EFFECT OF WOMEN ACCESS TO LAND ON HOUSEHOLD NUTRITIONAL OUTCOMES AMONG SMALL SCALE FARMERS IN MACHAKOS COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is wholly my original work and to the best of my knowledge, has not, wholly or in part, been presented for the award of any degree in this or any other university.

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Recommendation

This thesis has been submitted for examination with our recommendation as university supervisors.

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DEDICATION

This thesis is dedicated to my mum Rosemary Wanjeri Kariuki, my husband Zachary Simba and my siblings.

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ABSTRACT

Agriculture plays a vital role in the Kenyan economy. It helps in poverty mitigation and ensuring food security. In agriculture, women constitute the majority of small-scale farmers in Kenya, providing 89% of subsistence farming labor force and 70% of the cash crop labor force. However, they have limited access to land which hinders them from making the most constructive use of their time and energy in the agricultural sector and thus affecting household nutritional outcomes. Therefore, this study sought to determine the factors influencing women access to land and the effects of women access to land on household nutritional outcomes among small-scale women farmers. Multi-stage sampling technique was used to select 384 small-scale women farmers from Machakos County who were interviewed using a pre-tested semi-structured questionnaire. The household nutritional outcomes were measured using Households Dietary Diversity scores (HDDS) and Household Hunger Scale Scores (HHS). Data was analyzed using *Chi*-square test, double hurdle and Heterogeneous Treatment Effects (HTE) models. The results indicated that there existed a significant relationship between women access to land and the choice of farm enterprises since the *chi*-value of 374.84 was statistically significant at 1%. A higher percentage of women (46.2%) who had access to land were involved in food crop and livestock farming whereas 66.8% of those who did not have access to land were predominantly involved in livestock farming. Women access to land was positively influenced by household size, the value of productive assets, credit borrowed, extension contacts, social influence and the main source of agricultural information. However, it was negatively influenced by marital status, spousal age gap and distance to the market. The results also revealed that all households benefitted positively but differently from women's access to land in terms of nutrition outcomes. The maximum number of food groups consumed by households in which women had access to land were 12 food groups whereas for their counterparts it was 7 food groups. The highly consumed food groups were cereals (98.7%), vegetables (86.5%), oil/fats (91.7%), sugar/honey (98.4%) and miscellaneous/condiments (98.4%). Therefore, the study concluded that; women access and the extent of access to land is influenced by both women socio-economic and institutional factors. Most importantly, it was evident that women access to land had a great potential to improve household nutritional outcomes. Thus, the study recommended that in order to improve women access to land, women need to be motivated to join and participate in farmers' groups through which they could gain access to extension information and credit. In addition, women farmers should be sensitized on the need to invest in farm productive assets in order to enhance their bargaining power in the household and absorb risks associated with farming.

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LIST OF ABBREVIATIONS AND ACRONYMS

ATE	Average Treatment Effects
APE	Average Partial Effects
CAPE	Conditional Average Partial Effects
DH	Double Hurdle Model
EDS	Energy Diversity Scores
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
FCS	Food Consumption Scores
FIDA	Federation of Women Lawyers
GoK	Government of Kenya
HDDS	Household Dietary Diversity Scores
HFD	Healthy Food Diversity
HHS	Household Hunger Scale
HTE	Heterogeneous Treatment Effects
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
KES	Kenya Shillings
KNBS	Kenya National Bureau of Statistics
MS-HTE	Matching-Smoothing Heterogeneous Treatment Effects
MoALF	Ministry of Agriculture, Livestock and Fisheries
NCPD	National Council for Population and Development
NFNSP	National Food and Nutrition Security Policy
NGOs	Non-governmental Organizations
PLoS	Public Library of Science
QUANTIDD	Quantitative Index of Dietary Diversity
RCI	Recommendation Compliance Index
RFS	Recommended Foods Scores
SDGs	Sustainable Development Goals
SIDA	Swedish International Development Cooperation Agency
SM-HTE	Stratification-Multilevel Heterogeneous Treatment Effects
TT	Treatment effect of the Treated
TUT	Treatment effect of the Untreated
UAPE	Unconditional Average Partial Effects

VIF	Variance Inflation Factor
WEF	World Economic Forum
WGEA	Workplace Gender Equality Agency

CHAPTER ONE
INTRODUCTION

1.1 Background information

Agriculture is the mainstay of Kenya's economy, currently contributing about 30% to the Gross Domestic Product (GDP). The sector accounts for about 65% of Kenya's total exports; provides employment to more than 80% of the population and it is a source of livelihood for close to 80% of the Kenyan population living in the rural areas (KNBS, 2016). Hence, agriculture is seen as the main pathway contributing to poverty reduction and food and nutrition security (Kirimi *et al*., 2013; Verhart *et al*., 2015). As a result, it is among the key economic sectors expected to steer the Kenyan economy to a projected 10 percent economic growth yearly through the promotion of commercially-oriented and innovative agriculture (Kirimi *et al*., 2013; KNBS, 2016).

Small-scale farmers constitute the majority of agricultural producers in Kenya and produce about 63% of the total food that is consumed in the country (FAO, 2015). Therefore, small-scale agriculture is seen as one of the options contributing to farmers' income as well as encouraging household food diversification and eventually leads to improved household access to food. However, their productivity is hampered by limited access to land, low input use, insufficient and poorly maintained market infrastructures, limited/no access to extension services, use of obsolete technology and climate change (Kirimi *et al*., 2013). Small-scale agriculture tends to be labor intensive and mostly uses family labor with women providing 43 percent of the total agricultural labor force (SIDA, 2015). In Kenya, land is a vital resource because it is the principal source of living and material wealth for the majority of small-scale farmers in rural areas.

Access to land is a crucial issue because it is a valuable asset that is used for household food production as well as a key factor for shelter and community development. Land access is the process by which people either individually or collectively gain rights and opportunities to control and utilize land on a temporary or permanent basis (Khalid *et al*., 2015). The way land is owned, used and exchanged has extensive implications on the productivity of that land, equity and overall economic growth (Jin and Jayne, 2013). Adequate and safe access to productive land is crucial to a large number of small-scale poor farmers residing in rural areas in Kenya who depend on agriculture for their livelihood (Kirimi *et al*., 2013). This is because it downgrades their vulnerability to hunger, malnutrition and poverty as well as enhances their

participation in productive activities (Kirimi *et al*., 2013; Gyau *et al*., 2014; Menon *et al*., 2014; Doss *et al*., 2015).

According to World Bank (2012), women especially in many developing countries, are facing gender discrimination in terms of access to productive resources, which is fundamentally driven by gendered customary institutions, perceptions and norms. Gender inequality can be a cause and effect of hunger and malnutrition since gender and nutrition are inseparable parts of the vicious cycle of poverty (FAO, 2011a). However, there are four key pathways linking agriculture and nutrition, that is; gender-related factors, income from agricultural activities, subsistence agriculture and food prices (Carletto *et al*., 2015). Agriculture and household nutrition outcomes can thus be achieved by establishing a link between diversity in crop production, dietary diversity and women empowerment. Crop and dietary diversity among small-scale farmers are believed to be spearheaded by women empowerment (Doss *et al*. 2011). Land tenure formalization is one of the potential catalysts for women empowerment and economic development. Empowering women through access to resources such as land gives them household bargaining power besides financial security (Doss *et al*. 2011; Doss *et al*., 2015). This may improve household welfare because women are more likely than men to concentrate more on producing food crops for subsistence purposes rather than cash crops (FAO, 2012; Wiig, 2013; Kassie *et al*., 2014). This may enhance household food security and also improve the nutritional status of children since women are predominantly the caregivers in the household.

In terms of nutrition, small-scale women farmers who have access to land have a tendency of producing a wide variety of foods and spending a large proportion of their revenues on food expenditures, thus, improving their household dietary diversity and caloric intake (Kirimi *et al*., 2013). This is because women provide about 80% of the agricultural labor and account for about 60% of farm-derived income (FIDA, 2012; Kassie *et al*., 2014). In addition, through owning land, women are able to use it as a form of collateral for obtaining credit especially for financing agricultural production and start-up businesses (Lambrecht, 2016). The credit obtained can be used to procure the recommended agricultural inputs required for agricultural production and also through investing in non-farm businesses, they are able to bring changes in household incomes and eventually changes in their household nutritional outcomes. In addition, credit obtained can be used to purchase agricultural productive assets which improve their liquidity position in order to absorb risks in agriculture. Regardless of women being the

driving force behind subsistence farming and food security, which play an integral role in the household well-being and the economy as a whole, they still cannot fully exercise their right to property especially land (Kassie *et al*., 2014).

Due to the existence of gender discrimination in Kenya, the quest for development has led to a consensus that participation by both men and women as equal partners is fundamental for the sustained intervention of gender equality (World Bank, 2012). Also, gender and economic development issues in developing countries, Kenya included, continue to draw the attention of the researchers and policymakers (Meinzen-dick *et al*., 2010; Ndiritu *et al*., 2014; Lambrecht, 2016). This is because women play a key role in the agricultural sector and the economy in general. Therefore, the Government of Kenya has embarked on several strategies aimed at improving gender equality, for instance, through the constitution. In 2010 constitution of Kenya, there are several provisions that guarantee the rights of women to own property including land. For example, Article 40 (1) of the Constitution has entrenched equal rights for every person, either as an individual or in association with others, to procure and own property of any description in any part of Kenya (FIDA, 2012). Marriage and inheritance laws in the constitution provide another way of enhancing gender equality in the country.

Despite the fact that there are women's land rights or land laws protected in the constitution in Kenya, in reality, these rights are precluded by gendered customs and social attitudes due to poor implementation of the laws (Odeny, 2013). Therefore, the main source of restriction which is the customary practices and laws continue to prohibit women from owning property especially land. In Machakos County, gender inequality exists in property ownership especially land. According to Harington (2010), Kenyan women particularly the married women with no exception of women from Machakos County hold an exceptionally small proportion of registered title deeds. This not only denies women access to economic sustenance but also leave them socially ostracized (Makena *et al*., 2014).

1.2 Statement of the problem

Women farmers constitute the bulk of small-scale farmers in Kenya who rely heavily on agriculture for their livelihoods. They play an imperative role in the household where they are responsible for household food security but still face a challenge of limited access to land which is a crucial input for agricultural production. When women have access to land for agricultural production, they may gain improved status and subsequently enhanced control of income from

their production activities leading to greater influence in the household decision-making process. The influence is fundamental as women have a higher likelihood of making decisions that enhance their household welfare, particularly decisions on food and nutritional needs of the household since they are the primary caregivers. Despite this importance, women still have limited access to agricultural land and the role of socio-economic and institutional factors in influencing the access and extent of women access to land is not clear in the empirical literature. Furthermore, the implication of women access to land on household nutritional outcomes is not known. It is on this basis that this study was geared towards filling these knowledge gaps by using an exploratory study carried out among small-scale women farmers in Machakos County, Kenya.

1.3 Objectives

1.3.1 General objective

The main objective of this study was to contribute towards improved household livelihood outcomes through enhanced women access to land among small-scale farmers in Machakos County.

1.3.2 Specific objectives

1. To determine the relationship between women access to land and the choice of farm enterprises among small-scale women farmers.
2. To determine the effect of socio-economic and institutional factors on women access to land and the extent of access to land among small-scale women farmers.
3. To determine the effect of women access to land on household nutritional outcomes among small-scale farmers.

1.4 Research questions

1. Is there any significant relationship between women access to land and the choice of farm enterprises among small-scale women farmers?
2. What is the effect of socio-economic and institutional factors on women access and the extent of access to land among small-scale women farmers?
3. What is the effect of women access to land on household nutritional outcomes among small-scale farmers?

1.5 Justification of the study

Access to land and tenure security are central to rural poverty mitigation and food insecurity reduction in Kenya (Muraoka *et al*., 2014; Wanjala, 2015). However, equitable land access among small-scale farmers tends to be constrained by gendered customary institutions, norms and beliefs (Anukriti, 2014). Gender inequality in agricultural development has contributed to low agricultural productivity, high poverty levels, low agricultural investments as well as under-nutrition among rural households (FAO, 2011a; Kassie *et al*., 2014). Agriculture, gender and nutrition are cross-cutting issues in small-scale farmers' livelihoods. This study analyzed the effect of women access to land on household nutritional outcomes among small-scale farmers and therefore, it may contribute towards the achievement of National Food and Nutrition Security Policy (NFNSP) which aims to achieve good nutrition for optimum health of all Kenyans (GoK, 2011). In addition, this study will aid in the realization of one of the big four agenda, which is the achievement of food and nutrition security (KIPPRA, 2018). Furthermore, the empirical evidence from this study will inform in the realization of the second and fifth SDGs of achieving food security, improved nutrition as well as achieving gender equality and women empowerment.

According to County Integrated Development Plan of 2013-2017, the absolute poverty in Machakos County is estimated at 60.7% whereas the food insecurity is at 54%. Thus, with the county experiencing food insecurity, high poverty levels and gender inequality problems, this study is expected to generate crucial information that will expound on how women's access to land affects household nutritional outcomes among small-scale farmers. Consequently, the study is expected to inform researchers and policy makers at national and county level to formulate policies and programs aimed at ensuring gender equality in terms of access to land and improved nutrition, especially among the rural small-scale farmers.

1.6 Scope and limitation of the study

The study was carried out in Machakos County, Kenya. The sample comprised of small-scale women farmers with at most 10 acres of land. It targeted women farmers in households so as to evaluate their opinions about women access to land and household nutrition outcomes. However, the study was constrained by use of recall method, which was a deterrent factor in the data collection process, however, exhaustive probing was employed. Also, the study was limited in that it did not consider the seasonal variation in agriculture since cross-sectional data was used.

1.7 Operational definition of terms

Small-scale farmers: In this study, it refers to small-scale women farmers with at most 10 acres of agricultural land in Machakos County.

Household: It refers to a unit of people living together for a period not less than six months, they are answerable to one person, who is the household head and share the same eating arrangement.

Livelihood: It is defined as the productive assets needed as a means of living by a household, for example, land.

Land access: It is defined in terms of user rights and control rights, that is small-scale women farmers being in a position to utilize a piece of land and make decisions regarding it, for instance, either through a bequest (inheritance), buying, grant by the government, renting in among others for agricultural purposes.

Nutrition outcomes: It refers to dietary diversity in a household measured using household dietary diversity scores (HDDS).

Gender equality: It refers to a state where men and women have equal access to land regardless of one being a man or a woman (their gender).

Women household bargaining power: It refers to the negotiating capacity of small-scale women farmers within their households especially with regard to issues concerning land.

CHAPTER TWO
LITERATURE REVIEW

2.1 Challenges in small-scale farmers production systems in Africa

The agricultural population in Africa is estimated to be 530 million people, however, it is anticipated to upsurge to 580 million farmers by 2020 (Blein *et al*., 2013). Agriculture especially small-scale agriculture plays a crucial role in all African economies. The sector has a paramount role in employment as it accounts for about half of all Africa's new entrants to working population whereas in Asia this statistic is only 30% (Blein *et al*., 2013). It also contributes to the eradication of hunger and improved food security among rural households in Africa. The sector is a significant provider of raw materials for most industries as well as provides a market for goods produced in the industrial sector (FAO, 2011a; Blein *et al*., 2013; Wanjala, 2014). Moreover, it is one way through which most African countries earn foreign exchange through agricultural exports. Most agriculture in Africa is carried out by small-scale farmers, of which the majority are women who depend on it for their livelihoods (Gollin, 2014). Small-scale farming is labor intensive and tends to rely much on family labor and women form the largest proportion of family labor. For example, in Kenya, they provide 43% of the total agricultural labor force (SIDA, 2015). Thus, small-scale farmers feed the majority of the population not only in Africa but in the whole world.

The process of globalization and industrialization has generated opportunities for small-scale farmers to produce a variety of commercial crops, however, there is a high possibility that market integration, globalization and agro-industrialization will leave out these small-scale farmers from high-value markets (Baloyi, 2010). Despite the imperative role played by small-scale agriculture in Africa, the sector faces a lot of challenges. The key long-standing challenge of small-scale farmers is low productivity instigated by limited access to land, extension services, credit, technology and markets intensified by the volatile food and energy prices and lately by the global financial crisis (Salami *et al*., 2010; Gollin, 2014). Limited access to land is one of the major challenges experienced by small-scale farmers especially those situated in densely populated areas (Muyanga, 2013). This challenge is more pronounced among women farmers than men since in most African countries access to land is governed by discriminatory customary laws which tend to favor men (Cotula, 2011; Croppenstedt *et al*., 2013). This eventually affects agriculture in an economy since access to land is the basis of all human

activities and a vital factor in the attainment of gender equity, poverty reduction and economic growth.

Extension services in the agricultural sector play a crucial role in disseminating agricultural information, knowledge and technology along with hooking up farmers especially small-scale farmers with other players in the agricultural value chain (Pan *et al*., 2016). However, there is limited access to extension services in most African countries leading to a high ratio of extension officer to farmers (Kassie *et al*., 2014). Limited access to the market is also a major challenge faced by farmers. If farmers are unable to access markets then it is difficult for them to take part in formal market activities (Mpandeli and Maponya, 2014). Climate change is also affecting most of the small-scale farmers in Africa since they rely heavily on rain-fed agriculture (Frank and Buckley, 2012). Therefore, the changing and unpredictable rainy seasons have greatly affected their farm productivity and the ability to plan their agricultural activities. In Africa, it is estimated that 60% of economically active women depend on agriculture as their source of living and thus, they are in the frontline of the impacts of climate change in their endeavor to feed their families, communities and their countries (Oxfam, 2015).

Other challenges faced by small-scale farmers in Africa include poor infrastructure, pests and diseases, inadequate inputs and soil nutrients deterioration (Kibet, 2014). The above challenges, coupled with increasing population growth and urbanization implies that the sector may be hampered in generating sufficient food for the Kenyan population and Africa in general (Kirimi *et al*., 2013; Muyanga, 2013). The list of challenges faced by small-scale farmers in Africa is not exhaustive. However, most of these challenges can be solved if valuable advisory and extension services are rendered to farmers as well as if the governments get involved in improving infrastructures, underpinning research, extension and training as well as enhancing access to affordable inputs and credit (Kibet, 2014).

2.2 Small-scale land access in Africa

A key policy concern in all developing countries in the whole world for the past half-century is the reduction of poverty and food insecurity issues. Development agencies, Governments and Non-governmental Organizations have tried a series of alternative strategies in order to address poverty as well as food insecurity issues, nevertheless, this issues still remains pervasive in developing countries (Muyanga, 2013). In Africa, as in many parts of the world, poverty is indistinguishably related to lack of factors of production, especially land. Access to

land is a key prerequisite for agriculture and control over land is closely associated with status, power and wealth in many areas (FAO, 2011a). It remains as a fundamental asset in African rural areas since agriculture in this areas is seen as the main source of living and a critical input to a household's welfare function (Gyau *et al*., 2014; Muraoka *et al*., 2014; Wanjala, 2014; Fisher and Naidoo, 2016). According to Khalid *et al*. (2015), land access means that a person is in a position to utilize and control a piece of land comfortably and thus does not automatically imply ownership.

Females in most developing countries especially in African countries own or have access to considerably less land than their male counterparts (Kassie *et al*, 2014; Doss *et al*., 2015; Lambrecht, 2016). Nevertheless, as farmers as well as caregivers and through their provision of labor in agricultural-related enterprises, household farms and other farms, women make fundamental contributions to agriculture and household nutrition in developing countries. They contribute about 43 percent of the total agricultural labor force in most developing countries, that is, approximately 20 percent in Latin America to about 50 percent in Sub-Saharan Africa, Eastern and Southeastern Asia (FAO, 2011a; Croppenstedt *et al*., 2013). In Kenya, as in most other developing countries in Africa, women land access and land rights have been affected by a combination of customary laws, previous colonial policies and post-independence land reforms (Gyau *et al*., 2014).

In Ghana, about 80% of the total arable land is approximated to be under customary custody, where this land is usually controlled by extended families which are either the traditional head of the lineage or clan or family head (Lambrecht, 2016). Whereas in Cameroon, land access, ownership and rights have been affected by customary laws and practices as well as previous colonial policies (Puepi, 2010; Gyau *et* al., 2014). Tenaw *et al*. (2009) found that land in Ethiopia is a public property, thus, most of the small-scale farmers in Ethiopia face the problem of tenure insecurity, unequal access to land between males and females and lack of mechanisms of transferring and consolidating fragmented pieces of land. In Uganda, 75% of the agricultural land is being held under customary tenure. In most parts of Uganda, customary law is the crucial determinant of women's access to land (FAO, 2011a; Garber, 2013). Therefore, in this country, families but not individuals act as the custodian of land for present and future generations and women tend to access land through inheritance or donations. However, women access to land depend on individual families (Garber, 2013). Therefore, land access in most African countries is governed by customary laws in collaboration with statutory laws.

Inheritance is another way through which most small-scale women farmers acquire land and it is a critical public policy in most developing countries especially in Africa continent. It has mainly been characterized as an economic and a human rights issue which predominantly focuses on the content of alleged land rights and family laws (Cooper, 2012). Furthermore, land markets have become active in Africa and it is one of the ways through which small-scale farmers can access land (Holden and Otsuka, 2014; Lambrecht 2016). However, increasing land shortage has led to increased incidences of deceitful and fake land transactions due to lack of/defectively drawn land lease and sale agreements and production of fake land title deeds. This subsequently increases transaction costs incurred by concerned parties in the land markets.

2.3 Women land access in Kenya

Agriculture is the mainstay of most economies in developing countries, however, it is underperforming because of a number of reasons. One of the reasons is that women have limited access to opportunities and productive resources especially land which hinders them from making the most constructive use of their time and energy (FAO, 2011a; Ndiritu *et al*., 2014). According to 2008 global report by the Commission on Legal Empowerment for the Poor, limited as well as insecure access to land were highlighted as the key causes of recurrent poverty and impediment to development. Gendered access and control of productive resources have been more pronounced in developing countries where men have more control over user rights than women.

Accumulating evidence from most developing countries, for instance in Africa and South Asia has substantiated that women are underprivileged in recent customary as well as statutory land tenure schemes (Deere *et al*., 2012; Kieran *et al*., 2015; Sproule *et al*., 2015). Gendered customary institutions, norms, beliefs and views tend to hinder equal access to land among men and women in Kenya. This is despite the fact that women constitute 55% of total population of Kenya and providing 70% and 89% of cash crop and subsistence farming labor force respectively (Wanjala, 2014; Frosina and Mwaura, 2016). The inadequate user and control rights among women limit their productive potential and reduce their contributions to the agricultural sector in general and to the realization of more extensive social as well as economic development goals (FAO, 2011a; World Bank, 2012).

In the 2015 Global Gender Gap report, Kenya had a score of 0.719 in terms of gender equality, where 1.0 represent full equality and was ranked 48 out of 145 countries. This report points out

that there is still room for improvement in terms of gender equality in the country (WEF, 2015). Over the last decades, Kenya's policy together with the legal framework relating to women's rights and gender equality has been eradicating gender-based discrimination and promoting gender equality with the passing of new policies and laws. These guarantees are noticeably included in both vision 2030 and the 2010 Kenyan constitution (Frosina and Mwaura, 2016). In the Kenyan constitution, there are several provisions meant to promote women rights as well as gender equality in the country. They include the Matrimonial Property Act, 2013; Marriage Act, 2014; Land Registration Act, 2013 and the Land Act, 2012 among others (Gaafar, 2014). Furthermore, land policy principles in the Constitution of Kenya talks of equitable access to land, secure land rights, elimination of all forms of gender injustices in law and customs related to land, other resources and property. However, gendered land access is still pervasive in Kenya.

In terms of land title deeds, women hold only 5% jointly with men and only 1% is held by women alone (FAO, 2011a). Thus, male-headed households have a higher possibility of owning massive tracts of land than female-headed households (Croppenstedt *et al*., 2013). Women have only user rights through their affiliation with a male relative (Kassie *et al*., 2014; Wanjala, 2014). This situation is exacerbated by the interaction of legal rights and gendered social norms, which are discriminatory and obstructs women access to land (Cotula, 2011; Anukriti, 2014; Mishra and Sam, 2016). The overwhelming effects of property rights infringements including violence, food insecurity issues, poverty and homelessness normally harm especially women, their children and the economy in general. The discriminative practices persist despite the efforts put across by women groups, for instance, Federation of Women Lawyers (FIDA) which is often supported by development organizations in aligning these customary laws with principles of non-discrimination engraved in most countries' constitutions (Pedersen and Haule, 2013; Spichiger and Kabala, 2014).

Women usually face constraints in expanding their subsistence agricultural production to a commercial level owing to lack of resources especially land and other productive resources, high-quality inputs, credit and also lack of adequate know-how of improved farming practices and technologies. (Meinzen-dick *et al*., 2010; FAO 2011a; Kassie *et al*., 2014; Wanjala, 2014). Women may have access to land but at the same time lack control over it and this may hinder them from using that land as a form of collateral especially for financing agricultural activities as well as start-up businesses. This is notwithstanding the fact that women play a fundamental

role in small-scale livelihoods regardless of whether they are household heads or not since they have a tendency of spending a considerable part of their revenue on household food requirements. Therefore, improving women's bargaining power, status and influence as one way of empowering them in the household and society would entail safeguarding and strengthening of their land rights (Wanjala, 2014). For women to have full access to land there is a need to change some customary laws and increase gender balance within the national land legislation. Without paying specific attention to gender inclusiveness in land access, important segments of society may be excluded from the benefits that accrue to land administration, management and development schemes (FAO, 2011a).

2.4 Gender and household nutrition outcomes among small-scale farmers

Global food security crisis has been intensified by rapid population growth, increasing global food prices, urbanization and increasing demand for agricultural land (Muraoka *et al*., 2014). Regardless of the substantial efforts by various national governments, development partners and other Non-governmental organizations (NGOs) to mitigate food insecurity problems and enhance household nutrition status over the years, food insecurity problems are yet persistent in the world. A considerable proportion of the world's population, that is about 795 million people, who are mostly small-scale farmers are incapable of meeting their daily food needs (FAO, 2015). Undernutrition is a major food problem that is still persistent in almost all the world's poorest countries and particularly affects women of child-bearing age and infants. In Kenya, undernutrition contributes to an estimated one-third of all deaths to children under 5 years (USAID, 2014). Moreover, according to NCPD (2013), almost a third of the Kenyan population are food and nutritional insecure. The country's food security is often attributed to the performance of the agricultural sector and thus, agricultural development is seen as the main pathway to contribute towards food and nutrition security (Verhart *et al*., 2015). Therefore, agriculture is expected to deliver accessible, affordable and nutritious diet for all without doing any nutritional harm.

Gender has been identified as the key element in the linkage between agriculture and nutrition (FAO, 2012). Lambrecht (2016) termed gender as basically a social construct, which is founded past the boundaries of individual households. It refers to the social responsibilities and characteristics related to what it entails to be a man or a woman. According to FAO (2011a), gender roles are influenced by social, economic, ideological, tribal, religious and cultural factors which are crucial features in the allocation of resources and obligations between men

and women. SOFA (2011) found that in Africa, women produce a higher percentage of food (about 80%) consumed in the continent yet they utilize and control only 1% of the total agricultural land. Enhancing women's access to land is therefore essential in the development of the agricultural sector and African economies in general (Odeny, 2013). In developing countries, female-headed households continue to increase at a higher rate. Some of the main causes of the increase in the number of female-headed households include; male migration due to work, deaths of male household heads, family conflicts and troubles leading to divorce, women remaining single, increased empowerment of rural women and changes in women's roles. This has increased the importance of women as sole decision makers as well as breadwinners for their households (Kassie *et al*., 2014).

According to recent statistics, South Africa has the highest numbers of female-headed households which are estimated to be about 41.9%. It is relatively high compared to a range of 9.5% to 22.9% in West Africa and 24.4% to 29.5% in East Africa (World Bank, 2012). Food insecurity in South Africa is more pronounced in female-headed than in male-headed small-scale households (Tibesigwa and Visser, 2016). Statistics show that in South Africa, 45.6% of the population is food secure whereas 26% are really food insecure and 28.3% are at risk of hunger (Shisana *et al*., 2014; Tibesigwa and Visser, 2016). A recent study by Kassie *et al*. (2014), in which the relation between food security and gender in rural Kenya was measured, it was found that households with female heads are more susceptible than households with the male being the household head. Further, Babatunde *et al*. (2008) conducted almost a similar study in Nigeria and found that households with female heads were certainly more susceptible than their male-headed households counterparts. Tibesigwa *et al*. (2015) also found that rural agriculture contributes a lot to food security among small-scale farmers especially in female-headed households in South Africa. Linkages between gender and nutrition are vital and act through distinct pathways, thereby offering multiple opportunities for synergy (FAO, 2012).

2.5 Measurement of nutritional outcomes

There are several methods that can be used to measure the nutritional outcome of a household. The nutritional outcome of a household can be measured in terms of dietary diversity. According to Potts and Sealey-Potts (2014), dietary diversity consists of the total number of foods groups consumed by an individual or a household over a reference period. Thus, it is used comprehensively as a method for determining the food variety and nutrient sufficiency of various diets. Methods used to measure dietary diversity include: Energy density score (EDS), recommendation compliance index (RCI), Quantitative index of dietary diversity

(QUANTIDD), household dietary diversity scores (HDDS), food consumption scores (FCS) and Healthy Food Diversity (HFD)-Index among others. EDS measures energy density by calculating the ratio of total energy consumed to the daily weight of total food consumed in kcal/g, based on all foods and beverages apart from drinking water (Alkerwi *et al*., 2015; Sibhatu *et al*., 2015). RCI comprise of 13 food-based and nutrient-based components where a higher degree of observance to suggested intakes results in higher scores (Alkerwi *et al*., 2015). QUANTIDD uses a certain formula to measure dietary diversity by measuring the quantity of food consumed or energy intake within the reference period.

HDDS and FCS are used to measure dietary diversity by determining the number of different food groups contributing to the diet of an individual or household over a reference period. The food groups that are normally considered under HDDS are as follows: cereals, vegetables, root and tubers, meat, eggs, poultry and offal, fish, pulses/legumes/nuts, fruits, milk and milk products, oil/fats, sugar/honey and condiments. Therefore, scores range between 0-12 (Swindale and Bilinsky, 2006; FAO, 2011b; Kennedy *et al*., 2011). There are eight food groups in FCS with different pre-determined weights, they include cereals and tubers, pulses, milk, meat and fish, vegetables, sugar, fruits and oil/fats (WFP, 2008).

In this study, HDDS was used because it reflects better if a diet is quality since the number of different food groups consumed is calculated rather than the number of different foods consumed. Knowing that a household consumed, for example, an average of four different food groups implies that their diets offer some diversity in both macro- and micronutrients and thus their nutritional outcome is enhanced. Therefore, HDDS is a more meaningful indicator of household nutritional outcomes in terms of household dietary diversity than knowing that households consume different foods, which might all be cereals. Moreover, HDDS measures dietary diversity objectively and is suitable for statistical handling (Kant, 1996; Katanoda *et al*., 2006; FAO, 2011b; Jones *et al*., 2014). Household Hunger Scale Scores (HHS) was also applied in this study to crosscheck the results of HDDS and it is normally used to measure household nutritional status by determining the hunger in the household through asking occurrence and frequency of occurrence questions for a period of 30 days (Ballard *et al*., (2011).

2.6 Theoretical and conceptual framework

2.6.1 Theoretical framework

2.6.1.1 Unitary model

This study was informed by household economic theory. The theory tries to capture complex structures of households and their behavior. It assumes a household as a rational individual who is a producer and a consumer at the same time. There are two methods used to model household behavior, that is, the unitary model and collective model. First, the unitary model is similarly known as the common preferences model and was developed by Becker in 1965. In this model, a household is assumed to act as one and have common preferences. It merges goods purchased from the market, own produced goods and time to create utility for the household. This assumption requires that at least the household head is involved in making all the resource distribution decisions. According to Beninger and Laisney (2002), the unitary model assumes that the household maximizes a unique utility function and there is pooling of all family revenues. In this model, the allocations are inferred from the maximization of a utility function under time and budget constraints as follows;

$$Max U_i\left(C_w, L_w, C_h, L_h\right) \quad \ldots\ldots (1)$$

But $C_w + C_h \le g\left(L_w, L_h, W_w, W_h, Y\right),$

$$0 \le T - L_i \le H \forall i = w, h. \quad \ldots\ldots (2)$$

Where U_i, C_i, L_i, W_i, Y, H and T stand for utility, consumption, leisure, wage rate, earned income, work time in a week and the total time in a week respectively. Whereas, $i = w, h$ represent wife and husband respectively. One of the advantages of the unitary model is that it is relatively simple to analyze the effect of changes in policy on a single agent's behavior. However, with this unitary model, the intra-household distribution of resources is of no importance since a household is treated as an individual. Nevertheless, the question of intra-household redistribution of incomes can be central in determining household choices. Thus, collective models can be used to solve that.

2.6.1.2 Collective model

According to Chiappori (1992) and Browning and Chiappori (1998), collective models also known as pluralistic decision-making models, concentrate on the individuality of household

members by relaxing the assumption of aggregated preferences of household members. It thus describes a household as a group of individuals who are described by particular preferences and among whom a joint decision-making process takes place. The model encompasses some factors that may not be captured in a unitary model of household behavior, for example, how the increase in income of one of the household members, for instance, the woman, affect the well-being or food consumption of other members. It can also illustrate the influence of external factors like socio-economic and institutional factors, on household behavior (Phipps and Burton, 1992). By assuming Pareto optimality allocation of resources, consumption choices of individuals are derived. Thus, in a household, individuals' preferences are treated as egoistic (that is each person's utility, either the wife or the husband, is only defined by own leisure and consumption).

$$Max U_w(C_w, L_w) + \lambda(.) U_h(C_h, L_h) \quad \text{..... (3)}$$

$$C_w + C_h \leq g(L_w, L_h, W_w, W_h, Y),$$

$$0 \leq T - L_i \leq H \forall i = w, h \quad \text{..... (4)}$$

Where $\lambda(.) = \lambda(W_w, W_h, Y)$ represents the proportional weight of the husband or wife since their utility are estimated differently. Therefore, consumption depends on the household's income, whether off-farm income or on-farm income. Farming income depends on whether a farmer has access to land since land is a fundamental factor in agricultural production (FAO, 2011a; Wanjala, 2014). The advantage of the collective model is that it takes into consideration the intra-household and inter-household relations and the way these relations are defined in terms of gender. In general, the model evaluates how resources are allocated in and among different households. From both models, if small-scale farmers whether male or female have access to land, their consumption as a household as well as their incomes are expected to change and this consequently changes their household nutritional outcomes.

Therefore, this study was based on the collective model which is one of the approaches of modeling household behavior under household economic theory. This because collective models concentrate on the individuality of household members by relaxing the assumption of aggregated preferences of household members. For instance, the aim of this study was to evaluate the effects of women access to land on household nutritional outcomes.

2.6.2 Conceptual framework

The framework is operationalized as shown in Figure 1, which shows the interaction of various socio-economic and institutional variables that were deemed to have an influence on women access to land and household nutritional outcomes among small-scale farmers. Small-scale women farmers have distinct socio-economic characteristics which include: Age, spousal age gap, schooling years, household size, household farm size, off-farm income, remittances as well as the value of agricultural asset owned by the woman among others. These factors have some influence on women access to land as well as household nutritional outcomes. Institutional factors which include: credit access, market distance, women social influence and the number of contacts with extension services providers also have some effects on women access to land and household nutrition. Intervening variables like customary laws and land policies also influence women access to land. However, when a woman farmer has access to land, the household farm production is expected to change, provided she has access to adequate inputs, soils are fertile and the climate is favorable. Improved farm production leads to changes in household farming income which eventually leads to changes in household nutritional outcomes.

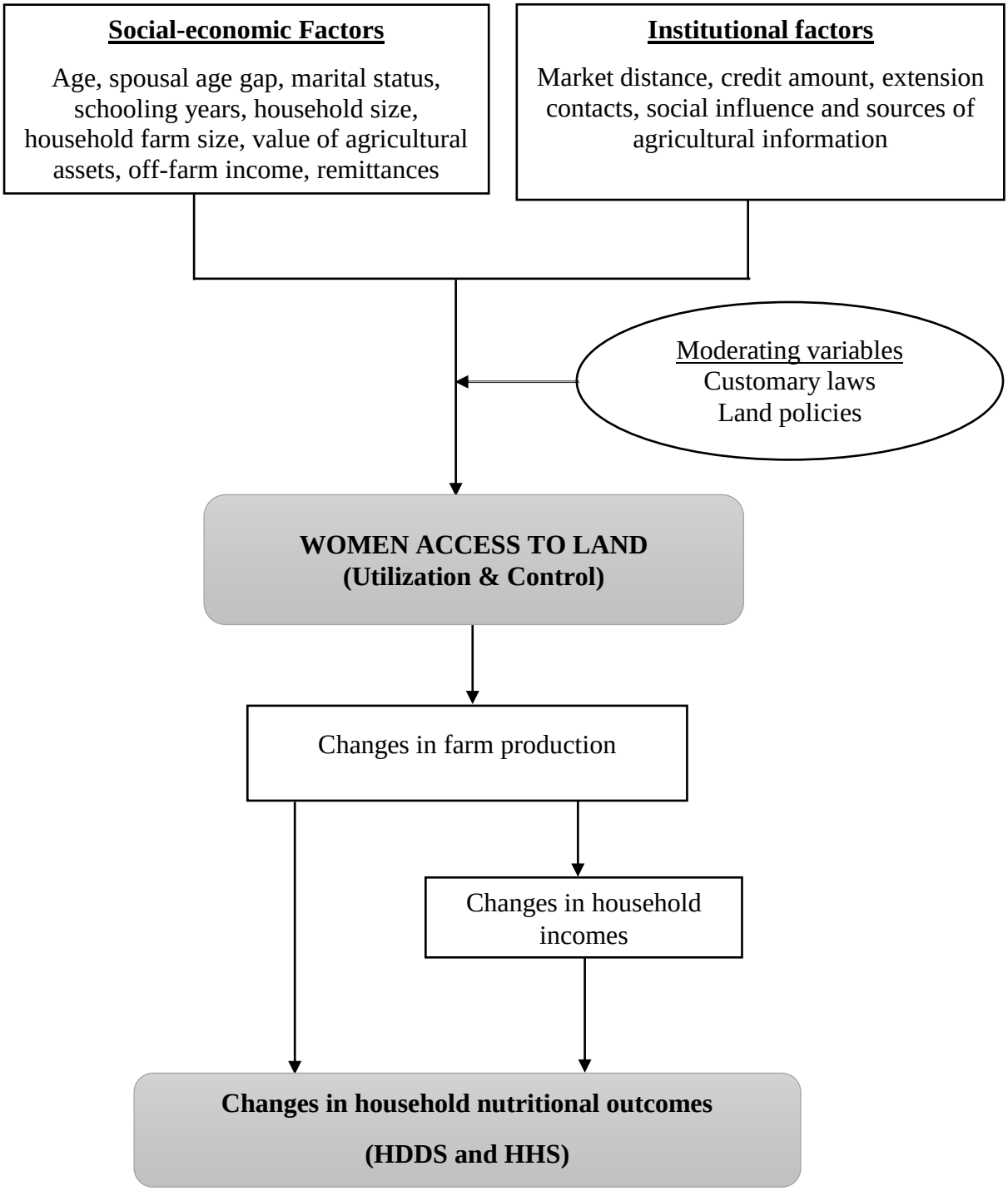


Figure 1: A conceptual framework on the effect of women access to land on household nutritional outcomes

CHAPTER THREE
METHODOLOGY

3.1 Study area

The study was carried out in Machakos County, Kenya. This is because it is among one of the counties that is semi-arid and has had frequent food security problems. Moreover, according to Machakos county integrated development plan 2013-2017, the absolute poverty in the county is at a rate of 60.7% and contribution about 4.7% to national poverty (GoK, 2013). The County has distinctive geographical and physical features which include; stand-alone hills and a small plateau found in the central part of the county and rising to about 1800-2100m above sea level. However, it has a huge plateau elevated to about 1700m in the West. The County is elevated to a height of 790 to 1594 m above sea level and the whole county covers an area of 6208.2 Km^2 and is divided into eight sub-counties namely: Mavoko, Kathiani, Machakos, Matungulu, Yatta, Masinga, Mwala, and Kangundo. The County experiences average annual temperatures that vary between 18˚C and 29˚C during the year. The average annual rainfall is unreliable and unevenly distributed and ranges between 500 mm and 1300 mm (GoK, 2013). The county experiences both long and short rains. Long rains are usually anticipated in the months of March to May, which is eventually followed by a cold season usually during July. The short rains fall between the months of October and December. Therefore, the County does not receive rainfall throughout the year which means that there are months that it experiences dry spells and these months are mostly January, February, August and September.

The erratic and unpredictable rains are conducive for growing cash crops like mangoes, avocados and pineapples. The main food crops grown are maize, beans, pumpkins, pigeon peas and cassava. A large number of the small-scale farmers in this county rely on rain-fed agriculture due to the unreliability of the rain and this results to low agricultural production, which eventually leads to food security problems in most part of the county (KNBS, 2016). Livestock rearing which is done in open fields is also a major economic activity in most parts of the County with small-scale farmers engaging mostly in goat farming, sheep rearing, beef production, poultry keeping as well as bee farming. According to the 2009 Kenya Population and Housing Census, the county has a population of 1,098,584 people with an average population of 188 persons per Square Kilometer. The map of the study area is as shown in Figure 2.

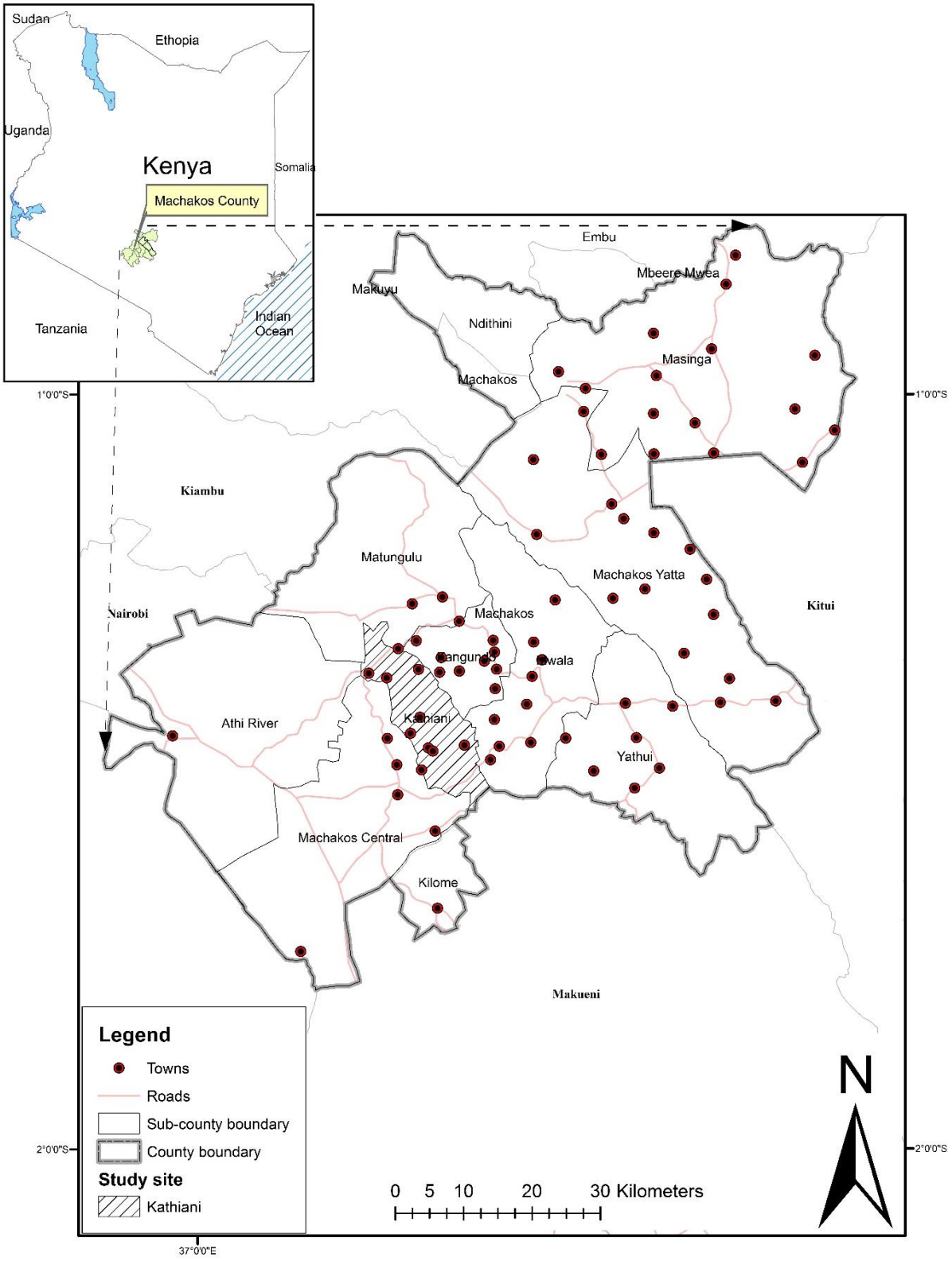


Figure 2: Map of Machakos County

Source: World Resource Center, 2017

3.2 Sample size determination

The required sample size was determined according to the sample size formula proposed by Kothari (2004), which is as follows;

$$n = \frac{\left(Z^2 pq\right)}{e^2} \quad \text{..... (5)}$$

Where; n = Sample size; Z is confidence level; p was the proportion of the population of interest, that is, small-scale women farmers in Machakos County. q was the weighting variable and it was computed as (1-p) and e was the allowable error. p was 0.5 since statistically, a proportion of 0.5 results in a sufficient and reliable size particularly when the population proportion is not known with certainty. This led to a q of 0.5. An error of less than 10% is usually acceptable according to Kothari (2004). Thus, an error of 0.05 was used to approximate the sample size. This formula resulted to a sample population of 384 respondents.

3.3 Sampling procedure

The target population was small-scale women farmers from Machakos County and multi-stage sampling procedure was used to select the respondents. First, one Sub-County that is, Kathiani was purposively selected since a larger part of this Sub-County is semi-arid and thus experiences food security problems. Then, random selection of two wards, that is, Kathiani Central and Mitaboni was carried out. Subsequently, 3 sub-locations in Mitaboni ward and 2 sub-locations in Kathiani central ward were randomly selected. Finally, using household lists obtained from Sub-County agricultural offices and some from village elders, systematic random sampling was used to select 77 households with women farmers per sub-location with the help of local extension officers and village elders. In total, 384 small-scale women farmers were interviewed. In the case of non-responses from the selected women farmers, replacement was done using the household lists.

3.4 Data collection and analysis

The study used primary data which was collected from the sampled small-scale women farmers by use of a semi-structured questionnaire (Appendix I) which was administered by well-trained enumerators. Before the actual data collection process, a pilot study was carried out to determine the suitability and validity of the questionnaire. Data collected was then cleaned, organized and analyzed using SPSS (version 20) and STATA (version 14) software.

3.5 Analytical framework

Objective 1: To determine the relationship between women access to land and the choice of farm enterprises among small-scale women farmers

Chi-square test was used to analyze this objective. It involved determining if there existed any significant relationship between women access to land and the choice of farm enterprises among small-scale women farmers in Machakos County. A table showing the cross-tabulation of a dummy variable (access to land) versus the different farm enterprises carried out by women was presented.

Objective 2: To determine the effect of socio-economic and institutional factors on women access to land and the extent of access to land among small-scale women farmers

The second objective was analyzed using a double hurdle model (DH). Two-step Heckman model could also be used to analyze this objective because a certain proportion of women did not have access to land. Nevertheless, the Heckman model is designed to be used in the situation where there is incidental truncation, that is, the situation in which the zeros are unobserved values (Wooldridge, 2002). In this study, a corner solution model appears to be more suitable than a selection model provided that the zero values are actually observed. Women who did not have access to land can be assumed to do so deliberately so that the observed values exemplify rational choices rather than censored zeros. Tobit regression is a common model used to estimate corner solution models. However, the Tobit regression model is restrictive in nature, as it supposes that the decisions to access land and the size of land accessed are determined by the same process. Therefore, a more flexible model for this study was the double-hurdle model which was proposed by Cragg (1971). The approach allowed application of the empirical model to study (i) whether or not a farmer has access to land (a dichotomous choice) and (ii) the extent of access to land among women farmers.

In this study, it was expected that some women farmers will not have access to land given the operational definition of land access in terms of user rights and control rights, thereby leading to some observations being zero. Hence, a truncated normal regression model was used in the second hurdle. The DH model was originally formulated by Cragg (1971) and applied in many studies including; Yen and Jones (1997), Newnan *et al.* (2003), Eakins (2016) and Hazarika *et al*. (2016). The first hurdle corresponded to factors affecting women access to land and the second hurdle determined the extent of access to land. The two hurdles used socio-economic and institutional factors as the independent variables. A different latent variable was used to

model each step in the double-hurdle model, with the probit model determining the probability that a farmer has access to land in the first hurdle and then a truncated normal regression model determining the extent of land access in the second hurdle. Eakins (2016) specified the model as follows;

$y_{i1}^{*} = W_i\alpha + \mu_i$ Access to land or not

$y_{i2}^{*} = X_i\beta + v_i$ Extent of land access

$y_i = X_i\beta + v_i$ If $y^{*}_{i1} > 0$ and $y^{*}_{i2} > 0$…… (6)

$y_i = 0$ Otherwise

Where y_{i1}^{*} is a latent variable describing whether the farmer has access to land or not and y_{i2}^{*} is a latent variable describing the extent of land access and y^{*} is the size of land that is accessed by a woman (or dependent variable) while μ_i and v_i are the respective error terms following a normal distribution and assumed to be independent, $U_i \sim N(0, 1)$ and $v_i \sim N(0, \partial^{2})$. Carroll *et al.* (2005) estimated the model using the maximum likelihood as follows;

$$L(\alpha, \beta, \sigma^2) = \prod_0 \left[1 - \Phi(w_i'\alpha)\Phi\left(\frac{x_i'\beta}{\sigma}\right)\right] \times \prod_1 \left[\Phi(w_i'\alpha)\sigma^{-1}\phi\left(\frac{y_i - x_i'\beta}{\sigma}\right)\right] \quad \text{..... (7)}$$

Where Φ and ϕ are the standard normal cumulative distribution function and density function respectively. It should be noted that the Tobit is nested in the double hurdle model. Therefore, a likelihood ratio (LR) test was used to determine whether a Tobit or a more flexible double hurdle model specification was actually preferable in this study. The log-likelihood of the whole DH model comprised of the summation of the log-likelihood values estimated in the first hurdle by the probit model and second hurdle by the truncated normal regression model.

To assess the impact of regressors on the extent of access to land, it was essential to analyze the partial effects of the significant variables. According to Mutlu and Gracia (2006), the probability of having access to land for each individual woman was estimated as follows;

$$P[y_i > 0/x] = \Phi\left(\frac{x_i\beta}{\sigma_i}\right) \quad \text{..... (8)}$$

While the conditional expected size of land accessed was estimated as follows;

$$E[y_i / y_i > 0, x] = x_i\beta + \sigma_i \left(\frac{\phi\left(\frac{x_i\beta}{\sigma_i}\right)}{\Phi\left(\frac{x_i\beta}{\sigma_i}\right)} \right) \text{..... (9)}$$

Similarly, the unconditional expected size of land accessed was estimated as follows;

$$E[y_i / x] = P[y_i > 0/x] * E[y_i / x, y_i > 0] \text{..... (10)}$$

The conditional expectation and the probability of a positive value of y_i are estimated by decomposing the unconditional expectation. The partial effect of each independent variable was estimated following procedures as proposed by Burke (2009). Equation (8) was used to estimate the partial effect on the probability that $y > 0$ (APE). While differentiating equation (9) with respect to each explanatory variable, yielded the average effects on the extent of women access to land conditional on a woman farmer having access to land (CAPE). To calculate the partial effect on the unconditional expected value of y (UAPE), equation (10) was differentiated with respect to relevant explanatory variables. Description of variables that were used in the double hurdle model are presented in Table 1 and were derived from previous related studies (Menale *et al*., 2010; Jin and Jayne, 2013; Kirimi *et al*., 2013; Wiig, 2013; Jones *et al*., 2014; Kassie *et al*., 2014; Menon *et al*., 2014; Muraoka *et al*., 2014; Ndiritu *et al*., 2014; Odoemelam *et al*., 2014; Carletto *et al*., 2015; Baloch and Thapa, 2016; Mishra and Sam, 2016; Adam *et al*., 2017).

Table 1: Description of variables used in the Double Hurdle model

Variables	Description of the variables	Expected sign
Dependent Variables		
Access	Whether a woman has access to land or not (dummy).	
Extent of access to land	Size of land accessed by women (Acres).	
Independent Variables		
Wmnage	Age of the woman (years).	+
Spseagegap	Age gap of married couples (years).	+
Wmrtalstatus	Woman marital status 1=married 0=otherwise (single, divorced, deceased)	+/-
Wmnschngyrs	The education level of the woman (Schooling years)	+
Hhsize	The number of household members in the household.	+/-
Hfmsize	Household farm size (acres).	+
Wmnassts	Value of assets that the woman owns/controls (KES).	+
Offincm	Woman non-farming income derived from other sources apart from farming (KES).	+
Wremttnces	Amount of remittance received by the woman in the last one year (KES)	+
Distmrkt	Proximity to the nearest input/output market (Walking minutes).	+/-
Creditamnt	The amount of credit borrowed in the last 3 years (KES).	+
Exten	The number of contacts with extension service providers in a year (continuous).	+
Sinfluence	It will be estimated using statements with Likert scale. 1=strongly disagree, 2=Disagree, 3=Neutral, 4=Agree and 5=strongly agree	+/-
Sagrinfo	***Sources of agricultural information***	
Other farmers	Dummy=1 if the woman got information from fellow farmers, 0 otherwise	+/-
Farmers' groups	Dummy=1 if the woman got information from a farmers' group, 0 otherwise	+/-
Extension agents	Dummy=1 if the woman got information from extension agents (government/private) , 0 otherwise	+/-

Objective three: To determine the effect of women access to land on household nutritional outcomes among small-scale farmers

The third objective on the effect of women access to land on household nutritional outcomes among small-scale farmers was analyzed using heterogeneous treatment effects model (HTE). Individuals are diverse not only in their background characteristics but also in how they respond to a specific treatment and that why it is vital to evaluate the heterogeneous effects of women access to land on household nutritional outcomes. This has made literature on impact methodology to recognize and allow for population heterogeneity in causal inferences (Xie *et al*., 2012). In this study, Household dietary diversity scores (HDDS) and Household hunger scales (HHS) were used to measure the nutritional outcomes of the selected households. HDDS measures dietary diversity based on the number of food groups consumed in a household as opposed to food items since they are more likely to accurately reflect the diversity of both micro and macronutrient intakes (Kennedy *et al*., 2011). Moreover, diets with more varieties of food groups are usually associated with greater nutrient and energy intakes (Kennedy *et al*., 2011; Jones *et al*., 2014). HHS is a household food deprivation scale. The scale consists of three occurrence questions and three frequency of occurrence questions which are used to develop household hunger scale scores which range between 0 and 6 (Ballard *et al*., 2011).

In this study, the population of interest was small-scale women farmers. This section presents the modeling that was used to determine the heterogeneity effects of women access to land on household nutritional outcomes (N) in order to understand the effect of women access to land on household nutritional outcomes. Therefore, women access to land is the treatment which is denoted by L where $L_i = 1$ if the i^{th} woman farmer had access to land and $L_i = 0$, if otherwise. Let N_{1i} and N_{0i} represent the household nutritional outcomes for households in which women had access to land and those in which women did not have access to land respectively. If treatment assignment is random, that is, if women access to land is random, the comparison of the treated and untreated groups would yield an estimate called the Average Treatment Effect (ATE):

$$ATE = E(N_1 - N_0) \quad \ldots\ldots (11)$$

Equation (11) is defined for the whole population but the interest of the study is to define the effects of women access to land for a subpopulation. Therefore, in order to determine how different subpopulation nutritional outcomes are affected by women access to land, two

quantities of interest were estimated. First, Treatment Effect of the Treated (TT) was calculated so as to determine the average difference of women access to land status among those individuals who were actually treated. This was given by;

$$TT = E\left(N_1 - N_0 \middle| L = 1\right) \quad (12)$$

Secondly, the average difference among farmers who did not have access to land, which is known as Treatment effect of the Untreated (TUT) was given by;

$$TUT = E\left(N_1 - N_0 \middle| L = 0\right) \quad (13)$$

According to Brand and Xie (2010), if the effects of women access to land are homogeneous across households, then ATE, TT and TUT values would be identical. A difference in these three quantities is an indication of heterogeneity in the effects of women access to land. However, ATE, TT and TUT statistics "ignores' the heterogeneity within group among farmers. Hence, there was a need to establish group level comparisons to determine group level causal inference. However, due to population heterogeneity as a result of contextual and socio-economic conditions, there was no guarantee that the group of women farmers who had access to land and that of those who did not have access to land were comparable. Thus, women access to land faces a problem of self-selection problem. This is caused by differences in their background characteristics coupled with benefits associated with having access to land (Xie *et al*., 2012).

Using equation (11) to determine causal inference, ATE statistic results in two sources of bias. First is the "pretreatment heterogeneity bias" or "endogeneity", which is the average difference occurring in cases where women have no access to land because of unobserved factors correlated with women access to land. Second is the "treatment effect heterogeneity bias", which is the difference between households in which women have access to land and those in which women did not have access to land (TT-TUT) (Brand and Xie, 2010; Xie *et al*., 2012). To draw a causal inference of women access to land on household nutritional outcomes, it was necessary to introduce the "strongly ignorable treatment assignment" assumption that has two implications (Brand and Xie, 2010). First, women access to land is independent of household nutritional outcomes given a number of covariates denoted by X such that $L \perp \left(N_0, N_1\right) \middle| X$ and second, that the probability of women having access to land for all values of X:

$0 < P(L = 1|X) < 1$ for all X is positive, as applied in other studies (Brand and Xie, 2010; Xie *et al*., 2012; Mutuc *et al*., 2013).

In the presence of heterogeneity, the following equation was estimated involving the two components of heterogeneous bias;

$$Yi = \alpha_i + \partial_i L_i + \beta' X_i + \upsilon_i \quad \text{……} \quad (14)$$

Where, α_i is the pretreatment heterogeneity, ∂_i is the treatment heterogeneity, β_i are the parameters to be estimated for covariates X_i and υ_i is the residual term. However, individual-level heterogeneity is unidentifiable since α_i and ∂_i are inseparable from υ_i without invoking the "ignorability" assumption. Nonetheless, since X is typically multidimensional, conditioning X is difficult because of the "curse of dimensionality" (Brand and Xie, 2010). This implies that increasing the number of characteristics used in matching households in which women had access to land with those in which women did not have access to land would lead to a reduction in the likelihood of finding an exact match. However, sometimes the inclusion of a relatively smaller number of characteristics can also result in farmers remaining unmatched (Mutuc *et al.,* 2013). The solution is to invoke the "ignorability" assumption, where Rosenbaum and Rubin (1983) found it sufficient conditioning the propensity score as a function of X. Propensity score is the likelihood of women having access to land given a set of covariates X (Brand and Xie, 2010) given by;

$$P = p(L_i = 1|X) \quad \text{……} \quad (15)$$

To evaluate heterogeneity in treatment effects of women access to land on household nutritional outcomes, equation (14) was decomposed to generate a non-parametric function of propensity scores and to reveal the pattern of access to land on household nutritional outcomes using a linear hierarchical model (Brand and Xie, 2010). Women were divided according to socio-economic and institutional characteristics, and then propensity scores determining the likelihood of women having access to land were predicted. Further, the determination of women propensity to access land which is associated with the variances in total household

nutritional outcomes was determined. To achieve this, two approaches proposed by Xie *et al.* (2012) were used; stratification multilevel (SM-HTE) and matching-smoothing (MS-HTE).

In stratification multilevel approach of estimating heterogeneous treatment effects, a probit regression model was estimated to predict propensity scores of women having access to land given a set of socio-economic and institutional characteristics. The women farmers were then grouped separately into balanced score strata at 1% significant level before estimating the effect of women access to land on the balanced propensity score strata (Level-1 slope) generated using ordinary least square regression model. Using the variance-weighted least squares regression, a linear trend of women access to land effect (treatment effect) across the propensity score strata was then generated (Level-2 slope).

Matching-smoothing (MS-HTE) overcomes two of the main weaknesses of the stratification multilevel (SM-THE). One of the weakness is the assumption of homogeneity within strata such that both all treated and untreated observations are considered interchangeable within a stratum. Secondly, the assumption of a linear trend in the pattern of treatment heterogeneity. In the matching-smoothing approach of estimating heterogeneous treatment effects; propensity scores were estimated and then matching was conducted based on propensity scores of women who had access to land (treated) and those who did not have access to land (control). Non-parametric smoothing method was then used to generate a graph of effects of women access to land as a function of the propensity scores. Propensity matching technique which was used in computing heterogeneity in effect of women access to land is critical in controlling for selection caused by observable women farmers' social, economic and institutional characteristics. Description of variables that were used in heterogeneous treatment effect analysis are presented in Table 2 and were derived from previous related studies (Brand and Xie, 2010; Xie *et al*., 2012; Mutuc *et al*., 2013; Jones *et al*., 2014; Kassie *et al*., 2014: Alkerwi *et al*., 2015; Sibhatu *et al*., 2015).

Table 2: Description of variables used in the heterogeneous treatment effects model

Variables	Description of the variables	Expected sign
Outcome variables		
HDDS	The nutritional outcome of a household measured using Household Dietary Diversity scores (HDDS).	
HHS	The nutritional outcome of a household measured using the Household Hunger Scale (HHS)	
Dependent variable		
Women access to land	Dummy variable of whether the woman has access to land or not	
Independent variables		
Wmnage	Age of the woman (years).	+
Spseagegap	Age gap of married couples (years).	+
Wmrtalstatus	Woman marital status 1=married 0= otherwise (single, divorced, deceased)	+/-
Wmnschngyrs	The education level of the woman (Schooling years)	+
Hhsize	The number of household members in the household.	+/-
Hfmsize	Household farm size (acres).	+
Wmnassts	Value of assets that the woman owns/controls (KES).	+
Offincm	Woman non-farming income derived from other sources apart from farming (KES).	+
wremttnces	Amount of remittance received by the woman in the last one year (KES)	+
Distmrkt	Proximity to the nearest input/output market (Walking minutes).	+/-
Creditamnt	The amount of credit borrowed in the last 3 years (KES).	+
Exten	The number of contacts with extension service providers in a year (continuous).	+
Sinfluence	It will be estimated using 7 statements with a Likert scale. 1=strongly disagree, 2=Disagree, 3=Neutral, 4=Agree and 5=strongly agree	+/-
Sagrinfo	***Sources of agricultural information***	
Other farmers	Dummy=1 if the woman got information from fellow farmers, 0 otherwise	+/-
Farmers group	Dummy=1 if the woman got information from a farmers' group, 0 otherwise	+/-
Extension agents	Dummy=1 if the woman got information from extension agents (government/private) , 0 otherwise	+/-

CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter is subdivided into three sections according to the three objectives of the study. The first section discusses the descriptive statistics comprising of women socio-economic and institutional factors. It also presents the results of whether there existed a significant relationship between women access to land and the choice of farm enterprises using *chi*-square statistics. The selected sample consisted of 69.4% of women who had access to land while 30.6% of the women did not have access to land. In the second section of the chapter, the empirical results of the double hurdle model on the effects of socio-economic and institutional characteristics on women access and the extent of access to land are discussed. The last section discusses the empirical results of a Heterogeneous Treatment Effects model (HTE) on the effect of women access to land on household nutritional outcomes.

4.1 Descriptive statistics

4.1.1. Women access to land and choice of farm enterprises

The results of a cross-tabulation of women access to land and the choice of farm enterprises are presented in Table 3. There was a significant relationship between women access to land and the choice of farm enterprises at 1% level. For the women who had access to land, a higher percentage (46.2%) were doing both food and livestock farming, however, none of them was doing cash crop farming only or cash crop and livestock farming. The remainder 53.8% of the farmers who had access to land were engaged in food crop, cash and food crop, livestock and food, cash and livestock farming. A large proportion (66.9%) of women who did not have access to land were doing livestock farming only because some livestock like poultry and small ruminants do not require one to have access to land.

Most of the women who had access to land were largely engaged in food crop and livestock farming because women are always concerned about their household food requirements. For livestock farming, Njuki and Sanginga (2014) concluded that they contribute a lot in the improvement of poor rural livelihoods by providing an alternative source of income and food thus keeping them away from experiencing poverty issues. This is because they are in most cases the only valuable asset women can possess and sell so as to cater for household emergencies and other family-related needs. FAO (2012) argues that women are more likely to concentrate more on food crops production for subsistence purposes and rearing livestock rather than cash crops since they are always concerned about their household nutrition.

Table 3: Cross-tabulation of women access to land and the choice of farm enterprises (%)

		Access to land				
Variable	**Description**	**No**	**Yes**	**Total count**	**Overall %**	***Chi*^{2} value**
Farm	None	33.1	0.0	39	10.2	374.84***
enterprises	Cash crop farming	0.0	0.0	0	0.0	
	Food crop farming	0.0	23.7	64	16.7	
	Cash and food crop farming	0.0	9.8	25	6.5	
	Livestock farming	66.9	0.8	81	21.1	
	Food crop and livestock farming	0.0	46.2	123	32.0	
	Food, cash and livestock farming	0.0	19.5	52	13.5	

Note: *** is significant at 1% level.

4.1.2 Socio-economic characteristics of women

Table 4 presents the results of marital status of the women. For women who were interviewed 81.8% were married whereas only 18.2 % were not married, that is, they were either single, divorced or deceased. There was a significant relationship between women access to land and their marital status at 1% level. In terms of marital status, a high proportion, that is, 64.3% of the women farmers who were married had access to land whereas 35.7 % of the women who did not have access to land were also married. However, for the majority of women, property ownership and access to land which is crucial for food production and sustainable means of living is reliant on natal and marital affiliations. Bettum (2014) and Kimanthi (2016) found that women access to land is closely defined by marriage and kinship ties and is generally determined by their marital status.

Table 4: Marital status of the small-scale women farmers (%)

		Access to land (%)				
Variables	**Description**	**No**	**Yes**	**Total count**	**Overall %**	***Chi*^{2} value**
Marital status	Married	35.7	64.3	314	81.8	19.74***
	Otherwise	8.6	91.4	70	18.2	
Total				384	100.0	

Note: *** is significant at 1% level.

Table 5 presents the results of mean age, spousal age gap, schooling years, household size, household farm size, off-farm income and women assets value. The average age of all sampled small-scale women farmers was 45 years but for women who had access to land it was 47 years while that of those who did not have access to land was 42 years. The t-test results indicated that there was a significant difference in the mean age of women farmers by access to land at 1% level. It shows that those women who had access to land had a higher mean age than those who did not have access to land. This may be because older women have more experience in terms of agriculture than younger ones and thus, they are aware of the benefits that come along with having access to land. Furthermore, this could be attributed to the unattractiveness of agricultural-related activities among young people. Afande *et al*. (2015) found that the average age of a farmer in Africa was about 60 years and this was because of non-attractiveness of agriculture to the youths who are supposed to replace the old farmers.

Table 5: Mean age, spousal age gap, schooling years, household size, household farm size, off-farm income and women assets value

Variables	**Access to land**		**No access to land**			
	Mean	**Std. Error**	**Mean**	**Std. Error**	**Overall mean**	**t-value**
Age	47.02	0.88	41.98	1.31	45.47	-3.181***
Spousal age gap	4.05	0.25	5.42	0.34	4.47	3.141***
Schooling years	9.37	0.24	9.19	0.29	9.32	-0.436
Household size	4.43	0.08	4.14	0.10	4.34	-2.071**
Household farm size	1.31	0.06	0.94	0.07	1.20	-3.544***
Value of agricultural assets	6001.99	420.42	4596.47	613.56	5570.09	-1.869*
Off-farm income	47080.62	3777.77	35685.59	5698.45	43579.09	-1.670*
Remittances	10953.67	1193.73	7410.84	1442.98	9864.98	-1.742*

Note: ***, **,* imply significant at 1%, 5% and 10% levels respectively. Std. Error stands for Standard Error.

The average age gap between spouses for all sampled women was 4.5 years whereas that of the women who had access to land was 4 years and for women who did not have access to land it was about 5.5 years. The difference in the age gap between the two groups was significant at

1%. Women who had access to land had a narrow age gap with their spouses as compared to their counterparts. This implies that women with a small age difference with their spouses have a higher possibility of having access to land than those with huge age differences. This is because women with spouses of almost the same age or have a narrow age gap tend to have the same reasoning capacity which may influence household decisions and eventually may have a positive influence on their access to land. However, a wider age gap between spouses makes women more vulnerable and in most cases deny them an opportunity to participate in household decision-making process thus giving men a chance to dominate when making key household decisions. Baba and Zain (2016) found that the wider the spousal age gap, the narrower the spousal communication which may affect women involvement in the household decision-making process.

All sampled households with small-scale women farmers had an average of 4 members. However, the households in which women had access to land had an average number of 5 household members while their counterparts had an average of 4 members and the difference was statistically significant at 5% level. Households in which women had access to land require more labor and thus more family members to carry out agricultural activities. Moreover, large households require more food and thus women in such households will tend to have access to more land so as to meet their household food requirements. This concurs with Seidu (2008) who pointed out that large households are better at providing free agricultural labor thus indicating the usefulness of larger households in improving farm efficiency.

The average household farm size for all sampled households was 1.2 acres. Nevertheless, the households where women had access to land had a relatively bigger size of land with an average of 1.31 acres compared to households in which women did not have access to land (0.94 acres). There was a significant difference in the mean of household farm sizes at 1% level. This implies that households, where women had access to land, had larger farm sizes than those households in which women did not have access to land. Households with larger tracts of land could be in a better position to give women land to farm than those households that have small pieces of land at their disposal.

The mean value of agricultural productive assets owned by all sampled women was KES 5,570. The mean value of agricultural productive assets owned by women who had access to land was at KES 5,985 while that of women who did not have access to land was at KES 4,596 and the

mean difference was significant at 10% level. Women who had access to land had more valuable assets than those who did not have access to land. The agricultural asset value is a proxy for wealth and thus women who had access to land were wealthier than their counterparts who did not have access to land. Thus, higher assets value improves women access to land. Also, women farmers who had access to land required more agricultural assets than those who do not have access to land. The higher value of productive assets among women who accessed land could be attributed to women farmers investing their farm proceeds into more income generating assets so as to improve their household incomes as well as their farm productivity.

The mean value of off-farm income earned by all women was KES 43, 579 but the mean value of off-farm income earned by women who had access to land was found to be KES 46,953 while that of women who did not have access to land was KES 35,686. The mean difference of off-farm income between the two groups was found to be significant at 10% level. Off-farm income consisted of income from off-farm employment, businesses and other incomes with the exception of farm income and remittances. Women who had access to land earned more off-farm income than those who did not have access to land. Off-farm income can be used as a source of capital for investment in commercial or subsistence farming. In addition, women participation in off-farm activities increases their bargaining power at the household level and this may have a positive influence on them having access to land. Moreover, participation in off-farm activities facilitates women exposure to information and knowledge, which could reduce the subjective opinion on the incapability of women being self-reliant (Rao and Qaim, 2011).

The average value of remittances received by sampled women was KES 9,865. However, the average value of remittances received by women who had access to land in the last one year was KES 11,095 while that of women who did not have access to land was KES 7,410. The average difference of the value of remittances received by the two groups of women was found to be significant at 1%. Remittances comprise of the money received by women from their relatives or friends either living in the country or abroad. This money can be used to acquire more land as well as required inputs for farming. Also, remittances can be used to fund other household expenditures, that is, food and non-food expenditures. Therefore, those women who receive more remittances have a higher possibility of having access to land. Coung (2009) who investigated the impact of internal and international remittances on the household welfare in

Vietnam found that internal remittances had a greater impact on non-food expenditures as compared to food expenditures whereas international remittances were chiefly used for investments and savings.

4.1.3 Institutional factors affecting women

Table 6 presents the results of the mean number of extension contacts, distance to the market and amount of credit. The women who had access to land had a mean of 1 contact with extension service providers within the last 12 months whereas those who did not have access to land had a mean of 0 contacts with extension service providers. The mean difference in terms of extension contacts was significant at 1% level. The number of contacts with extension services providers is a proxy for access to information, hence farmers who had access to extension services were more aware of benefits of agriculture and thus had access to land than those who did not have access to extension services. Njuki and Sanginga (2014) argued that agricultural extension services play an imperative role in disseminating agricultural information on new technologies and research aimed at improving agricultural productivity, which eventually motivates farmers in acquiring more land for farming.

Table 6: Mean number of extension contacts, market distance and amount of credit

Variables	Access to land		No access to land		Overall mean	t-value
	Mean	Std. Error	Mean	Std. Error		
Extension contacts	1.43	0.10	0.43	0.10	1.12	-6.052***
Market distance (walking min)	21.79	0.84	29.56	1.61	24.18	4.688***
Credit	7 042.02	1005.97	382.31	182.09	4995.55	-4.392***

Note: *** is significant at 1% level. Std. Error stands for Standard Error.

In terms of distance to the nearest input and/or input market, all women used an average of 24 minutes to walk to the nearest market. For women who had access to land, they used an average of 22 minutes to walk to the nearest input and/or input market while those who did not have access to land used an average of 30 minutes. The result indicated that there was a significant difference between the average times taken to reach the nearest market at 1% level. Distance from the household to the nearest market is a proxy for the ease of access to market and hence a measure of transaction cost. The location from the nearest market also played the role of a

proxy for information access and the potential market for the purchase of farm inputs as well as the sale of farm output. Women who were closer to the markets had access to land than those who resided far away from the market. This is because being closer to markets guaranteed them a ready market for high-value crops especially horticultural crops which occupy relatively smaller pieces of land. Ngomane and Sebola (2016) found that the inability of women to access land makes it difficult for them to access agricultural markets as markets prefer working with farmers who have enough land to produce commodities that meet their demands and standards.

On average, all women were found to have obtained a credit of KES 4,995 in the last 3 years. However, for the women who had access to land the average credit obtained in the last 3 years was KES 7,026 while that of those who did not have access to land was KES 381. The mean difference of total credit obtained in the last 3 years was significant at 1% level. This shows that farmers who had access to land, also, accessed more credit than their counterparts. Access to credit increased women farmers' capital base thus enabling them to acquire land and inputs for farming. Moreover, women farmers who had access to land had a higher chance of taking credit more than those farmers who did not have access to land. This is because some had access to land through inheritance and purchase and therefore, could use it as collateral for obtaining credit. The results are consistent with a study by Lambrecht (2016) who found that through owning land, women are able to use it as a form of collateral for obtaining credit especially for financing agricultural production and start-up businesses.

The main sources of agricultural information used by women are presented in table 7. About half of the women who had access to land, that is 55.97%, used other farmers as their main source of agricultural information whereas 25.37% used farmers' groups but only 18.66% used extension agents as their main source of information. For women who did not have access to land, a higher percentage (88.98%) used other farmers as their main source of information. There was a significant relationship between women access to land and the main source of agricultural information used by women farmers at 1%. Effective sources of agricultural information are important in shaping women farmers' perception, attitude and knowledge on agriculture as well as the importance of having access to land. This enhances women access to land and participation in agriculture.

Table 7: Main sources of agricultural information used by women farmers (%)

Variable	Description	Access to land		Chi^2 value
		No	Yes	
Main source of agricultural information	Others farmers	88.98	55.97	41.263***
	Farmers groups	3.39	25.37	
	Extension agents	7.63	18.66	

Note: *** is significant at 1% level.

Social influence as one of the institutional factors was first analyzed using factor analysis. This is because social influence had seven items which were designed and answered using a five-point Likert scale, ranging from strongly disagree to strongly agree. To determine the reliability of these seven items used to measure social influence, Cronbach's alpha coefficient was evaluated (MacKenzie *et al*., 2011). The obtained value was greater than the recommended value of 0.7 (it was 0.91), suggesting that the items were relatively reliable. Moreover, the Kaiser-Meyer-Olkin (KMO) test was conducted so as to check whether the data collected was appropriate for factor analysis. The value obtained for KMO was 0.84, thus suggesting that the sample was adequate and appropriate for factor analysis. The results are presented in Appendix 2. Social influence was found to be significant in explaining women access to land. After the factor analysis, only two factors were retained since they had eigenvalues greater than one. One factor was related to family members and the other factor was related to the peers/friends.

4.2 Effect of socio-economic and institutional factors on women access to land and the extent of access to land

4.2.1 Preliminary diagnostics of the variables to be used in the econometric analysis

Preliminary diagnostics for statistical problems of heteroskedasticity and multicollinearity were conducted to the socio-economic and institutional factors used in the econometric analysis. To detect heteroskedasticity for all hypothesized regressors, a white test was used and the results are presented in Table 8. The results indicated the presence of heteroskedasticity since a *chi*-square of 195.10 was significantly large. To counter this problem, robust standard errors were used in all analyses.

Table 8: White test results for heteroskedasticity

Source	chi^2	df	P-values
Heteroskedasticity	195.10	104	0.000
Skewness	65.34	13	0.000
Kurtosis	31.56	1	0.000
Total	292.00	118	0.000

Multicollinearity is a state of very high inter-correlations among the independent variables and was tested using the variance inflation factor (VIF) for all continuous variables and pairwise correlation test for all categorical variables. The results for continuous variables are presented in Table 9. The results confirmed that there was no serious linear relationship among the explanatory continuous variables tested since VIF values were less than 10.

Table 9: Variance inflation factor test results for multicollinearity

Variable	**VIF**	**1/VIF**
Years of schooling of the respondent	1.66	0.601
Age of the respondent	1.62	0.617
Log of remittances	1.50	0.666
Extension contacts	1.43	0.702
Log amount of credit	1.41	0.710
Log of off-farm income	1.29	0.777
Household farm size	1.28	0.782
Spouse age gap	1.20	0.836
Log of the value of women assets	1.18	0.846
Household size	1.13	0.885
Social influence from family members	1.12	0.895
Market distance	1.11	0.904
Social influence from friends	1.07	0.934
Mean VIF	1.31	

Note: VIF stands for Variance Inflation Factor

For categorical variables, the results are presented in Table 10. Similarly, the results confirmed that there was no serious linear relationship among the categorical explanatory variables because the pairwise correlation coefficients were less than 0.75 in all cases.

Table 10: Pairwise correlation coefficients for a categorical variable

	Marital status	Sources of agricultural information
Marital status	1.0000	
Sources of agricultural information	0.0190	1.0000

Note: If pairwise correlation coefficients are < 0.75 there is no multicollinearity

4.2.2 Effect of socio-economic and institutional factors on women access to land

Double hurdle model was used to determine factors influencing women access and the extent of access to land; however, the appropriateness of this model against a Tobit regression model was checked using a likelihood ratio test. The LR statistic was 100.80 ($p = 0.000$), convincingly rejecting the null hypothesis in favor of Tobit specification. This is an indication that there existed two separate decision-making stages in which women made independent decisions regarding their access to land and the extent of access to land. Tobit model was rejected because it is restrictive in nature, that is, it does not make any distinction between the two stages of decision making.

The log-likelihood of the double hurdle model comprised of the summation of the log-likelihood values estimated in the first and second hurdles and therefore, the log pseudo-likelihood for the fitted model was -359.62 and the model was found to be strongly significant at 1% level with a Wald *Chi*-square value of 110.07 ($p = 0.000$). The maximum likelihood estimates using craggit command are presented in Appendix II. The first stage of the double hurdle used a probit regression model to determine factors influencing women access to land whereas the second stage of the model used truncated normal regression to determine the extent of access to land. Average partial effects were used in explaining the effects of independent variables on the predicted values since are easier to interpret in terms of magnitude than the model coefficients. The results of the average partial effects of independent variables on three quantities of interest, that is, the probability of a woman having access to land (APE), the expected number of acres accessed given that the woman had access to land (CAPE) and the expected number of acres accessed by the woman (UAPE) are presented in Table 11. The standard errors for the APEs are obtained using the delta method following the procedure proposed by Burke (2009).

Spousal age gap had a negative influence on the probability of women access to land and was significant at 10%. An age difference of 1 year between spouses reduced the likelihood of a woman having access to land by 0.9%. Therefore, women with a higher age difference with their spouses were less likely to have access to land. This is possible because spouses who have smaller age gap have relatively same reasoning ability which may have a positive influence on women access to land. However, male spouses who are older than their female spouses tend to dominate especially when key decisions are made in the household thus depriving women a chance to contribute effectively in decision making and this may have a negative influence, especially in women access to land. The results are consistent with a study by Kritz and Adebusoye (1999) on determinants of women's decision-making authority in Nigeria, who found that spouse age gap had a negative effect on women's decision making authority regarding household issues, for example, agricultural-related decisions as well as household expenditure decisions. Guilbert (2013) also found that young women are characterized by restricted autonomy and low bargaining power and this may possibly affect their access to land.

The probability of women who were married having access to land was 23.3% lower than that of women who were not married (single, divorced and deceased), holding all other factors constant. Moreover, the Unconditional Average Partial Effects (UAPE) indicated that on average, the extent of access to land for women who were married was relatively lower as compared to those who were not married by 0.269 acres. This implies that women who were married had a lower likelihood of accessing land than those who were single, divorced or deceased. Women who are not married are more likely to make rational decisions than married women because they are the sole providers of their families and this may have a positive influence in terms of access to land. In addition, for married couples, the male spouses in most cases normally dominate when household decisions are made thus leaving their spouses with no or limited control over their agricultural land. In some communities, single women may have access to land through their fathers' inheritance or through renting or purchasing. Moreover, deceased women may have access to land through their husbands' inheritance whereas divorced women may have access to land through property sharing after divorce. Odoemelam *et al*. (2014) argued that in some African societies women can inherit land from their fathers if they are not married. Therefore, inheritance is seen as one of the crucial factors that determines women access to land and ownership.

Table 11: Average Partial Effects and Unconditional Average Partial Effects of DH model

VARIABLES	FIRST HURDLE			
	APE	**RSE**	**UAPE**	**RSE**
Socio-economic factors				
Age	0.001	0.002	-0.000	0.002
Spousal age gap	-0.009*	0.005	0.003	0.005
Marital status	-0.233***	0.079	-0.269***	0.074
Schooling years	-0.008	0.007	-0.020	0.006
Household size	0.028*	0.015	0.024	0.016
Household farm size	0.036	0.027	0.345***	0.041
Log value of agricultural assets	0.036**	0.018	0.048**	0.018
Log off -farm income	-0.003	0.005	-0.013***	0.005
Remittances	0.005	0.005	-0.012**	0.005
Institutional factors				
Distance to the market	-0.004***	0.001	-0.004***	0.001
Amount of credit	0.025***	0.007	0.020***	0.007
Extension contacts	0.036**	0.017	0.061***	0.018
Social influence				
Social influence from family members	0.063***	0.023	0.103***	0.026
Social influence from friends/peers	-0.047**	0.022	-0.101***	0.020
Sources of information				
Other farmers[1]	0.140*	0.078	0.065	0.074
Extension agents[1]	0.067	0.063	0.015	0.060
Log Likelihood	-165.228			
Number of observations	384			

Notes: *, **, ***=significant at 10%, 5% and 1% level, respectively. APE and UAPE stand for Average Partial Effects and Unconditional Average Partial Effects respectively. RSE stands for Robust Standard Errors calculated using the delta method. 1=base category: farmers' groups.

Household size had a positive influence on the probability of women access to land at 10% significance level. This implies that if household size increases by one member it increases the

probability of a woman having access to land by 2.8%, *ceteris paribus*. Household size as a proxy for labor availability may influence women access to land. This is plausible because the majority of small-scale farmers in Kenya use family labor and thus larger household size guarantee labor availability and this may possibly motivate women farmers in those households to acquire more land for farming. In addition, households with more members are associated with a higher demand for agricultural land since their food requirement is also high compared to households with fewer members. Odoemelam *et al*. (2014) and Nkonya *et al*. (2008) found that households with more members act as a driving force for women to acquire more land for farming since they have a helping hand in the farm.

The value of agricultural productive assets owned by women had a positive influence on their probability of having access to land and was significant at 5%. The results indicated that an increase in the value of assets owned by the woman by one Kenya Shilling increased the probability of the woman having access to land by 3.6%, all other factors held constant. In addition, the UAPE indicated that the value of productive assets owned by the woman had a positive influence on the number of acres accessed by the woman. Resource endowed women farmers, that is, those with a greater value of productive assets had a higher probability of having access to land than those who had lower assets value or no assets at all. Higher asset endowment improves farmers' liquidity position thereby ensuring that they are able to purchase or hire land for agricultural purposes with ease. In addition, asset ownership increases women bargaining power and therefore they are more likely to engage in the household decision-making process. Johnson *et al*. (2016) found that assets ownership was positively correlated with the involvement of women in household decision-making process as well as the share of household land over which they had an influence.

The effect of distance (measured by walking time) to the nearest input and output market on the probability of women access to land was found to be negative and significant at 1% level. Precisely, an increase in time taken to reach the market by 1 minute reduced the probability of a woman having access to land by 0.4%, holding all other factors constant. Moreover, the extent of access to land declines with distance to the market in the unconditional level. This implies that women who are closer to the market are more likely to have access to land than those who are far away from the market. Proximity to input and output markets reduces the transaction costs associated with agriculture. This is because nearness to the market enables women to have access to market information, credit institutions as well as reduces the transaction costs

associated with buying inputs and taking farm produce to the market. Seidu (2015) found that input and output markets serve as sources of market information which enhances the marketing of agricultural products. Therefore, women farmers closer to the market are motivated to acquire more land for farming since they can practice commercial agriculture especially horticultural farming with ease. Menale *et al*. (2010) noted that apart from affecting access to the market, the distance can also affect accessibility to market information which may affect farmers' transaction costs.

The amount of credit borrowed in the last three years was found to have a positive effect on the probability of women having access to land and it was significant at 1% level. This implies that 1% increase in credit borrowed in the last three years increased the probability of a woman having access to land by 2.5%, *ceteris paribus*. The UAPE also indicated that on average, credit borrowed had a positive influence on the extent of women access to land and was significant at 1% level. The amount of credit received improves the farmer's capability of paying for the transaction costs associated with accessing land, especially when renting in or hiring land. It also increases the capital base of the women farmers thus reducing cash constraints associated with farming. Therefore, it enables them to finance a host of agricultural activities like paying for labor as well as buying the required inputs. Jin and Jayne (2013) found that land purchases as well as renting require a much greater up-front payment and thus may only work well for small-scale farmers who have access to credit.

The number of contacts with extension agents had a positive influence on the probability of women having access to land and was significant at 10%. One annual contact with extension agents increased the probability of a woman having access to land by 3.6%, all other factors held constant. The unconditional influence (UAPE) of the number of contacts with extension agents on the extent of women access to land is estimated to be 0.061 acres. The results suggested that women access to land could be motivated by frequent contacts with extension agents. This is because through their contacts with extension agents the women farmers are able to acquire technical skills and knowledge which apparently motivates them to acquire land for subsistence and/or commercial farming. Knowledge gained through receiving extension services, therefore, plays an imperative role in women access to land. Gido *et al*. (2015) and Baloch and Thapa (2016), concluded that access to extension services increases farmers' knowledge and skills in agriculture which enhances their access to land as well as improves their agricultural productivity.

Social influence from family members had a positive influence on the probability of women having access to land and was significant at 1% level. Therefore, those farmers who experienced social influence from their family members in terms of access to land had a higher likelihood of having access to land than those who did not experience any influence from their family members. The unconditional influence (UAPE) of social influence from family members on the extent of access to land is estimated to be 0.103 acres. This implies that women whose family believes that women should have access to land are more likely to have access to land than their counterparts. Gyau *et al.* (2014) argued that women access to land depends mostly on customary laws as well as individual families. Adams *et al*. (2017) found that the influence of family members and peer-based reference groups is positively related to consumer decisions which in this case is the decision of having access to land or not. However, social influence from friends or rather peers had a negative and significant influence on the probability of women access to land at 5% level. Moreover, it had a negative influence on the extent of access to land in both conditional and unconditional levels. The influence from friends tends to affect consumers decisions. For example, if the friends do not have access to land, they may influence the woman in that direction, therefore, making her not to be concerned with access to land. Zaki *et al*. (2011) found that the behavior of the people can have a significant impact on the behavior of other people since people have a tendency to change their behavior in order to be equivalent with other people.

With regard to the main source of agricultural information, women farmers who used other farmers as their main source of agricultural information increased their probability of having access to land by 14.0% as compared to those who received agricultural information from farmers' groups. This implies that farmers who received agricultural information from other farmers had a higher probability of accessing land. This is because of the influence they experienced from other women farmers who had access to land. Other farmers are crucial channels through which women farmers can have access to knowledge and also help farmers in acquiring agricultural skills. This is because other farmers have a higher convincing power to their fellow farmers since they can easily observe how they are benefitting from having access to agricultural land. Moreover, they have an in-depth knowledge of their cultural practices and speak the same language, thus, they are known by other farmers and hence have their trust. Ssemakula and Mutimba (2011) who studied the effectiveness of the farmer-to-farmer extension approach found that this approach promoted farming, increased agricultural production and uptake of technologies.

4.2.3 Effect of socio-economic and institutional factors on the extent of women access to land

Effect of socio-economic and institutional factors on the extent of women access to land was determined in the second hurdle/tier of the double hurdle model using a truncated normal regression model. The maximum likelihood estimates of the second tier are presented in Appendix II. Conditional and unconditional average partial effects (CAPE and UAPE) for the second tier are presented in table 12.

Household farm size had a positive influence on the extent of women access to land and it was significant at 1%. For women who had access to land, an increase in household farm size by one acre increased their expected size of land accessed by 0.424 acres. In UAPE, household farm size had a positive influence on the extent of access to land, that is, it increased the size of land accessed by 0.345 acres. Women rely mostly on land accessed through inheritance and therefore when household farm size increases it is expected that their extent of access to land will increase. This is because households with bigger land size may be willing to allocate land to a woman so that she can do her own agricultural activities as compared to households with smaller pieces of land.

For women who had access to land, an increase in off-farm income reduced their extent of access to land. UAPE also indicated that off-farm income had a negative effect on the extent of women access to land. This is perhaps due to farmers' increased involvement in off-farm activities, which are expected to increase their amount of off-farm income and thus they tend to have less time for agricultural activities. Off-farm income plays a fundamental role in enhancing household income diversification and for this reason, there is no motivation for women farmers to access more land for agriculture since they have alternative sources of income. Mathenge *et al.* (2014) argued that engaging in off-farm activities divert time and effort away from agricultural activities which reduces farm productivity and women access to land. On the contrary, previous studies (Rao and Qaim, 2011; Woldeyohanes *et al*., 2016) concluded that higher off-farm incomes promote smallholder commercialization of agriculture if used as a source of liquidity for farm investments and this may eventually lead to women having access to more land for agriculture.

Table 12: Conditional Average Partial Effects and Unconditional Average Partial Effects of DH model

VARIABLES	SECOND HURDLE			
	CAPE	**RSE**	**UAPE**	**RSE**
Socio-economic factors				
Age	-0.001	0.003	-0.000	0.002
Spousal age gap	0.014	0.009	0.003	0.005
Marital status	-0.102	0.101	-0.269***	0.074
Schooling years	-0.017	0.011	-0.020	0.006
Household size	0.001	0.024	0.024	0.016
Household farm size	0.424***	0.071	0.345***	0.041
Log value of agricultural assets	0.024	0.038	0.048**	0.018
Log off-farm income	-0.014*	0.007	-0.013***	0.005
Remittances	-0.022**	0.009	-0.012**	0.005
Institutional factors				
Distance to the market	-0.001	0.003	-0.004***	0.001
Amount of credit	-0.000	0.011	0.020***	0.007
Extention contacts	0.041	0.043	0.061***	0.018
Social influence				
Social influence from family members	0.068	0.045	0.103***	0.026
Social influence from friends/peers	-0.083***	0.031	-0.101***	0.020
Sources of information				
Other farmers[1]	-0.070	0.129	0.065	0.074
Extension agents[1]	-0.054	0.106	0.015	0.060
Log Likelihood	-165.228			
Number of observations	384			

Notes: *, **, ***=significant at 10%, 5% and 1% level, respectively. CAPE and UAPE stand for Conditional Average Partial Effects and Unconditional Average Partial Effects respectively. RSE stands for Robust Standard Errors calculated using the delta method. 1=base category: farmers' groups.

With regard to remittances, an increase in the amount of remittances that women receive per year reduces their extent of access to land. The UAPE also indicated that remittances had a

negative influence on the number of acres of land accessed by the woman. Remittance income is normally considered as a substitute for farm income and non-farm income. Households in which the woman receives internal or external remittances from friends and/or relatives may tend not to engage in farming. This is possible because they have other non-farm sources of income which cater for their household needs. Jack *et al*. (2013) argued that remittances constitute an essential component of rural household income which is used for different consumptive and productive purposes. Moreover, Thapa and Acharya (2017) found that remittance recipient households have a tendency of spending more on consumption and human development investment which implies that remittance income aid in sustaining consumption. On the contrary, Kikulwe *et al*. 2014 found that remittances contribute significantly in the commercialization of agriculture and thus enhance women access and the extent of access to land.

Social influence from friends had a negative effect on the extent of women access to land and was significant at 1%. For women who had access to land, social influence from friends reduced their expected size of land accessed by 0.083 acres. Social influence refers to the extent to which members of a social network influence one another's behavior and experience social pressure to perform particular behaviors. The influence from friends tends to affect consumers decisions. In this case, if the woman friends do not participate in agricultural-related activities, they may tend to influence the woman in that direction, therefore, affecting their extent of access to land. On the contrary, Adam *et al*. (2017) concluded that the influence of family members or peer-based reference groups is positively related to consumer decisions which in this case; the decisions are with regard to women access and extent of access to land.

4.3 The effect of women access to land on household nutritional outcomes

4.3.1 Determinants of women access to land: Propensity score estimation

The effect of women access to land on household nutritional outcomes was determined by using Heterogeneous Treatment Effects model (HTE). The first step involved propensity score estimation. Table 13 presents the maximum likelihood estimates of a probit regression model used in predicting individual propensity scores. The probit regression was also used to determine the socio-economic and institutional factors that influence women access to land. Several variables were found to be significant thus influencing women access to land.

Table 13: Determinants of women access to land (probit estimates)

Factors	Coefficient	RSE	P-values
Socio-economic factors			
Age	0.002	0.007	0.777
Spousal age gap	-0.037	0.025	0.127
Marital status	-0.966***	0.295	0.001
Schooling years	-0.037	0.030	0.211
Household size	0.118*	0.066	0.073
Household farm size	0.147	0.111	0.183
Log of agricultural assets value	0.149**	0.076	0.050
Off -farm income	-0.014	0.022	0.530
Remittances	0.022	0.021	0.284
Institutional factors			
Market distance	-0.017***	0.005	0.001
Log of credit amount	0.102***	0.032	0.002
Extension contacts	0.150**	0.071	0.036
Social influence			
Social influence from family members	0.261***	0.083	0.002
Social influence from friends/peers	-0.196**	0.087	0.025
Sources of information			
Other farmers[1]	0.583*	0.342	0.088
Extension agents[1]	0.277	0.278	0.320
Constant	0.049	0.779	0.950
LR*chi*^{2}	144.80		
Pseudo R^2	0.305		
Log Likelihood	-165.228		
Number of observations	384		

Note: *, **, ***=significant at 10%, 5% and 1% level, respectively, 1=base category: Farmers' groups. RSE stands for Robust Standard Errors.

The probit regression results suggested that women farmers who were married were less likely to have access to land than those who were not married. Moreover, women farmers with more

household members and owned valuable agricultural assets were also more likely to have access to land. However, women who reside far away from input and output markets were less likely to have access to land. In addition, women farmers who received high credit amounts in the last three years and experienced more contacts with extension agents in the last one year were more likely to have access to land. The results also suggested that social influence from family members had a positive influence on the probability of women having access to land but social influence from friends/peers had a negative influence on the probability of women having access to land. Women farmers whose main source of agricultural information was other farmers were more likely to have access to land than other women farmers who used extension agents and farmers' groups as their main sources of agricultural information.

4.3.2 Methods of measuring household nutritional outcomes

After estimating the propensity scores for predicting the likelihood of a woman having access to land, treatment effects were determined to find the effect of women access to land on household nutritional outcomes. Household Dietary Diversity Scores (HDDS) and the Household Hunger Scale (HHS) were used to measure household nutritional outcomes. HDDS takes into account the number of food groups consumed by the household in the last 24hrs for a normal day. The reference period is shorter since longer periods result in less accurate information due to imperfect recall. The HDDS is based on the number of food groups proposed by FANTA (Swindale and Bilinsky, 2006; FAO, 2011b). These food groups and their scores are presented in Appendix IV and included: cereals, vegetables, root and tubers, meat, poultry and offal, eggs, fish, pulses/legumes/nuts, fruits, milk and milk products, oil/fats, sugar/honey, and miscellaneous/condiments. Figure 3 presents the percentage of households who consumed each food group in the last 24 hours.

The maximum number of food groups consumed by households in which women had access to land were 12 food groups whereas for their counterparts it was 7 food groups. A higher percentage (34%) of the households in which women had access to land had consumed 7 food groups in the last 24 hours. However, for the households in which women did not have access to land, a higher percentage (39.8%) had consumed only 5 food groups in the last 24 hours. The highly consumed food groups were cereals (98.7%), vegetables (86.5%), oil/fats (91.7%), sugar/honey (98.4%) and miscellaneous/condiments (98.4%). Meat-based products (i.e. poultry, offal and fish), eggs, milk and milk products were rarely consumed by many

households. For instance, 1.3% of the households consumed fish, while less than 14% consumed meat, poultry and offal.

In order to further assess household nutritional outcomes in terms of dietary diversity, households were categorized into three groups depending on their HDDS, that is, those who had low dietary diversity (≤ 3 food groups), medium dietary diversity (4 and 5 food groups) and high dietary diversity (≥ 6 food groups) (Ochieng *et al*., 2017). The results are shown in Table 14. While considering all the sampled households, 78.65% had high dietary diversity, that is, they had consumed 6 or more food groups in the last 24 hours. However, for women who had access to land 98.5% had high dietary diversity as compared to only 33.9% of women who did not have access to land.

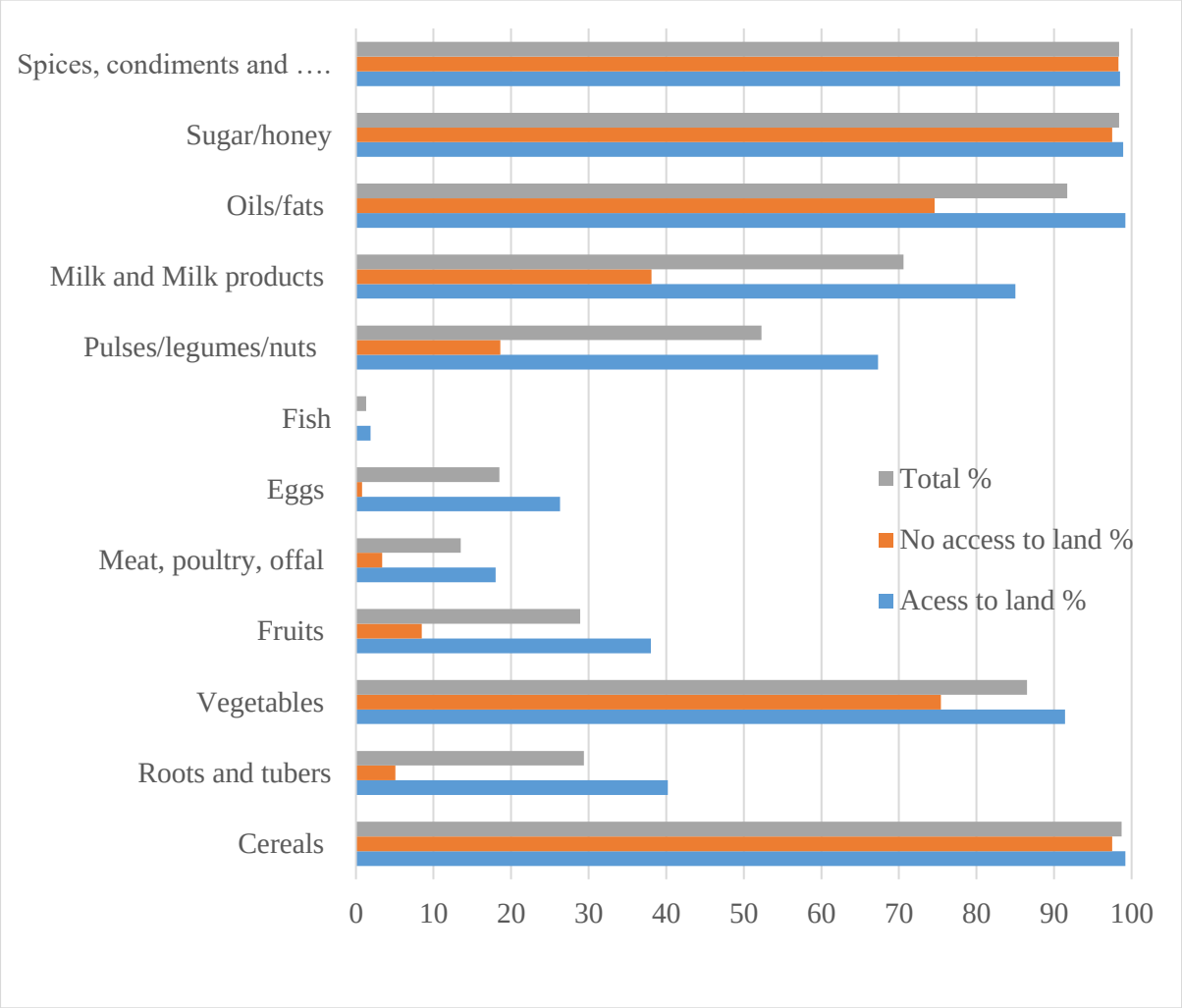


Figure 3: Percentage of households who consumed each food group in the last 24 hours

Table 14: Household dietary diversity scores (HDDS) classification

HDDS Classification	Access to land		No access to land		Total	
	No. of households	%	No. of households	%	No. of households	%
≤ 3 food groups (LDD)	0	0.0	1	0.9	1	0.3
4-5 food groups (MDD)	4	1.5	77	65.3	81	21.1
≥ 6 food groups (HDD)	262	98.5	40	33.9	302	78.6

Note: LDD stands for Low Dietary Diversity, MDD stands for Medium Dietary Diversity and HDD stands for High Dietary Diversity.

Household hunger scale (HHS) is an indicator for measuring household hunger. Respondents were asked three occurrence questions as well as three questions capturing frequency of occurrence. The HHS occurrence questions captured whether or not a specific condition associated with the experience of hunger or rather food insecurity occurred in the household during the last 4 weeks (30 days). Using the responses given by the respondents, HHS scores for every responding household were calculated and each household would have an HHS score of between 0 and 6. The scores for the interviewed households are presented in Table 15.

Table 15: Household hunger scale scores

HHS scores	Access to land		No access to land		Total
	No. of households	%	No. of households	%	%
0-1 (little /no hunger)	242	91.0	73	61.9	82.0
2-3 (Moderate hunger)	24	9.0	22	18.6	12.0
4-6 (Severe hunger)	0	0.0	23	19.5	6.0

According to Ballard *et al*., (2011), the HHS score ranges between 0 and 6, where 0-1 represents little to no hunger, 2-3 moderate hunger and 4-6 severe hunger in the household From the results, a higher proportion (91.0%) of all the households in which the woman had access to land experienced little or no hunger in the household as compared to 61.9% of their counterparts. None of the households in which women had access to land experienced severe hunger (with scores between 4-6) but for those households in which women did not have access to land 19.5% of them experienced severe hunger.

4.3.3 The effect of women access to land on household nutritional outcomes under the assumption of homogeneity

To demonstrate the homogenous effect of women access to land on household nutritional outcome two Poisson regression models were used. In the first regression, the dependent variable was Household dietary diversity scores (HDDS) and the independent variable was a binary variable of women access to land. In the second regression propensity scores (pscore) were included in order to control for self-selection bias. Similar regressions were estimated with the Household Hunger Scale (HHS) as the dependent variable. Table 16 presents the results of the two equations for HDDS and HHS as the dependent variable.

Table 16: Homogeneous effects of women access to land on household nutritional outcomes

	HDDS		**HHS**	
Variable	**Coeff.**	**Standard error**	**Coeff.**	**Standard error**
$Yi = \alpha + \beta Wlndac$				
Women access to land	0.397***	0.046	-1.416***	0.129
constant	1.636	0.041	0.365	0.077
$Yi = \alpha + \beta Wlndac + \lambda pscore$				
Women access to land	0.368***	0.055	-1.477***	0.160
Propensity score	0.087	0.090	0.186	0.290
constant	1.595	0.587	0.278	0.158

Note ***=significant at 1% level; Wlndac is a dummy variable for women access to land; pscore are the individual's propensity scores and Coeff is coefficient.

The β coefficient was positive and significant at 1% in the regression with HDDS as the dependent variable but negative and significant at 1% in the regression with HHS as the dependent variable. In the first Poisson regression with HDDS as the dependent variable, women access to land increases household nutritional outcomes by 40%. In contrast, if factors that might have induced self-selection or that influence women access to land are controlled by including propensity scores in the regression, women access to land increases household nutritional outcomes by 37%. However, in the first Poisson regression with HHS as the dependent variable, women access to land reduces household hunger scale scores thus

improving household nutritional outcomes. The results suggested that controlling for factors that might have induced self-selection through the propensity scores resulted in lower effects of women access to land on the outcome variable. However, this average effect obscure the heterogeneity in the effects of women access to land due to inherent differences among women farmers and thus, heterogeneous effects were estimated.

4.3.4 Heterogeneous effects of women having access to land on household nutritional outcomes

To determine the heterogeneity in effects of women access to land on household nutritional outcomes stratification multilevel (SM-HTE) and matching-smoothing (MS-HTE) approaches of estimating heterogeneous treatment were used as proposed by Xie *et al*. (2012). In stratification multilevel methodology, the method was an estimation of the heterogeneous effect of women access to land on household nutritional outcomes using propensity scores (Becker and Ichino, 2002). It started by constructing balanced propensity score strata before estimating the average effects of women access to land within each stratum using an ordinary least square regression model. Subsequently, by using variance weighted least squares regression, a linear trend was evaluated across different strata based on strata-specific effects of women access to land. Then, a linear trend was displayed graphically (Brand and Xie, 2010; Mutuc *et al*., 2013).

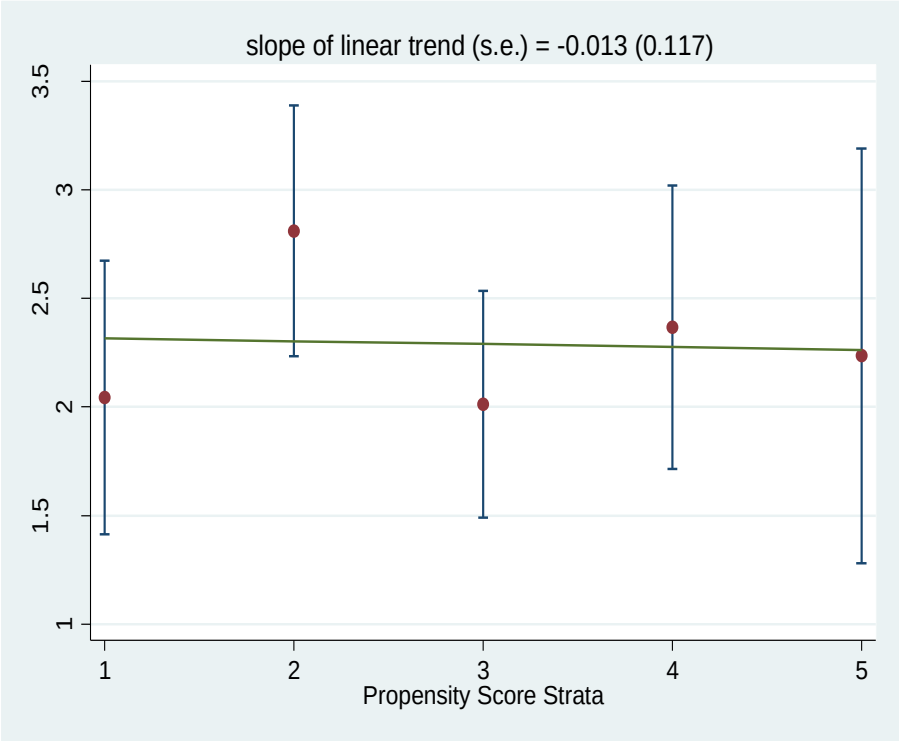
Table 17 presents the results of the SM-HTE approach, that is, level 1 and level 2 slopes and are plotted in Figure 4 (a) and (b) for Household Dietary Diversity Scores (HDDS) and Household Hunger Scale (HHS), respectively. Level 1 slopes are point estimates of stratum-specific effects of women access to land on household nutritional outcomes. For HDDS, the positive effect of women access to land is throughout the stratum rank at 1% significance level. The sub-group farmers who benefit most are somewhat in the mid strata (stratum 2 and 4). The downward linear slope (level 2 slope) illustrate the declining trend in effects of women access to land on household nutritional outcomes as measured by HDDS along the propensity stratum rank. Therefore, a unit change in stratum rank was associated with about 1.3% decrease in household nutritional outcomes. However, for HHS, the women farmers who significantly benefit most are somewhat in the middle strata (stratum 2 and 3). A unit change in stratum rank was associated with about 17.8% increase in household hunger which means a reduction in household nutritional outcomes as measured by HHS. This implies that households which are in the middle strata experience higher nutritional outcomes in both HDDS and HHS.

Table 17: Heterogeneous Treatment Effects by strata

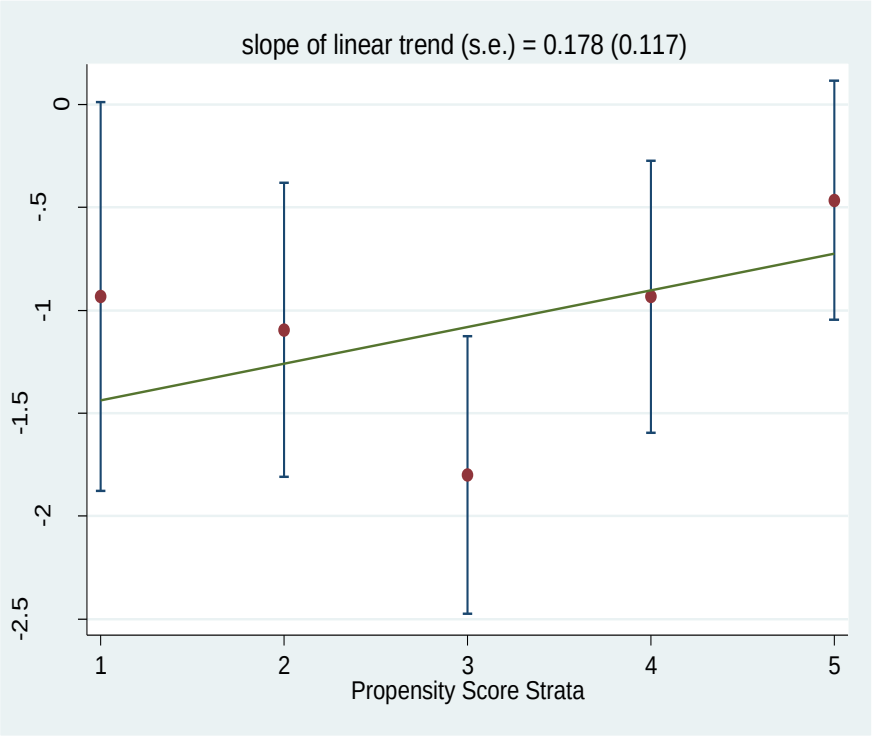
	HDDS		HHS	
Level-1 Slopes	**Coefficient**	**Standard Errors**	**Coefficient**	**Standard Errors**
1 (.00-.20)	2.044***	0.322	-0.932*	0.481
2 (.20-.40)	2.810***	0.295	-1.095***	0.364
3 (.40-.60)	2.012***	0.266	-1.800***	0.344
4 (.60-.80)	2.366***	0.333	-0.934***	0.337
5 (.80-1.00)	2.2359***	0.489	-0.474	0.297
Level-2 slope	-0.013	0.117	0.176	0.117

Note: *, *** = significant at 10% and 1% level, respectively. HDDS stands for Household Dietary Diversity Scores and HHS stands for Household Hunger Scale.

To explore the observable socio-economic and institutional characteristics that inform heterogeneity in effects of women access to land on household nutritional outcomes, the mean values of the covariates were estimated and are presented in Appendix IV. From the stratum-specific mean values, the age of the woman, schooling years and value of productive assets increases as the propensity scores increases along the strata. Moreover, household size, household farm size, number of contacts with extension agents as well as credit amount accessed also increase as propensity scores increase along the strata. However, with increased propensity scores, distance to the product market and spousal age gap are reduced. The results are similar with initial results on factors that determine women access to land estimated using a probit regression model.



(a)

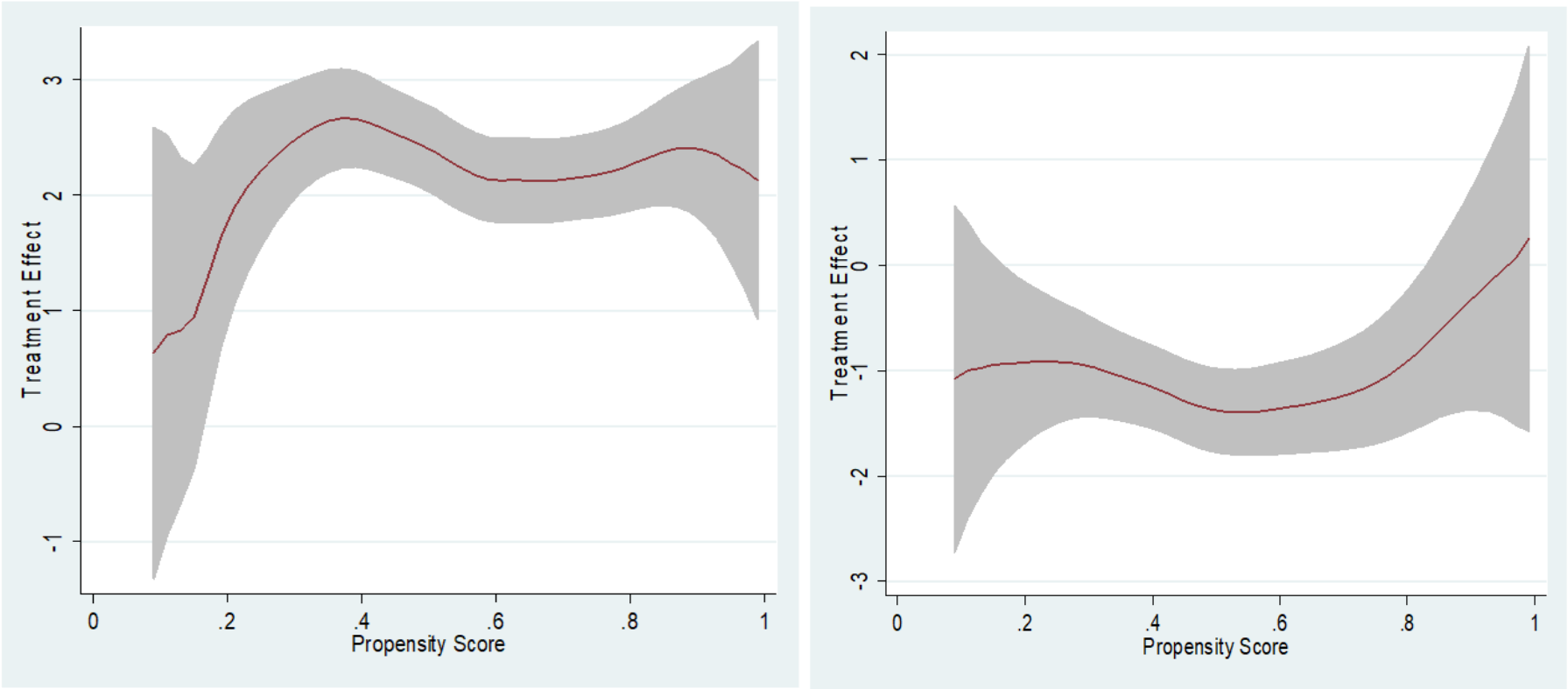


(b)

Figure 4: Stratified effect of women access to land on household nutritional outcomes

The matching-smoothing method of estimating heterogeneous treatment effects was estimated to overcome the limitations of the stratified multilevel approach of estimating heterogeneous treatment effects. The limitations include that of homogeneity assumption within the strata and another assumption is that a linear trend exists in the pattern of heterogeneity (Xie *et al*., 2012; Mutuc *et al.*, 2013) The matching-smoothing approach results are presented in Figure 5 (a) and (b) for HDDS and HHS, respectively. The local polynomial regression was used as a smoothing device (Epanechnikov kernel, degree 2, bandwidth 0.07) and the shaded region represents a 95% confidence interval. Consistent with the results under the stratified multilevel approach, there was an increase in household nutritional outcomes measured using HDDS in strata 1 and 2 before gradually declining in stratum 3, then slightly increasing in stratum 4 and eventually declining in stratum 5. Thus, households in strata 2 and 4 benefited most from women access to land. There was a slight decrease in household hunger (increase in household nutritional outcome) as measured using HHS in stratum 1 before slightly declining in stratum 2 and 3 and eventually increasing in strata 4 and 5. Households in stratum 2 and 3 benefited the most. In short, households that benefited most from women access to land in terms of improved household nutritional outcomes (when comparing HDDS and HHS) were somewhat in the middle stata, that is, in stratum 2 and 3.

The findings on stratification multilevel and matching-smoothing methods of estimating heterogeneous treatment effects revealed the presence of heterogeneity in the effects of women access to land on household nutritional outcomes. The results indicated that households across all propensity scores strata benefitted from women access to land in terms of household nutritional outcomes. Nevertheless, households in the middle strata seemed to benefit more than the rest. Therefore, women who are somehow likely to have access to land (middle strata) benefit most from having access to land in terms of household nutritional outcomes. The implication of the results is that all households in which women have access to land and those in which women did not have access to land exhibit some form of heterogeneity in terms of nutritional outcomes. Households in which women had access to land had a higher HDDS and a lower HHS as compared to those households in which women did not have access to land. Therefore, women access to land had a positive and heterogeneous effect on household nutritional outcomes.



(a) **(b)**

Figure 5: Matched differences in effects of women access to land on household nutritional outcomes

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. A higher percentage of women (46.3%) who had access to land were involved in food crop and livestock farming whereas, for those who did not have access to land, a higher percentage (66.9%) were involved in livestock farming. The results indicate that there existed a significant relationship between women access to land and the choice of farm enterprises.
2. The likelihood of women having access to land and the extent of access to land is influenced by both women socio-economic and institutional factors. This observation provides a wider spectrum of interventions to improve women access and the extent of access to land.
3. All households benefit positively from women access to land in terms of household nutritional outcomes. All the households across the strata benefitted significantly but differently from women access to land in terms of household nutritional outcomes. Women in the middle strata seemed to benefit the most. Thus, women access to land does not only led to a significant improvement in household nutritional outcomes but it is also an important policy issue for promoting gender equality in the society.

5.2 Recommendations

It is evident that land is a crucial resource for all because of the close relationship between land and livelihoods. Therefore, to improve women access to land, women should have access to credit facilities since credit borrowed increases the capital base of the women farmers thus reducing cash constraints associated with accessing land and farming. The government may introduce and strengthen Village Savings and Loan Associations (VSLAs) in order to enable farmers to acquire timely and affordable credit. Women farmers should be sensitized on the need to invest in productive agricultural assets so as to improve their bargaining power at the household level and absorb risks associated with farming. Further, women should also be linked conveniently with extension service providers so that they can acquire technical skills and knowledge essential in farming. Through extension service providers, the county and national government should come up with campaigns aimed at promoting women access to land which should target families and societies so as to change their beliefs with regard to women having access to land.

For county and national government together with development partners, they should invest in improving important infrastructures like roads which could enhance women access to input and output markets thus reducing transaction costs associated with farming. In addition, in collaboration with societies, they should prohibit early marriages that lead to wider age gaps between spouses thus disempowering women. Therefore, interventions that are geared towards promoting education especially among young girls should be encouraged. This is fundamental because education allows further mental development thus making women more assertive and empowered.

For policy analysts and development partners, there is a need not to assume homogeneity in the effects of any livelihood improvement programs and/or interventions. It is necessary for them to systematically evaluate the heterogeneity effects of these programs and/or interventions in order to customize and redesign them so as to effectively achieve their desired objectives. For instance, in this study, they should not assume homogeneity in effects of women access to land on household nutritional outcomes since women differ not only in background characteristics but in how they respond to a specific treatment.

5.3 Further research

This study was carried out in a low potential area that encounters food insecurity issues, therefore, a similar study can be carried out in both high and low potential areas so as to compare the effects of women access to land on household nutritional outcomes in both regions in order to give accurate policy recommendations. The study was limited in that it did not put into consideration the seasonality in agriculture since cross-sectional data was used. Therefore, similar research can be conducted while considering seasonal variations in agriculture.

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APPENDICES

Appendix I: Household survey questionnaire

Research on Women Access to Land and Household Nutritional Outcomes: Household-Level Survey in Machakos County, Kenya.

Questionnaire Serial No……..

My name is Veronica Kariuki, a student at Egerton University and I am part of a team from the University, who are undertaking research on the effect of women access to land on household nutritional outcomes among small-scale women farmers in this County. The purpose of this study is purely academic and you have been identified as one of the respondents who will assist in this research. Your contribution will be highly appreciated and utmost discretion will be accorded to your responses even as they will be solely used for research purposes.

SECTION A: GENERAL INFORMATION

A.1 Sub County	Scount……..
A.2 Ward	Ward…….
A.3 Village	Vill……..
A.4 Enumerator name	Enum……...
A6 Date of interview	Intviewdate……..
A7 Name of the respondent	Rname……..

SECTION B: DEMOGRAPHIC AND SOCIO-ECONOMIC FACTORS

B.1 Indicate the details of people who have been living in the household for at least six months in the table below (codes are below the table)

Demog.sav

ID	Name (start with household head)	Gender	Age (years)	Relationship to the household head	Years of schooling	Main occupation
	Name	**Gender**	**Age**	**Rshead**	**Yrschlng**	**Occup**
1						
2						
3						
4						
5						
6						
7						
8						
9						

10						
		Gender 1= male 2=Female		**Rshead** 1= Spouse 2= Parent 3= son/daughter 4= grandchild 5=other specify		**Occup** 1= farming 0=otherwise

B.2 Apart from farming, did you (**the woman**) earn income from any other source in the last 12 months? **Offinc**……..

1=yes 0= No **(If No skip to section C)**

B.3 If yes, where else did you (**the woman**) get income in the last 12 months (***Probe for remittances*)** and how much was it?

Offinc.sav

Other sources of income (off-farm sources)	Number of months earned/received in the last one year	Estimated average amount per month (KES)	Estimated **total** amount in the last 12 months (KES).
Srcesoffinc	**Nmnths**	**Averagamnth**	**Tamntoffinc**
1= salaried employment 2= casual laborer 3=self-employment 4= Remittances 5= Pension 6= Rental payments 7= other specify			

SECTION C: FARM LEVEL FACTORS

C.1 How many acres in **total** were you farming as a **household** in the last one season **Hhfsize**…….

C.2 Of the total household farm size, how many acres were under cash crops? **Acrescshcrops**……..who controlled that portion with cash crops? **Cshcropcntrl** …… And how many acres were under food crops? **Acresfdcrops** ……who controlled that portion with cash crops **Fdcropcntrl**…….. (*Use the codes below*).

1=Household head 2=Spouse 3=Both Household & spouse 4=Relative 5=other (specify)

C.3 Did you **(the woman)** have access to land in the last one season, that is, did you have any portion of land that you used and made all decisions or jointly with your spouse regarding it in the last one season (t*hat is, made all decisions or made over 50% of the decisions about what was planted, inputs used, how the harvest was used among other decisions)*? **Wlandac**……..

1= Yes 0= No **(If No skip to C.8)**

C.4 If yes, of the total household land size how many acres did you (**the woman**) **utilize and control** in the last one season? *Give ways in which she acquired land and the number of acres.* ***Land_access.sav***

Land access methods (see codes below)	Number of acres
Wlndacc	**Extwlndac**
<u>Wlndacc</u> 1=Inheritance 2=Renting 3=Hiring 4=Community land 5=Purchasing 6= Gift 7=Others specify	

C.5 Of the total land accessed by you **(*the woman*)** in the last season, is there a portion of it that is registered under your name? **Landreg**……..

1=Yes 0= No

C.6 Of the total land accessed in the last season, which enterprises did you carry out? **Wlenteprses**……

1= cash crop farming only 2= food crop farming only 3 = both cash and food crop farming 4= livestock farming only 5= food crop and livestock farming 6= cash crop and livestock farming 7= food, cash and livestock farming 8= other specify.

C.7 Using a scale of 1-10, how would gauge yourself in terms of getting involved in making the following decisions with regard to agricultural production in the last season, where 10 means you were fully involved in decision making (you were the sole decision maker) and 1 means you were not involved in decision making.

Decision_prodn.sav

ACTIVITY (*If a household does not engage in a particular activity enter code **98** and proceed to the next activity*)		The level of decision making on a scale of 1-10.
		Landmkng
Which Crops to be grown?	**Actv1**	
Where to source farming labor?	**Actv2**	
Which inputs to buy for agricultural production?	**Actv3**	
Whether to take the farm produce to market or not?	**Actv4**	
How much to sell or use for home consumption?	**Actv5**	
When or who would take the produce to the market?	**Actv6**	
How the money obtained from the sale of produce will be used?	**Actv7**	

C.8 Apart from crop farming do you (***Woman)*** own any livestock? **Lvstock**……

1= Yes 0= No (If **No skip to section E**).

C.9 If yes, tell me the type and number of livestock you own (***the woman***)

Livestock.sav

Livestock type	Number owned	Number sold in the last one year	Gross income (KES)
Lvstcktype	**Nlvstck**	**Nlvstcksold**	**Lvstckincm**
1=dairy cows 2=beef cattle 3=Heifer 4= Calves 5= goats 6= poultry 7=sheep 8= rabbits 9= pigs 10 = other specify			

SECTION E: HOUSEHOLD NUTRITION

E.1 Did **YOU OR ANYONE ELSE IN YOUR HOUSEHOLD** eat any kind of the following foods **yesterday during the day and at night (Last 24hrs**)*? (Probe to know if there was any function, for example, Marriage ceremony, funeral, a family party among others yesterday. If so, you should concentrate on the previous normal day.*

HH 24hrs nutrition.sav

FOOD GROUP		**EXAMPLES**	**Code** 1=Yes 2= No	Source of food *(see codes below the table)* **Primary source**
				Psrcefd
Cereals	**Fd1**	millet, sorghum, maize, rice, wheat		
Roots and tubers	**Fd2**	potatoes, yams, cassava		
Vegetables	**Fd3**	Kales, cabbage, carrots, pumpkins, French beans		
Fruits	**Fd4**	Mangoes, oranges, pawpaws, Pineapples, watermelons, passion fruits		
Meat	**Fd5**	beef, pork, lamb, goat, rabbit wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ		
Eggs	**Fd6**	Eggs		
Fish and sea foods	**Fd7**	fresh or dried fish or shellfish		
Pulses/ legumes/ nuts	**Fd8**	beans, peas, lentils, groundnuts		
Milk and milk Products	**Fd9**	cheese, yogurt, milk or other milk products		
Oils/fats	**Fd10**	Oil/ fat		
Sugar/honey	**Fd11**	Sugar, honey		
Miscellaneous/ condiments	**Fd12**	Coffee, tea, spices, condiments		

Source of food
1=Purchase
2=Own production
3=Traded goods/services (barter)4=Borrowed
5=Received as a gift
6=Food aid
7=other specify

HOUSEHOLD HUNGER SCALE (HHS)

E.2 ***Enumerator: Ask of the person responsible for Household Food Preparation (woman).***

We will ask about food availability in the household in the past 4 weeks (30 days).

1	In the past 4 weeks/30 days, was there ever **no food** to eat of any kind in your house because of lack of resources to get food?	0=no (**Skip to 2**) 1=yes	**HS1 ____**
1a	**How often** did this happen in the past [4 weeks/30 days]?	1 = Rarely (1–2 times) 2 = Sometimes (3–10 times) 3 = Often (more than 10 times)	**HS1a ____**
2	In the past [4 weeks/30 days], did you or any household member go to **sleep at night hungry** because there was not enough food?	0=no (**Skip to 3**) 1=yes	**HS2 ____**
2a	**How often** did this happen in the past [4 weeks/30 days]?	1 = Rarely (1–2 times) 2 = Sometimes (3–10 times) 3 = Often (more than 10 times)	**HS2a ____**
3	In the past [4 weeks/30 days], did you or any household member go a **whole day and night** without eating anything at all because there was not enough food?	0 = No (**Skip to section E.4**) 1 = Yes	**HS3 ____**
3a	**How often** did this happen in the past [4 weeks/30 days]?	1 = Rarely (1–2 times) 2 = Sometimes (3–10 times) 3 = Often (more than 10 times)	**HS3a ____**

E.3 In this household, who decides the foods to be cooked and consumed every day?

Fdecision…..... 1= Household head 2=Spouse 3=Both Household & spouse 4=children 5=House girl 6= other specify

E.4 Did you have access to any information on nutrition in the last one year? **Accninfo**……

1= Yes 0= No **(If No skip to E.6)**

E.5 If yes, where did you get that information on nutrition?

Srcentrninfo1…… **Srcentrninfo2**…… **Srcentrninfo3**…….

1= Health centers/hospitals 2= Other farmers 3= Community health officers

4= Media (TV & Radio) 5= Nutritional books and magazines 5= others specify.

E.6 Questions on nutritional knowledge of the woman (The *enumerator should tick the response given by the respondent)*

Nutrition-related statements .		Please **tick** the box that represents your answer on these nutrition-related statements		
		True	**False**	**Don't know**
Fruits and vegetables are rich in vitamins and minerals	**Nk1**			
Fish is a good source of protein.	**Nk2**			
Fruits provide vitamin C.	**Nk3**			
In order to stay healthy, one should consume a balanced diet.	**Nk4**			
Night blindness is caused by lack of vitamin A.	**Nk5**			
Protein-rich foods are needed to build and repair body tissues.	**Nk6**			
Vitamin D is provided by sun thus it is referred to as "sunlight vitamin"	**Nk7**			
Nutrients cannot be provided by just one kind of food.	**Nk8**			
At six months, babies should start eating foods in addition to breast milk.	**Nk9**			
One should drink a minimum of 1.5L of water per day.	**Nk10**			
We should use clean water to wash raw fruits and vegetables before eating them.	**Nk11**			
One should wash his /her hands before handling food.	**Nk12**			

SECTION F: SOCIAL NETWORK AND GROUP MEMBERSHIP

F.1 Do you belong to a farmer group/organization in the community? **Gmbershp**…….

1= Yes 0= No

F.2 In this village, do you have farmers whom you share agricultural information with? **Shareagrinfo**……....

1= Yes 0= No **(if No skip to F.4)**

F.3 If yes, provide the information below for the **TOP THREE FARMERS** whom you **frequently** talk/discuss with agricultural matters, for example, land issues, crops to grow, inputs to use among others.

Network_farmers_info.sav

	Name of network member (top 4 you mostly you interact)	Age (years)	Farm size (acres)	Distance to NM in Walking minutes	Communication frequency. (In terms of **number of days** she communicated with the network members in the last one month)
	Nmname	**Nmage**	**Nmfsize**	**Nmdist**	**Commfreqncy**
1					
2					
3					
4					

F.4 Question on social influence. *The enumerator should read the statements to the respondent and the respondent will indicate her level of agreeing or disagreeing with the statements.*

Sinfluence_nknowledge.sav

Social Influence		Please **tick** the box that represents your opinion in matters of access to land.				
		1=Strongly disagree	**2=Disagree**	**3=Neither agree or disagree**	**4=Agree**	**5=Strongly agree**
Those in my social circle think I (the woman) should have access to land.	**Sinflnce1**					
Our family members think I should have access to land.	**Sinflnce2**					
Our relatives think I should have access to land.	**Sinflnce3**					
Our friends think I should have access to land.	**Sinflnce4**					

People who are important to me think that I should have access to land.	**Sinflnce5**					
People who influence my behavior think I should have access to land.	**Sinflnce6**					
My peers at work think I should have access to land.	**Sinflnce7**					

F.6 What is the approximate distance from your homestead to the **nearest market** in walking minutes **Mrktdist**……

SECTION G: CREDIT AND EXTENSION ACCESS

G.1Did you (**the woman**) acquire any credit in the last **three years**? **Creditacc**……..

1= Yes 0= No **(If No skip to G.3)**

G.2 If yes, how much was it? **Amntcredit**.....

G.3 Did you receive any **extension services** in the last one year? **Extnacc**……

1=Yes 0= No **(If No skip to G.6)**

G.4 If yes, how many times in the last one year? The number of times in a year. **Nextn**……

G.5 You as the woman, where did you get agricultural information in the last one year **Srcesagrinfo**……

1=Others farmers 2=Farmers groups 3=Government extension workers 4=NGOs/ developmental agencies 4= Private extension workers 5= other specify.

G.6 Indicate the assets that the **household** owns and the ones that the **woman** owns, their number as well as their total current value (*if the household and the woman doesn't own any of the assets under number column write code 98*)

Hh assets_woman assets.sav

Asset Name	Number of all assets owned by the household	Total Current Value of assets owned by the household	Number of assets owned by the woman	Total current Value of assets owned by the woman
Assets	**Nhhassets**	**Vhhassets**	**Nwassets**	**Vwassets**
1. Radio				
2. Mobile phone				
3. Television				
4. Panga Knife				
5. Hoes				
6. Wheel Barrow				
7. Bicycle				
8. Ox-cart				
9. Ox-Ploughs				
10. Tractor				
11. Donkeys				
12. Moneymaker pump				
13. Generator				
14. Sewing machine				
15. Car				
16. Motorcycle				
17. Sheller				
18. Chaff cutter				
19. Sprayer pumps				
20. Beehives				
21. Solar panels				
22. Water tanks				
23. Batteries				
24. Others Specify				

SECTION H: PROGRESS OUT OF POVERTY INDICATOR (Pgpvty)

Progress_Poverty.sav

	Codes		Response
1. How many members does your household have?	1= Nine or more 2= Seven or eight 3= Six 4= Five 5=Four 6= Three 7= One or two	**Pvty1**	
2. What is the highest school grade that the respondent or spouse has completed?	0= None or pre-school 1= Primary standards 1 to 6 2= Primary standard 7 3= Primary standard 8 or secondary forms 1 to 3 4= Secondary form 4 or higher	**Pvty2**	
3. What kind of work is the main occupation of the male head/ spouse?	10= Does not work 1= No male head/spouse 2= Agriculture, hunting, forestry, fishing, mining, or quarrying 3=Any other	**Pvty3**	
4. How many habitable rooms does this household occupy?	1= One 2= Two 3= Three 4= Four or more	**Pvty4**	
5. What material is the floor of the house made of?	1= Wood, earth or other 2= Cement or tiles	**Pvty5**	
6. What is the main fuel used for lighting?	1= Collected firewood, purchased firewood, grass, or dry cell (torch) 2= paraffin, candles, biogas, or other 3= Electricity, solar, or gas	**Pvty6**	
7. Does your household own any electric or charcoal irons?	1= Yes 0= No	**Pvty7**	
8. How many mosquito nets does your household own?	0= None 1=One 2= Two or more	**Pvty8**	
9. How many frying pans does your household own?	0= None 1=One 2= Two or more	**Pvty9**	

END

Your participation in this study is greatly appreciated

Thank you.

Appendix II: Factor analysis for describing social influence constructs

Constructs	Items	Factor Loadings	*CR*	*AVE*	Kmo
Social influence	1. Those in my social circle think I (the woman) should have access to land.	0.8651			
	2. Our family members think I should have access to land.	0.9157			
	3. Our relatives think I should have access to land.	0.8669			
	4. Our friends think I should have access to land.	0.8945			
	5. People who are important to me think that I should have access to land.	0.9480			
	6. People who influence my behavior think I should have access to land.	0.9081			
	7. My peers at work think I should have access to land	0.9438	0.9064	0.6376	0.8439

Appendix III: Food groups used in the calculation of HDDS

	Food groups	Score
1.	Cereals	1
2.	Roots and tubers	1
3.	Vegetables	1
4.	Fruits	1
5.	Meat, poultry, offal	1
6.	Eggs	1
7.	Fish	1
8.	Pulses/legumes/nuts	1
9.	Milk and Milk products	1
10.	Oils/fats	1
11.	Sugar/honey	1
12.	Spices, condiments and beverages (miscellaneous)	1
Household Dietary Diversity Score (HDDS) is calculated by summing the number of food groups consumed in the household in the last 24-hours with a maximum score of 12 food groups per day.		

Appendix IV: Mean values for socioeconomic and institutional characteristics by propensity score strata

Variables	***Stratum 1 [.00-.20]***		***Stratum 2 [.20-.40]***		***Stratum 3 [.40-.60]***		***Stratum 4 [.60-.80]***		***Stratum 5 [.80-1.00]***	
	No access	*Access*	*No access*	*Access*	*No access*	*Access*	*No access*	*Access*	*No access*	*Access*
Age	38.64	41.85	42.26	39.14	41.32	41.11	44.83	50.02	52.00	49.05
Spousal age gap	6.64	5.54	5.02	6.33	4.74	5.71	5.61	3.61	3.00	3.32
Marital status	1.00	1.00	1.00	1.00	1.00	0.97	0.83	0.70	0.50	0.66
Schooling years	9.03	7.85	9.40	9.48	8.95	9.77	9.00	9.34	10.00	9.35
Household size	3.91	4.08	4.07	4.14	4.26	4.26	4.44	4.09	4.50	4.65
Household farm size	0.72	0.83	0.95	1.12	0.71	0.90	1.31	1.10	1.67	1.53
Women productive assets value(‘000)	2.39	2.45	5.55	4.12	4.64	4.19	6.09	4.82	5.41	7.27
Off -farm income (‘000)	21.65	11.67	49.05	70.77	28.26	33.77	37.59	37.72	37.17	52.28
Remittances(‘000)	3.56	2.04	7.07	14.10	4.11	8.57	18.56	10.34	8.00	12.23
Market distance	37.42	26.92	32.98	33.33	18.68	23.29	23.89	23.73	13.83	18.76
Amount of credit	1.00	1.00	1.00	1.00	264.11	1.00	1945.28	910.00	834.17	11890.77
Number of Extension contacts	0.06	0.00	0.36	0.48	0.00	0.43	1.28	1.05	1.83	2.01
Social influence from family members	-0.63	-1.37	-0.39	-0.39	0.23	0.34	-0.15	-0.11	-0.26	0.37
Social influence from friends/peers	0.54	1.10	0.22	0.07	0.16	-0.24	0.16	-0.06	-0.56	-0.22
Sources of information										
Other farmers[1]	0.00	0.00	0.02	0.00	0.00	0.03	0.11	0.09	0.17	0.41
Extension agents[1]	0.06	0.00	0.05	0.05	0.05	0.09	0.11	0.14	0.33	0.26

Note: No access refers to women who did not have access to land while access refers to those who had access to land; 1: the base category is farmers’ groups.

Appendix V: Stata Output

Testing for multicollinearity for continuous variables

```
. reg wlandac age_resp spage_gap yrschl_resp hhsize hhfsize mrktdist logamntcredit nextn  logvwass
> ets  logtamntoffinc  logremittances  fac1_1 fac2_1
```

Source	SS	df	MS	Number of obs	=	384
				F(13, 370)	=	10.54
Model	22.0860724	13	1.69892865	Prob > F	=	0.0000
Residual	59.6535109	370	.161225705	R-squared	=	0.2702
				Adj R-squared	=	0.2446
Total	81.7395833	383	.213419278	Root MSE	=	.40153

wlandac	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
age_resp	.0025973	.0018059	1.44	0.151	-.0009538	.0061485
spage_gap	-.0161103	.0056554	-2.85	0.005	-.0272311	-.0049895
yrschl_resp	-.0101754	.0072343	-1.41	0.160	-.0244008	.0040501
hhsize	.024932	.0167865	1.49	0.138	-.008077	.057941
hhfsize	.0226783	.0240742	0.94	0.347	-.0246611	.0700177
mrktdist	-.0054845	.0014048	-3.90	0.000	-.0082469	-.0027221
logamntcredit	.0156947	.0059228	2.65	0.008	.0040481	.0273414
nextn	.0535149	.0157899	3.39	0.001	.0224657	.084564
logvwassets	.0524539	.0184436	2.84	0.005	.0161865	.0887213
logtamntoffinc	-.0018063	.0055875	-0.32	0.747	-.0127936	.009181
logremittances	.0048727	.0052824	0.92	0.357	-.0055146	.0152599
fac1_1	.0722345	.0220136	3.28	0.001	.0289469	.115522
fac2_1	-.0634209	.021432	-2.96	0.003	-.1055647	-.021277
_cons	.2165084	.1927823	1.12	0.262	-.1625779	.5955947

```
. vif
```

Variable	VIF	1/VIF
yrschl_resp	1.68	0.596651
age_resp	1.63	0.615323
logremitta~s	1.50	0.668592
nextn	1.42	0.702519
logamntcre~t	1.41	0.710309
logtamntof~c	1.28	0.779979
hhfsize	1.28	0.783501
spage_gap	1.20	0.836283
logvwassets	1.19	0.843849
hhsize	1.13	0.882530
fac1_1	1.11	0.897845
mrktdist	1.11	0.901381
fac2_1	1.07	0.931075
Mean VIF	1.31	

Testing for multicollinearity for categorical variables (pairwise correlation)

	rmarit~s	srcesa~o
rmaritalst~s	1.0000	
srcesagrinfo	0.0190	1.0000

Testing for heteroskedasticity

```
. estat imtest

Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	195.10	104	0.0000
Skewness	65.34	13	0.0000
Kurtosis	31.56	1	0.0000
Total	292.00	118	0.0000

Factor analysis of social influence collected using a five point likert scale

```
. factor sinflnce1 sinflnce2 sinflnce3 sinflnce4 sinflnce5 sinflnce6 sinflnce7, pcf
(obs=384)

Factor analysis/correlation                      Number of obs    =        384
    Method: principal-component factors          Retained factors =          2
    Rotation: (unrotated)                        Number of params =         13
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	4.51589	2.93275	0.6451	0.6451
Factor2	1.58314	1.25942	0.2262	0.8713
Factor3	0.32371	0.10131	0.0462	0.9175
Factor4	0.22240	0.06496	0.0318	0.9493
Factor5	0.15744	0.03770	0.0225	0.9718
Factor6	0.11974	0.04206	0.0171	0.9889
Factor7	0.07768	.	0.0111	1.0000

```
LR test: independent vs. saturated:  chi2(21) = 2738.38 Prob>chi2 = 0.0000
```

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Uniqueness
sinflnce1	0.6828	0.5794	0.1981
sinflnce2	0.6646	0.6535	0.1312
sinflnce3	0.7063	0.5653	0.1816
sinflnce4	0.8876	-0.2895	0.1284
sinflnce5	0.8721	-0.4058	0.0748
sinflnce6	0.8992	-0.2967	0.1034
sinflnce7	0.8673	-0.4053	0.0835

. rotate

Factor analysis/correlation — Number of obs = 384
Method: principal-component factors — Retained factors = 2
Rotation: orthogonal varimax (Kaiser off) — Number of params = 13

Factor	Variance	Difference	Proportion	Cumulative
Factor1	3.56485	1.03067	0.5093	0.5093
Factor2	2.53418	.	0.3620	0.8713

LR test: independent vs. saturated: chi2(21) = 2738.38 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Uniqueness
sinflnce1	0.2313	0.8651	0.1981
sinflnce2	0.1742	0.9157	0.1312
sinflnce3	0.2587	0.8669	0.1816
sinflnce4	0.8945	0.2675	0.1284
sinflnce5	0.9480	0.1630	0.0748
sinflnce6	0.9081	0.2681	0.1034
sinflnce7	0.9438	0.1608	0.0835

Factor rotation matrix

	Factor1	Factor2
Factor1	0.8220	0.5695
Factor2	-0.5695	0.8220

. alpha sinflnce1 sinflnce2 sinflnce3 sinflnce4 sinflnce5 sinflnce6 sinflnce7

Test scale = mean(unstandardized items)

Average interitem covariance: .637632
Number of items in the scale: 7
Scale reliability coefficient: 0.9064

```
. estat kmo

Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
sinflnce1	0.8397
sinflnce2	0.7706
sinflnce3	0.8186
sinflnce4	0.8937
sinflnce5	0.8430
sinflnce6	0.8719
sinflnce7	0.8397
Overall	0.8439

Descriptive statistics and objective one results (*chi*^{2} results)

```
. **********Descriptive statistics- t test and chi-square test***
.
. ****Ttest for continous variables****
. ttest age_resp , by(wlandac)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	118	41.98305	1.313023	14.26309	39.38268	44.58342
1	266	47.0188	.8790116	14.33625	45.28806	48.74953
combined	384	45.47135	.7390947	14.48324	44.01816	46.92455
diff		-5.035746	1.583219		-8.148662	-1.92283

```
    diff = mean(0) - mean(1)                                      t =  -3.1807
Ho: diff = 0                                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0008         Pr(|T| > |t|) = 0.0016          Pr(T > t) = 0.9992

. ttest spage_gap, by(wlandac)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	118	5.415254	.3372921	3.66393	4.747265	6.083244
1	266	4.052632	.247136	4.030667	3.566032	4.539232
combined	384	4.471354	.2024465	3.967125	4.073308	4.8694
diff		1.362623	.4338003		.5096872	2.215558

```
    diff = mean(0) - mean(1)                                      t =   3.1411
Ho: diff = 0                                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9991         Pr(|T| > |t|) = 0.0018          Pr(T > t) = 0.0009
```

```
. ttest yrschl_resp , by(wlandac)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	118	9.194915	.2853968	3.100203	8.629702	9.760129
1	266	9.37218	.2392876	3.902662	8.901034	9.843327
combined	384	9.317708	.1873683	3.671654	8.949309	9.686108
diff		-.1772652	.4065418		-.976605	.6220746

```
    diff = mean(0) - mean(1)                                      t =  -0.4360
Ho: diff = 0                                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.3315         Pr(|T| > |t|) = 0.6631          Pr(T > t) = 0.6685

. ttest hhsize , by(wlandac)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	118	4.135593	.1041756	1.131637	3.929279	4.341908
1	266	4.432331	.0834837	1.361578	4.267955	4.596707
combined	384	4.341146	.0663936	1.301044	4.210604	4.471687
diff		-.2967376	.1432911		-.5784756	-.0149996

```
    diff = mean(0) - mean(1)                                      t =  -2.0709
Ho: diff = 0                                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0195         Pr(|T| > |t|) = 0.0390          Pr(T > t) = 0.9805

. ttest hhfsize , by(wlandac)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	118	.9377119	.0681972	.7408108	.802651	1.072773
1	266	1.309586	.0629733	1.027064	1.185595	1.433578
combined	384	1.195312	.0491338	.9628227	1.098707	1.291918
diff		-.3718746	.1049233		-.5781742	-.165575

```
    diff = mean(0) - mean(1)                                      t =  -3.5443
Ho: diff = 0                                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0002         Pr(|T| > |t|) = 0.0004          Pr(T > t) = 0.9998
```

```
. ttest vwassets , by(wlandac)

Two-sample t test with equal variances

------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     118    4596.466    613.5611    6664.98    3381.34    5811.592
       1 |     266    6001.992    420.4235     6856.9    5174.197    6829.788
---------+--------------------------------------------------------------------
combined |     384    5570.086    348.0719    6820.789    4885.715    6254.457
---------+--------------------------------------------------------------------
    diff |           -1405.526    751.9851               -2884.075    73.02188
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.8691
Ho: diff = 0                                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0312         Pr(|T| > |t|) = 0.0624          Pr(T > t) = 0.9688

. ttest tamntoffinc , by(wlandac)

Two-sample t test with equal variances

------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     118    35685.81    5698.449       61901    24400.33    46971.29
       1 |     266    47080.62    3777.767    61613.51    39642.36    54518.88
---------+--------------------------------------------------------------------
combined |     384    43579.09    3156.042    61845.54    37373.75    49784.43
---------+--------------------------------------------------------------------
    diff |           -11394.81    6824.659               -24813.41    2023.794
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.6697
Ho: diff = 0                                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0479         Pr(|T| > |t|) = 0.0958          Pr(T > t) = 0.9521

. ttest remittances , by(wlandac)

Two-sample t test with equal variances

------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     118    7410.839    1442.978    15674.75    4553.097    10268.58
       1 |     266    10953.67    1193.731    19469.17    8603.261    13304.07
---------+--------------------------------------------------------------------
combined |     384    9864.984    940.9674    18439.12    8014.876    11715.09
---------+--------------------------------------------------------------------
    diff |           -3542.826    2034.108               -7542.277     456.624
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.7417
Ho: diff = 0                                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0412         Pr(|T| > |t|) = 0.0824          Pr(T > t) = 0.9588
```

```
. ttest nextn , by(wlandac)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	118	.4322034	.1038717	1.128336	.2264908	.6379159
1	266	1.424812	.0990089	1.614786	1.229868	1.619756
combined	384	1.119792	.0791124	1.55028	.9642427	1.275341
diff		-.9926086	.1640136		-1.315091	-.6701262

```
    diff = mean(0) - mean(1)                                      t =  -6.0520
Ho: diff = 0                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000

. ttest mrktdist , by(wlandac)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	118	29.55932	1.609877	17.48775	26.37104	32.7476
1	266	21.79323	.8415682	13.72556	20.13622	23.45024
combined	384	24.17969	.7850223	15.38323	22.63619	25.72318
diff		7.766089	1.65674		4.508617	11.02356

```
    diff = mean(0) - mean(1)                                      t =   4.6876
Ho: diff = 0                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000

. ttest amntcredit , by(wlandac)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	118	382.3136	182.0881	1977.983	21.69761	742.9295
1	266	7042.023	1005.969	16406.86	5061.313	9022.732
combined	384	4995.549	716.0937	14032.51	3587.582	6403.517
diff		-6659.709	1516.315		-9641.078	-3678.34

```
    diff = mean(0) - mean(1)                                      t =  -4.3920
Ho: diff = 0                     degrees of freedom =      382

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

```
. ******chi-square test for categorical variables***
. tab rmaritalstatus wlandac, chi2
```

Rmaritalstatus	Wlandac 0	1	Total
0	6	64	70
1	112	202	314
Total	118	266	384

Pearson chi2(1) = 19.7446 Pr = 0.000

```
. tab shareagrinfo wlandac, chi2
```

Shareagrinfo	Wlandac 0	1	Total
0	105	175	280
1	13	91	104
Total	118	266	384

Pearson chi2(1) = 22.2658 Pr = 0.000

```
.
.
. tab wlenteprses wlandac, chi2
```

Wlenteprses	Wlandac 0	1	Total
0	39	0	39
2	0	64	64
3	0	25	25
4	79	2	81
5	0	123	123
7	0	52	52
Total	118	266	384

Pearson chi2(5) = 374.8363 Pr = 0.000

Double hurdle model results-Objective two

```
. **************DOUBLE HURDLE MODEL_craggit estimation**************************
.
. ***************ANALYSIS FOR OBJECTIVE TWO************************************
. xi: craggit  wlandac age_resp spage_gap yrschl_resp hhsize hhfsize mrktdist logamntcredit nextn
>  logvwassets  logtamntoffinc  logremittances  fac1_1 fac2_1  rmaritalstatus  i.srcesagrinfo , se
> cond(extwlndac age_resp spage_gap yrschl_resp  hhsize hhfsize  mrktdist logamntcredit nextn   lo
> gvwassets  logtamntoffinc logremittances   fac1_1 fac2_1  rmaritalstatus   i.srcesagrinfo ) vce(
> robust)

                                                Number of obs     =        384
                                                Wald chi2(16)     =     109.73
Log pseudolikelihood = -358.18447               Prob > chi2       =     0.0000
```

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tier1						
age_resp	.0020207	.0067579	0.30	0.765	-.0112245	.0152659
spage_gap	-.0373448	.0221573	-1.69	0.092	-.0807724	.0060828
yrschl_resp	-.0369613	.0271158	-1.36	0.173	-.0901072	.0161846
hhsize	.1177204	.062991	1.87	0.062	-.0057396	.2411804
hhfsize	.1470914	.1121272	1.31	0.190	-.0726738	.3668566
mrktdist	-.0173027	.0052795	-3.28	0.001	-.0276504	-.006955
logamntcredit	.102267	.0280079	3.65	0.000	.0473725	.1571615
nextn	.1496789	.068474	2.19	0.029	.0154724	.2838855
logvwassets	.1492958	.0719331	2.08	0.038	.0083095	.290282
logtamntoffinc	-.013832	.0208891	-0.66	0.508	-.0547738	.0271099
logremittances	.022099	.0205868	1.07	0.283	-.0182505	.0624484
fac1_1	.2608761	.0901708	2.89	0.004	.0841445	.4376076
fac2_1	-.1955518	.0916363	-2.13	0.033	-.3751557	-.0159479
rmaritalstatus	-.9657952	.3088543	-3.13	0.002	-1.571139	-.360452
_Isrcesagri_2	.5825572	.3213346	1.81	0.070	-.047247	1.212361
_Isrcesagri_3	.2760897	.2649597	1.04	0.297	-.2432216	.7954011
_cons	.0481829	.8241777	0.06	0.953	-1.567176	1.663542
Tier2						
age_resp	-.0025541	.0059382	-0.43	0.667	-.0141928	.0090845
spage_gap	.0275085	.0192498	1.43	0.153	-.0102204	.0652374
yrschl_resp	-.0339484	.0218962	-1.55	0.121	-.0768642	.0089674
hhsize	.0067969	.0441544	0.15	0.878	-.0797441	.0933379
hhfsize	.8292054	.0803704	10.32	0.000	.6716824	.9867284
mrktdist	-.0020527	.005601	-0.37	0.714	-.0130304	.008925
logamntcredit	-.0000422	.0192812	-0.00	0.998	-.0378326	.0377483
nextn	.0826794	.0807788	1.02	0.306	-.075644	.2410028
logvwassets	.0452156	.068734	0.66	0.511	-.0895007	.1799318
logtamntoffinc	-.0282417	.0128804	-2.19	0.028	-.0534868	-.0029966
logremittances	-.0406874	.020065	-2.03	0.043	-.0800142	-.0013607
fac1_1	.1285535	.0937783	1.37	0.170	-.0552487	.3123556
fac2_1	-.1652664	.0615977	-2.68	0.007	-.2859956	-.0445371
rmaritalstatus	-.2329605	.1992931	-1.17	0.242	-.6235677	.1576467
_Isrcesagri_2	-.121707	.2410669	-0.50	0.614	-.5941894	.3507755
_Isrcesagri_3	-.0970318	.2036226	-0.48	0.634	-.4961247	.3020611
_cons	-.0272245	.6660882	-0.04	0.967	-1.332733	1.278284
sigma						
_cons	.7974238	.1252967	6.36	0.000	.5518468	1.043001

Heterogeneous treatment effect model results-Objective three

Propensity scores estimation

```
**************************************************
Algorithm to estimate the propensity score
**************************************************


The treatment is wlandac
```

Wlandac	Freq.	Percent	Cum.
0	118	30.73	30.73
1	266	69.27	100.00
Total	384	100.00	

```
Estimation of the propensity score

Iteration 0:   log likelihood = -236.89594
Iteration 1:   log likelihood =  -172.4466
Iteration 2:   log likelihood = -165.81284
Iteration 3:   log likelihood = -165.23523
Iteration 4:   log likelihood = -165.22451
Iteration 5:   log likelihood = -165.22451

Probit regression                                 Number of obs   =        384
                                                  LR chi2(16)     =     144.80
                                                  Prob > chi2     =     0.0000
Log likelihood =  -165.2279                       Pseudo R2       =     0.3047
```

Wlandac	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
age_resp	.002008	.0070841	0.28	0.777	-.0118766	.0158925
spage_gap	-.0373567	.024484	-1.53	0.127	-.0853445	.0106311
yrschl_resp	-.0370216	.0296111	-1.25	0.211	-.0950583	.021015
Hhsize	.1178377	.0657581	1.79	0.073	-.0110458	.2467213
Hhfsize	.1471818	.1106395	1.33	0.183	-.0696677	.3640313
Mrktdist	-.0173089	.005389	-3.21	0.001	-.0278712	-.0067466
logAmntcre~t	.1022588	.0323943	3.16	0.002	.0387671	.1657505
Nextn	.1496901	.0714111	2.10	0.036	.009727	.2896532
logVwassets	.1493707	.0763741	1.96	0.050	-.0003198	.2990612
logTamntof~c	-.0138696	.0220866	-0.63	0.530	-.0571585	.0294193
logremitta~s	.0221118	.0206535	1.07	0.284	-.0183684	.062592
FAC1_1	.2608091	.0830541	3.14	0.002	.0980261	.4235921
FAC2_1	-.195812	.0873111	-2.24	0.025	-.3669386	-.0246855
Rmaritalst~s	-.9663877	.2953916	-3.27	0.001	-1.545345	-.3874308
_ISrcesagr~2	.5826621	.3415304	1.71	0.088	-.0867252	1.252049
_ISrcesagr~3	.2767131	.2783932	0.99	0.320	-.2689276	.8223537
_cons	.0491339	.7787391	0.06	0.950	-1.477167	1.575434

Homogeneous effects of women access to land on household nutritional outcomes

```
. *****HOMOGENOUS EFFECTS OF WOMEN ACCESS TO LAND ON HOUSEHOLD NUTRITIONAL OUTCOMES**********
. poisson hdds wlandac

Iteration 0:   log likelihood = -756.79239
Iteration 1:   log likelihood = -756.79235

Poisson regression                                Number of obs     =        384
                                                  LR chi2(1)        =      78.76
                                                  Prob > chi2       =     0.0000
Log likelihood = -756.79235                       Pseudo R2         =     0.0495

------------------------------------------------------------------------------
        hdds |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     wlandac |   .3970841   .0462849     8.58   0.000     .3063674    .4878008
       _cons |   1.636195   .0406222    40.28   0.000     1.556577    1.715814
------------------------------------------------------------------------------

. poisson hdds wlandac p

Iteration 0:   log likelihood = -756.31849
Iteration 1:   log likelihood = -756.31846

Poisson regression                                Number of obs     =        384
                                                  LR chi2(2)        =      79.71
                                                  Prob > chi2       =     0.0000
Log likelihood = -756.31846                       Pseudo R2         =     0.0501

------------------------------------------------------------------------------
        hdds |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     wlandac |   .3682249   .0550119     6.69   0.000     .2604036    .4760462
           p |    .087608   .0902135     0.97   0.331    -.0892071    .2644231
       _cons |   1.595241     .05868    27.19   0.000      1.48023    1.710252
------------------------------------------------------------------------------



. poisson hhs wlandac

Iteration 0:   log likelihood = -430.95814
Iteration 1:   log likelihood = -430.95545
Iteration 2:   log likelihood = -430.95545

Poisson regression                                Number of obs     =        384
                                                  LR chi2(1)        =     127.76
                                                  Prob > chi2       =     0.0000
Log likelihood = -430.95545                       Pseudo R2         =     0.1291

------------------------------------------------------------------------------
         hhs |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     wlandac |  -1.416011   .1289769   -10.98   0.000    -1.668801   -1.163221
       _cons |   .3651138   .0766965     4.76   0.000     .2147914    .5154362
------------------------------------------------------------------------------
```

```
. poisson hhs wlandac p

Iteration 0:   log likelihood = -430.75372
Iteration 1:   log likelihood = -430.75103
Iteration 2:   log likelihood = -430.75103

Poisson regression                              Number of obs     =        384
                                                LR chi2(2)        =     128.17
                                                Prob > chi2       =     0.0000
Log likelihood = -430.75103                     Pseudo R2         =     0.1295
```

hhs	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
wlandac	-1.477163	.1606667	-9.19	0.000	-1.792064	-1.162262
p	.1855521	.2904738	0.64	0.523	-.3837661	.7548703
_cons	.2779728	.1575367	1.76	0.078	-.0307936	.5867391

Heterogeneous effects of women access to land on household nutritional outcomes

```
. *****HETEROGENEOUS EFFECTS OF WOMEN ACCESS TO LAND ON HOUSEHOLD NUTRITIONAL OUTCOMES***********
> *****************
. xi:hte  hdds wlandac age_resp spage_gap yrschl_resp hhsize hhfsize mrktdist logamntcredit nextn
>  logvwassets  logtamntoffinc  logremittances  fac1_1 fac2_1  rmaritalstatus  i.srcesagrinfo  , n
> umblo(3) blockid(wa)
i.srcesagrinfo    _Isrcesagri_1-3     (naturally coded; _Isrcesagri_1 omitted)

                                                Number of obs =     384
```

hdds	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
TE by strata						
1	2.044289	.32159	6.36	0.000	1.413984	2.674594
2	2.809524	.2945549	9.54	0.000	2.232207	3.386841
3	2.01203	.2664975	7.55	0.000	1.489705	2.534356
4	2.366162	.3325373	7.12	0.000	1.7144	3.017923
5	2.238562	.4893277	4.57	0.000	1.279497	3.197627
Linear trend						
_slope	-.0128693	.1176788	-0.11	0.913	-.2435156	.2177769
_cons	2.328581	.3510658	6.63	0.000	1.640505	3.016658

TE = treatment effect

```
. xi:hte  hhs wlandac age_resp spage_gap yrschl_resp hhsize hhfsize mrktdist logamntcredit nextn
> logvwassets  logtamntoffinc  logremittances  fac1_1 fac2_1  rmaritalstatus  i.srcesagrinfo  , nu
> mblo(3) blockid(wa)
i.srcesagrinfo    _Isrcesagri_1-3     (naturally coded; _Isrcesagri_1 omitted)

                                                      Number of obs =     384
```

hhs	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
TE by strata						
1	-.9324009	.4814332	-1.94	0.053	-1.875993	.0111907
2	-1.095238	.363986	-3.01	0.003	-1.808637	-.3818387
3	-1.8	.3435938	-5.24	0.000	-2.473431	-1.126569
4	-.9343434	.3372742	-2.77	0.006	-1.595389	-.2732981
5	-.4738562	.2971946	-1.59	0.111	-1.056347	.1086344
Linear trend						
_slope	.1761168	.1169383	1.51	0.132	-.053078	.4053117
_cons	-1.611341	.4250801	-3.79	0.000	-2.444483	-.7781998

TE = treatment effect

Appendix VI: Research permit

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: 020 400 7000,
0713 788787,0735404245
Fax: +254-20-318245,318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KEN

Ref: No. **NACOSTI/P/17/29753/19369** Date: **11th October, 2017**

Veronica Njeri Kariuki
Egerton University
P.O. Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effects of women access to land on nutritional outcomes among small-scale farmers in Machakos County,Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Machakos County** for the period ending **10th October, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Machakos County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Machakos County.

The County Director of Education
Machakos County.

THIS IS TO CERTIFY THAT:
MISS. VERONICA NJERI KARIUKI
of EGERTON UNIVERSITY, NJORO MAIN CAMPUS, 0-100 Nairobi,has been permitted to conduct research in *Machakos County*

on the topic: *EFFECTS OF WOMEN ACCESS TO LAND ON NUTRITIONAL OUTCOMES AMONG SMALL-SCALE FARMERS IN MACHAKOS COUNTY, KENYA.*

for the period ending:
10th October,2018

.....
Applicant's Signature

Permit No : NACOSTI/P/17/29753/19369
Date Of Issue : 11th October,2017
Fee Recieved :Ksh 1000

.....
Director General
National Commission for Science, Technology & Innovation

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RESEARCH CLEARANCE PERMIT

Serial No.A 16107

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