ASSESSMENT OF HOUSEHOLD LAND SIZE AND LAND USE FOR SUSTAINABLE FOOD SECURITY IN MIXED FARMING SYSTEM OF KATHIANI SUB-LOCATION IN MACHAKOS COUNTY

Joseph Mwanthi Mutuku
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Department of Urban and Regional Planning
School of the Built Environment
University of Nairobi

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STUDENT

Joseph Mwanthi Mutuku

B63/88185/2016

Signature…….……Date……

SUPERVISORS

This Research proposal is submitted with our approval as University Supervisor(s):

Prof. Elijah Ndegwa

Signature……...Date…….…….…….

Dr. Rose Musyoka

Signature……Date…….……

DECLARATION

I, **Joseph Mwanthi Mutuku**, declare that this is my original work that it has never been published anywhere else.

Name: ……..……...

Signature: …….

Date: …….

ABSTRACT

This study was conducted in a rural setting of the populous hilly Kathiani Sub-location in Machakos County and aimed to address specific objectives as follows: determining the current household land sizes and uses; examining the impacts of household land size and uses on household food security; establishing the factors that influence household land size and use as well as profiling the intergenerational transfer of land rights and uses in the study area. Agriculture is globally relied upon as the main source of food and livelihoods. Household land sizes and uses have been determined as among the factors influencing household food security. Notably, food security is a widespread challenge world over. Globally, governments have struggled to feed their citizens. This state of affairs is prevalent in the third world countries with Sub-Saharan Africa and Kenya in particular suffering severe food shortages arising from overdependence on rain-fed agriculture, an ever-growing population in the wake of diminishing land sizes and continuously changing climatic conditions. The study adopted a cross-sectional survey design that aided data collection. Proportionate and stratified simple random sampling together with systematic sampling methods were applied in the household data collection of the studied twelve villages of the sub location and a sample of 183 respondents identified. Secondary data was obtained from review of existing scholarly materials and research reports. Primary data was obtained by administration of household questionnaires to the sampled households. Further, key informant interview schedules, focus group discussions guides, observation list and photography aided collection of additional primary data. The study found that original land sizes before subdivision ranged from one acre to slightly above nine acres with an average of 5 acres. Results show the current land sizes range from zero for those without land at all to slightly above nine acres with an average of 1.5 acres. Agriculture was the leading land use at 94% of the respondents. Paired T-test results $t = -1.713$, $p = 0.089$ and independent T-test of $t = -1.638$; $p = 0.115$ indicated lack of a significant relationship between land size and household food security. Land inheritances at 54% together with acquisition by purchase at 46% were the leading contributors to land subdivision. Such land subdivisions were fueled by cultural practices such as inheritance of land to on average 4 heirs with 46% of respondents having brothers who inherited their parents land, selling of land due to poverty and to meet education needs, population growth and to resolve land related conflicts. The effect of the subdivisions was a decrease in yields as reported by 58% of the interviewed households. Adoption of high-rise cluster settlement pattern, enforcement of land subdivision policies, establishment of minimum agricultural land sizes and education on adoption of other forms of wealth that can be bequeathed to children and alternative survival mechanisms were recommended as viable solutions to food security challenges in the study area.

DEDICATION

I dedicate this work to organizations, groups of people, communities and individuals, who work to make the world a better place for all.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF CHARTS

LIST OF MAPS

LIST OF PLATES

ACRONYMS AND ABREVIATIONS

CAADP	Comprehensive Africa Agriculture Development
CIDP	County Integrated Development Plan
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GSC	Growth and Service Centers
KARLO	Kenya Agricultural & Livestock Research Organization
LUC	Land Use Change
SPSS	Statistical Package for Social Sciences
SSA	Sub – Saharan Africa
STISA	Science, Technology and Innovation Strategy of Africa
UN	United Nations

CHAPTER ONE
INTRODUCTION

1.1 Introduction

In many developing countries, land is the primary source of livelihood for majority of the people both in rural and urban settings (Niroula & Thapa, 2005). But, beyond the urban setting, majority of the people in developing countries who live in rural areas depend on land as their source of income, mainly through agriculture. Agriculture can be termed the main economic pillar in many developing countries, giving job opportunities to about 60 percent of the workforce and contributing 30 percent of the gross domestic product (GDP) in the SSA (FAO et al., 2015). According to Kigutha et al, (1998) majority of the smallholder households in Africa depend on their farm produce for food supply throughout the year.

Food insecurity and related human health complications are persisting world challenges. According to the Food and Agriculture Organization (FAO), approximately 795 million people in the world (representing one in every nine persons) have suffered food insecurity in within 2010 and 2016 (FAO et al., 2015). The sub – Saharan Africa (SSA) specifically has the highest number of undernourished people. About 220 million people in the SSA, representing 30 percent of the total population, have experienced food security challenges (Muraoka et al., 2018). Although FAO has reported a decline in the percentage of the hunger-stricken population from 19 percent in 1990 to 10 percent in 2016, the slow pace in fighting food insecurity over this period remains worrisome.

The food insecurity and related problems are likely to accelerate in the near future with the increasing dynamics in human population. In the developing countries, which include majorly parts of Africa and Asia, many countries have registered a rapid population growth in the last decade. Whereas significant population growth is expected to happen in urban areas (UN-Habitat, 2009), several authors have pointed out the importance of rural setting (including land uses) in realizing food security.

In Kenya, for example, realizing food security highly depends on smallholder farmers' production. The smallholders' farmers in Kenya contribute about 75 percent

of labor force and market produce. Given these figures, it is certain that agriculture and especially smallholder farmers' activities (majorly in rural areas) play a key role in realizing food security in Kenya. However, the production level for many rural farmers is affected by several factors which directly or indirectly influence food security in Kenya.

According to Ahmed et al., (2017) families are said to be food insecure if their food demand outweighs or is equal to their household needs. In other words a family/ household is food secure when all its members at all times have physical and economic access to sufficient, safe, and nutritious food, which meets their dietary needs and food preferences for an active and healthy life (Gordillo and Jerónimo, 2013). Giovannucci et al., (2012) defined food sustainability as the production of food while ensuring nutrition security and without sacrificing the long-term health of the ecosystems and important cultures that give us food. He further noted that food sustainability should be achieved from the national level to the societal level then to individual level

The possibilities of households becoming food secure increases with decrease in household size and an increase in size of the cultivated land. There are chances of households becoming food-insecure when there is an increase in household size and decrease in the size of the land cultivated (Ahmed *et al.*, 2017). According to Joshi and Binaya (2017) increase in the size of farmlands was the chief contributor to increased production of main food crops realized at Taplejung and Bajura districts of Nepal over the period 1974/75 to 2013/14. Although there was an increase in production of major food crops, the yield growth remained below the population growth of the two districts with an exception of potatoes and wheat. They further noted that as a result of increased food production which was as a result of increase in farm sizes, families were food secure for a period of 9 months out of the year.

Soom (2016) pointed out that large families and small farm sizes have negative effects on food security. He noted that large families affected food security negatively in that, increased household size resulted in increased demand of food which may lead to food insecurity. He also argued that the likelihood of a household becoming food secure increased with increase in size of the cultivated land. Also, Omotayo et al.,

(2018) noted that poverty among the farming households which had large family sizes in the South West Nigeria was the main contributor to food insecurity in such families. He further argued that increase in household size increases food insecurity among the rural dwellers as it was the case with the rural residents of the South West Nigeria. He recommended that, if food security is to be realized particularly for households in rural areas, agricultural fields should be expanded and youths encouraged engaging in farming as a form of employment.

1.2 Research Problem

Agricultural production in many rural parts across the world is affected by numerous factors. Several studies have shown that agricultural production is adversely affected by climate change. The global climate change manifested in terms of prolonged droughts, temperature variation, flood cases, and other natural occurrences continue to alter how people farm (Zizinga et al., 2017). When climate change continues to strike, the rural communities which majorly include the elderly, children, women are the most vulnerable and subject to food insecurity because they have limited adaptive capacity.

In another work, Kalungu et al (2013) argue that the agricultural production in the rural Kenya is highly affected by rainfall patterns which in return, has direct impact on food security and sustainable livelihood for many households. Other factors found to have great effect on agricultural production in the rural areas include land subdivision and fragmentation. In his study, Klaus (2012) argues that land subdivision and fragmentation reduces agricultural production and called upon governments to form state-initiated programs to consolidate the rural land holdings. Increased population density in the rural areas increases the proportion of land used for settlement purposes which in turn reduces land allocated for food production leading to food insecurity (Agbo et al., 2014).

Various studies carried out by different scholars have pointed out how land uses and sizes affect rural livelihood and food security. FAO (2011) highlights how land fragmentation leads to constraints in food production in rural parts of Africa increasing risks to household food security. In another study Bentley (1987) examined the effects of land size and use (what he called fragmentation for economic and

ecological uses) on food, nutrition and livelihood security with cases from Europe. However, in Kenya, there is little work done to show how land uses and sizes in the rural areas affect food security and livelihood of the people in the rural. While some studies like Conelly and Chaiken, (2000) have showed how food security in rural Kenya is jeopardized due to land subdivision and small landholdings, not so much to write home about as only a few studies have been conducted in the area hence little literature exists in relation to household food security and land subdivision in rural Kenya. There does not exist sufficient information on household land size and land use changes in densely populated rural areas of Kenya and the effects of land subdivision and intergenerational transfer of land rights and uses to household food security. The country, and especially in the devolved system of governance, lacks sufficient quantitative and qualitative data on land sizes and use in different farming systems to guide policy and investment in agriculture for food security. Therefore, this study was designed to assess household land size and land use for sustainable food security in Kathiani Sub-Location with the aim of informing policy on land subdivision and transfer of rights and uses with bias to household food security.

1.3 Research Questions

i. What are the current household land size and uses in Kathiani Sub-Location?
ii. What are the impacts of land size and use on food security in Kathiani Sub-location?
iii. What are the factors influencing the use and size of household land in Kathiani Sub-location?
iv. What are the factors influencing inter-generational land use and land rights transfer in Kathiani Sub-location?

1.4 Research Objectives

i. To assess the current household land size and uses in Kathiani Sub-location.
ii. To examine the impacts of land size and use on food security in Kathiani Sub-location.
iii. To examine the factors influencing the use and size of household land in Kathiani Sub-location.
iv. To profile the factors influencing inter-generational land use and land rights transfer in Kathiani Sub-location.

1.5 Research Hypotheses

H_0: Null hypothesis:

i. Households that have significantly large land sizes are not relatively food secure as compared to those with small land sizes

Thus, the Alternative Hypothesis is as follows;

H_a: Alternative hypothesis

i. Households that have significantly large land sizes are relatively food secure than those households with smaller land sizes

The two variables for which the magnitude of relationship will be assessed are land size and use and food security (Land size and use being independent variables while food security being dependent variable).

1.6 Geographical Scope

This study was carried out in Kathiani sub-location in Kathiani division, Kathiani location, Kathiani constituency which is one of the eight constituencies of Machakos County in Kenya. Kathiani Sub-location has a coverage area of 7.1Km^2. Kathiani sub-location has a total population of 5723 people. The population density of the sub-location is 811 people per square kilometre (KNBS, 2009).

1.7 Justification

Agriculture is the backbone of Kenya's economy and it contributes enormously to the country's economy (Mwamuye *et al.*, 2012). It contributes 45 percent of government revenue and provides 75 percent of the industrial raw materials (Deloitte and Touche, 2016 and 2017). The industry is Kenya's leading exporter and it employs more than 60 percent of the country's total population (Muraya and Ruigu, 2017). Additionally , agricultural sector provides livelihood opportunities to more than 80 percent of the total population in the rural areas (Onono et al., 2013). Trend analysis of national GDP and agricultural GDP growth rates from 1986 to 2014 shows that agricultural performance is directly proportional to the national GDP. Studies done by FAO (2005); Marani (2012) and Bremner (2012) indicate that agriculture is the only source of food both for direct consumption and as raw materials for refined and packaged foods. This calls for adequate attention and investment in the agricultural sector. Sustained growth of the agricultural sector, therefore, will strongly influence the

overall national economic performance and also contribute to food, nutrition and livelihood security. Further, despite a lot of research in the agriculture sector, none addresses the gaps of household land sizes and use to household food security hence creating a gap that the study sought to address in a relatively rarely researched rural setting of Kathiani Sub-location. Knowledge of how different factors of production particularly land, relate with food and livelihood security can greatly contribute to the type of strategies that can be adopted in different farming systems for sustainable rural land utilization.

1.8 Definition of Terms

Land subdivision – This refers the process of dividing land parcels into several smaller pieces or tracts.

Food security - situation whereby all people at all times have physical and economic access to enough, safe and balanced diet food to cater for their dietary needs and food preferences for an active and healthy life (Napoli *et al.,* 2011).

Sustainable food security – is a situation whereby all people at all times have right to food and food production, physical and economic access to affordable, enough, safe and balanced diet food to cater for their dietary needs and food preferences for an active and healthy life while protecting the environment at the same time (Donkers, 2014).

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Dubois, O. (2011) authoring for FAO observes that the way land and water are used are central to improving food security and that demographic pressures, increased competition for land, climate change mostly have impact to increase vulnerability to food insecurity. Globally, land-use change has greatly affected food security (Muloo, 2016). The conversion of agricultural areas into other uses such as residential, industrial and settlement has led to vast decrease in food production (Kavitha *et al.,* 2015). Despite agriculture being the only sole provider of food either raw or for processing purposes worldwide, it is among the landscapes suffering the greatest transformations globally (Muloo, 2016).

Land use change is the main driver behind loss of many agricultural areas worldwide (Fahrig *et al*., 2007). The intensification of crop farming in fertile regions, increase in population density, land fragmentation, land subdivision and the abandonment of farming in less favorable areas are affecting food production globally, especially in third world countries (Bakker, 2007).

In India for example, land-use change for settlement and urbanization is a main driver behind loss of agricultural land just as is the case in Kiambu and Kajiado counties in Kenya where rich fertile farm lands and vast grazing ranches have been converted to brick and mortar to cater for mushrooming urban population. About 50.57 percent of the total built up and to-be built up land area in India is from agriculture land. Over the past few decades growth of urban areas in India's agricultural land has slowed down by 16.31 percent. As a result of the increasing demand of land and food security, it becomes important to protect and conserve farms by policy or guidelines (Kavitha *et al.,* 2015). Gitu, K. W. (2006) note that a decline in per capita food availability and chronic malnutrition linked with lack of sufficient dietary intake are as a result of households' lack of income to acquire basic food needs in Kenya, and it is, unexpectedly, more grave in high and medium potential areas due to high population density and small farm sizes in such cases where Kathiani Sub-location

lies. This sets the foundation to review further on the impacts of household land uses and sizes to their food security.

2.2 Household Land Sizes and Uses

Most Households in the rural areas are often faced with challenges of an exploding population, food insecurity, obsolete technology and resource scarcity and extensive pollution (Sinha *et al.,* 2000). Land size and use have been controlled, actively exploited and completely altered by human activities. Agricultural lands are the most common examples of anthropogenic landscapes (Holzel 1998). Agricultural lands, urban landscapes and mining centers are among landscapes which have undergone the most severe degree of man induced transformation (Holzel 1998). The net effect of such transformation is subdivision of agricultural land and a change in its use to other uses impacting on agricultural production. The rate of disruption and other forms of anthropogenic modifications are studied using a range of tools including remote sensing data and Geographic Information Systems (GIS). These tools, when combined with local level knowledge, allow for a more in-depth study.

Further, the dawn of the first remote sensing satellite (Landsat 1) in 1972 has contributed to the rise in the number of studies on land use and land cover studies. These studies were conducted in several areas including agricultural areas, urban areas and mining areas. Coleman and Galbraith (2000) carried out a study on the use of GIS and remote sensing data to detect agricultural land use change in and around Virginia. Using PAMAP GIS, they prepared a land use database from multispectral, multi-temporal data for LANDSAT MSS and TM for the years of 1975, 1986 and 1991. Based on this analysis, the study determined that substantial loss of forest and agricultural land was as a result of population increase and swift industrialization.

Also, Byeong-Hyeok *et al* (2010) worked on forest reclamation monitoring in the abandoned mine of the Samtan coal mining area located in Jeongseon-gun, Korea. Using multi-temporal satellite datasets, they analyzed the vegetation health effects to abandoned and forest recovered period. In this case, they used NDVI mapping to analyze vegetation and forest health on three multi-temporal Landsat 5 and 7 satellite

data sets. Results from the NDVI map were able to identify the newly recovered forests. It confirmed that natural forests were able to restore their vegetation health.

2.3 Impacts of Land Size on Household Food Security

Both land size and use have many positive and negative impacts on food and livelihood security worldwide (Donkers, 2014). Expansion of agricultural lands leads to increased food production which in turn may lead to realization of food security while reduction of agricultural lands leads to reduced agricultural production thereby resulting to food insecurity (Wanjiku, 2015). A good example was the expansion of rice cultivation area in Vietnam that has made the country the 5th largest producer of rice, its production increased from 25 million tons in 1995 to almost 40 million tons in 2010. Similar increase in production of rice was also experienced in other Asian countries as a result of expanding the rice fields. Vietnam is one of the greatest producers in the world but its product dropped from 7.7 million tonnes in 2012 to 6.7 million tonnes in 2013. This was as a result of acquisition of agricultural land by government, industrialists and use of agricultural land for residential and urbanization purposes (Bouallouch, 2016).

Increase in the size of the agricultural land creates employment to the idle population. In Vietnam more than half of the countries labor force works on the agricultural sector (Bouallouch, 2016). Up to 75 percent of the roughly 44.2 million people of Kenya work at least part-time in the agriculture sector and it also provides 60 percent total employment. Overall, it provides livelihood opportunities for over 80 percent of the rural population (Donkers, 2014). It also increases government revenue through exports. The sector alone contributes 45 percent of the total revenue Kenya earns (Deloitte & Touche, 2016 and 2017). Increasing the size of agricultural fields also expands food availability which in turn leads to expansion of food consumption (Panzarini *et al.,* 2013).

The relationship between household land size and farm productivity has been opined to be an inverse one by many scholars (Sen 1962; Saini 1971; Chand et al., 2011; Vu et al., 2012 & Amarea et al. undated). They postulated that output for each unit area of land increased with decrease in size of the farm. Notably, agricultural productivity in

the rural areas is the main source of household food and livelihoods for residents. Sen, 1962 argues that productivity per acre decreases with increase in holding size attributing it to concentration of inputs, labor and efficiency in small farm sizes as compared to large ones. This implies adoption of better farming techniques contributes to the inverse relationship between land size and productivity.

Vu et al. (2012) on "Farm size and Productivity: Empirical Evidence from Rural Vietnam," observed that the larger the size of holdings the lower the land productivity ascribed to the applications of larger amounts of inputs in small farms than larger ones due to land, labor and credit markets imperfections. They further attributed the inverse relationship to excessive labor utilization and presence of decreasing returns to scale in Vietnamese Agriculture.

In Shiselweni region, Swaziland, Kuwenyi and Masuku (2014) found that age, gender, land size and livestock ownership positively affected household food security. They observed that households which had land size greater than a hectare were food secure as compared to them who had less land sizes.

Upon studying, "Farm Size and Productivity: Understanding the Strengths of Smallholders and Improving Their Livelihoods", Chand et al. (2011) supported the proponents of inverse relationship between land size and productivity. Chand and team posit that overall Indian farm productivity was depended on usage of yield enhancing inputs, technology, irrigation access, crop intensity and choice of crops grown in the farm. They cross examined these factors and the findings affirmed their grounds on existence of inverse relationship between farm size and productivity per unit area. They however found out that the per capita output was low on small holdings notwithstanding higher productivity owing to the lower per capita land availability. They further went ahead to establish a link of the small sizes of total family cultivated parcels to household food and livelihood. In their examination to determine whether such tiny pieces generated enough income to take care of the livelihood needs of a farm family, they found out that 62 percent of the farmers in India whose holdings were less than 0.8ha of cultivable land risked malnourishment and lived under poverty. Their state was helped by their tapping opportunities that existed outside agriculture. Further, these smallholders earned terribly low per capita

amounts of income from agriculture with landholdings subdivision worsening the situation further.

In Bangladesh, Kobir et al. (2007) study found existence of positive correlations between size of household farm and a family's annual income and their contributions to household food security. Larger farm sizes implied higher annual income from the farm. The study's Problem Facing Index (PFI) indicated that insufficient land for farming, out of reach to communication media, scarce training facilities and deficient credit were the leading challenges that hindered households from attaining food security. These findings provide the critical role of sufficient or ideal farm sizes that can support food security requirements in small holdings agricultural rural areas.

Ifeoma and Agwu (2014) while assessing food security situation in Kano state, Nigeria, reported sale of tangible assets of land among the key elements contributing to household food insecurity bringing in context the key factor of land in agricultural productivity for food and household livelihood support. The arguments were supported by Omotesho et al. (2006) whose findings showed that small scale farmers with cultivable farm size less than half a hectare were food insecure as compared to those with larger cultivated farm size in Kwara State, Nigeria. Their Exp(β) statistics reported odds increase by a factor of 2.405 in favor of food security. This implied that a unit increase in household farm size, gross annual farm income, and total off-farm income increased the likelihood of a household to be food secure by a factor 0.0181, 0.0395 and 0.0223 respectively with an increase in household size decreasing probability of the household's food security.

In Borno State, Nigeria, Amaza et al. (2006) study found that household food security was significantly dependent on multiple factors with household size, gender and education level of household head, commercialization of agricultural output, type of household enterprise and more prominently household farm size being the leading determinants. The study findings showed that households which had large farms were in a less risk of food insecurity as opposed to those with small farms with a negative significant relationship to food insecurity. Consequently, commercialization of agricultural output threatened livelihoods especially with small farm sizes for subsistence production only; selling of farm produce risked household food security

status and livelihoods while the families that diversified their income sources and didn't solely rely on their farm enterprises had lower chances of food insecurity.

Recent findings in the arid areas of Borno State Nigeria by Mohammed et al. (2016) indicated a positive significant relationship between farming experience, education level, annual non-farm income, and farm size to household food security with household size having a negative significant relationship to food security. This concurs with Amaze et al. (2006) findings on relationship of farm size to household food security and is in agreement with Maziya et al. (2017) on the factors that contribute to household food security in Msinga, South Africa.

According to Amarea et al. (undated) in a panel data analysis effort to establish the effects of agricultural productivity to the growth of the welfare of farm households in Nigeria, agricultural productivity and household welfare are heterogeneously linked bridging the possibility of non-linkage between farm productivity and the household livelihoods. These arguments were supported by World Bank 2014 report on land and food security. In the report, the bank posits that both the small holder and large-scale farmers play an exceptionally critical role of enhancing agricultural productivity and that they produce enough to feed the world's poor. Additionally, the bank elaborates the vital commitment for countries in improving agricultural contribution to food security by raising agricultural productivity, improving off-farm employment in rural areas, reducing risk and vulnerability, linking farmers to market and making agriculture more sustainable and a source of environmental service too. This emboldens Amarea et al. (undated) panel findings linking agricultural productivity to household food and livelihood security.

Amarea's panel data analysis team established the attendance of an inverse relationship between land size and productivity with productivity declining with land size owing to market failures. Further, the findings showed that family size, wealthier households (financial power to acquire inputs and technology), climate and soils, labor and distance of farming plot to dwelling had positive significant relationship to agricultural productivity while infrastructure had a significant negative effect on agricultural productivity owing to its effect on transaction costs and access to information indicating that unorganized and illegal sub-division of holdings without

the prerequisite infrastructure negatively impacts agricultural productivity. Further, the panel models revealed that land productivity had significant positive effects on consumption growth by raising real household incomes and probably indirectly increasing agricultural output which induce job creation. The direct linkage of agricultural productivity and household livelihood and food security with land asset at the core of the findings is the premise of the panel outcome and the basis for the impacts of household land size to its food and livelihood security.

Ackah et al. (undated) on farm size and returns to productivity in Ghana found out that the inverse relationships on farm size and productivity was not functional. Their findings showed a positive relationship between farm size and productivity possibly by all means in the form of yield quantities, value of yield and net returns in both aggregate and individual levels for rice and maize. As such, they concluded that the higher the farm size the higher the returns to productivity. The findings implied that large farms assured higher returns to households with guaranteed farm incomes and support to their livelihoods as compared to small holdings.

Similar findings were recorded by Rao, (1967) who, despite many findings reporting inverse relationship between farm size and productivity in India, observed that in Punjab the gross farm output remained constant over all farm sizes and no significant variations to write home about the inverse relationship. The findings were echoed by Anupana and Falk, (2018) who reported a positive relationship between average plot size and agricultural productivity from cultivation in India and advocated for the consolidation of tiny plots to make economic sense in productivity. This relates to the need to support livelihoods and food security needs of agricultural households in India contrasting completely to earlier studies of the prior 1990s.

Ngema et al. (2018) posited that household farm size in Maphumulo Local Municipality, South Africa, did not have an impact to household food and livelihood security. This attributed to the findings that average farm size was six hectares which they termed as sufficient enough for a household to produce enough to feed themselves throughout the year. Their findings showed education, receiving infrastructural facilities particularly for irrigation, household income, household size and access to credit influenced the household food security status.

In Msinga, Kwa – Zulu Natal, South Africa, Maziya et al. 2017 provided study insights on household food security. In their findings, household size, livestock units held in a household, access to grants, credit for agricultural purposes, marital status, gender of household head, farm size, farming experience and competence in fertilizer use have significant influence to household food security. The case for farm size was positively correlated at $p = 0.03$ to household food insecurity implying an increase in size of household land significantly increased the possibility of the household to be food secure.

A two stage least square regression analysis by Kakota et al. (2015) on determinants of household vulnerability to food insecurity in the semi-arid districts of Malawi showed that household size, land size, income and access to climate information were the major determinants of household vulnerability to food insecurity. The study's descriptive statistics indicated female headed households were more vulnerable to food insecurity than male headed ones attributed to the inability for female headed houses to access sufficient food production resources.

In attempts to understand the causes of household food insecurity in Koredegaga Peasant Association, Oromiya zone, Ethiopia, Haile et al. (2005) found that the size of household farm positively and significantly correlated to the likelihood of a household being food secure with parametric score of 0.062 that implied that land size change by a similar margin affected directly impacted on the food security status of a household. Other factors of size of household, application of fertilizer, per capita aggregate production, ownership of an ox and education level of farm household heads had significant effects on household food security.

Tefera and Tefera (2014) reported that in Mareko District, Guraghe Zone Southern Ethiopia, food secure households had significantly larger farm sizes (1.44ha) than food insecure ones (0.97ha) at one percent significant level. The findings indicated that cultivated land, household size, use of improved seeds, and age and education level of household head, on and off farm incomes amongst other factors influenced household level food security. Cultivated land positively impacted on household food security significant at 10 percent probability level. This was translated to imply that

the larger the owned cultivated land the higher the probability of the household being food secure and vice versa due to the probability to produce more with larger cultivated land size as opposed to smaller ones.

Lindqvist & Nordin (2011) in an award panel discussion observed that the growth in the world population will go on in absolute numbers with urbanization cushioning the rate of population increase in the rural areas. They note that, among the world population, smallholder farmers are the worst hit by food insecurity and that the largest number of undernourished children live in small farms. Narrowing down to several nations, they posit that majority of Sub-Sahara Africa countries are facing the dilemma of consistently and continuously declining farm sizes to micro size levels of even less than 0.12ha. The shrinking farm sizes are continuously intensively farmed to meet subsistence requirements resulting to a decrease in yields and aggravated poverty for Africa's rural livelihoods. China is not left behind, though highly mechanized with specialized machines for small farms, the challenge of a burgeoning population and urbanization have placed the country in a perennial food importation and particularly cereals from Brazil (maize), Vietnam and Thailand (rice) (Ibid).

Jayne et al. (2003) notes the presence of a strong relationship between household income and access to land specifically for farm sizes below 1.0 hectares per capita. Their results from five Sub-Saharan Africa countries show a consistent decline in farm sizes overtime with about a quarter of the farming household being landless whereas the per capita variations in farm sizes are concentrated within villages in the rural areas of these five countries. The implication is challenged ability to access food due to its unavailability or dismal on and off farm incomes and hence growth in poverty levels.

On the effects of diminishing land sizes and its implications on household food and livelihood security, Kenya, a developing country has had its fair share of challenges. Ruth Mbula, authoring for Daily Nation on September 11, 2017 reported that subdivision of agricultural land in Kisii and Nyamira Counties threatened food production and security in the region. Quoting from a report by Moi University's Department of Agricultural Economics and Resource Management, she reported regional administrative and agricultural authorities as calling for an end to the

subdivision of land as the resulting small parcels were uneconomical for both settlement and food production. The said report was quoted as having established that consistency diminishing in farm sizes negatively impacted on farm level efficiency particularly food production (Daily Nation, September 11, 2017).

Maengwe, (2017) on effects of land subdivision to food security in Kaputiei North, Kajiado found out that uncontrolled land subdivision has been rampant overtime. The findings indicate that the uncontrolled subdivision has resulted to the reduction in livestock keeping and intensive agricultural activities save for poultry keeping which does not rely on rangelands. This, Maengwe notes has threatened livelihoods and food security in the area with most of the agricultural land being converted to industrial, commercial and residential areas as part of the growth of Nairobi's metropolis area.

In Nyando District, Kenya, Atieno, (2006) study found that availability of land (farm size and cultivated land), labor and household size together with distance to the nearest market center influenced household food security and contributed nearly 50 percent of all food security variations. She notes that shrinking farm sizes contributed to a consistent growth on the inadequacy of food production especially in the most densely populated areas.

Muraoka et al. (2014) on evidence from Kenya to support land access, land rental and food security study's econometric analysis found a significant positive relationship between land access and food security. They opined that a 10 percent increase in operated land size increased the per capita total consumption by 0.8 percent and the per capita home-produced food consumption by 2 percent. The findings indicated a clear and consistent positive relationship between operated land size and total production per capita, household income per capita and net crop revenue per capita with households holding larger farm sizes earning almost 80 percent higher than those with the smallest sizes. This indicates the critical importance of sufficient land sizes for agricultural production to aid household food security in Kenya.

Gicheru et al. (2010), noted that smaller land units resulting from land subdivision are not capable of sustaining the rural peoples' life which is depended on agricultural

activities as their means of livelihood, hence resulting to food insecurity and diversion to other means of livelihoods either in the smaller or larger urban areas.

2.4 Impacts of Household Land Use on Food Security

Land use changes impact on access to food. Intensification and extensification (changes in land cover say from natural grass land) along with changes in type of cropping and farming technologies impact on food security. These land use changes impact on livelihoods, social cohesion, economic systems, patterns of migration and on cultural norms and preferences. Land use changes as a result of population increase leads to increased vegetation clearance attributed to clearing of land for settlement eventually increasing soil erosion which reduces agricultural production, Menberu, (2014).

In North Central Nigeria, Ibrahim et al. (2009) findings revealed that insecure households had smaller average land holdings (1ha) as compared to land holdings of secure households which had higher average land sizes of 2.1ha. Notably, the findings indicated that household resource allocation to sole and mixed cropping defined its food security status. The study discovered that effective allocation of resources to dedicated crops aided a household's food security. This implies that the larger the area a household allocated to food crops the higher the guarantee the household would be food secure. Household size was the other factor determined to have influenced a household's food security where food insecure households had a larger family size as opposed to a leaner family size for food secure ones.

These findings by Ibrahim et al. (2009) were more or less a complete replica of Muhammad-Lawal, A. & Omotesho, O.A. who in 2004 found that in Kwara State Nigeria, optimal farm resource allocation, and land in particular, to crops determined a household's food security. Muhammad-Lawal and Omotesho reported that a farmer's decision on the crops to plant and resource allocation determined the household income from the farm and the possibility to have sufficient food quality and quantities throughout the year. They observe that optimal allocation of resources being land, labor and capital to maize, cassava/yam, and cassava/maize/yam at 1, 0.167 and 1.068ha respectively would yield maximum annual income sufficient to provide the household with the required net per capita calorie intake.

Mwaura, F. M., & Adong, A. (2016) attributed household land use decisions in Uganda as based on need to harvest for household consumption, risk averseness in agriculture especially for monoculture, and balancing household resource allocation for optimal returns. They postulated that these factors were behind the cropping patterns observed in the study where maize, cassava and banana were allocated the largest proportions of cultivated land in Central 2, East Central, Eastern and Western; West Nile and South West respectively in season one and season one and two consecutively.

Kilel, (1993) study on the impact of sugarcane farming on household food security in Belgut Division, Kenya found that the allocation of land to cash crops rose consistently on the introduction of sugarcane farming with the area allocated to food crops fading. With the significant relationship confirmed, further, the area allocated to sugarcane farming had significantly increased as compared to the other cash crops. The findings showed a significant correlation between acreage allocated to food crop and the output with a change on the acreage under food crops positively affecting the output where increase in acreage resulted to an increase in food crop output and vice versa. Further, gender influenced household food security. Women preferred to have larger areas under food crops as compared to men who had interest in sugarcane, and with productivity and earnings from cane being unpredictable, most households, the study concluded where at threat of food insecurity bringing into context the role of household land use decisions and its effect to household food security.

Agricultural land subdivision poses a major threat to livelihoods as posed by Limo (2016) when she studied a maize farming system of Trans Nzoia West Sub-county. She observed that subdivision reduces the agricultural output of the farm with crop production being largely affected as opposed to livestock keeping since zero grazing and high yielding dairy breeds could be managed in a small parcel of land. Therefore, zero grazing land use would be best preferred to crop farming and as such potentially aid in household food security hence land use decisions seen to impact on household food security. Agricultural land subdivision was attributed to selling/purchase of agricultural land together with subdivision for inheritance (Ibid).

A household decision on land use will most likely impact on its household food security. As it can be deduced from the literature review, allocation of large land to a specific crop will mean a higher yield from as compared to others allocated small portions of the land albeit with influence from other factors of extensification and intensification. Further, a dominant crop will impact on household food security. For instance, allocation of dominant sugarcane crop over an entire household parcel will interfere with household food security in that in case of a slight failure in the dominant crop or an effect of pests and diseases will impact on yield. An implication on cash crop productivity, a variation on market prices over the same will impact on household food security since cash crops have to be converted to food crops by selling the cash crop and acquiring the food crops from the market. Therefore, land use and land crop allocations have the ability to influence household food security.

2.5 Factors Influencing Household Land Size and Use

Land sizes have been on the decline over time with virtually a quarter of Sub Saharan countries' population being landless, having control of less than 0.1 hectares net per capita together with the rented land, Jayne et al. (2003). Household family farm sizes increase with economic development, Eastwood et al. (2009). In low- and lower-middle-income countries, the latest available data on farm census showed that the average farm sizes were on the decline (Lowder et al. 2016). These scenarios suggest the negative effect of diminishing land sizes identified above as posing a major threat to household food security globally, Kenya not left behind in the category of middle-income countries of Sub-Saharan Africa.

Henry et al. (Undated) study summary report tabled at Plamerston North City Council in 2012 indicated that exogenous factors – largely economical and external to a household – and intergenerational succession norms were identified as the leading drivers for agricultural land subdivision in New Zealand. They observe that the subdivision of agricultural land directly impacts on household land sizes where a large contiguous parcel is shared amongst sons of the household.

Sial et al., (2012) report that combined effects of institutional, technological and demographic factors contributed to the increase in the number of farms. They attribute continued decrease in farm sizes mainly to cultural factors of inheritance and transfer.

Jayne et al. (2014) insinuate that scarcity of agricultural land in Sub-Saharan Africa is set to continue bolstered by rising population densities which tend to intensify land use, change in localized population density comprising of rural-rural and rural-urban migrations, quality of land, market access conditions and land allocation policies and institutions. The paper denotes emergence and growth of Growth and Service Centers (GDCs) as leading contributors to scarcity of agricultural land attributed to population densities and demand to service their inevitable goods and services at their hinterland. A burgeon of these centers to large cities are reported by the team as compromising agricultural land and constraining its viability of productivity. They posit that with these pressures on land coupled with the right of intergenerational land transfer to children in African cultural systems, land sizes will keep declining unless explicit actions are identified and implemented to the letter.

A multiple linear regression by Doti, (2017) results showed that agro-ecology, age of the head of household, land availability and size of family were significant contributors to variations in household land sizes in Kombolcha District of East Hararghe, Oromia, Ethiopia. The study concluded that aged farmers had subdivided their land among married children and retained just a small parcel for their living, large families held large land sizes which when subdivided also brought variance on the land sizes and that relatively large farm sizes existed in the midlands as compared to the lowlands attributed to lowlands' susceptibility to low productivity and animal and human disease.

According to empirical results by Bizimana et al. (2004), population to land ratio, tenure certainty, off-farm employment and access to agricultural training have significant influence on worked farm area. The findings indicated that population to land ratio had strong negative impact on the area operated with population increase greatly resulting to scarcity in farmed area. The study conducted in Butare, Rwanda, a very high-density rural set up indicated the huge impact of population growth to land sizes resulted to small uneconomical units that called for rise in fragmentation. Notably, off farm income increased the rate of fragmentation due to additional earnings and hence increased the farm sizes and so did the surety of tenure and access to agricultural training.

The rising land pressures in the more densely populated areas are a major threat to future household farm land size and use, food, nutrition and livelihood security (Kihima, 2017). Land pressures have resulted to land fragmentation which is a situation where by an individual owns several pieces of land which are scattered in a geographical area (Gicheru *et al.*, 2010).

Increase in population density exerts more pressure on the agricultural land which results to smaller land sizes, lower incomes and higher off-farm enterprises, Agbo et al. (2014). Population increase increases the proportion of land used for settlement purposes with an increase in population density in the rural areas affecting land size and use, Menberu (2014). Consequently, the size of land allocated for agricultural purposes reduces resulting to food insecurity (Muyanga and Jayne, 2014). Further, they noted that increase in population was significantly correlated to shrinking farm sizes and cultivated areas as well as agricultural intensification (Ibid).

Food and Agricultural Organization (FAO) on land utilization in the medium potential areas of Eastern Kenya foresighted that population increase was a major dent on household land size with farm sizes decreasing against increasing population. Museleku et al. (2018) findings on drivers of agricultural land subdivision in dry lands of Kenya the case of Kajiado County indicated that socio-cultural and economic factors of agricultural land inheritance practices, demand for urban housing, the price of agricultural land and individualization of land tenure were the greatest significant contributors to subdivisions of land in Kajiado County.

Studies identify underlying and proximate cause/moderating factors as major drivers of land use changes, van Vliet et al. (2015); Bosselmann, A. S. (2012). Major land use changes were associated to globalization, societal change and post socialism, van Vliet et al. (2015). Technological, economic, institutional and location factors were determined as underlying factors while farmers/farm managers as the moderators whose tastes, attitudes and characteristics influenced land use decisions. Demographic and socio-cultural factors had least significant influence in driving land use changes in the study conducted in Europe (Ibid).

Bosselmann, A. S. (2012) observed the underlying demographic factors of population density and rural-urban migration, prices of outputs and inputs, economic factors of labor and incentives, urbanization, and policy and institutional factors such as policies on land tenure, agriculture, market regulations and producer organization; societal factors like beliefs and values, consumption, and deagrarianization; and technological and infrastructural factors of road networks, agro-technology and market infrastructure at interplay with proximate causes of moderating factors composed of farm factors – size, tenure type, soil quality, typography; and location – and household factors of household demographics, farming background, duration of residence, family labor, education and wealth being the significant drivers of household land use decisions supporting specific crop types and varieties as for subsistence or cash crop uses.

Briassoulis, H. (2009) was more or less in sync with Bosselmann, A. S. (2012) when her study findings identified societal and biophysical factors – local climate and weather, topography, bedrock and soil type, surface water and groundwater – as major drivers of land use land cover changes. She postulated that land use decisions and choice of land use at the household level are influenced by household size, age, gender, employment, education, values, attitudes and personal traits of household members, accessibility, regional land use structure, transportation costs, parcel size, costs of production, financial support, land tenure and ownership and land management practices.

Climate change, population growth, shortage of farmlands and shortage of rainfall were identified as the major reasons behind land use changes in Ethiopia, Agidew, A. & Singh, K. (2017). They reported that these factors contributed to food security challenges and together with land degradation, land fragmentation, rural-urban migration, reduction of crop yields and soil erosion forced a shift of the household land use decisions to adaptable crops that aided the family meet food security and nutrition requirements.

Ebanyat et al. (2010) study on the Teso systems of Eastern Uganda observed that policy-institutional factors and population growth were significant drivers of household land use changes. Political impacts comprising collapse of marketing

systems and land management institutions were seen to contribute to changes in cropping and livestock keeping with livestock keeping growing consistently while variance on crop types taking firmer grip on the farmers where previously least important crops gained mileage over the earlier considered most important ones as well as emergence and growth of cash crops.

Kang'ara et al. (2001) observe that population growth completely forced a reduction of the land sizes in Embu with 50 percent of the household holding less than an acre as settlement and farm. They posit that the scenario championed for change in crop and livestock allocation on land use with eradication of coffee monocrop and growth of diversification as a solution to the challenges on land by the uncontrolled population densities.

2.6 Inter-generational Transfer of Land Rights and Use

According to Alila and Atieno, 2006, land use productivity, the ability of households to cope with shocks and social organization of communities are largely influenced by the manner in which land rights to a property are defined and documented, what these rights and obligations convey and the extent to which they facilitate land exchange. Globally, governments implement land policies with the aim of striking a balance between these often conflicting multiple objectives. Further, any recommendations that don't consider the multi-facetd nature of rights to land are either politically unacceptable and rejected on the outset or are impposible or difficult to implement just incase they are passed into law. The interaction between equity and efficiency goals of land policies are illustrated by a few countries who portray the need for these policies to meet the ever changing dynamic environment (Onono *et al.,* 2013).

There are many factors influencing the inter-generational land use and land rights and key among them is the size of the household. This refers to the number of siblings in a family. In situations where the household size is big, more of the agricultural land tends to be used for settlement purposes. This result to surplus of agricultural labor which was initially being used in the farms hence unemployment to most of the people. When this happens, the unemployed people move to the urban centers in search of other means of livelihoods (Mwamuye *et al.,* 2012).

Land fragmentation which refers to a method of land ownership where an individual owns several pieces of land which are scattered over a given geographical area is another factor that affects inter-generational land use and land transfer rights greatly. Land fragmentation has been a hindrance to the achievement of meaningful socio-economic growth, and is responsible for poor utilization of agricultural land and it discourages public and private investment (Bashir, 2012).

The household land size and uses are governed by policies. These policies regulate land use and management including mode of land acquisition, transfer, subdivision and even use for land. The study focused on the most important international and local policies as discussed in the following section.

2.7 Policy and Legal Provisions

Policy and legal provisions are the laws that are either Acts of parliament or Articles of the constitution that govern land use and management in the country. These policies and legal provisions may as well be the international treaties, laws and regulations that Kenya has consented and/or signed or is mandated to adhere to. The policies and legal provisions are all about management of land in the most optimal way possible to aid in meeting food requirements of the people, conservation of land and land related resources including wild, soil and nature.

2.7.1 Policy Provisions

According to Business Dictionary, policy provisions refers to an article, clause, or stipulation in an agreement, contract, deed, instrument, or statute that explains a specific condition, effect, implication, qualification, or requirement. Policy provisions are critical in guiding course and procedure of activities as well as providing legality to actions and processes. Absence of these policies may render processes insecure and unprotected by law since there does not exist a policy framework for undertaking such activities. This may expose activities and processes to legal redresses in courts which could render them useless and stop their execution. In this context, the policy provisions relate to agriculture and food security which are essential public healthy debates in the country with aim of achieving a food secure nation.

Every nation is interested in promoting and sustaining its economic growth. Agricultural sector is recognized as the pillar to many countries economic growth as it contributes to GDP significantly through multiple ways including creation of employment and generation of income that aids in poverty alleviation (Jennifer Brown, 2012). Governments world over should therefore effectively promote the agricultural sector due to its ability to aid socioeconomic development and food and livelihood security.

Tanzania recognizes the agricultural segment as a critical component of food provision to her citizens, source of employment, income, poverty eradication measures and industrial growth. The country's vision 2025 envisages transforming the country from a low agricultural economy to a semi-industrialized state through highly productive and modernized agriculture bolstered by industrial and service activities. This,the vision observes, will be achieved by active mobilization of humans and other resources focused in the achievement of common goals. As a result, the Ministry of Industry and Commerce, 1998 indicates that the government resolved to increase the size of land under agricultural production on the strategy of reducing poverty. The agricultural sector in Kenya is under multiple policies with some of the most important ones being:

2.7.1.1 Sustainable Development Goals (SDG)

The United Nations Development Program (UNDP) defines Sustainable Development Goals (SDGs) as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. These SDGs commonly referred to as Global Goals are seventeen in number and came to effect in 2016 after replacing the then famous Millennium Development Goals (MDGs). These SDGs are important in that they exist to guide the United Nations policy and their member states in the process of ending poverty, protecting the planet and ensuring everyone in the globe enjoys peace and prosperity.

Sustainable Development Goal number two is aimed at ending hunger, improving nutrition, achieving food security and promoting sustainable agriculture (United Nations, 2018). According to the SDG review report of 2017, efforts to combat hunger and malnutrition have advanced significantly since 2000. The reports observe

that to end hunger, achieve food security and end malnutrition for all calls for continued concerted efforts particularly in Africa and Asia. Further, increasing productivity capacity of the agricultural sector demands increased investments in the sector including government spending and aid. Increased agricultural capacity won't be possible unless land size and use management is regulated including determination of ideal household land size that can support a household food security year-round. This goal number two may never be achieved in the wake of diminishing farm sizes.

2.7.1.2 Science, Technology and Innovation Strategy of Africa (STISA 2024)

According to the African Union (2014), a total 239 million Africans are directly affected by food insecurity. Of these victims, 30 to 40 percent of children under five years of age suffer chronic under-nutrition at this critical stage for both survival and cognitive and physical development. The African Union emphasizes on growth and development of the rural economy and agriculture through Comprehensive Africa Agriculture Development Program (CAADP) as a remedy for poverty alleviation and accelerated socioeconomic development. A unanimous Declaration to end hunger in Africa by 2025 was as a result ratified by heads of state, government of African Union, representatives of international organizations, civil society organizations, the private sector, academia, farmers, cooperatives, youths, and other partners. As part of the strategy to end hunger, the African Union has formulated the Science, Technology and Innovation Strategy of Africa (STISA 2024) which has six priority areas of intervention with priority number one being eradication of hunger and achieving food security. Its associated research and innovation areas include agriculture/agronomy in terms of cultivation techniques, seeds, soil and climate (Africa Union, 2014). Their emphasis is on land use methodologies that adopt modern technologies and support food production that is sufficient for meeting household's food and basic needs requirements. Land is the only resource that is the bed rock for food production in SSA and with a growing population reported by Jayne et al. 2014, SSA is highly exposed to a decrease in household land sizes since a scramble by everyone to get a place to settle and farm results to continued formal and informal subdivision of agricultural land.

2.7.1.3 Evolution of the National Spatial Policy 2015-2045

The first agricultural policy in the country was enacted as **The Swynnerton Plan of 1954** by the colonial government with the aim of restructuring how land in African

reserves should be owned. According to the policy, progressive African farmers were allowed to grow crops. Land tenure systems in the African held areas were restructured to match the European ones with indigenous Africans conferred permanent land holding rights. It was meant to ostensibly open an avenue for native farmers to have access to good credit using their title deeds issued under the plan. Further, the conferment of land rights vides the title deeds were supposed to appease the natives so they could abandon their clamor for more land from the white colonial rulers. The plan advocated for increased agricultural production and therefore called for provision of farm inputs and infrastructure facilities in agricultural areas considered to be wielding high potential for production. The plan failed majorly because it marginalized and neglected the Arid and Semi-Arid (ASALs) parts thus an imbalanced development in different parts of the country.

The Development and Use of Land (Planning) Regulations were enacted in 1961 as a subsidiary legislation of the Land Planning Act Cap 303. The main objective of the act was to provide for the planning land use and development. According to the act, planning principles and regulations were required to consider health amenities and community's convenience together with the proper land use planning and development density in an area. These development regulations guided the subdivision of land in former European settlers farming reserves, use of land along main truck road infrastructure and in the peri urban areas. The act also established a central authority that was responsible for guiding land use and development. These planning regulations were ideally critical in the determination of how land was to be used in any area and therefore were supposed to provide a foundation upon which food security would have been anchored in farm production by guiding on specific agricultural land use and setting aside sufficient land for high capacity agricultural production.

Most importantly, the policies failed to address a myriad of challenges in land and land use in Kenya. Despite having a new constitution promulgated into the supreme law in Kenya with it the establishment of devolution, the previous policies remained static and never addressed issues of unregulated urbanization, environmental degradation especially in high potential areas, skewed/unbalanced development, poor economic performance in agricultural areas, tourism industry, inadequate and poor

transport systems and infrastructure facilities as well as sub-optimal use of land and underutilization of rich natural resource endowments. This saw the formulation of the National Spatial Policy in launched in 2017 to fill the gaps and provide a way in land use and management.

Objectives of the National Spatial Policy: The National Spatial Policy was launched by the ministry of land in 2017 and would be effective until 2045 when it should have been revised to keep abreast with continued changes in land use and management. Two main objectives of the National **S**patial Policy particularly on agricultural production included the optimization of land natural resources use to achieve development sustainably and creation of human settlements that are functional and livable in both rural and urban areas. These two main objectives were futuristic especially on the use of land sustainably with a focus on reliance of land to sufficiently cater for future generations' basic food requirements.

2.7.1.4 Vision 2030 on Agriculture Sector

Vision 2030 recognizes the agricultural sector's contribution to the country's economy. It aims at maintaining a sustained economic growth of 10 percent over the next 25 years (GoK, 2018). This will be achieved through efficient use of resources, tracking of land use pattern, raising human resource productivity to international levels, agricultural institutions transformations so as to encourage the agricultural growth at the private sector and household levels, improving yields in key crops, increasing small holder specialization in the cash crop sector to at least 2-3 key crops per plot and livestock and crop productivity increases. The introduction of policies on land use by farmers utilizing the medium and high agricultural potential areas are some of the other strategies envisaged in the blueprint. One of the agriculture flagship projects is developing an agriculture land use master plan while the environment flagship project is mapping land use pattern in Kenya. The efficient use of land resources sustainably could not be attained with continuous land subdivision which makes land use uneconomical and unproductive to support a rural household. Should the policy be implemented to the letter, it would certainly be a foundation upon which land subdivision would be discouraged. In so doing, optimization of land use for reliable productivity that can sustain household food requirements especially in the rural areas would be attained.

2.7.1.5 Devolution and the County Government

Devolution was established under the 2010 constitution of Kenya and came into effect upon the first general election under the 2010 constitution in 2012. It was a turning point in the governance of the country as power and management of resources were decentralized to 47 county governments. The County Governments Act of 2012 stipulates the role and responsibilities of county governments under the devolution system of governance in terms of land use and natural resources management. Agriculture was identified as a devolved function upon which responsibility to manage agricultural land use and environmental management was put under the devolution. The Schedule 4 of Kenya's 2010 constitution has devolved county planning and development, agriculture and specified central government policies for implementation by the county governments. The County and National Land Commission (NLC) have total control on land subdivision and fragmentation under different land ownership regimes. The way a county government handles land management issues determines the levels of land sub-division. Kajiado County Government for instance put an embargo on land subdivision for the previous regime ended in 2017. Over the five-year period, backed up by the County Governments Act 2012, land subdivision had been freeze in aid to the protection of ranches for cattle keeping and keep at bay continuous subdivision of land for urbanization purposes. Based on this premise, the devolved governments of Kenya can manage land subdivision for purposes of agricultural productivity and as such support household food production aiding in the eradication of poverty and food insecurity.

2.7.2 Legal Provisions

The legal provisions are the basis upon which policies and legislations on land use and management are established.

2.7.2.1 The Constitution of Kenya, 2010

Article 43 section 1 (c) of the country's 2010 Constitution gives every individual citizen the right to have access to adequate high-quality food so as to be free from hunger. This basically tasks the national government in ensuring every citizen exercises the right to access quality and sufficient food that meets their dietary requirements. Section 1 of Article 60 calls for efficient, equitable, sustainable and productive holding, use and management of land with observance of certain principles such as land rights security, equitable land access and productive and sustainable land

resources management among others (GoK, 2010b). As can be deduced from reviewed literature, uncontrolled land subdivisions are the reasons for uneconomical land sizes which is a detriment to optimal land productivity and thus putting a threat to food security.

2.7.2.2 The Land Act, No. 6 of 2012

The Land Act is an act of parliament that gave effect to Article 68 of the 2010 Constitution of Kenya. It makes provisions for broad variety of issues on public, private and community land in Kenya. It makes provisions for sustainable management and administration of land and land-based resources including acquisition of land especially compulsory land acquisition by the government. As such, it is purely a legal document that is the bottom-line reference point in the undertaking of this study as it is the law that manages and administers land and land-based resources. Whereas, in this context, land is the main factor of production and in particular food production in the rural setting where food security is largely depended on land. Section 159 Article No.6 of The Land Act, 2012 concerns itself with minimum and maximum land holding sizes. However, the section does not give specific minimum and maximum acres an individual or a household should have. Section 159 (1) (a) only states that the minimum land holding acreage shall be subject to the provision of article 66 (1) of the Constitution of Kenya which does not state the minimum and maximum land holdings either (GoK, 2012a). This puts a dilemma on what would be an ideal household land size, and with continued population growth, Kenya's high potential areas are constantly putting pressure on land resources with very minute land sizes, some without a shape being subdivided for settlement purposes and threatening food security.

2.7.2.3 Revised Agriculture Act, 2012

It is an Act of parliament that aims at promoting and maintaining a stable agriculture, catering for conservation of soil and its fertility, as well as the stimulation of agricultural land development in line with the right agricultural practices of good land and husbandry management (Kenya, 2012).

These policy and legal provisions provide the foundations upon which land can be owned and utilized for purposes of meeting household food requirements. However, they fall short of key provisions like ideal household land sizes and region based

minimum and maximum household land sizes that would sufficiently support a household's food requirements as well as support other basic requirements especially in the rural areas. They, as a result, provide the basis upon which a non-scientific minimum household land size can be determined through this study for a specific densely populated rural setting of Kathiani sub-location.

Besides the legal and policy provisions that informed the study on land administration and management in Kenya, an in-depth look into the theories on the subject of study is undertaken. The theories are based on their role and importance of land management and use for production of food to sustain a household food security. Theories are an in-depth body of knowledge in a specified theme area and in our context on food security. They provide a detailed knowledge upon which the study is guided and give insights on the subject of study. Three theories have been identified as fundamental to the study and discussed as follows.

2.8 Theoretical Framework

2.8.1 Sustainable Livelihood Theory

The sustainable livelihood theory came from the existing literature on rural livelihood and wellbeing, agrarian change and rural development done by influential economists such as Carl Marx, Amartya Sen and Williams (Yin *et al*., 2015). They argued that, in order to alleviate poverty within the rural people and enhance rural development sustainability should be the key factor to be considered. They also argued that more attention has to be given to the factors that either enhance or constrain the means through which people make their living in a sustainable manner (Yin et al., 2015).

The sustainable livelihood theory provides a more comprehensive and integrated approach to poverty eradication in the rural areas (Pedersen, 2010). A livelihood is a means through which people utilize their abilities and the resources they have to make their living while a sustainable livelihood is the one resilient and able to recover from stress and unexpected disturbances, retain or improve its assets and properties and provide a sustainable means of livelihood for the next generations while supporting other sources of livelihood at the local and worldwide extent in the short and long term (Carney, 2016).

There are many livelihood components with the capital assets through which people make a living being the most important ones (Haan, 2012). This resource includes both tangible properties and resources and intangible ones such as claims (Su and Shang, 2012). Households frequently combine multiple readily available assets in different ways to engage in livelihood activities that aid them make a living (Knutsson, 2006). Carney, 2016 elaborates on five different capital assets as shown in Figure 1. They include

i. Natural capital- this are assets that occur naturally on the earth's surface. They include; land (soil), water and air and environmental services such as pollution sinks and hydrological cycle from which resources are transmitted and services to make a living are derived.
ii. Financial or economic capital- this includes the capital base and economic assets required by the rural poor to carry out various livelihood activities. Capital base for a livelihood includes money, savings and credits and debits from financial institutions.
iii. Physical capital- It includes basic infrastructure such as roads and buildings, equipment's used for production purposes and various technologies involved in carrying out a livelihood activity.
iv. Human capital- human capital involves being physically fit, able to work, being healthy and having the skills and knowledge required to execute different livelihood activities.
v. Social capital- this are social networks, affiliations, social networks, and associations that people create when carrying out different livelihood activities that require coordinated efforts.

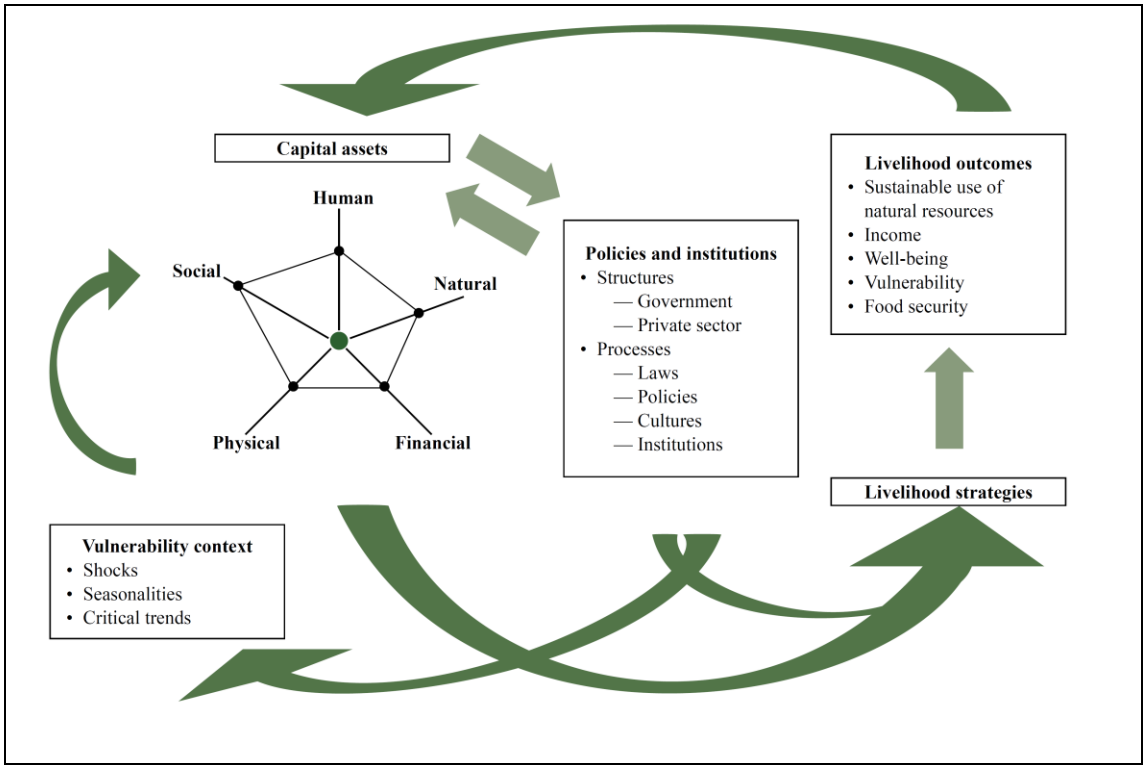


Chart 1: Sustainable livelihood framework
Source: Carney (2016)

Sustainable livelihood approach provides variety of activities that the poor carry out in combination in order to make a living (Lisocka, 2015). This is very important for the poor people who carry out a number of different economic activities as their means of livelihood (United Nations, 2009). Also, by creating awareness of the different assets that the poor use to make a living, the approach provides a holistic view on what resources are important for eradicating poverty among the poor. In addition the sustainable livelihood approach gives poor people the insight to the underlying causes of poverty among them (Krantz, 2001).

Although the sustainable livelihood approach gives a comprehensive and integrated approach to poverty eradication among the poor, it is faced with a number of weaknesses. The approach does not clearly define who the poor people are and what constitutes poverty. Poverty is a multi-dimensional issue and cannot be eradicated by only addressing the economic perspective of the poor people (UN, 2009). This factor has to be put in place if this theory is considered to be applied. Also the sustainable livelihood approach is faced by biases during program planning and implementation (Krantz, 2001)

2.8.2 The Basic Resources Theory

This is one of the earliest and most preferred theories which have been adopted widely in the third world countries to promote households development particularly in the rural areas (Davis and Cobb, 2009). According to the theory, the presence, quality and quantity of natural resources in an area determines the economic development experienced by any particular community within that area (Code *et al.*, 2008). The theory also acknowledges the fact that natural resources availability in any particular area attracts both local and international investors and as a result more income to the local people and employment would be realised (Anonymous, 2010).

Even with the presence of high quality and enough natural resources in any given area there must be skilled man power to tap its potential in order to realise economic development in that particular area (Code *et al.*, 2008). Notably, its completely incorrect to assume that presence of high quality and sufficient natural resources in a particular region will obviously spur economic growth in that economic region (Davis and Cobb, 2009).

In relation to the agricultural subsector, economic development of Kathiani region would be due to the presence of enough and high-quality natural resources in the area. For example, the availability of extensive land and good soils for farming activities in any particular area would attract people to invest in farming subsector. This would in turn result to improved wellbeing of the farmers through income increase and employment creation. It would also lead to development of infrastructure such as modern transport infrastructure which is very crucial for farming as an industry. However, the economic value of the agricultural subsector in any given area cannot be fully harnessed unless there is a skilled manpower on farming issues.

2.8.3 Entitlement Theory

Sen (1981) came up with the idea of food security being a demand concern, where it is viewed in terms of entitlements, which influence capacity to access food. In this perspective, the capability of families to access food through production, transfers or purchase is key in defining household food security. Hence, household food security is a function of the availability of food within the country and the level of household resources that are necessary to produce or purchase food as well as other basic needs. Sen pointed out that, famines occur not because there is no enough food produced, but

due to lack of access to sufficient food. In order for a household to be food secure one of the requirements is that it should be near the source of the food. Food availability is affected by factors such as community's proximity to centers of production and supply, restrictions on trade and international policies that affect food supplies. Sen's work was none the less a radical break through, before him the availability of food was thought to be the overriding determinant of famine.

According to Sen, People's exchanges of entitlements to their livelihood sources reflect their ability to acquire food. Famine occurs when a large number of people suffer a complete collapse in their exchange entitlements (Reutlinger, 1984). The entitlement theory has two major drawbacks. The key drawback is that it implies a straight forward sequence of entitlement failure leading to hunger and then to malnutrition, starvation and death. Its second weakness is that it implies that peoples actions are largely determined by their need to consume food (Nnajiofor and Ifeakor, 2016). An important extension to entitlement theory focuses on the role of investments in determining house hold vulnerability to food insecurity. When households are able to generate a surplus over and above their basic food requirements, the excess resources are diverted into assets of different kinds which can be drawn upon when they face crisis (Rentmeester, 2014), in such circumstance we may relate food security to the idea of vulnerability to poor resource endowments of households, focusing more clearly on the risk where avoidance becomes central to attaining food security.

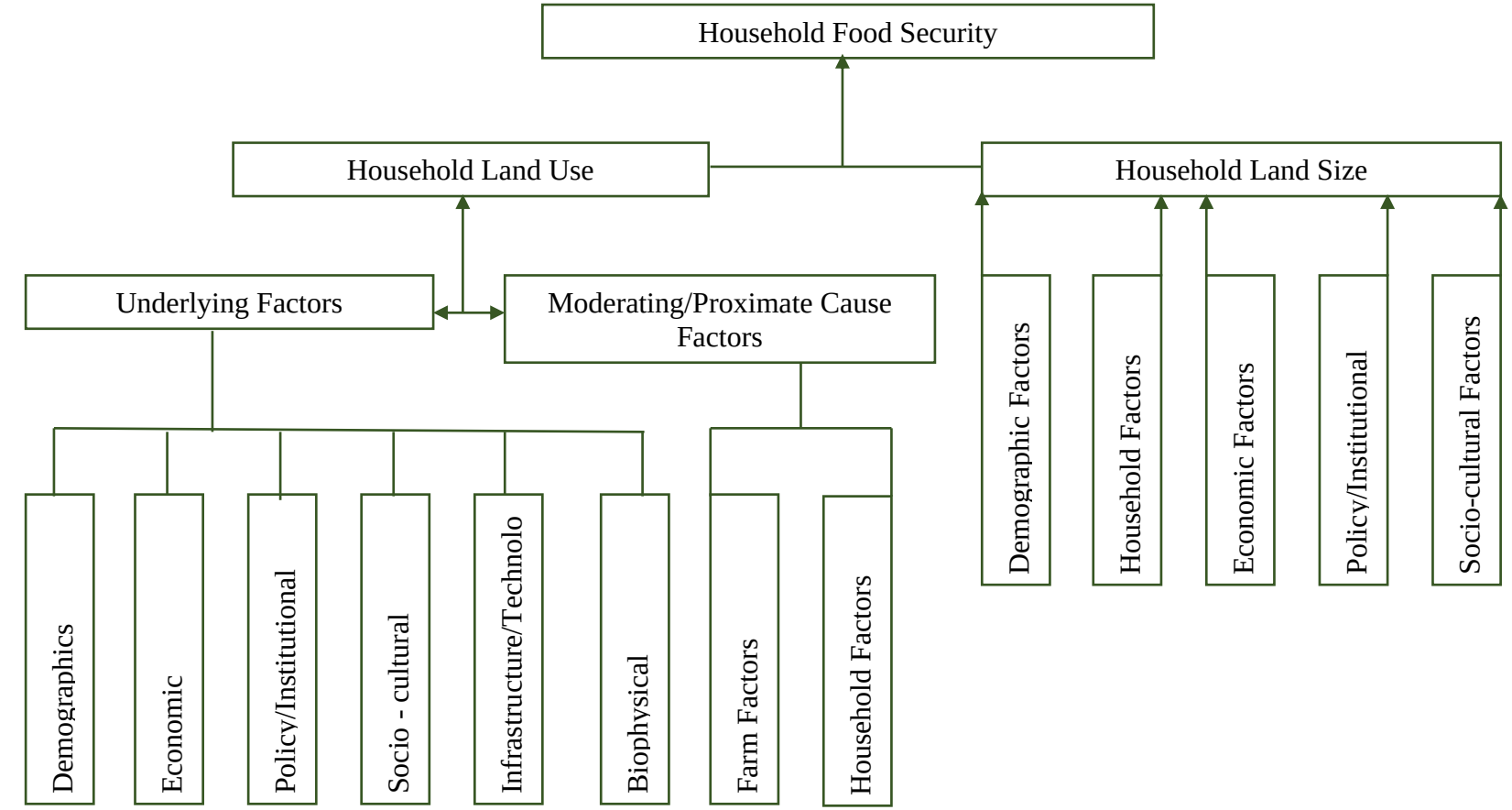
2.9 Conceptual Framework

The conceptual framework in this study will be based on the sustainable livelihoods Model as a way of assessing how land use affects land size and its influence on land transfer and how these three factors contribute to livelihood security (Solesbury, 2003). The Sustainable livelihoods serve as an integrating factor that allows policies to address development, sustainable management, the available local resources, and eradication of poverty (Knutsson, 2006).

In this study, the agricultural land size has direct impact on food and livelihood security and socioeconomic characteristics of the people of Kathiani sub-location. Food and socioeconomic characteristics are influenced by land size, use and land

ownership rights; hence the need for constant review of these factors and integration of the beneficial land management practices in Kathiani Sub-location. Large agricultural lands which have defined land ownership have higher agricultural yields compared to the smaller ones, which have been subdivided (see Bentley, 1987). Large agricultural lands contribute to food and livelihood security which in turn transforms livelihoods of rural farmers. In the long run, rural agricultural production is also influenced by other factors beyond the land itself. These factors include people's lifestyle, credit facilitation, farming practices, breeding, diseases and pest control, land transfer systems and households' dynamics (Kigutha et al., 1998). Continuous monitoring and evaluation of agricultural land size, control and management of land subdivision, land transfer systems and land ownership should be put into consideration. Monitoring land size, land transfer systems and ownership of agricultural land will increase food and livelihood security in that unregulated land subdivision will be detected and addressed in a timely way hence discouraging the resulting minute land sizes.

Chart 2: The Conceptual Framework



Source: Author, 2018

CHAPTER THREE
RESEARCH METHODOLOGY

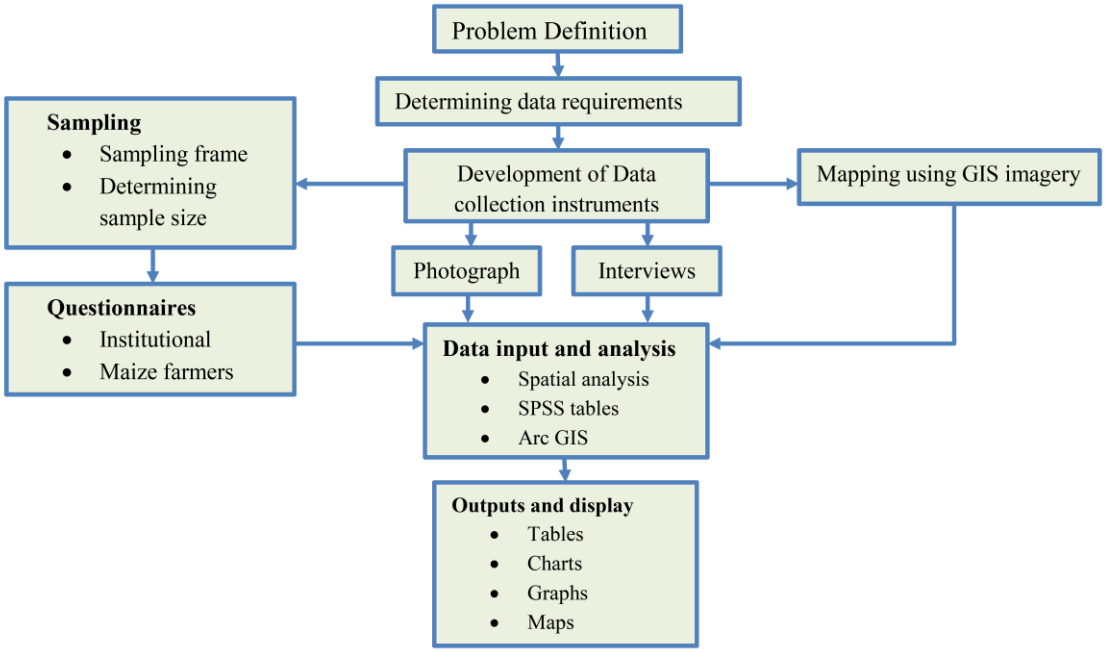
3.1 Introduction

This chapter covers different stages and phases that were implemented in executing the study. The chapter begins by discussing the research design that was employed in the study followed by the methodology that was used to achieve the objectives of the study. Target population selected for the study, sampling methods and sample size, data need matrix, and methods of data collection, data analysis and ethical consideration were also included in this chapter.

3.2 Research Design

According to Orodho and Kombo (2002), a research design is a scheme, outline or plan that is used to generate answers to research problems. This study adopted the descriptive survey design by revealing variables that contribute to changes in land sizes, land use and showing how the variables influence food and livelihood security in Kathiani sub-location. The study design was suitable since it revealed variables like changes in land size and use, increase in human population, bias in implementation of policies that directly affect food and livelihood security either negatively or positively and management strategies that are employed by ministry of agriculture, ministry of lands and KARLO in the study area. The study design is as summarized in Figure 3.

Chart 3: Summarized Research Design



Source: Author, 2018

3.3 Target Population

The study targeted the entire population of the study area which comprised of maize farmers. This was so as maize farming was homogeneous to every household in the study area. Opinion leaders, administrators, religious leaders, professionals and political leaders of Kathiani sub-location, Machakos County were also targeted due to their knowledge, experience and rich history of agricultural processes in the study area. The selected population is amongst the most densely populated household rich sub location of the county and is stratified to male, female, widow, widower and children headed households. A representative sample was picked from each category of the strata comprising of male, female, widow, widower and children headed households.

3.4 Sampling Plan

Orodho and Kombo (2002) defines sampling plan as a process of selecting a number of individuals or objects from a population such that the selected group contains elements representative of the characteristics found in the entire group. This study employed the following sampling techniques:

3.4.1 Purposive Sampling

Purposive sampling technique was relied upon in the identification and selection of individuals or cases which had the information related to the objectives of the study (Tongco, 2007). In purposive sampling, the researcher samples with a purpose in mind and sampling for proportionality is not a primary concern (Palinkas *et al*., 2015). In this study purposive sampling was used to systematically and proportionately identify the specific respondents for the study. It aided in getting data from identified institutions like KALRO, Ministry of Agriculture and Ministry of Lands as key informants for in-depth interviews in the study area based on the objectives of the study.

3.4.2 Stratified Sampling

This technique was used to sample various households based on gender and age of head of household. The target population was grouped into strata of male headed, female headed, widow and widower headed, and children headed households. These strata formed the basis for the application of simple random sampling that resulted in the identification of respondents that participated in providing the requisite information through the data gathering instruments.

3.4.3 Simple Random Sampling

The simple random sampling procedure was used to select sample of the whole population of maize farmers (Kothari, 1999). This sampling method was used because it ensured an equal probability chance of individuals to be selected (Utara, 2011). The main idea was that each maize farmer from the study area had an equal chance of being selected. The random sampling method aided in the identification of the first respondent in each strata of the already organized data then proportionately identify the subsequent ones up to the last respondent, being the 183 household of the targeted population.

3.4.4 Sample Size

A sample is a smaller number drawn from the population that is used to make conclusions regarding the whole population. According to Mugenda and Mugenda (1999), with a population of less than 10,000 people, a sample between 10 percent and 30 percent is enough to represent the entire population. Kathiani sub-location has a total of 5653 people, 1458 households, as per the 2009 National housing and

population census. The entire sub-location is homogenous in terms of agricultural activities core being in maize and food crop farming and thus a representative sample was sufficient to collect the desired statistics that eventually responded to the study objectives. The assistant chief, working with cluster heads (a cluster composed of ten households under the Nyumba Kumi initiative of the national government) provided a list of all households from 10 villages excluding the market center which was purely an urban setting not engaged in features structured for the purpose of the study. Adopting the below Cochran (2007) formula, a representative sample of 183 households was drawn.

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where: n = Sample size

Z = Confidence level, taken at 95% where standard Z score is 1.96

e = Desired level of precision at ±5 percent

p = Estimated proportion of an attribute present in the population

q = 1 – p

Thus, applying the above formula with a finite population of 1458 households, a sample size of 305 households was arrived at. However, due to cost and time constraints, Mugenda & Mugenda (1999) proposal that any sample size 50 percent and above of the outcome of the formula was sufficient, a 60 percent of the sample size, giving 183 households was adopted as the sample size for the study.

Thus, a total of 183 households were interviewed by administration of household open and closed questionnaires. A proportionate sampling, based on the total village population was used to determine the number of respondents per village. A stratified random sampling was then conducted on basis of household headship with male, female, single, widow, widower and children headed households forming the structure of the stratification then followed by proportionate sampling to identify the specific number of respondents per strata.

A random sampling procedure was adopted first to determine the first village to be visited and the others followed chronologically and second to determine the first respondent in the first randomized village. Having identified the first respondent via simple random method, a systematic sampling methodology was then adopted to

identify the remaining 183 respondents from the strata of the entire household population. A sample case of a farm with no settlements or physical boundaries demarcations was adopted as a controlling model for comparisons with the settled villages of the study sub-location.

3.5 Data Need Matrix

Table 1 shows the data which was needed to successfully achieve the objectives of this study.

Table 1: Summarized Data Need Matrix

	Data Needed	Data collection methods	Source
Objective 1	• Satellite images • Thematic maps	• GIS integration and presentation	Ministry of lands Farmers (Maize)
Objective 2	• Land size and use • Maize production • Use of produced yield • Income (Maize yields) • Maize dependants • Opinion on food and livelihood security.	• Questionnaires • Interviews • Observation • Electronic gadgets (Cameras)	Ministry of Lands Farmers (Maize) KARLO Ministry of Agriculture
Objective 3	• Land size and use • Factors influencing the size and use of land	• Questionnaires • Interviews • Cameras • Observation	KARLO Ministry of lands Farmers (Maize)
Objective 4	• Rights of land transfer • Inter-generational	• Questionnaires • Interviews • Observation	Ministry of Lands Farmers (Maize) KARLO

	land use trends • Factors informing inter-generational land use and transfer rights	• Electronic gadgets (Cameras)	

Source: Author, 2018

3.6 Data Collection Methods

Quantitative and qualitative data was collected from multiple sources by multiple methods. This was so to aid in the triangulation of data and achieves high level of validity of the findings. The data sources were both primary and secondary. Data collection methods comprising of interviews, group discussions, round table discussions, document reviews, observation and photography were used to obtain the required data for the research.

3.6.1 Literature Reviews

The study entailed a detailed review of existing literature related to household land size and land use and its relationship to household food security. Existing literature comprising of books, journals, periodicals, research reports and scholarly articles on the subject of study were reviewed and findings documented as literature review. Existing images, maps, population census reports food security reports, historical documents, climate, rainfall and temperature reports, soil maps, and dominant crop reports were reviewed to provide a foundation to and ground the study. Additionally, the researcher reviewed case studies from other countries with high population densities and land size, use and fragmentation challenges in relation to food security challenges to provide a basis for solving the identified food security challenges.

3.6.2 Interviews

The researcher conducted household interviews, focus group discussions and specific key informant interviews with the aid of interview schedules and discussion guides.

3.6.2.1 Household Interviews

Through the aid of well-formulated open and closed questionnaires, household interviews were conducted by the researcher. With the assistant of well-trained research assistants drawn from the study area, household interviews were conducted in 183 households, earmarked as sample size respondents earlier.

3.6.2.2 In-depth Interviews

This data collection method was used partially to collect data from key informants and relevant organizations due to its high cost and its appropriateness in capturing data based on experimentation and observation in both formal and informal environments (Kothari, 1990). Key informant interviews were conducted by use of well-choreographed interview schedules relating to the specific key informant and the role they play that had effect in the study area. Additionally, the very elderly in the sub-location, male and female over eighty years were interviewed to provide a critical historical perspective on the changes in land sizes and uses over time and the gradual implications of such changes to household food security.

3.6.2.3 Focus Group Discussions

The researcher conducted four focus group discussions comprising of married couples, the young, professionals and religious leaders. Gender parity was observed in all the groups with males and females participating in the discussions in all categories and where possible on a 50 percent side. A focus group discussion guide helped the researcher guide through the sessions that lasted a maximum one hour and focused solely on land sizes and uses, their changing nature and their effects on household food security.

3.6.2.3 Round Table Discussions

A roundtable discussion comprising of the assistant chief and cluster heads was conducted. It aided in gathering data on land size and use trends, population trends and the challenges households were experiencing as far as these key variables were concerned.

3.6.3 Observation

Observation was used as a tool to purposefully and selectively watch and listen to verify the respondents' information and the information from the secondary sources and have a feel of the impacts of land use and size on food and livelihood security. It facilitated capturing data on observable phenomena such as crops grown, size of household land, farming technology and method adopted, farming practices and the state of infrastructure facilities. The researcher formulated an observation checklist that aided in field observation of land use trends, patterns and land sizes. Additionally, the observation aided in gathering information on farming methodologies adopted,

settlement patterns and homestead layouts and boundary demarcations. As such, vital first hand data were obtained that contributed largely to the final report.

3.6.4 Photography

Digital cameras were used to take pictures of the current status of land uses, sizes, physical infrastructure status. Still and moving images were captured by use of still and aerial digital cameras and scanners. The images for housing structures, boundaries/farm demarcations, land use, malnutrition cases and data collection processes were captured. They provided the real evidence of the actual land sizes and use in the study area and their impacts on household food security.

3.6.5 Instrument Administration

Household questionnaires were administered to the sampled households to determine the actual land sizes and use allocations and size of homesteads and structuring units within the compounds. This was essential in aiding triangulation of data collected via interviews and aided in authenticating accuracy of the gathered data.

3.6.6 Extraction of Official Statistical Reports

Official statistical reports by Kenya National Bureau of Statistics on contribution of agriculture to the economy, the population reports and the changing trends on the contribution of agriculture to household security were extracted. Statistical abstracts and economic review reports over the same were gathered to aid in establishing a foundation for the validation of the study.

3.7 Methods of Data Analysis

All the gathered data was then analysed and interpreted to obtain its inherent meaning. Data analysis tools used included the Statistical Package for Social Sciences (SPSS) and the ArcGIS tools. The SPSS tool aided in the generation of frequency tables, charts and graphs as well as in the statistical t-tests, chi-square and Pearson's correlations tests for comparison and correlation of the data to determine the extent of land size and use effects on household food security and if actually land size and use changes is among other factors fuelled by a rising population. The ArcGIS tool aided in the study and interpretation of land size and use changes overtime, aiding in the interpretation and understanding of LandSat images and the changes that have happened since 1954 and providing for comparisons between then and currently.

3.8 Data Presentation Plan

All the data collected was analyzed using both qualitative and quantitative analyses techniques and a GIS/Remote Sensing based assessment of land use/land cover was done as elaborated above in order to facilitate presentation and assimilation of summarized data. This provided a quick comparison of variables using different sets of data. The data collected from research questionnaires was edited, coded and subjected to descriptive statistics for calculation of frequencies, means and percentages and the results presented in figures, tables, maps, graphs and charts. Qualitative data from in-depth interviews, questionnaires and observation was edited, organized descriptively into themes which were presented in discussions, narrative forms and citations through transcription (Burnas, 2000). GIS and Remote Sensing was used to assess the Spatial and Temporal changes in the area extent of different land use in order to assess land use changes.

3.9 Ethical Consideration

The word ethics comes from a Greek word "Ethos" which refers to the peoples way of life and social norms for conduct which distinguishes between what's wrong and right (Akaranga and Makau, 2016). Research ethics requires the researcher to protect the dignity of the respondents and publish the information resulting from the research work well (Akaranga and Makau, 2016). In this research, respondents were allowed to act independently by giving their informed consent to participate in the study verbally. Before the respondents can give their consent, the purpose of the study was fully explained to them and assured confidentiality of their information. They were also assured that their names will not be divulged. A research approval was also sought and granted by the university and the National Council for Science, Technology and Innovation (NACOSTI). Research questionnaires were administered to the respondents by the researcher himself as the principal researcher together with well-trained research assistants. Information collected from the respondents was only to be accessible to the researcher and the supervisor only. After the study has been completed and final report written the data collection tools were destroyed.

CHAPTER FOUR
THE STUDY AREA

4.1 Introduction

This chapter discusses the geographical location, demographic dynamics, climatic and physiographic features, socio-economic and cultural profile, social infrastructure and physical infrastructure of the study area in details.

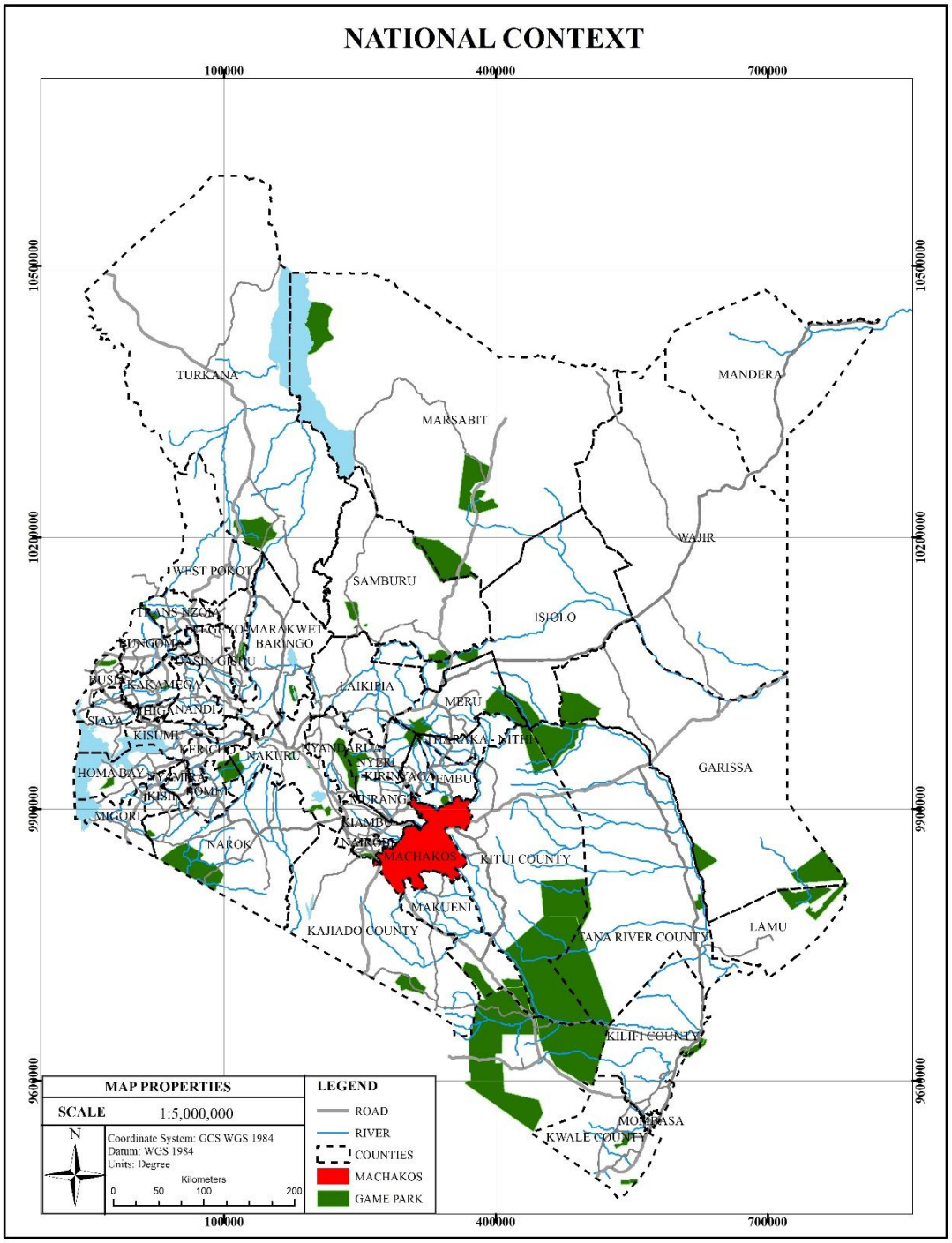
4.2 Geographical Location

Kathiani sub-location is located in Kathiani division which is in Kathiani constituency, Machakos County. The County borders Kiambu, Muranga and Embu counties to the north, Makueni County to the South and Kitui County to the East. Kathiani constituency covers 3 percent of the total 6208.2 Km^2 area of Machakos County. The constituency is made up of two divisions namely Athi river and Kathiani. Kathiani division has a coverage area of 207 Km^2 and it lies on longitude $37^0$20'E – 37^0 30' E and latitude 1^0 30'S -1^0 20' S.

4.3 Demographic Dynamics

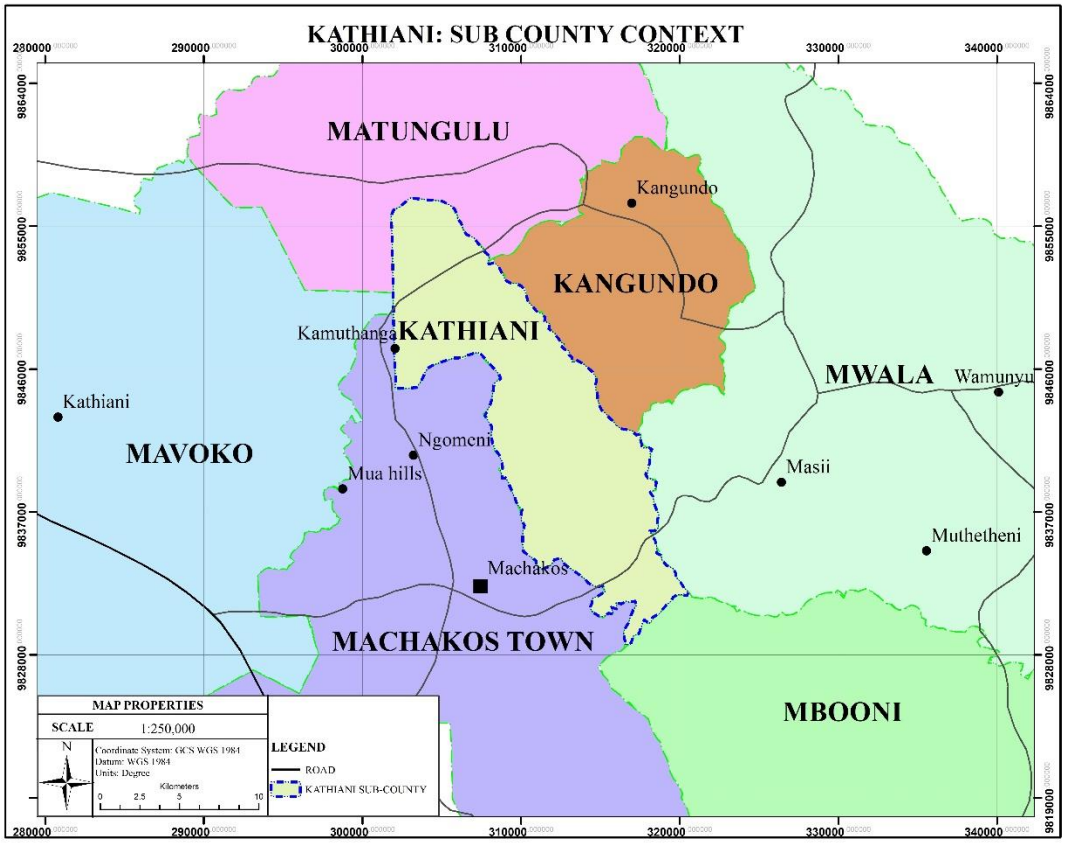
Kathiani sub-location is mainly inhabited by the Kamba community and is amongst the highly populated sub-divisions of Machakos County. As per the 2009 census, Kathiani Sub County registered 104,217 people and was projected to hit 122,439 people by 2017. The population growth projections indicated a two percent growth across the entire Machakos County where Kathiani sub-location lies (CIDP, 2017).

Map 1: Location of Kathiani Sub-location at National Context

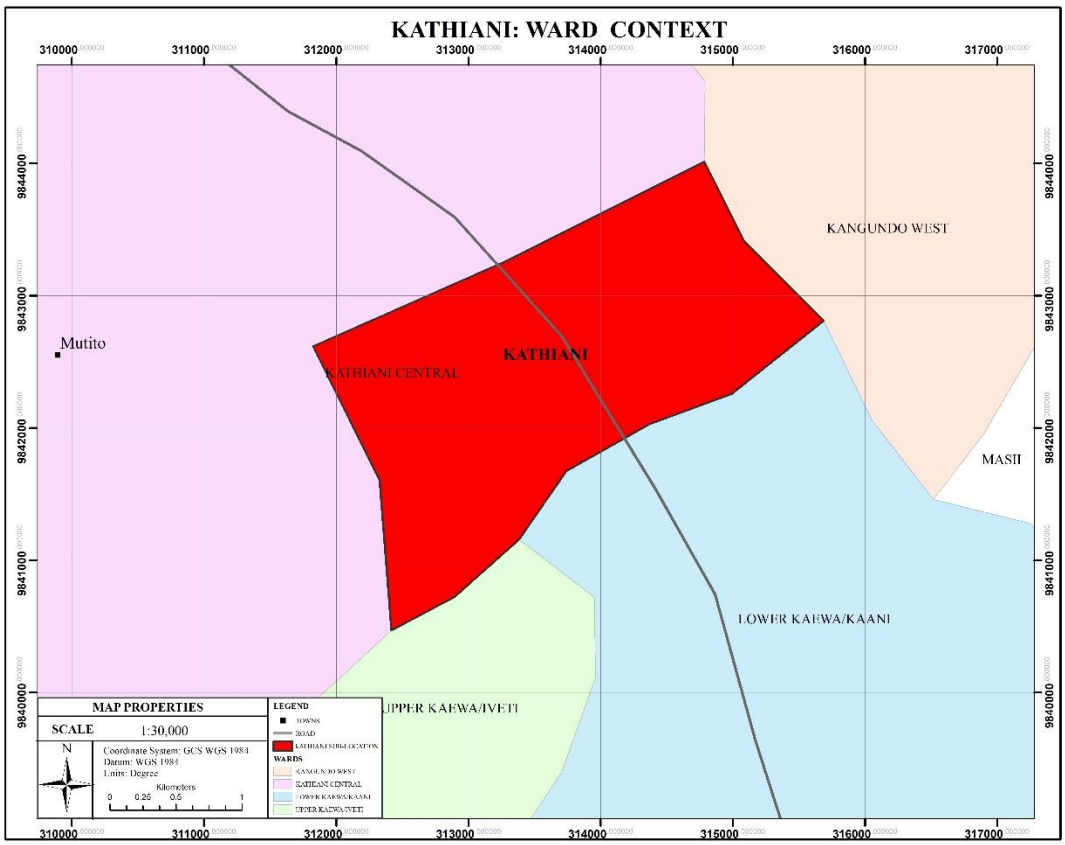


Source: University of Nairobi Arc GIS Data (Author, 2019)

Map 2: Location of Kathiani Sub-location at Sub-county Context



Map 3: Location of Kathiani Sub-location at Ward Context

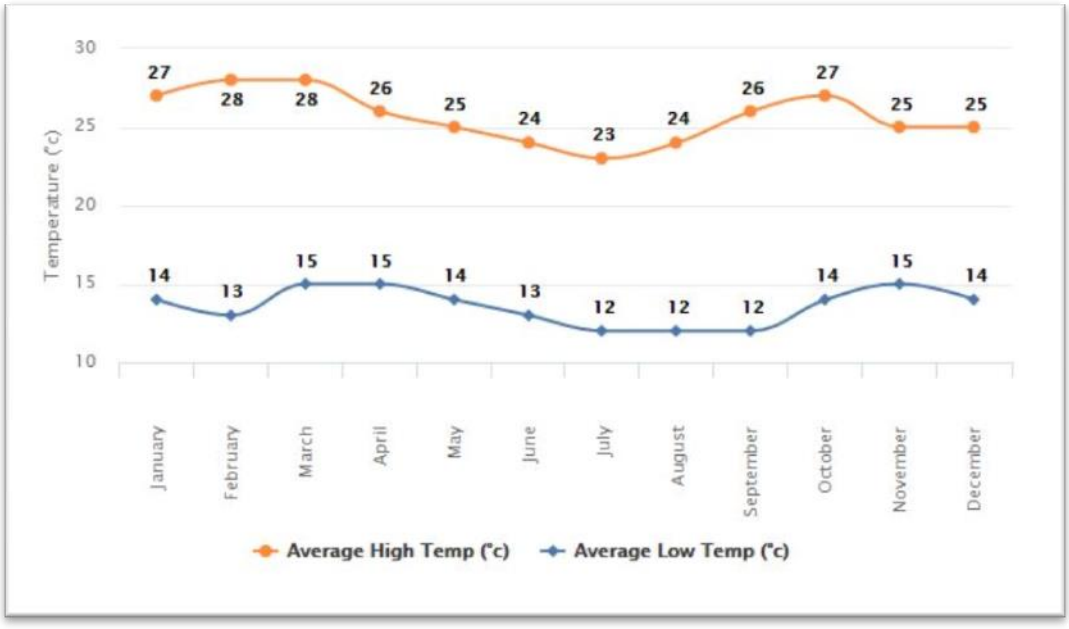


4.4 Climatic and Physiographic Features

Kathiani enjoys a hot and dry climate (semi-arid). Average annual rainfall ranges from 500 mm to about 900 mm, which is unevenly distributed and very unreliable (World weather online, 2016). The area has two rainy seasons, that is, October to December which are short rains and long rains which occurs between the months of March to May (World weather online, 2016). Lowest rainfall is received during the month of June which goes to as low as 4mm, while the highest is received during the month of November which goes up to 600mm (Figure 3.3). Rainfall received during the two rainy seasons is very high. The dry periods are between February to March and August to September during which very little rainfall is received (Figure 3.3). The temperatures of Kathiani sub-location range from a minimum of 12^{o}C to a maximum of 27^{o}C (Figure 3.2). The hottest months are March and October each with an average monthly temperature of 21.5^{o}C and 20.5^{o}C respectively (Figure 3.2). Coldest month is July with an average monthly temperature of 17.5^{o}C (Figure 3.2). The average annual temperature of Kathiani sub-location is about 19^{o}C (World weather online, 2016).

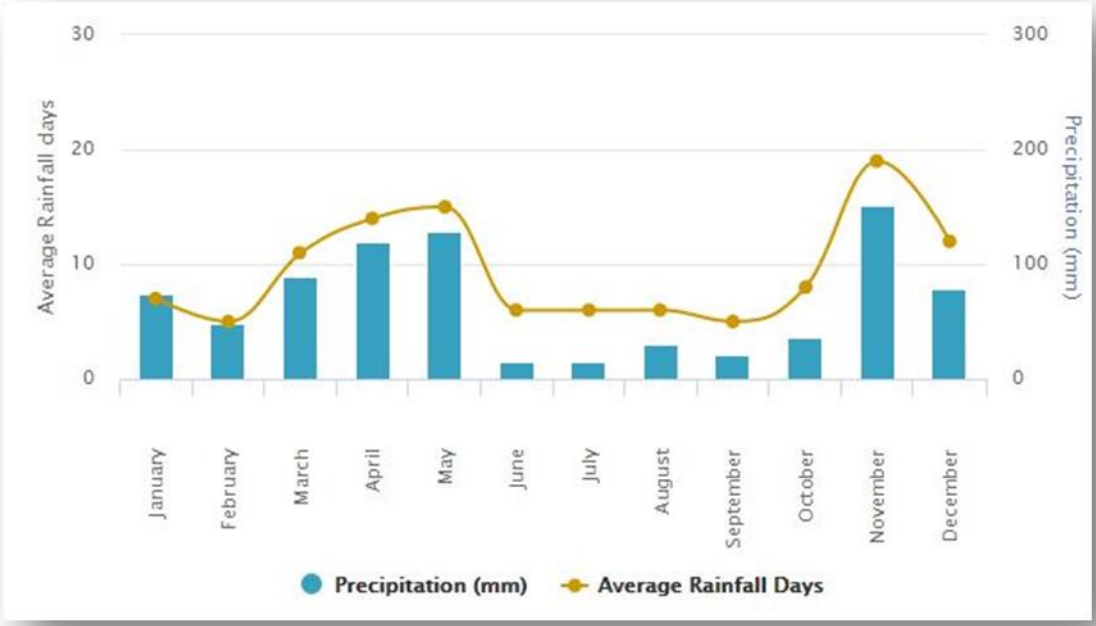
Kathiani is characterized by steep slopes, plains, forests and valleys which plays an important role in attracting tourists who bring in revenue to the county and the country at large, the hills are used as prayer places, sources of rivers especially the hills and habitat for wildlife and birds for the forested areas.

Chart 4: Average Temperature (°C) for Kathiani Sub-location



Source: World Weather Online, 2016

Chart 5: Average Rainfall in (mm) for Kathiani Sub-location



Source: World Weather Online, 2016

4.5 Socio-economic and Cultural Profile

Kathiani sub-location is inhabited by the Kamba community which culturally practices sedentary crop and livestock farming with maize as their staple crop. Agriculture and livestock keeping which are highly affected by land use change are the main economic activities carried out in Kathiani sub-location. They account for the population's household heads main sources of food (Kavoi *et al*., 2010). The two sub-sectors contribute 70 percent of the household food and income in Kathiani Location. They are the leading sub-sectors in terms of food and livelihood security, employment and contribution to socio-economic welfare of the population (Kavoi *et al*., 2010). About 75 percent of Kathiani residents are employed by the agricultural sector while 75 percent work in the livestock sector. Rapidly increasing human settlements structures are being noticed in the area of study (Willett, 2015). The area is characterized by mixed land use patterns which include residential plots and business premises such as petrol stations, commercial premises, shops and educational institutions (Ogara, 2014). Transformation of agricultural lands to industrial areas, settlement areas and urban areas in the study area is quite vivid leading to shrinking farmland.

4.6 Social Infrastructure

Kathiani sub-location has one level 4 hospital, several public health centers, dispensaries, and several private clinics (CGM, 2013). Since the sub-location does not have enough heath facilities, the doctor patient ratio is very low as it stands at 1:60000 (Maurice, 2015). The sub-location has five secondary schools and over 43 primary school (Nthambi & Orodho, 2015). Although, there are many small market centers within the sub location, the main urban center serving the sub-location is Kathiani. Since large proportions of the people living in the area are Christians, churches are the main religious structures found in the area. There are very few Muslims living in the area hence very few mosques found in the sub-location.

4.7 Physical Infrastructure

Kathiani sub-location is served by a series of tarmacked and rough road networks. About 40 percent of the road network within the area is tarmacked while 60 percent is covered by rough roads (Nthambi, 2015). Transportation of agricultural products from the farms to the markets and homes is not easy since most of the rough roads are impassable especially during the rainy season. Although most of the rivers passing through Kathiani sub-location are seasonal they have well maintained and functional bridges which connect different places within the sub-location. There is no railway lines and dykes within the study area.

CHAPTER FIVE
DATA ANALYSIS, DISCUSSION AND PRESENTATION

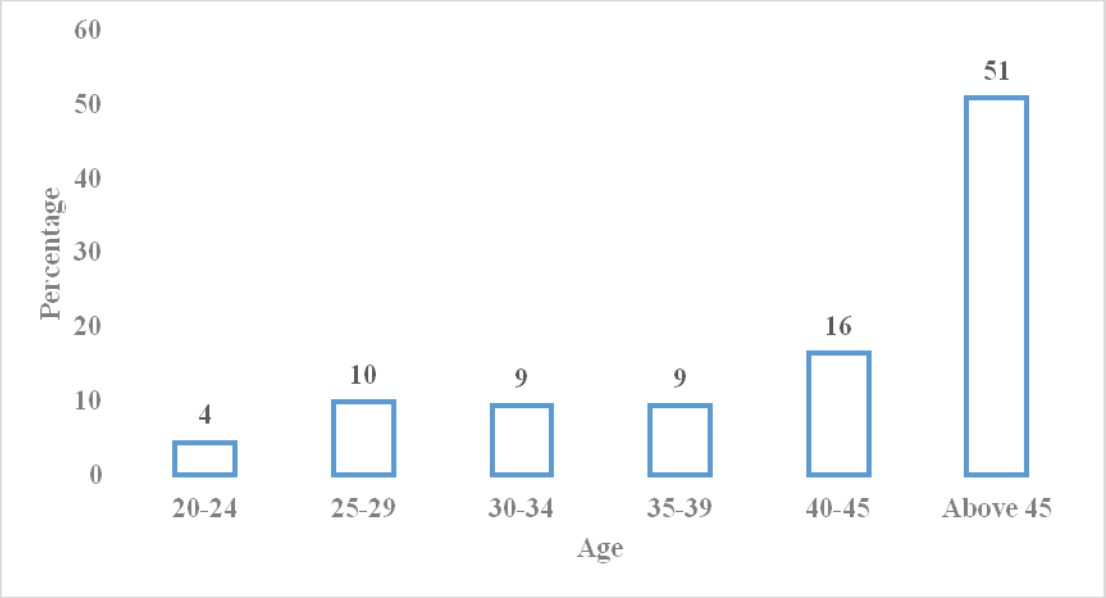
5.0 Chapter Overview

This chapter presents the findings of the study and discussion of the results as per the data collected from the field. The findings are presented in relation to the study objectives. The first section provides the overview of household land sizes and uses in Kathiani Sub-location. Section two discusses the impacts of land size and use on food security within the area of study. Section three presents the factors influencing the use and size of household land in Kathiani Sub-location while the fourth section presents the factors influencing the inter-generational land use and land rights transfer in Kathiani Sub-location.

5.1 Respondents Characteristics

5.1.1 Age of Respondents

Chart 6: Age of the Respondents



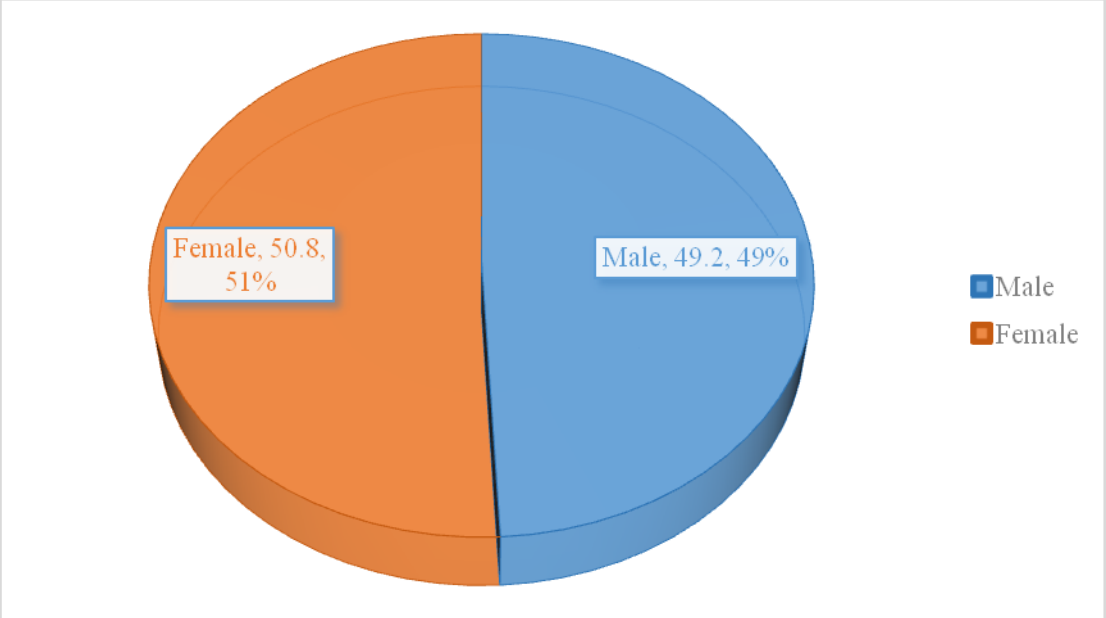
Source: Field Survey, 2018

Majority of the respondents, about 51 percent of them aged above forty-five years. Above 85 percent of the respondents were over thirty years of age while the minimum age was 20 years. All respondents were therefore, mature adults and would make sense of the study, provide reliable information and had capacity to own or rent land for farming purposes.

5.1.2 Gender of Respondents

At approximately 51 percent, females were the majority respondents compared to males who constituted 49 percent of the respondents. This was attributed to the fact that men were largely engaged in economic activities away from home as a way of increasing household income. Gender parity is also in play with almost a fifty percent aside of either gender responding and thus giving the study a vital desired wider view of the subject under investigation. It was also an indication that land related decisions are equally shared among either gender in the study area.

Chart 7: Gender of the Respondents



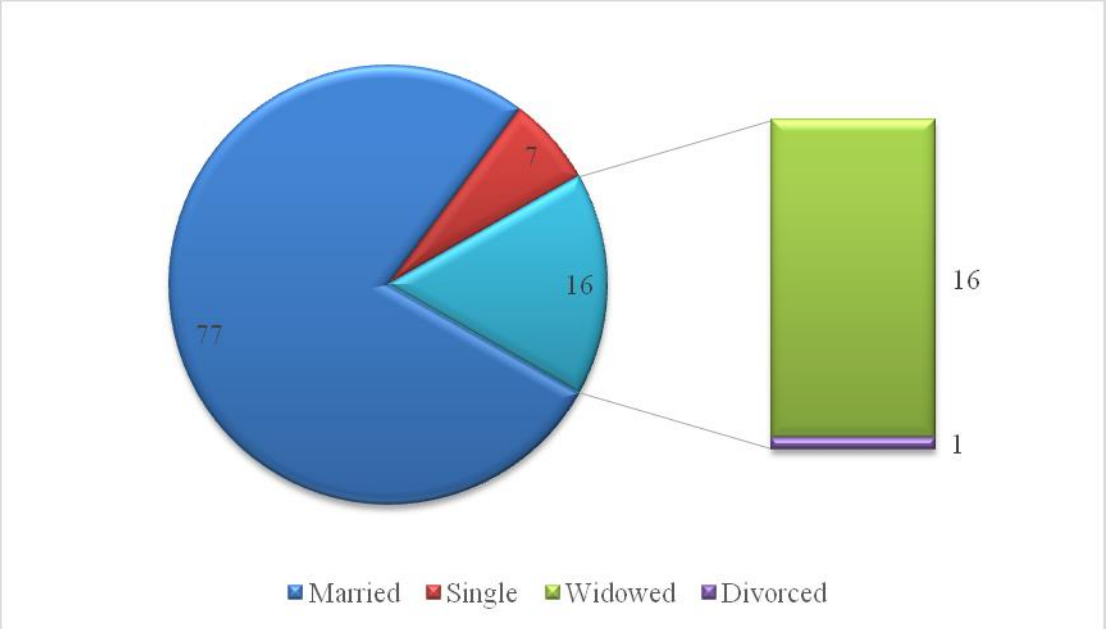
Source: Field Survey, 2018

5.1.3 Marital Status of Respondents

Majority of the respondents at about 77 percent were married while 16, 7 and 1 percent were widowed, single and divorced respectively. This implies that majority of land related decisions are possibly conducted in consultation with the spouse while the widows held sole responsibility over land size and use decisions as did the single and divorced ones. Single respondents comprised of men and women who had established homes away from their parents and had not gotten married at all, some with, others without children. Widowed respondents were responsible for land size and use decisions which affected mostly immediate dependents being children since their spouse had passed away. Most importantly is the fact that respondents were

responsible people who had role over household units and whose land size and use decisions affected other parties' most immediate dependents.

Chart 8: Respondents Marital Status

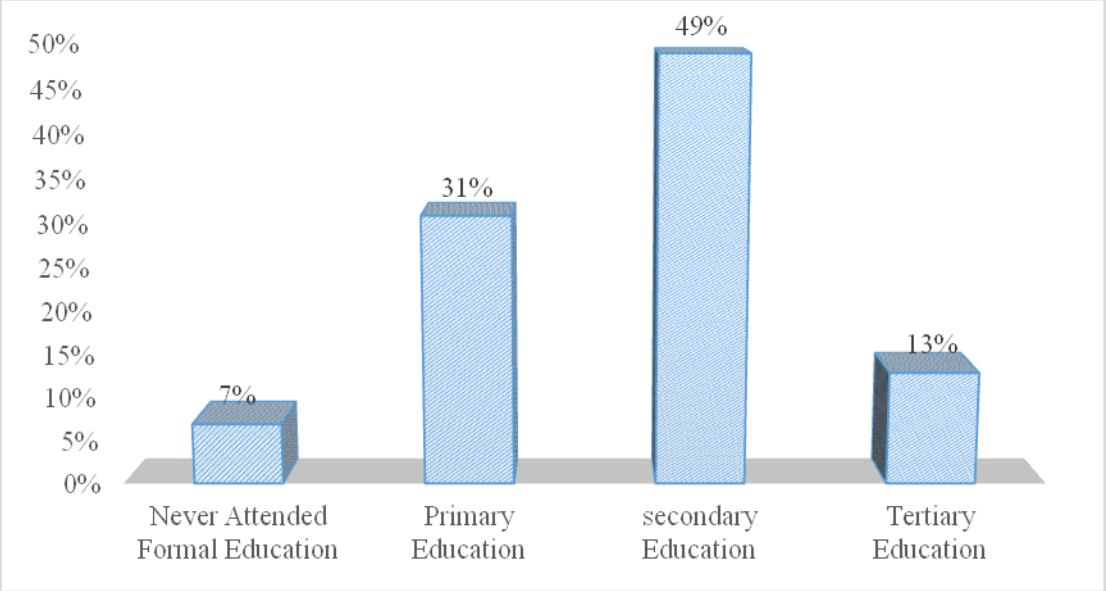


Source: Field Survey, 2018

5.1.4 Education Level of the Respondents

In order to get an understanding of the level of education of the respondents, respondents were asked their highest-level education that they have attained. It is then understood that most of the respondents had attained a secondary level of education 49 percent, a minority of 7 percent never attended any formal education, 31 percent had attained primary education while 13 percent had gone beyond the tertiary education as shown in Chart 9. Low literacy levels were attributed to lack of sufficient funds to finance education at the time the respondents were growing up. The effect was that majority of them got married at tender age while others dropped out of school to do menial jobs. Most importantly and related to the study was that almost all the interviewee turned to agriculture due to the presumption that agriculture did not necessarily require much technical knowhow as it is also cultural and anyone could undertake it. As a result, the quality of their agricultural practice is wanting and hence the productivity of their farms affected significantly.

Chart 9: Education Level of the Respondents

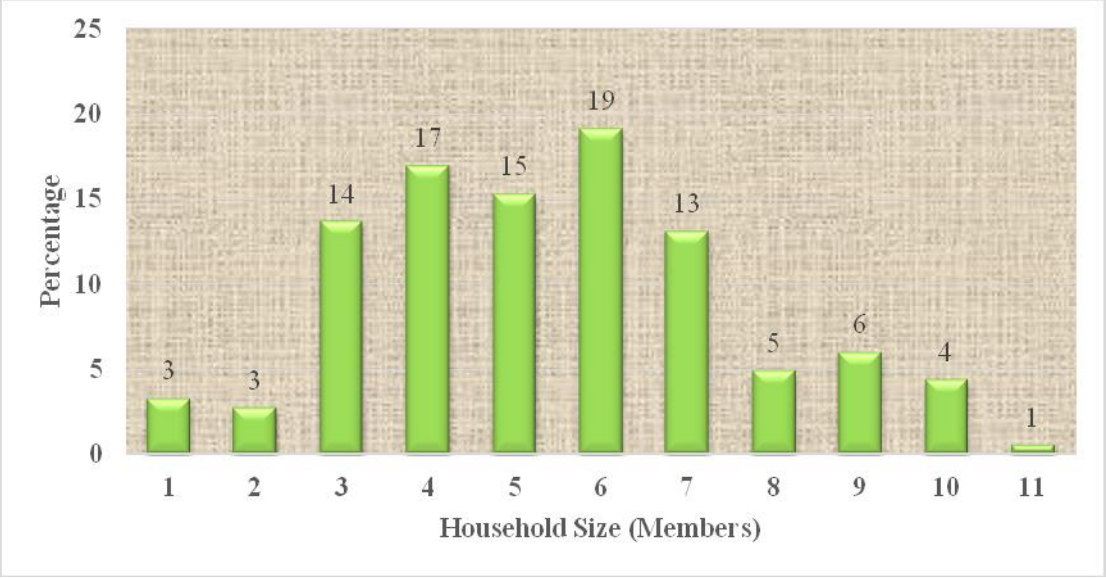


Source: Field Survey, 2018

5.2 Household Characteristics

5.2.1 Household Size

Chart 10: Household Size



Source: Field Survey, 2018

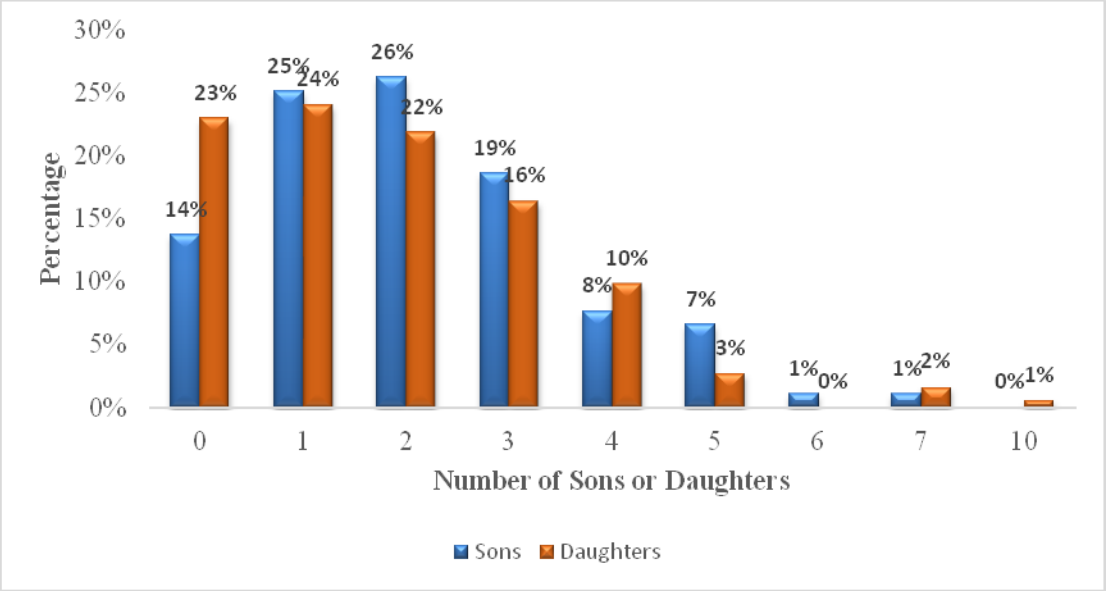
On average, a household in Kathiani sub location comprises of five members. One and eleven members form minimum and maximum family size in Kathiani sub location. Majority of the households, approximately 78 percent as can be deduced from Chart 10 have between three and seven members. The large size of households indicates higher number of mouths to feed and the eventual effect on land size and use. Culture in the study area has it that sons have to be heirs of their parent's parcel

and the need for settlement affects the space available for agriculture not forgetting the small size of parcels that occasion from subdivision for inheritance purposes. This is in agreement with Jayne et al., (2003 & 2014) reports that culture dictates that land has to be subdivided to heirs within the African settings.

5.2.2 Household Sons and Daughters

On average each household had two sons and two daughters. There were more sons than daughters in majority of the households. Sons ranged from zero to seven with daughters from zero to ten in a household. Majority of households, approximately 48 percent, had between one and two sons and daughters. The more the number of sons, the higher the possibility of subdivisions for inheritance as compared to the daughters who are believed to get married and inherit their husbands' share. Additionally, the higher the number of sons implies a possibility of exhausting farm produce much faster than households which had more daughters than sons as daughters are believed to consume less than sons and thus decreasing prevalence to food insecurity. Moreover, the higher the number of sons implied the higher the probability of increase in the number of settlements which consumed land for agricultural productivity.

Chart 11: Sons and Daughters in a Household

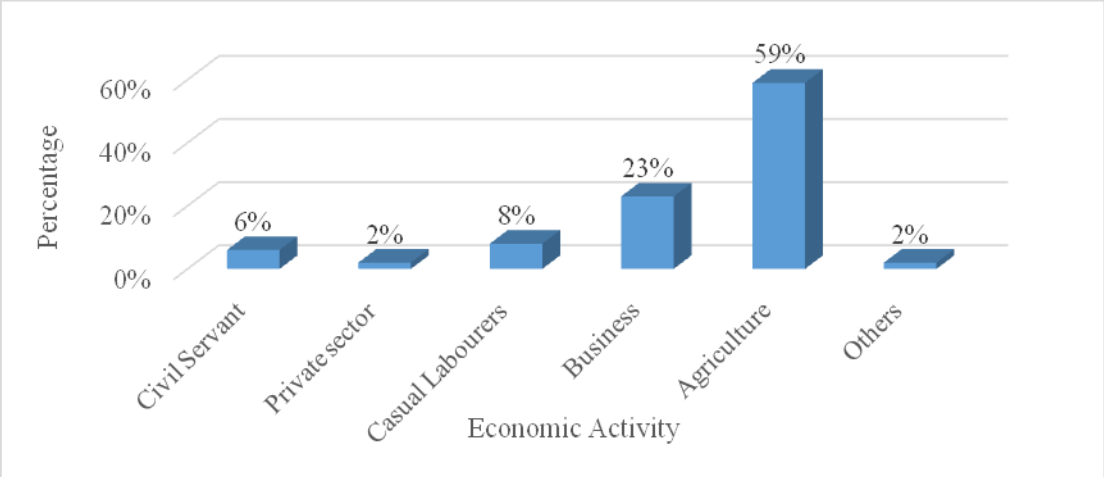


Source: Field Survey, 2018

5.2.3 Main Household Economic Activities

Majority of the respondents constituting 59 percent of the total respondents interviewed indicated that agriculture was the main economic activity, while some 23 percent others noted that small-scale businesses was their main economic activity. Additionally, 8 percent of the respondents were casual laborers while some 6 percent were found to be civil servants and two percent were working in the private sector. A paltry 2 percent of the respondents were involved in other economic activities such as land brokers and being students as shown in Chart 12. This is completely a sign of dependence on land, just as is the case countrywide, as the main resource that provides daily food requirement to households as reported by Kigutha et al. 1998.

Chart 12: Main Economic activities of Household in Percentage



Source: Field Survey, 2018

5.2.4 Household Head Main Economic Activities

According to Table 2, farming is the leading occupation of household heads at about 62 percent followed by self-employment, casual labourer, civil service and private sector employment at 24, 9, 4 and 2 percent respectively. Those in self-employment undertake micro business within the local market to supplement their farming produce. Notably, observation showed that there is overdependence on rain fed agriculture and with majority of household heads engaging in farming as their main occupation, any negative effects to the farm size or land use or changes in climate and environment adversely affects livelihoods as household food security is in all circumstances affected. Most importantly, the occupation outside farming by household head is meant to support the family acquire other basic requirements to complement farm produce and their absence implies complete household dependence

on agriculture which is in itself unreliable and thus subjecting families to dangers of malnutrition and adverse poverty effects.

Table 2: Main Occupation of Household Head

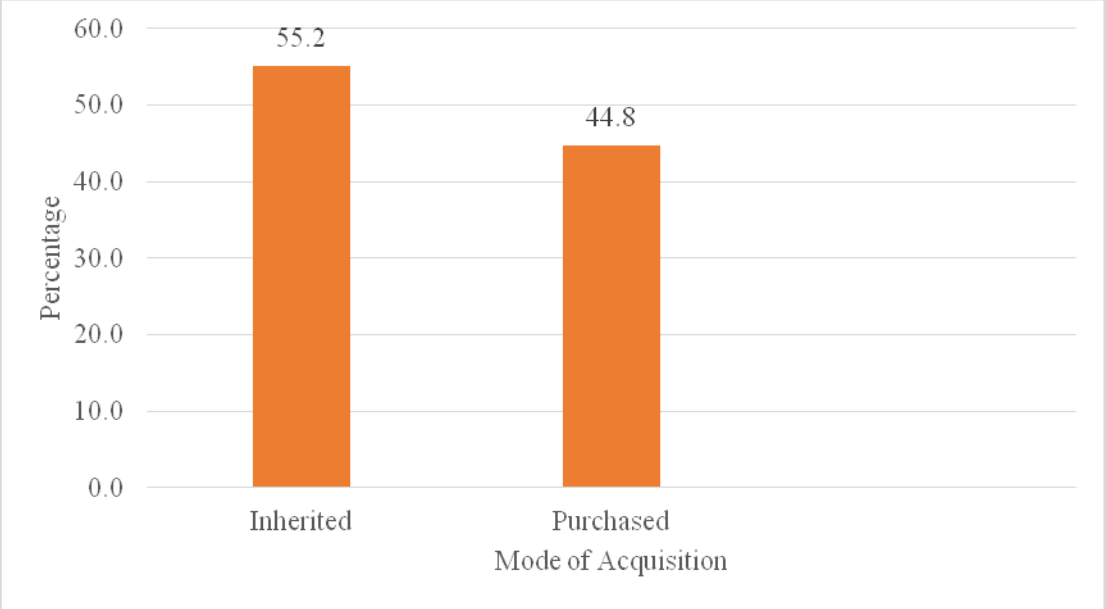
Occupation	*Frequency*	*Percent*
Civil Servant	7	4
Employee in private sector	3	2
Casual Laborer	16	9
Self-employed	44	24
Farming	113	62
Total	183	100

Source: Field Survey, 2018

5.3 Household Land Size and Uses in Kathiani Sub-location

5.3.1 Mode of Land Acquisition

Chart 13: Mode of Land Acquisition



Source: Field Survey, 2018

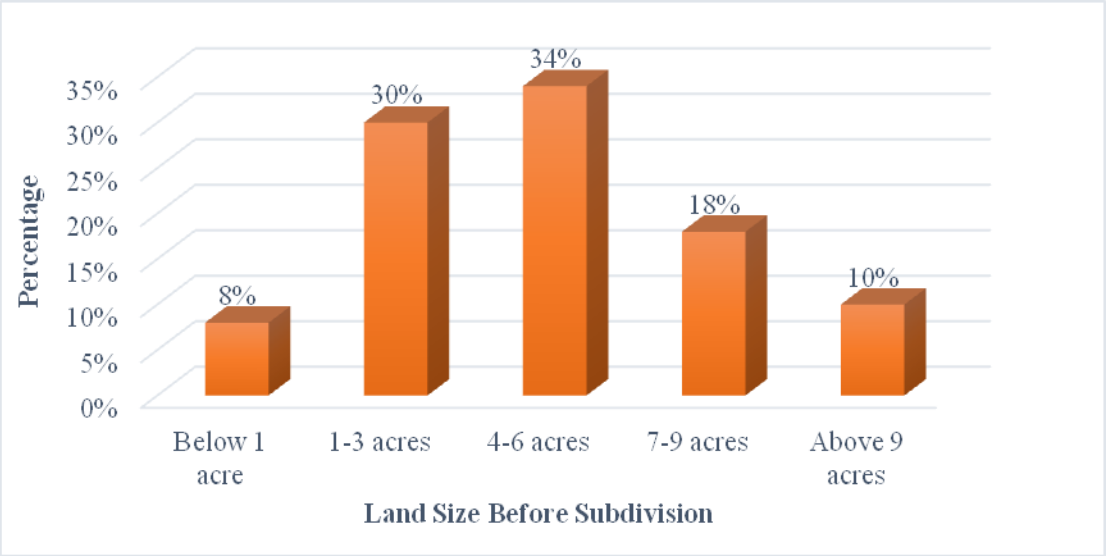
Inheritance was the main way of acquiring land for 55 percent of the respondents while 44 percent others obtained land through purchase. These two methods of land acquisition had effects on household land sizes since the land had to be subdivided to accommodate heirs or buyers. With inheritance leading the mode of land acquisition for the respondents who were household heads, it brought to the fore the tradition that

children have to be heirs of their parents' land indicating intergenerational transfer of land was highly practiced. Buying of land was on the rise in the area occasioned by influx of migrants, both native and non-native Kamba, from neighboring major towns. In fact, it was observed that the majority of the buyers were purchasing plots for putting up residential homes while they worked within Thika and Machakos towns let alone the daily commuters to and back from Nairobi and Kangundo.

5.3.2 Original Parent Land Size before Subdivision

Majority of the respondents (34 percent) said that their original parents land size was between 4-6 acres, 30 percent being between 1-3 acres, 18 percent being between 7-9 acres, 10 percent having more than 9 acres of land, and 8 percent having below an acre of land. As can be deduced from Chart 14, majority of the respondents, at approximately 62 percent, their original parent's land before subdivision exceeded four acres indicating that mechanization and use of modern technology on land was very possible before subdivision. This in turn implied production was probably higher and possibly sustained a household all year round.

Chart 14: Original Land Size before Subdivision



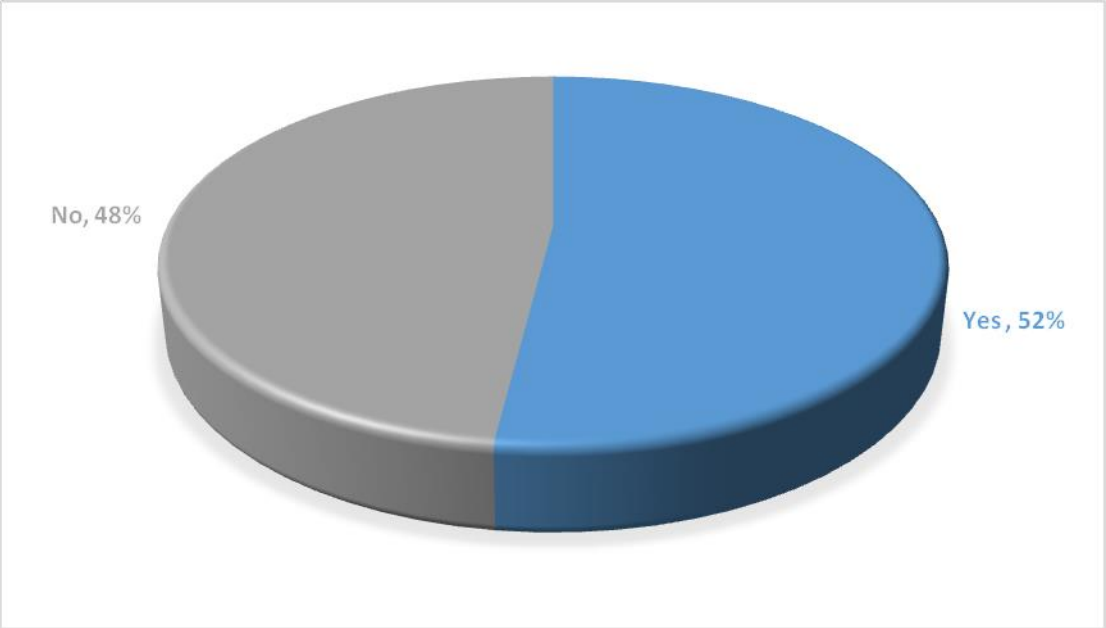
Source: Field Survey, 2018

5.3.3 Subdivision of the Original Parents' Land

Respondents reported that their parents' land had been subdivided. A majority of 52 percent acknowledged that their parents' land had been subdivided while the remaining 48 percent said that their parents' land had not yet been subdivided as shown in Chart 15. Those who acknowledged their parents' land had been subdivided

associated it with the old age of their parents which forced them to divide the land amongst their children. They also said that the land was subdivided in order to avoid land conflict among the children in the family. Also, land fragmentation was brought about by polygamous families where each wife had to be given her own piece of land hence other parcels were acquired elsewhere for them. Those who said their parents land had not been subdivided, said was because their parents had not decided to subdivide the land to them. In this context, they had erected their houses within the parent's homestead and tilled portions of their parents' land that had been assigned to them to farm and obtain food for their children. As noted from the focus group discussions, parents assigned portions of their land to their children which would turn out to be their share of inheritance from them. This implicated food production since homesteads had several households each farming small portions of land and having to engage in other activities to supplement insufficiency of what had been harvested. Informal land subdivision was therefore on the rise since most of these respondents were reported not to have obtained any documents to their portions. This affected household food security since yield from small portions of land never lasted household from one season of harvest to the other.

Chart 15: Original Land Subdivision



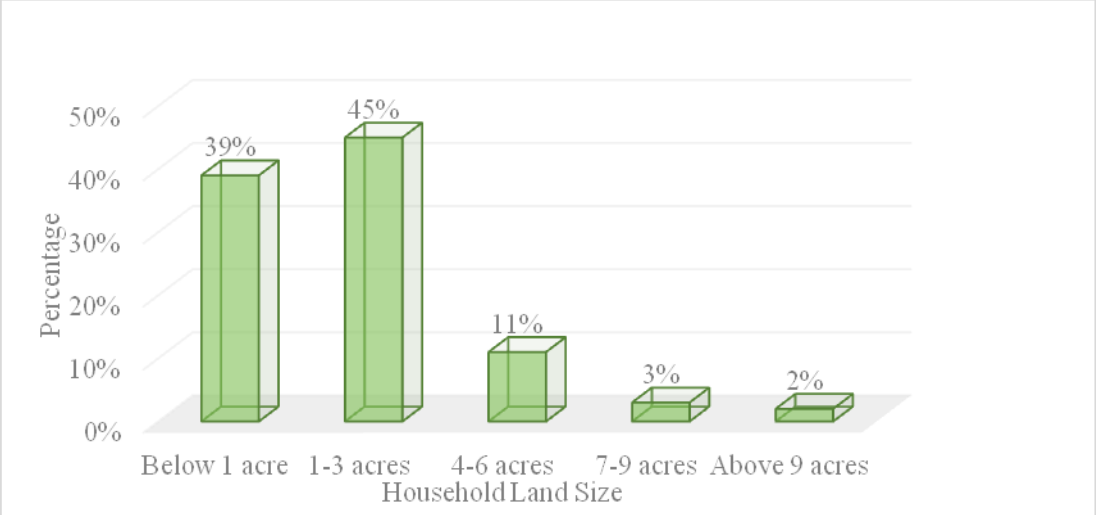
Source: Field Survey, 2018

5.3.4 Current Household Land Sizes

From the study findings, 39 percent of the respondents indicated that they owned less than one acre of a land, while some 45 percent of the respondents indicated that they

owned 1-3 acres of land. In addition, 11 percent of the respondents were found to own 4-6 acres of land and 3 percent others owned 7-9 acres. Approximately 2 percent of the respondents indicated that they owned above 9 acres as shown in Chart 16. They indicated that the continued land subdivision amongst the family members as the main reason for the small land sizes they held. Majority of those who had more than 6 acres of land said that they had bought their land and hence not subjected to subdivision. Additionally, families which had a few members had also large pieces as compared to the ones which had higher number of members. Also, encroachment of the agricultural land by markets was also mentioned as a key factor leading to increased land subdivision in the region which in turn has led to small land sizes. This, as Jayne et al. 2014 and Museleku et al. 2018 observe, has negative impact on agriculture in that it reduces land under agriculture leads to low agricultural production in the region affecting food and livelihood security of the local communities and the country in the long run.

Chart 16: Household Land Sizes



Source: Field Survey, 2018

Plate 1: Small maize plantation

Source: Field Survey, 2018

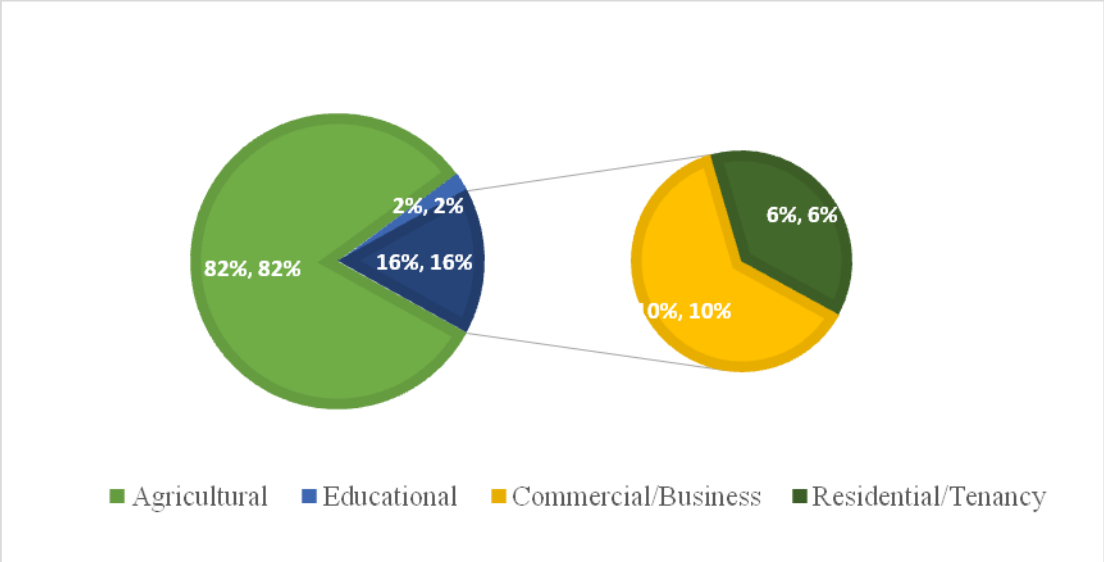
Plate 2: A small Pigeon Peas plantation

Source: Field Survey, 2018

5.3.5 Household Land Uses

Data collected from the field indicated that 82 percent of the respondents used their land for agricultural activities while ten, six and two percent used their land for commercial, residential and educational purposes respectively. Ideally, this makes agriculture the main land use activity in the study area and in essence the major source of income to the households and its dependence as the core determinant of household food security. Crop failure or challenges in productivity, decrease in farm sizes and climate change factors which are both endogeneous and exogenous to the household would thus impact on farm production and in return affect the household's food security.

Chart 17: Household Land Uses in Percentage



Source: Field Survey, 2018

The findings of this study are in line with findings of a study done by Madallah and Tarawneh (2014) on urban sprawl on agricultural land in Shihan Municipality Area, Jordan. In their study findings they concluded that encroachment of agricultural areas by markets and urban areas was a key factor leading to subdivision of agricultural land adjacent to the markets and urban areas as people subdivide the land to sell or develop for urban purposes. They further noted that the end result of encroachment of agricultural lands by markets and urban areas was reduced food production which affects food securrity. The land use patterns in the study area are the same as land use patterns of Amazon, Brazil as noted by Vasco *et al.,* (2018). In both cases more land is used for agricultural purposes specifically subsistence crop production and livestock keeping.

Plate 3: Forest Plantations and Settlements

Source: Field Survey, 2018

Plate 4: Other land Uses in Kathiani

Source: Field Survey, 2018

5.4 Impacts of Land Size and Use on Food Security

Land size and use allocation was expected to have effect on household food security. Majority of the respondents in the study area practiced mixed farming comprising of food and cash crop farming and livestock keeping. Observation data collection method, photography as in Plate five and six together with key informants and focus group discussions indicated that Coffee had been for the longest period of time the leading cash crop while maize and beans together with peas and green grams were the major food crops grown in the study area. It was observed that forest/tree farming was the other major cash crop after coffee. It was revealed from the discussions, interviews and photography that major coffee farms had been phased out due to poor prices and low yields while the few coffee trees were scattered all over the maize, beans and peas farms.

Tree farming was on the tragedy of failing attributed to challenges of lack of sufficient farm sizes and the duration trees take to mature for their conversion to cash and lastly to food was seen as another major setback. As a result, a few tree farms remained or only those with bigger farms had the luxury and the capacity to set aside space within their farms to grow trees. With diminishing farm sizes, participants of focus group discussions observed that trees will most probably take the place for crop farming owing to favourable climatic conditions and the ability to have huge numbers to form a forest and hence yield high returns as compared to crops.

As observed, just a single coffee factory remained standing serving the existing few coffee trees in the study area. Coffee was being phased out due to its low prices and yields while the lack of sufficient farm sizes to grow the trees alongside food crops aggravating the situation. All farms were now focused on maize and beans as the main food crops in the focus to sustain livelihoods. This elaborates on the impacts land size and use has on household food security. Notably, land subdivision was ongoing, legal and illegal, and it was reported to have determined farm harvests. A large undivided farm adjacent to the study area, farmed by participants of focus group discussions and household respondents was the controlling experiment. It was reported to have been producing double the settled farms. The stated farm had no physical boundaries and farmers demarcated their specified farming area by the number of terraces.

With this in mind of participants and respondents, it was observed just as it was reported, those with large farms, unsettled and without visible boundaries harvested much as compared to those with small farms, they had the power to allocate crops in their farms and easily practiced intercropping as opposed to mixed cropping. Livestock keeping had been reduced to zero grazing with dairy keeping being the leading type of animals kept mostly in the well up families while majority zero grazed a few goats, sheep and indigenous cattle in their households. Zero grazing was also beneficial to these households as they used the manure in their farms to increase farm productivity and aid in household food security albeit insignificant.

Plate 5: Mixed Farming: Beans, Cow Peas and Pigeon Peas

Source: Field Survey, 2018

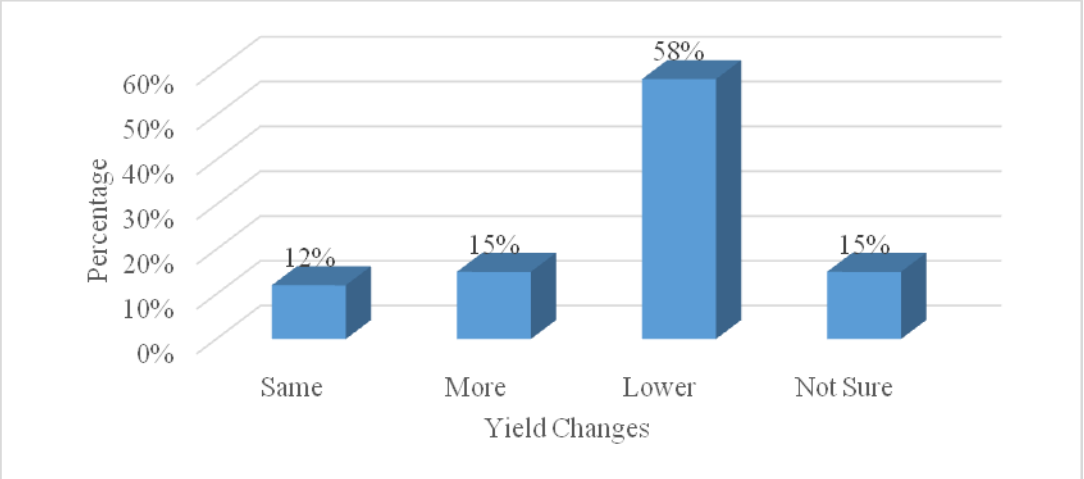
Plate 6: Mixed Farming: Maize and Pigeon Peas

Source: Field Survey, 2018

5.4.1 Changes in Agricultural Production after Land Subdivision

Out of the 52 percent of those who said their parents' land had been subdivided in Chart 18, about 58 percent of them noted that yield produced had decreased while some 12 percent said that there was no change in the yield produce before and after land subdivision as shown in Chart 19. Almost 15 percent said the yield had increased while another 15 percent were not sure whether the yield reduced, increased or remained the same. Those who acknowledged reduction in yield associated it with the small sizes of land achieved after land subdivision saying that the land was not enough hence the low yield. For the increase in yield production, respondents associated it with the improvement of individual pieces of land through adding more manure to the land and practicing modern farming methods. This implied more intensification on the resultant small parcels thus yield remained unchanged or increased marginally.

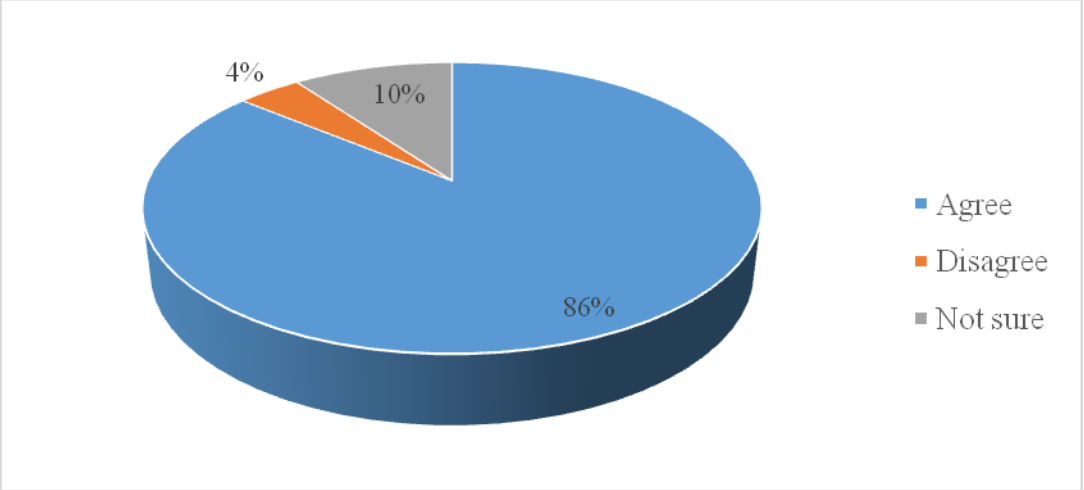
Chart 18: Changes in Yield Production after Land Subdivision



Source: Field Survey, 2018

Out of the total respondents interviewed 86 percent agreed that land subdivision leads to low yields while 4 percent disagreed. Roughly 10 percent of the respondents were not sure whether land subdivision reduces agricultural production or not.

Chart 19: Land Subdivision Leads to Low Crop Yield



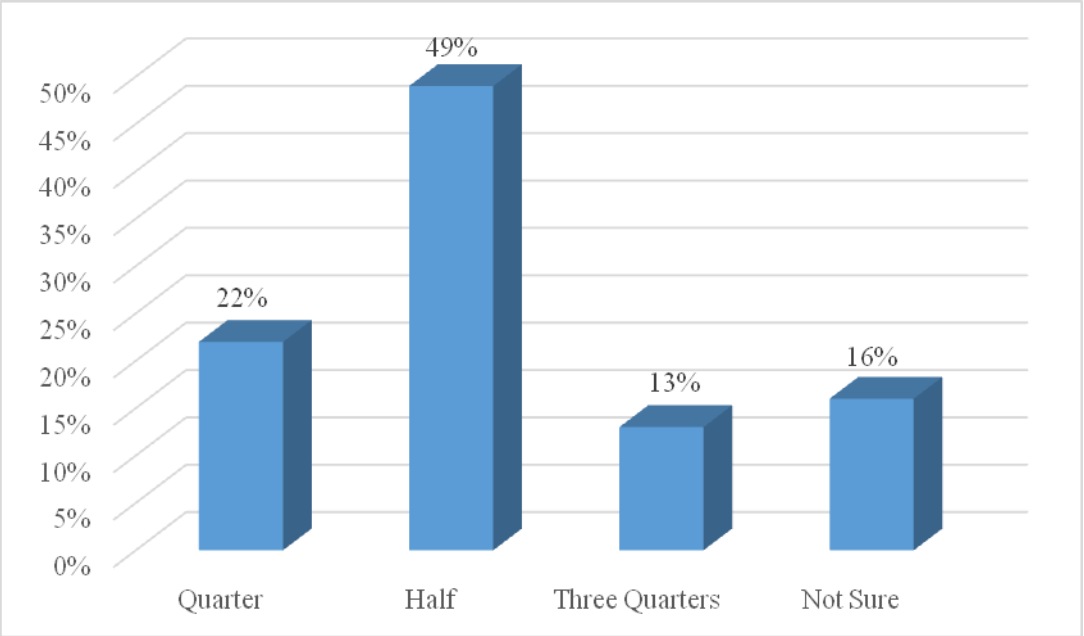
Source: Field Survey, 2018

The Majority 86 percent response indicated that subdivision's effect of decreasing the farm crop yields impacted on household's food security and thus serious interventions were required. Notably, regardless of the type of crop planted, focus group discussions revealed that as long as the farmed space has diminished, the produce was too little to support majority of households in the study area a year or a season.

5.4.2 Reduction in the Amount of Yield Produced

The research also wanted to know from the 58 percent of the respondents who said the yield had reduced, by how much the yield had gone down after the land subdivision. Out of the 58 percent, 49 percent of them said the yield had reduced by half, 22 percent said by a quarter, 13 percent by three quarters, and 16 were not sure by how much the yield had reduced by as shown in Chart 20. Worth noting from the Chart 20 is the fact that majority of the respondents, approximately 62 percent of them concurred that the decrease in yield was more than half the initial yield before subdivision. This was such a huge change that impacted hugely on households noting the exogenous factors still continued to impact on the households and possibility of hunger-stricken households was thus higher as compared to the prior times before land subdivision.

Chart 20: Variance of Yield Reduction

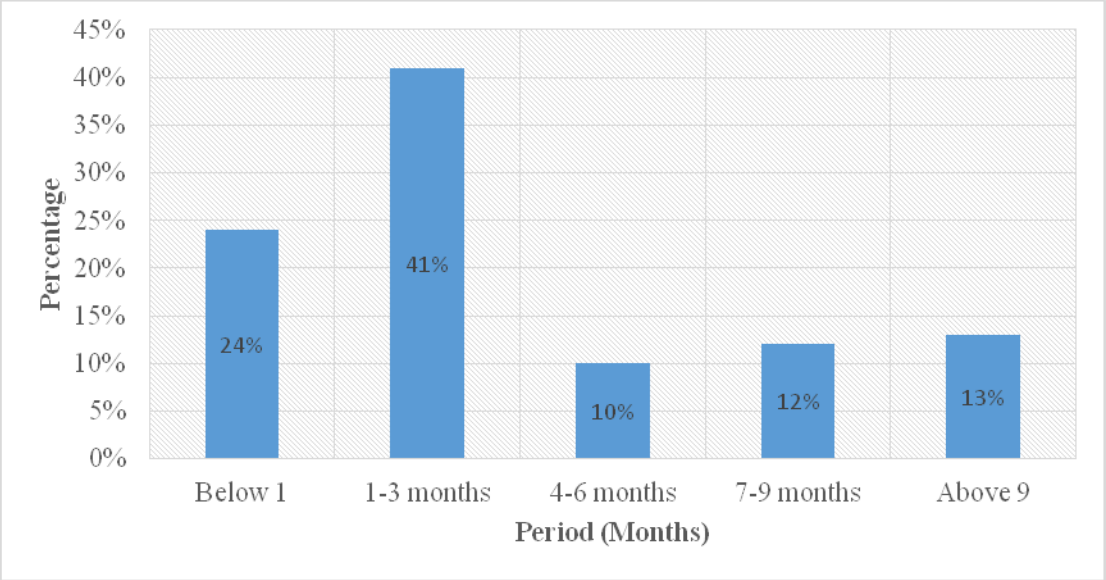


Source: Field Survey, 2018

5.4.3 Duration the Agricultural Yield Feeds a Family

Majority of the respondents (41 percent) noted that their agricultural yield lasted their families 1 to 3 months while 24 percent of the respondents said that their agricultural production feeds their families for less than a month as per Chart 21. An estimated 13 percent, 12 percent and 10 percent indicated that production from their farms was able to feed their families for more than 9 months, 7-9 months and 4-6 months respectively. They noted that after exhausting their agricultural yields, they resulted to buying food from the shops. Those whose agricultural yields fed their families for a longer period had large pieces of land compared to those whose yield fed their families for a shorter period of time. About 83 percent of the respondents noted that they had not skipped any meal within the last 3 months indicating that quite a good percentage of the residents of the study area were food secure. The remaining 17 percent of the respondents noted that they had skipped at least one meal within the last 3 months prior data collection as in Chart 22. The main reason they gave was lack of food and money to purchase the same.

Chart 21: Period in Months Farm Yield Lasted a Household

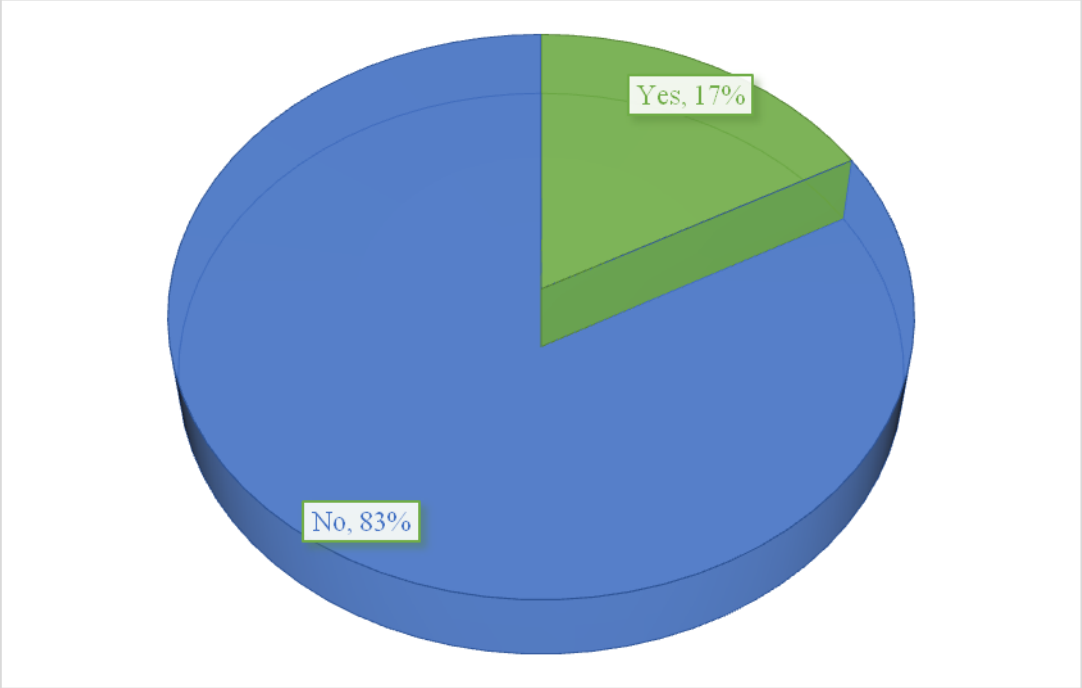


Source: Field Survey, 2018

As can be deduced from the Chart 21, a paltry 13 percent of the respondents had farm yield last their households more than nine months. This indicated that almost 87 percent of the households were food insecure and had challenges obtaining food for a period of not less than three months in a year holding that agriculture/farming was the only source of food and income to the household. And this is especially true due to the fact that a whopping majority of about 82 percent as per Chart 14 practiced agriculture. Majority of the respondents, roughly 65 percent experienced severe food shortages as their farm produce lasted up to a maximum three months.

As per Chart 22, a few of the respondents, about 17 percent of them skipped a meal the previous three months before data collection with a majority 83 percent not having skipped a meal. Data collection took place in August, about two months after maize harvest from the season ending May. Actually, pigeon peas were still in the farm and being harvested whilst data collection was taking place as evidenced on Plate five and six. This gives a picture of how the situation most likely would be months to the next season. It also means that other coping mechanisms had been devised by households to feed their households and thus decreased their dependence on the farm.

Chart 22: Skipping a Meal Three Months Prior Data Collection

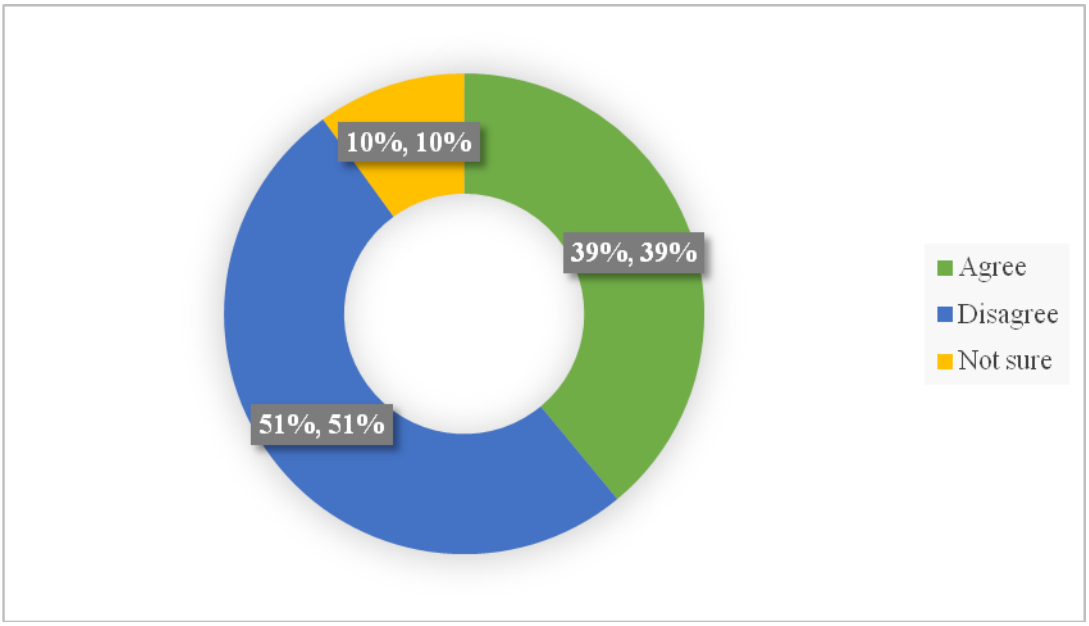


Source: Field Survey, 2018

5.4.4 Modern Farming Techniques on Small Land Sizes

A higher number of the respondents, 51 percent disagreed that modern farming methods can easily be applied on small land sizes. They argued that modern farming methods such as the dry land farming techniques of using certified seeds, manure application, and right planting techniques required large pieces of land for them to be carried out conveniently. Another 39 percent of the respondents were of the opinion that modern farming methods can be practised on small land sizes as per Chart 23. They argued that land size does not matter but the technology. Just a small portion of 10 percent of the respondents was not sure whether modern farming methods could be applied on the small pieces of land or not. The agreement was based on lack of sufficient land to practice mechanization let alone free-range herding and livestock keeping. Those who said that mechanization could be practiced noted that ultra-modern technology as practiced in Indian farms (Rao 1967, Saini 1971 and Chand et al. 2011) would be suitable for the minute farm sizes and would in the end result to increased farm produce. This ideally implies the innovativeness households had gotten to in the process of acquiring feeds for their households.

Chart 23: Morden Farming Techniques Application to Small Farm Sizes

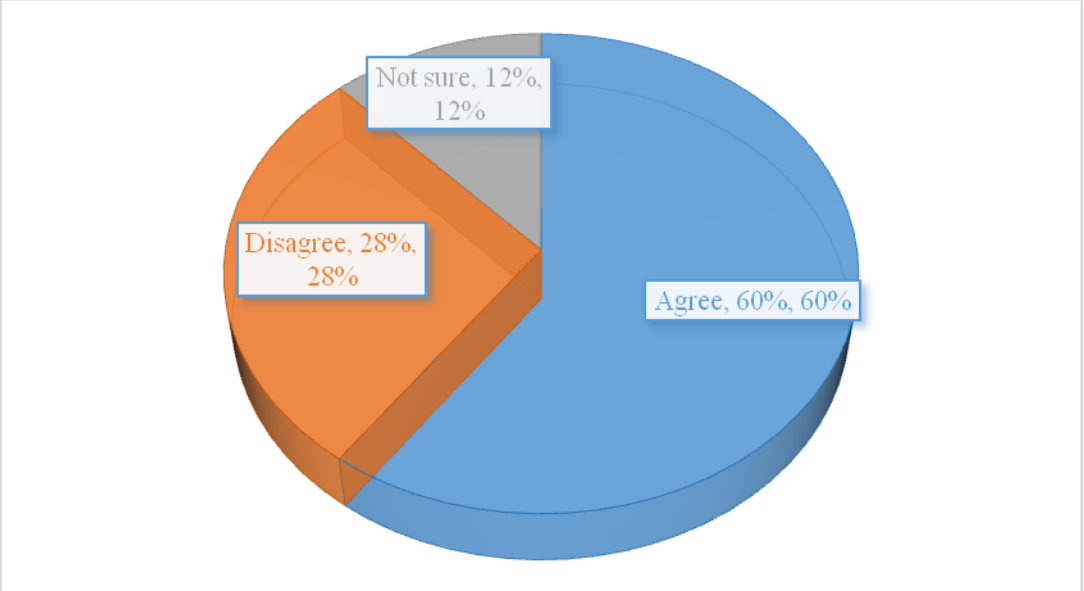


Source: Field Survey, 2018

5.4.5 Reduction in Number of Cattle Kept

Majority 60 percent of the respondents agreed that there was reduction in the number of cattle they kept due to reduction in land sizes as in Chart 24. Almost 28 percent of the respondents disagreed while 12 percent did not know whether the number of cattle had reduced or not.

Chart 24: Livestock Kept Decreased with Decrease in Land Sizes



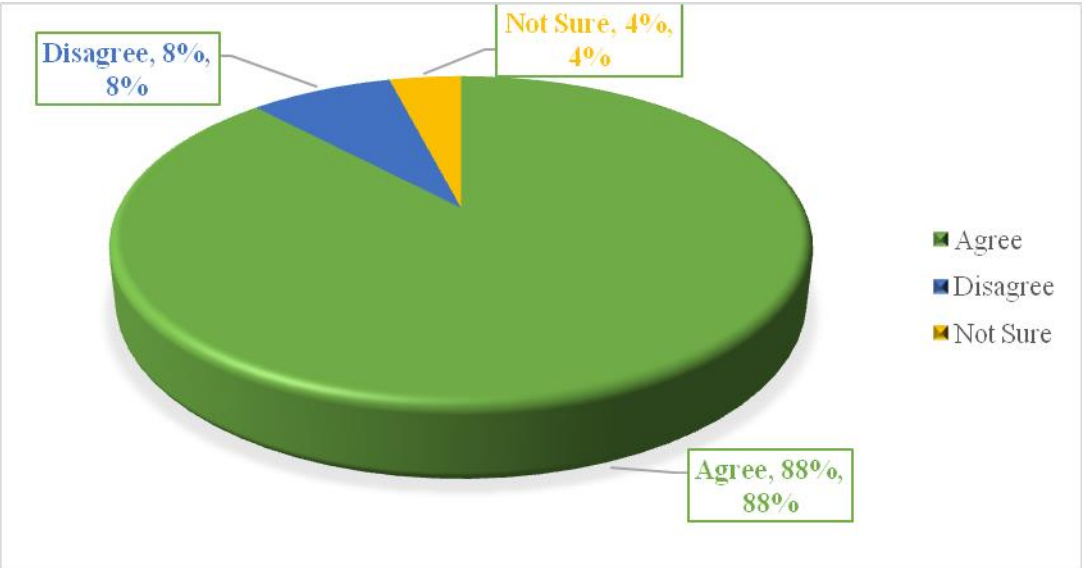
Source: Field Survey, 2018

What the study established from observation, key informant interviews and focus group discussions was the fact that most households no longer keep large heads of cattle, free range field pasturing had been completely phased out over the years. They attributed the shift to lack of sufficient land for the kind of livestock management. Additionally, paddocking was also not possible as land sizes had completely diminished. They argued that initially, all the hilly areas of the sub location were grazing areas, and with few people settling in the area, they kept thousands of cattle. The decrease in farm sizes which they attributed to growth in population was the major factor with zero grazing being on the rise. The explanation to the majority of the respondents who disagreed with the probe that number of livestock kept decreased with land subdivision was that they never had livestock before land subdivision but when it was subdivided, they acquired their own few cattle that they zero grazed in their small farm else they were recent settlers or young households and lacked sufficient history of the study area.

5.4.6 Increase in Zero grazing

A whopping 88 percent of the respondents agreed that they were turning to zero grazing as a result of declining land sizes. They noted that they lacked large parcels of land where they could go looking after their cattle on a free range hence forced to turn to zero grazing. About 8 percent of the respondents disagreed that zero grazing was fast increasing as a result of declining land sizes while 4 percent were not sure of whether zero grazing was on the rise as per Chart 25. Although zero grazing has the advantages of manure and biogas production, the inability to keep huge herds of cattle which would have a higher production of same by-products was reported to have a direct impact on household food security by key informants and in focus group discussions.

Chart 25: Zero Grazing and Diminishing Land Sizes



Source: Field Survey, 2018

The results of this study support findings of a study done by Musemwa *et al.,* (2013) on the factors affecting efficiency of field crop production among resettled farmers in Zimbabwe. The results of their study concluded that land size and use played a vital role in the amount agricultural yield produced. They further noted that the larger the size of agricultural land, the more yield would be produced resulting to food security. The results of this study also concur with the findings of another study which was done by Muraoka *et al.*, (2018) on land access, land rental and food security in Kenya. The results of their study indicated that the increased subdivision of agricultural land in the rural parts of Kenya has resulted to reduced agricultural yields and reduction in the number of livestock reared in the rural areas of the country. Consequently, this has led to food insecurity in the rural areas of Kenya.

The findings of this study does not support findings of a study which was done by Wycliffe (2017) on effects of land subdivisions to food security in Kaputiei north, Kajiado County, Kenya. In the findings of his study, he found out that increased land subdivision had in turn increased the number of livestock and poultry in the region. He attributed this to the increased settlement of people who are not naturally known for pastoralism in the region. The findings of this study are also not in line with the findings of a study done by Mondal (2008) on the effects of land use changes on livelihood pattern of small farmers in Madertala village under Dumuria Upazila in Khulna District, Bagladesh. In the results of his study he concluded that land use

change has positive effects on livelihood pattern largely in terms of creating employment, increasing the amount of income generated, seasonality and improving social identity. This was through using the same small pieces of land for two or more different productive purposes in a single year. This led to the improvement of food security in area.

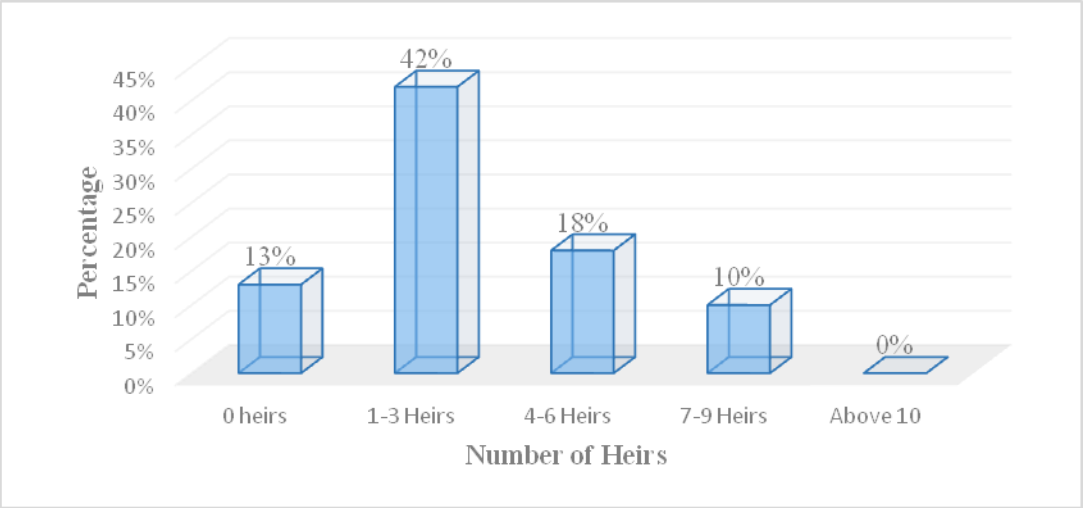
5.5 Factors Influencing Household Land Size and Use

The study required to know the factors influencing the use and size of household land by local communities living in Kathiani Sub-location. This was attained by analyzing the number of heirs in each household, gender of the family members, tenure system in the area, economic value of the land, know-how of the modern farming techniques and population pressure.

5.5.1 Number of Heirs

From the findings as indicated in Chart 26, an estimated 42 percent of the respondents indicated that there were 1-3 heirs in their families, 18 percent said their families had 4-6 heirs while 13 percent had no heirs in their families. While there was no family with 10 heirs and above, 10 percent of the respondent's families had 7-9 heirs. As is seen on the Chart 26, almost 70 percent had more than one heir indicating that land inheritance was most likely to be shared by at least an heir. The larger the number of heirs in the family and especially if they are males the more the subdivision of the land hence reducing the size and to some extend the use of the land. The smaller the number of heirs, the less the subdivision of the agricultural land hence the land size remains larger as compared to when the heirs are many. Consequently, agricultural production goes down when land size becomes small exposing households to food insecurity.

Chart 26: Total Number of Heirs in the Household



Source: Field Survey, 2018

5.5.2 Gender and Land Inheritance

Majority of the respondents, 96 percent noted that they had sisters during the land subdivision process while 4 percent indicated that they had no sisters. As per the focus group discussions, females were culturally not allowed to inherit land from their parents as they were to be married and inherit their husbands' land. This meant that only male born children were culturally allowed to inherit their parents land.

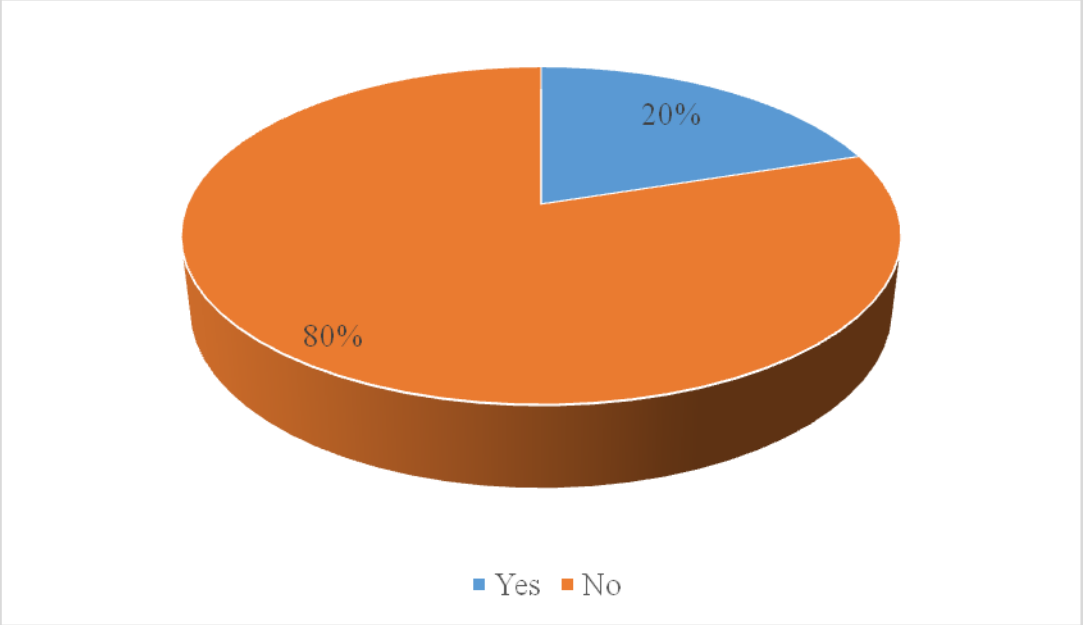
Table 3: Sisters during Land Subdivision for Inheritance

Response	**Frequency**	**Percentage**
Yes	96	96
No	4	4
Total	**100**	**100**

Source: Field Survey, 2018

Out of the 96 percent of the respondents who indicated they had sisters, 80 percent of them noted that their sisters did not inherit their parents land while 20 percent said their sisters inherited land as per Chart 27. They noted that the main reason as to why their sisters did not inherit their parents land was because they would get married and own their husbands' land and there was no way they would own land at both their parents and their husbands place. For the 20 percent who said their sisters inherited their parents land, noted that they were included in the inheritance of the land by their parent's good will.

Chart 27: Female Land Inheritance

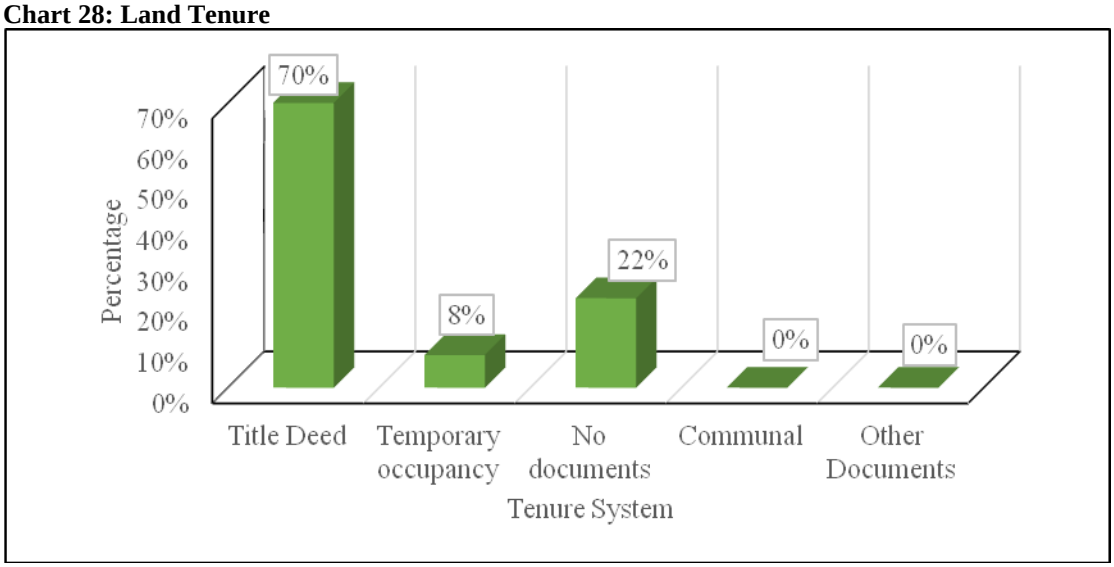


Source: Field Survey, 2018

5.5.3 Status of Household Land Ownership

Tenure system dictated the use of the land in Kathiani sub-location as noted by the 8 percent of the respondents who said that since they had leased their land from other community members they could not use the land the way they wanted but as agreed with the land owners. Although majority of the respondents; that is about 70 percent had title deeds for their lands, 22 percent of them had no documents for their land while 8 percent were temporary occupants. These temporary occupants comprised of those who had leased land for a season or two for purposes of agriculture. They noted that lack of the land documents did not deny them a chance of using their land as they wanted. Therefore, there could not be established a link between land tenure and farm production and hence land use did not necessarily depend on the tenure type.

Chart 28: Land Tenure



Source: Field Survey, 2018

5.5.4 Influence of Land Location on its Value

Through open ended questions and focus group discussions, it was reported that the economic value and location of the land determined how they used their land. They noted that land near the roads and market places had higher economic value as compared to land further away from the roads and it would have a higher economic value if used for commercial purposes rather than agricultural activities. As a result, majority who held land located near roads used it for commercial purposes with a stream of linear shops lining up the road leading to the sub location's only major market. This affected agricultural production due to conversion of land use from agriculture to commercial use.

5.5.5 Size of Parents' Land before Subdivision

Some of the respondents noted that size of their land was determined by the original size of their parents' land. They pointed out that the larger the original size of their parents' land; the larger the portion of land they received after subdivision for inheritance was done.

Table 4: Correlation between Household Size and Family Land Size

Correlations			
		Household size	What is the total family land size in acres
Household size	Pearson Correlation	1	-.089
	Sig. (2-tailed)		.263
	N	175	159
What is the total family land size in acres	Pearson Correlation	-.089	1
	Sig. (2-tailed)	.263	
	N	159	167

Using correlation analysis, there is a negative correlation coefficient of -0.089 indicating that there is inverse relationship between household size and family land size. However, the relationship between the variables is very weak. With sig at 0.263, there is actually no significant relationship between household size and household land size in Kathiani sub-location. It implies that whether the household size is large or small, there are no restrictions on the size of land the family can own hence a small household size can own a large or small land size and vice versa.

Table 5: Correlation between Household Size and Likelihood to Skip Meal

Correlations			
		Household size	Has your family skipped a meal due to food shortage
Household size	Pearson Correlation	1	.016
	Sig. (2-tailed)		.846
	N	175	153
Has your family skipped a meal due to food shortage	Pearson Correlation	.016	1
	Sig. (2-tailed)	.846	
	N	153	159

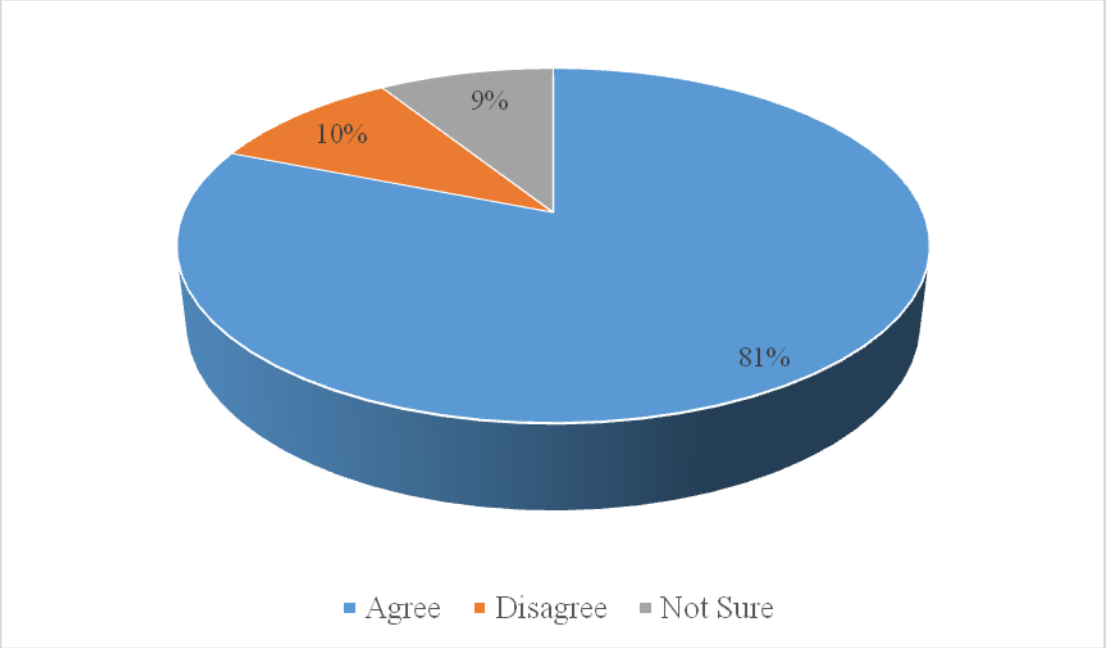
The correlation table 5 above shows a positive correlation of 0.016 between household size and family member skipping a meal. It shows a significant relationship between household size and food security. The larger the household size the higher

the possibility of the household being exposed to food security challenges and the opposite is true.

5.5.6 Population Pressure

Majority of the respondents, around 81 percent, agreed that increase in population leads to increased land subdivision while 10 percent disagreed as per Chart 29. About nine percent of the respondents were not sure whether population pressure resulted to a rise in subdivision of land. Increased land sub-division led to smaller land sizes leading to low agricultural production hence food insecurity. According to focus group discussions and key informant interviews, population growth was attributed to low mortality rates, high life expectancy and influx of both native and non-native migrants who are rapidly buying land within the study area. The influx of migrants was attributed to proximity of the study area to major towns of Nairobi, Machakos and Thika fueled by well-developed infrastructure facilities particularly roads and electricity.

Chart 29: Land Subdivision due to Population Pressure



Source: Field Data 2018

5.5.7 Personal Decision

Through open ended question majority of the respondents stated that it was upon them to decide how to use the land allocated to them. They said that they were not dictated on how to use their land after it had been allocated to them.

The results of this study concur with findings of another study which was done by Kalantari and Abdollahzadeh (2008) on factors affecting agricultural land fragmentation in Ramjerd Sub District in Fars Province of Iran. In the results of their study they asserted that the main factors influencing the size and use of household land in Ramjerd Sub District were; population pressure, the inheritance system where land was subdivided amongst the heirs; economic value of the land and the spreading of climatic and other hazards risks whereby smaller fields were considered to lessen the damage of soil erosion and protect crops in severe climatic conditions.

The findings of this study are also similar to the results of another study which was done by Ahmed *et al.,* (2017) on status and determinants of small farming households' food security and role of market access in enhancing food security in rural Pakistan. The results of their study indicated that family size and the price of land were the main factors determining agricultural land size and use in the rural Pakistan.

Additionally, the findings of this study are similar to findings of another study done on the implications of agricultural land subdivision on productivity by Syagga (2018) in Kajiado County, Kenya. In the findings of his study, he found that the main drivers of agricultural land subdivision in Kajiado County were; agricultural land inheritance practices, individualization of land tenure, price of agricultural land and encroachment of agricultural land by urban areas. Consequently, the continued subdivision of agricultural land as a result of the above factors led to low agricultural production from the farms and also livestock production.

5.6 Intergenerational Transfer of Land Rights and Use

The study sought to find out the main factors influencing the inter-generational land use and rights transfer in Kathiani Sub-location. The factors were ranked according to the number of respondents mentioning it as a consideration for land use and rights transfer in the study area. Table 6 shows the main factors influencing intergenerational land use and land rights transfer in Kathiani Sub-location. Majority of the respondents (92 percent) noted culture as a factor influencing intergenerational land use and land rights transfer in Kathiani Sub-location. This was associated with the fact that only males were supposed to inherit land in the study area. Only a small

proportion of the parents (20 percent) included their daughters in the inheritance of their land. This factor has made majority of the women in the study area lack land transfer rights.

About 82 percent of the respondents mentioned traditional practices whereby people in the study area used their land the way they used it because traditionally the land was being used for the same purpose as a factor influencing intergenerational land use and land rights transfer. They also noted that tradition affected land rights transfer in that in some cases the first-born sons in the study area were allocated large portions of land as compared to the other siblings.

As indicated in Table 6, roughly 22 percent of the respondents indicated presence of a will from the parents in cases where they die before land subdivision as a factor influencing intergenerational land use and land rights transfer in the study area. In some cases, they highlight how the land should be used and subdivided amongst the heirs hence influencing the use and transfer of rights for the land.

Reduction of conflicts amongst the siblings was mentioned by 45 percent of the respondents as a factor influencing intergenerational land rights transfer in the study area as shown in Table 6. They pointed out that parents subdivided their land to the children to avoid conflicts which would arise from the use and size of the land amongst the siblings. Roughly 38 percent of the respondents mentioned marriage as a factor influencing intergenerational land use and land rights transfer in Kathiani Sub-location. They noted that in some cases if a man was not married, he was not allocated land and instead the land was given to the married ones. In other families, if a lady never married, she would be allocated some piece of land by her parents. About 12 percent of the respondents mentioned other factors such as the ancestral influence whereby ancestors dictated the use of specific portions of land before they died.

Table 6: Inter-generational Land Use and Rights Transfer in Kathiani

Issues/Factors	Frequency	Percentage
Culture	92	92
Tradition	82	82
To reduce conflicts	45	45
Marriage	38	38
Presence of a will	22	22
Others	12	12

Source: Field Survey, 2018

The study concurred with findings of a study done by Bird (2011) on land inheritance: a gendered analysis of factors influencing the intergenerational transmission of poverty in developing countries. In the findings of her study, she argues that both men and women should have equitable land ownership and inheritance rights in order to reduce poverty which is brought about by intergenerational transmission of land in the developing countries. She further argues that for developing countries to be food secure, cultural and traditional practices which deter women from inheriting land and enhancing poverty in rural areas in low income developing countries should be addressed through formulation of new policies by policy makers. The findings of this study are also supported by findings of another study done by Lobley, Baker and Whitehead (2010) on some international comparisons of farm succession and retirement in the Unites states. In the finding of their study they found that farms succession in the United States was being influenced by failure to create interest for possible successors, lack of interest by supposed to be successors influenced by inability to foresee a sustainable livelihood based on agriculture by the current generation and failure to plan retirement in advance.

5.7 Hypothesis Testing

The study sought to determine the result to the alternative hypothesis that: Households with large land sizes were relatively food secure as compared to those with small land sizes. Correlation, independent and paired t-tests were conducted to justify or nullify the hypothesis.

Correlation between household land size and duration farm produce lasted a household results are shown in Table 7.

Table 7: Correlation on Land Size and Duration of Produce

		3.3 What is the total family land size in acres	4.7 How long the yield feeds your family
What is the total family land size in acres	Pearson Correlation	1	.057
	Sig. (2-tailed)		.488
	N	167	149
How long the yield feeds your family	Pearson Correlation	.057	1
	Sig. (2-tailed)	.488	
	N	149	160

A Pearson correlation r = 0.057 indicates a marginal, very weak non-significant relationship. These results imply that there is a very small link between household land size and food security. Its interpretation that households with small land sizes have relatively shorter periods of food sufficiency as compared to those with large land sizes who have longer periods of food security is upheld however at very marginal levels. This is true in the study area noting that those with large farm sizes were able to diversify their land uses with even space to plant trees and coffee as cash crops to supplement any food crop shortage in their households. Similarly, those with small land sizes were forced to practice mixed cropping and the produce was bound to be low due to challenges of mono-cropping with no opportunity for diversification in place, hence having to establish alternative mechanisms to support their food insecurity challenges.

Further, in order to validate the Correlation results, independent and paired sample tests were conducted and results presented in Tables 8 and 9.

Table 8: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
What is the total family land size in acres	Equal variances assumed	.	.	-1.638	23	.115	-85.542	52.209	-193.545	22.462
	Equal variances not assumed			.	.	.	-85.542	.	.	.

With variables being the total land size owned by a household and whether the household skipped a meal in the last three months preceding data collection due to lack of food completely, the results showed t = -1.638; p = 0.115 equal variances assumed. Notably, there is a significant negative relationship between the two variables indicating lack of a relationship between them.

Similarly, a paired sample test of the comparison of means between household land sizes and duration farm produce supported a household showed t = -1.713; p = 0.089 as shown in Table 9. These results indicated a significant negative relationship between the variables. We thus accept the null hypothesis that there is no significant relationship between household land sizes and food security. With sig = 0.089 is greater than alpha = 0.05 implying the relationship actually doesn't exist as sig is greater than alpha.

Table 9: Comparison of Means: Land Size Vs Duration Produce Lasts a Household

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	**3.3** What is the total family land size in acres - **4.7** How long the yield feeds your family	-3.185	22.691	1.859	-6.858	.489	-1.713	148	.089

Ideally, what these two tests imply is the fact that there is no significant relationship between household land sizes and food security contrary to the marginal non-significant relationship from the correlation tests. The case is explained by the fact that land sizes in the study area have decreased to non-economical levels and agriculture is practiced majorly to produce food for the household, but however, not relied upon independently to feed the household. Residents were identified as engaging in other non-farm activities including engaging in informal juakali activities in the nearby market center, engaging in casual labor, running small businesses and kiosks along the road and in the market center, obtaining domestic employment from wealthy households, migration to urban centers like Machakos, Thika and Nairobi for formal employment, civil and private sector employment, remittances from children, getting food aid from government and non-governmental organizations among others as observed and reported in focus group discussions and key informant interviews.

CHAPTER SIX

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

6.0 Chapter Overview

This chapter comprises of three sections: Section one entails the summary of the study findings in relation to the objective of the study. Section two contains conclusions on the study findings while the last section provides recommendations as to how to improve food and livelihood security in Kathiani Sub-Location, Machakos County.

6.1 Summary of the Findings

The aim of the study was to assess the current household land size and uses in Kathiani Sub-location, examine the impacts of land size and use on food security in the study area, scrutinize the factors influencing the use and size of household land in Kathiani Sub-location, as well as to profile the factors influencing the intergenerational land use and land rights transfer in the study area.

6.1.1 Household Land Size and Uses in Kathiani Sub-location.

Majority of the households in Kathiani Sub-location own small pieces of land as a result of the continued land subdivision with majority of households owning less than 3 acres of land. Only a small proportion that is, 16 percent of the households owns more than 3 acres of land. The small land sizes have led to low agricultural production although this does not translate to food insecurity in Kathiani due to other factors such as economic activities. Agriculture was reported as the major source of food in the study area, which was a rural setting just as was found by Sen 1962 and Jane et al. 2003 in India and across multiple Sub-Saharan countries. Although majority of the households in the study area used their land for agricultural activities, food production remained low. Other land uses in Kathiani Sub-location include: commercial, educational and residential which supplement agriculture. The findings are in agreement with scholars that productivity of land is not necessarily on the size of the land but rather the intensity and technology used in the food production process (Ackah et al. (undated), Amarea et al. (undated) & Chand et al. (2011)) among others. The findings showed that household land use depended on household size and household land size with the head of the household having a vital role mostly in consultation with the spouse where possible in determining cropping mechanisms.

6.1.2 Impacts of Land Size and Use on Food Security

Majority of the respondents in the study area were in agreement with Sen 1962 and Jane et al. 2003 when they indicated that agriculture was their main economic activity just as it's the main source of food in the rural households. They further noted that agricultural yields in the area had reduced by half as a result of the increased land sub-division which made agricultural land inadequate. Additionally, majority of the respondents (60 percent) noted that the increased land subdivision in the study area had reduced the number of cattle kept in most of the households. The rate of zero grazing is rapidly increasing in Kathiani sub location due to lack of large parcels of land for free range cattle grazing. These findings on rise in zero grazing and decrease in free range livestock management systems agrees with Ramaswamy & Sanders (1992) who reported that a reduction of communal land availability for pastoralism, fallow system breakdown and low crop yields in Sub-Saharan Africa was fueled by population growth. All these have been accelerated by the increased land subdivision in study area.

6.1.3 Factors Influencing Household Land Size

From the findings of this study a number of factors were found to influence the size and use of household land in Kathiani Sub-location. They include; the number of heirs in the household. The higher the number of heirs in the family, the smaller the land sizes were. The smaller the number of heirs per household the large the land sizes were. Gender of the family members also influenced the size of household land in the study area. Households in the study area held to the cultural belief that females should not inherit their parents land since they would get married. As a result, families which had many female siblings, had large pieces of land since the land was not intensively sub-divided as compared to the ones which had many males. All these results seem to concur with scholars' findings who reported demographic factors, household demographics, socio-cultural factors as well as economic factors as determinants of household land size and uses Briassoulis (2009), Bosselman (2012) and Vliet et al. (2015).

The original size of the parent's land size also influenced the size of household land after subdivision. The larger the original size of the parent land, the larger the portions of land subdivided to the siblings and vice versa. Population increase in the study area

had also led to more fragmentation of the land making household land sizes small. This contributed to subdivision of land to meet demands for heirs and immigrants from neighboring areas resulting to population increase which exerted pressure on land as postulated by Kang'ara et al (2001), Menberu (2014), Muyanga & Jayne (2014), Kihima (2017) and Museleku et al. (2018). The use of land in the study area was also dependent on the decision of the household head. Tenure system influenced the way land would be used in the study area. Those who had leased their land, used it as dictated by the owner of the land. Those who had tittle deeds for their land used it the way they wanted without being told how to use it. Additionally, economic value and location of the land such as proximity to market or road or a trading center influenced the way the land would be used. Land close to the roads and market places was used for commercial purposes while the ones further away were used for agricultural purposes.

6.1.4 Intergenerational Transfer of Land Rights and Use

From the data collected and analyzed, the study established several factors influencing the inter-generational land use and land rights transfer in the study area. Key among them includes the tradition and culture of the people of Kathiani Sub-Location where land rights are passed on from parents to siblings (Jayne et al. 2003). Also, they followed the tradition of using their land for the same purpose they found their parents using it.

Marriage was also a key factor influencing the intergenerational land use and land rights transfer in Kathiani sub-location. In most families if a man is not married, he is not allocated land and also if a lady is not married, she is allowed to inherit some portion of her parents' land as per Kamba customs. Also, presence of a will influenced inter-generational land use and land rights transfer in the study area. The land would be used and transferred as per the provisions of the will. Attempts to prevent occurrences of conflicts among the siblings also influence the way land rights would be transferred in the study area.

6.2 Conclusion

Household land size and use influences food security in the study area. As a result of continued land sub-division, households' land portions in Kathiani sub-location are small in size that is, less than 3 acres per household and are used for agricultural purposes. Some of the impacts of land size and use on food and livelihood security in Kathiani Sub-location includes: creation of employment opportunities to the locals, reduction of agricultural yields, and reduction of the number of cattle kept in the study area and increased rate of zero grazing due to lack of large parcels of land for free range grazing in the study area.

Numbers of heirs per household, gender of the family members, tenure system in the study area; economic value and location of the land, original size of the parents' land before subdivision; population increase and personal decision were found to be some of the factors influencing the use and size of household land in Kathiani Sub-location. Inter-generational land use and land rights transfer in Kathiani Sub-location was found to be influenced by; tradition and culture of the people of Kathiani Sub-location; marriage; presence of a will from the parents; and avoidance of conflicts amongst the siblings.

6.3 Recommendations Based on Findings

Based on the findings on the impacts of land size and use on food and livelihood security, the following recommendations are made to address the identified impacts. The recommendations are thereby categorized into two namely; short terms which comprise of recommendations that the farmers are to integrate immediately into their farming practices and secondly, the long-term recommendations which will take longer periods for full implementation**.**

6.3.1 Short-term Recommendations

1. Uncontrolled land subdivision and use needs to be checked to ensure improvement in agricultural yield, which is the main factor in the realisation of food security.
2. Formal education and trainings should be provided to the local communities on; how to apply modern farming technologies, how to add value to their agricultural products, and how to solve some of the challenges they face in the

subsector. This should be done by the County government of Machakos in collaboration with the ministry of agriculture, livestock and fisheries.

3. Improvement of infrastructure that includes roads, electricity, water, health and markets. The lack of these major facilities discourages local communities from engaging on agricultural activities and accessing markets for their agricultural yields as well as agricultural inputs; the facilities will go a long way to improving farming practices in the area which will in turn improve food and livelihood security in the region.
4. The County government should develop marketing channels such as farmers' website and other platforms where they can be advertising their products. This could diversify and expand market for their agricultural products.
5. Diversification of crop farming such as introduction of fruit farming and bee keeping would provide some income to supplement food crops and hence play a role in mitigating food shortage in the household.

6.3.2 Long- term Recommendations

1. Both the national and county governments should put in place clear policy, legal and institutional frameworks to prescribe allowable minimum economical and optimal agricultural land sizes in different ecological zones of the country.
2. Laws guiding subdivision/fragmentation of agricultural land should be observed through enhanced surveillance by the Government of Kenya. Individual titles should have restrictions on the minimum allowable sizes.
3. The government in partnership with other private and civil society organisations should develop strategies to reduce reliance on rain-fed agriculture by encouraging and promoting irrigation farming to mitigate the effects of climate change on food and livelihood security in Kathiani Sub-location in Machakos County.
4. Parents should identify alternative ways of bequeathing wealth to their children rather than land. Such mechanisms would include shares in the stock market and in companies among others or even operate businesses which they can run across generations as the case for Mulleys Supermarket.

6.4 Areas for Further Studies

A comprehensive research should be done to determine the rate of adoption of modern farming technologies in Kathiani sub-location and its implications on food and livelihood security and the environment. Its implications on the amount of food produced, conservation of the land and moisture and its convenience for adoption by the farmers should be the center of the research.

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APPENDIX 1: HOUSEHOLD QUESTIONNAIRE

DECLARATION: Information generated through this questionnaire will be held professionally and will be used solely for research purposes.

Sub-location……..…….…….

Questionnaire No……..….

Name of Interviewer…….…….…….…….…..…

Date of Interview…….…….…….

Telephone No. of Interviewer…….

1.0 Respondent Profile

Tick (√) in the bracket provided, the appropriate answer.

1.1 Name of the respondent (Optional)…….

1.2 How old are you? (Years).....

1.3 Marital status

Married ( ) Single ( ) Widowed ( ) Divorced ( )
Separated ( )

1.4 Gender or respondent

Male ( ) Female ( )

2.0 Household Data

2.1 What is the size of your household? ……..……....

2.2 How many are Sons? …….……

2.3 How many are Daughters? …….……

2.4 What is the number of other males living in your household? ……...

2.5 What is the number of other females living in the household? ……..

2.6 What is the highest education level attained by the household members?

Household members	**Age**	**Education levels**					Occupation
		None	**Pre-primary**	**Primary**	**Secondary**	**Tertiary**	
Father							
Mother							
Son/Daughter							
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

2.7 How many brothers did you have at the time of land inheritance?…….

2.8 Did all of them inherit equal share of your parents' land?.....

2.9 How many sisters did you have at the time of inheriting land?……..

2.10 Did any of them inherit land from your parents?.....

2.11 If yes to 2.10 above, how many acres did each inherit?.....

2.12 What are the cultural practices that influence the use and inheritance of land?.....
.....

.....

.....

3.0 Land holding arrangements

3.1 Do you own land?

Yes ( ) No ( )

3.2 If yes, how many pieces of land do you own?.....

3.3 What is the total family land size in acres?.....

3.4 Owned land characteristics

No.	Spatial Location and distance from home (Km)	Size in Acres	Mode of acquisition	Main use	Tenure System	Ownership document
1						
2						
3						
4						
5						
	Total					

3.5 Do you rent any land? Yes ( ) No ( )

3.6 If the answer to 3.5 is yes, then complete the table below.

No.	Spatial Location and distance from home (km)	Size in acres	Main use	Duration of renting	Cost of renting (annually)
1					
2					
3					
4					
5					
	Total				

3.9 Off-farm income generating activities

Other Source of Income	Frequency	Estimated amount per year (Ksh)

3.10 How big was your parents` land parcel before any sub-division?.....acres

3.11 Has your parents' land parcel ever been subdivided?.....

3.12 (a) If yes to 3.11, what were the reasons for the subdivision……
……
……
……....

(b) If the sub-division was to heirs, how many heirs or beneficiaries? …….…….

3.13 What is your opinion on continued subdivision of land?.....
.....
.....
.....

3.14 What is the reason for your above opinion in 3.13?.....
.....
.....
.....

3.15 State one major problem of land subdivision to a farmer……
……

3.17 In your opinion how much land would be enough for your household in acres?.....

3.18 Explain your reason for the preferred number of acres in 3.17 above……
……..……

4.0 Land Uses, Food and Livelihood Security

4.1 What is the main economic activity that the household head engages in? .....

4.2 Do you practise any agriculture?

Yes ( ) No ( )

4.3 If **Yes to 4.2**, what are the main crop and livestock land use activities on the farm?

Activity	**Area (Acres or Sq. Metres)**	**Yield (kgs) (other) in Seasons**		**Use (Kgs) (Other)**		**Price per unit weight (Min-Maximum)**		**Average income to the family (Kshs.)**
CROPS		**Season 1**	**Season 2**	**Consumed**	**Sold**	**Min**	**Max**	
1								
2								
3								
4								
5								
LIVESTOCK TYPE	**No. Animals**	**Yield/Animal/Year**		**Use (Kgs) (Other)**		**Value (Ksh)**		**Average income to the Family**
				Consumed	**Sold**			
1								
2								
3								
4								
5								

Food and nutrition security

4.4 Compare the yield you get currently in your farm and the yields that used to come from your father's farm before sub-division.

Yields are the same ( ) Currently yields are lower ( )

Yields are more ( ) I`m not sure ( )

4.5 By how much has the yield change? A Quarter ( ) Half ( ) Three Quarters ( )

4.6 What do you think is the reason for the changes in yield?

……

……

……

4.7 For how many months in a year do the current yield from your farm feed your family?.....

4.8 If not 12 months – how many months in a year do you have the following situations

Intensity of scarcity		**Duration of far yield availabili (months)**	**Coping Strategies Employed**
a	Sufficient food	At least 12 Mon	
b	Mild Scarcity	9 Months	
c	Moderate Scarcity	6 Months	
d	Severe Scarcity	3 Months	

4.9 In the last 3 months, has your family ever skipped a meal because of food shortage?

Yes ( ) No ( )

4.10 In a typical week, what are the main food types that your household feeds on?

	Monday	**Tuesday**	**Wednesda**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Morning							
Lunch							
Supper							

4.11 How often do you take the following meals?

Type of Meal/Food	**Frequency of intake (Daily, Weekly, Mont Annually, Other)**
Milk	
Beans	
Chicken	
Fish	
Beef	
Pork	
Mutton	
Goat Meat	
Fruits	

Views on Land Subdivision

Give your opinion or comment on the effect of land sub-division or fragmentation on food security. State whether you agree or disagree with the comment.

4.12 Land fragmentations exists due to population pressure

Agree ( ) Disagree ( ) Not sure ( )

4.13 Small sub-divided parcels lead to low crop yield

Not true ( ) Agree ( ) Disagree ( ) Not sure ( )

4.14 Modern farming techniques can easily be applied on small land sizes

Agree ( ) Disagree ( ) Not sure ( )

4.15 With small land sizes, number of cattle kept has gone down

Agree ( ) Disagree ( ) Not sure ( )

4.16 If you agree in 4.15 above, the change was from how many to how many?.....

4.17 Zero grazing is fast growing as a result of declining land sizes

Agree ( ) Disagree ( ) Not sure ( )

4.18 How can small land sizes be farmed economically?.....

.....

.....

.....

4.19 What farming techniques have farmers adopted in the face of land subdivision?.....

.....

.....

.....

4.20 Do you have any question for us?.....

.....

APPENDIX 2: KEY INFORMANT SCHEDULE

DECLARATION: This interview is meant for research purpose only and the information obtained will remain confidential.

INTERVIEW SCHEDULE: ASSISTANT CHIEF, KATHIANI SUB-LOCATION

Name of respondent……..……...
Gender of respondent……...
Name of interviewer…….
Schedule number…….
Interview Guide Questions

a) What are the main crops grown in Kathiani Sub-location?

b) What is the production per acre, per crop per year?

c) What proportions of the total land is occupied by the listed crops? Indicate crop by crop?

d) Where do the farmers sell their surplus produce?

e) What are the types of livestock reared in the sub-location?

f) What is their average annual production per type of livestock?

g) What is the average family size in Kathiani sub location?

h) Do you receive cases of household food shortages in the sub location?

i) What is the frequency of cases?

j) How do you respond to issues of food shortages in the sub location?

k) Do we have instances of relief food being supplied to households in the sub location?

l) If yes, How often? And for how long?

m) What is the major contributor of insufficient food production in the sub location?

n) What is the average land holding in the sub-location?

o) How are household land parcels organized?

p) Is the mode of settlement/organizing farms a hindrance to productivity?

q) If yes, what is your proposal on a new mode of settlement?

r) Are the average land holdings adequate for sustainable food production?

s) What would you propose to be the ideal/minimum land size required to produce enough food to feed a household till the next harvesting season?

t) How do we achieve and maintain the minimum land size?

APPENDIX 3: SPECIFIC KEY INFORMANTS SCHEDULE

DECLARATION: *Information generated through this questionnaire will be held professionally and will be used solely for research purposes.*

Name of Respondent……..…….....
Occupation of Respondent……..
Gender of Respondent…….....
Age of Respondent……
Name of Interviewer…….
Schedule Number……..

Specific Interview Guide Questions – The very oldest in the sub location

a) When did you first settle in Kathiani sub-location……
……
……..

b) How many acres of land did you settle on……
……..

c) How many acres do you own currently?

Yes ( ) No ( )

d) If No to (c) above, what is your current land size?.....

e) What is the cause of the change to your land/farm size?

f) Were there neighbours with larger farm/land sizes than you?

Yes ( ) No ( )

g) What were the sizes of farms those days?

h) Has there been farm/land size changes since then?

i) What notable changes can you remember?

j) What in your view is the cause of these changes?

k) What was the main crop grown at the time you settled here?

l) What other major crops were grown?

m) What determined the kind of crop one planted?

n) Are there notable cropping changes over time?

o) If Yes to (n) above, what changes in cropping have happened since then?

p) What was the level of productivity per acre then?

q) Are there notable productivity changes over time?

r) If Yes to (o) above, what changes in productivity have happened since then? Decrease, Increase?

s) What do you think occasioned these changes?

t) Do you have any question for us?

APPENDIX 4: FOCUS GROUP DISCUSSION GUIDE

Focus Group: Consent details

Thank you for accepting to participate. We are interested to hear your valuable ideas, facts and opinions on how population growth has affected your land sizes and land use decisions in relationship to food and livelihood security and so be able to provide policy recommendations and viable solutions to the county and national governments and national land management agencies.

- *The purpose of the study is to examine the impacts of household land size and use on household food and livelihood security. We hope to learn things that*
- *can help come up with solutions to land management and enhance sustainable food and livelihood security once implemented.*
- *The information you give us is completely confidential and your name shall not be associated with anything you say in the discussions. We understand how important it is to keep the information private. We will ask all participants to keep the information very confidential.*
- *You may refuse to answer any question or withdraw from the discussions at any time*
- *We may have to tape the discussions so as to be able to capture the thoughts, ideas and opinions we hear from the group*

Record of FGD participants

No.	Name	Age (Years)	Gender	Marital status	Land owned (in acres)	Signature
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Discussion Guiding Questions

a) When did you settle in the sub-location and where did you migrate from?
b) What are the reasons for settling in the sub-location?
c) How did you acquire the land you reside on?
d) What was the original size of the farm land?
e) What kind of crops did you grow and what types of livestock did you keep when you first settled in the area?
f) Have there been changes in the types of crops grown and types of livestock reared?
g) What kind of crops do you currently grow? What's the average acreage per crop?
h) What is the total production per harvest season? Is it adequate for your household? How long does it last?
i) And how come you settled to plant the crops you plant as opposed to the other crops?
j) What type and number of livestock do you currently keep?
k) What are the reasons for these changes?
l) Have the land/farm size you reside on changed overtime? What is the current land size? What brought about these changes?
m) Are there other land parcels owned by your household apart from the one you reside on? How many parcels? What is the average distance of location from the homestead? What kind of farm activities are undertaken in these other farms?
n) Has farm productivity been changing over time? Why is it so?
o) Do you own the land parcels you occupy? Any ownership documents?
p) Is productivity dependent on ownership of land?
q) What is the settlement pattern in your homestead? Does it affect the available space for farming?
r) How much land would you say is adequate for you to produce enough food to last you till the next harvest season?
s) How do we achieve and maintain that adequate land both for the current and future generations?

APPENDIX 5: OBSERVATION CHECKLIST

The following will be observed during the field survey:

i. Land sizes
ii. Settlement patterns
    - Linear
    - Clustered
    - scattered
iii. Housing structures
    - Type of structure
    - Number of structures
    - Arrangement of the structures
iv. Field crops
    - Type of crops
    - Area allocated for each crop
    - Condition of the crops
v. Livestock kept
    - Type of livestock
    - Number of each type
vi. Demarcations of farm sizes
    - Physical or imaginary boundaries
vii. Accessibility of the farms
    - Road sizes
    - Road conditions

APPENDIX 6: PHOTOGRAPHY CHECKLIST

The photographs of the following items shall be captured during the field survey:

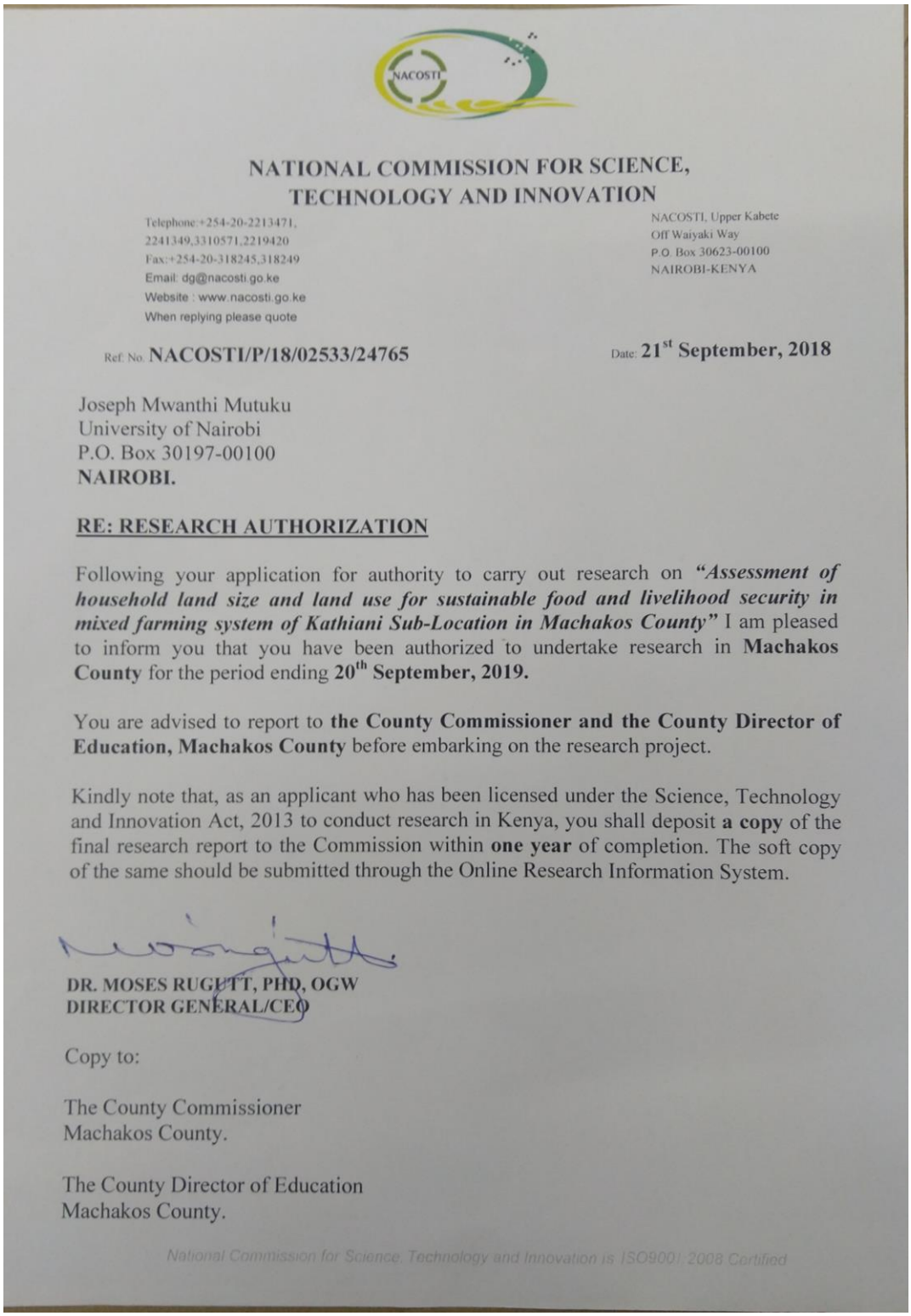
i. House structures
ii. Cultivated farms
iii. Uncultivated farms
iv. Demarcations of farms
v. Cases of malnourished individuals, if any

APPENDIX 7: DOCUMENT REVIEW GUIDE

The following documents shall be reviewed

i. Satellite images in time intervals of 10 years beginning 1954 to document the historical changes in land size and use in the sub-location since 1954
ii. Hospital/dispensary/clinic record sheets on dietary related diseases such as marasmus, kwashiorkor and malnourishment

APPENDIX 8: NACOSTI APPROVAL



NATIONAL COMMISSION FOR SCIENCE,
TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

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

Ref: No. **NACOSTI/P/18/02533/24765**

Date: **21st September, 2018**

Joseph Mwanthi Mutuku
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Assessment of household land size and land use for sustainable food and livelihood security in mixed farming system of Kathiani Sub-Location in Machakos County"*** I am pleased to inform you that you have been authorized to undertake research in **Machakos County** for the period ending **20th September, 2019.**

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

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

DR. MOSES RUGUTT, PHD, OGW
DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Machakos County.

The County Director of Education
Machakos County.

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