate in urban agriculture.
ii) Household's demographic and farm characteristics significantly determine a household's decision to grow maize, groundnuts or rape.
iii) Urban agriculture has a significant positive effect on household income.
iv) Maize, groundnuts and rape production have a significant positive effect on household income.

1.5 Significance of the study

According to the reviewed literature, urban agriculture has become a common survival strategy for most urban households in Zambia. It is believed that it is associated with the potential to address hunger, food shortages and poverty, and food insecurity. Nonetheless, the government and the municipal councils have accorded little attention to this segment of the sector. Agriculture is still considered to be a rural activity with no place in the urban area. It is actually an illegal activity in most African countries. In a few countries where it has been recognized, there is lack of policy and institutional support for urban agriculture, including in Zambia. This paper aimed at empirically establishing the economic benefits of urban agriculture to households. The results would provide important information that might help the government and policy makers to make informed decisions on whether to recognize and integrate urban agriculture in agriculture policies. The results would also help urban households to make informed decision on whether urban agriculture is economically viable as a livelihood coping strategy. The study would also add to the existing body of knowledge on urban agriculture.

1.6 Organization of the Report

This thesis is structured into five chapters. The first chapter introduced the study and gave an overall background of the study. It further highlighted the research area of focus by identifying the problem to be studied, the general and specific objectives and concluded with the research hypotheses. The second chapter reviews literature on urban agriculture. It provides information on the definitions of urban agriculture, the driving forces of urban agriculture, the extent of the practice in SSA, the constraints and benefits of the activity, and concludes by discussing previous studies on determinants of household participation in urban agriculture and the impact of urban agriculture on household income. Chapter three gives details of the methodology of the study. It provides a theoretical behavioral framework of household participation in urban agriculture based on the Random Utility Model. It also provides an empirical estimation of household participation in urban agriculture using Logistic regression model. The chapter further provides an empirical estimation of the effect of urban agriculture on household income using the propensity score matching method to estimate the Average Treatment Effect (ATT). The results and discussions are given in Chapter four while conclusions and recommendations from the thesis are discussed in Chapter five.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on urban agriculture. The chapter provides existing information on the various definitions of urban agriculture, the extent and reasons for urban agriculture, the constraints of urban agriculture, the benefits of urban agriculture, and concludes by discussing previous studies on determinants of household participation in urban agriculture and the impact of urban agriculture on household income in Zambia and other countries.

2.2 Definitions of Urban Agriculture

Various definitions of urban agriculture exist in literature. UNDP (1996) defines urban agriculture as an activity that makes use of natural resources and recycles urban waste found in the urban and peri-urban areas in order to produce crops and livestock. According to FAO (1999), urban and peri-urban agriculture compete for resources such as land and water, which are found in the cities and are used by the urban residents for housing and drinking. Mougeot (2006) defines urban agriculture as an industry that involves the growing, processing, and distribution of food and non-food plants, trees, crops and the raising of livestock, directly for the urban market, both within and on the fringe of an urban area.

From the above definitions, urban agriculture is commonly characterized by farming inside the city and just outside the borders of the city (peri-urban). It employs resources such as land, labor, water, etc. available in the city. It encompasses diversified crop and livestock. There are two main types of urban farming practices depending on the location of cultivation. Farming may be done on an enclosed private plot such as a residential backyard plot. Backyard cultivation is mostly associated with vegetable gardening, grown primarily for home consumption. Open-space cultivation is another type of urban farming and involves cultivating vacant state or public-owned land located away from an individual's residence. It may be vacant land found along the road side or near the center of the city (Ibrahim Game and Richaela Primus, 2015).

2.3 The Extent of Urban Agriculture in Zambia and Other Countries

Urban agriculture has increasingly been identified as an important coping strategy adopted by urban dwellers to curb poverty and food insecurity in Sub-Saharan Africa (SSA). The activity is reported to have increased tremendously in the central cities of most SSA countries. However, the actual extent and scope of urban agriculture remains debatable (Ayerakwa, 2016; Frayne *et al.*, 2014; Lee-Smith, 2013; Orsini, 2013; Stewart *et al.*, 2013). According to the African Food Security Urban Network (AFSUN) survey that was conducted between 2008 and 2009 in 11 Southern African Cities, approximately 65% of the sampled households in Blantyre (Malawi), 60% in Harare (Zimbabwe), 22% in Maputo (Mozambique), and about 50% in Maseru (Lesotho) practiced urban agriculture. The AFSUN survey also reported that less than 10% of the sampled households in Windhoek (Namibia), Gaborone (Botswana), Manzini (Swaziland), Cape Town, and Johannesburg (South Africa), and 4% in Lusaka (Zambia) were engaged in urban agriculture (Crush *et al.*,2011). This was contrary to Simatele and Binns (2008) report that 41% of urban households in Lusaka (Zambia) and 37% in Maputo (Mozambique) were involved in urban agriculture (Hichaambwa *et al.*, 2009).

The reason for the variance between the two surveys is that AFSUN study in Lusaka was conducted in Chipata compound while the study by Simatele and Binn was based on urban agriculture activities in Chilenje, Garden compound and Six Miles (Frayne *et al*., 2014; Simatele and Binns, 2008). This scenario confirms that the extent and scope of urban agriculture varies across the city and from one city to another (Ayerakwa, 2016). About 79% of urban households in Kitwe, 93% and 92% in Kasama and Mansa are involved in farming (Hichaambwa *et al.*, 2009). These empirical findings provide an indication of the importance of agriculture among urban households.

2.4 Reasons for practicing Urban Agriculture

Many underlying factors have contributed to the rising importance of urban agriculture in Sub-Saharan (SSA). Policies such as the Structural Adjustment Programmes (SAPs) implemented in the 1980s and 1990s alongside economic recessions in most African countries led to food price inflation and high unemployment levels (Masvaure, 2013; Hampwaye, 2008; Drakakis-Smith, 1996). Also, rapid urbanization, mainly attributed to migration from rural to urban areas, had adverse social and economic consequences on the development of the urban economies. In Zambia, over 40 percent of its total population was estimated to live in urban areas (Stewart *et al.*, 2013; World Bank, 2011; Crush and Frayne, 2010; CSO, 2012). It was projected that about 90% of the world's population growth would be in the urban areas by the year 2030 and that 70% of the world population will be living in urban areas in the year 2050 (Ibrahim Game and Richaela Primus, 2015; IFPRI, 2003).

Some of the social and economic consequences of urbanization included high unemployment levels, food shortages, high food prices, deteriorating public services, and high poverty levels. This threatened the food security of the urban population whose food access was dominated by purchases. Increased food prices had a negative impact on their purchasing power especially among the low-income households. The above mentioned trends negatively affected the livelihoods of the urban population, forcing them to resort to urban agriculture as one of the coping strategy (Poulsen *et al*, 2015; Warren *et al.*, 2015; Orsini *et al.*, 2013; Hampwaye, 2008).

2.5 Constraints of Urban Agriculture

Urban agriculture faces many challenges. These constraints range from physical, social, political, and institutional to lack of a legal framework (Badami and Ramankutty, 2015; Masvaure, 2013; Salcu and Attah, 2012; Hampwaye, 2008). Despite its growing popularity, the activity is still considered illegal in most countries and it is not recognized by local authorities. It is not included in the urban planning and there are no clear policies on urban agriculture (Badami and Ramankutty, 2015; Oladele *et al.*, 2012; Binns and Lynch, 1998). Even though it has been recognized and included in the urban land use system in countries such as Tanzania, enforcement of the legislation has been limited (Masvaure, 2013; Mireri *et al.*, 2007). Limited access to land and water, the two most vital inputs of production, is a barrier to entry for urban agriculture. Urban agriculture competes for these resources with other alternative uses in the urban areas. In addition, lack of land tenure security for urban farming discourages farmers from expanding cultivated land or investing in water and soil improvements. This is because security of their produce is not guaranteed (Hampwaye, 2008).

Other constraints faced by urban agriculture are limited access to variable inputs (fertilizers, seeds, etc.) and credit facilities, lack of storage and waste facilities, poor access to markets, high transport costs, inadequate extension support, and lack of institutional organization to support urban agriculture. Others include the lack of skills to manage and process information, lack of government funding to support urban agriculture, by-laws that hinder rearing of livestock, lack of investment in support services and administrative structures and price subsidies for imported staples (Hampwaye, 2009; Hampwaye, 2008; Mireri, 2002).

The environmental implication of urban agriculture is another important constraint that has contributed to lack of support for the activity by local authorities. There is an argument that due to constraints on access to water for urban irrigation, farmers may resort to the use of untreated water for farming which may be hazardous to human and animal health. Also improper application of chemicals and inappropriate farming practices may cause soil and environmental degradation. Run-off fertilizers and other chemicals may cause water pollution (Mireri *et al.*, 2007).

A study in Kano, Nigeria, revealed that urban water passages are often highly polluted with domestic and industrial toxic waste. It may have serious implications on the quality and safety of produce grown (Olofin, 1996; Lewcock, 1995). According to Mireri *et al* (2007) lack of suitable land for various categories of urban farmers may cause farmers to farm on hazardous sites with serious health implications. Urban agriculture is said to generate wastes that must be efficiently managed to safeguard the lives of the urban residents. Other concerns raised pertaining to livestock rearing in dense urban areas were unpleasant odor, noise pollution, traffic jams and hazards.

2.6 Potential Benefits of Urban Agriculture

According to previous studies, urban agriculture has the potential to alleviate poverty and improve household food security. IFPRI (1996) suggests that urban agriculture is one way of solving hunger and poverty problems faced by the urban poor. It has been identified as a potential source of employment, a potential source of income, and that it has the potential to provide an improved diet to low-income households that cannot afford to purchase a diversified nutrition (Oladele *et al*., 2012; Warren *et al.*, 2015; Ayerekwa, 2016;). Urban agriculture is also known to improve the standard of living for the farming families as well as to provide a source of cheap food, especially in the face of rising food prices (Badami and Ramankutty, 2015; Orsini, 2013; UNDP, 1996; Smith, 1998; Mougeot, 2006).

The significant role of urban agriculture in employment creation was evidenced by the 1988 census on urban agriculture in Tanzania in which it was ranked as Dar es Salaam's second largest employer (UNDP, 1996). Other than family labor, skilled labor is also employed in commercial urban agriculture. In Kenya, urban agriculture makes a huge contribution to national development. It was estimated that 25.2 million kg of crops worth about 60.9 million KES (about 4 million USD in 1985), were produced in urban areas in one season (IDRC, 1994).

Despite the negative impacts mentioned earlier, urban agriculture is also associated with environmental benefits. The activity recycles urban waste into manure. It brings vacant and under-utilized areas into productive use, thereby reducing soil erosions caused by wind-blown on bare land and conserving natural resources outside cities (Shamusudi *et al*., 2014; Smit and Nasr, 1992).

2.7 Previous Research Studies on Urban Agriculture

Urban agriculture is receiving the much needed attention it deserves. This is evidenced by the rapid proliferation of research studies on urban agriculture, especially in Africa where the activity is widely practiced (for example: Hampwaye, 2008, 2007 in Zambia; Rakodi, 1985 in Zambia; Maxwell, 1995 in Uganda; Mbiba, 1998, 1999; Egziabher, 1994 in Ethiopia; Lee-Smith, 1998 in Kenya; Maxwell and Zziwa, 1992;; Drakakis-Smith, 1996; Mlozi *et al.*, 1996 in Tanzania;; Sanyal, 1987, 1984; Lee-Smith *et al*.,; and many others).

Despite the overwhelming research response, there have been very few studies that have tried to quantify factors that influence household participation in urban agriculture especially in Zambia (for example: Maxwell, 1995; Onyango, 2010; Dossa *et al*., 2011; Barry, 1972). Most of the studies identify factors that affect household participation in urban agriculture without measuring the magnitude or direction of the effect. They are mainly descriptive analysis.

2.7.1 Determinants of Household Participation in Urban agriculture

In order to quantify factors that influence household participation in urban agriculture, Maxwell (1995) applied the logistic regression model. He estimated the probability of household participation in urban agriculture based on household characteristics. He reported that the income, age, sex, and education level of the household head had no statistically significant association with household participation in farming. The size of the household, however, showed a significant positive relation with farming. He also found that the length of time that the household head had lived in an area (city) had a positive significant effect on participation. This is consistent with observations from studies by Warren *et al*., (2015), Jongwe (2013), Masvaure (2013), Kekana (2006), Mbiba (2005), Mougeot (2005), Maxwell and Zziwa (2002), and Grossman *et al*., (1996).

Maxwell (1995) and Kekana (2006) point out that it takes a considerable period of time to gain access to land for farming in urban areas. This means that it takes someone who has lived in a city for a long time to be able to engage in farming. All these observations contrast with perceptions commonly held by municipal authorities that urban agriculture is practiced by mainly recent in-migrants from rural areas. These are assumed to have the zeal for the activity since it is a natural part of their rural livelihood.

Onyango (2010) used uni-variate statistical techniques to examine the association among age, gender, education level, income and place of origin with household participation in urban and peri-urban agriculture. According to her findings, the size of the household and the length of stay in a locality had a positive significant association with participation in farming. This confirmed earlier studies by Warren *et al.*, (2015), Jongwe (2013), Masvaure (2013), Kekana (2006), Mbiba (2005), Mougeot (2005), Maxwell and Zziwa (2002), Grossman *et al.*, (1996) and

Maxwell (1995). Household size was analyzed in terms of total members, total number of children and the age distribution in the household. Onyango posited that a household with many members would require more food and this would put pressure on such a household to find alternative sources of food, including urban farming. Households with more adults would be in a position to engage in urban agriculture since more labor would be available for the activity. She highlighted that urban farming is not a temporal business for recent in-migrants as they try to settle in the city but rather it is a survival strategy used by urban dwellers to mitigate food insecurity.

Onyango (2010) further reported that the percentage of women participating in urban agriculture was significantly higher than men, which supported similar results on the relationship between gender and participation in farming by Warren *et al*., (2015), Devereux (2001), Maxwell and Zziwa (1992) and Mbiba (1995). She attributed these findings to the fact that it is typically the responsibility of a woman to ensure that food is available for the family. Women resort to urban agriculture as a source of food to supplement consumption needs. In addition, Onyango indicated that although the level of education had no significant association with participation in farming, the majority of household heads practicing it had obtained only primary education.

This confirms results by Kekana (2006) and Jongwe (2013) who indicated that participants in urban agriculture have a comparatively lower educational level but contrast with other findings that ascertain that most urban farming practitioners had attained post-high school educational level such as Warren *et al*., (2015), Sawio (2005), Mbiba (1995), and Maxwell and Zziwa (1992). Age had a positive significant relation with participation in urban agriculture which is similar to findings by Masvaure (2013).

Barry (1972) used the Tobit approach in a case study of determinants of urban livestock adoption in Khorongo, Cote d'Ivoire. He observed that age was positively related to urban adoption of small ruminants. The household's number of years in crop farming showed no significant relation with urban adoption of small ruminants. From his observations, he concluded that (i) women were more likely to adopt small ruminants compared to men; (ii) educated people were less likely to adopt small ruminants compared to the uneducated people; (iii) foreigners were better skilled to be adopters of livestock production than the local people; (iv) experience was not a significant factor in adoption of small ruminants; and (v) on average, middle-aged people were more likely to adopt livestock production than younger and older people. These findings are consistent with the majority of observations from other studies.

Dossa *et al*., (2011) carried out a cross location analysis of the impact of household socio economic status on participation in urban agriculture in three West African cities (Kano in Nigeria, Bobo Dioulasso in Burkina Faso and Sikasso in Mali). The aim of the study was to explore the relation between household socio-economic status and participation in urban agriculture. Assets were used as a proxy for household socio-economic status. Their results suggest no significant association between the household assets and participation in urban agriculture.

Dossa *et al*., (2011) results are in agreement with other studies that report that urban agriculture is not practiced only by the poor but by all socio-economic groups (Mkwambisi *et al*. 2010; Maxwell 1995; May and Rogerson 1995; and Egziabher *et al*. 1994) What differs is their motivation for participation and the differences in enterprises of interest (Rezai *et al*., 2016; Simatele and Binns 2008; Binns and Lynch 1998; Smit *et al*. 1996; Maxwell 1995). However, a variation in the extent of participation in the three cities was observed. Household size was significantly and positively associated with the level of participation in urban agriculture. On average, farming households had larger families than non-farming households in all the three cities (Warren *et al*., (2015), Jongwe (2013), Masvaure (2013)

Mkwambisi (2010) noted that heads of farming households represented all the educational levels meaning there was no significant relation between educational level and participation in urban agriculture. The study further revealed no significant difference between urban agriculture and non-urban agriculture households with respect to their migration status. It was reported that poor asset households were more likely to engage in field crop production for consumption while wealthier households were likely to engage in gardening mainly as a source of income.

2.7.2 The Impact of Urban Agriculture on the Livelihood of Urban Households

The major focus of the literature on urban agriculture is how it can contribute to food security both at household level and at city level. Generally, there exists a consensus among city case studies that urban agriculture does improve the food security of households engaged in it through increased income and improved nutritional status (Nugent, 2000; Amar-Klemesu and Maxwell, 1998). However, Zezza and Tasciotti (2010) argue that while urban agriculture may have the potential to address issues of food insecurity, evidence from most studies is limited by lack of reliable statistical data. They claim that most of the data available is highly qualitative or anecdotal. Accordingly, they caution against overemphasizing the role of urban agriculture in poverty reduction, as its share of income and overall agricultural production is limited. Nonetheless, they quickly acknowledge that its significance to those household groups who derive a livelihood and substantial income from it should not be ignored.

Maxwell (1995) investigated the impact of urban agriculture on nutrition. He applied both a bivariate and multivariate comparison of the nutritional status of children in farming and non-farming households in Kampala whilst controlling for the influence of income. Height- for- age was used as a proxy for nutritional status. The results indicate a strong and statistically significant positive association between farming in the city and improved child nutritional status for the low and middle income groups. This is similar to study conclusions by Rezai *et al* (2016), Frayne *et al* (2014), Jongwe (2013), and Stewart *et al* (2013). Interestingly the relationship appeared to reverse in the higher income group. He suggests that the small number of children (small sample size) in this income group could have affected the results.

Similarly, Maxwell *et al*., (1998) reported that urban agriculture in Kampala is positively and statistically significantly associated with higher nutritional status in children after controlling for the socio-economic status and demographic characteristics of the households. They also observed that farming households reported a significantly lower proportion of moderately to severely malnourished children compared to non- farming households.

Ogden (1993) in Kigali was cited by Amar-Klemesu (2001) to have reported that urban agriculture is positively associated with nutritional status of the household. In Nairobi, Mwangi (1995) was cited to have reported few differences in mean nutritional status among income groups and that children from non-farming households were somewhat more likely to be moderately malnourished than those from farming households. However, Amar-Klemesu and Maxwell (1998) argues that these studies lack conclusive evidence to indicate that there is a positive link between urban agriculture and nutritional status of children except for the work in Kampala. She suggests that most of these studies conclusions are based on height-for-age, which is an indicator of stunting, and stunting is an indicator of long term chronic under-nutrition and poverty. She further maintains that as long as other factors that affect nutritional status other than food intake are not controlled for or determined, such as care provided and incidence of disease, the results would not be consistent.

Zezza and Tasciotti (2010) investigated whether urban agriculture is significantly associated with greater calories consumed per capital and changes in diets as measured by share of calories from different major food groups. It was noted that participation in urban agriculture is associated with

increased calories intake and diversity in the food diet consumed by the farming household. These quantitative results are in consensus with earlier quantitative analytical results by Maxwell *et al*. (1998) who reported that child nutritional status was significantly higher among farming households compared to non- farming households.

Kekana (2006) provides a descriptive discussion of the socio-economic analysis of urban agriculture in Soshanguve, Pretoria. According to this study, urban agriculture increases household access to food by making adequate food available through own production. The study also reveals that the nutritional status of the urban farming households improves as a result of access to fresh and a variety of food produce. It suggests that household income improves through earnings from the sale of the surplus produce and income savings resulting from a reduction on food expenditure. These findings are consistent with similar studies by Asomani-Boateng (2002) who further suggest that urban agriculture has the potential to provide jobs to a significant number of unemployed people and to manage open bare urban spaces by protecting them from erosion.

Kutiwa *et al* (2010) analyzed the contribution of urban agriculture to food security with a focus on maize, the staple food in Zimbabwe. This was done to determine whether direct harvests from the maize field were sufficient to ensure food security for the urban farmers. The total amount of maize consumed from own production by the household for the year was compared to the national recommended consumption of 153kg of cereal (maize) each year. The study reveals that per capita cereal consumption from own production was 91.2kg of maize per year. These results indicate that on average, the harvest was not enough to meet the food security needs. An insignificant correlation was noted between gender and food sufficiency from own production. Nonetheless, food sufficiency from own production was correlated with household size. The larger the household size, the less sufficient is the food from own production. It was also reported that urban agriculture did contribute to dietary diversity of urban farming households investigated.

2.7.3 The Impact of Urban Agriculture on Urban Household Income

The impact of urban agriculture on household income is often measured in terms of money savings accumulated as a result of reduced food expenditure and cash income realized from the sale of surplus agricultural produce. More money is made available for the purchase of other needed food and non-food items thereby improving food security (Badami and Ramankutty, 2015; Warren *et al*., 2015; Salcu and Attah, 2012; Kekana, 2006; Asomani-Boateng, 2002; Maxwell, 2000). A limitation of these studies is that conclusions made are not based on reliable quantitative analysis due to lack of records on production sales. Few studies have quantitatively measured the impact of urban agriculture on household income (for example: Kutiwa *et al*.,2010; Zezza and Tasciotti, 2010; Nugent, 1999). Zezza and Tasciotti (2010) studied the impact of urban agriculture on income with a focus on the income share from urban agriculture. The study found that the percentage of urban households that earn income from agriculture varied from 11% in Indonesia to about 70% in Vietnam and Nicaragua. Income from urban agriculture as a share of total income ranged from 1% to 27%. A further observation is that few studies have used regression analysis to determine the impact of urban agriculture on household income.

Kutiwa *et al* (2010) used a simple regression model to estimate the effect of urban agricultural income on total household income. The results showed that total farm income has no significant effect on household total income. A limitation of such an analysis is the problem of endogeneity.

Other factors such as income from non-farm activities could play a role in influencing the level of income from urban agriculture. To date, no study has used the Propensity Score Matching model to estimate the Average Treatment Effect in order to measure the effect of household participation in urban agriculture on household income. This is a key contribution of this study.

2.8 Insights from Literature

Urban agriculture is widely defined by different scholars. The common attributes from the different definitions is that urban agriculture is practiced inside and around the boundary of a city/town. It may involve a wide range of enterprises such as crops, livestock and fisheries. Urban agriculture employs land which is either privately owned land and/or public/ state owned land. Urban food produce is mainly grown for household consumption while the surplus is sold for income generation. Urban agriculture is increasingly being practiced in urban cities of Africa. The driving force of urban agriculture include rapid rate of urbanization that led to high unemployment levels, high food prices, food shortages and increasing poverty levels. Previous research studies on factors that affect household participation in urban agriculture, indicate that that household' socio-economic characteristics have an effect on household' decision to practice urban agriculture. There is also a consensus among scholars that urban agriculture does improve household food security through improved nutrition and increased income. To date, no study has used the Propensity Score Matching model to estimate the Average Treatment Effect in order to measure the effect of household participation in urban agriculture on household income. This is a key contribution of this study.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter outlines the scope of the study, research design, sampling, data sources and methods of data analysis that were employed in this study. It discusses the theoretical framework for household participation in urban agriculture and the empirical estimation models used to determine the relationship between household socio-economic characteristics and participation in urban agriculture. Further, econometric models applied to estimate the effect of urban agriculture on household income are discussed. The chapter concludes with a description of factors that are hypothesized to influence household participation in urban agriculture. However, the major limitation of this study is that the dataset that was used is from a survey that was conducted in 2007. The socio-economic environment of the country may have changed over the past 12 years and this could have a significant effect on the study results. More recent dataset on Zambian urban agriculture is required to ascertain the impact of urban agriculture on household income. So far, recent data does not exist.

3.2 Operational Definitions

1. ***Urban agriculture:*** maize, groundnuts and/or rape production inside the city or town of residence of the household.
2. ***Household food expenditure:*** value of food consumed at home + food consumed away from home + value of consumption from own production.
3. ***Household non-food expenditure:*** Value of non-food items (i.e. groceries, household goods, and durable and non-durable assets.
4. ***Household total expenditure:*** Household food expenditure + Household non-food expenditure.
5. ***Household total income:*** Household total expenditure + total revenue received from the sale of crops grown.

3.3 Scope of the study

This study covered two cities of Zambia namely Lusaka and Kitwe (Figure 3.1 below). These cities exhibited a significant proportion of households involved in urban agriculture (41%, and 79% respectively). Lusaka and Kitwe are cosmopolitan cities, Lusaka being the capital city of Zambia and Kitwe is the largest city on the Copperbelt (Hichaambwa *et al*., 2009). The population of interest for this study were households in both cities who were involved in agricultural production on land found inside the cities of residence (treated group), and households in both cities who were not engaged in any agricultural activities (control group) on land found inside the cities of residence during the period of August, 2007 to January, 2008 and February, 2008 to July, 2008. Agricultural activities were limited to cereals (maize) production, legumes (groundnuts) and vegetable (rape) production. The study concentrated on major crops grown.

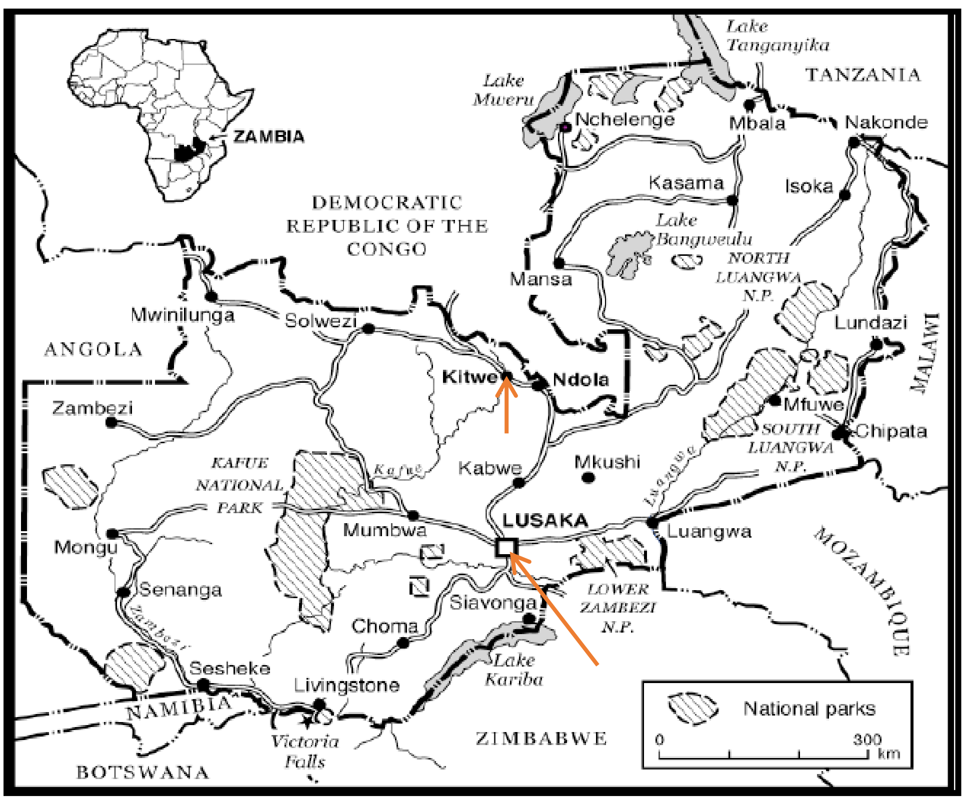

Figure 3. 1 Map of Zambia Showing the Study Areas; Lusaka and Kitwe
Source: Hampwaye, 2008

3.4 Research design, sampling procedure, sample size and data sources

This study used a two rounds seasonal (Feb-July, 2007 and Aug 2007 to Jan, 2008) secondary Cross sectional data to determine factors that affect household participation in urban agriculture and the effect of urban agriculture on household income. This data was obtained from the 2007/2008 urban food consumption/expenditure survey.

3.4.1 The Urban Food Consumption / Expenditure Survey

The survey was done by the Central Statistical Office (CSO) in conjunction with the Food Security Research Project, now called Indaba Agricultural Policy Research Institute (IAPRI). The survey was done through administering questionnaires on households in Lusaka, Kitwe, Kasama and Mansa districts.

3.4.2 Sample Design and Coverage

The Urban food consumption/expenditure survey covered 120 Standard Enumeration Areas (SEA) across the 8 strata that have been established in Lusaka, Kitwe, Kasama and Mansa. This coverage for the urban food consumption/expenditure survey corresponded to a probability of approximately 2400 non-institutionalized private households residing in the urban areas of the target districts.

3.4.3 Sample Size Determination

For the majority of human population based studies, the minimum sample requirement assuming simple random sampling is 400 observations units. However, the sample size does not take into account the complexity of the sample design. Adjusting the simple random sampling sample with an appropriate design effect factor as well as response rate yields the ideal sample. In Zambia, the design effect factor for common proportions varies between 1.2 and about 2.5. The survey adopted the factor of 1.5 to estimate the sample requirement for a district. The expected ideal sample size was around 600 households per district. However, since agricultural households constitute a rare population in the urban agriculture, the survey deliberately oversampled the primary sampling units in order to achieve the desired sample size of 4800 respondents.

3.4.4 Sample stratification

The sampling frame that was used by the urban consumption/expenditure survey has been developed from the 2000 census of the population and housing. The census frame was administratively demarcated into 9 provinces, which was further divided into 72 districts. The districts were further divided into 155 constituencies, which were also divided into wards. Wards nest census supervisory areas, which in turn nest standard Enumeration Areas. For the purpose of the survey, Standard Enumeration Areas constituted the ultimate Primary sampling units. All the SEAs and their corresponding households were further stratified into either rural or urban areas. Only the urban areas of the four districts namely Lusaka, Kitwe, Mansa and Kasama were covered in the urban consumption survey. Sample allocation to districts was varied based on the size of the urban parts of the districts.

3.4.5 Sampling procedure

The urban consumption/ expenditure survey employed a two-stage stratified cluster sample design whereby during the first stage, 120 SEAs were selected with probability proportional to estimated size from 8 strata across the districts. The size measure was taken from the frame developed from the 2000 census of population and housing. During the second stage, 18 households were systematically selected from the total number of households expected to be residing in the selected SEAs. However, for the purpose of this study, only households in Lusaka and Kitwe cities were considered in the study sample. Urban agriculture is widely practiced in Mansa and Kasama towns. Majority of urban households by default are engaged in some form of agricultural practices. Mansa and Kasama (92% and 93%) districts were dropped from the final sample of this study leaving a total sample size of 2, 682 households.

3.5 Methods of Data Analysis

In this study, both descriptive statistics and econometric models were employed to analyze the data. Descriptive statistics such as mean, standard deviation, percentages and frequencies were used to summarize household characteristics that influence household participation in urban agriculture. The t-test was also used to compare and contrast socio-economic characteristics between urban agriculture participants and non-participants. The logistic regression model was applied to determine the relationship between household socio-economic characteristics and the decision to participate in urban agriculture. The logistic regression model was also applied to determine the relationship between household socio-economic characteristics and the decision to grow maize, groundnuts or rape. The propensity score matching methods was applied to estimate the effect of urban agriculture on household income. The propensity score matching methods was further used to estimate and compare the effect of maize, groundnuts and rape production on household income.

The computer statistical package, STATA version 14 was used to compute these statistics.

3.6 Theoretical Framework of Factors Influencing Household Participation in Urban Agriculture

Household participation in urban agriculture can well be understood by using discrete choice models. Discrete choice models are models that are based on probabilistic consumer theory (McFadden, 1974a). They are used to analyze an individual's decision-making behavior when making a choice among a variety of alternatives. They have been widely used to model discrete choices such as labor force participation, travel demand and purchase of a brand of products (McFadden, 1974b). Discrete choice models assume that an individual is a utility maximizing economic agent who behaves rationally by choosing an alternative with the highest utility. Maximization of utility is determined by both observed factors (e.g. characteristics of an individual and attributes of the alternatives) and unobserved factors (e.g. taste) which may vary across individuals. In order to use discrete choice models, the set of alternatives must be mutually exclusive, exhaustive and there should be a finite number of them (Trains, 2007). With this approach, the discrete choice model that will be employed in this study is a Random Utility Model (RUM).

RUM is a choice model that can be used to create a foundation for the use of discrete choice econometric methods (Rubey and Lupi, 1997). The model can be applied to either binary or multinomial choices, and it includes a random variable which controls for unobserved relevant factors. A binary choice model is when an individual is faced with a choice between two alternatives while a multinomial choice model is when an individual has to make a choice among more than two alternatives. The framework of this model is that individual *i*, has to make a choice among *J* alternatives. Each of the J alternatives exhibits observable, measurable attributes which can be denoted by a vector X_{ij}. Vector X_{ij} includes all observable attributes including individual i observable characteristics. The conditional utility of individual *i* from alternative *j* can be represented as:

$$U_{ij} = BX_{ij} + u_{ij}$$

Where:

U_{ij}	Is the maximum utility individual *i* can attain from choosing alternative *j*.
X_{ij}	Is a vector of all observable attributes of individual *i* and alternative *j*.
B	Is a vector of parameters.
u_{ij}	Is a random variable. It represents a vector of all unobserved attributes of Individual *i* and alternative *j*.

In this model, utility maximization is a function of household socio-economic attributes and farm attributes which is denoted by the vector X_{ij} and may include:

(1) Gender of the household head (2) Age of the household head (3) Marital status of the household head (4) Educational level of household head (5) Household size (6) Land ownership (7) Farm size (8) Location of farm. (9) Household city of residence (10) Household period of stay in locality (11) Access to extension services (12) Proximity to market (13) Proximity to main road (14) Access to fertilizer.

According to the theory of utility maximization, a consumer will choose an alternative with the highest utility. So if an individual chooses alternative *k*, then it is assumed that *k* has the highest utility among the J alternatives (Rubey and Lupi, 1997). If Y_i is assumed to be a variable indicating the best alternative for individual *i*, then using probabilities:

$$\Pr ob(Y_i = k) = \Pr ob(U_{ik} > U_{ij}) \qquad \text{for every } j \neq k$$

The assumption is that the error term is identically and independently distributed across J alternatives and N individuals. From the model, it is observed that what is of interest is not the absolute magnitude of utility derived from an alternative but the differences in utilities among alternatives. Furthermore, utility maximization depends on attributes of alternatives and individuals. The decision to participate in urban agriculture can be modeled using the binary choice model. This is because participation in urban agriculture is a dichotomous dependent variable which can take only two values where:

$D_i = 1$ if household participates in urban agriculture (alternative 1)

$D_i = 0$ if household does not participate in urban agriculture (alternative 2)

There are only two alternatives to choose from, participation or non-participation.

Let:

U_{1i} denote the maximum utility that household *i* obtains if the household chooses to participate in urban agriculture.

U_{0i} denote the maximum utility that household *i* obtains if the household chooses not to participate in urban agriculture.

Since theory tells us that the household will choose the alternative with the highest utility, if household *i* choose to participate in urban agriculture, then utility derived from participation must be greater than that from non-participation.

$U_{1i} \geq U_{0i}$

$U_{1i} - U_{0i} \geq 0$ We let;

$$U_{1i} - U_{0i} = Y^*$$

Where:

Y^* is assumed to be some value that represents the difference in utilities between participation and non-participation. If a household chooses to participate, it means $Y^* \geq 0$ and if a household chooses not to participate, then $Y^* < 0$. We know from the model that Y^*, which is the difference between the maximum utilities obtained from participation and non-participation in urban agriculture depends on household characteristics. Then Y^* can be regressed as:

$$Y_i^* = BX_i + u_i \qquad u_i \approx N(0, \sigma^2)$$

But note that Y^* is unobservable since it is a measure of utility. However, this challenge can be overcome by referring to participation choices made for guidance as follows:

If $D_i = 1$ (household participation) then $Y_i^* \geq 0$

If D_i =0 (household non-participation) then Y_i^* <0

In terms of probability, the probability of participating in urban agriculture will be:

$$\Pr ob\,(D_i = 1) = \Pr ob\,(Y_i^* \geq 0).$$

3.7 Empirical Model: Factors Influencing Household Participation in Urban Agriculture

3.7.1 The Logistic Regression Model

The Logistic Regression Model (LRM) is a form of regression, which relaxes the assumption of a metric nature of the dependent variable, and also provides a range of diagnostic and explanatory techniques for non-metric dependent variables (Hair Jr. *et al*., 2006). Generally, logistic regression is free of restrictions, and it has capacity to analyse a mix of all types of independent variables (continuous, discrete and dichotomous) (Tabachnick & Fidell, 2007). In addition the variety and complexity of data sets that can be analysed are almost unlimited (Tabachnick & Fidell, 2007). Unlike multiple regression methods, there is no assumption about the distribution of the predictor variables (such as normality, linearity, or equal variances) (Tabachnick & Fidell, 2007).

3.7.2 Specification of the Logistic Regression Model

Since participation in urban agriculture is a binary dependent variable with the option of either participation or non-participation, the binomial logistic regression model was adopted as the most appropriate tool to identify determinants of household participation in urban agriculture (Tabachnick & Fidell, 2007). In this study, the probability of the household participation in urban agriculture was modeled as a function of household socio-economic characteristics. Factors that influence participation in urban agriculture were used as independent variables for the Logistic regression model. The Logistic regression model has a binary dependent variable: it takes the value of 1 in the case that the household participates in urban agriculture and 0 otherwise.

The binomial logistic regression model was used to determine how each independent variable affects household probability of participation in urban agriculture and the direction of relationship between the dependent and independent variables. Accordingly, the model is specified as follows:

Logit (p) = $b_0 + b_1 x_1 + b_2 x_2 + ... b_n x_n$

Logit is defined as log odds;

Logit = $\frac{1}{1-p} = \frac{\text{Probabilit y of participat ion/adopti on}}{\text{Probabilit y of non - participat ion/ adoption}}$

Logit (p) = In $\left[\frac{p}{1-p}\right]$;

Where In = natural logarithms. The subscript **n** means the nth observation in the sample. **P** is the probability of the outcome of interest (participation in urban agriculture) or (y=1) and is either equal to 1 when farmer has adopted urban agriculture or equal to 0 otherwise. In this case, p is the probability that a farmer adopts or participates in urban agriculture or maize, groundnuts or rape production and $1-p$ is the probability that a farmer does not adopt or participate in urban agriculture or maize, groundnuts or rape production. b_0 is the intercept term (constant of the equation), and b_s are the regression coefficients of all the various factors affecting participation in urban agriculture or maize, groundnuts or rape production in this case. X is vector of various factors affecting household participation in urban agriculture or maize, groundnuts or rape production which can be dichotomous or continuous. The binomial Logit model was used in this study because it is easier and simpler to estimate and to interpret.

3.8 Theoretical Framework of the Effect of Urban Agriculture on Household Income

An Impact analysis is the assessment of the effects of an intervention, technology or treatment on an outcome of interest. It entails examining whether the observed changes in the wellbeing of participants in an intervention can indeed be attributed to the intervention. This is because other factors other than the intervention itself (observable and unobservable characteristics of those who receive an intervention) may be responsible for the observed changes in the outcome of interest of the treated (Rosenbaum and Rubin, 1983). Therefore, accurate estimates of the effects of an intervention or treatment can be obtained by analyzing and comparing the outcome of participants after an intervention, with how they would have been without the intervention (known as the counterfactual outcome). The counterfactual outcome is defined as the outcome of the participants of an intervention had they not received the intervention. In other words, what would have been the status of the recipients of an intervention in terms of the outcome variable of interest in the absence of the intervention?

In experimental studies, information about the counterfactual outcome is not necessary when evaluating the effects of an intervention. The treatment effects of an intervention is simply obtained by analyzing and comparing the outcome of the treated group with the non-treated (control group) group. The treatment effect is computed as the difference in outcome between the treated group and the non-treated group. This is because in experimental studies, the participants of an intervention are randomly assigned to the intervention. This entails that the intervention is the only underlying factor that differentiates the treated group from the non-treated group. Thus the outcome of the non-treated group, also known as the control group, serves as a proxy for the counterfactual outcome i.e. What would have become of the treated group in respect to the outcome of interest, had they not received the intervention (Heinrich *et al.* (2010). Experimental evaluations produce valid and reliable estimates of the treatment effects by eliminating the problem of biasness.

On the other hand, observational studies (nonrandom) such as this study suffer from a challenge of how to estimate the counterfactual outcome due to the absence of data on the outcome of participants, had they not received the treatment. According to Holland (1986) it is impossible to observe the outcomes of the same unit in both treatment and non-treatment conditions at the same time. It is either you are in the treated group or the non-treated group. It is not possible to observe the counterfactual outcome of the treated. Also, the mean outcome of the non-treated individuals in observational studies cannot be used to estimate the treatment effect because it could be that covariates which determine the treatment decision also determine the outcome variable of interest (Rosenbaum and Rubin, 1983). This means that the outcomes of individuals from the treatment and comparison groups would still differ even in the absence of treatment leading to what is known as selection bias (Grilli and Rampichini, 2011)

Likewise, information on the control group in this study cannot be used to estimate the counterfactual outcome because the treatment (urban agriculture) is not randomly assigned to households but rather households decide for themselves whether to participate in urban agriculture or not. This approach would lead to biased and inconsistent estimates due to the presence of endogeneity arising from sample selection bias, particularly "self-selection bias (Holland, 1986). Urban farmers and non-farmers (control group) may differ not only in their farming status but also in other characteristics that affect both participation in urban agriculture and the household income (Heinrich *et al.*, 2010). Selection bias may arise in that there may be unseen (unobserved characteristics) differences between the treated (participating households) and the control (non-participating households) groups which may be driving participating households to engage in farming and these factors may be correlated with the dependent variable, household income. In such a case, it would be difficult to precisely estimate the effect of participation in urban agriculture on household income and obtain objective causal inference (Rubin, 2008). Henceforth, observed differences in outcome between the treated and control groups would not be entirely attributed to the intervention or treatment.

In order to overcome the challenge of selection bias and to solve the problem of the counterfactual outcome, there is need to control for systematic differences between participating and non-participating households that may have an effect on household income. The outcome of participants of an intervention must be compared with non-participants with similar observable characteristics. This can be achieved by matching the treated individuals with one or more untreated individuals with similar covariates. A number of matching models have been designed to apply in impact analysis. An example is the Propensity score matching (PSM) method (Rosenbaum and Rubin, 1983), which was adopted and adapted to this study. The PSM method produces more consistent and reliable estimates (Wooldridge, 2005).

3.9 Empirical Model of the Effect of Urban Agriculture on Household Income

The propensity score matching methodology was applied to evaluate the effect of urban agriculture on household income in this study. The PSM method was chosen because of the nature of the study (observational) and the lack of baseline data.

3.9.1 Propensity Score Matching method (PSM)

The PSM method is a semi-parametric method that can be used to reduce or get rid of selection bias and obtain unbiased estimates in non-experimental or observational studies. It is also useful in the absence of baseline data (Lechner 1998; Rubin, 1974). The PSM method is designed to ensure that impact estimates are solely based on outcome differences between comparable treated and non-treated individuals (Rubin, 2008; Rosenbaum, 2006; Heckman, 1996). It is applied by matching participants and non-participants of an intervention based on observable covariates or characteristics (Zhao, 2006; Abadie and Imbens, 2002). The underlying principle of this technique is to find in a large group of non-treated units, units that are similar to the treated subjects in all relevant pre-treatment characteristics X and then match these comparable units (Rosenbaum and Rubin, 1983). In this study, the idea is to identify and select from a large group of non-farming households (control group), households that have observable relevant socio-economic characteristics that are similar to the farming households (treated group) and then match them. Any observed differences in income between the matched farming and non-farming households will then be attributed to urban agriculture. It should be noted that the matching control group should be well selected and adequate enough to make reasonable comparisons and conclusions.

3.9.1.1 Propensity Scores (PS)

Rosenbaum and Rubin (1983) proposed the use of propensity scores as a convenient and efficient way to match non-treated units with their comparable treated units rather than using covariates. They argue that matching based on covariates will result in dimensionality complications especially when matching is done on many covariates while matching on propensity scores reduces the dimensionality problem by allowing matching to be done on a single variable (the propensity score) rather than on the entire set of covariates. Then the outcome of participants and non-participants with similar propensity scores can be compared to obtain the treatment effect. The propensity score is defined as the probability that a unit in the combined sample of treated and untreated units receives the treatment, given a set of observed variables (Caliendo and Kopeinig, 2008; Rubin, 2008; Heckman *et al.,* 1998). It is the probability of participation conditional on observed characteristics, *X*. Propensity score estimates balance covariates between the treated and control units.

3.9.1.2 Assumptions of the PSM

The method of PSM relies on two conditions for the results to be considered valid and reliable (Khandker *et al.,* 2010): (1) Conditional Independence Assumption (CIA) and (2) Common Support condition. The CIA, also known as confoundedness assumption or selection on observables assumption states that given a set of observable covariates *X* that are not affected by the treatment; potential outcomes *Y* are independent of treatment assignment *D* (Khandker *et al*., 2010; Lechner, 2002; 1999; Rosenbaum and Rubin 1983). This condition is specified as $(Y_0),(Y_1) \perp D_i / X_i$. It assumes that assignment to treatment is independent of the outcomes, conditional on the covariates (Rosenbaum and Rubin, 1985, 1985, 1984, 1983). In this case, it assumes that participation in urban agriculture is based on observable characteristics and that the effects of urban agriculture on household income is not influenced by any correlation between unobserved characteristics and a household's decision to participate in urban agriculture.

The common support condition known as the overlap assumption assumes that the probability of assignment to a treatment is positive but less than one. The common support assumption is specified by $0 < P(D_i = 1/ X_i) < 1$.It implies that treatment observations have comparison observations "nearby" in the propensity score distribution (Khandker *et al*., 2010; Rosenbaum and Rubin 1983). If there is little or no overlap in the distributions of the estimated propensity scores in the treatment groups, the estimated ATT would be invalid (Rubin and Thomas, 1992).The greater the overlap, the more comparable the groups are and therefore the smaller the bias (Heckman *et al.,* 1998; Heckman *et al*., 1997).

3.9.1.3 Application of the PSM methodology

Caliendo and Kopeinig (2008) identified the following three (3) steps that are necessary when implementing PSM:

1. Estimate the propensity scores

The propensity scores can be estimated by either a logit or a probit model (Becker and Ichino, 2002). One of the key issues in estimating the propensity scores is the identification and selection of variables to include in the model. The goal is to obtain estimates of the propensity scores that statistically balance the covariates between treated and control units (Rubin and Thomas, 1992). The general principle is to include only variables that influence simultaneously the treatment status and the outcome variable (Smith and Todd, 2005). It is also proposed that theory and literature review of previous empirical findings on factors that affect participation in an intervention can guide in identifying the variables to include in the propensity score estimation model (Black and Smith, 2004; Heckman *et al.,* 1998). Based on the above mentioned principle and guidance in selection of variables to include in propensity scores estimations, the age of the household head, class of residence of the household, number of adult household members, household size, gender of the household head, marital status of the household head, the main source of livelihood of the household, the highest level of education of household head, the price expected prices of maize, rape, and groundnuts were used to estimate the propensity scores in this study. The propensity score can be specified as:

$P(X_i) = \Pr(D_i = 1 / X_i)$.

2. Choose a matching algorithm

The second step is to choose a matching algorithm that will use the estimated propensity scores to match untreated units to treated units. There are basically four (4) commonly employed matching algorithms in PSM. These are (1) Nearest Neighbor matching (NN) (2) Radius or Caliper matching (3) Kernel matching, and (4) Stratification matching methods (Becker and Ochino, 2002).

For the Nearest neighbor matching method, an individual from the comparison group is chosen as a match for a treated individual in terms of the closest propensity score (Blundell *et al.*, 2005; Rausenbaum and Rubin, 1985; Rubin, 1974). For each treated observation, select a control observation j that has the closest value of the covariate, *x*. For nearest neighbor, matching can either be “with replacement” (an untreated individual can be used more than once as a match) or “without replacement (an untreated individual can only be used only once as a match. It entails a one-on-one matching). Matching with replacement is comparably widely used because it takes care of issues of limited covariates and small sample size (Smith and Todd, 2005; Cochran and Rubin, 1973).

The radius matching specifies a “caliper” or maximum propensity score distance by which a match can be made. The basic idea of radius matching is that it uses not only the nearest neighbor within each caliper, but as many comparison units as are available within the caliper. Each treated observation is matched with control observation j, that fall within the specified radius (Dehejia and Wahba, 2002).

The kernel matching method compares the outcome of each treated person to a weighted average of the outcomes of all the untreated persons, with the highest weight being placed on those with scores closest to the treated individual (Smith and Todd, 2005; Heckman *et al*., 1998). Each of treated observations is matched with several control observations, with weights inversely proportional to the distance between treated and control observations.

The stratification matching method compares the outcomes within the intervals/ blocks of propensity scores. Unfortunately, there is no clear rule for determining which algorithm is more appropriate in each context because there is no matching algorithm that is superior to the other. However, a key issue that should be considered is that the selection of the matching algorithm implies a bias / efficiency trade-off. Therefore, the best is to employ more than one matching algorithm to ensure robustness of results. This study used a set of three (3) matching algorithms; the nearest neighbor, the radius and the kernel.

3. Estimating impact of an intervention

After propensity scores have been estimated and a matching algorithm has been chosen, the impact of the intervention can be estimated by computing the average treatment effect on the treated (ATT). ATT is the recommended estimate of treatment effects and not the popularly estimated average treatment effect (ATE). Generally, the PSM estimator for ATT can be written as (Cameron and Trivedi, 2005):

$$T_{ATT}^{PSM} = E_{p(X_i)} / D_i = 1\{E[Y_i(1) / D_i = 1, P(X_i)] - E[Y_i(0) / D_i = 0, P(X_i)]\}$$

3.9.2 Estimation of the Average Treatment Effect on the Treated (ATT)

To effectively measure the impact of urban agriculture on household income, we consider both farming and non-farming urban households. The farming households were considered as the treatment group and non-farming households were the untreated (or control) group. The challenge is that we only observe people in one situation at a time, either participating or not participating in urban agriculture. Using the income model;

If we let $y_{1,i}$ be the outcome for household i with treatment ($D_i = 1$)

i.e. total income for a household participating in urban agriculture

$y_{0,i}$ be the total income for household i without treatment $(D_i = 0)$

i.e. total income for a non-participating household in urban agriculture

Then the treatment effect (TE) for household i is the difference in outcomes (total income) between participating (treatment group) and non-participating (control group) households.

The treatment effect (TE) is:

$$y_{1,i} - y_{0,i}$$

The average treatment effect (ATE) is:

$$E(y_{1,i} - y_{0,i})$$

Using the above relationships, ATE can be expressed as:

$$E(y_i / D_i = 1) - E(y_i / D_i = 0) = E(y_{1i} / D_i = 1) - E(y_{0i} / D_i = 1) + E(y_{0i} / D_i = 1) - E(y_{0i} / D_i = 0)$$

Where:

$E\left(y_{1i}/D_i=1\right)-E\left(y_{0i}/D_i=1\right)$; is the average treatment effect on the treated (ATT). It is the average increase in income of participants compared to non-participants.

$E\left(y_{0i}/D_i=1\right)-E\left(y_{0i}/D_i=0\right)$; is selection bias.

The selection bias is the difference in average income between households that participated in urban agriculture, had they not participated, and non-participating households. It is defined as the difference between counterfactual mean income and mean income of non- participants. From the above derivations, ATT can only be effectively determined if the outcome of the treated and control in the absence of the treatment is the same. In other words, if selection bias is absent or zero.

Mathematically, if $E\left(y_{0i}/D_i=1\right)-E\left(y_{0i}/D_i=0\right)$ =0 (Wooldridge, 2002; Maddala, 1983)

3.10 Defining Variables Hypothesized to Influence Household Participation in Urban Agriculture.

This section highlights and discusses some factors from literature that are hypothesized to have an influence on a household's decision to participate in urban agriculture. However, not all factors reviewed from literature were included in this study. This was because of a challenge of missing variables in the secondary data used for this study. Due to this limitation, this study considered mainly the demographic characteristics of households. Table 3.1 below highlights and describes some of the factors that were considered and included in this study.

Table 3. 1: **Defining variables hypothesized to influence household participation in urban agriculture**

Variables	Definition	Measurement	Expected sign
Participation	Household participation in urban agriculture	1=Yes, 0=No	
Sex	Gender of head of household	1=Male, 0=Female	+
Marital status	Marital status of head of household	1=Married 2= Never married 3= Monogamously married 4= Polygamous married 5= Divorced 6=Widowed	+/-

		7= Separated 8= Cohabiting	
Household size	Number of people in a household	Number	+/-_
Age	Age of household head	Number of years	+/-
Education	Highest level of education of household head	1=Primary 2=Secondary 3=Tertiary	+/-
City	City of residence	1=Lusaka, 2=Kitwe	+/-
Adult household members	Number of household members above 18 years old	Number	+/-
Livelihood	Household's main source of livelihood	1=Formal business 2=Informal business 3=Farming 4=Salaried 5= Other wages	+/-
Location	Location of residence	1= Low cost residential 2= Medium cost residential 3= High cost residential	+/-
Maize price/kg	Expected output price of maize	Rebased Kwacha	+
Rape price/kg	Expected output price of rape	Rebased Kwacha	+/-
Groundnuts price/kg	Expected output price of groundnuts	Rebased Kwacha	+/-

3.11 SUMMARY OF METHODOLOGY

This study covered two cities of Zambia namely Lusaka and Kitwe. The study used Cross sectional data that was obtained from the 2007/2008 urban food consumption/expenditure survey done by Indaba Agricultural Policy Research Institute (IAPRI) and Central Statistical Organization (CSO). The sample population was households in both cities who were involved in agricultural production as well as those who did not engage in any agricultural activities on land found inside the cities of residence during the period of August, 2007 to January, 2008 and February, 2008 to July, 2008. The total study sample size was 2,682 households. The study concentrated on some major crops grown in the country namely maize, groundnuts and rape. Both descriptive statistics and econometric models were employed to analyze the data. The logistic regression model was applied to determine the relationship between household socio-economic characteristics and the decision to participate in urban agriculture as well as the decision to grow maize, groundnuts or rape. The propensity score matching methods was used to estimate the average treatment effect to measure the effect of urban agriculture on household income and to further measure and compare the effect of maize, groundnuts and rape production on household income. The computer statistical package, STATA version 14 was used to compute these statistics.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents and discusses descriptive statistics and results of econometric models of determinants of household participation in urban agriculture. Under descriptive statistics means, standard deviations, and percentages are used to describe individual, household and farm characteristics that affect household decision to participate in urban agriculture. Within the chapter, an empirical analysis of the determinants of household participation in urban agriculture is done using the logistic regression model. As the chapter progresses, the propensity score matching method is applied to estimate the effect of urban agriculture on household total income. In this study, household total expenditure is used as a proxy for household total income.

4.2 Descriptive statistics

4.2.1 Household socio-economic characteristics

Table 4.1 below presents a summary of socio-economic characteristics of the sampled households for this study. The table compares these characteristics between households that practiced urban agriculture (participants) and households that did not practice urban agriculture (non-participants). *t* testing was used to determine the significance of variations across the two strata (participants and non-participants). The t-statistic value was also reported as shown in the table below. The table results shows that out of the 2682 households that participated in this study, only 618 respondents were engaged in farming, suggesting 23.04% rate of household participation in urban agriculture. This entails that 76.96% of the respondents did not practice urban agriculture. From the analyzed data, the age of the respondents ranged from 19 to 90 years. Further, the average age of the household head was 42years. As can be seen in the table above, the majority of the sampled households were male-headed (80.6%) while only 19.4% were female-headed.

Table 4. 1: Summary statistics of demographic characteristics of sample households by the status of urban agriculture participation

Variable description	Total sample		UA Participants		UA Non –Participants			
Household characteristics	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	t-Statistic	Sig. lev.
Age of the HH head (years)	42.03	12.789	47.76	12.867	40.31	12.256	-13.13	***
Male headed HH (%)	80.65	0.395	81.88	0.386	80.28	0.398	-0.88	
Number of Adult HH members	4.69	2.367	5.48	2.260	4.45	2.348	-9.61	***
Household Size	5.52	2.742	6.39	2.610	5.26	2.728	-9.11	***
Highest Educational level of Household Head								
No formal education (%)	2.72	0.163	5.02	0.218	2.03	0.141	-4.01	***
Primary (%)	21.33	0.410	20.55	0.404	21.56	0.411	0.54	
Secondary (%)	50.26	0.500	44.98	0.498	51.84	0.500	2.99	***
Tertiary (%)	25.69	0.437	29.45	0.456	24.56	0.431	-2.44	***
Main Source of Livelihood of Household Head								
Formal business (%)	6.75	0.251	4.85	0.215	7.32	0.260	2.23	
Informal business (%)	23.01	0.421	18.12	0.386	24.47	0.430	- 1.91	
Farming (%)	3.28	0.178	7.61	0.265	1.98	0.140	-4.52	
Other wages (%)	6.86	0.253	5.83	0.234	7.17	0.258	0.71	
Salaried employment (%)	52.13	0.500	50.97	0.500	52.47	0.500	0.65	
Location of Residence of Household								
Low cost residential (%)	72.56	0.446	65.70	0.475	74.61	0.435	4.37	***
Medium cost residential (%)	10.14	0.302	9.22	0.290	10.42	0.306	0.86	
High cost residential (%)	17.30	0.378	25.08	0.434	14.97	0.357	-5.86	***
Marital Status of Household Head								
Married Head of HH (%)								
Never married HH head (%)	10.14	0.302	4.53	0.208	11.82	0.323	5.29	***
Monogamously married (%)	70.47	0.456	75.73	0.429	68.90	0.463	-3.27	***
Polygamous married (%)	0.71	0.084	0.65	0.080	0.73	0.085	0.21	
Divorced (%)	5.00	0.218	3.56	0.185	5.43	0.227	1.87	*
Widowed (%)	12.16	0.327	14.72	0.355	11.39	0.318	-2.23	**
Separated (%)	1.45	0.120	0.81	0.090	1.65	0.127	1.53	
Cohabiting (%)	0.07	0.027	0	0	0.10	0.031	0.77	
City of Residence of Household Head	50.41	0.500	66.83	0.471	45.49	0.498	-9.46	***

HH located in Kitwe (%)								
HH located in Lusaka (%)	49.59	0.500	33.17	0.471	54.51	0.498	9.46	***
HH Monthly Expenditure (K)	1815.85	1876.14	2222.25	2398.453	1694.17	1670.2	-6.18	***
	N=2682		N=618		N= 2064			

Unequal-variance *t* test: *=10% sig. level; **=5% sig. level; ***=1% sig. level

Most household heads were monogamously married (71.2%) as reflected in the table above. 10.14% were never married before, 0.71% were in polygamy marriages, 5% were divorced, 12.16% were widowed, 1.45% were separated and only 0.07% were cohabiting. In terms of the distribution of education, 97.3% of the respondents had attended formal education. Of those respondents who attended school, 21.33% attended only primary education while more than half (50.3%) managed to reach secondary level of education. In addition, a relatively high percentage (25.7%) of the respondents managed to attain tertiary level of education. This could be attributed to the increase in the number of tertiary education facilities in most parts of urban Zambia. The table also depicts that the average household size was 6 members and the average number of adult persons was 5.

From the total sample respondents, about 50% of the respondents were located in Kitwe town while the other half were located in Lusaka town. This means that both towns (Lusaka 49.6% and Kitwe 50.4%) had an almost equal representation of the total sample size. Results further indicate that 72.56% of the total respondents were from the low-cost residential areas, 10.14% were from the medium-cost residential areas and 17.30% were from the high cost residential areas as highlighted in table 4.1 above. These results suggest that majority of the households included in the study sample were from the low-cost (low income) residential areas. Basically, it is hypothesized that households from low-cost residential (low income households) areas are more likely to adopt urban agriculture as an alternative survival strategy and a source of cheap food.

Comparably, Table 4.1 results indicate statistically significant differences in the household's characteristics between urban agriculture participants and non-participants. Notably, older (48 years for participants and 40 years for non-participants) household heads were more likely to engage in farming than the younger ones. Similarly, urban agriculture household heads were more likely to be more learned (29.4% had reached tertiary education) than non-agriculture household heads (24.6% had reached tertiary education). Compared to non-participants (69.62%), participants were more likely to be married (76.38%). Among the unmarried respondents, the urban agriculture households tended to have a higher proportion of widowed heads (14.6%) than non-agriculture households (11.4%). This suggests that widows were more likely to resort to urban agriculture to fend for themselves and their families after the death of their spouses. A significant difference was also noted in terms of the households' residential area between participants and non-participants. Contrary to the belief that low-cost residential households are more likely to engage in farming, the study results show that households from the high cost (25.1% participants vs. 15% non-participants) areas were relatively more likely to engage in farming than households from the low cost (65.7% participants vs. 74.6% non-participants) areas. When compared to non-participation households, participating households had larger household size and more adult members. This result suggests that the larger the household size, the more likely the household participation in urban agriculture. It was also noted that a significantly larger proportion of households of Kitwe town (66.8%) were adopters of urban agriculture compared to Lusaka town (33.17%).

4.2.2 Households farming characteristics

Table 4.2 presents farming characteristics of households practicing urban agriculture. In this study, urban agriculture was limited to three (3) crops namely maize (cereal), groundnuts (legume) and rape (vegetable). Households who grew one or more of these crops within the boundaries of their town of residence were captured as farming households. The decision to limit urban agriculture to maize, groundnuts and rape production was guided by the significant proportion of households who engaged in the production of these crops relative to other crops. Table 4.2 below shows that the total number of households practicing urban agriculture in this study was 618 households. The table further shows that farming households grew their crops either in a garden or in a field.

Table 4. 2: Summary statistics of farm characteristics of urban farm households in Zambia

Variable definition	n=(618)			
Farming characteristics	Mean	Std. Dev.	Min	Max
% HH who planted crops in a garden	49.68	0.500	0	1
% HH who planted crops in a field	50.32	0.500	0	1
% Garden/field located inside HH residential plot	41.26	0.493	0	1
% Garden/field located within HH residential area	18.28	0.387	0	1
% Garden/field located within HH residential town	36.09	0.481	0	1
% Garden/field located outside HH residential town	4.37	0.205	0	1
% HH who planted maize	61.65	0.487	0	1
% HH who planted groundnuts	28.48	0.452	0	1
% HH who planted rape	27.83	0.449	0	1
Total area cultivated (ha)	0.45	1.480	0.0005	25.5
Total area allocated to maize production (ha)	0.37	1.284	0	20
Total area allocated to groundnuts production (ha)	0.07	0.266	0	5
Total area allocated to rape production (ha)	0.01	0.031	0	0.5
Rape revenue (Kwacha)	1.93	26.430	0	599.91
Maize harvests (kg)	207.08	886.563	0	11500
Groundnuts harvests (kg)	11.50	57.864	0	950
Rape harvests (kg)	1.51	10.018	0	139.91
Maize productivity (kg/ha)	544.49	1385.471	0	8625
Groundnuts productivity (kg/ha)	132.29	688.483	0	10000
Rape productivity (kg/ha)	234.86	1044.980	0	233175
Maize price (kwacha)	13.08	593.292	764.70	3823.50
Groundnuts price (kwacha)	107.46	5136.348	5593	28173
Rape price (kwacha)	29.15	1421.687	1390	8575
Maize sales (Kgs)	54.59	570.547	0	100062.50
Groundnuts sales (Kgs)	1.29	12.883	0	10062.50
Rape sales (Kgs)	0.38	4.149	0	69.96
Maize revenue (Kwacha)	101.70	1326.180	0	30779.18
Groundnuts revenue (Kwacha)	19.08	185.145	0	2830.96

According to the results shown in the table, an equal proportion of households grew their crops in a garden (49.7%) and in a field (50.3%). Results also indicate that the fields or gardens used for crop production were located in four (4) different areas. Either within the household's residential plot, within the household's residential area but outside its residential plot, within the household's town of residence but away from its residential area, or outside the household's town of residence.

The results in Table 4.2 show that the majority of the households' gardens or fields used for crop production were located inside the household's residential plot (41.3%). About 36.1% of the household's gardens and fields were located within the household's town of residence while 18.3% of the household's fields and gardens were found inside the household's residential area Only a small proportion of household's gardens and fields were located outside the town of residence (4.4%). However, this study was interested only in urban farming households with gardens and fields found within the limits of the boundaries of town of household residence (within Lusaka and Kitwe towns). This means that households with fields and gardens along the periphery of the town of residence or outside Lusaka and Kitwe towns were not included in the study. These results show that urban farmers have a challenge of access to land for crop production. Most of the households use land within the confinement of their compounds for farming.

Table 4.2 results shows that out of 618 farming households, 61.7 %, 28.5% and 27.8 % were involved in maize, groundnuts and rape production respectively. These results indicate that maize was highly grown among the respondent households. This may be attributed to the crop's significance as a staple food of the country. Further analysis of the data showed that the average household farm area under cultivation was only 0.447 hectares for urban agriculture participants. In addition, the minimum and maximum farm area under cultivation was 0.00005 and 25 hectares respectively. A significantly larger portion of this land was allocated to maize (0.373 ha) production. Only 0.066 ha was allocated to the production of groundnuts and a lesser amount (0.005 ha) was used for growing rape. A possible explanation is that in this study, all the rape produced by the farming households was grown in gardens. Most of the gardens were located in the backyards of the household's residential plots with limited available space for gardening.

The data also revealed that among urban agriculture participants, the average crop productivity for maize, groundnuts, and rape was 544.5kg/ha, 132.3kg/ha and 234.90kg/ha compared to the national average crop yield of maize and groundnuts which are about 1.5mt/ha and 0.68mt/ha respectively. Further analysis show that on average, a total of 201.083 kilograms of maize, 11.5 kilograms of groundnuts and 1.510 kilograms of rape were harvested. Of these harvests, only 54.592 kilograms of maize was sold indicating a proportion of 21.15 % sales of the total harvests. 1.285 kilograms of groundnuts (11.17 %) was sold and 0.379 kilograms of rape (25.1%) was sold. This means that 78.85% of the maize harvested, 88.83% of the groundnuts harvested and 74.9% of the rape harvested was retained for home consumption. These results suggest that most of the urban farmers are subsistence farmers. Crops are mainly grown for household food consumption, nutrition and food security. Compared to the other crops, rape was the mostly sold crop. This could be because of the availability of a ready market for the crop. Furthermore, it was observed that among the participants of urban agriculture, revenue obtained from maize, groundnuts and rape sales was K101.70, K19.10 and K1.93 respectively as depicted in Table 4.2 above.

4.3 Determinants of household participation in Urban Agriculture.

In this study, one of the objectives was to identify the determinants of urban agriculture participation in Zambia. A logistic regression model was employed to determine the degree of influence and the direction of the relationship between household socio-economic characteristics and the household decision to participate in urban agriculture. Further analysis was done to determine the relationship between household demographic characteristics and the crop grown. Model diagnostics were performed to check for possible model specification errors. Tests showed that the model was free from omitted variables and multi-collinearity. The Hosmer-Lemeshow test=9.46; (p-value = 0.3049) indicated that the model could not be rejected and thus fitted well.

Table 4.3 below presents factors that influence household participation in urban agriculture and factors that influence which crop to grow. The main crops grown by the sampled households were maize, groundnuts and rape as depicted in the table. The logit regression revealed that the age of the household head, city of residence of the sampled household, total kilograms of harvested crops, residential area of household, and the marital status of the household head were statistically significantly related to the household participation in urban at 99% significant level.

The highest level of education attained by the household was also statistically significant at 95% confidence level. Furthermore, the main source of livelihood and gender of the household head showed statistically significant relationships with urban agriculture participation at 90% confidence.

From the results, the age of the household head has a positive significant effect on the decision to participate in urban agriculture. Increasing the age of the household head by 1 year increases the probability of urban agriculture participation by 0.6%. This is mainly because agriculture in urban areas is practiced more by older people than younger ones who mainly focus on formal jobs and/or businesses. Farming is viewed to be a primitive activity for the older people. Another possible explanation is that the older people are faced with limited options of alternative sources of food and/ or income. They tend to adopt farming as a survival strategy. This result is consistent with findings by earlier studies.

Onyango (2010) found that the age of the household head positively and statistically significantly influenced the decision to participate in urban agriculture. It was reported that on average, persons between the ages of 36-50 years old were more likely to engage in urban farming. This supports results of this study which indicated that the average age of urban agriculture participant is 48 years, suggesting that the middle aged persons are more likely to farm. On the contrary, Maxwell (1995) in his study discovered that the age of the household head had no significant influence on the decision to participate in urban agriculture although he indicated that on average, older persons participated in urban agriculture compared to their counterparts.

The city of residence of the household showed that households in Kitwe town were 12.7% more likely to engage in urban farming than residents of Lusaka town. This scenario is expected considering the history of urban agriculture in Zambia. History shows that the prevalence of urban agriculture increased in Zambia in the face of structural adjustment programs during the period when the country was going through an economic crisis.

Table 4. 3: Logit regression results for factors affecting urban agriculture participation in Zambia

Independent Variables	*Dependent Variable:* Participation in UA (0/1)			UA maize production (0/1)			UA groundnuts production (0/1)			UA rape production (0/1)		
Household characteristics	Coefficient	Robust Std. Err.	Marginal effects	Coefficient	Std. Err.	Marginal effects	Coefficient	Std. Err.	Marginal effects	Coefficient	Std. Err.	Marginal effects
Age of Household head	0.0223***	0.0026	0.0060	0.0177***	0.0029	0.0031	0.0178***	0.0043	0.0014	-0.0059	0.0050	-0.0005
Category of residence(Low-cost=1; 0 o/w)	-0.2621***	0.0689	-0.0690	0.0942	0.0847	0.0167	0.2073*	0.1329	0.0211	-0.3217**	0.1101	-0.0280
Adult Household members	0.0420	0.0793	0.0113	-0.0155	0.0945	-0.0027	-0.2317*	0.1351	-0.0220	-0.1353	0.1357	-0.0105
Household size	-0.004	0.0685	-0.0011	0.0176	0.0816	0.0031	0.1437	0.1157	0.0143	0.1565	0.1165	0.0148
Gender of head (female=1; 0 o/w)	0.1472	0.1122	0.0422	0.1457	0.1308	0.0258	0.0323	0.2109	0.0025	0.0744	0.1904	0.0058
Town of residence (Kitwe=1; 0 o/w)	0.4698***	0.0590	0.1267	0.1142*	0.0690	0.0226	1.9181***	0.1703	0.1562	1.1118***	0.1154	0.0865
Marital status (married=1;0 o/w)	0.2678***	0.1021	0.0760	0.1892	0.1205	0.0375	0.2374	0.1895	0.0184	0.0365	0.1719	0.0028
Main source of livelihood (salary=1; 0 o/w)	-0.0498	0.0869	-0.0134	-0.3027***	0.0970	-0.0535	-0.0210	0.1492	-0.0016	0.2505*	0.1714	0.0195
Main source of livelihood (informal business=1; 0 o/w)	-0.1816*	0.0945	-0.0508	-0.2074**	0.1038	-0.0362	0.0819	0.1581	0.0063	0.0790	0.1927	0.0061

Main source of livelihood (formal business=1; 0 o/w)	-0.2474*	0.1412	-0.0624	-0.5919***	0.1763	-0.1031	-0.1747	0.2777	-0.0135	0.0383	0.2563	0.0030
Main source of livelihood (farming=1; 0 o/w)	0.2821*	0.1530	0.0758	-0.1444	0.1707	-0.0255	-0.0761	0.2085	-0.0059	0.6604	0.2468	0.0047
Primary education (yes=1; 0 o/w)	-0.1238	0.0782	-0.0346	-0.0328	0.0867	-0.0058	0.0012	0.1273	0.0001	-0.0904	0.1569	-0.0070
Tertiary education (yes=1; 0 o/w)	0.1500**	0.0753	0.0403	-0.0603	0.0929	-0.0107	-0.1795	0.1480	-0.0139	0.4332***	0.1190	0.0307
Maize price per kg	-	-	-	0.0012***	0.0002	0.0002	-	-	-	-	-	-
Groundnuts price per kg	-	-	-	-	-	-	0.0002***	0	0.00001	-	-	-
Rape price per kg	-	-	-	-	-	-	-	-	-	0.0007***	0	0.0001
_cons	-2.1569	0.1773	-	-3.2235	0.2183	-	-5.5057	0.3817	-	-4.1977	0.3396	-

Sample size=2682 Significance levels:*=sig at 10%, **= sig at5%; ** *=sig at 1%

The Copperbelt province was hit more by this development, being the center of the mining industry on which the national economy depends. The urban residents of the Copperbelt province were adversely affected by this turn of events, hence resorted to urban agriculture for survival (Hampwaye, 2008). Urban agriculture has since spread and been adopted in other parts of the country as an alternative and affordable source of food and income.

Interestingly, further analysis of the results indicates that attaining primary education as the highest level of education had a statistically and significantly negative influence on the decision to participate in urban agriculture while attaining tertiary level of education indicated a positive significant influence on the decision to participate in urban agriculture. According to the study results, attaining primary education as the highest level of education lowered the likelihood to adopt urban agriculture by 3.5% while attaining tertiary level of education raised the probability of urban agriculture adoption by 4.0%. This is similar to earlier study results which reported that tertiary education has a positive influence on urban agriculture participation and that most urban agriculture participants have attained post-high school level of education (Sawio, 2005; Mbiba, 1995; Maxwell and Zziwa, 1992).

On the contrary, Onyango (2010) reported that majority of household heads had attained primary education as their highest level of education. Likewise Kekana (2006) reported that urban agriculture participants comparatively have lower educational levels. However, Dossa *et al* (2011) and Maxwell (1995) found no statistical significant relationship between the educational level of the household head and participation in urban agriculture. The possible explanation for this study results is that for households with only primary level of education, the low literacy levels negatively affects their level of understanding of technicalities associated with farming. There is a known challenge of limited access to extension services among urban farmers .Most of them rely on self-reading and research. Hence they decide to shy away from it. A positive relationship at tertiary level suggests that the higher the level of education attained the more likelihood to participate in urban agriculture. The highly educated household heads are able to read, understand and apply the knowledge on farming. Also educated people are known to be risk takers and are more inclined to adopt new innovations or technologies.

Contrary to the expected positive relationship between low-cost residential area and participation in urban agriculture, this study revealed that households located in low-cost residential areas were 6.9% less likely to participate in urban agriculture. This could be attributed to the fact that people located in low density areas are low income earners and thus find it expensive to purchase inputs for agriculture. Another possible explanation could be that low-cost residential plots are smaller compared to high-cost residential plots. The challenge of access to land for cultivating negatively affects participation in urban agriculture. As earlier observed from this study, the majority of the sampled households grew their crops on residential plots. Other earlier studies reported that urban agriculture is not practiced by only the poor but by all socio economic groups or socio-class. (Dossa *et al*., 2011; Mkambisi, 2010; Egziabher *et al.*, 1994).

Further analysis of the data indicated that household's that were in informal businesses as their main source of earning a livelihood were 5.1% less likely to participate in agriculture. Similarly, households that depended on formal business as their main source of income were 6.2% less likely to participate in urban agriculture.

Total kilogram of harvested crops was statistically significant and positively associated with participation in urban agriculture and recorded a marginal effect of 0.00003. This meant that a household head harvesting more crops by 1 Kg was 0.003% more likely to engage in urban agriculture. This could be attributed to the positive motivation one derives from having a good harvest from the previous season and as such they are more likely to continue with urban agriculture.

Results also show that the marital status of the household head is an influential factor in the decision to engage in urban agriculture. Household heads that are married are 7.6% more likely to participate in urban agriculture. This is possibly that marriage comes with family responsibilities, meaning a high demand for food and income. In addition, results on gender shows that female headed households were 4.2% more likely to participate in urban agriculture than the male headed households as depicted in Table 4.3 above.

4.3.1 Determinants of household participation in urban Maize production

Further analysis of the logistic regression model was done to determine the factors that influence the type of crop that the urban farming household decides to grow. For this study, the crops were limited to maize, groundnuts and rape production. The results showed that the age of the household head, the expected output market price of maize and the household's main source of income were statistically significant to household decision to grow maize at 99% confidence level while city of residence and marital status of the household head indicated statistical significance at 90% level of confidence.

From the results depicted in Table 4.3 above, age of the household head shows a statistically significant positive relationship with the decision to grow maize. Increasing the age of the household head by 1 year increases the probability of the household decision to grow maize by 0.3%. Likewise married household heads were 3.8% more likely to grow maize than the unmarried household heads. Kitwe town also showed a statistically significant positive association with household decision to grow maize. Residents of Kitwe town were 2.3% more likely to grow maize than residents of Lusaka town.

For the main source of livelihood of the household head; salaried, informal business and formal business all showed a statistically significant negative influence on household decision to grow maize. Salaried, informal business and formal business households were 5.4%, 3.6% and 10.3% less likely to grow maize. This means that household heads who earned a salary and those in both formal and informal businesses were less likely to involve in maize production. The possible reason is time management. Maize production is involving. It requires a lot of time and labor; hence households with other commitments tend to shun it.

In addition, results reveal that the expected output price for maize had a statistically significant positive influence on the decision to grow maize. A K1 increase in the expected output market price for maize increased the probability of the household to grow maize by 0.02%.

4.3.2 Determinants of household participation in urban groundnuts production

Table 4.3 results shows that the age of the household head, the expected market price of groundnuts and, the city of residence of the household were statistically significantly associated with the household decision to grow groundnuts at 99% confidence level. The number of adult members of the household showed a statistically significant relationship with the household's decision to grow groundnuts at 95% confidence level while household size and the socio-economic class of the household indicated statistical significance at 90% confidence level.

Increasing the age of the household head by 1 year increases the probability of growing groundnuts by 0.14%. It was also found that residents of Kitwe district were 15.6% more likely to grow groundnuts than Lusaka households. In addition, K1 increase in the expected output market price of groundnuts increased the probability of the household to grow groundnuts by 0.001%.

Household size played a significant role in the decision to grow groundnuts. As Table 4.3 indicates, larger families are 1.4 % more likely to grow groundnuts. Contrary, the number of adult members of the family had a negative influence on household decision to grow groundnuts.

An additional adult member to a household reduced the likelihood of growing groundnuts by 2.2%. This is possibly because adult members of the family who are most likely in their youthful age consider the activity to be for the elderly persons and therefore shun the practice. Since groundnut production is labor intensive, demanding a lot of labor, such households decide not to grow the crop.

The area of residence of the household was positively related to the household's decision to grow groundnuts as depicted in the table above. Households in low-cost areas were 2.1% more likely to grow groundnuts. A possible explanation is that from the data, majority of the households that grew groundnuts planted on public land found along the roads away from their plots. This means that the challenge of limited land within their plots did not affect their decision to grow groundnuts.

4.3.3 Determinants of household participation in urban rape production

Results show that the area of residence of the household, the expected output market price of rape, the city of residence of the household, household size, and the highest level of education of the household head statistically and significantly influence the household's decision to engage in rape production. Households from low-cost residential areas were 2.8% less likely to grow rape compared to households from high residential areas. The possible explanation is that most of the households grow rape in the gardens (as shown in this study) and these gardens are mainly located in the backyard of their residential plots. Generally, low-cost residential areas are high density areas with plots located close to each other compared to high-cost residential areas. This poses a challenge of small, if any, or lack of available space within the plots for gardening.

The expected output market price of rape was significantly positively associated with the household decision to grow rape. K1 increase in the expected output market price of rape increased the probability of the household to grow rape by 0.01%. Kitwe town also showed a statistically significant positive association with household decision to grow rape. Residents of Kitwe district were 8.7% more likely to grow rape than residents of Lusaka district. Households which earn a salary can afford to buy these inputs and rape production is not labour and time intensive.

In addition, tertiary education increased the probability of growing rape. Household heads who had reached tertiary level of education were 3.1% more likely to grow rape than households with primary or secondary level of education. Also household size had a positive significant influence on decision to grow rape. Households with larger families were 1.5% more likely to grow rape. This could be because of the high nutritional needs, hence such households resort to own rape production for consumption.

4.4 Impact of urban agriculture on household income.

The second objective of this study was to determine the effect of urban agriculture on household income. The Average Treatment Effect on the Treated (ATT) was used as a measure of the effect of urban agriculture on household income. Household total expenditure was used as a proxy for household income. In order to achieve this objective, the propensity score matching method was employed. Propensity score matching method was chosen because it gives more consistent and realistic estimates than Instrumental variables and Heckman's methods (Woodridge, 2005). In this study, the variable urban agriculture participation was considered to be the treatment and log of household income was the outcome variable**.** The treated group was households that practiced urban agriculture and the control group was households that did not practice urban agriculture between February, 2007 and January, 2008. Five steps were involved in calculating the ATT using the propensity score matching methods. These included:

1. Estimating the propensity scores
2. Matching the propensity scores
3. Selecting the region of common support
4. Checking balancing property of the estimated propensity scores
5. Estimation of the ATT

The treatment effect analysis was done using propensity score matching estimators. The Hosmer-Lemeshow test was used to test the goodness of fit of the model.

4.4.1 Estimation of Propensity Score for urban agriculture

In this study, the Logistic regression model was applied to estimate the propensity scores as shown in Table 4.4 below. The propensity score shows the conditional probability of being treated. The covariates that are included in the model are used to predict the propensity score; hence it is very vital that only variables that influence simultaneously the participation decision and the outcome variable, but are not affected by the treatment should be included in the model for propensity score estimation (Abebe, 2011). Guidance was sought from economic theory and previous empirical studies in selecting the variables to include in the model. Variables that indicated statistical significance in the probability of participation in urban agriculture were included in the model. Table 4.4 below reports results of logit estimates of the predicted propensity score.

The variables age, married, formal business, informal business, farm, low-cost, primary, secondary, and Kitwe were included in the propensity score estimation model. The propensity score ranges between the value of 0 and 1. The treatment variable is urban agriculture which takes the value of 1 if a household practiced urban agriculture and 0; otherwise. The mean propensity score is 23.6%. The McFaden Pseudo R^2 =0.10. The low value of the Pseudo R^2 suggests that there is not much significant difference in characteristics between urban agriculture participants and non-participants. This model diagnostic result suggests that the data fitted well in the estimated model.

Table 4. 4: Estimating propensity scores -the logit model

Variable	Coefficient	z-value
Age of HH head	0.0453***	11.27
	(0.004)	
Marital status	0.4047***	3.52
(married=1; 0 o/w)	(0.1150)	
Primary education	-0.2446*	-1.80
(yes=1; 0 o/w)	(0.1356)	
Tertiary education	0.2204*	1.74
(yes=1; 0 o/w)	(0.1266)	
Main source of livelihood	-0.3202*	-1.47
(formal business=1; o/w)	(0.2182)	
Main source of livelihood	-0.2637**	-2.07
(informal business=1;o/w)	(0.0719)	
Main source of livelihood	0.6041***	2.53
(farming=1; 0 o/w)	(0.2389)	
Category of residence	-0.4835***	-4.13
(low-cost=1; 0 o/w)	(0.1169)	
Town of residence	0.8263***	8.09
(kitwe=1; 0 o/w)	(0.1021)	
	-3.5793	-14.96
Constant	(0.2391)	

*=10% sig. level; **=5% sig. level; ***=1% sig. level

4.4.2 Matching the propensity scores and selecting the Region of Common Support

The underlying principle of the propensity score matching method is to match sample units in the treated group with sample units in the control group based on similar propensity score (Nazli, 2010). In this case, urban agriculture participants were matched with non-participants with similar values propensity scores. Matching is done within the region of common support which is defined by the propensity scores of the treated sample units and the control sample units. The region of common support refers to the area of overlap of the propensity score of the treated sample units and the control sample units. All values that do not fall within the region of common support are discarded.

The region of common support was selected and reported. Observations whose propensity scores lay outside the region of common support were discarded from the model. Results show that the condition of common support was selected and satisfied in the region of [0.05310174, 0.78309622]. Out of 2, 682 observations, 2, 603 observations were matched meaning that 79 observations were discarded. These were households with propensity score values below 0.05310174 and above 0.78309622. The optimal number of blocks used to define the region of common support was 8 blocks. This number of blocks ensured that the mean propensity score was not different for treated and controls in each block.

The common support assumption was also supported graphically by the kernel density distributions of the estimated propensity scores of households as plotted in Figure 4.1 below. As shown in Figure 4.1, the densities of the scores are on the y-axis and the propensity scores are on the x-axis. The figure shows a good overlap of propensity scores of urban agriculture participants and non-participants indicating that the condition of common support was satisfied.

4.4.3 Checking balancing property

The main purpose of the estimation of propensity score was to balance the distributions of relevant variables in both treatment and control (Abebe, 2011). Before proceeding with the estimation of the ATT, balancing tests were done to ensure that the balancing property of the propensity score matching was satisfied and to also ensure that the two groups in the model had similar observable characteristics, and thus were comparable. The propensity score and covariate balancing test was applied to determine the validity and reliability of the results obtained. Five

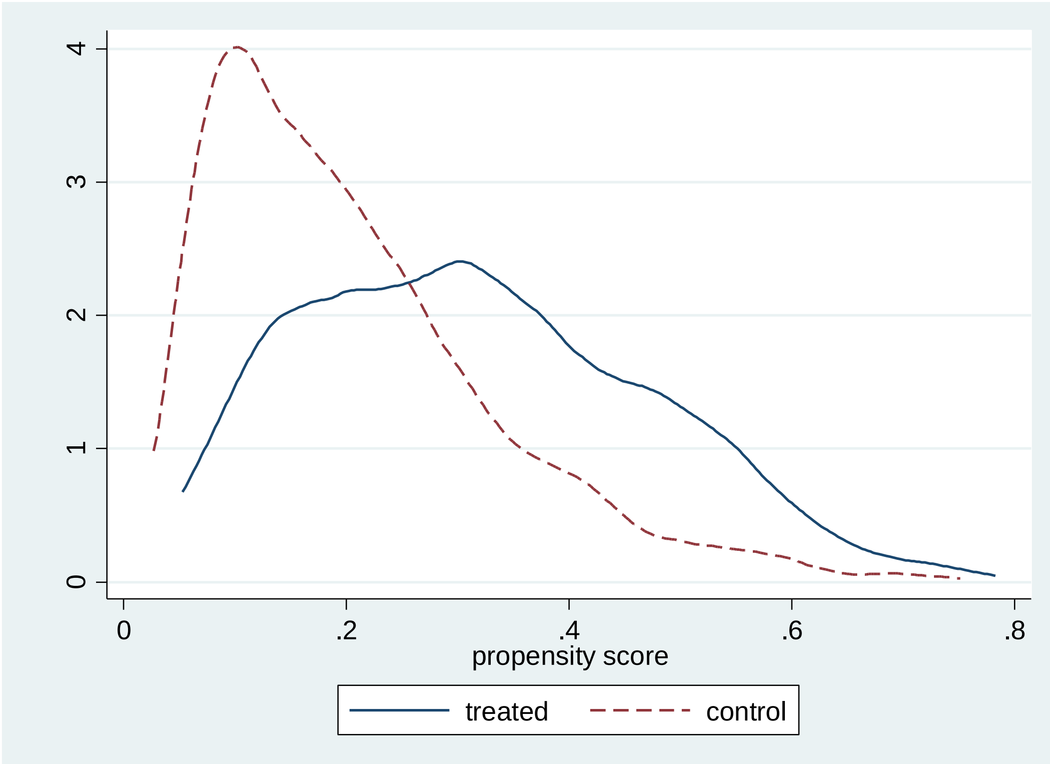

Figure 4.1: Area of common support for the treatment and control groups

(5) different approaches of the balancing tests were employed in this study. These included the t-test, the standardized percentage bias, the Pseudo R^2, the Rubins' B and the Rubin's R. Table 4.5 below shows results of the propensity scores and covariate balancing tests using the t-tests and standardized percentage bias tests as indicated in the table below:

Table 4. 5: Balancing tests of propensity scores and covariates (t-tests and standardized % bias)

Variable	Sample	Treated	Untreated	% bias	T	p>t
age	unmatched	47.775	40.311			
	Matched	47.775	47.651	1.0	0.16	0.870
Married	Unmatched	0.764	0.696			
	Matched	0.764	0.755	1.9	0.35	0.723
Primary	Unmatched	0.206	0.216			
	Matched	0.206	0.204	0.3	0.05	0.957
Tertiary	Unmatched	0.294	0.246			

	Matched	0.295	0.299	-0.9	-0.16	0.874
Formal	Unmatched	0.049	0.07			
Business	Matched	0.049	0.046	0.9	0.17	0.864
Informal	Unmatched	0.181	0.245			
Business	Matched	0.181	0.188	-1.5	-0.29	0.775
Farming	Unmatched	0.076	0.020			
	Matched	0.076	0.066	4.8	0.70	0.483
low-cost	Unmatched	0.657	0.746			
	Matched	0.657	0.659	-0.5	-0.08	0.933
Kitwe	Unmatched	0.668	0.455			
	Matched	0.668	0.658	2.0	0.36	0.715

Unequal-variance *t-test*: *=10% sig. level; **=5% sig. level; ***=1% sig. level

1. *The t-test*

The t-test was applied by comparing the statistical significance of the mean differences of the covariates between the treated group and the untreated group both before and after matching. According to this test, the balancing property of the matching methods is satisfied if the mean differences of the covariates between the treated group and the untreated group are statistically insignificant after matching. Table 4.5 results shows that several variables indicated statistically significant differences before matching. After matching the differences were minimal and statistically insignificant suggesting that the balancing property was satisfied.

2. *The standardized percentage (%) bias test*

The standardized percentage bias is the percent difference of the sample means in the treated and non-treated (full or matched) sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups (formulae from Rosenbaum and Rubin, 1985). According to literature reviewed, a percentage bias reduction below 3% or 5% is considered to be sufficient for balancing property (Abebe, 2011). In this study, all the covariates have a percentage bias value below 3% except for the variable farm which shows a value above 3% but below 5% as depicted in Table 4.5. These results suggest that the balancing property was satisfied.

3. *Pseudo R^2, the Rubin's B and the Rubin's R tests*

Table 4.6 shows results of the propensity scores and covariate balancing tests using the Pseudo

R^2, the Rubin's B and the Rubin's R tests as indicated in the table below:

Table 4. 6: Balancing tests of propensity score and covariate (Rubin's B and Rubin's R tests)

$P_s R^2$	LRChi2	P>Chi2	Mean Bias	Med Bias	B	R	% Var
0.008	13.80	0.182	3.0	1.3	21.1	1.04	0

The Pseudo R^2 test

The Pseudo R^2 indicates how well the covariates explain the probability of participation. The value of the Pseudo R^2 before matching was compared to its value after matching. According to this test, the value of Pseudo R^2 after matching should be fairly low. (Abebe, 2011). Results indicates a value 0.10 and 0.08 before and after matching respectively, suggesting that the balancing property was satisfied.

The Rubin's B test

The Rubin's B is the absolute standardized difference of the means of the linear index of the propensity score in the treated and (matched) non-treated group. It is recommended that B be less than 25 for the samples to be considered sufficiently balanced (Rubin, 2001). Results presented in Table 4.6 shows a B value of 21.1. Therefore, it can be concluded that the covariates were sufficiently balanced.

The Rubin's R

The Rubin's R is the ratio of treated to (matched) non-treated variances of the propensity score index). Rubin (2001) recommends that R be between 0.5 and 2 for the samples to be considered sufficiently balanced. Results in Table 4.6 indicate an R value of 1.04 which falls between 0.5 and 2. It can be concluded that the balancing property was satisfied.

4.4.4 Estimation of ATT of urban agriculture participation

The ATT was used to calculate the average effect of urban agriculture on household total income. ATT was estimated using three different matching estimators: the nearest neighbor, the kernel and the radius matching methods. Table 4.7 presents the estimated results of ATT for the different matching methods. Columns 4 and 5 represent the values of expected household total income for urban agriculture participants and non-participants both before and after matching for each of the three matching methods. Column 5 represents average treatment both before and after matching for urban agriculture participants and non- participants respectively.

Table 4. 7: Expected log of household total income: treatment effects of urban agriculture

Variable	**Matching method**	**Sample**	**UA participants**	**UA Non-participants**	**ATT**	**S.E**	**T.Stat.**
Log of household total income	Nearest neighbor	Unmatched	9.1137	8.8944	0.2193	0.0375	5.84
		Matched	9.1382	8.9472	**0.1910**	0.0500	3.82
	Radius	Unmatched	9.1137	8.8944	0.2193	0.0375	5.84
		Matched	9.1137	8.9764	**0.1373**	0.0426	3.22
	Kernel	Unmatched	9.1137	8.8944	0.2193	0.0375	5.84
		Matched	9.118	8.9730	**0.1445**	0.0431	3.35

For the nearest neighbor method, results indicate that without matching, the expected household total income for urban agriculture participants is 21.9% higher than the expected household total income for urban agriculture non-participants. These results are misleading. The estimated figure could potentially have been due to unobserved characteristics of participants which could have also had an influence on the outcome. Therefore, it is not a true reflection of the effect of urban agriculture on household income. More reliable results were obtained using the ATT estimates after matching. ATT estimates give more reliable and useful interpretation of the results.

Column 6 of Table 4.7 above shows that after matching, the average treatment effect of urban agriculture on household total income is 0.19096. This implies that households that participated in urban agriculture would be expected to have 19.1 percent more income than their counterparts who had not participated in urban agriculture. Likewise for the Radius matching methods, results indicate that before matching participation in urban agriculture increased household income by 21.9% compared to non-participants. After matching, the average treatment effect shows that participation in urban agriculture increased the expected household income by 13.7 % compared to non- participants. For the Kernel methods, results in Table 8 shows that before matching urban agriculture increased household total income of participants by 21.9%. After matching, the expected household income of participants was 14.5% more than their counterparts. It can be observed from the results that participation in urban agriculture increased household total income in the ranges of 13.7% to 19.1% and these results were significant at 95% confidence level. This implies that urban agriculture positively and significantly increases household total income of urban agriculture participants.

4.5 Treatment Effects of Maize production on household income

4.5.1 Estimation of the propensity scores for urban maize production

In this study, further analysis was done to discuss the effect of the crop grown on household total income. This section discusses the effect of urban maize production on household income. PSM model was used to determine household characteristics that satisfied the required condition of common support. Only variables that significantly influenced household decision to grow maize were included in the PSM model. The variables age of the household head, marital status, town of residence, salaried, informal business, formal business, and the expected output market price of maize were included in the PSM model. Logit model was employed to estimate the propensity scores as depicted in Table 4.8 below. The McFaden Pseudo R^2 =0.19. The low value of the Pseudo R^2 suggests that there is not much significant difference in characteristics between urban agriculture participants and non-participants. This model diagnostic result suggests that the data fitted well in the estimated model.

Results show that out of a total of 2, 682 households, 381 households participated in urban agriculture representing 14.21% rate of participation. The region of common support was selected and reported. Observations whose propensity scores lay outside the region of common support were discarded from the model. Results show that the condition of common support was selected and satisfied in the region of [0.03026267, 0.60784854]. Out of 2, 682 observations, 2, 678 observations were matched meaning only 4 observations were discarded. These were households with propensity score values below 0.03026267 and above 0.60784854. Stata analysis results showed that the balancing property was satisfied. The optimal number of blocks used to define the region of common support was 6 blocks.

Table 4. 8: Logit model estimation of propensity scores for maize production

Variable	Coefficient	z-value
age	0.0428	9.45
	(0.0045)	
Kitwe	0.1544	1.32
	(0.1166)	
Married	0.2877	2.16
	(0.1333)	
Salaried	-0.5786	-3.90
	(0.1484)	
informal business	-0.5385	-3.24
	(0.1661)	
formal business	-1.0256	-3.36
	(0.3054)	
constant	-3.5534	-11.99
	(0.3454)	

*=10% sig. level; **=5% sig. level; ***=1% sig. level

4.5.2 Estimation of ATT of urban maize production on household income

The ATT was used to calculate the average effect of urban maize production on household income. ATT was estimated using three different matching methods: the nearest neighbor, the kernel and the radius matching methods. Table 4.9 below presents the estimated results of ATT for the different matching methods. Columns 4 and 5 represent the values of expected household total income for urban households that grew maize and households that did not grow maize both before and after matching for each of the three matching methods. Column 5 represents the average treatment effect both before and after matching for the sample urban households that grew maize and households that did not grow maize respectively.

Table 4. 9: Treatment effects of urban maize production on household total income

Variable	Matching method	Sample	Maize production participants	Maize production Non-participants	ATT	S.E	T. Statistic
Log of household total income	Nearest neighbor	Unmatched	8.9325	8.9470	-0.0145	0.0455	-0.32
		Matched	8.9540	8.8440	0.1100	0.0613	1.79
	Radius	Unmatched	8.9325	8.9470	-0.0145	0.0455	-0.32
		Matched	8.9334	8.8700	0.0638	0.0500	1.28
	Kernel	Unmatched	8.9325	8.9470	-0.0145	0.0455	-0.32
		Matched	8.9325	8.8541	0.0784	0.0484	1.62

For all the estimators used in this study, results in Table 4.9 above show that without matching, urban maize production reduced household total income for participants by 1.45% compared to non- participating households. These results suggest that households that did not grow maize were better off compared to households that did grow maize. However, these results are misleading and unreliable because they are based on incomparable observable characteristics of the two groups of households. With matching done, results indicate that for the nearest neighbor estimation results, urban maize production increased household total income for participants by 11% compared to households that did not grow maize. For the radius methods, results indicate that the total income for households that grew maize was 6.38% higher than their counterparts. Kernel methods show that total income for households that grew maize was 6.38% higher than their counterparts. This means that the average treatment effect of maize production on household total income ranged from 6.38% to 11%. Maize production has a positive and significant effect on household income.

4.6 Average treatment effects of groundnuts production on household income

4.6.1 Estimation of the propensity scores for urban groundnuts production

This section discusses the average treatment effect of urban groundnuts production on household income. PSM model was used to determine household characteristics that satisfied the condition of common support. Only variables that significantly influenced household decision to grow groundnuts were included in the PSM model. The variables age of the household head, town of residence (Kitwe), number of adult members of the household, household size, and category of residence (low-cost) were included in the PSM model. Logit model was employed to estimate the propensity scores as depicted in Table 4.10 below.

Table 4. 10: Logit model estimation of propensity scores for groundnuts production

Variable	Coefficient	z-value
Age	0.0460	7.55
	(0.0060)	
low-cost	-0.0523	-0.27
	(0.1923)	
adult members	-0.1659	-0.79
	(0.2092)	
household size	0.1527	0.86
	(0.1784)	
Kitwe	1.9524	8.32
	(0.2345)	
constant	-6.1646	-15.91
	(0.3875)	

*=10% sig. level; **=5% sig. level; ***=1% sig. level

Results show that out of a total of 2, 682 households, only 176 households participated in urban groundnuts production representing 6.56% rate of participation. The region of common support was selected and reported. Observations whose propensity scores lay outside the region of common support were discarded from the model. Results show that the condition of common support was selected and satisfied in the region of [0.01053928, 0.40006452]. Out of 2, 682 observations, 2, 176 observations were matched meaning a total of 506 observations were discarded. These were households with propensity score values below 0.02878704 and above 0.99047615. Stata analysis results showed that the balancing property was satisfied. The optimal number of blocks used to define the region of common support was 6 blocks.

4.6.2 Estimation of ATT of urban groundnuts production

The ATT was used to calculate the average effect of urban groundnuts production on household income. ATT was estimated using three different matching methods: the nearest neighbor, the kernel and the radius matching methods. Table 4.11 below presents the estimated results of ATT for the different matching methods. Columns 4 and 5 represent the values of expected household total income for urban households that grew groundnuts and households that did not grow groundnuts both before and after matching for each of the three matching methods. Column 5 represents the average treatment effect both before and after matching for the sample urban households that grew groundnuts and households that did not grow groundnuts respectively.

Table 4. 11: Treatment effects of urban groundnuts production on household income

Variable	Matching methods	Sample	Groundnuts Production participants	Groundnuts Production Non-participants	ATT	S.E	T. Stat.
Log of household	Nearest	Unmatched	8.9018	8.9479	-0.0461	0.0642	-0.72
Total come	neighbor	Matched	8.9254	8.8742	0.0512	0.0952	0.54
	Radius	Unmatched	8.9018	8.9479	-0.0461	0.0642	-0.72
		Matched	8.9254	8.8751	0.0503	0.0761	0.66
	Kernel	Unmatched	8.9018	8.9479	-0.0642	0.0642	-0.72
		Matched	8.9018	8.8925	0.0760	0.0760	0.12

Results in Table 4.11 shows that for the nearest neighbor and radius estimators, without matching, urban groundnuts production reduced household total income for participants by 4.61% compared to non- participants. For the kernel methods, household incomes for groundnuts growers reduced by 6.42% compared to the households that did not grow groundnuts. These results suggest that households that grew groundnuts were worse off compared to households that did not produce groundnuts. However, this outcome is misleading and unreliable because it is based on incomparable observable characteristics of the two groups of households. With matching done, results indicate that for the nearest neighbor estimation results, urban groundnuts production increased household total income for participants by 5.12% compared to households that did not produce groundnuts. For the radius methods, results indicate that the total income for households that produced groundnuts was 5.03% higher than their counterparts. Kernel methods show that total income for households that produced groundnuts was 7.6% higher than their counterparts. This means that the average treatment effect of maize production on household total income ranged from 5.03% to 7.6%. Household participation in urban groundnuts production positively and significantly increased household income.

4.7 Average treatment effects of rape production on household income

4.7.1 Estimation of the propensity scores for urban rape production

This section discusses the average treatment effect of urban rape production on household income. PSM model was used to determine household characteristics that satisfied the condition of common support. The variables age of the household head, town of residence (Kitwe), the highest level of education of the household head, household size, and category of residence (low-cost) were included in the PSM model. Logit model was employed to estimate the propensity scores as depicted in Table 4.12 below.

Table 4. 12 Logit model estimation of propensity scores for rape production

Variable	Coefficients	z-value
Age	0.0162	2.23
	(0.0072)	
Low-cost	-0.8849	-4.86
	(0.1820)	
Tertiary	0.9872	5.28
	(0.1870)	
Household size	0.1351	4.53
	(0.0297)	
Kitwe	0.1453	4.30
	(0.1733)	
Constant	-4.4553	-11.55
	(0.3857)	

*=10% sig. level; **=5% sig. level; ***=1% sig. level

Results show that out of a total of 2, 682 households, only 172 households participated in urban rape production representing 6.41% rate of participation. The region of common support was selected and reported. Observations whose propensity scores lay outside the region of common support were discarded from the model. Results show that the condition of common support was selected and satisfied in the region of [0.01778384, 0.5201388]. Out of 2, 682 observations, 2, 267 observations were matched meaning a total of 415 observations were discarded. These were households with propensity score values below 0.01778384 and above 0.5201388. Stata analysis results showed that the balancing property was satisfied. The optimal number of blocks used to define the region of common support was 6 blocks.

4.7.2 Estimation of ATT of urban rape production on household income

The ATT was used to calculate the average effect of urban rape production on household income. ATT was estimated using three different matching methods: the nearest neighbor, the kernel and the radius matching methods. Table 4.13 below presents the estimated results of ATT for the different matching methods. Columns 4 and 5 represent the values of expected household total income for urban households that grew rape and households that did not grow rape both before and after matching for each of the three matching methods. Column 6 represents the average treatment effect both before and after matching for the sample urban households that grew rape and households that did not grow rape respectively.

For all the estimators used in this study, results in Table 4.13 above show that without matching, urban rape production significantly increased household total income for participants by 57.1% compared to non- participants.

Table 4. 13: Treatment effects of urban rape production on household income

Variable	Matching methods	Sample	Rape Production participants	Rape Production Non-participants	ATT	S.E	T. Stat.
Log of household total income	Nearest neighbor	Unmatched	9.4788	8.9083	0.5705	0.0640	8.91
		Matched	9.4595	9.3202	0.1393	0.0928	1.50
	Radius	Unmatched	9.4788	8.9083	0.5705	0.0640	8.91
		Matched	9.4668	9.2598	0.2069	0.0689	3.00
	Kernel	Unmatched	9.4788	8.9083	0.5705	0.0640	8.91
		Matched	9.4668	9.1962	0.2706	0.0678	3.99

However, these results are misleading and unreliable because they are based on incomparable observable characteristics of the two groups of households. With matching done, results indicate that for the nearest neighbor estimation results, urban rape production increased household total income for participants by 13.9% compared to households that did not grow rape. For the radius methods, results indicate that the total income for households that grew rape was 20.7% higher than their counterparts. Kernel methods show that total income for households that grew rape was 27.1% higher than their counterparts. This means that the average treatment effect of rape production on household total income ranged from 13.9% to 27.1%. Rape production had a positive and significant effect on household income.

4.8 REMARKS

The hypotheses test results indicate that household's demographic and farm characteristics significantly determine a household's decision to participate in urban agriculture and that urban agriculture has a significant positive effect on household income. There is a causal relationship between a household's socio-economic characteristics and a household's decision to participate in urban agriculture. A household's socio-economic activities further determine a household's decision on the crop to grow among maize, groundnuts and rape. Results further show that urban agriculture has a significant positive effect on household income. Participation in urban agriculture increases household income in the range of 13.7 to 19.1%. Maize, groundnuts and rape production positively and significantly impact on household income. Maize, groundnuts and rape production raises household income in the range of 6.38 to 11%, 5.03 to 7.6% and 13.9 to 27.1% respectively. From these results, rape was the most profitable crop among the selected sample crops.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter begins with the conclusions of the study where the study's objectives and key findings are summarized. It later presents the policy recommendations proposed based on the key findings. The chapter closes by proposing areas where this research was limited to explore for future research.

5.2 Conclusions

Empirically, results of this study show that Urban Agriculture has a positive significant effect on household income. Farming households had higher incomes compared to non-farming households with similar socio-economic characteristics. It can therefore be concluded that engaging in Urban Agriculture increases household income. It was also found that maize, groundnuts and rape production are productive activities that significantly increase household income.

Results also show that household decision to participate in urban agriculture is influenced by the household's socio-economic characteristics. Generally the age of the household head, the town or city of residence of the household, the highest level of education attained by the household head, the marital status of the household head, the area (class) of residence of the household, the employment status of the household head and the gender of the household head show a significant influence on the household's decision to participate in urban agriculture. Older household heads are more inclined to engage in urban farming than the younger household heads. This could be attributed to the notion among urban societies that farming is a rural activity for the aged people and therefore they tend to shun it. Residents of Kitwe town are more engaged in urban farming than residents of Lusaka town. It is reported that urban agriculture was first started on the Copper-belt province before it spread to other parts of the country. This could be the plausible explanation for this scenario. Results indicate that household heads with higher level of education are more capable of adopting urban agriculture than of lower levels of education. Relatively, higher education helps in making well informed decision with regard to adoption of a technology or innovation.

It can also be concluded from the results that married households are more involved in urban agriculture in comparison to their counterparts. Also, female-headed households are more engaged in urban farming compared to male-headed households. This could imply that female-headed have limited alternative livelihood strategies, hence they resort to farming to provide for their families. The likelihood of households in low-cost residential areas to participate in urban agriculture is low compared to high-cost residential households. Low-cost residential plots are smaller compared to high-cost residential plots; therefore, they are faced with challenge of limited land to cultivate within their compounds. Households that are in informal and formal businesses as their main source of earning a livelihood are less likely to participate in urban agriculture.

Results further show that household characteristics have different effects on a household's decision with regards the kind of crop to grow. The age of the household head and the output market price of maize indicate a positive significant effect on the household's decision to grow maize, Results also show that married household heads and households that reside in Kitwe town are more likely to engage in maize production while formally employed household heads are less likely to grow maize. For groundnut production, the age of the household head and the size of the household show a positive influence on a household's decision to produce groundnuts while the number of adult members of the household has a negative influence on the decision to participate in groundnuts production. Kitwe residents and low-cost or high density residents are more likely to grow groundnuts. Being a resident of Kitwe town, the output market price of rape, attaining tertiary level of education, the household size and being in formal employment positively influence a household's decision to participate in rape production while residing in the low-cost or high density area show a negative influence.

5.3 Recommendations

As observed from the results, urban agriculture participation increases household income and thus farmers engaged in urban agriculture are well off compared to their non-participating counterparts. Increased income is in twofold: through direct savings on food purchases and through the sale of produce. However, potential benefits of urban agriculture are constrained by lack of a policy and institutional support system to the activity. Another major setback for urban agriculture is the marginalization of urban farming in urban planning and land use allocation system. More attention is given to industrial and residential development activities because urban agriculture is considered a rural activity. This poses a challenge of limited access to land for urban farmers. Hence, the activity does not perform to its full potential. This consequently creates a knowledge gap and a perception that the activity is not economically viable.

Agriculture in general, has been recognized as an important sector with the potential of alleviating poverty and ensuring food security in Zambia. Yet, the practice is viewed negatively when it is practiced in the urban environment. Restricting agriculture is a way of restricting development options for the country at large because what is crucial is the economic viability and not necessarily the location of the activity. Thus, the government of the republic of Zambia, NGOs and other civil society organizations need to recognize the potential economic benefits of urban agriculture and increase their efforts in encouraging people in urban areas to engage in agriculture. This has the potential to significantly increase their capacity to earn more and thus spend more.

The government of Zambia should consider the following in order to create an enabling environment for urban agriculture:

- To integrate urban agriculture into the agricultural development policy framework
- To set up an institutional organization with the mandate to create a strong support system to urban agriculture. The Institution should create and coordinate input-output farmer linkages within the urban areas and the outside world and promote appropriate technologies.
- To recognize urban agriculture as a land use developmental activity and consider it in urban planning

- To consult and collaborate with other stakeholders in developing appropriate strategies to promote urban agriculture and strategize on how best to harness the potential benefits of the activity
- Adequate research on urban agriculture should be a starting point in promoting it in order to be equipped with adequate knowledge on the extent of practice of the activity, constraints faced by urban farmers and potential benefits of urban agriculture.
- Urban households should consider adopting urban farming as an alternative source of food for home consumption and income generation.
- To provide support services to urban farmers such as access to quality, affordable inputs (seeds, fertilizers, chemicals, credit facilities, storage and waste facilities etc).

The above mentioned suggestions will not only result in higher numbers of urban populations engaging in agriculture but also increased capacity by people to alleviate poverty and increase food security at the household and national levels.

5.4 Future Research

Considering the fact that the government of Zambia intends on making agriculture as the economy's mainstay but agriculture participation in urban areas is still low, there is need for more studies using recent dataset to investigate the economic impact of urban agriculture (to include livestock production) on household income and household food nutrition. Furthermore, incoming research should focus on undertaking a thorough analysis of the factors that constrain people in urban areas from engaging in urban agriculture on a big scale and should also focus on how land tenure systems in urban Zambia affect participation in agriculture.

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