GENDERED ANALYSIS OF RISK ATTITUDES AND VEGETABLE COMMERCIALIZATION AMONG SMALLHOLDER FARMERS IN KILIFI COUNTY

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DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has not been presented in part or whole for the award of degree in any institution.

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Recommendation

This thesis has been submitted to the graduate School of Egerton University with our approval as university supervisors.

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DEDICATION

I dedicate this work to my loving parents, late mother Victorianna Kadzo Ruwa, brother Steven Konde and the entire Ruwa family for their sincere support.

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ABSTRACT

Commercialization has potential of enabling rural households to advance in vegetable production through better access to financial services, and enriched market coordination and participation. In recent years, there have been efforts to boost vegetable commercialization particularly among smallholder female farmers in Kilifi County. Since risk attitudes vary from male to female farmers, the differences in risks and risk perceptions of farmers may in part explain the unwillingness of farmers to participate in vegetable commercialization. The existing literature on gender and risk attitudes in agricultural commercialization has been scanty among smallholder farmers. The general objective of the study is to contribute towards improved livelihood through enhanced vegetable commercialization among male and female smallholder farmers in Kilifi County. Multistage sampling procedure was used to select a sample of 332 smallholder vegetable farmers in Jilore and Kakuyuni wards of Malindi Sub-County, in Kilifi County. Primary data was collected through face-to-face interviews by use of a pre-tested semi-structured questionnaire. Analyses were carried out using STATA statistical software version 14. Gender was categorized – based on who manages the vegetable farms – into male managed (37%), female managed (24%) and joint-management (39%). The Eckel and Grossman model was much preferred for eliciting risk attitudes of farmers. The results showed that 61% of the farmers were risk averse, 18% risk neutral and 21% risk loving. Among the risk averse, joint-management farmers were the most risk averse (44%) compared to male (34%) and female farmers (22%). Risk attitudes of farmers were positively influenced by age, group membership, household size, number of school years, off-farm activities and location dummy. On the other hand, Risk attitudes were influenced negatively by contact with extension agent, access to credit and the interaction term between group membership and level of trust. Additionally, the mean Household Commercialization Index (HCI) for all farmers was 0.74 suggesting that farmers were commercial oriented. Female farmers were found to have a lower HCI of 0.70 compared to male and joint-management who each had an HCI value of 0.75. Tobit model results revealed that risk attitude, household size, farm size, farm assets, access to credit, production information and social capital influenced the intensity of vegetable commercialization. The study therefore recommends policies and programs that will minimize the gravity of financial risks, promote access and ownership of productive resources and implementation of appropriate risk mitigation measures tailored to the needs of rural farmers, particularly among women, so as to enhance vegetable production and commercialization in Kilifi County.

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LIST OF ACRONYMS AND ABBREVIATIONS

AIVs	African Indigenous Vegetables
AVE	Average Variance Extracted
CE	Certainty Equivalent
CIDP	County Integrated Development Plan
CR	Composite Reliability
CRRA	Constant Relative Risk Aversion
ELCEM	Equally Likely Certainty Equivalent Model
EUT	Expected Utility Theorem
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GoK	Government of Kenya
HCI	Household Commercialization Index
KMO	Kaiser-Meyer-Olkin
KNBS	Kenya National Bureau of Statistics
KES	Kenyan Shillings
MoALF	Ministry of Agriculture, Livestock and Fisheries
NLS	Non-linear Least Squares
SDGs	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
UN	United Nations

CHAPTER ONE
INTRODUCTION

1.1 Background of study

Agriculture is the key contributor to the Kenyan economy, accounting for 26 percent of the Gross Domestic Product (GDP) annually. It provides employment to about 80 percent of the rural labour force and over 18 percent in formal employment (MoALF, 2017). However, the sector exhibited a slow growth rate of 1.6 percent in Real Gross Value Added, from KES 879.6 billion in 2016 to KES 893.3 billion in 2017. This was as a result of prolonged drought and pest and disease infestation that reduced both crop and livestock production. (KNBS, 2018). Horticulture is a major subsector in agriculture with key exports being flowers, fruits and vegetables. Revenues from horticultural exports increased by 13.6 percent, from KES 101.5 billion in 2016 to KES 115.3 billion in 2017, whereby both flowers and vegetable exports entailed 71.3 percent and 23.3 percent, respectively, in total horticultural export earnings. The increase was attributed to better prices in vegetables and flowers in the export market (KNBS, 2018).

Majority of farmers in Kenya are smallholders who produce domestic food for local consumption. A large percentage of them engage in subsistence farming, with commercial agriculture practiced by a few. This is due to the resource-poor nature of these farmers. Most of them live in the rural areas and because of high poverty levels they cannot afford production inputs such as certified seeds, fertilizer, financial resources and land (Betek and Jumbam, 2015). In addition, extension services are limited due to a relatively low number of extension officers and the technology that is disseminated to farmers is sometimes expensive or inappropriate for them (Betek and Jumbam, 2015; Todaro and Smith, 2015). This largely explains why agriculture continue to lag behind in third world countries.

Agricultural enterprises are faced with shocks that constitute risks (Niane and Burger, 2012). Li (2014) defined risk as a precarious event that could exhibit undesirable outcomes. Contemporary farming decisions made by households are majorly governed by how farmers comprehended risk, and their capacity to deal with that risky situation (Hagos and Geta, 2016). Smallholder farmers are subjected to various kinds of risks. Global warming and rapid climate changes causes risks of unpredictable weather patterns, especially when rain fed agriculture is a common practice (Binswanger-Mkize, 2013). Delayed or short rainy seasons is a common trend. Widespread crop diseases and pests, post-harvest losses and

environmental calamities such as drought, earth quakes, floods and famine usually affect crop production. These are termed as production risks. These risks influence the amount and quality of vegetable yield (Ayinde, 2016). Furthermore, threats to farmers may emerge from poor market organization caused by imperfect information, poor infrastructure, inadequate institutional support, and high associated transaction costs (Okoye *et al.,* 2016). Disturbances in policy implementations such as changes in taxation and government expenditure patterns, as well as price instabilities influenced how marketing decisions are carried out in the household (Binswanger-Mkize, 2013; Campenhout *et al*., 2016). These threats, termed as price risks, have a macro effect on the economy that consequently influences prices of inputs and vegetable output that farmers encounter in the market.

Farmers tend to have a positive risk attitude towards agricultural practices that are easier to comprehend and adopt. For instance, agricultural innovations that are associated with minimal production risks and require less amounts of capital are more likely to be perceived positively. A decrease in production risks is associated with higher yields (Murage *et al*., 2015; Zeweld *et al.,* 2017). Generally, risk attitudes of farmers differ over space and time and also depending on the enterprise under consideration. While some studies depict farmers to be highly risk averse (Niane and Burger, 2012; Haneishi *et al.,* 2014), other studies portray farmers to be risk neutral (Ayinde, 2016). These attitudes can influence resource allocation and quantity of produce to be sold in successive vegetable production cycles. The more risk averse farmers are, the less likely for them to use optimal levels of inputs (Niane and Burger, 2012). When off-farm income of farmers increases they became less willing to partake risky decisions in agriculture (Ayinde, 2016), on the contrary, farmers who cannot access financial aid, inputs or lack risk coping mechanisms prefer less risky agricultural decisions (Campenhout *et al*., 2016).

In terms of gender, the attitude towards risk differs from male to female farmers. Women cultivate vegetables primarily for household consumption and retail any surplus either to their immediate neighbors, local markets or through kiosks where consumers dwell. In most cases small scale vegetable production is carried out to supplement household income and women often provide much of the required labour (Ali, 2015; Muriithi, 2015; Torimiro *et al*., 2016; Oduol *et al.,* 2017). In the African setting, men usually have access to resources like land, farm equipment and credit. Their position in the household with resources at their disposal, they are able to control decisions, and that permits them to be more risk takers compared to their female counterparts (Niane and Burger, 2012; Meijer *et al*., 2015). From a cultural

perspective, chauvinistic behaviour discriminately favors men. While many women perceive production risks as major constraints, men mainly recognize marketing risks as threats to agricultural commercialization. Introduction of agricultural innovations that minimize production risks may be positively perceived by women compared to men (Murage *et al*., 2015; Kiratu *et al.,* 2016).

Gender disparities in resource distribution further leads to different agricultural commercialization decisions in the household. Women are undermined owing to the stereotypic notion that confine them to household chores and provision of agricultural labour (Fischer and Qaim, 2012a). While men engage in cash crop farming or non-farm activities, which is associated with higher incomes, women are often confined to subsistence production. Women undertake most of the production decisions while men take control of the marketing decisions, in the household. Joint decision making is uncommon as women are not involved. The result is inefficiencies in production as information from the market is not incorporated in the planning of successive planting seasons (Fischer and Qaim, 2012a; Rao and Qaim, 2013; FAO, 2014; Chege *et al*., 2015). Moreover, better access to resources and higher incomes among male farmers increases their likelihood of engaging in riskier agricultural decisions, such as investments in improved technology (Campenhout *et al*., 2016). These issues have aggravated efforts of empowering women to encourage them to undertake risky, but profitable agricultural decisions in the household.

Women represented 52 percent of the population in Kilifi County, with gender inequality being extremely high (GoK, 2013). Food insecurity in the County is high with crop failure on the rise. Vegetable farming is majorly practiced under irrigation. Despite public interventions on expansion of irrigation schemes, commercial vegetable farming is still limited. The percentage of households consuming vegetables in 2016 (67%) is estimated to have increased compared to the previous year (58%), whereas nearly all the food commodities are obtained from other neighboring counties, such as Mombasa and Taita-Taveta (Oyugi *et al*., 2016).

1.2 Statement of the problem

Vegetable commercialization has the potential to increase household income and subsequently enhance livelihood among smallholder farmers, as it is a high value crop. Recently, in Kilifi County, there has been proliferation of male and female smallholder farmers venturing in commercial vegetable production as a livelihood strategy due to the increasing demand for the produce both within the County and in the neighboring towns.

However, the level of vegetable commercialization particularly among female farmers remains relatively low. A myriad of risks and farmers' perceptions towards those risks could partly explain the trend. Preferences towards risks determine how farmers behave in the presence of risks, which influences their decision making and economic progress in the household. These risk attitudes affect how capital is allocated in production and ultimately influence commercialization of vegetables. Since, risk attitudes differ from male to female farmers, these differences result into diverse outcomes in management and resource allocation on vegetable farming, affecting the level of commercialization. However, information regarding the link between risk attitudes and vegetable commercialization is scarce in the empirical literature as it remains unclear how risk attitudes of farmers may affect the level of vegetable commercialization. Moreover, there are limited studies specifically analyzing the role of risk attitudes through gender lens. It is from this context that the present study aims to fill this knowledge gap by determining the role of risk attitude in vegetable commercialization among male and female smallholder farmers in Kilifi County.

1.3 Objective

1.3.1 General objective

The general objective is to contribute towards improved livelihood through enhanced vegetable commercialization among male and female smallholder farmers in Kilifi County.

1.3.2 Specific objectives

i. To determine the relationship between gender and perceived risks of commercial oriented smallholder farmers.
ii. To determine socio-economic and institutional factors influencing male and female vegetable farmers' attitudes towards risk.
iii. To determine the influence of risk attitude on the level of vegetable commercialization among male and female smallholder farmers.

1.4 Research questions

i. How does the relationship between gender and perceived risks affect commercialization of vegetable by commercial oriented farmers?
ii. How do socio-economic and institutional factors influence male and female vegetable farmers' attitudes towards risk?
iii. How does risk attitude influence the level of vegetable commercialization among male and female smallholder farmers?

1.5 Justification

Vegetable farming is extensively practiced in Kenya with commercial agriculture being the driving force in uplifting rural poor smallholder farmers. The prominence of vegetable commercialization has generated employment avenues and improved food security and incomes for smallholder farmers (Muriithi, 2015; Torimiro *et al*., 2016). Gender inequality has traditionally been a challenge in the agricultural industry, from income disparities to resource discrimination (Meijer *et al*., 2015; Muriithi, 2015; Torimiro *et al*., 2016). Thus, results from this study will contribute in the formulation and implementation of better policies especially those related to women empowerment, creation of employment, and provision of opportunities for growth to resource-poor smallholder farmers, as per the Kenyan Vision 2030 and Kilifi County Integrated Development Plan (CIDP), 2018-2022. Additionally, this research will offer beneficial information that will assist in improvement of smallholders' living standards, in accordance with the Sustainable Development Goals (SDGs).

Furthermore, projects under the Ministry of Agriculture, Livestock and Fisheries (MoALF, 2015), such as the Urban and Peri-urban Agriculture Project offer opportunities to women to initiate agricultural enterprises. The National Horticulture Policy of 2012 also strives to empower women in the horticultural sector through its policy interventions. Sadly, majority of women still do not have an opinion on how vegetable incomes are spent, as the proceeds fall in the hands of their male counterparts or spouses. It is in this context, that the present study, which is in line with current agricultural policies, aims at assessing women's role in agriculture while providing their views about vegetable commercialization, risks they face as well as decision making roles in the household. Findings from this study will enhance promotion of the vegetable sector as well as increase female participation in domestic and high value vegetable markets. For this reason, this research will be of great value to smallholder farmers of Kilifi County, fellow researchers and policy makers.

1.6 Scope and limitations of the study

This study only addresses the role of risk attitude in vegetable commercialization, using a gendered analysis among smallholder farmers. The research is conducted in Kilifi County. It is limited to smallholder farmers who produce and retail vegetables. Vegetables that are considered for the study include; Tomatoes, Okra, African night shade, Eggplant and Leaf Amaranthus, since they are the major horticultural crops cultivated in the study area. The type of data collected is cross sectional data where a semi-structured questionnaire was used to

collect information on farmers' risk perceptions. This study is however limited by smallholder farmers' inadequacy to provide precise information concerning their risk behaviour and commercialization trends due to poor record keeping. Though intense questioning and examining during data collection improved the precision of data collected. In addition, the study did not consider time preference of money in the elicitation of risk attitudes as it would be too complex for rural farmers to understand.

1.7 Operational definition of terms

Commercialization: It is the use of modern technologies and market opportunities in agriculture so as to increase revenues (Muriithi, 2015). In this study the term refers to retailing of vegetables by smallholder farmers in order to earn profit

Commercialization decisions: These are resolutions by farmers influenced by gender on the level of commercial agriculture and subsequent assessments of their production and marketing choices in the household.

Gender: It refers to social characteristics associated with being a man or woman and the affiliation among themselves. It defines the roles that men and women play in the society, (UN, 2001).

Risk: In the context of this study, risk is any event that has a negative implication to the farmer but whose likelihood of occurrence is not known with certainty. For instance, weather variability, price fluctuations, transportation hurdles and other marketing uncertainties.

Risk attitudes: This is how farmers behave towards risks which affect how they make household decisions concerning production and marketing of vegetables. An example is a farmer can decide not to undertake commercialization decisions because he or she anticipates a decline in prices.

Risk preference: This is the degree to which a farmer is willing and ready to accept risk in the course of their vegetable commercialization.

Smallholder: In this study, the term refers to a farmer cultivating not more than five acres of land and engaging in production and commercialization of vegetables (GoK, 2013).

CHAPTER TWO
LITERATURE REVIEW

2.1 Vegetable commercialization

Commercialization improves incomes and living standards of smallholder farmers in a country. Through commercial agriculture, farmers are able to access credit services, market information, extension services, technology among others, which eventually increases productivity and welfare of farmers (Muriithi and Matz 2015; Ochieng *et al.*, 2016). Vegetable commercialization in established outlets such as supermarkets, groceries and open-air markets has increased food security and enhanced nutrition at the household level boosting the Kenyan economy (Chege *et al*., 2015).

According to Todaro (2015), vegetable commercialization can be classified into three categories. First is the traditional or subsistence farming where farmers are majorly engaged in farming for household use. These farmers are mostly poor and highly risk averse. Rain fed agriculture is predominant and little or no use of inputs such as fertilizer is observed. They are also referred to as smallholder farmers 'type A' (Hagos and Geta, 2016).

Second, diversified or mixed farming is the transitional category from traditional farming to commercialization. Under diversified farming, crops are grown for both home consumption and retail. Surplus produce is sold in the markets. There is a mixture of rain fed agriculture and unsophisticated technologies such as irrigation. Improved seeds, use of fertilizer and credit avenues are also available and used in this category. The farmers are well incorporated into the market compared to the previous category. This category is also referred to as smallholder farmers 'type B' (Hagos and Geta, 2016). Diversified or mixed farming is a way of increasing incomes as well as spreading risk hence attitudes can range from risk neutral to risk loving (Ali, 2015; Ayinde, 2016; Kiratu *et al*., 2016).

Finally, modern commercialization or specialized farming is at the top on levels of commercialization. For this category, household consumption is not the primary goal. Farmers are majorly profit-oriented as they use optimal resources including mechanization, use of hybrid seeds, fertilizers and herbicides. Farmers are also market oriented. Due to large profits realized, farmers are able to cope with risky decisions, hence they exhibit risk loving tendencies. This classification is also termed as 'emerging commercial farmers' (Hagos and Geta, 2016). At the tip is a level mostly occupied by large scale farmers or farms owned by governments where farming is highly capital intensive involving large tracks of land.

However, this level will not be considered in this research study. Figure 1 below illustrates the levels of vegetable commercialization.

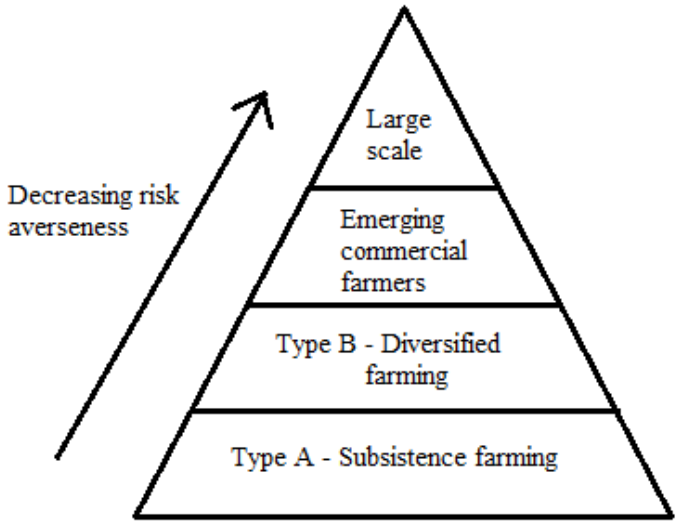

Figure 1: Relationship between risk attitudes and level of vegetable commercialization

2.2 Measuring level of commercialization

Von Braun *et al*. (1994) and Strasberg *et al*. (1999) in their studies developed an index to measure level of commercialization called the Household Commercialization Index (HCI). This index is sometimes referred to as the Household Crop Commercialization Index (CCI). In their research, HCI was estimated as the proportion of output retailed to overall output produced by the farm, expressed in monetary terms, in a particular production period. The greater the index (example, HCI > 0.5), the more commercialised a farmer is. Bekele *et al*. (2010) and Ochieng *et al*. (2016) also adapted this index and used percentages such that farmers who had attained an index of more than fifty percent were considered commercialised. Those who had less than fifty percent were considered subsistence farmers.

Marketable surplus is another measure that has been used by FAO (1989) and Mahaliyanaarachchi and Bandara, (2006) which is almost similar to HCI. In this measure greater amounts of marketed surplus indicate increased commercialization while lesser marketed surplus means more subsistence farming. The marketed surplus is calculated as a percentage of total output produced. Marketed surplus below 25 percent of total output represented “subsistence farmers”; a range between 25 – 50 percent denoted “transition farmers” and above 50 percent represented “commercial farmers”.

This research study will adopt the Household Commercialization Index developed by Von Braun *et al*. (1994) and Strasberg *et al*. (1999) to quantify the level of vegetable

commercialization. Monthly average prices of output sold by household and total output produced will be taken into account. An index of above 0.5 denoted "Emerging commercial farmers", greater than zero but below (or equal to) 0.5 to denoted "Type B" farming while an index equal to zero symbolized "Type A" farming. The advantage of using the HCI is that it avoids generalizations of farmers into either "commercialised" or "non-commercialised" groups (Rahut *et al*., 2010; Carletto *et al*., 2016).

2.3 Factors that influence vegetable commercialization

Several studies (Betek and Jumbam, 2015; Muriithi and Matz, 2015; Akinlade *et al*., 2016; Torimiro *et al*., 2016), have assessed determinants of vegetable commercialization. Even though male farmers were engaged in exportation of vegetables while female farmers produce locally for domestic consumption (Muriithi, 2015), the decision on whether to undertake commercial agriculture and choice of vegetable crops to cultivate was majorly determined by men. They had authority over incomes earned from off-farm sources, on-farm and even income from their spouses (Muriithi, 2015). Even though joint decision making has been employed, fewer female in male headed households participate (Zakaria, 2017). Thus, risk attitudes affect how capital is allocated in the production process which ultimately influences commercialization of vegetables. These risk attitudes differ from male to female farmers basing on who is the plot manager involved in making decisions. The differences result in diverse outcomes in management of the farm and allocation of resource hence influencing vegetable commercialization.

Second, an increase in off-farm income allows farmers to venture into vegetable farming because the revenue from off-farm activities can be used in financing on-farm activities that increase vegetable production (Sharaunga and Mudhara, 2016). Thus, off-farm income has a positive influence on the level of commercialization. Additionally, access to market outlets and information may significantly enhance commercialization decisions. Previous studies (Fischer and Qaim, 2012b; Chege *et al.,* 2015; Muriithi and Matz, 2015; Muriithi, 2015), have showed the great importance of market information especially to smallholder farmers. As farmers become aware of the needs of consumers, transaction costs resulting from information asymmetry are greatly reduced hence increasing commercialization tendencies (Okoye *et al.,* 2016). Furthermore, the education level of the farmer positively influences level of commercialization. As farmers become more educated, they are more eager to undertaking commercialization decisions (Ochieng *et al*., 2016).

Age of the household head was seen to positively affect level of commercialization, according to Akinlade *et al*. (2016). As farmers grow older, they gain more experience and in turn are more prepared to commercialize their vegetables. Moreover, an increase in the size of the household negatively influenced commercialization (Muriithi, 2015). A household with more members means consumption rate will be higher, hence discouraged farmers from undertaking commercialization decisions. The type of production technology such as irrigation farming and use of certified inputs can influence vegetable commercialization positively. Farmers who participated in enriching technologies had a higher chance of increasing yields and therefore in a better position to retail vegetables compared to those that did not use technology (Betek and Jumba, 2015; Ochieng *et al*., 2016; Torimiro *et al.,* 2016).

Ownership and size of land demonstrates the magnitude of vegetable commercialization. Farmers who do not own land and/or have a smaller land size shun away from vegetable commercialization. An increase in size of land leads to expansion of vegetable production thus influencing commercialization positively (Ochieng *et al*., 2016; Torimiro *et al.,* 2016). Moreover, extension agents are usually at the forefront in driving changes in vegetable farming from subsistence to commercial. Extension officers offer knowledge and technical assistance to rural farmers. Farmers who frequently engaged extension officers in their vegetable farming are more willing to venture in commercial farming (Muriithi and Matz, 2015; Ochieng *et al*., 2016). Distance to the market negatively affects vegetable commercialization. Farmers who lived far from market centers incurred costs of transportation, acquiring of inputs and losses due to perishability of vegetables. These transaction costs reduce smallholder farmers' market involvement (Ochieng *et al*., 2016; Okoye *et al.,* 2016).

Farmers who participated in social networks such as membership in farmer groups, cooperatives or unions are more willing to participate in markets, (Liverpool-Tasie *et al*., 2011; Okoye *et al*., 2016; Zhang *et al*., 2017). Through these networks, transaction costs are greatly minimized thus increasing commercialization trends. Finally, availability of credit is fundamental for vegetable commercialization to thrive. Incomes from other sources may not be sufficient to serve as capital. Credit institutions are therefore essential in providing farmers with affordable agricultural loans at fair interest rates. If farmers are able to accumulate assets through savings, then enough capital can be raised to propel vegetable commercialization (Muriithi and Matz, 2015; Ochieng *et al*., 2016).

2.4 Gender roles in vegetable farming

Agriculture tends to favor men more than women even though women endured the entire burden that comes with farming. The existing gender roles in Africa depicted women to be involved in more manual activities on the farm compared to men (Galiè *et al.*, 2017). For instance, women provided more labour in farming compared to men (Ali, 2015; Muriithi, 2015; Ali *et al*., 2016; Torimiro *et al*., 2016; Oduol *et al.*, 2017). Women in male-headed households were involved in the production and harvesting of fruits and vegetables while the men either managed income flows or attend to off-farm activities (Muriithi, 2015; Oduol *et al.*, 2017). Additionally, vegetable farming that employs climate change technologies such as conservation agriculture has pushed women to the edge, since conservation agriculture entails rigorous manual activities such as composting and vermiculture, which are labour intensive (Jost *et al.*, 2015). Overall, the division of labour in the household has worsened efforts of empowering women in the household. Due to male chauvinism and cultural injustice in the society, women were still undermined (Fischer and Qaim, 2012a; Galiè *et al.*, 2017).

Resource accessibility was yet another aspect that differentiated gender roles in the household. Women in female headed households did not have access to most resources and therefore were biased to vegetable farming that require less and affordable inputs. This is demonstrated by female farmers in the agro-pastoral region of Kenya who registered a higher adoption rate of African Indigenous Vegetables (AIVs), which was easier to manage with affordable resource requirement (Mshenga *et al.*, 2016). Previous studies (Fischer and Qaim, 2012a; Chandra *et al*., 2017; Galiè *et al*., 2017; Mishra *et al*., 2017), have reported that female-headed households had difficulties in accessing agricultural resources such as land, inputs and finances. Their studies confirmed that agricultural resources were normally biased towards men. Zakaria (2017) reported that only 24 percent of women in male-headed households in Northern Ghana were involved in joint control of agricultural resources. For instance, in the African context land ownership has always been dominated by men with women denied a chance to advance their productivity in farming. It is from these cultural and ethnical norms and customs that hamper gender equity (Galiè e*t al.*, 2017).

Furthermore, income generation and expenditure distinctly defined male and female obligations in the household. Women whose husbands earned substantial amounts of income from off-farm activities had an incentive to engage in vegetable production since their husbands funded their activities (Sharaunga and Mudhara, 2016). Although men provided the financial resources, management of the vegetable plots was still under their control, so was

income. Thus, this incentive was bounded to a certain degree. Female headed households were reported to have a lower net income and higher costs of production in Philippines compared to male headed households. This was mainly due to the small sized farms that female farmers owned and their high affinity to off-farm job opportunities (Mishra *et al.,* 2017). Unequal allocation of income on agricultural activities in the household drove women to search for non-agricultural jobs in the informal sector which had lower wages compared to men in the same sector.

Available literature has revealed how gender inequality is present in vegetable production. However, women have proven to be essential agents in the commercialization of vegetables. Galiè *et al*. (2017) argued that, women were implicitly enlightened on farming activities as they provided the labour. The burden of caring for the family and tending to vegetable farming prompts for labour-saving technologies that are affordable and culturally accepted, (Quisumbing and Pandolfelli, 2009; Kilic *et al.,* 2014). Additionally, social protection interventions through women empowerment programs and projects are on the rise as they are tailor-made to benefit female farmer's needs (Jones *et al.,* 2016). An example is increased microfinances in the rural to cater for financial needs of female farmers. A study by Sarwosri *et al*. (2016) on microfinance lending of African female farmers in Madagascar found that female farmers were twice likely to receive agricultural loans compared to their male counterparts. Women apportion a small fraction of land for vegetable production where any surplus vegetables are sold to nearby markets. The income earned was a means of self-reliance as women catered for nutrition needs and well-being of family members (Muriithi, 2015; Kouser *et al.,* 2016; Galiè *et al.,* 2017). From this point of view, the determination shown by women as active participants in vegetable farming should act as a channel towards agricultural programs that promote gender equity.

2.5 Risk in smallholder agriculture

Risk and uncertainty are terms which are frequently used interchangeably but have different connotations. Risk is defined as unpredictable outcomes with the likelihood of exposure to adverse effects (Hardaker *et al.,* 2015). On the other hand, uncertainty refers to possession of inadequate information about a certain event. A certain value is attached to risk and it is from this value that signifies the level of risk of farmers (Hardaker *et al.,* 2015).

Hazards encountered in vegetable production can be classified into different categories of risk. According to the OECD (2009) handbook on holistic approach on risk management in

agriculture, risks are broadly classified into production risks, marketing risks, financial and institutional risks. Production risks are nature related as they also include ecological conditions of the crops; from unpredictable weather patterns, climate change to changes in production technologies and pests and diseases infestation in crops, resulting into low yields (OECD, 2009; Hardaker *et al.*, 2015).

Marketing risks, also referred to as price risks are influenced by price fluctuations and unstable foreign exchange rates. Prices of both inputs and output determine the quality and magnitude of production (OECD, 2009; Ayinde, 2016). Inconsistency in prices and foreign exchange rates influence future decision making on inputs allocation. Additionally, institutional risks arise from changes in agricultural policies that directly affected farmers (Hardaker *et al.*, 2015; Campenhout *et al*., 2016). For instances changes in taxation could deter farmers from optimal production of vegetables for both domestic and export markets. Inadequate institutional sustenance, insufficient market information and impoverished market involvement of farmers generate transaction costs that increased overall production costs (Okoye *et al.*, 2016).

Finally, financial risks emanate when farmers seek for capital required for vegetable production. Access to finances from credit institutions subjected farmers to inflationary effects on interest rates that could cripple them in payment of loaned funds plus interest rate in full (Hardaker *et al.*, 2015; Cochrane and Thornton, 2017). This research study focuses on all the aforementioned types of risks in its analysis. It is from these risks that farmers develop perceptions and traits which influence their decision-making capabilities.

2.6 Factors that influence risk attitudes of farmers

With risk attitude as the dependent variable, independent factors such as age, household size, off-farm income among others, influence risk attitudes. These factors were disaggregated by gender, therefore separate analyses were conducted for male farmers, female farmers and both male and female farmers who mutually managed the vegetable plot (joint-management). The subsequent paragraphs give detailed discussions from findings of various studies. Theriault *et al.* (2016), found out that the gender of the household head impacted on decisions on adoption of soil intensification strategies. Generally, male plot managers recorded higher adoption rate of soil-restoration strategies compared to female plot managers. Moreover, in a research about determinants of smallholder farmers' perception towards smart subsidies in Nakuru Kenya, it was discovered that the gender of the household head being a male had a

negative implication on adoption of the subsidy (Kiratu *et al*., 2016). Again, due to the disposition of the African culture, a study on gender dimensions of agriculture and climate change in farming communities found that extension officers conveyed information on climate smart agriculture to men who were considered as the 'farmer' and left out female farmers. This resulted in low adoption of the technology by female farmers in Ghana and Bangladesh (Jost *et al*., 2015). Ultimately, gender of household head determined how decisions on vegetable production were arrived at considering varied risk preferences between male and female farmers. Secondly, a research conducted by Ayinde (2016) argued that as age of farmers increased, their readiness to undertake risk declined. This means that young farmers are willing to accept a risk compared to older ones. Ullah *et al.* (2015), also found similar results whereby young farmers were more risk loving, in a study on factors that affected farmers' risk attitude and risk opinions in Pakistan. Thus, age of farmers has a significant impact on risk attitudes.

Furthermore, the source of income in the household is seen to influence attitudes of farmers. In a study on risk analysis in the adoption of vitamin A cassava in Nigeria, a rise in yearly income from farmers who adopted the new variety registered an increase in risk tolerance (Ayinde, 2016). Additionally, a study by Kiratu *et al*. (2016) revealed that both off-farm and on-farm income were amalgamated such that an increase in off-farm income raised on-farm income creating positive perception towards risk. This means that the magnitude of income from various sources positively influences risk tolerance behaviour of farmers. Past studies, (Ullah *et al*., 2015; Iqbal *et al*., 2016; Saqib *et al*., 2016) reported that as farmers became more educated, the less willing they were to take risks. As farmers advance in education, the more knowledge they acquire concerning risks facing them and how to safeguard themselves, hence tend to be more risk averse. In addition, farmers who are more experienced are more likely to be risk averse compared to those who have less or none.

Availability of credit can be used as a risk mitigation measure as explained by Ullah *et al*. (2015). According to the study, farmers who were able to access credit were willing to take risks compared to those who had no access. Moreover, ownership of land by a household can influence risk attitudes of male and female farmers. A study on gender and experimental measurements of risk attitudes on output market price, conducted in Senegal, found that men were major land owners. An increase in land size under horticultural farming compelled farmers to be risk averse towards prices of output in the market. Availability of land means

more vegetables and fruits to be sold. Due to price volatility in the market, farmers are not willing to sell their vegetables, hence the inverse relationship (Niane and Burger, 2012). Finally, a study by Iqbal *et al*. (2016) found that access to market information was a significant attribute that influenced the risk attitude of a farmer. Exposure to agricultural information reduced risk averseness as farmers were exposed to new technology as well as appropriate risk mitigation measures.

2.7 Measurement of risk attitude

Different approaches have been used to elicit risk attitudes. The most widely known is the experimental or lottery games by earlier works of Binswanger (1980) and Holt and Laury (2002), who were the pioneers. Other approaches included the safety-first principle method (Olarinde and Manyong, 2007; Ayinde, 2016), use of Certainty Equivalents (CE) (Niane and Burger, 2012; Ahsanuzzaman, 2014) and the Equally Likely Certainty Equivalent Method (ELCEM) (Binici *et al*., 2001; Binici *et al*., 2003; Ullah *et al*., 2015; Iqbal *et al*., 2016; Saqib *et al*., 2016). Binswanger, (1980) used interview method and lottery experimental approaches in India where farmers participated and received real monetary gifts or rewards or incurred losses according to choices made.

Binswanger (1980) found that results from the interviews were erratic compared to those from the lottery games. He concluded that wealth was not the only factor that determined risk attitudes but other external constraints also influenced risk attitudes. Holt and Laury (2002) had similar work as that of Binswanger (1980), but the major difference was that the author used both hypothetical and real lottery games. While his conclusions showed high pay-offs increase risk averseness, the author found risk attitudes to be unaffected when hypothetical pay-offs were used. Recent researches have made some slight modifications to the original works of the pioneer authors to use certainty equivalents (CE). A certainty equivalent (CE) was a guaranteed payoff that an agent was to receive for him/her to be indifferent between accepting the payoff and taking a gamble (Ahsanuzzaman, 2014). This approach used two prospects, risky outcome and a less risky/ambiguous outcome. The CE is a midpoint where the respondent was indifferent in accepting the payoff or the risk. Thus, a single CE was derived for a particular situation and matched with the respective utility. The Equally Likely Certainty Equivalent Method (ELCEM) used CEs; however, the difference between CE and ELCEM was that ELCEM derived numerous CEs from a single scenario which were then matched with a utility function. Risk attitudes were then derived from this utility function. Both CE and ELCEM could use hypothetical or real payoffs.

Finally, the Eckel and Grossman method developed by Eckel and Grossman (2002) used real payoffs in their experimental games in eliciting risk attitudes. Respondents were presented with five gambles, each having a probability of 0.5 for either a gain or loss. The first gamble was a sure bet with minimal risks while the fifth gamble had higher payoffs and greater risks. According to Dave *et al.* (2010), the Coefficient of Relative Risk Aversion (CRRA) was deduced by individual choices under the assumptions of CRRA. The advantage of this method over the ELCEM was its simplicity in comprehension by respondents who were mostly illiterate rural farmers (Dave *et al.,* 2010; Charness *et al.,* 2013). Secondly, the method had less noisy estimates, meaning minimal errors from respondents' choices, compared to sophisticated ones like the ELCEM (Dave *et al*., 2010; Charness *et al*., 2013). It should be noted that results on estimation of risk attitudes by use of this method was consistent with other risk eliciting methods, but more advantageous to respondents with low mathematical skills (Dave *et al.,* 2010; Charness *et al.,* 2013). Nonetheless, the disadvantage of the Eckel and Grossman was that it could not distinguish the extent of risk loving behaviour as compared to the ELCEM (Dave *et al.,* 2010; Charness *et al.,* 2013). This study therefore employed the Eckel and Grossman model due to the advantages that it offered, given the nature of this study where rural smallholder farmers are involved. The ELCEM was used to test the robustness of the Eckel and Grossman.

2.8 Theoretical and conceptual framework

2.8.1 Theoretical framework

The study employed the Expected Utility Theory (EUT) by von Neumann and Morgensten (1944). According to the theory, farmers were presented with risky uncertain choices in the determination of their level of utility. Farmers maximized utility with respect to their wealth. The Eckel and Grossman model, established by Eckel and Grossman (2002), was employed. It entailed six gambles. According to Dave *et al.* (2010) and Charness *et al.* (2013), a risk coefficient under the assumptions of the Constant Relative Risk Aversion (CRRA) is denoted as an interval on a chosen gamble, where utility is signified by the function below, where in this case, income represented wealth, such that;

$$U(x) = x^{1-R} \quad (2.1)$$

Where R signified the coefficient of relative risk aversion and x to represent wealth. The intervals were derived trough comparison between adjacent gambles and compute R that created same utility level for payoffs linked to individual neighboring gamble (Dave *et al.*, 2010). In this case, the intervals to be used in computation of R relates to the gamble chosen

by the respondent when he/she was indifferent between what he/she chose and the two adjacent gambles (Charness *et al.*, 2013). Thus, respondents with $R > 0$ were categorized as risk averse, $R < 0$ as risk loving and $R = 0$ as risk neutral. Focus group discussions were used in the generation of the highest and lowest income values in vegetable commercialization. Table 1 illustrates the Eckel and Grossman model.

Table 1: Eckel and Grossman measure of risk attitudes

Choice (0.5/0.5 gamble)	**Low payoff (KES)**	**High payoff (KES)**	**Expected return (KES)**	**Standard deviation**	**Implied CRRA range**
Gamble 1	28,000	28,000	28,000	0	$3.46 < R$
Gamble 2	24,000	36,000	30,000	6,000	$1.16 < R < 3.46$
Gamble 3	20,000	44,000	32,000	12,000	$0.71 < R < 1.16$
Gamble 4	16,000	52,000	34,000	18,000	$0.50 < R < 0.71$
Gamble 5	12,000	60,000	36,000	24,000	$0 < R < 0.50$
Gamble 6	2,000	70,000	36,000	34,000	$R < 0$

Adopted from Dave *et al.* (2010) and Charness *et al.* (2013).

2.8.2 Conceptual framework

The conceptual framework in Figure 2 below illustrates the factors that determined risk attitudes and level of commercialization. It explains the socio-economic factors such as age, gender of household, income and among others, that have an impact on risk attitude of farmers. For instance, as farmers advance in age, they become more risk averse. This is also true with increase in farming experience. As for gender of household head, women who normally lack resources for vegetable farming tend to be more risk averse compared to their male counterparts. Institutional factors on the other hand include credit access, production technology, availability of extension services, availability of information sources, distance to market and social capital. As the distance to the market progresses, farmers become reluctant to engage in vegetable commercialization due to increased costs. Hence, they are likely to be risk averse. However, if information sources are available and farmers have access to credit, their risk tolerance would be high. The resultant risk attitudes derived from farmers, coupled with socio-economic factors and institutional factors influenced commercialization behaviour.

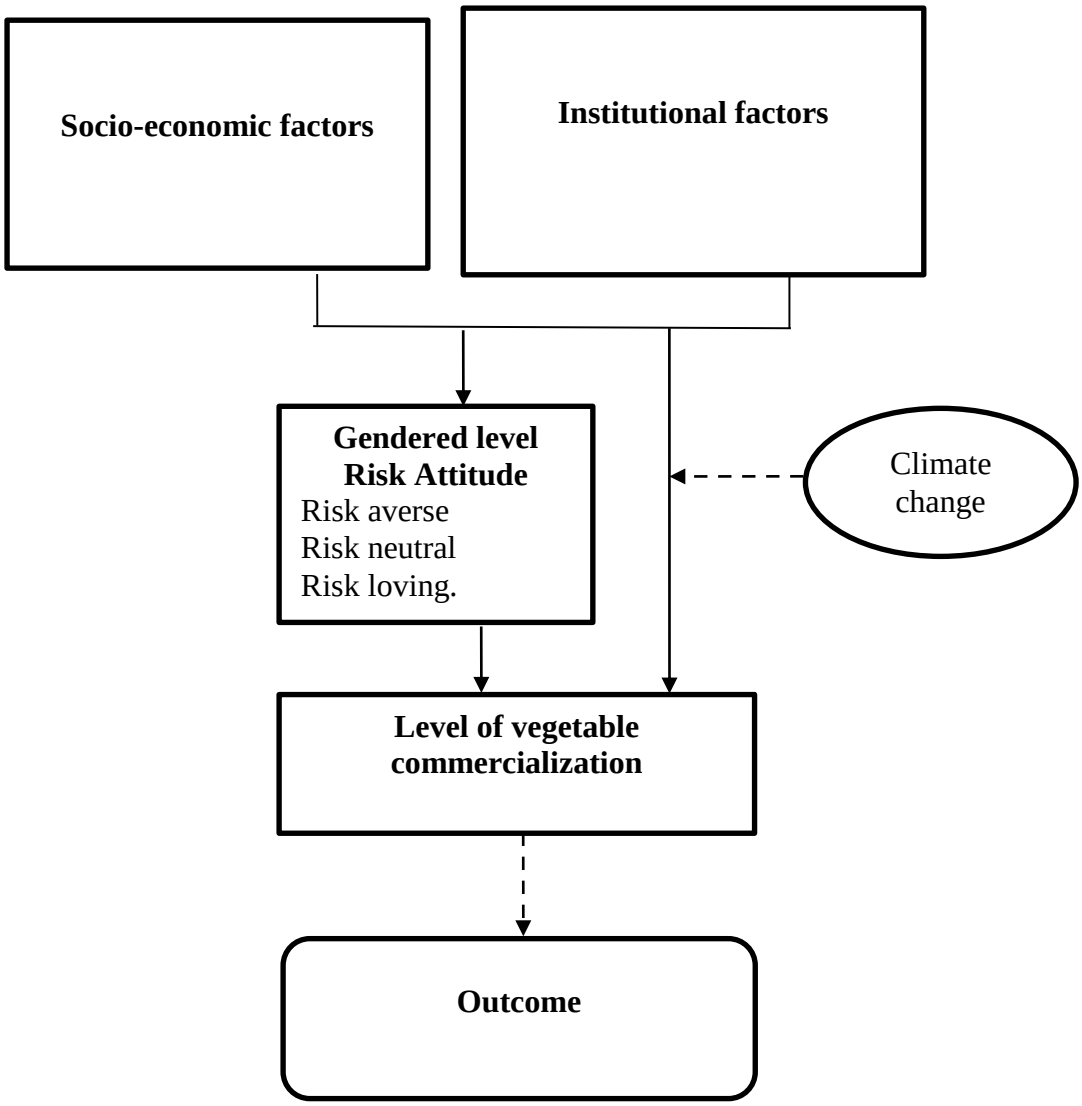

Figure 2: Conceptual framework on risk attitudes and vegetable commercialization

However unpredictable weather patterns as an intervening variable, affects this relationship whereby drastic changes such as prolonged famine or floods, can have negative implications on commercialization trends. All things considered, it is implied that a farmer exposed to favorable socio-economic and intuitional factors, with the right attitude towards risk is likely to increase commercialization of vegetables and ultimately enhance income, food security and improve living standards. However, it should be noted that the overall outcomes of improved incomes and food security were not measured in the current study.

CHAPTER THREE
METHODOLOGY

3.1 Study area

This research study is conducted in Malindi Sub-County. This Sub-County is located in a semi-arid area where vegetable commercialization is an upcoming enterprise by smallholder farmers, as a means of improving their livelihood. The presence of river Galana greatly benefits vegetable farmers as irrigation is made possible (Kilifi County Integrated Development Plan (CIDP), 2018-2022). Malindi Sub-County is among the seven sub counties that constitute Kilifi County. It lies north of Kilifi north Sub-County, South of Magarini Sub-County and to the East is the Indian Ocean, at the position 3˚13′25″ S to 4˚0′0″S and 39˚0′0″E to 40˚748″ E. The population of this Sub-County is 162,712 people according to the 2009 census and occupies an area of 627.20 square Kilometers, (GoK, 2013). The Sub-County comprises of five wards namely; Jilore, Kakuyuni, Ganda, Malindi Town, and Shella as illustrated in figure 3. Temperature ranges between 23.3˚C during cold months and 29.9˚C in hottest months. The Sub-County receives rainfall amounts between 119.9mm and 230.0mm annually, with two rainy seasons during April-June and October – December (KNBS, 2015). However due to climate change, delays in rainfall and long frequent periods of drought, the need for irrigation is highly emphasized (Kilifi County Integrated Development Plan (CIDP), 2018-2022).

Major agricultural activities practiced in the Sub-County include crop farming, livestock rearing and fishing. Dairy and beef farming are practiced in small scale. Fishing is done in the Indian Ocean. Smallholder farmers in the Sub-County practice both rain-fed and irrigated agriculture. Crops cultivated under rain-fed agriculture include; maize, pulses and cassava. However, these crops are mostly for household consumption while cashew nuts and coconuts are mainly cash crops. Horticultural crops are majorly cultivated under irrigation along River Galana, which drains its water into Indian Ocean. They include Tomatoes, Green Bell Chilies, Okra, Bananas, Leaf Amaranthus, Eggplant and African night shade (Oyugi *et al*., 2016). The Sub-County has two major markets for vegetable produce, located in Malindi town.

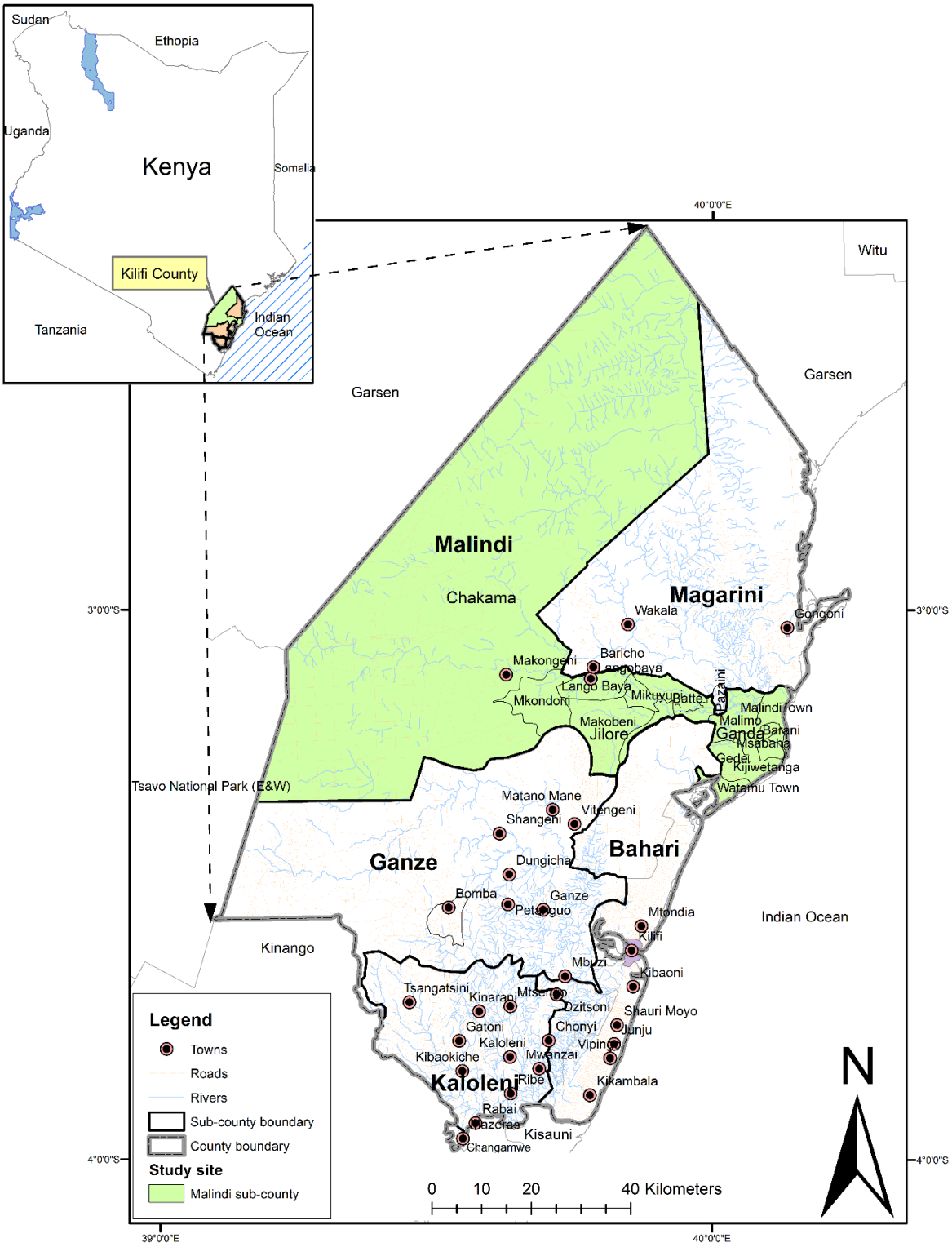

Figure 3: Map of Kilifi County

Source: World Resource Center (2017)

3.2 Sampling technique

Multistage sampling procedure was employed in selection of respondents for the study. First, Malindi Sub-County was purposively selected due to the presence of river Galana where irrigation of horticultural crops was highly practiced and the existence of two major vegetable markets. Secondly, within the Sub-County, Jilore and Kakuyuni wards were purposively selected for the study due to high concentration of horticultural farmers. Then a transect walk method was employed where respondents were systematically chosen along a transect line (Pollard, 1977); in this case, farms along the river shore represented the transect line. Two source lists were generated for the two wards with the help of extension officers in the respective areas. Linear systematic random sampling method was used to arrive at the desired sample size. A random name was selected at the top of each list to choose the first farmer who initiated the data collection process. Thereafter, every seventh name that was selected qualified for the interview. The sample consisted of male plot managers, female plot managers and jointly managed vegetable plots managers.

3.3 Sample size determination

The study adopted the formula by Kothari (2004) to derive a sample size from a known population of 2450 vegetable farmers, 1300 from Jilore ward and 1150 from Kakuyuni ward. A 95% confidence interval was used, where Z represented the value of the standard variate at the given confidence level (Kothari, 2004), as illustrated in appendix two. The sample size derived was;

$$n = 332 \qquad (3.1)$$

Referring to appendix two, N was the population of farmers in Jilore and Kakuyuni wards and p was the proportion of the population containing vegetable farmers who were of major interest to the study. $q = 1 - p$ and ℓ was the acceptable error. p was assumed to be 0.5, q = 0.5, z = 1.96 and $\ell$was assumed to be 0.05. The justification for using an acceptable error of 0.05 was so as to obtain a narrow confidence interval that was as close to the derived sample size as possible (Naing *et al.,* 2006). However, it should be noted that during the interviews, not all respondents would be available for the study, therefore replacements drawn from the population was made for those absent.

3.4 Data collection and analysis

The study used both primary and secondary data. Primary data was obtained through a semi structured questionnaire distributed to horticultural farmers. Pretesting of the questionnaire was conducted to assess its viability in the field. Secondary data was sourced from Ministry of Agriculture reports, books and journals. The questionnaire contained four parts; part one consisted of the general information of the farmer and part two on the socio-economic factors where data on production and marketing of vegetables was collected. Part three consisted of the institutional factors and part four covered the experimental part of the study, that is the ELCEM and Eckel and Grossman model. Data collected was analyzed using STATA version 14 statistical package.

3.5 Analytical framework

3.5 1 To determine the relationship between gender and perceived risks of commercial oriented smallholder farmers

Both male and female farmers were presented with a Likert scale to rank risks that they often encountered in commercialization of vegetables. The ranking was done according to the farmer's judgment. It was expected that farmers had varied perceptions on the types and magnitude of risks. Descriptive statistics was used in the calculations of mean, median, standard deviation, frequency distribution and percentages, which were represented in pie charts and graphs. Factor analysis was used to verify whether the risk constructs are true indication of the nature of risks that farmers face in vegetable farming. Thereafter, a chi-square test was used to determine the relationship between gender and perceived risks by farmers. The results from descriptive statistics was fundamental in describing, comparing and making inferences about the population from the sample.

3.5.2 To determine socio-economic and institutional factors influencing male and female vegetable farmers' attitudes towards risk

The Eckel and Grossman model was used in determination of risk attitudes of farmers, while the ELCEM was used as a robustness check for the Eckel and Grossman model. The Eckel and Grossman model, established by Eckel and Grossman (2002), entails six gambles. With reference to table 1, respondents chose only one gamble as they move through the choice of gambles from one to six. Gamble one is a sure payoff with zero variance while gamble six has same payoffs as that of gamble five but with a higher variance (Dave *et al*., 2010). This meant that expected payoffs increased with rising standard deviations between high and low payoffs. A loss or gain on payoffs has a probability of 0.5 each. According to Dave *et al.*

(2010) and Charness *et al.* (2013), a risk coefficient under the assumptions of the Constant Relative Risk Aversion (CRRA) is denoted as an interval on a chosen gamble, as shown in equation (2.1).

Additionally, both male and female respondents were asked to choose gamble choices together in the case of joint-management farmers. This process is useful to evaluate the conventional perceptions that male and female farmers possessed towards their respective counterparts. It should be noted that hypothetical payoffs were used in this model, however to improve on accuracy of this game, respondent were incentivized according to choices they made.

As a test for robustness of the Eckel and Grossman model, the ELCEM was used. The experimental game addressed real choices through use of hypothetical payoffs. The annual income of vegetable farmers was estimated to range between KES 0 and KES 100,000. A utility value of one was attached to the higher income (KES 100,000) and zero to the lower income (KES 0). A 0.5 probability of gain or loss was attached to the above stated income range. The farmer was presented with two risky situations and was asked to quote an income value with conviction, that he/she will rather have, in monetary terms, than take a risk of growing vegetables and receiving an income of either KES 0 or KES 100,000, where both values have a 0.5 chance of success or failure. This value represented a sure outcome with a probability of one. Say the farmer chose KES 50,000. This amount represented his/her CE for the payments of the income range of KES 0 to KES 100,000. The farmer was then asked again to quote an income value between KES 0 and KES 50,000 with equal probabilities, where he/she was indifferent to vegetable farming. Assuming he/she chose KES 30,000, this value represented the CE for the income range of KES 0 to KES 50,000. The process was repeated and numerous CE were obtained together with their associated utilities.

Similarly, the experiment was then repeated for the higher values of income. This time, the farmer was asked to quote a value where he/she was indifferent to vegetable farming in the range of KES 50,000 to KES 100,000 that had a probability of 0.5 of loss or gain. Suppose the farmer chose KES 70,000. This value represented his/her CE for the payments of KES 50,000 to KES 100,000. The farmer was asked again to choose a value where he/she was indifferent to vegetable farming from the income range of KES 70,000 to KES 100,000. Assuming the farmer quoted KES 80,000, again this value represented the CE for payments

of KES 80,000 to KES 100,000. The process was repeated where several CE were obtained with their associated utilities. The whole procedure was reiterated for all the farmers.

According to Binici *et al.* (2003), a cubic utility function was then used to measure risk aversion. The example below illustrates calculation of utilities for the different CE values according to Binici *et al.* (2003); Ullah *et al*. (2015); Iqbal *et al*. (2016) and Saqib *et al*. (2016);

$$u(50{,}000) = 0.5(0) + 0.5(100{,}000) = 0.5(0) + 0.5(1) = 0.5$$
$$u(30{,}000) = 0.5(0) + 0.5(50{,}000) = 0.5(0) + 0.5(0.5) = 0.25 \quad (3.2)$$

The utility values were regressed on their corresponding CE values using the Non-linear Least Squares Method (NLS) according to Binici *et al*. (2003), to derive a cubic utility function. Other functional forms that could be used to elicit risk attitudes were; the negative exponential, power and expo-power utilities. The advantage of using the cubic function over the ones stated above was that the function could display both increasing and decreasing risk aversion coefficient, whereas the negative exponential assumed constant risk aversion in all levels of income, thus inappropriate (Binici *et al.,* 2001). The cubic utility function is as shown below;

$$U(w) = \alpha_1 + \alpha_2 w + \alpha_3 w^2 + \alpha_4 w^3 \quad (3.3)$$

Where α_s are coefficients and *w* represented wealth. In this experiment, annual income is a proxy for wealth. The first derivative of the utility function represented a positive value of *w,* that is income. This is signified by the positive slope of the utility function. The second derivative with respect to *w* is usually used to quantify risk aversion. The sign of this derivative signified whether the risk attitude was averse (U″ (w) < 0), neutral (U″ (w) = 0) or loving (U″ (w) > 0) (Binici *et al.,* 2003).

However, utility is normally measured in ordinal scale, therefore the shape of the utility function could be converted into quantitative form using the coefficient of Absolute Risk Aversion r_a (w). Mathematical derivation of coefficient of absolute risk aversion according to Arrow (1965) and Pratt (1964) is as follows;

$$r_a(W) = -\frac{U''(w)}{U'(w)} = -\left[\frac{(2\alpha_3 + 6\alpha_4 w)}{\alpha_2 + 2\alpha_3 w + 3\alpha_4 w^2}\right] \quad (3.4)$$

Where r_a (w) > 0 denoted risk aversion, r_a (w) = 0 denoted risk neutral and r_a (w) < denoted risk loving (Binici *et al.,* 2003).

Determination of factors influencing risk attitudes

Having derived the risk attitudes of farmers, the determination of factors that influence these attitudes is in order. A dependent variable that consisted of more than two outcomes required an ordered probit model. This model is used to assess the factors that influence risk attitudes of farmers. The advantage of using the ordered probit model over the OLS regression was the ease in estimation of the dependent variable especially when there exist imbalanced variations between categories from one level to another (Duncan *et al.,* 1998; Briggs, 2003). Traditional regression evaluation become unsuitable. Additionally, the normality distribution assumption of the ordered probit model allowed for ease of manipulation that arises from specification problems (Denkyirah *et al*., 2016). There are three possible outcomes of risk attitudes that farmers perceive; risk loving, risk neutral, and risk averse. These attitudes are assigned values: 0 to represent risk Averse, 1 to represent risk Neutral and 2 to represent risk loving.

The model was created around a latent regression as attested by Alauddin and Tisdell (2006) and Batool *et al*, (2017):

$$y^* = x\beta + \varepsilon \tag{3.5}$$

Where, y^* is the latent variable representing risk attitudes (extent of risk aversion) of farmers, x represented explanatory variables that determine risk attitudes and ε was the error term.

$y^*$is unobserved. What could be observed was:

$y = 0$ if $y^* \leq 0$

$y = 1$ if $0 < y^* \leq \mu_1$

$y = 2$ if $\mu_1 < y^* \leq \mu_2$ (3.6)

The μ_s are unknown threshold variables to be estimated with β. These variables define estimations for varied observed values of y (where y = 2 is the highest level of risk aversion). The threshold variables can be deduced as intercepts in the equation (3.6) above. It was presumed that the error term was normally distributed with an expected value of zero and variance of one. A respondent has the following probabilities;

$\text{Prob}(y = 0|X) = \Phi(-x'\beta)(\mu_0 = 0)$

$Prob(y = 1|X) = \Phi(\mu_1 - x'\beta) - \Phi(-x'\beta)$

$Prob(y = 2|X) = \Phi(\mu_2 - x'\beta) - \Phi(\mu_1 - x'\beta)$ (3.7)

For all the probabilities to be positive, one must have;

$0\langle\mu_1\langle\mu_2$ (3.8)

The probabilities of a farmer belonging to the three risk attitude categories is represented as follows;

$$prob(y = 0|X) = \Phi(-x'\beta)$$

$$Prob(y = 1|X) = \Phi(\mu_1 - x'\beta) - \Phi(-x'\beta\ )$$

$$Prob(y = 2|X) = 1 \qquad (3.9)$$

For these probabilities, the corresponding marginal effects is as follow;

$$\frac{\partial \text{Prob}(y = 0|X)}{\partial X} = \Phi(-x'\beta)\beta$$

$$\frac{\partial \text{Prob}(y = 1|X)}{\partial X} = [\Phi(-x'\beta) - \Phi(\mu_1 - x'\beta)]\beta$$

$$\frac{\partial \text{Prob}(y=2|X)}{\partial X} = \Phi(\mu_1 - x'\beta) \qquad (3.10)$$

These marginal effects measure the change on the probability outcomes of the dependent variable due to a unit change in the independent variable. The model was disaggregated by gender, that is, separate analyses were made on male farmers, female farmers and joint-management farmers.

The variables that were used in the ordered probit model have been derived from previous literature (example, Niane and Burger, 2012; Jost *et al*., 2015; Ullah *et al.*, 2015; Ayinde, 2016; Iqbal *et al*., 2016; Kiratu *et al*., 2016; Saqib *et al*., 2016; Theriault *et al.*, 2016) and are presented in Table 2.

Table 2: Description of variables to be used in the ordered probit model

Variables	Description and unit of measurement	Expected signs
Dependent variable		
RskAtt	Level of risk attitude (0 = risk Averse, 1= Risk Neutral and 2 = risk loving)	
Independent variables		
Socio-economic		
Age	Number of years of farmer	+ve
Schyrs	Number of school years (continuous)	+ve
SHH	Number of people in a household	+ve
PartOFFI	Participate in off-farm activities (dummy variable 1 = yes and 0 otherwise)	-ve
Farmsize	Size of land (continuous)	+ve
LogAssets	Farm assets in monetary value (continuous)	-ve
Institutional		
CrdtAcc	Credit Access (dummy variable 1 = yes and 0 = otherwise	-ve
ExtServ	Extension services (number of contacts with extension officer as a continuous variable)	-ve
AccInfo	Access to information concerning the market for vegetables (dummy 1 = yes and 0 = otherwise	-ve
DistMkt	Distance to nearby market (by foot in minutes)	+ve
Prodtech	Production Technology (dummy 1 = irrigation and 0 = otherwise)	-ve
SocioCap	Group heterogeneity (Heterogeneity index)	+/-ve
	Number of household members attending same group as respondent (continuous)	-ve
	Decision making (10-point Likert scale)	-ve
	Trust (10-point Likert scale)	-ve

3.5.3 Objective 3: To determine the influence of risk attitude on the level of vegetable commercialization among male and female smallholder farmers

The Household Commercialization Index (HCI) was used to derive the magnitude of vegetable commercialization. Von Braun et al. (1994) and Strasberg et al. (1999) were the developers of this index. The advantage of using this index is its continuous scale that avoids lumping farmers into bilateral groups such as "commercialised" and "non-commercialised", but further provides the intensity of commercialization (Carletto *et al*., 2016). In their studies, HCI was estimated to be the proportion of output retailed to overall output produced by a farmer, expressed in monetary terms. The HCI was derived as follows;

$$\varphi_i = \frac{\sum_{i=1}^{n} S_k}{\sum_{i=1}^{n} Q_k} \text{ Where, } \rightarrow Q_k \geq S_k \text{and } 0 \leq \varphi \leq 1 \quad (3.11)$$

Where,

$\varphi = 0$, subsistence oriented

$0 < \varphi \leq 0.5$, diversified farming

$\varphi > 0.5$, commercial oriented

φ_i Represented the HCI of a farm household *i* ranging from 1, 2, 3… *I,* cultivating *k* vegetables. S_{ki} was the value of vegetables *k* sold for household *i* and Q_{ki} was the value of total production of a household *i* cultivating *k* vegetables, with *k* ranging from 1, 2, 3...*K*. The values of Q_{ki} and S_{ki} were both in monetary terms. A greater index meant higher commercialization by a farmer (Bekele *et al.*, 2010). In this study, vegetables that were considered include; Tomatoes, Okra, African night shade, Eggplant, and Leaf Amaranthus since they were majorly grown by farmers in the study area. It should be noted that the study did not derive individual indices for each vegetable crop but rather an aggregate of all the crops was used to derive the commercialization index. It could also be converted into a percentage.

A Tobit model was used to determine the factors that influenced level of commercialization. The Tobit model was developed by Tobin (1958). This model was chosen due to the nature of the dependent variable, HCI, which permitted censoring from below or above in the estimation of a linear association between the dependent and independent variables (Dube and Guveya, 2016). This variable is continuous with the index running from zero to one. The advantage of using this model over the OLS is its efficiency in operation in the presence of measurement errors in the dependent variable (Manning, 1996; Ochieng *et al*., 2016). Additionally, the characteristic of the index yielding some observations as zero made this

model appropriate (Ayuya, 2010), as it translated them into corner solutions (Denkyirah *et al*., 2016). Rahman (2016) reported that the benefit of using a tobit model was that the choice to carry out an activity (use of pesticides) and the magnitude of that activity (intensity of pesticide application) could jointly be estimated by the same variables, thus rendering the model more efficient as compared to the probit model which only provided information on choice.

y* is the latent variable that cannot be observed. What is observed is y. It assumed that the observed dependent variable is;

$$y_i = \max(y_i^*, 0) \quad (3.12)$$

Where, $y_i^*$is the latent variable from the conventional linear regression model. Thus, the model is expressed as;

$$y_i^* = x_i\beta + \varepsilon_i \quad (3.13)$$

Where,

$$y_i = y_i^* \text{ if } y_i^* > 0$$

$$y_i = 0 \text{ if } y_i^* \leq 0 \quad (3.14)$$

$y_i$is the HCI, β is the resultant vector of estimated parameter, x_i are the independent variables and ε_i is the error term presumed to be independently normally distributed N (0, σ^2). The marginal effect according to Greene (2003), is measured when a unit change in independent variables affects a change in the commercialization index as shown below;

$$\frac{\partial(y_i^*|x_i)}{\partial x_i} = \beta \quad (3.15)$$

However, since y_i^* is unobserved, the marginal effect of the observed y_i is expressed as follows;

$$\frac{\partial(y_i|x_i)}{\partial x_i} = \beta\Phi\left(\frac{\beta' x_i}{\sigma}\right) \quad (3.16)$$

The tobit model (equation 20) is disaggregated by gender whereby separate analyses will be conducted for male, female and joint-management farmers. The variables that are used in the tobit model were derived from previous literature (example, Liverpool-Tasie *et al*., 2011; Fischer and Qaim, 2012a; Betek and Jumbam, 2015; Chege *et al*., 2015; Muriithi, 2015; Muriithi and Matz, 2015; Akinlade *et al*., 2016; Ochieng *et al*., 2016; Okoye *et al*., 2016; Sharaunga and Mudhara, 2016; Torimiro *et al*., 2016; Zhang *et al*., 2017) and are presented in Table 3. The risk attitude variable was tested for endogeneity problems, whereby a two stage

Heckman model was used. Although, it should be clearly noted that this objective is only interested in the association between risk attitudes and commercialization, and not claiming causality.

Table 3: Description of variables to be used in the tobit model

Variables	Description and unit of measurement	Expected signs
Dependent variable		
HCI	Household commercialization index (runs from 0 to 1 thus continuous)	
Independent variables		
Risk attitude		
RskAtt	Level of risk attitude (0 = risk Averse, 1= Risk Neutral and 2 = risk loving)	-ve/+ve
Socio-economic		
Age	Number of years of farmer (continuous)	+ve
SchYrs	Number of years of schooling (Continuous)	
SHH	Number of people in a household (continuous)	-ve
PartOFFI	Participate in off-farm income (dummy 1 = yes and 0 otherwise)	+ve
LogAssets	Farm assets in monetary value (continuous)	
Farmsize	Size of land (continuous)	+ve
Institutional		
CrdtAcc	Credit Access (dummy variable 1 = yes and 0 = otherwise	+ve
ExtServ	Extension services (number of contacts with extension officer as a continuous variable)	+ve
MktOutlet	Market outlet (dummy variable 1 if farm gate, 0 otherwise)	-ve
GrpMem	membership to farmer associations/groups (dummy 1 = yes and 0 = otherwise)	+ve
SocioCap	Group heterogeneity (Heterogeneity index)	+ve
	Number of household members attending same group as respondent (continuous)	+ve
	Decision making (10-point Likert scale)	+ve
	Trust (10-point Likert scale)	+ve

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results and discussion of the study and it is divided into three sections. The first section involves a detailed discussion of the descriptive statistics on socioeconomic and institutional characteristics of smallholder vegetable. Subsequently, findings on how gender relates to risks that farmers encounter during vegetable commercialization, is discussed in details. The risks encountered will be grouped into three categories namely; production risks, marketing risks and financial risks. Both F-tests and chi-square tests are used to analyze the relationship between these risks and gendered risk attitudes of farmers. Gender was categorized into three groups namely; male farmers, female farmers and joint-management, based on who manages the vegetable plots. Both male and female respondents under joint-management were interviewed together. For the sampled farmers, 37 percent of the sample size represented male farmers, 24 percent represented female whereas 39 percent constituted farmers under joint-management.

4.1 Descriptive statistics

4.1.1 Farmer and farm characteristics

Table 4 presents findings of vegetable farmer's age, household size, farm size, farm assets and number of school years, by gender.

Table 4: Mean values of continuous socio-economic variables

Variable	**Gender of vegetable plot manager**				
	Pooled	**Male**	**Female**	**Joint-management**	**F-value**
Age	39.60	38.46	42.13	39.13	0.77**
Household size	7.00	7.00	7.00	7.00	1.11
Farm size	2.13	2.16	1.70	2.36	1.19
Farm assets ('000 KES)	123.09	127.49	71.97	150.79	1.2**
Number of school years	5.07	6.31	2.14	5.70	4.27***
Sample size	n=332	n_1=124	n_2=80	n_3=128	

Note: ***, ** = Denote significant at 1% and 5% level, respectively.

The results showed a significant difference in the mean age of vegetable farmers at five percent level of significance. Smallholder female farmers had the highest mean age of 42 years, followed by joint-management with a mean of 39 years. Male farmers reported the

lowest mean age of 38 years. Female respondents were relatively older compared to their male counterparts. This is probably because young male farmers were more energetic to carry out the agronomy and marketing part of vegetable farming, thus appreciated its value. On the other hand, older male farmers might have concentrated on cash crop farming, which was more profitable, as they left vegetable commercialization to their wives. Muriithi (2015) found that male farmers engaged in cash crop farming while women were left to carryout vegetable production.

There was a significant difference in farm assets by gender at five percent level of significance. Farm assets was a combination of livestock assets, agricultural assets and consumer durables in monetary value. Joint-management farmers reported the highest value of farm assets (KES 150,787.70) compared to male (KES 127,492.20) and female (KES 71,968.38) respondents. Female farmers had the lowest value of farm assets. This probably because of the norms in the African background that could have inhibited female control over wealth. Johnson *et al.* (2015) found that access and control of wealth was vital for minimizing poverty level and female access and control of wealth through agricultural development projects, was hindered by societal norms and household duties.

Number of schooling years was significantly different by gender at one percent level of significance. The results from the study disclosed that in general, vegetable farmers were illiterate. The mean number of schooling years was five years. This indicated that majority of the respondents had reached primary level. Male farmers were more educated with a mean of six years in school. Female farmers were the most illiterate with a mean of two years in school. This is probably because of the social order of the community that favored male education and minimized opportunities for women who were heavily burdened with household chores to advance in education. Murage *et al.* (2015) found that even though more women attained primary level schooling, very few advanced beyond this level. This was because of the cultural setting of African countries that denied opportunities for women to progress in education owing to the weight of household chores bestowed upon them.

4.1.2 Institutional characteristics

Table 5 presents results on number of contacts with extension agents, number of household members in same group, decision making in group activities and trust for members in group.

Table 5: Mean values of continuous institutional variables

Variable	Gender of vegetable plot manager				
	Pooled	**Male**	**Female**	**Joint**	**F-value**
Number of contacts with extension agents	2.43	2.00	1.60	3.36	3.00***
Number of household members attending same group as respondent	1.00	1.00	1.00	1.00	0.82
Decision making in group activities	1.82	1.54	2.26	1.82	0.01**
Trust for members in group	1.80	1.65	2.46	1.51	0.22
Sample size	n=332	n_1=124	n_2=80	n_3=128	

Note: ***, ** = Denote significant at 1% and 5% level.

Number of contacts with extension agents was statistically significant by gender at one percent significance level. The average number of contacts with extension agents was two. Female and male farmers had relatively equal number of contacts with extension agents. However, farmers under joint-management had more contact at a mean of three. This is probably because decision making under joint-management was mutually done thus leading to differences in opinions between husband and wife on what is to be implemented on the farm. Extension agents were therefore instruments of knowledge because they cleared any uncertainties and farmers sought their guidance on vegetable farming. Contact with extension providers was thus essential in acquiring knowledge on vegetable production and marketing. The more the number of contacts the more likely farmers would participate in vegetable farming. Djoumessi *et al.* (2017) and Gebrehiwot *et al.* (2017) found that extension services were avenues of introducing modern technology to farmers. In addition, farmers who had numerous interactions with extension agents were more likely to engage in vegetable marketing as compared to those farmers who had no interaction.

Involvement in decision making concerning group activities was statistically significant by gender at five percent level of significance. Farmers were asked to rate their monthly involvement in decision making concerning group activities in a scale of one to ten, one being no involvement in decision making, while ten being highly involved. Male farmers had a mean level of 1.5 and join-management had a mean of 1.8. Female farmers had a higher mean level in group decision making of 2.5. Generally, a level below five on the scale indicated minimal involvements in group decision making. Farmers who were involved in decision making concerning group activities were more likely to increase their knowledge

and skills on vegetable commercialization and at the same time acquire information on market feedback for their produce. Arinaitwe *et al*. (2017) found that participation in group decision making was an important feature that motivated farmers to undertake market decisions in the household level, as it provided them with consistent information on the demand for their produce.

Table 6: Chi-square results of categorical institutional variables (%)

Variable	**Gender of vegetable plot manager**			
	Male	Female	Joint	χ^2 value
Access to credit				
No	30.84	13.64	55.52	4.50
Yes	20.83	29.17	50.00	
Participation in off-farm activities				
No	38.71	29.03	32.26	8.83**
Yes	35.62	17.81	46.57	
Group heterogeneity				
Low	31.92	20.21	47.87	13.33***
High	27.78	7.64	64.58	

Note: ***, ** = Denote significant at 1% and 5% level.

Table 6 presents results on access to credit, participation in off-farm activities and group heterogeneity by gender. Participation in off-farm activities was statistically significant by gender at five percent level of significance. Farmers who received additional income from off-farm activities were 44 percent while those who did not engage in off-farm activities were 56 percent. Joint-management had the highest percentage (47 percent) of respondents who engaged in off-farm activities with female respondents reporting the lowest percentage (18 percent). On the other hand, male farmers reported the highest percentage (39 percent) of respondents who did not engage in off-farm activities whereas female farmers had the lowest percentage (29 percent). The differences in participation of off-farm activities by gender between joint-management and female farmers is probably because husbands preferred off-farm activities that generated more income as they left vegetable farming and household chores to their wives. Thus, participation in off-farm investments could have acted as a cushion against adverse vegetable risks and thus improved farmers' vegetable productivity. Oduol *et al.* (2017) found that men usually engaged in off-farm activities while their wives engaged in vegetable production. In addition, Arinaitwe *et al*. (2017) and Sharaunga and Mudhara (2016) found that off-farm income motivated farmers to venture into farming which not only increased income but also acted as a risk mitigation measure.

Group heterogeneity was statistically significant by gender at one percent level of significance. It was used to measure the degree of diversity of group members that enabled them to create meaningful social networks. A lower group heterogeneity meant that farmers were almost identical in all aspects such as ethnicity, occupation, economic status, religion, age group and education level. On the other hand, a higher group heterogeneity integrated farmer of all backgrounds. Respondents under joint-management had the highest group heterogeneity at 65 percent while female respondents had the lowest group heterogeneity at 20 percent. The reason for the low percentage in female farmers could be because they preferred all women groups which made farmer-farmer interaction easy, hence were able to create stronger social networks. Additionally, since men were considered major decision makers, their presence in groups would have denied female farmers full participation in group activities. Furthermore, groups that had diverse ethnicity, economic status and age group of members are more likely to have differences in opinions which would provide more learning experience to group members. Schroeder *et al.* (2013) found that female farmers enhance their incomes and overall livelihood when organized in women-only rice grower groups in Benin. In additionally, Korir *et al*. (2017) and Sinyolo and Mudhara (2018) found that heterogeneity in groups improved information sharing, promoted strong social networks and enhanced smallholder farmer's income.

4.2 Relationship between gender and perceived risks of commercial oriented farmers

Characteristics of vegetable risks encountered by smallholder farmers

Tables 7 and 8 presented the factor loadings, Cronbach alpha values, Kaiser-Meyer-Olkin (KMO) values and average variance extracted (AVE) results of vegetable risks using factor analysis. Factor analysis was performed so as to confirm the internal uniformity and convergence of the constructs (Olsen *et al.*, 2017). Three constructs were used to categorize vegetable risks into production risks, marketing risks and financial risks. A Likert scale was use to rank the frequency and severity of each construct, in order to determine weighted scores. The scale ran from 1-5 for the frequency measurement (where 1 meant not at all and 5 meant most frequent) and severity measurement (where 1 meant not at all and 5 meant most severe). The kaiser's criterion for identification of factors to retain, was adopted, where factors that had eigenvalues of above and equal to one were chosen (Yong and Pierce, 2013). Factor loadings of above 0.5 were considered substantial enough to ascertain the least loading required to comprise a construct (Sen and Antara, 2018). All the factor loadings were above

0.5 (0.506 – 0.702). Table 7 and table 8 present factor analysis results of the frequency and severity of vegetable risks, respectively.

Sampling adequacy was measured using Kaiser-Meyer-Olkin (KMO), developed by Kaiser (1974). According to the author, KMO values of more than 0.5 were acceptable, above 0.5 to 0.7 were considered as average, above 0.7 to 0.8 were seen as commendable, above 0.8 were considered marvelous and above 0.9 were seen as spectacular. KMO values from the analyses ranged from 0.500 to 0.712 indicating that separate and consistent factors were estimated (Yong and Pierce, 2013). Furthermore, Cronbach alpha values were estimated to measure the internal consistency reliability. Alpha values of above 0.7 were considered as better values that indicated adequate dependability among items in the factors (Yang and Wu, 2016). All the alpha values in both tables were above the 0.7 threshold thus signified moderate reliability. Lastly, estimate values of Average Variance Extracted (AVE) for all the factors (0.725 to 0.988) were above the 0.5 threshold, indicating that each construct was highly associated to its respective items (Yang and Wu, 2016).

Table 7: Factor analysis for profiling frequency of vegetable risks constructs

Vegetable Risks	**Items**	**Factor loadings**	**KMO**	**CR**	**AVE**
Production Risks	Unpredictable weather patterns	0.654	0.705	0.747	0.911
	Pest and disease infestation	0.571			
	Technological changes (production technology, methods of farming, certified inputs, etc.)	0.544			
	Changes in horticultural regulations by the government	0.506			
Marketing/Price Risks	Changes in vegetable input prices	0.656	0.694	0.709	0.725
	Changes in vegetable output prices	0.622			
Financial Risks	Sudden rise in interest rates	0.702	0.712	0.787	0.988
	Limited access to financial services	0.693			

Note: chi-square= 552.39; *df*= 45; p-value= 0.000; KMO: Kaiser-Meiyer-Olkin; CR: composite reliability; AVE: average variance extracted

The results of the confirmatory factor analysis for frequency of vegetable risks (LR test: independent vs. saturated: chi-square= 552.39; *df*= 45 and p-value= 0.0000) and severity of vegetable risks (chi-square= 701.50; *df*= 45 and p-value= 0.0000) indicated a good fit with data.

Table 8: Factor analysis for profiling severity of vegetable risks constructs

Vegetable Risks	**Items**	**Factor loadings**	**KMO**	**CR**	**AVE**
Production Risks	Unpredictable weather patterns	0.550	0.662	0.727	0.949
	Technological changes (production technology, methods of farming, certified inputs, etc.)	0.607			
	Changes in horticultural regulations by the government	0.633			
Marketing/Price Risks	Changes in vegetable input prices	0.528	0.619	0.712	0.803
	Changes in vegetable output prices	0.553			
	Pest and disease infestation	0.605			
Financial Risks	Sudden rise in interest rates	0.663	0.500	0.702	0.816
	Limited access to financial services	0.666			

Note: chi-square= 701.50; *df*= 45; p-value= 0.000; KMO: Kaiser-Meiyer-Olkin; CR: composite reliability; AVE: average variance extracted

Table 9 and figure 4 presents mean values of vegetable risks profiled according to frequency and severity of risk, disaggregated by gender. The average frequency of occurrence of marketing risks was 2.61. Marketing risks that farmers encountered include; changes in vegetable input and output prices, pests and disease infestation. It was unexpected that pests and disease infestation was clustered in marketing risks, however, cost of inputs such as herbicides and pesticides increase with increase in vegetable pests and diseases, which directly affects marketing of vegetables. The findings indicate a significant difference in the frequency of marketing risks by gender at one percent level of significance. Basically, all the farmers in the three classifications of gender encountered marketing risks less frequently. Female respondents had the lowest mean of 2.23, followed by 2.65 for joint-management. Male farmers had the highest mean in frequency of marketing risks at 2.73. Less frequent

marketing risks could have meant that prices of inputs and vegetable produce were relatively volatile from one season to the next, thus farmers were moderately concerned about marketing risks.

Table 9: Mean scores of frequency and severity of vegetable risks by gender

Variable	Gender of vegetable plot manager				
	Pooled	Male	Female	Joint	F-value
[1]Frequency of Production risks	2.40	2.43	2.25	2.47	1.21
[2]Severity of Production risks	2.43	2.46	2.32	2.49	1.11
[1]Frequency of Marketing risks	2.61	2.73	2.23	2.65	1.83***
[2]Severity of Marketing risks	3.53	3.61	3.52	3.45	0.98
[1]Frequency of financial risks	0.97	0.96	0.80	1.08	1.97***
[2]Severity of financial risks	1.15	1.13	1.08	1.21	1.61**

Note: ***, ** = Significant at 1%, and 5% level.
[1]Frequency: 1=not at all, 2=less frequent, 3=frequent, 4=more frequent, 5=most frequent
[2]Severity: 1=not at all, 2=less severe, 3=severe, 4=more severe, 5=most severe

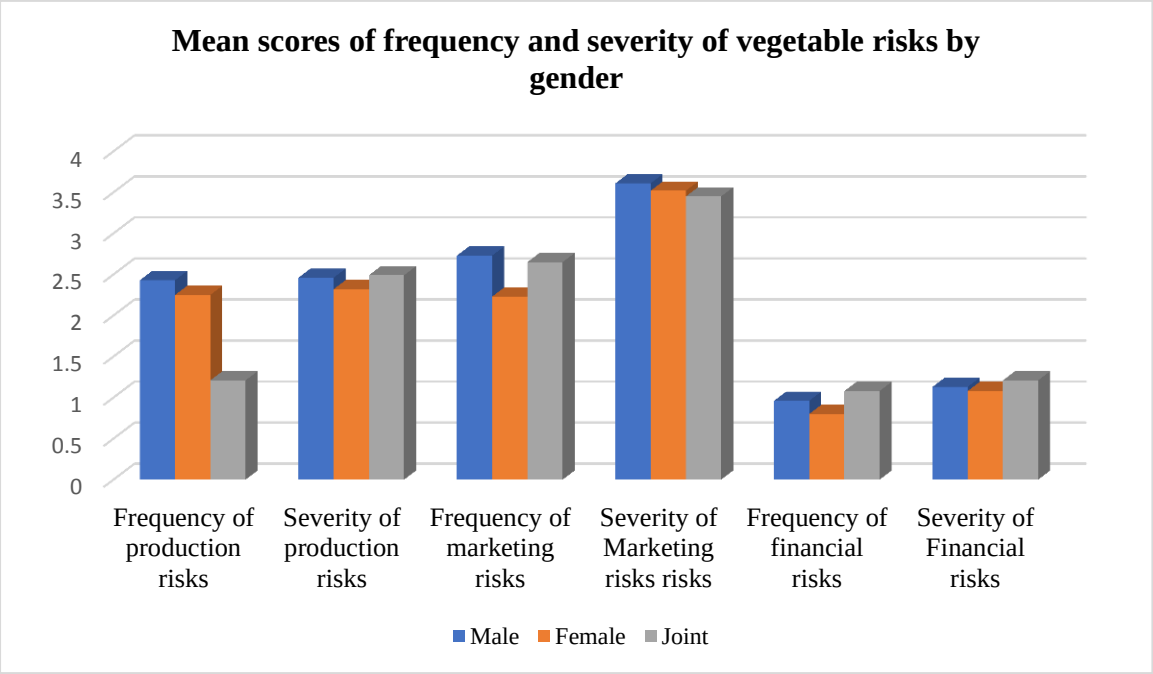

Figure 4: Mean scores of frequency and severity of vegetable risks by gender.

Although, male farmers encountered more marketing risks compared to female farmers, probably because male farmers were mostly involved in marketing of vegetables, thus more prone to marketing risks as compared to female farmers who were confined in the production of vegetables. Duhan (2017) found that frequent marketing risks could have adverse effects

on vegetable marketing, leading to a decrease in production, and overall decline in incomes. Also, Muriithi (2015) reported that male farmers handled the marketing part of vegetables while women were involved in its production, as they were the major providers of farm labour.

The frequency of financial risks was significantly different by gender at one percent level. Financial risks encountered by farmers were sudden rise in interest rates and limited access to credit services. The mean value of frequency of financial risks was 0.97. In general, all farmers were not at all affected by financial risks, however joint management had the highest mean (1.08), when compared to male (0.96) and female (0.80) farmers. The reason behind this could be because joint decision making is done in joint-management households, where both male and female farmer source for financial support. Female farmers had no problem in accessing loans in informal institutions, because the type of loans they sought were smaller in amount and short term. On the other hand, the male household head owned agricultural resources which could be used as security for accessing loans. Therefore, availability of credit services could have increased the frequency of access to loans. However, with increase in access to loans and volatile interest rate charges in informal financial institutions, loan repayment might have been a burden to both farmers, thereby hindering vegetable farming. Sarwosri*, et al.* (2016) found that female farmers had no challenges in accessing short term loans, whereas male farmers were well endowed with resources including access to financial support (Mishra *et al*., 2017) In addition Duhan (2017) found that vegetable farmers were faced with financial risks related to borrowing credit, which hindered vegetable farming.

Furthermore, there exists a significant relationship between severity of financial risks and gender of vegetable farmers, at five percent level of significance. Financial risks were less severe, with a mean value of 1.15. Male and Jointly-management farmers had a mean of 1.13 and 1.21 respectively, while female farmers had the lowest mean of 1.08. The severity of financial risks was greater for male as compared to female farmers probably because male farmers could easily access loans from informal financial institutions, given that they owned agricultural resources which could be used as security. Since informal institutions provided less stringent conditions for loan access, male farmers could have borrowed substantial amounts which could have been diverted to other non-agricultural activities, crippling vegetable farming. Inflationary interest rates from informal institutions could have burdened male farmers in loan repayment, increasing the gravity of financial risks. Cochrane and

Thornton (2017) found that access to financial support from credit institutions subjected farmers to volatile interest rates that crippled them in repayment of loaned funds plus interest rate in full.

4.3 Econometric analysis

4.3.1 Socio-economic and institutional factors influencing male and female vegetable farmers' attitudes towards risk

This second section reports the econometric analysis of vegetable farmers' attitudes towards risk. It is subdivided into two sub-sections. The first sub-section consists of a segment on robustness check of risk attitude methods, and a second segment on preliminary diagnostics that test for multicollinearity and heteroscedasticity of socio-economic and institutional factors. Thereafter, the second sub-section involves econometric analysis in the determination of socio-economic and institutional factors that influence farmers' attitudes towards risk.

4.3.2 Robustness check of risk attitudes of vegetable farmers

Before proceeding any further, it is imperative to compare results of Eckel and Grossman model and ELCEM to ascertain any significant differences in measurement of risk attitude of vegetable farmers. It should be noted that the ELCEM method was purely hypothetical. The Eckel and Grossman model provided an incentive, in form of Safaricom airtime, to farmers who participated in the study. The awarding (of this incentive) was strictly based on choice of gamble among the six gamble choices provided. Farmers were offered two rounds of participation in the game and the incentive was only applicable to the second round. Detailed information about the procedure of the Eckel and Grossman experimental game is found in appendix one, section four of the questionnaire (question 40). Table 10 presents results of the Eckel and Grossman model experiment.

Table 10: Results of the Eckel and Grossman experimental game

	Eckel and Grossman model			
	Round 1		**Round 2**	
Risk attitudes	Freq.	%	Freq.	%
Risk averse	203	61.14	92	27.71
Risk neutral	58	17.47	75	22.59
Risk loving	71	21.39	165	49.70
Total	332	100	332	100

Farmers under round one, of the model experiment, were highly risk averse at 61 percent, while 18 percent were risk neutral and 21 percent were risk loving. On the contrary, majority of farmers under round two of the experiment were risk loving (49 percent) while 27 percent were risk averse and 22 percent were risk neutral. The reason behind the differences in results between round one and two could be because of the provision of an incentive. Even though incentivized experimental games provided more accurate results in determination of risk behaviour, (Charness *et al.,* 2013), these instruments are usually built on theoretical lottery choices instead of qualitative based questions which take into account daily choices in risk behaviour by respondents (simple framework). Therefore, experiments that adopt an incentivized framework can possibly create further confusion to respondents, masking their true behaviour towards risk (Charness and Viceisza, 2016). For this reason, results of round one could have portrayed true risk attitudes of vegetable farmers; therefore, these results were used in the study. Furthermore, a comparison in risk attitudes between the Eckel and Grossman model and the ELCEM is presented in Table 11.

Table 11: Frequency distribution table on risk elicitation methods

	Eckel and Grossman		**ELCEM**	
Risk attitudes	Freq.	%	Freq.	%
Risk averse	203	61.14	200	60.24
Risk neutral	58	17.47	60	18.07
Risk loving	71	21.39	72	21.69
Total	332	100	332	100

The Eckel and Grossman model estimated 61 percent of the overall sampled farmers to be risk averse, 18 percent as risk neutral, and 21 percent as risk loving, whereas the ELCEM estimated 60 percent of the sampled farmers to be risk averse, 18 percent to be risk neutral, and 22 percent as risk loving. Though the results presented negligible differences in risk attitudes of farmers, the Eckel and Grossman model had a few extra farmers (one percent) who were risk averse. The results of these two risk elicitation methods are in line with previous studies. For instance, Haneishi *et al.* (2014) found 60 percent of the farmers who cultivated both rice and maize in Uganda to be risk averse. In addition, Meraner and Finger, (2017) also found majority of the livestock farmers in Germany to be risk averse. Table 12 presents chi square results of the Eckel and Grossman and ELCEM elicitation methods.

Table 12: Chi-square results of risk elicitation methods across gender (%)

Risk elicitation method	**Gender of vegetable plot manager**			
	Male	Female	Joint	χ^2 value
Eckel and Grossman Model				
Risk averse	34	22	44	9.22*
Risk neutral	35	31	34	
Risk loving	50	24	26	
ELCEM				
Risk averse	34	22	44	6.48
Risk neutral	42	26	32	
Risk loving	44	28	28	

Note: * = Significant at 10% level.

There is a significant difference in variations of risk attitudes across gender, in the Eckel and Grossman model, at 10 percent level of significance. Farmers under Eckel and Grossman model exhibited significant difference in risk attitudes across gender as compared to farmers under ELCEM method. This probably because of the complexity of experimental games. The ELCEM was more complex compared to Eckel and Grossman, therefore it could have been possible that some farmers did not fully understand the game and as a result their answers may not have fully portrayed their behaviour towards risk. On the other hand, the simplicity of the Eckel and Grossman model permitted rural farmers to comprehend the experimental game, and thus contribute their views accordingly. Dave *et al.* (2010) and Charness *et al.* (2013) reported that the advantages of Eckel and Grossman method over the ELCEM was its simplicity in comprehension by respondents who were mostly illiterate rural farmers, and the method had less noisy estimates, thus minimal errors from respondents' choices. Overall, the Eckel and Grossman model proved to be a better method for risk measurement compared to the ELCEM.

Majority of the farmers who displayed risk aversion behaviour were under joint-management at 44 percent, while male and female farmers were at 34 percent and 22 percent respectively. In addition, male farmers were the most risk neutral at 35 percent, while joint-management and female farmers were at 34 percent and 31 percent respectively. Lastly, male farmers were the most risk loving at 50 percent whereas joint-management and female farmers were at 26 and 24 percent respectively.

Factors that determine risk attitude of vegetable farmers

After derivation of risk attitudes, the ordered probit model was used to determine the socio-economic and institutional factors that influence farmers' risk attitudes. Preliminary assessment of predictor variables was then performed to examine any statistical anomalies. Multicollinearity and heteroscedasticity tests were the main diagnostic tests of concern. Multicollinearity is present if there exists a linear relationship between two or more predictor variables. The Variance Inflation Factor (VIF) was used to test for collinearity in continuous variables while discrete variables were paired up and their correlation coefficients were determined. A VIF value of one implied no relationship among continuous predictor variables, a value of more than one and less or equal to five indicated that predictors were moderately correlated whereas a value of more than five implied greater associations among predictor variables. Table 13 presents results of the multicollinearity test. A mean VIF value of 1.24 suggested that there was an average association between continuous explanatory variable.

Table 13: Variance Inflation Factor (VIF) test for continuous explanatory variables

Variable	**VIF**	**1/VIF**
Age	1.08	0.9301
Number of School years	1.06	0.9472
Farm size	1.04	0.9597
Farm assets (logAssets)	1.02	0.9833
Number of contacts with extension agent	1.04	0.9641
Group membership*Household members belonging to same group	1.72	0.5806
Group membership*Trust in group members	1.76	0.5679
Mean VIF	**1.24**	

Additionally, Table 14 presents the pairwise correlation between discrete variables. The results of the test indicated that explanatory variables had coefficients of not more than 0.40, which meant that there was no dependency between predictor variables. Thus, all the explanatory variables were viable enough to be used in the regression analysis.

Table 14: Pairwise correlation test results for discrete explanatory variables

	Ward	Off-farm activities	Credit Access	Group membership	Group membership*Group heterogeneity
Ward	1.0000				
Off-farm Activities	-0.0366	1.0000			
Access to credit	0.1079	0.0104	1.0000		
Group membership	0.1843	-0.1161	0.1147	1.0000	
Group membership*Group heterogeneity	0.0104	-0.1427	-0.0628	0.3994	1.0000

The White's general test for heteroscedasticity was used and the results were presented in Table 15. This test was much preferred as it does not restrict non-linear forms of heteroskedasticity, where the error term is not normally distributed and explanatory variables can take non-linear forms (Wooldridge, 2014).

Table 15: Test results for heteroskedasticity

	Male farmers			**Female farmers**			**Joint-management**		
Source	**χ^2**	**df**	**P**	**χ^2**	**df**	**P**	**χ^2**	**df**	**P**
Heteroscedasticity	106.85	74	0.0075	63.92	64	0.4795	58.94	64	0.6556
Skewness	51.49	13	0.000	13.78	12	0.3149	26.45	12	0.0093
Kurtosis	0.52	1	0.4720	1.74	1	0.1868	0.00	1	0.9650
Total	158.86	88	0.0000	79.44	77	0.4020	85.39	77	0.2399
	Chi^2 (74) = 106.85			**Chi^2 (64) = 63.92**			**Chi^2 (64) = 58.94**		
	Prob > chi2 = 0.0075			**Prob > chi2 = 0.4795**			**Prob > chi2= 0.6556**		

A higher chi-square value and a lower p-value signified existence of heteroscedasticity. The results from the table indicated that male farmers had chi-square values of 106.85 with a probability value of less than 0.05. Thus, heteroscedasticity was present. However, according to Wooldridge, (2014), to counteract the problem of heteroscedasticity, the use of robust standard errors in the regression analysis is acceptable.

The results of the association between the dependent variable and the independent variables in the ordered probit model is presented in Table 16. The Wald chi-square value for the model of the overall sample was 48.64, while male plot managers, female plot managers

joint-management models had wald chi-square values of 48.55, 27.23 and 19.25 respectively. These values denoted that the null hypothesis, that all 14 independent variables being zero, could be rejected at one percent significance level for the overall sample and male farmers' models, and at five percent for female farmers' model. This means that the model fits the data well as all the independent variables could be well explained by the model. Socio-economic and institutional factors such as age, household size, years of schooling, farm size, farm assets, participation in off-farm activities, number of contacts with extension agent, access to credit, location dummy and group membership influenced the risk attitudes of male, female and jointly-managed vegetable plot managers. Additionally, interaction terms of group membership with variables such as household members belonging to same group, trust in group members and group heterogeneity were included in the regression analysis.

Table 16: Marginal effect results of ordered probit model on factors influencing risk attitudes of vegetable farmers by gender

Variables	Overall sample		Male farmers		Female farmers		Joint-management	
	Coefficient	Robust Std. Err.	Coefficient	Robust Std. Err.	Coefficient	Robust Std. Err.	Coefficient	Robust Std. Err.
Household characteristics								
Age	0.0285**	0.0126	0.0455**	0.0186	-0.0048	0.0239	0.0405**	0.0194
Age squared	-0.003**	0.0001	-0.0005***	0.0002	0.0008	0.0003	-0.0004**	0.0002
Household size	0.0098	0.0092	0.0287**	0.0125	0.0280	0.0196	-0.0191	0.0156
Number of school years	0.0124**	0.0058	0.0151**	0.0070	0.0360***	0.0138	0.0005	0.0100
Farm size	-0.0044	0.0158	0.0127	0.0237	0.0514	0.0358	-0.0156	0.0213
Farm assets (logAssets)	0.0661*	0.0351	0.0717	0.0513	0.0998	0.0746	0.0222	0.0561
Off-farm activities (1 if yes)	0.1015**	0.0513	0.0950	0.0865	-0.0476	0.1080	0.1930**	0.0782
Institutional characteristics								
Contacts with extension agents	-0.0092*	0.0049	-0.0045	0.0055	-0.0309***	0.0109	-0.0043	0.0077
Access to credit (1 if yes)	-0.1602	0.1054	-0.1172	0.1310	-0.3419***	0.1178	0.2411***	0.0647
Social capital interaction effects								
Group membership (1 if yes)	0.2944**	0.1478	0.4873***	0.0361	0.0631	0.7491	0.3309***	0.0866
Group membership*Household members attending same group as respondent	0.0176	0.0451	0.1375*	0.0812	0.1031	0.0773	-0.1982**	0.0282

Continuation of table 16

Group membership*Trust	-0.0492	0.0337	-0.1509*	0.0697	-0.0367	0.0881	-0.0330	0.0439
Group membership*Group	-0.1296	0.1085	-0.1591	0.1929	0.0075	0.1545	-0.2627	0.2191
Heterogeneity								
Location dummy								
Ward (1 if Jilore ward)	0.1928 ***	0.0495	0.2117***	0.0759	0.2994***	0.0903	0.1100	0.0743
/cut1	-4.0971	1.3571	-6.6072	2.0484	-4.6751	3.2644	-0.6985	2.3954
/cut2	-3.3673	1.3473	-5.8757	2.0370	-3.6286	3.2234	0.0284	2.4030
Number of observations =	332		124		80		128	
Wald $Chi^2_{(14)}$ =	48.64		48.55		27.23		19.25	
Pseudo R^2 =	0.0844		0.1841		0.2029		0.0810	
Log pseudo likelihood =	-284.3692		-99.7018		-63.0573		-96.2024	
Prob > Chi^2 =	0.0000		0.0000		0.0180		0.1555	

Note: ***, **, * = Significant at 1%, 5% and 10% level, respectively.

Results from the ordered probit model in Table 16 indicates that the variable age in the overall sample is positive and significantly associated to risk attitudes of vegetable farmers at five percent significance level. Generally, an increase in age of a farmer by one year increases the probability of risk averseness by two percent. Gender differences in vegetable farming show that age of male farmers and joint-management were positive and significantly associated to risk attitudes at five percent significance level for each. That is, an increase in age by one year increases the probability of risk averseness by three percent for a male farmer and four percent for joint-management. However, the quadratic term age squared, which represented a nonlinear association between age and risk attitudes, was negative and significant at five percent level for each of the above-mentioned gender categories. That is, as the age farmers increased, the probability of risk averseness increases up to a certain point where further increase to the farmers' age led to decline in risk aversion behaviour. Even though decision making under joint-management was mutual between partners, the male farmer, who was also the head of the family, had the final opinion. Therefore, results might have implied that older male farmers were less willing to make risky decisions in vegetable farming as compared to young farmers. This is probably because old age comes with abundance of indigenous knowledge of types and sources of vegetable risks, through years of farming. The experience acquired might have compelled old farmers to avoid making decisions that are risk prone, hence adopting a risk aversion behaviour. Oparinde *et al.* (2018) reported that as farmers grew older, they became less willing to take risks on the farm, hence adopted a risk averse or neutral behaviour. In addition, Saqib *et al*. (2016) found that older farmers were more risk averse because they possessed innate knowledge and experience on environmental hazards which enabled them to avoid taking risks.

Household size of male farmers is positive and significantly associated to risk attitudes at five percent level. An additional member in the household is likely to increase the probability of risk averseness of male farmers by three percent. This is probably because of the African social and cultural norms that emphasized on large households as a symbol of men's wealth and pride, more so in the rural areas. This could have resulted in an increase in household consumption, limited agricultural resources and unskilled human capital which might have trapped male farmers in a poverty cycle, unable to increase vegetable marketable surplus, leading to a decline in income. Low income levels might have reduced capital allocation for successive planting seasons, which may have compelled farmers to implement non-risky decisions in vegetable production. Subsequently, male farmers would have adopted a risk

aversion behaviour. Akanbi (2016) reported that people living in the rural areas had large household sizes and this could have been explained by cultural and social reasons, as well as their occupation, in this case farming. Additionally, Dadzie and Acquah (2012) and Ullah *et al*. (2015) and Yusuf *et al.* (2015) reported that as the households increased in size, farmers became more risk averse due to intensified consumption needs of family members.

Furthermore, the number of years of schooling for farmers in the overall sample is positive and significantly associated to risk attitudes at five percent significance level. That is, as farmers add an extra year in their education, the probability of risk averseness increases by one percent. Diving deeper to gender disparities reveals both male and female farmers to be positively and significantly associated to risk attitudes at five percent and one percent significance levels, respectively. An additional year in schooling by male and female farmers increased their probability of risk averseness by two percent and four percent, respectively. Educated female farmers were more risk averse as compared to their male counterparts. This is perhaps because education equipped farmers with more knowledge about the sources of risks they face. This knowledge might have influenced the choice of production techniques and resource allocation on the farm, which could have resulted in implementation of strategies that were safe. However, female farmers were generally more involved in vegetable farming as compared to male farmers. Therefore, education, combined with their indigenous knowledge on vegetable risks, would have fortified them against risks making them highly risk averse compared to male farmers. Muriithi (2015) reported that female farmers were more involved in vegetable farming as compared to male farmers. In addition, Iqbal *et al.* (2016) and Saqib *et al*. (2016) reported that farmers who were educated were highly risk averse because the knowledge they acquired allowed them to better understand the risks they encountered and therefore formulate strategies that protected them from such risks.

Farm assets is positive and significantly related to risk attitude of farmers in the overall sample at 10 percent level of significance. An addition in farm assets by one percent increases the probability of risk averseness by 0.000661 units. A combination of livestock, agricultural equipment and consumer durables constituted farm assets. This variable shows no gender differences in risk attitudes in relation to possession of farm assets, signifying that farmers might generally be risk intolerant to vegetable farming with increase in farm assets. Perhaps the reason could be that vegetable farming is covered with numerous risks, from perishability, pest and disease infestations to price fluctuations, which could have discouraged farmers from investing capital in this venture and instead practice cash crop

farming which is more profitable with fewer risks involved. As a result, farmers adopt a risk aversion behaviour to vegetable farming as cash crop farming becomes more lucrative. Muriithi (2015) reported that cash crop farming was more profitable than vegetable farming. In addition, Yusuf *et al*. (2015) reported that one of the risk management methods which smallholder farmers practiced was avoiding cultivation of crops that were highly risky, for instance vegetable farming (Niane and Burger, 2012).

Moreover, there is a positive and significant relationship between participation in off-farm activities and risk attitudes of farmers under joint-management, at five percent level. A farmer who participated in off-farm activities increased the probability of risk averseness by 19 percent as compared to a farmer who did not engage in off-farm activities. This is probably because both male and female farmers under joint-management had various small off-farm businesses which might have generated more income compared to vegetable income. Since agriculture is a risky business, farmers might be compelled to switch their productive resources to off-farm activities and forgo production of vegetables. In the process, their level of risk averseness to vegetable farming escalates, as they practiced it for subsistence purposes only. Ayinde (2016) found that as off-farm income of cassava farmers increased, their risk tolerance in adoption of a new cassava variety, declined. This was because off-farm income outweighed the annual income from cassava farming.

The number of contacts with extension agent is negative and significantly associated to risk attitudes of farmers in the overall sample at 10 percent. Generally, an additional contact with an extension agent decreases the probability of risk averseness by one percent. However, gender categorization shows only female farmers in contact with extension agents, to be negative and significantly related to risk attitudes at one percent level of significance. An increase in contact with extension agents by one unit reduced the likelihood of female farmers being risk averse by three percent. Regular contact with extension agent is seen to increase the risk tolerance of female farmers. This is probably because extension agents have the role of disseminating agricultural information on improved production technologies and market information to farmers. Female farmers are major providers of farm labour. Perhaps repeated contact with extension agents might have provided them with vital information on how to boost vegetable production volumes as well as market information on vegetables that are on high demand, thus improving their risk seeking behaviour. Iqbal *et al.* (2016) found that farmers who had access to market information through contact with agricultural

department exhibited risk taking behaviour because the information acquired enabled them to adopt suitable risk management strategies to cope with uncertainties at the household level.

Furthermore, access to credit is negative and significantly related to risk attitudes of female farmers, while positive and significantly related to risk attitudes of joint-management, at one percent level for each. Female farmers who had access to credit reduced their probability of risk averseness by 34 percent as compared to those that had no access to credit. In addition, joint-management farmers who had access to credit increased their probability of risk averseness by 24 percent as compared to those that had no access to credit. Female farmers who had access to financial support were highly risk tolerant probably because the rural setting promoted the growth of informal financial services from moneylenders and relatives and friends, which had lenient conditions on access to financial support. Since female farmers are mostly involved in vegetable production, the loans they acquired were mainly short term depending on the vegetables' production cycles. With financial support, female farmers become confident when coping with risks as they can allocate capital to agricultural technologies that enhance vegetable productivity, thereby becoming risk takers. On the other hand, decision making under joint-management usually had male influence, whereby loaned funds meant for vegetable farming could have been directed to other activities in the household. This would have crippled vegetable production, leading to a decline in income and loan repayment a heavy burden. As a result, farmers under joint-management would adopt a risk aversion behaviour towards vegetable farming. Sarwosri, *et al.* (2016) reported that female farmers were more likely to receive financial aid as compared to their male counterparts because their farming activities required small loans for short-term periods, which were easily available. However, male farmers had a weak loan repayment behaviour due to the nature of loans acquired, which were not agricultural related.

Group membership is positive and significantly associated with risk attitudes of farmers in the overall sample at five percent level of significance. In general, an additional farmer joining a group increases the probability of risk averseness by 29 percent. Taking gender differences into consideration, group membership of male farmers and joint-management was equally positive and significantly related to risk attitudes at one percent level for each. An additional farmer, under male and joint-management, joining a group increased the probability of risk averseness by 49 percent and 33 percent respectively. This is probably because farmers joined groups/associations in order to benefit from services that could help them mitigate risks that they encountered in vegetable production. For instance, services such

as access to financial support could have safeguarded farmers against financial risks, production information and technical know-how could have enabled them mitigate production risks, while access to profitable markets and market information could have safeguarded them against marketing risks. However, due to the weak institutional framework, groups prioritized the social function over the main objective of the group, and eventually these groups/associations fail to support farmers in alleviating vegetable risks. As a result, group members display risk aversion behaviour to vegetable production. Yusuf *et al*. (2015) reported that farmers, in Nigeria, who were members of groups or associations, were highly risk averse because of the inferior cooperative structure and weak group cohesion that failed in mitigating members' agricultural risks.

Additionally, the interaction term, group membership and household members attending the same group as the farmer, is positive and significantly related to risk attitudes of male farmers at 10 percent level, while negative and significantly related to risk attitudes of farmers under joint-management at five percent level. An additional household member joining a farmer group attended by a male farmer increases the probability of risk averseness by 13 percent. On the other hand, joint-management farmers that have household members attending the same group as them decrease their probability of risk averseness by 20 percent as compared to none group members. An additional household member joining a group that male farmers attend might increase knowledge base of members due to an increase in information sharing. However, decision making in the group might pose a challenge since members may not be able to reach a consensus. This can create chaos in groups as well as at the household level, on which decisions to implement, hindering vegetable production. Male farmers in turn adopt a risk aversion behaviour. On the contrary, joint-management farmers make farming decisions as well as carryout farming activities together. An additional household member attending the same group as the farmer might have increased the knowledge base of the household, thereby promoting sharing of ideas. As a result, household members could have contributed their input to the household's economic performance by participating in group activities such as coordinated marketing of vegetables and acquiring of production information and techniques that are crucial for maximizing vegetable output and household income. The outcome would be improved risk bearing capacity of farmers under joint-management. Arinaitwe *et al*. (2017) found that increase in group membership promoted information sharing and participation in group activities. However, increase in membership also affected implementation of decisions, as it proved difficult to reach a consensus on

which activities were to be executed. On the other hand, Zhang *et al*. (2017) and Hao *et al.* (2018) reported that membership in farmer groups and cooperative societies had a positive impact on market participation and the type of marketing channels farmers chose.

Finally, the location dummy was positive and significantly related to the risk attitude of farmers in the overall sample at one percent level of significance. Generally, the probability of risk averseness increased by 19 percent for a farmer located in Jilore ward compared to a farmer from Kakuyuni ward. Taking gender disparities into consideration, the location dummy is positive and significantly associated to risk attitudes of male and female farmers at one percent level of significance for each. The probability of risk averseness increased by 21 percent when a farmer located in Jilore is male and 30 percent, when a farmer is female. This is probably because Jilore ward is located in the rural parts of Malindi Sub-County, where vegetable production is the major economic activity. Farmers in the rural, especially female, might have difficulty in obtaining information concerning the market demand and modern farming techniques due to their far-off distance from the town. Therefore, they lack the chance to associate with advanced farmers who can share their knowledge with them. The limited information flow might have increased their risk averseness. Iqbal *et al*. (2016) found that farmers who were situated away from the town were more risk averse as they lacked the chance to acquire beneficial knowledge from innovative farmers who had the opportunity of access to information.

4.3.3 Socio-economic and institutional factors influencing vegetable commercialization among male and female smallholder vegetable farmers

This third section reports the econometric analysis of factors influencing vegetable commercialization among male and female vegetable farmers. Household commercialization index (HCI) was used to calculate the level of vegetable commercialization. The vegetables that were considered in the study were Tomatoes, Okra, Leaf Amaranth, African night shade and Eggplants. All farmers practiced irrigation farming, mainly furrow and basin irrigation methods. Figure 5 illustrates the mean household commercialization index for the overall sample and for each gender classification. A mean household commercialization index of 0.74 suggested that majority of the respondents were highly commercialised. Male farmers and joint-management each had a mean HCI of 0.75 while female farmers had a mean of 0.70, however, the difference between the HCI values across gender was not significant.

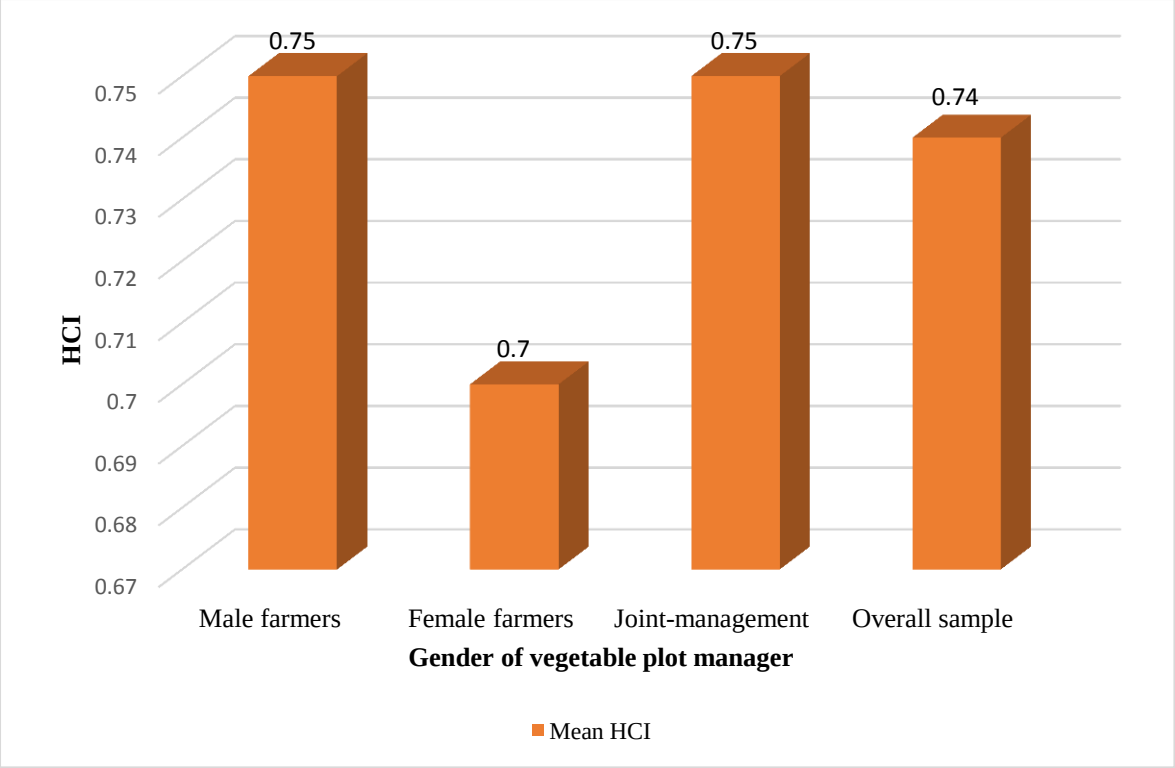

Figure 5: Mean values of HCI by gender

According to the levels of commercialization, for a farmer to be classified under subsistence farming, the HCI should be zero. These types of farmers were also known as 'type A' according to Hagos and Geta, (2016). Furthermore, an HCI value of more than zero and less than 0.5 represented farmers under diversified farming, also referred to as 'type B', while an HCI value of more than 0.5 to a value of one represented farmer under 'emerging commercial farmers' category. Table 17 presents the levels of HCI by gender.

Table 17: Levels of Household Commercialization Index (HCI)

Level of HCI	**Gender of vegetable plot manager** (in percentage)					
	Overall	Male	Female	Joint	Total	χ^2 value
Subsistence farming (Type A) (HCI=0)	0	0	0	0	0	5.84*
Diversified farming (Type B) (0<HCI≤0.5)	5	44	44	12	100	
'emerging commercial farmers' level (HCI>0.5)	95	37	23	40	100	
Total	100					

Note: * = Significant at 10% level.

The level of HCI was significantly associated to gender at 10 percent level of significance. None of the sampled farmers practiced subsistence farming. The results indicated that zero percent practiced subsistence farming, five percent of the overall sample practiced diversified farming, while 95 percent were under 'emerging commercial farmers' category. An analysis by gender of the results of HCI indicated that 44 percent of male farmers and 44 percent of female farmers practiced diversified farming, while only 12 percent of farmers under joint-management were in this level. On the other hand, joint-management had the highest percentage (40 percent) of farmers under the 'emerging commercial farmers' category, while male farmers and female farmers had 37 percent and 23 percent, respectively. From these results, majority of joint-management farmers practiced vegetable farming for commercial purposes, hence were profit oriented. However, female farmers were burdened with household chores, thus could have used part of the vegetable output to cater for family needs, hence the lower percentage under 'emerging commercial farmers' category. Muriithi (2015) found that female farmers practiced vegetable production majorly for home consumption and the little income earned from surplus vegetable output sales was used to cater for family needs.

A tobit model was used in the determination of factors influencing commercialization among vegetable farmers. The results of the econometric analysis were presented in Table 18. The log likelihood for the overall fitted model was 278.78 and a chi-square of 43.89, strongly significant at one percent level. On the other hand, log likelihoods for the fitted models by gender were 112.43 for male farmers, 63.28 for female farmers and 126.57 for joint-management. Their corresponding chi-square values were 25.37, 26.56 and 16.81 with the fitted model of female farmers significant at 10 percent level. Thus, explanatory variables of female farmers' tobit model are able to satisfactorily explain changes in vegetable commercialization. Socio-economic and institutional factors such as age, age squared, household size, years of schooling, farm size, farm assets, participation in off-farm activities, number of contacts with extension agent, access to credit, group membership and location dummy influenced the level of vegetable commercialization of male, female and joint-management. Additionally, interaction effects of group membership with household members belonging to same group and trust in group members, as well as interaction between contact with extension agent and access to information on vegetable production, were included in the regression analysis.

Table 18: Results of tobit model on factors influencing commercialization of vegetable farmers by gender

Variables	Overall sample		Male farmers		Female farmers		Joint-management	
	coefficient	Std. Err	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.
Risk Attitudes								
Risk neutral	-0.0112	0.0173	-0.0019	0.0283	-0.0152	0.0424	0.0003	0.0260
Risk loving	-0.0273	0.0155	-0.0536**	0.0244	0.0082	0.0378	0.0106	0.0236
Household characteristics								
Age	0.0012	0.0031	-0.0004	0.0049	0.0082	0.0077	0.0035	0.0048
Age squared	1.4e-05	3.41e-05	9.66-e06	5.69-05	-7.46e-05	8.05e-05	-3.94e-05	5.64e-05
Household size	-0.0012	0.0023	0.0011	0.0035	0.0008	0.0062	-0.0067*	0.0034
Number of school years	0.0031**	0.0013	0.0024	0.0019	0.0020	0.0043	0.0017	0.0021
Farm size	0.104***	0.0037	0.0086	0.0058	0.0222*	0.0115	0.0082	0.0056
Farm assets (logAssets)	0.0169*	0.0090	0.0212	0.0140	0.0464**	0.0224	0.0068	0.0126
Off-farm activities (1 if yes)	0.0047	0.0127	0.0286	0.0208	0.0233	0.0312	0.0110	0.0194
Institutional characteristics								
Access to credit (1 if yes)	-0.0395*	0.0232	-0.0080	0.0390	-0.0675*	0.0445	0.0534	0.0496
Type of market outlet (1 if farm gate)	-0.0227	0.0184	0.0308	0.0282	-0.0325	0.0463	-0.0580*	0.0298
Contacts with extension Agents	0.0030	0.0022	-0.0038	0.0028	-0.0066	0.0053	-0.0002	0.0026
Institutional characteristic interaction terms								
Production information*Number of Contact with extension agents	-0.0014	0.0018	0.0050	0.0037	0.0103*	0.0061	-0.0006	0.0030

Continuation of table 18

Social capital and interaction terms								
Group membership (1 if yes)	-0.0004	0.0571	-0.0725	0.0937	-0.4746*	0.2678	0.0996	0.0747
Group membership*Household members attending same group as respondent	0.0169	0.0113	-0.0099	0.0220	0.0536**	0.0223	-0.0048	0.0229
Group membership*Trust among group members	-0.0051	0.0068	0.0095	0.0122	0.0430	0.0310	-0.0109	0.0084
Group membership*Group heterogeneity	0.0054	0.0305	-0.0686	0.0506	0.0781	0.0662	-0.0010	0.0529
Location dummy								
Ward (1 if Jilore ward)	0.2795**	0.0128	0.0140	0.0203	0.0682**	0.0330	0.0282	0.0190
Constant	0.5237***	0.1178	0.4687**	0.1964	-0.0351	0.0330	0.0282***	0.0190
/Sigma	0.1044	0.0041	0.0777	0.0062	0.1097	0.3225	0.0647	0.0160
Number of observations =	332		124		80		128	
LR $Chi^2_{(18)}$ =	43.89		25.37		26.56		16.81	
Pseudo R^2 =	-0.0854		-0.1272		-0.2656		-0.0711	
Log likelihood =	278.7866		112.4365		63.2812		126.5713	
Prob > Chi^2 =	0.0006		0.1150		0.0876		0.5363	

Note: ***, **, * = Significant at 1%, 5% and 10% level, respectively
Risk category: 1 if risk neutral, otherwise 0; 1 if risk loving, otherwise 0.

Results of the tobit model in Table 18 indicates that the risk attitude of male farmers is negative and significantly associated to the household commercialization index at five percent significance level. A male farmer with a risk loving attitude reduced the level of commercialization by 0.0536 units as compared to a similar farmer who is risk averse. This is probably because vegetable farming is associated with numerous risks, and since male farmers are more interested in lucrative ventures, such as cash crop farming, a farmer with a risk loving attitude might opt to reallocate his resources to a profitable, less risky enterprise. Thus, the farmer becomes more cautious when implementing decisions concerning vegetable farming, as he takes into account the risks involved and ways of mitigating them. Information on risk mitigation measures might have provided a foundation for implementation of more productive decisions, that are less risky, market oriented, maximize profit and minimized costs. Consequently, with enough information at his disposal, a male farmer becomes risk averse towards vegetable risks, thereby cautiously increasing vegetable production and marketing which ultimately improves the level of commercialization. Muriithi (2015) reported that cash crop farming, mostly practiced by male farmers, was more lucrative than vegetable farming. In addition, Niane and Burger (2012) found that majority of farmers who practiced horticulture were risk averse, as they implemented farm decisions dependent on their risk situation. However, it should be noted with concern that these results pinpoint the association between risk attitudes and commercialization and not claiming causality. The appendix four section provides results of a two-step Heckman model to test for endogeneity.

The household size of farmers under joint-management was negative and significantly associated to the household commercialization index at 10 percent significance level. An additional household member under joint-management reduced the level of commercialization of the farmer by 0.0067 units. This is probably because a larger household may consume relatively more quantities of vegetables and due to slowness in decision making in joint-management households, the rate of vegetable production drops below consumption rate. This leads to a decline in surplus marketable vegetables and overall decrease in revenues. A decline in vegetable income might reduce the capital required for successive planting seasons, resulting in a decline in commercialization level. Abdullah *et al.* (2017) and Gebrehiwot *et al.* (2017) found that households that had more members were less commercialised because increase in consumption needs reduced the marketable surplus of agricultural produce leading to a decline in revenues.

Number of years of schooling was positive and significantly related to household commercialization index of farmers in the overall sample at five percent level of significance. An additional year in school increased the intensity of vegetable commercialization by 0.0031 units. Although, there was no gender differences in years of schooling, farmers were generally literate enough to improve their household commercialization index. This is probably because education provides farmers with a comprehensive understanding of knowledge and skills that are vital in implementation of technologies and commercialization decisions that boost vegetable surplus output. An increase in marketable surplus could have increased revenues thereby increasing the intensity of commercialization. Gebrehiwot *et al.* (2017) found that education provided knowledge which improved the marketing proficiency of vegetable farmers thereby enhancing their revenues through increased vegetable sales.

Additionally, the farm size of farmers in the overall sample was positive significantly associated to the household commercialization index at one percent level of significance. An increase in size of the farm by one acre increased the intensity of commercialization by 0.104 units. Taking into account gender disparities in vegetable plot allotment, the farm size of female farmers was positive and significantly associated to the household commercialization index at five percent significance level. An additional acre dedicated to vegetable farming increased the level of commercialization by 0.0222 units. This is probably because an increase in farm size might have motivated women to enhance production beyond subsistence farming, by overcoming societal obstacles of limited access and ownership of production assets such as land, thereby increasing surplus output. Revenue from surplus output might have been invested back in vegetable production thus greatly improving commercialization level of female households. Dietz *et al.* (2018) reported that intensifying access to agricultural resources to women improved their contribution in implementation of productive decisions in the household, which ultimately boosted yields and increased incomes.

The coefficient of farm assets was also positive and significantly related to the household commercialization index of farmers in the overall sample at 10 percent level of significance. An addition in farm assets by one percent increases the intensity of vegetable commercialization by 0.000169 units. Gender disaggregation in vegetable commercialization presents ownership of farm assets to be positive and significantly associated to the household commercialization index of female farmers at five percent significance level. An addition in wealth by one percent increases the level of commercialization of female farmers by 0.000464 units. Generally, female farmers were discouraged from owning farm assets mainly

due to cultural norms that constrained female inheritance and acquisition of productive assets. However, the positive sign suggests that female farmers possess farm assets that lead to an improvement in vegetable commercialization. This is probably because physical assets such as farm equipment might have been used to increase farm productivity livestock might have provided additional income. An overall increase in wealth might have been crucial in augmenting capital for vegetable farming. Mariyono (2017) reported that farmers who had enough wealth were able to invest in agricultural technologies that enhanced production which improved their vegetable commercialization levels.

Furthermore, access to credit services was negative and significantly associated to household commercialization index of farmers in the overall sample at 10 percent level of significance. Farmers who had access to credit reduced their level of commercialization by 0.0395 units as compared to those that had no access. On the other hand, gender differences in vegetable commercialization indicates access to credit, by female farmers, to be negative and significantly related to household commercialization index at 10 percent significance level. The level of commercialization decreased by 0.0675 units for female farmers who had access to credit compared to those who had no access. This was quite unexpected since previous studies (Muriithi and Matz, 2015; Ochieng *et al*., 2016) have linked credit access to an increase in commercialization of vegetables. Therefore, the likely explanation for this inverse relationship could be because credit institutions, both formal and informal, were highly scarce in rural areas. Formal institutions that were available were inaccessible and had stringent conditions that farmers had to comply to in order to access loans. Female farmers had very low credit worthiness due to lack of collateral, thus they might have had access to smaller loans from informal institutions. However, due to high interest rate charges and farming being a risky venture, repayment of loaned funds might have burdened these farmers. Income from vegetable sales, which should have been invested back in vegetable production, is instead used in loan repayment leading to decline in vegetable commercialization. Sarwosri, *et al.* (2016) found that female farmers had a difficult time when it came to loan repayment due to the hostile cultural background which African female farmers faced, such as lack of collateral, that inhibited agricultural progress.

Type of market outlet was negative and significantly associated with the household commercialization index of farmers under joint-management at 10 percent significance level. A farmer under joint-management selling vegetable output at the farm gate reduces their level of commercialization by 0.0580 units as compared to a similar farmer selling vegetables at

the market. Farmers who sold their farm produce at the farm gate had low commercialization index. This is probably because agricultural decisions were jointly made and through division of labour, both harvesting and retail of vegetables was simultaneously done on the farm. However, sale of vegetables at the farm gate was associated with relatively low prices as compared to selling at the market, probably because of limited access to information on market demand, hence low vegetable income. The low income coupled with slow decision making in joint-management hindered selling of vegetables, hence reducing commercialization level. Gebrehiwot *et al.* (2017) found that farmers who were in contact with the market were more commercialised because access to market information enabled them to plan production activities accordingly, in order to meet market demand.

The interaction term of access to production information and number of contacts with extension agent, was positive and significantly associated to household commercialization index of female farmers at 10 percent significance level. For female farmers that had access to vegetable production information from an extension agent, their level of commercialization increased by 0.0103 units as compared to a similar farmer who had no access to such information. The reason behind this is because extension agents are major sources of information and technical know-how for farmers in the rural areas. Since most female farmers are involved in the production aspect of vegetable commercialization, extension agents might have targeted women in order to disseminate beneficial information such as, use of appropriate and improved farm inputs as well as use of modern methods of farming. This knowledge might have equipped female farmers with the necessary skills to increase vegetable production, increase sales volume and improve commercialization level. Djoumessi *et al.* (2017), Gebrehiwot *et al.* (2017) and Mariyono (2017) reported that farmers who were in regular contact with extension agents were more commercialised because they acquired knowledge and practical skills that enabled them to enhance vegetable production and increased market participation.

On the other hand, there was an inverse relationship between group membership and household commercialization index of female farmers, at 10 percent level of significance. For female farmers who were members of a group, the level of commercialization decreased by 0.4746 units as compared to those farmers who were not members. This is probably because agricultural groups are designated to provide beneficial information on market demand and prices of inputs, technical know-how on vegetable production and financial support. However, these groups have a component of social function, which may dominate the

primary goal of agricultural groups, thus creating difficulty in prioritizing and implementing group activities over social activities. The outcome would be inhibited information flow concerning vegetable production and the eventual decline in commercialization level of female farmers. Yusuf *et al*. (2015) reported that membership in groups by farmers hindered their productivity on the farm, due to the inferior cooperative structure of groups which fail to prioritize goals of the group over other activities.

In addition, the interaction term, group membership and household member belonging to same group as respondent, was positively associated to the household commercialization index of female farmers at five percent level of significance. For a female farmer that had household members attending the same group as her, the farmer's level of commercialization increased by 0.0536 units as compared to a similar farmer who attended group meetings alone. This is probably because groups were avenues of knowledge dissemination on vegetable production, where farmers were able to acquire information on modern methods of farming, use of optimum inputs, market information on consumer needs, collective marketing of vegetable produce, obtain technical skills and in some cases financial aid. Therefore, an increase in household members attending same group as female farmers might probably boost households' knowledge base as household members might be able to make informed decisions on resource allocation in vegetable production. These decisions might enhance production volumes and increase vegetable income. Akinlade *et al*. (2016) and Kibiringe (2016) reported that increase in group membership increased commercialization level of farmers as its improved members' social capital which allowed them to acquire knowledge, market information, agricultural inputs and farm equipment necessary to enhance productivity and boost marketable surplus.

Lastly, the location dummy was positive and significantly related to the household commercialization index of farmers in the overall sample at five percent level of significance. A farmer located in Jilore ward was likely to increase the level of commercialization by 0.2795 units as compared to a farmer from Kakuyuni ward. Taking into consideration gender disparities in vegetable commercialization shows the location dummy to be positive and significantly associated to household commercialization index of female farmers, at five percent level. A female farmer located in Jilore ward increases her level of commercialization by 0.0682 units as compared to a similar farmer from Kakuyini ward. This is probably because Jilore ward is located in the rural areas of Malindi Sub-County, where vegetable farming is the main economic activity. Since vegetable farming is labour intensive, female

farmers are the major providers of farm labour in the rural households. Availability of labour could have increased marketable surplus output, resulting in an improvement in household incomes and overall boost in vegetable commercialization. Oduol *et al.* (2017) and Zakaria (2017) reported that farming activities in the rural areas promoted agricultural commercialization, because of the abundance of farm labour mainly provided by female farmers.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the study, it can be concluded that;

i. There was a significant relationship between gender and perceived risks. Farmers under joint-management experienced financial risks more frequent while the severity of financial risks was greater for male farmers. Volatile interest rates from informal financial institutions burdened farmers in loan repayment since most smallholder farmers relied more on informal lending institutions. Marketing risks were more frequent for male farmers because they were mostly involved in marketing of vegetables.

ii. Vegetable farmers were generally risk averse, with joint-management farmers being the most risk averse. Female farmers who had access to credit services were less risk averse because financial support augmented capital required for boosting vegetable production. Farmers (both male and female) in Jilore ward were more risk averse compared to those located in Kakuyuni ward because of distance from the nearest town, which created differences in access to market information.

iii. Female farmers were the least commercialised. Male farmers with a risk loving attitude reduced their level of commercialization as they reallocated their resources from vegetable farming, to a less risky lucrative enterprise (cash crop farming). On the other hand, female farmers who were members of a group reduced their level of commercialization because the social function dominated the primary goal of the group.

5.2 Recommendations

For policy analysts, the results on the risks encountered by smallholder farmers depicts financial risks to be the most frequent and severe to commercial oriented farmers. There is need for implementation of policies that will help in minimizing the gravity of financial risks. Policies that are tailor-made to address gender specific financial constraints, more so in the informal sector, should be implemented in order to promote access of affordable financial support. For instance, implementation of a policy that geared towards enhanced farmer's access to credit institutions to provide alternative credit source. This could be through group insurance and advocacy.

Farmers exhibited high risk aversion due to inadequate agricultural resources and limited market information. These results emphasize on the importance of understanding farmers' risk attitudes and perceptions that have implications on research institutions and policy formulators, in advocating for both male and female empowerments in agriculture. There is need for policies and programs that promote access and ownership of productive resources and increased information flow in rural areas, especially to women. For instance, dissemination of weather and market related information in a language that farmers can understand in order to address information disparities. In addition, programs that target women who have no access to productive resources, like water pumps and ploughs, should be emphasized in order to improve on access to resources.

Finally, female farmers who were members of producer groups, were found to have a lower commercialization index, while male farmers with a positive attitude towards risk were also found to be less commercialised. The findings underline the importance of strengthening agricultural groups so that the social function does not outweigh the goals of the group. There is need for groups that provide better services, abide to group laws that foster achievement of goals, promote cohesion, enhance capacity building and incorporate farmers to profitable vegetable value chains. In addition, vegetable value chains need to be enhanced in order to increase incomes of farmers. This will promote male participation in this enterprise. Furthermore, information on risk mitigation measures in vegetable farming should be disseminated, more so in rural areas, so as to promote vegetable commercialization. Therefore, policies and programs should be put in place that advocate for implementation of appropriate risk mitigation methods tailored to the needs of rural farmers. This may include, an increase in registration of female producer groups by agricultural offices, in order to closely monitor progress and integrate them in lucrative value chains. Moreover, crop insurance covers and advanced production technologies, like new seed varieties that are disease resistant, should be customized to meet the needs of rural farmers.

5.3 Suggestions for further research

The main aim of the study was to assess gendered risk attitudes and vegetable commercialization among smallholder farmers, in order to advocate for pertinent policies that contribute towards improved livelihoods in Kenya. However, the study recommends further research;

i. In a related background using panel data to assess gendered risk attitudes and their influence on vegetable commercialization among smallholder farmers, so as to improve their livelihoods.
ii. In examining gendered adoption of risk management strategies.
iii. In examining the feasibility of credit-insurance linkage.

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APPENDIX

APPENDIX 1: Respondent questionnaire

My name is JUDITH MATSEZI MUMBA a student from Egerton University, and a resident of Malindi. I am conducting a study that intends to provide a clear insight of the smallholder vegetable farmers' attitude towards risk and how it affects the commercialization of vegetables in Malindi Sub-County, Kenya. Your esteemed participation in answering the enclosed questions will be greatly appreciated and treasured. This study will assist in policy formulation towards improved living standards through reduction in risks and enhancement of the institutional framework in the Sub-County. The information you provide will be treated with utmost confidentiality as it will only be used for the purpose of this research study.

PART 1: GENERAL INFORMATION

Time started _____

Questionnaire No. (**QN**) _____

Date (dd/mm) _____

Ward (**Wrd**) _____ *1 = Jilore 2 = Kakuyuni*

Location (**Loc**) _____

Sub-Location (**Subloc**) _____ *1 = madunguni 2 = Mongotini 3 = paziani 4 = Malimo 5= langobaya 6 = Mkondoni*

Name of vegetable plot manager (**Nme**) _____

Telephone No. (**Tel**) _____

Name of Enumerator _____

PART 2: FARM AND FARMER'S CHARACTERISTICS

1.1 Age of vegetable plot manager (**Age**) _____

1.2 Gender of the vegetable plot manager (**Gen**) *1 = male, 0 = Female* _____

1.3 What is the total number of household members? (**SHH**) _____

1.4 Education level of the household head? (**EducLev**) *1= not gone to school 2= primary 3 =secondary 4 =college 5 =university* _____Years of schooling _____

1.5 How long have you been a vegetable farmer? (**FamExpe**) _____

Land

6) What is nature of land ownership? (**NatLnd**) _____ *1 = rented, 2 = self-owned, 3= communal, 4= other (specify)* _____

7) What is the size of land allocated for? (**LndSize**)

Vegetable production (acres) _____ other crops (acres) _____

8) What is the nature of vegetable production? (**ProdTech**) **_____** *1= Irrigation farming 0 = Rain-fed farming*

9) If selected 1) in 8 above, indicate the type of irrigation method (**IrrgMed**) _____

1 = furrow irrigation, 2 = sprinkler irrigation, 3 = drip irrigation, 4 = basin irrigation 5 = sub-surface irrigation 6 = other, specify _____

10) Do you have access to irrigation equipment? (**AccIEq**) *1= yes, 0 = No* _____

11) If yes in 10) above, name the equipment (**TypEq**) _____

1 = sprinkler, 2 = drip kit, 3= other, specify _____

Assets

12) Indicate the number and value of farm assets that you have owned for the last 12 months

Biological (only consider animals that are mature enough to be sold)	Number	Average value per Asset (V)	Total value (TV)
Cattle			
Goats			
Sheep			
Chicken			
Ducks			
Other, *Specify* _____			
Other, *Specify*_____			

Physical	Number	Average value per Asset (V)	Total value (TV)
Irrigation equipment			
Spray pump			
Water pump			
Jembe			
Panga			
Rake			
Axe			
Machinery (tractor, plough)			
generator			
Watering can			
wheelbarrow			
Bicycle			
Solar panel unit			
motorcycle			
Shed (animals)			

Television			
Storage house (crops)			
Vehicle			
Weighing scale			
Mobile phone			
radio			
Other, specify _____			
Other, specify _____			
Other, specify _____			

Labour

13) What is your main source of farm labour? (**Lbr**) _____

1 = family, 2 = casual labourer, 3 = permanent worker, 4 = other, specify _____

14) If selected *1*) in 13 above, fill the table using the codes provided: *1 = male, 0 = female*

Gender of family member providing labour	Number of Adults providing labour	Number of children Below 18 years providing labour
M		
F		

Sales from vegetables in the past season

15) How many seasons did you cultivate vegetables in the past year? _____ 1 = *1 season, 2 = 2 seasons 3 = other, Specify* _____

16) Who manages this vegetable plot? (**PltMngr**) _____ *1 = household head 2 = spouse 3 = children 4 = jointly managed*

17) If selected jointly managed, which activity does each household member do? (**PltMngAct**)

Fill in the table provided using the codes provided below.

1 = nursery bed preparation, 2 = land preparation, 3 = cultivation, 4 =weeding, 5 = fertilizer application, 6 = harvesting, 7 = packaging, 9 = transporting, 10 = selling 11 = other, specify _____

Household member	**Activities**										
Household head											
Spouse											

18) Kindly fill in the table below using the codes provided.

Crop: *1= Tomatoes, 2 = Okra, 3 = Amaranthus, 4 = kales, 5 = other, specify _____*

Unit of measurement*: 1 = kg, 2 = sisal bags, 3 = crate, 4 = bucket, 5 = bunch 6= other, specify _____*

Occurrence of loss: *1 = nursery bed preparation, 2 = land preparation, 3 = transplanting, 4 =weeding, 5 = budding 6 = fruit formation, 7 = harvesting, 8 = sorting/grading, 9 = packaging, 10 = transporting, 11 = other, specify _____*

Point of sale: *1 = farm gate, 2 = market, 3 = use of intermediaries 4 = supermarket outlets 5 = other, specify _____*

Crops (use codes above) Crp	Land size under production LndSizeProd	Unit of measurement of crop (use codes above) UMesCrp	Amount of crop harvested AmCrpHarv	Amount of crop consumed AmCrpCon	Amount of post-harvest loss AmPstHarvLss	Amount of crop sold AmCrpSld	Price per unit of output of crop PperUOpt	Total Revenue of sold crop TRcrpSld	Occurrence of loss (use codes above) OccLoss	Point of sale PoSale
Main rain season										

Transportation costs

19) Kindly fill the table using the codes provided.
Crop*: 1= Tomatoes, 2 = Okra, 3 = Amaranthus 4 = Kales 5 = other, specify _____*
Unit of measurement*: 1 = kg, 2 = sisal bags, 3 = crate, 4 = Bucket 5 =Bunch 6 = other _____*
Means of transport*: 1 = on foot, 2 = Bicycle, 3 = motorcycle 4 = personal car/pickup, 5 = public transport 6 = other, specify_____*

Condition of road*: 0 = Very bad, 1 = bad, 2 = good, 3 = very good, 4 = Excellent*

Crop (**Crp**	Distance on foot to nearest market (minutes) **DistMkt**	Unit of measurement per crop **(UMesCrp)**	Transportation cost per unit of measurement of crop **(TranCperC)**	Number of units of crop transported (**NUCTran)**	Total transportation cost per crop (**TranCsts)**	Means of transport to nearest market **(MeTranNeMkt)**	How would you rank the condition of the road to the nearest market? (**ConRoNerMkt)**

Off-farm income
20) Do you participate in off- farm income? **partOFFI** *1 = yes 0 =No* _____
21) If yes in **20**) above kindly fill the table below using the provided codes

Source of off-farm income **SrceOFFI**	Number of months **NMonOFFI**	Average income per month **InMonOFFI**	Total off-farm income **TotOFFI**

1 = Trading business 2 = salary 3 = remittances from relatives 4 = pension scheme (NSSF) 5 = man-day wages 6 = other, specify _____

22) Do you engage in any non-vegetable on-farm income generating enterprises? **NonVegOnFI** *1 = yes 0 =No* _____

23) If yes in **22**) above, fill in the table below

Source of non-vegetable on-farm income*: 1 = cattle 2 = sheep 3 = goats 4 = poultry 5 = bananas 6 = coconuts 7 = cashew nuts 8 = pulses 9 = Maize 10 = other, (specify) _____*

Source of non-vegetable on-farm income **SorNonVegOnFI**	Number of units sold in the last 12 months **NuUSldNonVegOnFI**	Average value per unit sold **AveValUnSld**	Total income **TotNonVegOnFI**

PART THREE: INSTITUTIONAL CHARACTERISTICS

Contractual arrangements

24) Do you engage in contract farming? **EngCon** *1 = yes, 0 = No* _____

25) If yes in **24**) above, fill in the table using the codes provided.

Means of contractual arrangement: *1 = retailer contracts 2 = use of intermediaries, 3 = supermarket outlets 4 = schools 5 = other, specify* _____

Crop*: 1= Tomatoes, 2 = Okra, 3 = Amaranthus 4 = kales, 5 others specify* _____

Type of crop **Crp**	Means of contractual arrangement **MeConArrgmt**	Frequency of contractual arrangements within a month **FreqConArrgmt**	In a scale of 1-10 how would you rank your involvement in future contractual arrangements with the current partner? **FuConArrngmnt**

Extension services

26) Do you have access to extension services? **ExtServ** *1 = yes 0 = No* _____

27) If yes in **26**) how many times have you been in contact with an extension agent in the last 12 months? **ContExtAgnt** _____

Training and Information sources

28) Do you have access to information on vegetable commercialization? **AccInfo** *1=yes 0=No* _____

If yes in 28) above, what type of information do you have access to? **TypInfo** _____

1=production, 2=marketing, 3=Financial, 4 = legal 5=all the above, 6=other, (specify) _____

29) Where did you get this information from? **SorcInfo** _____

1= Extension officers 2= television 3= fellow Farmer 4= Farmer group/association 5= radio 6 = phone 7 = internet 8 = social media 9= trainings attended 10 = NGOs 11 = farmer field days 12 = chief barazas 13 = others, (specify) _____

30) If you received training in 29) above, fill the table below using the codes provided.

Nature of training **NatTrng**	Institution that provided training **InstProvTrng**	Number of trainings attended in the last 12 months **NuTrngAtt**	Do you have access to a demonstration farm nearby? **AccModFam**	In a scale of 1 – 10 how would you rank the usefulness this training to vegetable commercialization? **TrngUseful**

Nature of training*: 1= production related 2 = marketing related 3 = financially related 4 = 0ther, (specify)* _____

Institution providing training*: 1= Ministry of Agriculture office 2= Private organisations, 3= NGO's, 4= Farmer to farmer, 5 = Media, 6 = social media, 7 = farmer group, 8 = others, (specify)* _____

Do you have access to a demonstration farm*: 1= yes, 0 = No*

Credit access

31) Do you require credit for commercialization of your vegetables? **ReqCrdt** *1 = yes, 0 = No* _____

32) Have you had access to credit in the last 12 months? **CrdtAcc** *1 = yes, 0 = No* _____

33) If yes state the total amount of credit acquired in the past 12 months? **AmCrdtAcq** _____

34) Name the type of institution that provided the credit **TypCrdtInst** _____ *0 = money lenders, 1 = ROSCAs, 2 = village banks, 3 = microfinances, 4 = commercial banks, 5 = friends and relatives, 6 = other, specify* _____

Social capital

35) Do you belong to any farmer group/association? **GrpMem** 1*=yes, 0=No* _____

36) If yes in **35**) above fill the table and use the codes provided below

Group name **GrpNme**	Number of female members **NoGrpFem**	Number of male members **NoGrpMle**	How long have you been a member? (months) **Grptime**	Number of household members who belong to this group **GrpHHmem**	Meetings per month **GrpMeMon**	What type of Group do you belong to? (**GrpTyp**)	Group activities **GrpActvt**	Existing relationship among members **RlspGrpmem**	Role of the group **GrpRle**	On a scale of 1-10 how would you rank your involvement in decision making in the group? **DecMakGrp**	On a scale of 1-10 how would you rank your level of trust for members in the group? **TrstGrpmem**

Group type: *1 = farmer group 2 = welfare group 3 = ROSCAs 4 = savings and credit 5 = other, specify* _____
Group activity*: 1 = production, 2 = marketing, 3 = financial 4 = other, (specify)* _____
Existing relationship*: 1 = friends, 2 = family, 3 = neighbors, 4 = farmers, 5 = other, (specify)* _____
Role of group*: 1 = information, 2 = training, 3 = provide credit, 4 =ROSCAS 5 = other, (specify)* _____

Kindly describe the characteristics of members in the group you belong **GrpHeterognty**

Group name **GrpNme**	Do members of the group belong to the same; (tick where appropriate)							
	Neighborhood **Neigbhd**	Occupation **Occptn**	Tribe **Trbe**	Religion **Rlgn**	Education level **Educlevl**	Gender **Gen**	Age group **AgeGrp**	Economic status **EconStat**

PART FOUR: MEASUREMENT OF RISK ATTITUDE
Severity and frequency

37) *In the table provided below kindly tick risks encountered in vegetable farming, the frequency of occurrence, and then rank the risks identified starting with the most severe to the least severe. (**EncRsks**)*

Vegetable Risks	**Tick**	**Frequency**[1]	**Severity**[2]
Production Risks			
Unpredictable weather patterns (**UnWePatt**)			
Vegetable pests and diseases (**VegPstDis**)			
Rainfall and floods (**RnfalFlds**)			
Prolonged drought (**ProlDrgt**)			
Technological changes (production tech, methods of farming, certified inputs, etc.) (**TechChge**)			
Marketing/price risks			
Changes in vegetable Input prices (**ChageVegInp**)			
Changes in vegetable output prices (**ChageVegOutPr**)			
Institutional risks			
Changes in horticultural regulations by government (**ChngeHortPolic**)			
Financial risks			
Sudden rise in interest rate (**SudRseIntRates**)			
Limited access to Credit (**CrdtAcc**)			

[1] ***Frequency**: 1=not at all, 2=less frequent, 3=frequent, 4=more frequent, 5= very frequent*

[2] **Severity:** *1 = not at all, 2 = less severe 3 = severe 4 = more severe 5 = most severe*

Perception on Risks

38) Kindly fill the table using codes for ranking as provided below (*tick where appropriate)*
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

Perception on risks (**RskPercp**)	rank				
	1	2	3	4	5
I like to dedicate **all my assets** (land, farm equipment, capital, e.t.c) in commercialization of vegetables to acquire **high profits** regardless of the **risks involved**					
I prefer to dedicate **part of my assets** in commercialization of vegetables to acquire **enough profits** taking into account the **risks involved**.					
I prefer to **engage** in vegetable production that exposes me to **less risks** in decision making					
I like **new** vegetable enterprises that have **uncertain** outcomes					

If vegetable commercialization is **highly profitable** but involves **great risks**, then I opt for the **high profits** with **awareness** on risk mitigation measures					
I **prefer** vegetable commercialization because I **know** the **risks** involved.					

ELCE Experimental Method to elicit risk attitudes

39) *This is an experimental game that is hypothetical in nature. It is geared towards determining your risk attitude. Assuming your annual vegetable income ranges from KES.0 - KES. 100,000. You are presented with two outcomes, to either earn 0 KES or KES 100,000, where each outcome has a probability of 0.5 gain or loss. You, as a vegetable farmer must quote an income value that you will rather have with certainty than take a risk of growing vegetables and receiving an income of either KES 0 or KES 100,000, where both values have a 50% chance of success or failure.*

Annual Income range	**Certainty equivalent**
Lower values	
1. 0 – 100,000	***A***
0-A	***B***
0-B	***C***
0-C	***D***
0-D	***E***
Higher values	
1. ***A*** – 100,000	***F***
F - 100,000	***G***
G - 100,000	***H***
H - 100,000	***J***

Note*: a guide for enumerators on conducting the experiment is given in the next page*

(40) Eckel and Grossman model

This is a hypothetical game therefore no real payments will be offered, however an incentive, in form of airtime will be awarded according to the choice of gamble. You are presented with six gambles with the payoffs representing your income from vegetable production, as shown in the table below. The income variability in the gambles are as a result of unpredictable weather patterns. Each gamble has a probability of 0.5 for a gain and 0.5 for a loss. This means, heads will represent the high payoff and tails the low payoff.

Taking this scenario to the farm, a ***high payoff*** *signifies* ***high profits*** *from vegetable commercialization due to* ***less risks*** *in vegetable production.* ***Low payoffs*** *signify* ***low profit*** *from vegetable commercialization due to* ***more risks*** *in vegetable production. You are asked to choose one gamble among the six alternatives. Upon selection of the gamble, a coin will be*

tossed for you and whichever side the coin lands will represent your hypothetical income from vegetable production.

NB:

1. *If the coin lands on the high payoff side for gambles 1, 2 and 3 you are rewarded with KES 10 safaricom airtime.*
2. *If the coin lands on the high payoff side for gambles 4 and 5 you are rewarded with KES 20 safaricom airtime.*
3. *If the coin lands on the high payoff side for gamble 6, you are rewarded with KES 30 safaricom airtime.*
4. *The awarding of airtime is ONLY applicable to the second round.*

Choice (0.5/0.5 gamble)	**Low payoff (KES)**	**High payoff (KES)**	**First round**		**Second round**	
			L	**H**	**L**	**H**
Gamble 1	28,000	28,000				
Gamble 2	24, 000	36,000				
Gamble 3	20,000	44,000				
Gamble 4	16,000	52,000				
Gamble 5	12,000	60,000				
Gamble 6	2,000	70,000				

Time preference

41) *This question is about your preference for receiving money today or in three months. Example; would you prefer to receive KES 28,000 in cash today or wait till you harvest your vegetables, sell and earn an income of KES 28,000?* (**TPref**)

	Bid	**Tick where switching occurs**
1.0	KES 24,000 today or 28,000 KES in three months?	
2.0	KES 20,000 today or 28,000 KES in three months?	
3.0	KES 16,000 today or 28,000 KES in three months?	
4.0	KES 12,000 today or 28,000 KES in three months?	
5.0	KES 8,000 today or 28,000 KES in three months?	
6.0	KES 4,000 today or 28,000 KES in three months?	

Time ended _____

…. Thank you for your cooperation….

APPENDIX 2: Equations and ANOVA Table

Sample size determination

$$n = \frac{z^2 \cdot p \cdot q \cdot N}{\ell^2 (N-1) + z^2 \cdot p \cdot q} \quad (2.1)$$

$$n = \frac{1.96^2 \cdot 0.5 \cdot 0.5 \cdot 2450}{0.05^2 (2450 - 1) + 1.96^2 \cdot 0.5 \cdot 0.5}$$

$$n = 332$$

ANOVA Table

Variable	**Gender of vegetable plot manager**				
		SS	**df**	**MS**	**F-value**
Age	Between groups	30.82	51	0.60	0.77**
	Within groups	221.13	280	0.79	
	Total	251.96	331	0.76	
Household size	Between groups	10.06	12	0.83	1.11
	Within groups	241.89	319	0.75	
	Total	251.95	331	0.76	
Farm size	Between groups	25.89	29	0.89	1.19
	Within groups	226.05	302	0.74	
	Total	251.95	331	0.76	
Farm assets (‘000 KES)	Between groups	239.95	310	0.77	1.2**
	Within groups	12	21	0.57	
	Total	251.95	331	0.76	
Number of school years	Between groups	37.43	13	2.87	4.27***
	Within groups	214.51	318	0.67	
	Total	251.95	331	0.76	
Number of contacts with extension agents	Between groups	25.56	12	2.13	3.00***
	Within groups	226.39	319	0.70	
	Total	251.95	331	0.76	
Number of household members attending same group as respondent	Between groups	8.98	4	0.29	0.82

	Within groups	250.77	327	0.76	
	Total	251.97	331	0.76	
Trust for members in group	Between groups	8.98	9	0.99	0.22
	Within groups	242.97	322	0.75	
	Total	251.95	331		0.76

APPENDIX 3: Enumerator guide

Conducting the ELCE experimental method

Assume the annual income of vegetable farmer is estimated to range between KES 0 and KES 100,000. Present the farmer with an option of earning either KES 0 or KES 100,000. Take a coin and use the heads to represent KES 0 and tail to represent KES 100,000. Toss the coin and whichever side the coin lands will be the income of the farmer. The heads and tail represent the two risky outcomes. The farmer must quote an income value that they will rather have than take a risk of growing vegetables and receiving an income of either KES 0 or KES 100,000, where both values have a 50% chance of success or failure. Whatever value the farmer will quote will be termed as the Certainty Equivalent (CE) value of that income range. For instance, Say the farmer chooses KES ***A*** between the ranges from KES 0 to KES 100,000. This ***A*** value is the amount representing his/her CE for the payments of KES 0 to KES 100,000.

Again, present an income range between 0 and ***A*** and ask the farmer to quote an income value that they will rather have than take a risk of growing vegetables and receiving an income of either KES 0 or KES ***A***. If the farmer chooses KES ***B*** then this will represent his/her CE value for the income range of KES 0 to KES ***A***. repeat this process till you get all values from ***A, B, C, D***, to ***E*** as indicated in the table above.

Similarly, repeat the experiment for the higher values of income. Present the farmer with an option of earning KES ***A*** (value got from the previous round) or KES 100,000. Ask the farmer to quote an income value that they will rather have than take a risk of growing vegetables and receiving an income of either KES ***A*** or KES 100,000. Say the farmer quoted KES ***F*** between the range of KES ***A*** and KES 100,000. F is the CE for the payments of KES ***A*** and KES 100,000.

Again, present an income range between KES ***F*** and KES 100,000 and ask the farmer to quote an income value that they will rather have than take a risk of growing vegetables and receiving an income of either KES **F** or KES 100,000. If the farmer chooses KES ***G,*** then this will represent his/her CE value for the income range of KES **F** to KES 100,000. Repeat this process till you get all values from ***F, G, H, J***, to ***K*** as indicated in the table above.

APPENDIX 4: Stata output

Two Stage Heckman model

```
. by PltMngr, sort : heckman hci Age SHH SchYrs Farmsize logAssets partOFFI CrdtAcc ContExtAgnt GrpMem GrpMemHHmem GrpMemTrstGrp GrpMemGrpHet
> , twostep select(RskATT_EG_Rnd1 = Age SHH SchYrs Farmsize logAssets partOFFI CrdtAcc ContExtAgnt GrpMem GrpMemHHmem GrpMemTrstGrp GrpMemGrp
> Het)
```

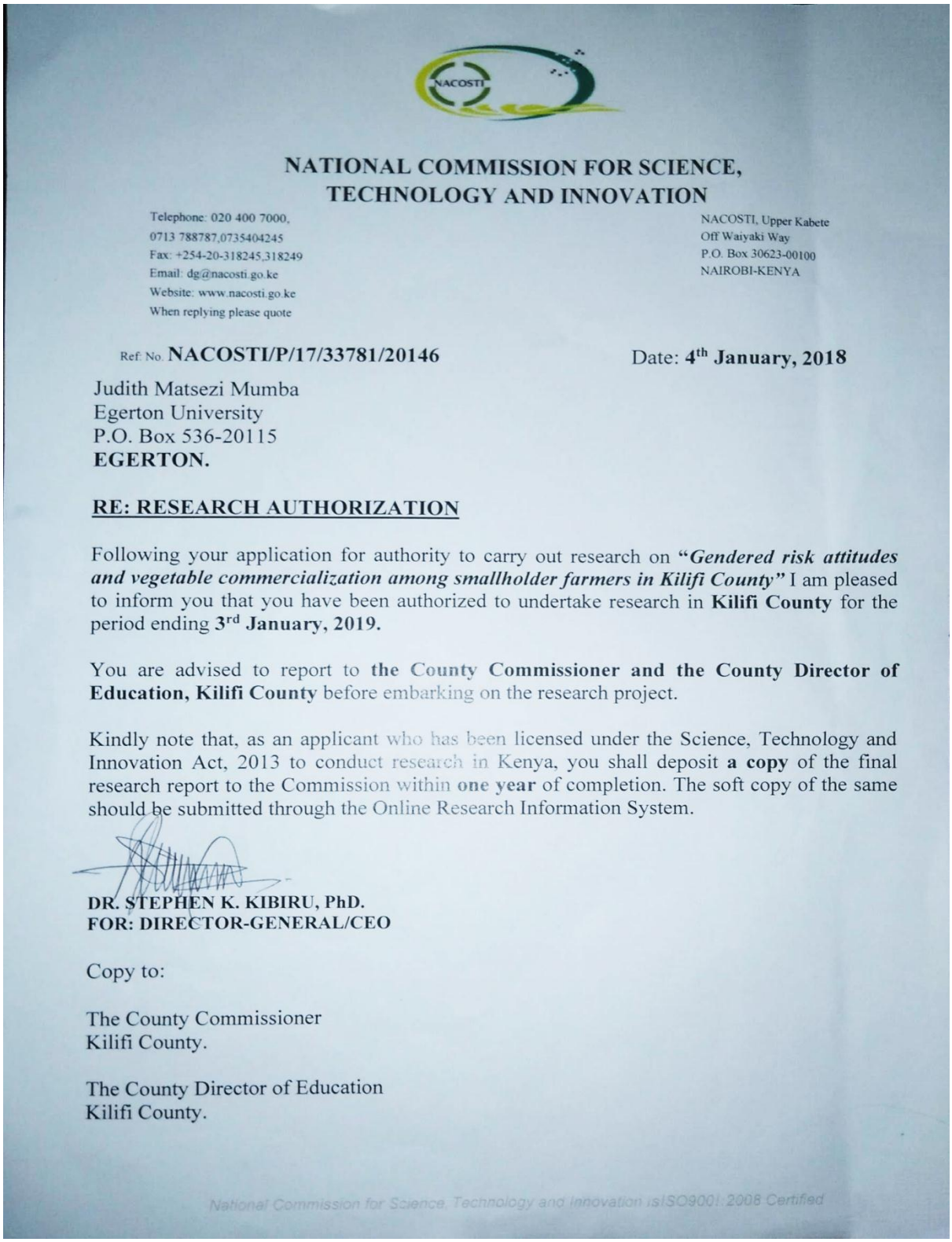
```
-> PltMngr = male manag

Heckman selection model -- two-step estimates   Number of obs     =       124
(regression model with sample selection)        Censored obs      =        22
                                                Uncensored obs    =       102

                                                Wald chi2(12)     =     22.86
                                                Prob > chi2       =    0.0289
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
hci						
Age	-.0001304	.0009891	-0.13	0.895	-.002069	.0018082
SHH	.005597	.0047974	1.17	0.243	-.0038056	.0149997
SchYrs	.002107	.0032979	0.64	0.523	-.0043568	.0085709
Farmsize	.0018759	.0060783	0.31	0.758	-.0100373	.0137892
logAssets	.0173714	.0160853	1.08	0.280	-.0141552	.0488981
partOFFI	.0280786	.0243609	1.15	0.249	-.0196679	.0758251
CrdtAcc	.0202103	.0447124	0.45	0.651	-.0674244	.1078449
ContExtAgnt	-.0025193	.0040069	-0.63	0.530	-.0103727	.005334
GrpMem	-.0374121	.1008149	-0.37	0.711	-.2350056	.1601814
GrpMemHHmem	-.0473076	.0235268	-2.01	0.044	-.0934193	-.001196
GrpMemTrstGrp	.0134787	.0127836	1.05	0.292	-.0115767	.038534
GrpMemGrpHet	-.1583948	.0581298	-2.72	0.006	-.2723272	-.0444624
_cons	.5249282	.1901787	2.76	0.006	.1521848	.8976716
RskATT_EG_Rnd1						
Age	.0331346	.0192536	1.72	0.085	-.0046018	.0708709
SHH	-.1377308	.0617829	-2.23	0.026	-.258823	-.0166386
SchYrs	.1499739	.0438336	3.42	0.001	.0640616	.2358861
Farmsize	.0455183	.1133249	0.40	0.688	-.1765944	.267631
logAssets	.290483	.2548423	1.14	0.254	-.2089987	.7899647
partOFFI	.6878702	.4155221	1.66	0.098	-.1265382	1.502279
CrdtAcc	-.774873	.9940269	-0.78	0.436	-2.72313	1.173384
ContExtAgnt	-.0798268	.0370965	-2.15	0.031	-.1525347	-.0071189
GrpMem	2.507659	2.605486	0.96	0.336	-2.599001	7.614318
GrpMemHHmem	-.1869509	.3491104	-0.54	0.592	-.8711948	.4972929
GrpMemTrstGrp	-.2298034	.3261028	-0.70	0.481	-.8689531	.4093463
GrpMemGrpHet	-.1454242	.8745305	-0.17	0.868	-1.859472	1.568624
_cons	-3.244563	2.655334	-1.22	0.222	-8.448922	1.959796
mills						
lambda	-.0392461	.0822003	-0.48	0.633	-.2003558	.1218636
rho	-0.40643					
sigma	.09656377					

APPENDIX 5: Research permit



NATIONAL COMMISSION FOR SCIENCE,
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NAIROBI-KENYA

Ref: No. **NACOSTI/P/17/33781/20146**

Date: **4th January, 2018**

Judith Matsezi Mumba
Egerton University
P.O. Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Gendered risk attitudes and vegetable commercialization among smallholder farmers in Kilifi County"*** I am pleased to inform you that you have been authorized to undertake research in **Kilifi County** for the period ending **3rd January, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Kilifi 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.

DR. STEPHEN K. KIBIRU, PhD.
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Kilifi County.

The County Director of Education
Kilifi County.

National Commission for Science, Technology and Innovation is ISO9001: 2008 Certified

CONDITIONS

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 17007

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MISS. JUDITH MATSEZI MUMBA
of EGERTON UNIVERSITY, 127-80200 MALINDI,has been permitted to conduct research in *Kilifi County*

on the topic: *GENDERED RISK ATTITUDES AND VEGETABLE COMMERCIALIZATION AMONG SMALLHOLDER FARMERS IN KILIFI COUNTY*

for the period ending:
3rd January,2019

.....
Applicant's Signature

Permit No : NACOSTI/P/18/33781/20146
Date Of Issue : 4th January,2018
Fee Recieved :Ksh 1000

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