ASSESSMENT OF HOUSEHOLD LAND SIZE AND USE FOR SUSTAINABLE FOOD AND LIVELIHOOD SECURITY IN THE IRRIGATED RICE FARMING SYSTEM OF KIRATINA SUB LOCATION IN KIRINYAGA COUNTY

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Declaration

I, **Harrison Kioko Simon**, do hereby declare that to the best of my knowledge, this is my own original work that has not been published elsewhere.

Name: …….

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Abstract

Globally, food and livelihood insecurity have persisted for decades, especially in developing countries like Kenya. This is attributed to multiple factors that vary from place to place. This study focused on the most densely populated irrigated rice farming system of Kiratina Sub-location, Kirinyaga County. Its aim was to determine how household land size and use affect food and livelihood security, profile the factors that determine household land size and use and interrogate the land rights and use transfer across generations. The study adopted a cross-sectional survey design. A stratified proportionate random sampling method was applied in each of the thirteen villages leading to selections of 206 household respondents. Interviews, observations, focus group discussions and photography were conducted. The study found that the sub-location's household land size ranged from zero to ten acres with an average of 1.48 acres. Agriculture was the main economic activity employing 79% of household head. Every household practiced some form of agriculture. Rice farming was the main land use taking up 91% of the land while human settlement, and other forms of land uses took 9%. The study established a significant difference between household land size for those with severe food insecurity and households that were fully food secure with $t=2.952$; $p = 004$. There was no significant difference between household land size for mild and moderate food secure households and households that were fully food secure with $t=1.444$; $p=0.152$ and $t= -0.426$; $p=0.671$ respectively. In 69% of the households, land inheritance to an average of four heirs was the leading contributor to land subdivision. Land subdivision contributed to the reduction in farm size and total farm yields in 87% of the households. Production was influenced by factors related to farm inputs, household size, rice variety and farm maintenance. Population growth, human settlement and cultural factors of land inheritance, which accounted for 71.8% change in average household land size from 3.9 to 1.1 acres within a generation, affected land use. On farm-based food security lasted a farming household on average eight and half months. The regulation to produce rice only threatens nutritional security. Introduction of legume or livestock enterprises can improve the nutritional security. Adoption of an ideal household land size was recommended at a minimum of 2 acres. Intensification of rice production through use of high yielding varieties and high-rise cluster settlement pattern were recommended as interventions for addressing household food security challenges in Kiratina sub-location.

Dedication

This work is a special dedication to my family, parents and siblings, and to people, county governments and all organizations of goodwill with interest in providing land-oriented solutions to the progress of all.

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Acronyms

AGRA	Alliance for a Green Revolution in Africa
CFS	Committee on Food Security
CIDP	County Integrated Development Plan
ECA	Economic Commission for Africa
FAO	Food and Agriculture Organization
FGD	Focus Group Discussions
GDCK	Germany Development Cooperation in Kenya
GDP	Gross Development Product
GoK/GOK	Government of Kenya
KCIDP	Kirinyaga County Integrated Development Plan
KER	Kenya Economic Report
KFSS	Kenya Food Security Steering Group
KIHBS	Kenya Integrated Household Budget Survey
KIPPRA	Kenya Institute of Public Policy Review
KNBS	Kenya National Bureau of Statistics
MoA	Ministry of Agriculture
MRIS	Mwea Rice Irrigation Scheme
NIB	National Irrigation Board
NRDS	National Rice Development Strategy
PRB	Population Reference Bureau
SSA	Sub Saharan Africa
SRI	Systems for Rice Intensification
WFP	World Food Program

CHAPTER ONE

INTRODUCTION

1.0 Importance of Agriculture in Kenya

Agriculture sector is the mainstay of Kenya's economy. It is the driver of the country with a contribution of 26.5 percent in 2016 and 25 percent in quarter one of 2017 to the country's Gross Domestic Product (GDP). The Kenya Economic Report (KER) 2017 by Kenya Institute for Public Policy Research and Analysis (KIPPRA), the sector's share of GDP increased in 2016 to 32.6 percent from 30.4 percent in 2015.

Deloitte and Touch on a similar report argues that as of 2016, the sector contributed over 26 percent to the country's GDP. Generally, on average, the sector has for the past three years consistently contributed over 25 percent to the country's GDP. In addition, it indirectly contributes about 27 percent to GDP through linkages with manufacturing, distribution and other service-related sectors.

The sector is also a source of livelihoods and employment for Kenyans an estimated over 75 percent of the citizens depending on it, fully or in part time, for their livelihoods. The sector employs over 60 percent of Kenyans with 80 percent of the rural people deriving their livelihoods from agriculture related activities. It is the source of 75 percent of the country's industrial raw materials and according to Food and Agricultural Organization (FAO) more than 65 percent of the governments export earnings.

The government earns over 45 percent of her revenue from the sector making it the single largest contributor to the economy's growth and development. According to Kenya National Bureau of Statistics (KNBS), the agriculture sector growth rate of its contribution to the country's GDP has been growing since 2012, from a low of 2.8 percent in 2012 to 4.4 percent in 2016. Agriculture, whether domestic or international, is the only source of food both for direct consumption and as raw materials for refined and packaged foods (FAO, 2005; Marani, 2012 and Bremner, 2012.

Trend analysis over the years indicate that growth in agriculture contribution rates to the GDP results to a proportionate growth in the overall GDP. This rubberstamps the authority the sector has as the backbone of the country's economy. It is therefore established as the pillar to reckon with for the overall development of the country and

the economy as a whole. Additionally, a report on Kenya's Agricultural Policy and Sector Performance: 1963-96, it shows that the sector contribution to the GDP decreased from 35 percent in 1963 to 25 percent in 1996. This contribution has since stagnated over the years succeeding 1996 and at times going down to even 24 percent. It implies that, the sector performance has been dwindling and as such directly or indirectly affected the overall economic growth. This is a cause for alarm as development is threatened when the economic giant isn't performing.

1.1 Importance of Agriculture in Kirinyaga County

Agriculture is the driver of the county's economy and the major source of occupation. According to State of the Counties report by Nation media group, 80 percent of Kirinyaga people directly or indirectly rely on agriculture to sustain their livelihoods. The 2013 KCIDP reports that 87 percent of Kirinyaga's total population derive their livelihood from agriculture which accounts for 72 percent of household income.

Data from KNBS shows that 40 percent of Kirinyaga county residents are directly employed in agriculture (KNBS and SID, 2013). GoK, 2014 findings show that at least 46 percent of household heads (see Table 1 below) in Kirinyaga county are employed in crop and/or livestock farming with an additional 1.4 percent employed as farm laborer in other farms and another 0.3 percent occupied in livestock and livestock product trading. This implies that agriculture is the mainstay economic activity of the county. It is the main source of household food and provides raw materials for agro-based industries GoK, (2014). Kirinyaga County is home to Kenya's leading rice irrigation scheme, the Mwea irrigation scheme.

Rice, currently grown in paddies, is the dominant crop with tea, coffee, bananas, tomatoes, beans, mangoes, maize and horticultural activities, especially fruits and vegetables being the other major crops grown in the area (KCIDP, 2013, Daily Nation February 3, 2018). Mostly, these are staple and cash crop foods that earn the residents a living. According to GoK, (2014), the county earned Kshs. 5.7B as income from agriculture with rice and sweet potato contributing 55 percent of the total income earnings. Agro-processing industries such as rice mills, tea and coffee factories, dairy and fish processing factories are some of the major sources of employment to residents of the county. Besides, livestock keeping of beef and dairy cattle, sheep and goats,

poultry and rabbits as well as fish farming is practiced and is a source of livelihood to the county residents (GoK, 2014; Kenya Information Guide, 2015).

Table 1: Primary Occupation of Household Head

	Proportion (percent) of household heads (by gender) engaging in type of occupation			
Type of occupation	**Male adult (n=169)**	**Female adult (n=58)**	**Youth (n=15)**	**Total (n=242)**
Crop and/or livestock farming	53.1	63.4	23.2	46.4
Formal salaried employment	21.9	7.3	23.2	20.6
Self-employed business-trade/services	15.4	12.2	32.6	19.5
Other occupations	4.4	14.6	18.9	9.3
Old/Retired /Pensioner	3.9	0.0	0.0	2.5
Farm laborer in other farms	0.9	2.4	2.1	1.4
Livestock and livestock product trading	0.4	0.0	0.0	0.3
Total	100.0	100.0	100.0	100.0

Source: GoK, 2014

1.2 Food and Livelihood Status in Kirinyaga County

Kirinyaga County boasts of 116,980 Ha arable land which is 79 percent of the county's total land size (CIDP, 2013). Further, average farm size of 5.2ha for large scale farms and 1ha for small scale ones (CIDP, 2013). According to a study by Mugambi et al. 2016 on Mother's and Households' food security status in Kangai and Mutithi locations of Mwea West Sub county, 40 percent of the households were severely food insecure with 21percent others being moderately food insecure and 39 percent were found to be food secure. Wakibi et al. (2015) reports Kirinyaga County as the most food secure county in Kenya at 95 percent food security score attributed to its agro-ecological location in the upper highlands and not so very much fragmented farm lands as in most upper midland zones of Kisii County. Despite declining farm sizes owing to population increase and land fragmentation for inheritance, (KCIDP, 2013), the county is the leading producer of rice, producing over 50 percent of total rice produced in Kenya,

and sweet potatoes as well as other major food crops (Kenya Information Guide, 2015; GoK, 2014; KCIDP, 2013). The rice is produced as a cash and food crop to supplement farm incomes from other cash and food crops grown in the county.

1.3 Statement of the Research Problem

Over the last decade, Kenya has been struggling with food production to meet the food demands of her growing population. Population projections estimate that the country has over 45 million people to feed and provide sufficient food and nutrition for her citizens (KNBS, 2009). A report by published Tegemeo Institute on Trends in Kenyan Agricultural Productivity: 1997–2007 concludes that the mean land owned per household has declined in the past decade due to the increasing population and land fragmentation. The report notes that per capita cultivated land has slightly declined posing a threat to food security and rural livelihoods especially in the densely populated areas (Kibaara et al. 2009).

Kirinyaga County population has been increasing over time. According to the Kirinyaga County Integrated Development Plan (KCIDP), the County's population as per 2009 census stood at 528,054 and was projected to reach 595,379 by 2017. This is a 13 percent increase. It is not clear how household land size, land use and productivity changed within the same time frame. The farm sizes have been declining as a result of land subdivision for inheritance (KCIDP, 2013). The county mean household land size was estimated at 1.0 ha (2.5 acres). However, there is no indication as to what land size would be optimal to sustain a household with food, nutrition and livelihoods under different farming systems. Mugambi et al. (2016) have provided evidence that households are becoming more vulnerable to food insecurity with 61 percent of the investigated households of Mwea West Sub-county indicating that they were at risk of food insecurity. However, the study did not stipulate the root cause of the problem.

Rice, a food crop, is globally one of the key food crops in the fight against hunger, and in Kenya it is the third most important food crop after maize and wheat. Although rice production in the country has been on the increase, the difference is attributed to the increase in the area under rice cultivation. A report by the Ministry of Agriculture (MoA) on National Rice Development Strategy (NRDS) (2008-2018) shows that the average yield per hectare has been on the decline from a high of 3.4 tons in 2003 to 2.8 tons in 2008 (17.7percent). However, the cause of this decline has not been

documented. Additionally, rice production is 80 percent dominated by irrigated government schemes and only a paltry 20 percent by subsistence farmers who completely rely on rain-fed production that register very low yields.

There exists an information gap in the documentation of information in the county regarding the household land sizes that would be sufficient for food crops such as maize, rice, beans, peas and others for sustainable food and livelihood security. Additionally, the level of land fragmentation and its relationship with food and nutrition security and the relationship between land size and food security is also missing. This study seeks to establish the relationship between the declining farm sizes, changing land use and their impacts on household food and livelihood security. It also seeks to interrogate the intergenerational land transfers and its inherent threat to food and nutrition security as there not an iota of information regarding this. This will aid in informed decision formulations and policy recommendations on land use, subdivision, intergenerational land transfer as they impact on food, nutrition and livelihood security.

1.4 Research Questions

The study sought to answer the following questions:

a. What are the current household land sizes and uses in Kiratina Sub-location, Mwea Rice Irrigation Scheme?
b. How does household land size and use affect food and livelihood security in Kiratina Sub-location Mwea Rice Irrigation Scheme?
c. What factors determine the size and use of household land inKiratina Sub-location, Mwea Rice Irrigation Scheme?
d. How has land changed ownership since establishment of Kiratina Sub-location, Mwea Rice Irrigation Scheme?
e. What planning interventions can ensure sustainable food and livelihood security of farming households in Kiratina Sub-location, Mwea Rice Irrigation Scheme?

1.5 Objectives of the Study

The objectives of this study were to:

a. Examine the current household land size and its impact on food and livelihood security in Kiratina Sub-location, Mwea Rice Irrigation Scheme.
b. Establish the current land uses and their impact on food and livelihood security in Kiratina Sub-location.
c. Analyze the factors that influence the size and use of household land in Kiratina Sub-location.
d. Interrogate the inter-generational transmission of land rights and land use in Kiratina Sub-location.
e. Recommend planning interventions that can create a sustainable household land size, food, and livelihood security in Kiratina Sub-location.

1.6 The Study Hypotheses

The study hypothesis is as follows: -

H_o: Households that are food secure have significantly larger land sizes than households that are food insecure.

H_a: Households that are food secure do not have significantly larger land sizes than households that are food insecure.

1.7 Geographical and Theoretical Scope

The geographical coverage of the study will be the most densely populated rural sub-location in Mwea Rice Irrigation Scheme. It will focus on the relationship between land size, land fragmentation, land uses and land tenure on food and livelihood security. Kiratina Sub-location is thus the study area as it is the most densely populated rice farming sub-location in a rural Mwea Sub-county, Kirinyaga County as in Table 2 below.

Table 2: Mwea Division Population Density

	Male	Female	Total	Households	Area in Sq. Km	Density
KIRINYAGA	260,630	267,424	528,054	154,220	1,479.1	357
MWEA DIVISION	88,809	87,452	176,261	51,444	516.7	341
MUTITHI LOCATION	13,554	13,310	26,864	7,607	106.8	252
RUKANGA SUB-LOCATION	3,039	2,860	5,899	1,407	35.0	169
KABIRIRI SUB-LOCATION	4,392	4,309	8,701	2,578	38.9	224
KIANDEGWA SUB-LOCATION	2,856	2,763	5,619	1,724	13.7	411
KINYAGA SUB-LOCATION	3,267	3,378	6,645	1,898	19.3	345
THIBA LOCATION	**20,488**	**20,612**	**41,100**	**12,041**	**96.0**	**428**
NGUKA SUB-LOCATION	5,412	5,656	11,068	3,150	17.3	640
KIRATINA SUB-LOCATION	**6,092**	**6,059**	**12,151**	**3,759**	**16.7**	**726**
WAMUMU SUB-LOCATION	8,984	8,897	17,881	5,132	62.0	289
NYANGATI LOCATION	7,700	8,131	15,831	4,721	33.6	471
NYANGATI SUB-LOCATION	3,936	4,358	8,294	2,489	17.1	485
KIRIMARA SUB-LOCATION	1,244	1,227	2,471	711	9.3	265
MATHANGAUTA SUB-LOCATION	2,520	2,546	5,066	1,521	7.2	701
TEBERE LOCATION	22,579	22,337	44,916	13,843	82.8	542
MURINDUKO LOCATION	14,851	13,399	28,250	7,930	158.8	178
KANGAI LOCATION	9,637	9,663	19,300	5,302	38.8	498

Source: KNBS, 2010

1.8 Justification of the Study

The study is justified on the premise that food insecurity has been most prevalent issue in our country. The most important thing to note is the fact that when a nation is unable to feed her citizens, it cannot implement development projects. The world most stable economies have solved food insecurity challenges once for all. A hungry man can deliver nothing at the place of work, being malnourished hinders that capacity for reasoning, innovation and performance. Deaths arising from food insecurity, loss of livestock due to lack of feedstock for domesticated animals, and lack of the purchasing power to afford an ever-rising price of food items is a worrying trend that deserves a relook on the basics for food production, which if well-handled will resort to sufficient food for the entire country. As such, it is highly justified to study if indeed household land fragmentation, land subdivision and use allocation is a major factor contributing to food insecurity in the country.

1.9 Significance of the Study

The outcome of the findings will be paramount for adoption as foundations to the solutions of food insecurity in the country, particularly in the rural areas, highly dominated by dense populations of the poor in our society where majority live below a dollar a day.

The study objectives are significant in ensuring the right solutions and data are obtained that if implemented will solve food insecurity challenges in the country. The findings will inform land management agencies and the national government on policy formulations and implementations to ensure food and livelihood security and land management are checked and envisaged in law.

The results will provide basis for informed decisions by the county government and other development agencies on necessary project implementations and actions to achieve sustainable food and livelihood security.

1.10 Limitations of the Study

The study was conducted against constraints of time and finances. Otherwise, with much time and sufficient financial resources, the study would be carried out in the entire rural areas of the country, Kenya.

1.11 Project Structure

The project envisaged to respond to the objectives by adopting chronologically the following format: -Abstract, Introduction, literature review, research methodology, results/findings, discussion of findings, recommendations and conclusions.

Abstract provides an overview of the entire project. The introduction provided a background of the study, the statement of the study problem detailed the information gap, the research questions and objectives, the research hypothesis, justification and significance of the study, the theoretical and geographical scope of the study as well as limitations of the study.

The literature review comprised of a detailed evaluation of previous research in the study area and elaborated on the knowledge gap that was completed by carrying out the study. The research methodology profiled the research design adopted, data collection

methods and instruments, data analysis tools and methods and the data presentation techniques used for the study findings.

The results/findings of the study composed of an outline of the primary data collected from the field in relation to the research questions and hypothesis, often provided in figures, tables and graphs. The discussion of findings detailed comments of the results, their meanings and interpretations in a wider context together with explanations for unexpected outcomes. The recommendations were useful in answering the objectives of the study and was informed by outcomes of the field data and the discussions thereof. The conclusions emphasized on meeting the aims of the study by elaborating the most significant achievement of the objectives, noted the limitations to the study, suggestions for further research and provide future directions.

1.12 Definition of Terms

Key terms identified were defined as follows

a. Land fragmentation

There are several definitions of land fragmentation. According to Oxford Dictionary, fragmentation refers to the process or state of breaking or being broken into fragments (portions). van Dijk (2003) in Kiplimo L.B. &Ngeno V. (2016) distinguished four dimensions under which land fragmentations can be defined: fragmentation in ownership; number of users (or size of use-units); internal fragmentation and fragmentation due to overlap of ownership and use. Obonyo V., Otieno C., &Ang'awa F. (2016) define land fragmentation as the practice of farming a number of spatially separated plots of owned or rented land by the same farmer and can be seen as common phenomenon in many developing countries. In the context of this study, we adopt Dovring et al. (1960) in Karagwa M. (2010) who regard land fragmentation as the division of land into a great number of distinct plots.

b. Food security

For the sake of this study, food security shall be defined as the availability and adequate access by people at all times to sufficient, safe, nutritious food to maintain a healthy and active life (World Food Program, 2018)). In this context, WFP identifies food availability, access to food and the utilization of food as the basic key elements that can be used to determine if one is food secure or otherwise. Food and Agricultural

Organization (FAO) on The State of Food Insecurity (2001) refined the definition of Food Security to mean that, “Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”. It is this definition by FAO that was also adopted by Kenya Food Security Steering (KFSS) Group, 2008 when they launched a report on food security status in the country. These two definitions by world agencies concerned with food security form the foundation under which the term shall be used for the purpose of this study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The chapter reviews secondary documents and literary materials on the study topic. It provides a brief overview on food and livelihood security. It further details literature review on the impacts of land size on food and livelihood security, impacts of household land use on food and livelihood security, factors that determine household land size and use, intergenerational transmission of land rights, possible planning interventions for sustainable food, nutrition and livelihood security. The chapter concludes with a theoretical and conceptual framework and a brief synthesis of the studies reviewed.

2.1 Food and Livelihood Security

Food security is a broad concept that includes issues related to the nature, quality, food access and security of food supply (Iram and Butt, 2004). Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (CFS, 2012). The definition provides availability, access and utilization of food as the main dimensions of food security. Lack of these three aspects either by a way of farm produce or market purchase results into food insecurity (Wambua, 2013). Upon conducting a study on the factors influencing food security in Bungoma County, Michael, (2015) concluded that food prices, subsistence/smallholder agricultural production, use of farm inputs, availability of agriculture extension and agriculture research and development are the key factors that determined food security.

A household is food secure when it has access to the food needed for a healthy life for all its members (adequate in terms of quality, quantity, and safety and culturally acceptable) and when it is not at undue risk of losing such access (Bajagai, Undated). Bajagai further notes that households that are food insecure are characterized by: Members of household (mainly adult) worried that their food would run out before they got money to buy more; Food they bought just didn't last and they didn't have money to get more; They couldn't afford to eat balanced meals, have to rely on inexpensive non-nutritious food; An adult had to cut the size of meals or skipped meals because there was not enough money for food; They had to eat less than they felt they should

because there was not enough money for food; They had been hungry but did not eat because they could not afford enough food; They had to acquire food through socially unacceptable means such as charitable assistance, buying food on credit etc. (Ibid).

A livelihood is the means by which a person or household makes a living over time, Concern Worldwide, (2004). Chambers and Conway, 1992:7 observe that livelihood comprises people, their capabilities and their means of living, including food, income and assets. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base. Following the definition, it is noted that a sustainable natural resource base is critical for livelihood security. A sustainable livelihood is achieved when these assets combine both the tangible productive assets associated with economic analyses (e.g. land, labor, capital, and stocks) and the intangible assets more familiar to sociological and anthropological enquiry (e.g. social capital, health and educational status) (Kauti, 2009).

As seen above, it can be deduced that land, a major component of natural resources, is at the center of food and livelihood security. This paper examines the implications of land size and use on food and livelihood security.

2.2 The Impacts of Land Size on Food and Livelihood Security

Gurung, et al (2016) noted that a farmer's landholding size was the most important indicator of well-being in a contemporary rural livelihood. Their findings on transformation from rice farming to commercial aquaculture in Bangladesh revealed that relatively larger farm sizes generated sufficient food and farm income, securing food and livelihood security for the households throughout the year as opposed to the households with smaller farm sizes.

There exists an inverse relationship between farm holding size and productivity, Saini, (1971). Lerman and Sutton, (2006) agree with Saini, (1971) that small farms achieve higher efficiency and productivity as opposed to larger corporate farms. wa Githinji, (2011) implies that there exists an inverse relationship between land size and productivity.

A study on Land fragmentation and farm productivity in China in the 1990s undertaken by Nguyen, et al. 1996 found that fragmentation does have an economic cost in China

and ended up proposing consolidation of land to enhance farm productivity. Babatunde et al (2008) gender-based analysis of vulnerability to food insecurity in Nigeria found that increase in farm size and crop output reduces vulnerability to food insecurity in male headed households.

Chauvin et al. 2012 postulate that Sub-Saharan Africa (SSA) has the necessary fertile land and labor to be food self-sufficient. The available land in East Africa is overly subdivided into small and uneconomic units, resulting generally in fragmented production systems and low productivity and hence a recipe for food and livelihood insecurity (Salami et al. 2010).

A study conducted in five Sahel countries by Jayne et al. (2003) on small holder income and land distribution in Africa: implications for poverty reduction strategies found that there are strong correlations between landholding size, education levels, and income, indicating that most households with small landholdings have limited potential to break out of poverty through high-return off-farm activities. This indicates the pivotal role of landholdings to food and livelihood security. They further report that off-farm income shares are highest for the bottom land quartile and decline as landholding size rises indicating the key role of farm sizes as source of livelihoods for rural dwellers (Ibid). This is affirmed in their conclusions that a very small incremental addition to land access is associated with a large relative rise in income.

Kiplimo B. and Ngeno V. (2016) point out that Sub-Saharan Africa's major concern is the declining farm sizes in both ownership and use which ideally implies dis-economies of scale in food production. Dixon et al. (2001) noted that increased operated farm or herd size, either through consolidation of existing holdings or the extension of farming onto new agricultural land was a reliable option contributing to household food and livelihood security and poverty eradication.

In their study on understanding the effect of land fragmentation on farm level efficiency: an application of quantile regression-based thick frontier approach to maize production in Kenya, (Kiplimo and Ngeno, 2016) found that there was a close correlation between the total mean land holding, average scale of production and the resulting average output of farmers within the four quartiles and they concluded that continuous decline in farm size was likely to negatively impact on farm level efficiency especially food production.

Alemu et al. (2017) on Effects of Land Fragmentation on Productivity in Northwestern Ethiopia asserts that land fragmentation overall effects, of reducing farm land sizes, on productivity and net farm income undermines livelihood prospects of small holder farmers insinuating that livelihoods are largely dependent on land productivity and farm net incomes for which their increase or decrease affects the overall food and livelihood security of the household.

Agriculture remains the most important economic activity in Kenya, although less than 8 percent of the land is used for crop and feed production (Chauvin et al., 2012). This indicates that land is one of the essential factors in the achievement of food and livelihood security. Chauvin et al, further observes that, farming in Kenya is typically carried out by small producers who usually cultivate no more than two hectares (about five acres) using limited technology (Ibid). This argument is supported by Germany Development Cooperation in Kenya, (2017) which notes that Kenya's agricultural sector is dominated by smallholder farming systems, with 75 percent of national food production being primarily for household level subsistence. This is an indication that the country is largely dependent on small farm sizes for her food and livelihood sustenance.

According to GOK. (2010), Kenya's arable land has been subdivided into very small sizes that are becoming uneconomical for farm enterprises. This implies that small land sizes are a challenge to food production and hence a contributing factor to food and livelihood insecurity especially in the rural areas. A study conducted in 88 villages spanning five districts of maize-legume systems in Kenya by Kassie et al. (2012) concluded that the probability of being food secure and food expenditures increase with farm size and level of education. They concluded that food security increases depending on the quality of extension workers; quality of land and farm size. Obonyo et al. (2016) study findings concluded that small land acreages arising from fragmentation, leads to low yields in terms of food and livestock productivity and hence household food insecurity as the produce could not sustain households throughout until the next harvest.

Ravallion, (1997) in Jayne et al. (2003) argues that where access to land is highly concentrated and where a sizable part of the rural population lacks sufficient land or education to earn a livelihood, then special measures will be necessary to tackle the problem of persistent poverty. This supports the argument that household land size is a

key determinant to food security since poverty is associated with the inability to service basic needs comfortably. Khan and Gill, (2009) found that food availability requires the increased production of crops and livestock products. They reported that marginalization of land contributes negatively to food accessibility which is a determinant factor of food security.

Ogechi and Hunja, (2012) observed that agricultural land fragmentation, increase in population and urbanization results to a decrease in agricultural land and food production leaving the rural livelihoods food insecure. A study by Tittonell, (2007) showed that farmers who had relatively larger farm sizes had longer periods of food security as compared to them that had smaller farm sizes. They pointed out that households which had achieved 12 months food self-sufficiency owned almost twice the area of land owned by the food insecure households.

Bogale and Shimelis, (2009) support the findings by reporting that cultivated land size influences on household food security. They enunciate that households with larger farm size have less risk of being food insecure due to better chances to produce more, diversify the crops and also larger volume of crop residues. According to Santiphop, et al. (2012), a farmer's motivation to grow a certain type of crop is highly dependent on land ownership type and the size of landholding size with the focus of feeding their households being prioritized.

A study on factors influencing pastoral and agro-pastoral household vulnerability to food insecurity in the dry lands of Kenya: a case study of Kajiado and Makueni counties conducted by Amwata et al. (2016) found that land size had positive and significant influence on household food security. They posit that households with larger landholdings were more likely to be food secure because of more farm production with all other factors holding constant. Muraya's, (2017) findings show that farm sizes among other variables were statistically significant determinants of aggregate agricultural output; thus, agricultural productivity was depended on the farm size.

Mwavali, (2009) analysis of findings indicate that declining agricultural production in Vihiga District was as a result of land fragmentation which contributed to household's socio-economic effects of food insecurity, reduced income and increased disputes with neighbors. Mbuthia et al. (2017) study on household food security in Kitui County shows that farm size was a key determinant of household food security. She argues that

households with large farm sizes were food secure as they had access to food throughout the year as opposed to them that had small farm sizes whose harvest would last but a few months. She points out that despite the key role played by land on household food security, continuous land fragmentation has reduced land size beyond reasonable sizes that can sustain agricultural productivity (Ibid).

Upon conducting a study on the impact of land fragmentation/Segmentation on production and food security the case of three major regions in Kenya, Musambayi, (2013) findings show a significant relationship between land fragmentation and food security owing to the fact that uncontrolled subdivision of agricultural land results to reduced productivity.

2.3 Impacts of Household Land Use on Food and Livelihood Security

Land plays a crucial role in agricultural development for developing countries. It has direct impact on the livelihoods of farmers, income generation and poverty situations in rural economies, Vixathep et al. (2013). Food security depends on the land resources available to the household or community and their ability to mobilize resources for the production and/or distribution of food to achieve an active and healthy life (ECA, U. 2004). The optimal allocation of land use is an activity to improve the efficiency of land use types by specifying the appropriate use of land (Zhang et al. 2012).

Pitakpongjaroen and Wiboonpongse, (2015) argued that farmers in Thailand, pressurized by decline in highland agricultural area moved away from traditional methods of food production in order to improve their economic well-being by switching to mono-crops with high retail values. Maize had since been adopted as the mono-crop owing to the high prices it fetched as opposed to other food and cash crops, however, with time, need for agrochemicals due to its under productivity further worsened the situation resulting to low income to the farmers. This left many stranded of their course of action to support livelihoods and food security.

Upon conducting the study which aimed at identifying agricultural production systems which were both environmentally friendly and capable of providing the farmers and their families with food security and an improved standard of living, Pitakpongjaroen and Wiboonpongse, (2015) concluded that diversification of crops and adoption of perennial fruit plants in farm use allocation was key in determining household incomes from the farm as well as food and livelihood security.

Findings by Walangitan et al. (2012) on optimization of land use and allocation to ensure sustainable agriculture in the catchment Area of Lake Tondano showed that households that allocated a large farming area to a single crop, especially rice, corn or forest stood better yields to support decent lives as compared to them that practiced mixed crop farming at equal plots sizes. Their analysis comprised of income to meet decent living needs, farming income in each type of land use such as annual crop farming, rice paddies, forests, residential, mixed farming; and agricultural job opportunities created by the respective farming land use activities. In this case, the household food and livelihood security are seen to take root and fully embedded in household land use allocation.

The above results introduced residential land use as a component factor in food and livelihood security of a household. Payne, (Undated) in Williamette River basin Atlas 2ed. postulates that rural residential development has the potential to affect resource lands by occupying productive areas and interacting with farm and forestry practices which implies that even land allocated for residential activities has the potential to determine food and livelihood security of a household.

Gurung et al. (2016) study showed that most of the farmers in Bangladesh had shifted from rice cultivation to aquaculture which just the few rich could manage successfully. With the strain noted by their findings on the poor farmers who could not manage the shift and changes in land use, they postulated in their discussions of findings that intercropping and diversification of rice farming by households was the surest way to ensuring food and livelihood security for all households in rural Bangladesh. They argued that alternative or integrated rice and fish farming ensures household food security and improves household income. They further noted that diversifying rice cropping systems in rotation with other cereals and high-value crops could increase land productivity, farmers' income, and family nutrition.

Walker and others (2002) argue that households' economic ability, availability of labor, house holding farm size, need for survival, prevailing socio–economic and political environment determines household land use decisions. This provides the view that it's not only needs to meet food and livelihood security needs that are the only key determinants of choices of household land use allocations.

Santiphop et al. (2012) enthuses that land use allocation to crops is based on the need to feed families, and earn income from cash crops. As such, land use allocation is as a result of need to complement both food requirements and income from cash crops for sustainable living, all just but as strategic means for the household survival.

Ebanyat et al. (2010) argued that investigations of household land use decisions are context-specific to regions, implying that outcome of such studies will vary from place to place and yield possible different outcomes. Study findings on farm diversity and resource use efficiency: targeting agricultural policy interventions in East Africa farming systems undertaken by Kansiime and others (2017) showed that income across different farm types weren't significant with specialized farm types yielding more crop income as opposed to diversified and off farm specialized types. As such, they concluded that livelihood strategies are more distinct on the basis of the proportion of income from farming activities, farmed area, and land use patterns (proportion of land allocated to various enterprises), rather than off farm income. The results further indicated that farmed area showed a positive effect on output across all farm types which implied that allocation of more land to a specific crop type was a recipe for achieving higher returns across all farm types Kansiime et al. (2017).

Ebanyat et al. (2010) working on drivers of land use change and household determinants of sustainability in smallholder farming systems of Eastern Uganda observed that there were increases in household cultivated lands paralleled by declines and eventual disappearance of some land uses, particularly grazing and ranching household land uses. Their findings indicated that households were allocating land on basis of projected income from the farmed crop with cotton being allocated largest chunks due to its ability to fetch high yields from the market followed by subsistence food crops and decline in livestock keeping due to insecurity in the Teso area of Eastern Uganda.

In support of these arguments, Pichon, (1997) observed that soil fertility, topographical location of farmland, the duration of settlement (farm age) and household resource endowments significantly influence land use decisions. Owners of larger cattle herds left large farm areas under pasture and reduced the share of farm area allocated to food crops. He further noted that smaller farms used land more intensively and cleared most of the forest for annual and perennial cropping. The findings showed that families with

larger farms cleared less proportions of forests; pastures and this was more important on the larger rather than the small farms and closely related to ranching land use. Further, farm household demographic characteristics such as education level of household head, family and wage labor, and consumer units had significant effects on land use decisions (Ibid).

Bremner, (2012) authoring via Population Reference Bureau (PRB) reports of a growing evidence of the fact that declining farm sizes make it more difficult for farmers to grow enough food that can secure their livelihoods and feed their families. The organization points to a survey conducted in Kenya that revealed that two of every three families felt land was insufficient for their children to stay in the community and farm and that majority of the farmers reported insufficiency in production of food that can support their families.

Germany Development Cooperation in Kenya, (2017) reports that Kenya is forced to import basic foods at higher costs owing to rapid population growth, climate change effects and unsustainable land use patterns which put pressure on land resources.

2.4 Factors that Determine Household Land Size and Use

Farm sizes are decreasing in Africa and Asia, and will continue to do so, Fanzo (2017). Farm sizes are declining over time with approximately a quarter of agricultural households in five Sub-Saharan Africa countries controlling less than 0.1 hectares per capita of land, Jayne et al. 2003.

Rapsomanikis, (2015) observes that policy measures such as regulations restricting rural-urban migration, subsidies, and taxes together with population growth in the rural areas and urbanization against a fixed agricultural land affects farm size. These policy implications on land distribution and allocation are a driver to land fragmentation and hence small uneconomical land sizes, Shuhao, (2005). The arguments are supported by Kibaara et al. (2009) of Tegemeo Institute who suggest that policy changes to control declining landholding/farm sizes are needed. They insinuate that the average small farm size is continuously declining owing to modest population growth and the closing of land frontiers in many areas.

An Africa agricultural report by AGRA, (2016) shows that continuous farm structural change and dynamism overtime is compounded by a myriad of items. It indicates that

farm size changes in the rural areas is influenced by increased interest in land by urban-based professionals or influential rural people and rising rural populations. The organization observes that, in densely populated areas, investor farms growth may be exacerbating problems of land scarcity within rural communities (AGRA, 2016).

Bremner, (2012) reports that farms in Africa will likely get smaller as a result of subdivision of agricultural land by farmers among their children attributing this to continued growth in rural population.

Headey & Jayne, (2014) postulate that land pressures are severe in high density sub-Saharan Africa. They note that small farms are getting smaller and will continue to shrink as the population continues to grow. This implies that population growth is a determinant of farm sizes and particularly it encourages land subdivision for settlement and food production purposes.

Jayne et al. (2014) further supports Headey & Jayne, (2014) by noting that population growth puts pressures on land resulting to diminishing farm sizes in arable rich African countries. Besides, they put it out that in areas where localized land frontier is exhausted, many rural young people entering the labor force will have less access to less land than their parents due to subdivision among siblings. Bringing the cultural/customary issues of land succession which fosters land subdivision and fragmentation further decreasing the farm sizes.

Muyanga & Jayne, (2012) allude that higher population densities are associated with small farm sizes with their study findings showing that an increase in population density by 100 persons per km^2 is associated with 9 percent smaller farm sizes and a decrease in cropped area by 8 percent.

A study conducted on the influence of land fragmentation on agricultural production among farming households in Vihiga District, Kenya by Mwavali, 2009 postulated that land fragmentation was due to population pressure compounded by the cultural practice of land inheritance. Mbuthia et al. 2017 holds out that farm sizes in Kitui County were declining owing to cultural practices of land inheritance which resulted to subdivision of land amongst children. She notes that most of the households owned very small parcels of land due to increased subdivision among the children and selling of small portions of land to supplement their incomes.

Masters et al. (2013) observe that rapid change in farm sizes is a result of demographic transition and resulting to less land being available per family to a point where non-farm opportunities shall expand enough to absorb all new workers. They note that Asia as a whole has now passed this turning point so its average farm sizes can rise, while in Africa average farm sizes will continue to fall for many years.

Research findings by Musambayi, (2013) point out to a significant relationship between land fragmentation and population increase and government land reforms. This implying that increase in population and government policies on land reforms play a major role in determining farm/land sizes.

Perz, (2001) reports that the net effects of farmer's background, neighborhood context, institutional context, off-farm incomes, and household demographic variables exerted significant effects on the prominence of land uses. He stressed on the role of demographic variables and availability of labor as playing key roles in determining household land use allocation. Pichon, (1997) working in the Ecuadorian Amazon found security of land tenure to have significantly influenced land-allocation decisions. Browder et al. (2004) ascertained that the amount of land farmers have allocated to different productive uses, and household characteristics were important factors influencing small farmer land use decisions.

Deadman, (2005) reports that the types of agricultural activities engaged in by farm families is influenced by household characteristics, such as available capital resources and household labor. Upon completing the study on agent-based simulation models on household land use decisions in Altamira region, Brazil, he concluded that households make land use decisions based on the available household resources, the performance of past crops, and the characteristics of their property.

Tittonell, (2007) suggested that land use resource allocation was on the basis of soil fertility with farmers allocating fertile areas for cropping activities and least fertile for grazing and perennial crops that didn't require much fertility to yield.

Leonard et al. (2011) findings indicate that farmer's age, household size, and household structure are simultaneously related to both the extent of farm operations and the intensity of land use, taking into account local environmental conditions.

Desiring to identify the root causes of household land use determinants, Santiphop et al. (2012) points out that market demand for better returns, easier to sell cash crops, low production costs, resource availability (land and inputs), and increasing commercialization coupled with household characteristics as major determinants of household land use decisions.

Briassoulis, (2009) points out that a variety of biophysical and societal factors play an essential role in land use decisions. She further points out that numerous interdependent demographics, economic, socio-cultural, organizational, technological, and institutional factors affect the decision of land managers to maintain or change the current use and utilization of the land and concludes by arguing that land ownership and tenure are perhaps the most influential factors.

McCracken et al. (2002) observe that individual families' agricultural strategies on land use activities are shaped by environmental factors, economic trends, government policies, and household demographic and labor changes over time. They further suggest that succession of generations have influence on land use activities with each successive generation determining their preferred choice of agricultural activities to pursue.

These arguments are supported by Moran et al. (2002) who points out that as household's age and begin to lose members, their land use strategy switches. Bringing in the context of labor and demographic factors as key determinants of land use decisions.

Browder, (2002) enthuses that exogenous forces including household-level characteristics (personal attributes, social history, and cultural identity), institutional/structural factors (external financing), environmental factors etc. operating at various spatial levels (household, locality, region, and nation) enter into the determination of how household resources are used.

Inheritance, purchasing, renting and offering land as a gift are some of the land tenure methods that are practiced globally which encourage land fragmentation leading to small holdings that can't sustain productivity resulting to low yields and hence food insecurity (Obonyo et al. 2016). A study conducted on land use and land cover change in Keumbu, Kisii County by Ogechi and Hunja, (2012) showed that population increase led to the conversion of more agricultural land into settlement use. The household population growth was attributed to more land being allocated for construction of

housing units to accommodate growing family sizes and hence the settlement use took precedence over agriculture.

A study conducted by Kodiwo, (2012) reveals that socio-economic factors, including and not limited to demographic characteristics, education, income differentials, farm inputs, and distance and land tenure were the majority contributors to the spatial variations in land use intensity between farmsteads.

By contrast with other scholars, Ayamga et al. (2016) report that a household's decision to invest on land is influenced by land documentation and duration of tenure security. This is to imply that household's land use is determined by holding critical documents on land ownership and the length and security of lease.

2.5 Intergenerational Transmission of Land Rights

Kiplimo and Ngeno, (2016) observe that regular transfer of property from one generation to another is regulated and driven by traditions, customs and formal succession laws which has the effect of reducing the land/farm sizes. Obonyo, et al. (2016) findings on Land Fragmentation and Food Security in Ugunja Sub-County, Siaya County, Kenya shows that inheritance of land was the leading method of land acquisition/cause of land subdivision at 68.3 percent followed by purchasing of land at 26.3 percent while leasing and gifting of land were at 2.6 and 1 percent respectively. This implies that land subdivision was to foster transfer of land to children from their parents, and so to speak fueling further land fragmentation as each child scrambles for a share of the inheritance.

Bremner, (2012) argues that Africa's declining farm sizes are as a result of farmers subdividing land to their children somehow agreeing on succession laws reported by Kiplimo and Ngeno (2016). The documentation of land transfer of ownership from generation to the next is however a missing link as there seem to be insufficient literature over the same. Additionally, recorded changes of the changing and dwindling land sizes and uses overtime, and as envisioned by this study based on Swynnerton Plan of 1954 is totally missing. The study will therefore undertake to use Geographic Information System to provide a systematic graphical representation of the interval-based changes in land/farm size and use of the study area.

2.6 Possible Planning Interventions

Study findings by Shuhao, (2005) concludes that consolidation of small, fragmented plots into a smaller number of larger plots located at smaller distances to the homestead (1) reduces production costs, (2) causes a shift from labor-intensive methods towards the use of modern technologies, (3) increases technical efficiency and increases input use efficiency, (4) contributes to soil quality improvement, and (5) increases the availability of the two major yield-limiting factors in rice production in the research area.

Obonyo et al. (2016) recommends that settlement policies should be reviewed to encourage land consolidation to increase food productivity and undertake sensitization programs on family planning to control population growth and as a result reduce pressures on land.

Alemu et al. (2017) suggests that legislation on land use and population growth control programs should be adopted to aid in determining the minimum economic farm land sizes, improve land productivity together with ways of strengthening off farm activities and livestock sector to create more labor and hence sustainable livelihoods.

The Standard Newspaper, (2014) reporting on, now is the time to determine minimum, maximum land sizes points to Institution of Surveyors of Kenya commissioned survey which reported that land use, land tenure system, household land sizes and gender, socio-cultural practices, ecology and infrastructure level as main components of consideration in determining appropriate land sizes in Kenya. The news agency recommended need for a policy that can address issues of maximum and minimum land sizes in Kenya.

Bremner, (2012) on Population and Food Security: Africa's Challenge (Part 2) proposes that support to voluntary family planning programs, empowering women and girls to improve health and eliminate hunger, supporting research and programs that link agriculture, nutrition, and reproductive health as possible solutions to improving agriculture, nutrition and women's reproductive health.

Additionally, considering the inverse relationship on land size and food and livelihood security, the need for efficiency and adoption of technology for increased farm yields

would come in handy as a reliable option to solving productivity challenges associated with small land/farm sizes.

Ambwere, (2003) observes that productivity on subdivided land is constrained by declining land sizes, lack of credit and lack of appropriate farming technologies. He brings into context the role of technology as a major contributor to solving productivity challenges associated will small farm sizes with need to increase efficiency in production.

A report titled, "Agriculture in Africa", by Blein, (2013) posits that agricultural intensification is a sure way to increasing agricultural productivity. The sustainability of the intensification will be aided by conservative use of traditional inputs as well as on sustainable techniques on controlled manuring, agro-environmental techniques, controlled use of inputs and investment in modern equipment.

Nyariki, (2011) findings point that season, farm size and adoption of modern technology influence small holder farms efficiency, noting that land size impacts on scale efficiency associated with land fragmentation. He points to off farm activities to supplement underproductive small size farms as a result of continued use of age-long traditional farming methods. This implies the key role of technology in increasing productivity of small holder farms.

Gurung et al. (2016) recommends adoption of mechanization to increase rice productivity in Bagladesh noting small holder farmers risked food insecurity. Besides mechanization, the team recommended provision of technological services, technical training and adoption of crop production technologies together with diversification as essential to increasing yields and enhancing farm productivity.

Saini, (1971) postulates that variability of inputs such as labor, management and use of technology are key determinants of farm productivity noting efficiency is achieved in small farm sizes hence an inverse relationship between productivity and land size.

Systems of rice intensification (SRI) (Business Daily, March 8, 2016) is a technology applicable in watering rice paddies. The critical technology cuts amount of water used in paddy fields by 40percent as opposed to flooding method that has been adopted in Kenya for years and is contributor to low yields. The methods aid in increased

productivity from two to over four tons per acre playing a key role in small scale farmers productivity.

2.7 Theoretical Framework

A number of theories explaining the burgeoning world population have established a theoretical base upon which the study can be conducted. The theories include the Malthusian Theory of Population, The Boserupian Theory and The "Needs" Theory.

2.7.1 The Malthusian Theory of Population

The theory of population by Malthus (1766-1834), commonly referred to as the Malthusian Theory of Population, is a foundation base for which this investigation can be undertaken. Malthus postulates that there's a tendency of all animated beings to increase beyond the nourishment provided and thus an impediment to their development and happiness. His theory is founded on the basis that an exponential population growth should happen parallel to the food productivity and thus every life brought to earth should be guaranteed to overcome the difficulty of obtaining food for subsistence (Malthus, 1803).

Ideally, this is not the case, the ratio of population growth far outpaces that of food productivity. Additionally, a constraint is placed on inability for land to expand further to aid food productivity, he notes that, "Man is confined in room. When acre has been added to acre until all the fertile land is occupied, the yearly increase in food must depend upon the melioration of the land already in possession." This argument explains the diminishing land sizes which makes them unproductive and thus unable to support livelihoods. The theory is founded on the premise that population growth far outstrips agricultural productivity posing food security challenges, (Ibid).

Bremner, (2012) notes that one out of four people in sub-Saharan Africa lacks adequate food for a healthy and active life with 30 million children being underweight and the population growth projected to more than double by 2050. Population Reference Bureau survey conducted in Kenya found out that families do not have sufficient land available for their children to stay and farm as farmers subdivided agricultural land among their children making it unsustainable for food productivity. This is totally in agreement with Malthusian theory that 'man is confined in a room' where land can't be expanded further and only must rely on the available one.

2.7.2 The Boserupian Theory

The Boserupian theory focuses on the relationship between population, environment and technology. Her concept on population comprises of population density and size while that of environment refers to land resources and its related factors like climate, soils etc. Technology in this case was adopted to mean the techniques, tools and inputs in agricultural productivity (Marquette, 1997). Boserup's theory points to the fact that regardless of population growth, man shall not diminish but rather the population growth is a stimulus for an intensification of agriculture, which is the triggering mechanism for higher levels of productivity due to the technological change and division of labor that accompany the process (Turner et al. 1993).

2.7.3 The "Needs" Theory

Turner et al. (1993) explored the "needs" theory with origins in the works of Chayanov and Boserup. According to them, the theory argues that farmers are responsive primarily to the biological needs of the immediate population that they must feed (Turner et al. 1993). Thus, output is achieved through the least effort means perceived by the farmer and is limited by the immediate need. The theory further asserts that as population – land ratio increases, farmers are 'forced" to employ great labor and technical inputs to achieve greater production, that is, output per unit area of land grows (though the reverse is also possible) (Ibid). This argument ideally implies that population growth puts pressure on land resources and thus measures ought to be put in place to match productivity to ensure enough food for consumption is available otherwise food insecurity sets in. They put it out that the "needs" theory focuses on behavior of farmers in consumption production and explains why total output is increased in relation to population stresses placed on the farmer hence a subsistence or, a "need" theme (Ibid).

Turner and team on population growth and agricultural change in Africa suggests that agricultural development in Africa faces population-related challenges that recur across multiple case. They posit that the overall low density of population and dispersed settlement patterns, absence of effective localized markets, rudimentary transportation networks, inadequate incentives to adopt more demanding technologies, and the existence of large areas of potential agricultural and pastoral lands denied by diseases

that could be productive by higher populations are some of the factors impeding agricultural development in SSA.

The theories provide a potential foundation for which this study can be based. The focus of this study is to determine the impacts of population growth on land use and sizes and their effect on household food and livelihood security. The Malthusian theory provides the much-needed room for understanding whether indeed population growth in the study area is the reason behind land size or else is intensification happening in the study area as informed by The Boserupian theory. Notwithstanding, the study will examine the linkages between land size, use and changes overtime to identify whether these changes were occasioned as a result of the elements of the needs theory. Considerably, all the elements of investigation have a root base in the three theories which the researcher intends to obtain explicitly the reality on the ground and if they are supported by either of the theories.

2.8 The Conceptual Framework

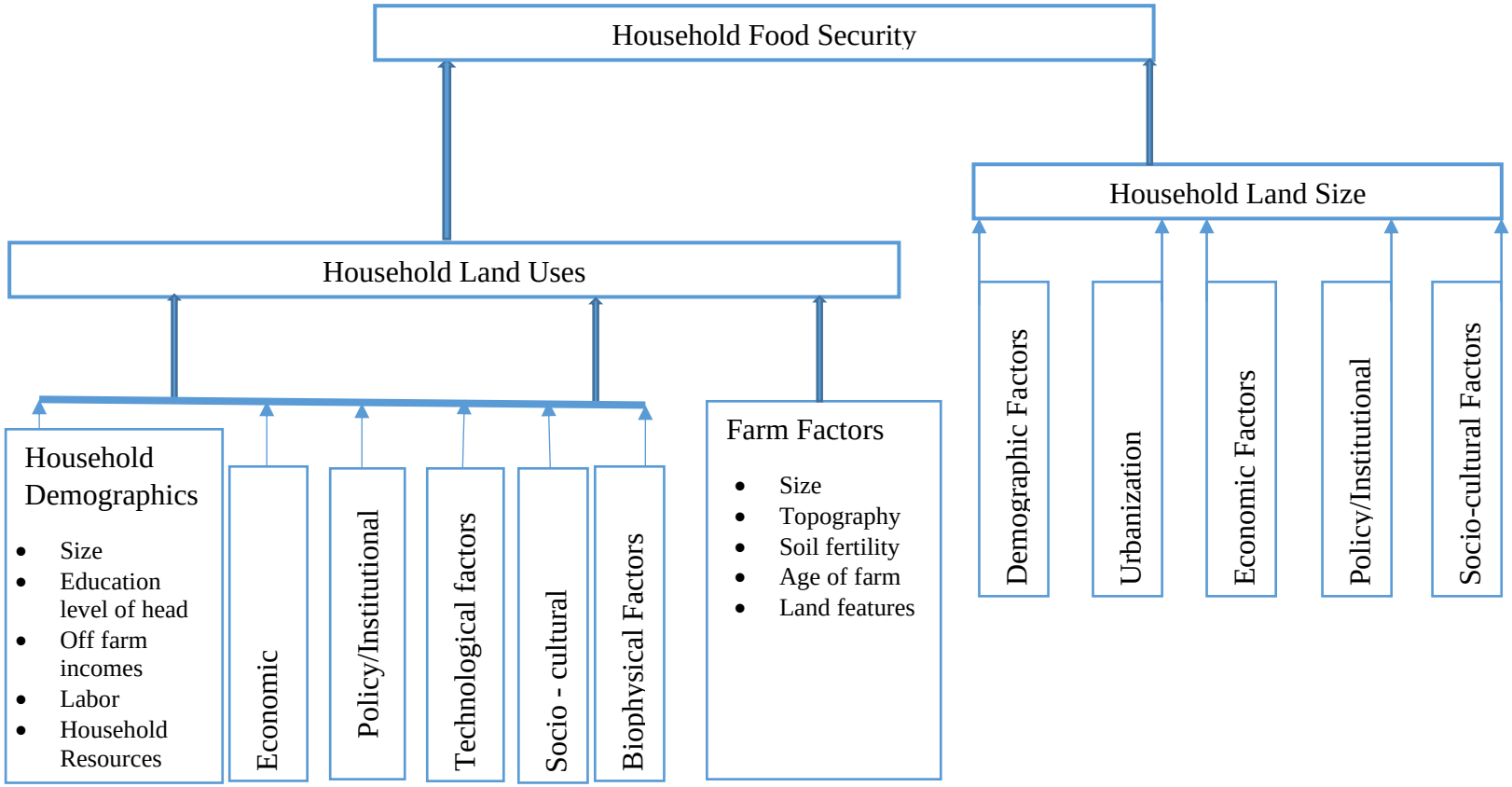
The study will be carried out to seek to fill the missing information gap as shown in the conceptual framework Figure 1. From literature review, it is worth reporting that most of the scholars have attributed land sizes and use to a number of factors including but not limited to household demographic factors, population growth, and passing on land ownership to dependents through subdivision and inheritance of land. However, literature is missing on whether successive intergeneration land transfers have impact on land size, use and food security of the household. Though it is common understanding that land subdivision for purposes of inheritance have an impact on the land size, the documentation over the same is missing.

Additionally, there is no documentation on intergenerational land transfers from generation to the other, how it takes place and what drives it which is the foundation for which this study findings would attempt to answer. Also, literature that directly links household land use allocation impacts the household's food and livelihood security is missing, actually, data shows that households with large farm sizes and labor shortage largely remain food insecure as opposed to them that have small farm sizes with sufficient labor and efficient farm maintenance.

The study focuses on finding out if household land use allocation responds to the "needs" theory that production is geared towards solving the immediate biological need

to feed the immediate household members for the time being. The conceptual framework provides the foundation to seek answers as to whether farm/land size and household food and livelihood security is dependent on population growth (as per Malthusian Theories), and whether food and livelihood security is dependent on household land size, use and population size (say, household size).

Figure 1: Schematic Conceptual Framework



2.9 Summary of Literature Review

Literature is in agreement of the fact that land size and use have an effect on food and livelihood security of a household. However, the point of departure is that some scholars point to a positive correlation of the relationship between land size and food productivity while others stick to an inverse kind or relationship between these two variables. We could as such not be able to ascertain the kind of relationship as regards these variables for the specific study area and thus an information gap exists.

There seem to be disagreements from varied studies on the main drivers of household land size and use with the interplay of both endogenous and exogenous factors pulling each other apart. The focus of this study is to establish a clarity of the determinants of household land size and use activities and their impacts on household food and livelihood security for the study area. Notably, Galvin et al. 2008 argue in favor of land sub-division. They are of the opinion that land subdivision has its own advantages. This is contrary to the largest portion of literature reviewed which shows land fragmentation/subdivision as having a huge negative impact on food and livelihood security. The study is focused on bringing out the exact picture of the study area and so provide a focused approach to solving the challenges should they be reported as such.

It is these varied opinions and views of scholars that provide a gap for which this study is founded to aid in understanding the land size and use determinants and their impacts on food and livelihood security.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

The chapter undertakes to elaborate on the research design adopted for the study. It details the target population and the sampling plan that was used for the success of the study. A data needs matrix was formulated and well outlined on the actual data needed to make the study successful and ensure the right data was collected. The chapter has given a detailed explanation of the data collection methods used in the main study and the tools that were used to analyze the gathered data. Data presentation plan and ethical considerations for the actual research project have been explained in details.

3.1 Research Design

The study adopted a cross-sectional survey design where the target population was interviewed only once. A correlational design was used in identification of the relationships of household land sizes and uses vis-à-vis food, nutritional and livelihood security in Kiratina sub-location of Mwea Rice Irrigation Scheme.

3.2 Target Population

The target population for the study comprised of all the households, community leaders, opinion leaders, religious leaders, political leaders, administrators and professionals in Kiratina sub-location. The target population was structured as indicated in Table 3 below. A representative sample was picked from each category of the target population.

Table 3: Target Population for Households

	Male	Female	Total	Households	Area in Sq. Km	Density
Kiratina Sub-location	6,092	6,059	12,151	3,759	16.7	726

Source: KNBS, 2010

3.3 Sampling Plan

The study was carried out in a rural sub-location in Mwea Sub-County with the highest population density. The choice of the highest population density was to examine how high population density was interacting with land size and use and how that impacted on household food and livelihood security. It was conducted in all twelve villages of the sub location where each village was weighted against the total population of households and a proportionate sampling of both male and female headed households was conducted. The villages were randomly sampled to determine the sequence of administering the instruments without bias.

For households, the study adopted a stratified multistage random sampling method where to start with, households were stratified based on household headship i.e. male headed, female headed. This was followed by proportionate simple random sampling of the households. For the households sampled the head of the households were interviewed.

3.4 Sample Size

Kiratina Sub location has an estimated population of 12,151 people with 2528 households recorded by the Kenyan National Bureau of Statistics in April 2018 for the purpose of preparing for the 2019 National Housing and Population Census exercise. The data was used to determine the sample size of the key target population on the basis that it was collected by a trusted national state corporation and it was more current than the 2009 National Housing and Population Census report.

A stratified sampling technique was used to identify the 206 respondents of the key target population. The households were stratified into Male, Female and Child Headed households. However, there were no cases of Child Headed Households with all possible similar cases having been reported to have been adopted by relatives. The study adopted the finite population correction factor to compute the Mugenda and Mugenda Research Methods formula, also available online under http://courses.wcupa.edu/rbove/Berenson/10thpercent20edpercent20CD-ROMpercent20topics/section8_7.pdf to determine the sample size. The formula below was adopted to determine the sample size.

$$n = \frac{Z^2 pq}{d^2}$$ where: n = the desired sample size

z = the standard normal deviate at the required confidence interval

p = the proportion in the target population estimated to have characteristics being measured

q = 1- p

d = the level of statistical significance test

To compute the sample size, the total number of households of 2,528 was used as the total population size at 95 percent confidence level tested at 5 percent significance level. With the above formula, the sample size was determined at 334 respondents (household heads). However, due to cost and time constraints, a total of 206 respondents were interviewed. This is 61.7 percent of the total sample size determined by the above formula.

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.

3.5 Data Needs Matrix

The data needs for the study are presented in form of a table. Table 4 presents the data needs that the study sought to address.

Table 4: Data Needs Matrix

Research objectives	**Data needs**	**Data sources**	**Data collection methods**	**Data analysis methods**	**Data presentation methods**	**Expected output**
To determine the current household land size and its impact on food and livelihood security in Mwea, **Rice Irrigation Scheme**	The initial household land size The current household land size The historical land productivity pattern Current land productivity level/status The link between land size and land production Traditional and cultural issues on land sub-divisions	Secondary sources. Field survey	Literature review Observation Interviews Instrument administration	SPSS/Ms Excel Spatial analysis through GIS Statistical tests and correlations	Maps Photographs Descriptive texts Report	The existing physical layout/ plan of the area A report on historical land size changes and current state of affairs at the ground

To Establish the current land uses and their impact on food and livelihood security in the Kiratina Sub-location.	Information on different types of land uses Land use changes overtime Effects of land uses on productivity Trends in household land use	Secondary sources of existing literature Field survey	Literature review Observations Interviews Photography	Descriptive analysis Use of SPSS Statistical tests and correlations	Photographs Descriptive texts Maps Report	A report on various land uses and any historical changes that has occurred
To analyze the factors that influence the use and size of household land in the Kiratina Sub-location	Existing policies, theories, and concepts The reasons behind the current household land size and use	Secondary sources Interviews	Literature review Field survey	Descriptive analysis Hypothesis Tests	Report Bar Graphs Charts	A detailed report elaborating on key influences on why land uses and sizes are the way they are

To document inter-generational transmission of land rights and land use in the Kiratina Sub-location	Historical trends on land transfers, land rights, and access to land.	Secondary sources Field survey	Literature review Observations Interviews Discussions	Descriptive analysis SPSS/Statistical tests	Maps Photographs Tables &Report Descriptive texts	A detailed report documenting the changes since 1956 (when the scheme started)
To recommend planning interventions for sustainable food and livelihood security	Applicable land uses Alternative scenarios/ options/solutions	From study findings and reports	Synthesis of findings	spatial analysis through GIS/SPSS	Reports Maps	Appropriate physical plan/design that would support food security initiatives for sustainable livelihoods.

3.6 Data Collection Methods

Both qualitative and quantitative data was collected. The methods used for data collection included documents review, observation, interviews, photography and instrument administration

3.6.1 Documents Review

The study reviewed existing literature on the relationships between household land sizes, fragmentation, tenure and land uses with food and livelihood security. Additionally, land use change data was obtained from analysis of aerial Google Earth photographs since 2005 as there was no images prior to 2005. Spot images of land use and land cover changes were also analyzed. Population census reports and maps on rainfall, temperature, soil types, and dominant crop cover as well as population structure maps of the Kiratina Sub-location were also reviewed.

3.6.2 Observation

The researcher formulated an observation checklist, **Appendix 4** that ensured all observable data was captured. The checklist encompassed relevant key features of the study area such as forests, crop cover, farmlands, house types and the materials used for construction, farm boundary markers, household compound sizes and layout amongst others.

3.6.3 Interviews

With the aid of a well-formulated questionnaire of both open ended and closed questions, data on land sizes, subdivision, fragmentation and use allocation, from members of households, religious leaders, administrators and professionals was obtained. Key informant interviews, focus group discussions were also conducted with the aid of open-ended customized interview guides. This helped in obtaining a respondent's original ideas and thoughts. The round table discussions with administrators, mainly the chief, his assistants and the village elders supported gathering of data on food and livelihood trends of the Kiratina Sub-location as well as any institutional memories on land issues, land related conflicts and possible solutions.

3.6.4 Photography

Still and aerial images were captured with the aid of a photography checklist that helped to validate data obtained via observation. It acted as evidence of the actual situation on the ground and provided a basis for comparisons with existing photography on the area. This helped to visualize the levels of land subdivision in Kiratina Sub-location, the changes over time and their implications on food security and livelihoods.

3.6.5 Instrument Administration

With the use of the appropriate tools and instruments, the actual measurements of the household land size and land allocation for different land uses was undertaken. This acted as validation of data gathered via the interview method.

3.7 Data Collection

Data was collected by use of household questionnaires (Appendix 1), focus group discussion guide (Appendix 3), key informants schedules (Appendix 2), observation checklist (Appendix 4) and photography list (Appendix 5). With the assistance of 16 research assistants, the household questionnaires were administered between 30th July and 2nd August, 2018 to all the twelve villages of Haraka, Eastleigh, Kasarani A, B&C, Kiratina, Maendeleo, Thiba North, Jericho, Gakungu A&B, Huruma and Karima. Focus group discussions of religious leaders, youth, and married middle aged men and women were conducted on 3rd August, 2018 at the assistant chief's premises with one participant from each of the twelve villages where possible and gender parity of 50 percent aside was strictly adhered to unless inevitable. The professionals FGD was conducted a week later. Key informant interviews were conducted at a later date with interviews conducted for the assistant chief, the sub county agricultural extension officer, and the very aged personalities in the sub location, the county physical planner and the county lands officer.

The collected data focused on responding to the study objectives that included household demographics with key interest on the household head, household land size, household land use, off farm income, household food and livelihood security and settlement patterns.

3.8 Data Collection Challenges and Solutions

In the course of data collection, a number of challenges were experienced. The cost of administering the data collection instruments was too high and so was the inevitable time requirement for the entire exercise to be successful. Non responsive respondents made it difficult to collect data while others turned away the research assistants as they were unwilling to respond to the questionnaire making the process lengthy and slow. Being a cluster village settlement, the data collection period coincided with the rice planting period and so it was difficult to trace the sampled respondents as they went to their respective farms kilometers away without our trace. Failure to turn up for focus group discussions, particularly the professionals made it difficult to collect such vital data forcing a later date which also required high level of lobbying for quorum to warrant a discussion. Some key informants requested to complete the schedule by themselves and ended up taking too much time to respond to them which really delayed the process. To sum it all, mistrust by respondents owing to the high number of studies conducted in the study area with promises given not honored was a major challenge for the administration of the research instruments.

However, with great exception, the data was collected with all questionnaires completed by reliable respondents of the target population. Well-wishers provided the critically required financial back up that saw the data collection exercise completed as scheduled. The administrators played a key role in supporting collection of data where they passed word to all residents to expect us and accord us time and attention. Further, the administrators made group discussions work by getting alternative participants to replace those who had dropped due to other impromptu commitments.

3.9 Data Analysis Methods

Once all the data was collected, various methods were used for its analysis. Frequency distributions and measures of central tendency were generated by use of Statistical Package for Social Sciences (SPSS). Correlations were undertaken with the right data sets that aided in measuring the association between household land sizes and uses on the one hand and food and livelihood security on the other. Additionally, statistical tests such as T-tests and Chi-Square were carried out to test the stated hypotheses while a detailed analysis of documents, maps and photographs was carried out to assess the

relationship of different variables. Analysis of qualitative data involved both case and cross-case analysis depending on the variables identified.

3.10 Data Presentation Plan

Collected and analyzed data is presented in this study according to recognized formats that have made it easy to understand. Tables, pie charts, bar graphs and line graphs have been used to present the findings graphically. Descriptive data has been presented through text narratives to provide interpretations of the findings.

3.11 Ethical Considerations

The study was scientifically conducted and observed key ethical considerations. All internationally accepted standards for what is right and wrong in conducting the research were strictly adhered to. By conducting the study, the researcher was bound to confidentiality and secrecy of collected data and information. Findings are for the purpose of the study and any publications will adhere to consent regulations that guide research world over. The research was based on honesty, objectivity, and respect for intellectual property, social responsibility, confidentiality, and non-discrimination. The study realized the intended goals and objectives by adoption of voluntary participation of all participants.

CHAPTER FOUR

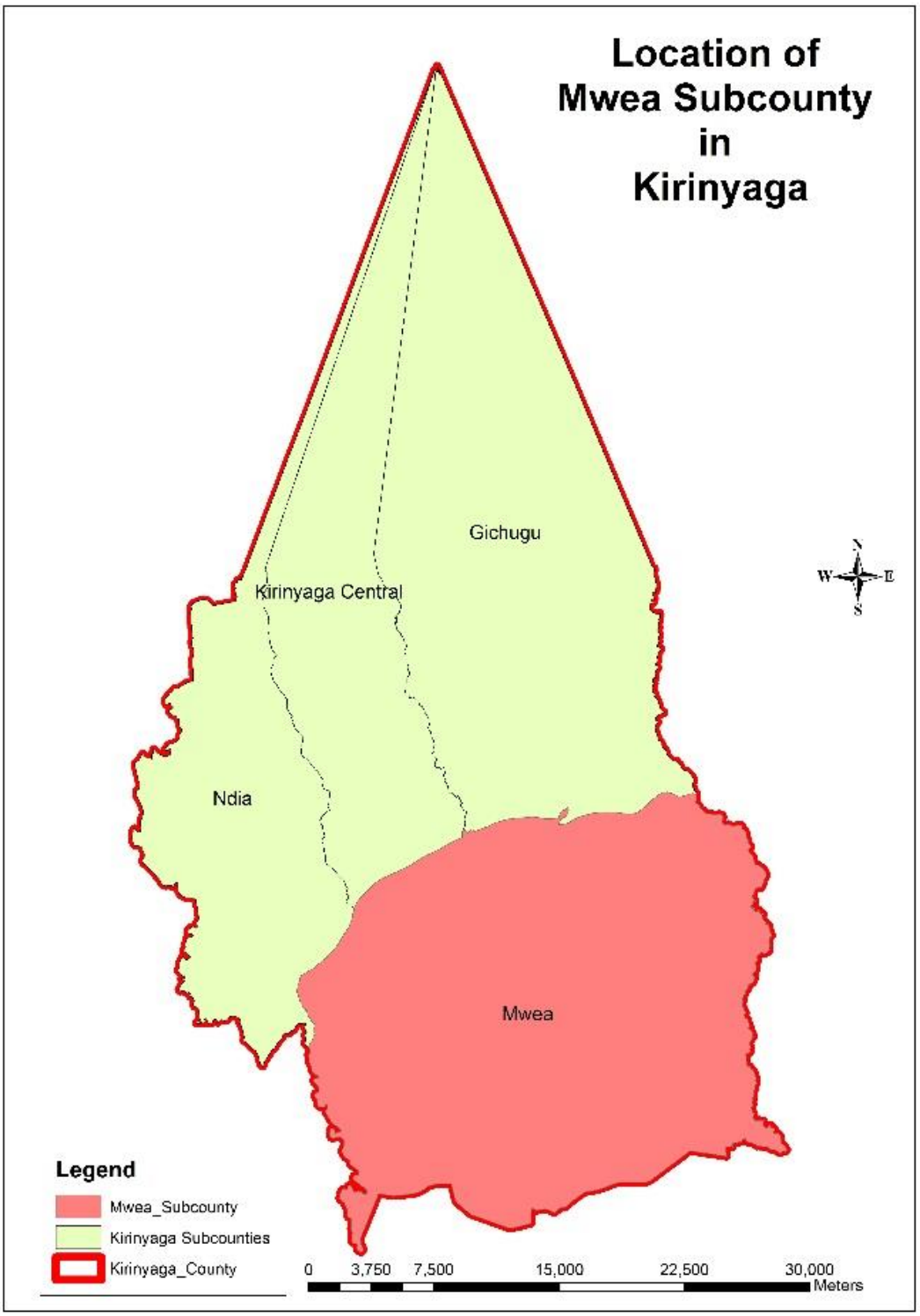
BACKGROUND TO THE STUDY AREA

4.1 Geographical Location

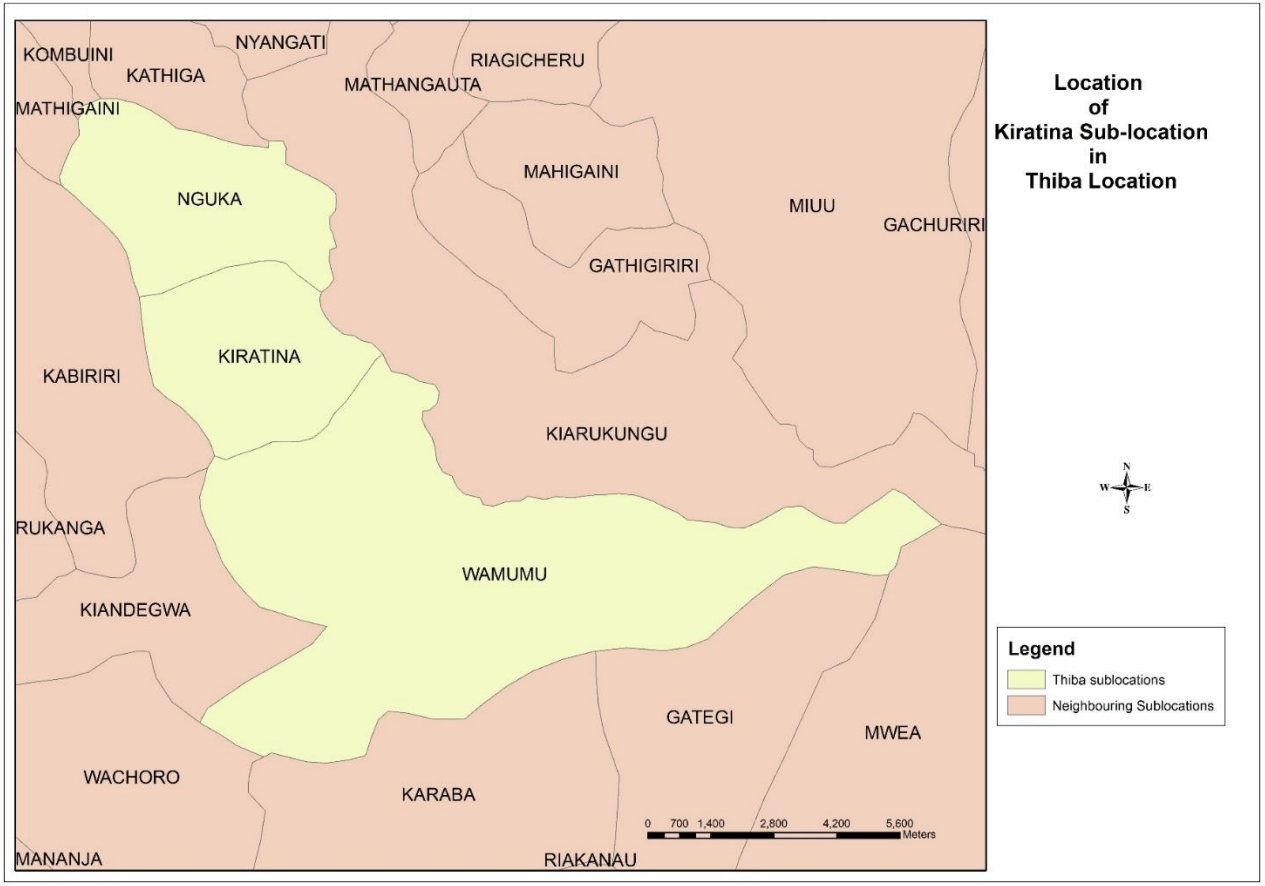
Kirinyaga County is one of Kenya's 47 counties that were established under the 2010 constitution. It became operational following the 2013 general elections. Kirinyaga County sits at the foothills of Mt. Kenya, some 115 km North East of Nairobi.

Map 1: Location of Kirinyaga County in Kenya

Map 2: Location of Mwea Sub-county in Kirinyaga County



Map 3: Location of Kiratina Sub-location in Thiba Location



4.2 Demographic Dynamics

Some 528,054 people lived in Kirinyaga County as per the 2009 census and of these 260,630 were males while females were 267,424 (GoK, 2014; KICDP 2013, KNBS, 2010). Based on annual growth rate of 3 percent, the County's population was projected to be 598,816 (295,557 males and 303,259 females) by 2017 (GoK, 2014).

Table 5: Kirinyaga County Population Projections

Census			**Projections**								
2009			2012			2015			2017		
Male	Female	**Total**	Male	Female	**Total**	Male	Female	**Total**	Male	Female	**Total**
260,630	267,424	**528,054**	272,626	279,733	**552,359**	285,175	292,608	**577,783**	293,860	301,520	**595,379**

Source: 2009 Kenya Population and Housing Census/KICDP 2013

The county had a population density of 468 people per square kilometer. It was projected to grow to 528 people/Km^2 by 2017. The table below provides population density per constituency per square kilometer.

Table 6: Kirinyaga County Population Projections per Constituency

Constituency	**Census 2009**		**Projections 2012**		**Projections 2015**		**Projections 2017**	
	Population	Density	Population	Density	Population	Density	Population	Density
Ndia	99,515	471	104,095	493	108,887	515	112,203	531
Mwea	190,512	372	199,281	389	208,453	407	214,802	419
Kirinyaga Central	113,355	653	118,572	683	124,030	714	127,807	736
Gichugu	124,672	543	130,410	568	136,413	594	140,567	612
Total	**528,054**	**468**	**552,359**	**490**	**577,783**	**512**	**595,379**	**528**

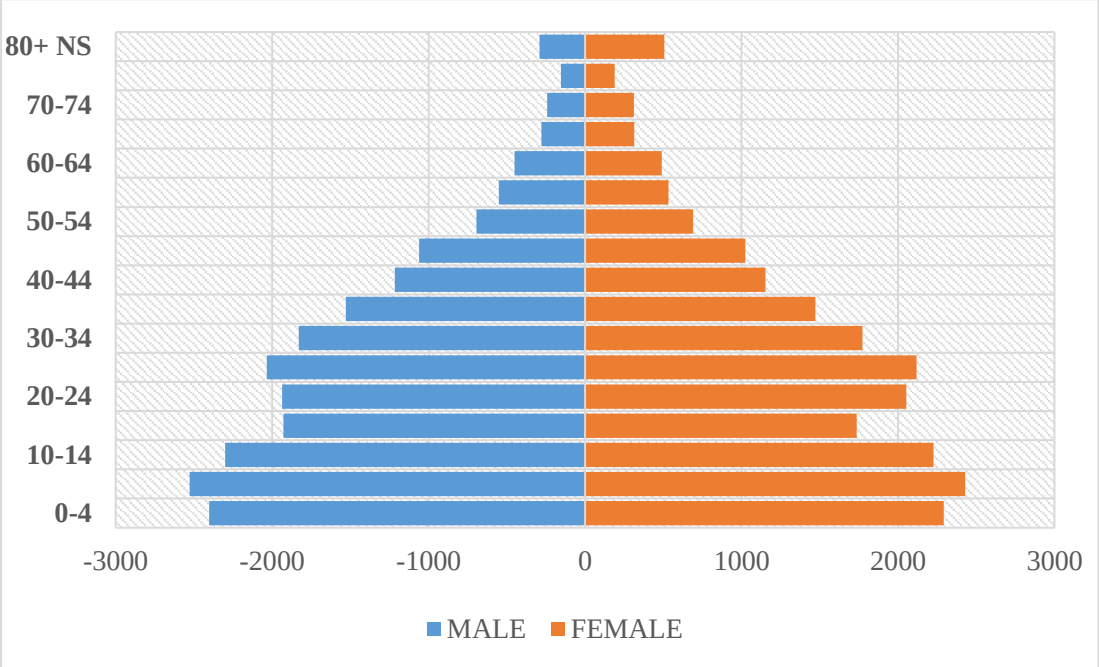
Source: KNBS, 2010/KICD 2013

The statistics indicate Kirinyaga Central was the most densely populated constituency with 653 people/Km^2 in 2012 attributed to major urban centers such as Kerugoya which had a high population density of 1,294 while Mwea had the least population density of 372. This study focuses on an irrigated rice farming system and as such it settled on Mwea constituency where rice farming is practiced under irrigation system.

4.3 Population Distribution by Age Groups

On age sex distribution, the population comprises mainly of young people and a few elderly persons who are above 70 years. This indicates moderate dependence ratio for the working population age group of between 24 and 54 years and high adult mortality rates hence diminishing age cohorts of above 65years. It too indicates fast population growth with low infant mortality rates as shown in Figure 2.

Figure 2: Age Sex Pyramid



Source: National Housing Population Census, 2009

4.4 Climatic and Physiographic Conditions

Kirinyaga County lies between 1,158 meters and 5,380 meters above sea level in the South and at the Peak of Mt. Kenya respectively. It has an annual average temperature of 20°C which ranges between 12°C and 26°C and 1250mm of average annual precipitation with two major rainy seasons – March – May long rain season and short rain season between October - December. The county has a tropical climate with an equatorial rainfall pattern influenced by its position along the equator and on the windward side of Mt. Kenya.

The county can be divided into three ecological zones, the lowland areas, the midland areas and the highlands. It is endowed with a thick, indigenous forest with unique types of trees covering Mt. Kenya Forest.

Mt. Kenya is a major physical feature and its 350.7km^2 forest is home to wildlife and grazing land on its lower parts. The county boasts of six major rivers that include: Sagana, Nyamindi, Thiba, Rupingazi, Ragati and Rwamuthambi all draining to Tana River. The County's geology comprises of volcanic rocks and is rich in volcanic soils.

4.5 Socio-Economic/Cultural Profiles

Agriculture is the main economic activity employing over 80 percent of the population directly and indirectly. Other economic activities include business (largely supported by the agriculture sector), civil service, teaching and private employment in coffee, tea and rice factories. The main farming industries are coffee, tea, rice, horticulture, dairy, maize, beans and most recent by introduction of fish farming in the County. Most residents of the County are Christians. A few Muslims are found in the major towns. Most traditional cultural activities and practices have been diminishing over time.

4.6 Social Infrastructure

4.6.1 Education

The County had 348 ECD centers, 326 primary schools, 143 secondary schools and 29 tertiary institutions as of 2013. The study area has both public and private educational institutions as indicated in Table 6 below.

Table 7: Educational Institutions

Name of Institution	Category
Thiba Secondary School	Public
Mukou Secondary School	Public
Mukou Primary School	Public
Thiba Primary School	Public
Mwea Central Academy	Private Primary
Mwea Goodwill Academy	Private Primary

Source: Field Survey, 2018

Each of the four primary schools has an ECDE center for preprimary education.

4.6.2 Health

The County had 202 health facilities as of 2013 with a total bed capacity of 764 of which 109 and 39 of them were public health and mission/NGO institutions respectively led by Mwea Mission Hospital, and 54 private clinics. The county has three level four hospitals in Kirinyaga Central, Mwea and Gichugu constituencies. Additionally, there are 10 level three facilities, 45 level two facilities and 51 level one facilities which are spread all over the county with a doctor population ratio of 1:13,518 and nurse population ratio of 1:1,226 as of 2015, and 82 hospital beds for every 100,000 people in the same year. The average distance to the nearest health facility was 5 kilometers as of 2013. Thiba dispensary is the only health facility in the study area. It provides services such as antenatal care, curative outpatient services, immunization, integrated management of childhood illnesses, family planning, and tuberculosis diagnosis among other services.

4.6.3 Financial Institutions

Major commercial banks in Kenya, such as KCB, Equity Bank, Co-operative Bank, Family Bank, Barclays Bank and Sidian Bank, have presence in the county with at least 17 branches located there as of 2013. Additionally, 8 micro-finance institutions, 18 building societies and five insurance companies and at least 58 agency banking points were operating within the county in 2013. The study area is served by financial institutions in Ngurubani town with major financial institutions having operations from there. Ngurubani town is barely 500 meters from the study area. Multiple Mpesa and KCB agents have operations within the study area.

4.6.4 Markets and Urban Centers

There are three major towns in the county namely Kerugoya, Sagana and Wang'uru while Kagio and Kagumo comprise the urban centers. The growth of these towns and urban centers is largely dependent on the agriculture sub sector. Wang'uru also known as Ngurubani or famously Mwea town borders the study area and serves the residents of the area studied.

The towns and urban centers are however not well planned and lack basic sewerage systems and proper solid waste management systems.

4.6.5 Recreational Facilities

The County has undisputed scenic areas led by the beautiful white snowcapped peaks, hanging and V-shaped valleys of Mt. Kenya towering at 5,199M above sea level. The Mt. Kenya forest is rich in thick, indigenous forest with unique species of trees, flora and fauna, such as bushbucks, black fronted duiker, elephants, waterbucks, elands, tree hyrax and white-tailed mongoose among others and over 130 bird species, forming exceptional recreational sites in the county. It has four major tourist hotels. Other recreational sites include *Ndaraca ya Ngai (Bridge of God)* which is a natural bridge, Mwomboko Kenya dancers formed in 1940's and Thingira cultural village as a cultural training site. Children playground together with an ordinary football pitch act as the leading entertainment points of the study area. Other recreational facilities are available within the neighboring villages and market centers like Ngurubani town.

4.7 Physical Infrastructure

4.7.1 Transport Infrastructure

Kirinyaga County has a total road network of 1,109.11Km of which 106.5Km is bitumen, 462.05Km is gravel and 540.5Km is earth surface. The county road network is well established with seven major roads namely Makutano – Embu road, Kutus – Karatina road, Baricho road, Kiburu road, Kutus – Sagana road, Kutus – Kianyaga road and Kabare – Kimunye road traversing through it.

The County has a railway line which is 5km long and the only railway station in Ndia is nonfunctional and the only airstrip in the county which is highly underutilized is located in Mwea Constituency.

The gravel and earth surfaced roads are non-motorable during the rainy season making it difficult for farmers to transport their produce to the market during the rainy season. This limits efficiency of the agricultural sector.

Considering the telecommunication sector, the county has a mobile phone coverage at 99 percent with 693 units of fixed line stands. It has 14 cyber cafes, five sub-post offices and courier services linked to PSV transporters.

An approximate 3km section of Makutano – Embu tarmac road serves the study area while all other roads within the sub location are earth and gravel surface roads. All

villages and farms are well interlinked by the murram and gravel roads which are challenging to use during heavy rains.

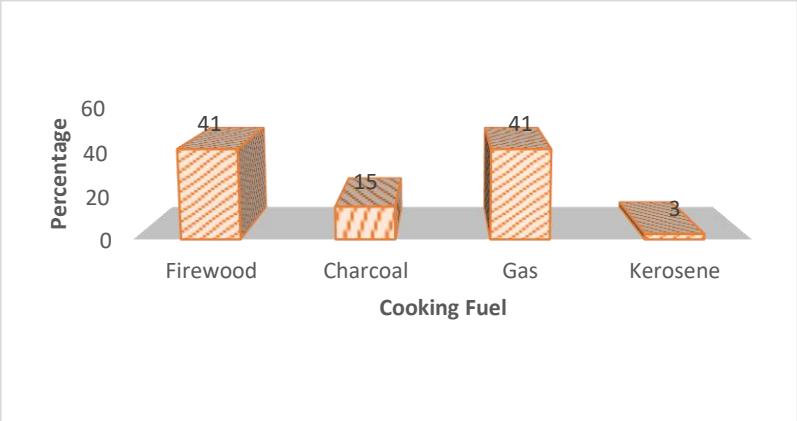
The sub location is almost 100 percent covered by telecommunication networks led by Safaricom, Airtel and Telkom in that order. It is well linked to PSV and associated courier services from Ngurubani town where postal services are also availed.

4.7.2 Source of Energy

Wood is the main source of energy with 75 percent and under one percent of the residents using wood for cooking and lighting respectively. All major towns of the county are connected with electricity with 16 percent of the residents using it for lighting, 34 percent use lanterns and a further 45 percent use tin lamps. Most importantly, 40 trading centers aren't connected to the national grid.

In the study area, wood is the main source of cooking energy contributing about 56 percent of total energy used for cooking followed closely by LPG at almost 41 percent while kerosene is the least form of cooking energy estimated at 3 percent. All villages in the study area are connected to the electricity grid which is the main mode of lighting in the study area.

Chart 1: Source of Cooking Energy



Source: Field Survey, 2018.

4.7.3 Water and Sanitation

Mt. Kenya is the main source of water that drains into the rivers flowing within the county. The county boasts of six major rivers arising from drainage of snow melting from Mt. Kenya. These rivers are the major sources of water and include Sagana,

Nyamindi, Rupingazi, Ragati, Thiba and Rwamuthambi. Thiba River, the eastern boundary of the study area is the major source of water for the sub location. It drains its water into Tana River. Water from the river is reticulated through the irrigation canals where it's accessed by the residents for domestic and agricultural use. The reticulation of water through the canals for agricultural use in the farms is managed by the National Irrigation Board (NIB).

Plate 1: Water Reticulation

Source: Filed Survey, 2018

4.8 History of Mwea Rice Irrigation Scheme (MRIS)

The MRIS began as a detention camp for Mau Mau detainees at the wake of the state of emergency in 1954 (NIB). The establishment was to provide useful work to Mau Mau detainees resulting to hasty decisions to put up the settlement scheme with a sole purpose to cultivate and produce the rice crop. First rice trials/research had been undertaken on the then common grazing land by the colonial government in 1953 just after a pilot scheme had been started in 1951. The scheme was established as a settlement one with all tenants unemployed and landless hence settled in it (Wright, 1962). Located 100Km North East of Nairobi, the rice irrigation scheme became functional in 1954.

Wright, 1962 and field survey reports indicated that each tenant was allocated 4 units of one acre each and a house erect at a 50 by 100ft plot in a village at the inception of the scheme. Initially, there were only two blocks, Mwea (Nguka) and Tebere blocks of 7500 acres apiece and only 5000 acres had been developed for irrigated rice cultivation by 1962 served by Nyamindi and Thiba rivers. The allocated land belonged to the

government, with the title deed under the custody of NIB. No land subdivision was allowed neither was a growth in population admitted with children who turned 18 in the scheme expected to leave and eke a living far away outside the scheme (Field Survey, 2018).

There were only 1,246 tenants by 1962 each of whom had been allocated with four one-acre plots for rice cultivation only under strict set of rules, a house in a nearby village to stay and an extra land to grow vegetables for own consumption. The scheme was under the management of the government including water management, farm tools, spraying services, fertilizers and seeds. NIB was responsible for managing the scheme and ensuring availability of these essential farm inputs for increased productivity.

Rice nurseries were communal where land had been set aside for germinating the seedlings by a village until individual transplanting to their farms. Tenants were to cater for the cost of fertilizers, seedlings, farm tools, mechanization and water rotivation. After the produce was ready, the government would collect the paddy (unmilled but threshed rice by farmers) at the collecting centers where it weighed, dried to 15 percent moisture content, packaged and shipped off to then Central Province Marketing Board which sold the rice and paid the government which in turn paid the tenants after deducting its fees for costs incurred.

Currently, the MRIS is developed on 30,350 acres of government gazetted land with Basmati 370 Rice, commonly known as Pishori, being the main crop. A total of 26,000 acres is under irrigation of which 22,000 acres is in the main scheme while 4000 acres is by out-growers (NIB). The number of tenants stands at 7,022 with rivers Thiba and Nyamindi serving the rice farms with water.

Until 1998, the scheme was run solely by NIB as mandated by the Irrigation Act Cap 347. In 1998, the system of tenants channeling their paddy through NIB collapsed when they revolted and failed to deliver their crop and demanded that they be allowed to market the crop on their own. This was occasioned by the fact that farmers surrendered most of their paddy to the board but would end up earning very little from it.

Following the revolt, Mwea Rice Framers Cooperative Society assumed responsibility for the scheme management. Owing to lack of finances, skilled personnel and lack of machinery for scheme maintenance, the farmers realized they couldn’t go it alone

during the period which also saw deterioration of infrastructure and inability to cultivate.

Participatory irrigation management approach was then adopted in 2003. NIB, after a restructuring process, assumed responsibility for primary and secondary infrastructure, land administration, capacity building, irrigation expansion and rehabilitation of irrigation infrastructure. On the other hand, farmers became responsible for tertiary infrastructure, farming and maintaining their farms and other non-core roles which were initially held by the NIB.

Currently, farmers market their paddy, cater for the seedlings and fertilizers and no longer practice communal nursery beds. Since 1998, children at age of 18 no longer leave the scheme and the number of villages have since increased from 18 in 1962.

CHAPTER FIVE

RESEARCH FINDINGS

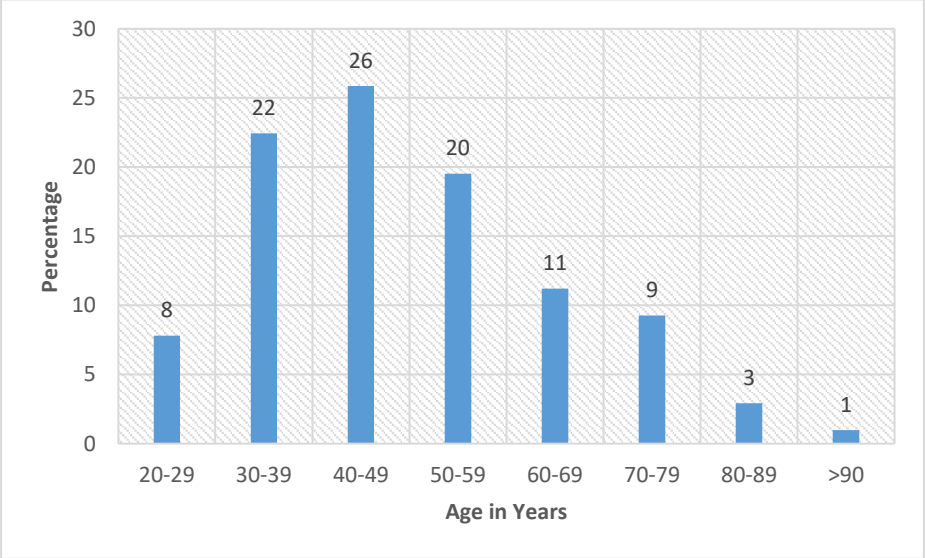
5.0 Introduction

The chapter provides an overview on the analysis of findings from the data collected in the field. The study findings are presented as per the objectives. Section one covers respondent's demographics and a brief overview of the findings. The other sections are on household land size and impacts of land size and land use on food and livelihood security, the factors that influence household land size and use as well as the intergenerational transfer of land rights and use in the study area as per the study findings.

5.1 Respondents Characteristics

5.1.1 The Age of Respondents

Chart 2: Age of Respondents



Source: Field Survey

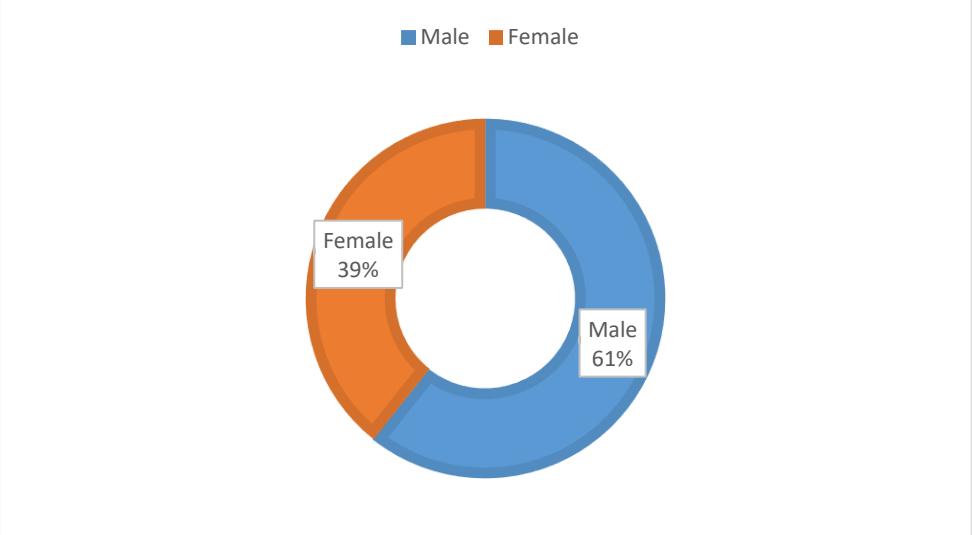
Majority of the respondents were aged between 40-49 years. Approximately 70 percent of the respondents were above 40 years of age and thus were capable of owning land, engage in land use decisions as well as provide a rich historical information on land in the study area. The mean average age of the respondents was 49 years with a minimum and maximum age of 20 years and 95 years respectively. All respondents were adults

and therefore able to participate in the study and give reliable information as they were in a capacity to make land related decisions.

5.1.2 Gender of Respondents

Sixty-one (61) percent of the respondents were male while 31 percent were females. This implies that majority of the households are headed by male and female headed households form a small proportion of the study area. It also reflects that majority of land in the study area is owned by men. It shows adherence to the stratified sampling methodology adopted in the survey where household heads were first classified as male or female. This indicates that gender parity was respected in the study and that male and females have ability to make decisions on land use, size and acquisition.

Chart 3: Gender of Respondents

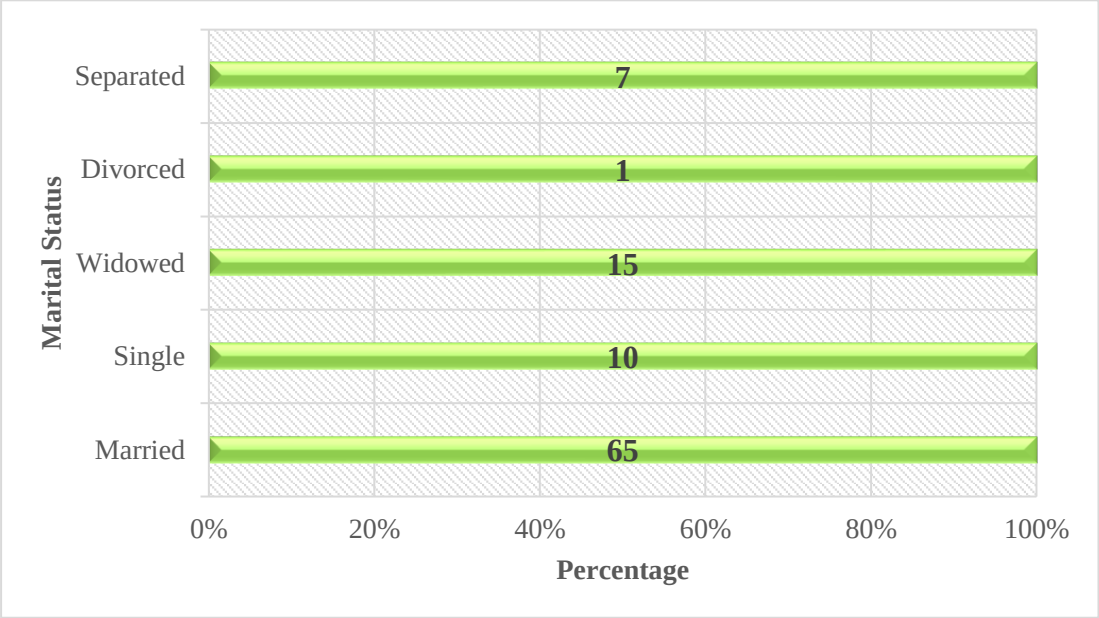


Source: Field Survey, 2018

5.1.3 Marital Status of the Respondents

About 65 percent of the respondents were married with about 10 percent being single. The rest of the respondents were either separated at 7 percent, divorced at one percent or widowed at 15 percent. This is an indication that the respondents were possible land owners and took responsibility for land size, use, and acquisition decisions.

Chart 4: Respondents Marital Status

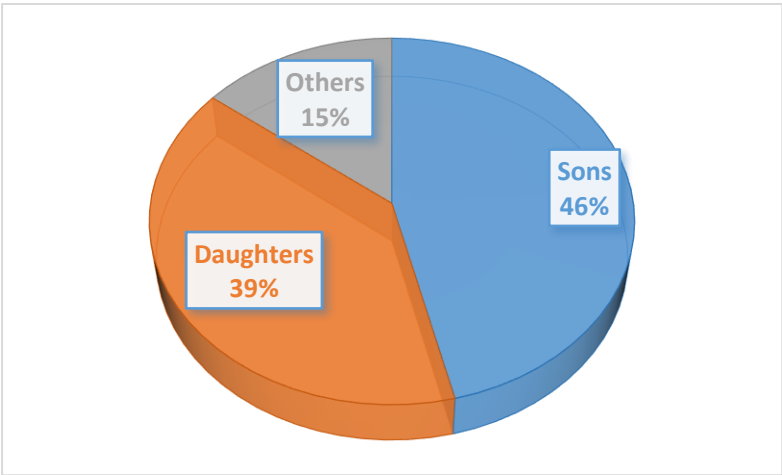


Source: Field Survey, 2018

5.2 Household Characteristics

The mean average household size was 4.44 (five members) with the least household size of one member and a maximum of 15 members. Majority of the households had at least four members with approximately 32.3 percent of them having less than four members. The implication is on household food and livelihood security. Ideally, large household sizes consume more at a go as compared to smaller ones and therefore with equal land sizes, other factors remaining constant, these larger households would most likely face food and livelihood security issues when compared to small family sizes.

Chart 5: Household Composition



According to field survey Chart 5, sons were the majority members of the households at about 46 percent of the interviewed households with estimated 39 percent and 15 percent being daughters and other males and females respectively. The other males and females comprised of

grandsons and granddaughters, and siblings to the household heads or their spouses' or even parents to the household heads or their spouses'.

5.3 Household Land Sizes and Ownership

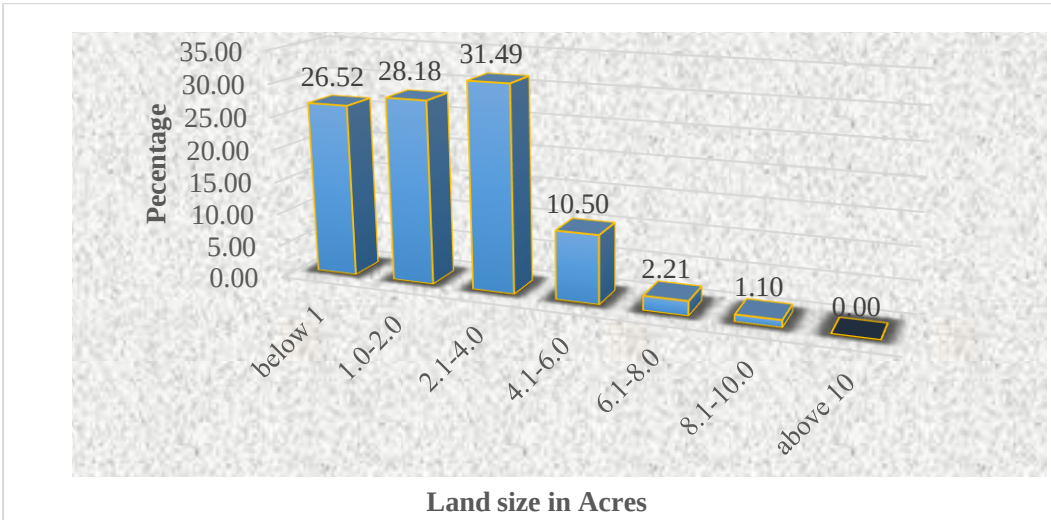
5.3.1 Land Ownership Characteristics

About 73 percent of the respondents in the study area own land as compared to 27 percent who do not own any. On the number of pieces, one owns, approximately 51 percent owned one piece with 31 percent, 8 percent and 5 percent owning two, three and four pieces respectively while the remaining 5 percent owned five, six or ten pieces. Focus group discussions (FGD) revealed that those who didn't own land were emigrants of other counties who settled in the study area for purposes of providing casual labor and earning income or are business people who originate from other counties and settled in the study area for purposes of conducting their businesses. They rent properties where they reside while a few who could afford have purchased small parcels where they have put up their homes but don't own farming parcels.

5.3.2 Household Land Size

About 55 percent of the families owned less than 2 acres of land while approximately 45 percent of the households owned between two and ten acres. The mean land holding size per household was 1.48 acres with a minimum and maximum household land size of zero acres (who didn't own land at all) and 10 acres respectively. The minimum land holding size per household for those who owned land was 0.13 acres. Majority of the households own either one acre at about 35.6 percent or 4 acres at about 20.1 percent. The land holding sizes are majorly less than the proposed minimum agricultural rural land sizes of 2.5 acres per household in a yet to be adopted and published Land Laws Amendment Act 2016 pending in parliament for the last two years.

Chart 6: Household Land Size



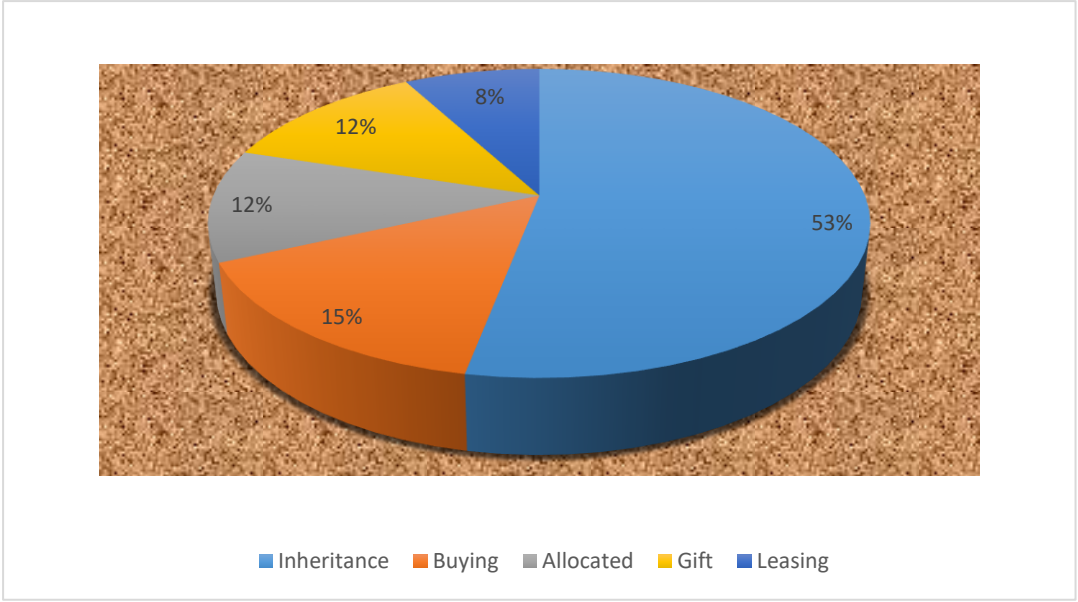
Source: Field Survey, 2018

FGD outcomes indicated that most of the participants admitted that their households held less than an acre of land. Their argument and the outcomes of the household questionnaires indicating a majority of households owning less than two acres of land were confirmed by the county physical planning office, the sub county agricultural office and the chief's office. According to the sub county agricultural office, most households hold even less than a quarter an acre of land with a maximum household holding size of four acres. The assistant chief's office noted that the entire sub location is barely 2500 acres of land which supports a population of slightly above 12,000 people. This indicates a strain on land resources for the purposes of farming and settlement.

5.3.3 Mode of Land Acquisition

Inheritance was found to be the dominant mode of land acquisition accounting for approximately 53 percent of all respondents followed by buying (15 percent), government allocation and gift each around 12 percent and leasing at 8 percent as indicated in Chart 7. Allocation was indicated as the original mode of land acquisition since the entire scheme land has been under the management of NIB, a state corporation that owns the land under irrigation.

Chart 7: Mode of Land Acquisition

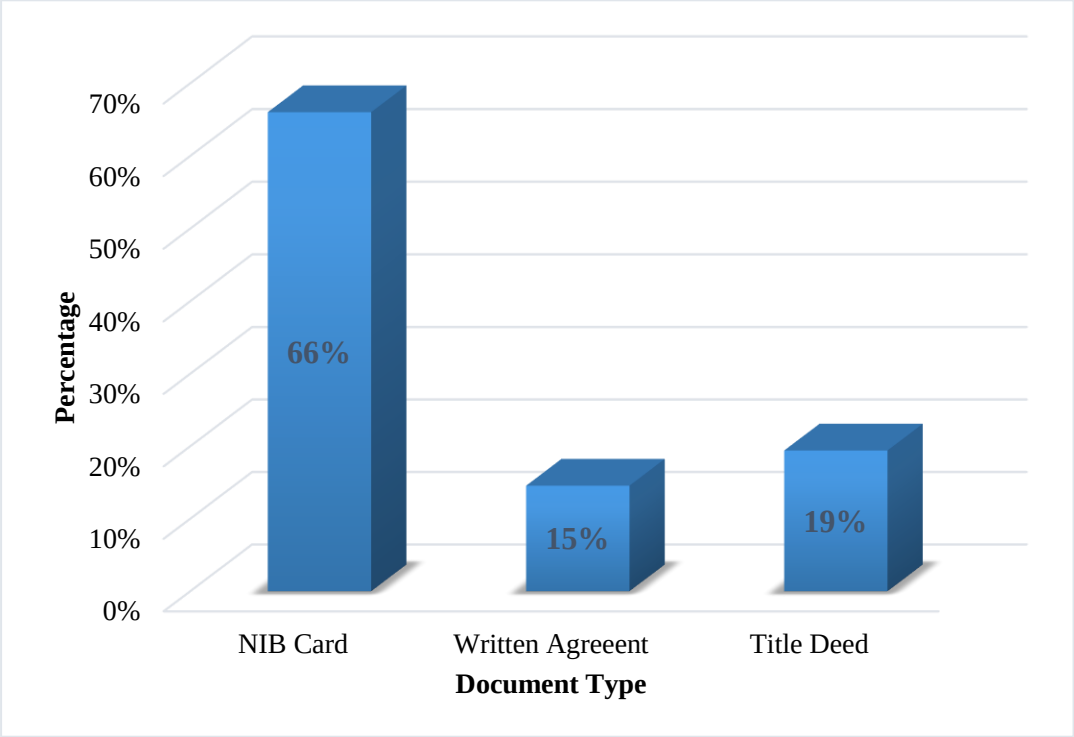


Source: Field Survey, 2018

5.3.4 Land Tenure and Ownership Documents

Leasehold at an estimated 82 percent was determined as the dominant land tenure system with freehold land tenure system being the only other tenure system in play at approximately 18 percent. Majority of the land holders do not have title deed but rather hold a NIB allotment card at 66 percent as the only evidence of land ownership. A few land owners, at 19 percent have title deeds to their held land while others hold written agreements (19 percent) as proof of land ownership. The county physical planning office was in agreement with the kind of state on land ownership documents by indicating that the land is entirely government land that is held, managed and controlled by the NIB. The elderly key informants and focus group discussions described the residents as squatters on government land since they never held a 100 percent freewill on the land they own due to lack of assurance of security of tenure on land. Regardless of this, land tenure and absence of documents did not hinder agricultural activities on land and hence didn't impact on household food and livelihood security negatively.

Chart 8: Land Ownership Documents



5.3.5 Rent Land Characteristics

As indicated in Table 7, some respondents, approximately 31 percent, rented land as compared to 69 percent who didn't rent any land. Qualitative data shows that those who rented land needed more land for rice farming (at approximately 92 percent on Table 7) as a result of small uneconomical land sizes acquired after inheritance or never owned any farm land at all and needed land to farm to feed their families and sustain their living. Others, at 8 percent, indicated that they needed land to grow other crop types and vegetables to supplement their rice as food crops. As can be deduced from Table 7, the minimum and maximum rented land size was 0.25 and 5 acres respectively with an average land letting size of 1.3 acres for at least a season which is equivalent to at least five months from August to December. Rented land was located some 3.25 kms on average away from the family residential site with 40 km being the longest distance of rent land location.

Table 8: Rent Land Characteristics

		Frequency	Percent	
Do you rent any land	Yes	63	31	
	No	143	69	
	Total	206	100	
Rent Main Use	Rice Farming	58	92.0	
	Other Crops	5	8.0	
	Total	63	100	
		Minimum	Maximum	Mean
Rent Spatial Location (km)		.00	40.00	3.2500
Rent Size (acres)		.25	5.00	1.2723
Duration of Renting (months)		1.00	3.00	2.0000

Source: Field Survey, 2018

5.3.6 Land Inheritance

A majority 69 percent of the respondents inherited land from their parents compared to approximately 31 percent who did not inherit land. Key informants and FGDs indicated that inheritance was the largest contributor to land subdivision. Of the 69 percent respondents who inherited land likely shared their parents parcel with an average three brothers and two sisters.

Of the 96 respondents who indicated that they had sisters at the time of land inheritance, 66 percent of them reported that none of their sisters inherited their parents land with just a few of about 34 percent indicating their sisters were part of those that inherited their parents land. This was attributed to cultural practices that women weren't allowed to inherit their parents land but rather that of their husbands.

While 53 percent of respondents had brothers at the time of land inheritance, a minority 28 percent of them responded that their parents land was not shared equally amongst the brothers with the remaining 72 percent noting that their brothers inherited equal share of their parents' land. While the mean average land inheritance was 1.1 acres, the average land inherited by sisters was 0.3 acres. This indicates a very huge discrepancy in land inheritance as women appear to inherit smaller portions as compared to men. It confirmed the discussions that women would only inherit their parents' share of land after subdivision for inheritance with all having to depend on that portion for their food production regardless of their number.

Asked whether there were cultural issues related to land, a resounding majority 69 percent agreed to the existence of cultural practices around use and inheritance of land as compared to 31 percent who were not aware or disagreed on the existence of cultural practices around land inheritance. Of the 140 responses on the specific cultural practices around land, a majority 20 percent indicated that only men were allowed to inherit their parents land. This was totally in agreement with the FGDs outcomes where it emerged from all groups that originally, only sons had the exclusive rights to inherit their parents land.

The argument by approximately 28 percent of the respondents that sons didn't inherit equal share of land was backed by the cultural practices that only the first born son was allowed to inherit the parents land, that the first born son was favored and inherited a larger portion of their parents land and that if one was able to buy their own land, they needed not squeeze themselves in the small portion of their parents land. Women weren't allowed to inherit their parents land except in cases where they were not married or their marriages had issues and resulted in divorce forcing them back to their parents' land. Even then, they were not given exclusive land ownership rights but only farmed the land that the parents didn't give their sons.

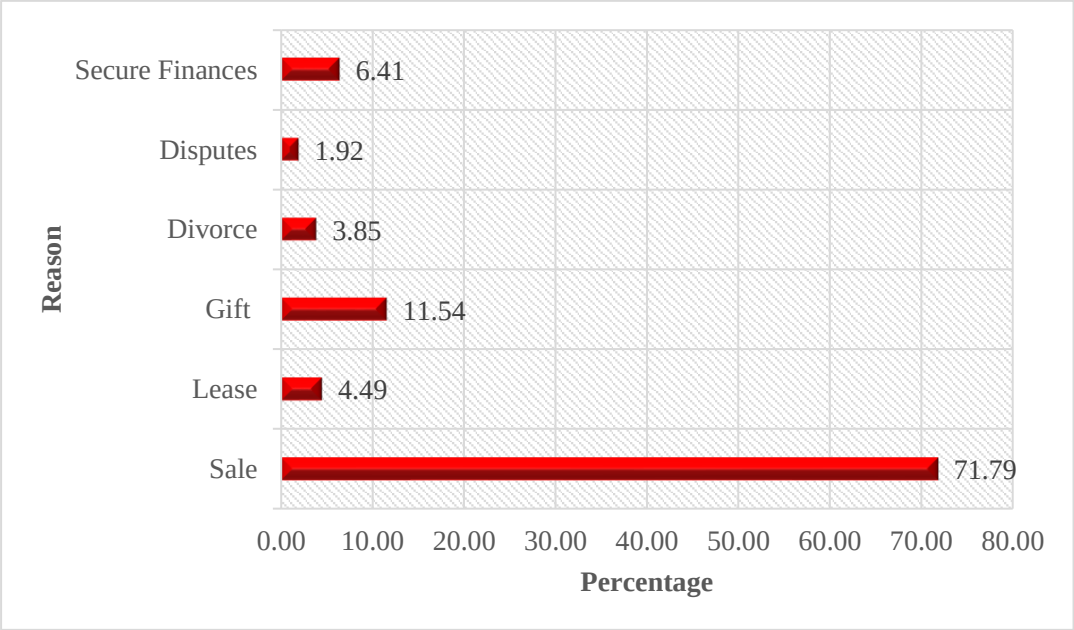
Additionally, women were supposed to have land as a form of inheritance given to their husband by their parents and therefore couldn't inherit their parents land. Finally, inherited land was not supposed to be sold at all, a respect to the ancestors and that it should be passed on from generation to generation via inheriting by the sons.

5.3.7 Land Subdivision

A resounding 87 percent reported that the family piece of land had been subdivided and with only 13 percent who reported that the family land had remained intact overtime was the clearest indication that the rate of land subdivision was rampant. The subdivision for inheritance purposes was the leading reason for land subdivision in which case the number of beneficiaries ranged from 1 to 15 with a mean of 3.74 that translated to an average of 4 beneficiaries. The result could be reported to have serious effects on the land sizes with sizeable reduction to an average of 1.1 acres after subdivision from the original mean holding size of 3.9 acres.

Apart from subdivision of land for purposes of inheritance, a number of other reasons were cited as having contributed to land subdivision. These reasons are represented in Chart 9 adding up to 31 percent which is the difference percentage from the 69 percent subdivision for inheritance purposes.

Chart 9: Other Reasons for Subdivision of Land



Source: Field Survey, 2018

At approximately 72 percent, selling was the other major reason for land subdivision followed by gift, securing finances, lease, divorce, and disputes at 12 percent, 6 percent, 4 percent, 4 percent and 2 percent respectively. The proportionate share of the 31 percent to sum up to 100 percent after inheritance taking up 61 percent of the contribution to subdivision stood at 22, 5, 2 and 2 percent respectively for selling,

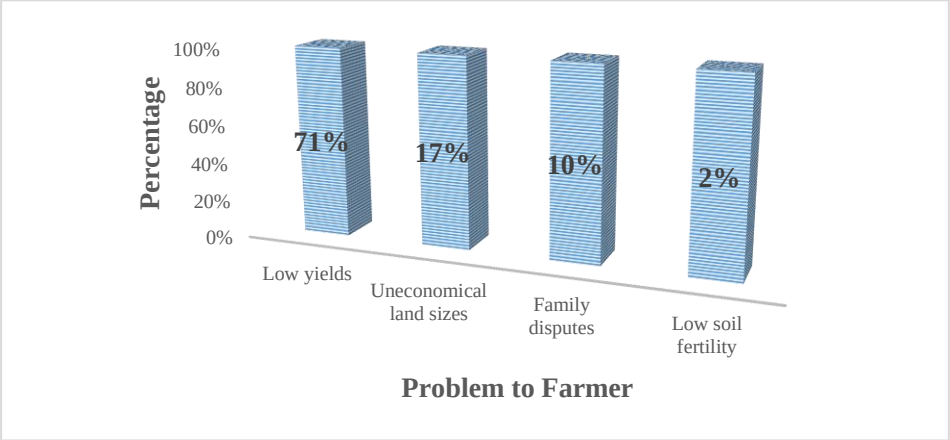
gifting, credit purposes and leasing with the other factors being largely negligible. The indirect effect of the rampant land subdivision was low productivity hence a detriment to household food and livelihood security. Disputes related to land inheritance were the reasons that indicated the value of land to household food production.

Inheritance and selling of land were reported as the major reasons for land subdivision and it was reported to reduce farm sizes by all the key informants. This was attributed to an exponential growth in population and need to inherit land by children as a custom. Also, poverty contributed to the selling of land which forced even some from the sub location to become squatters elsewhere.

5.3.8 Effect of Land Subdivision to a Farmer

Reduction of yields at approximately 71 percent was cited as the major effect of land subdivision to a farmer. Notably, even them that reported that subdivision resulted to reduction of the farm sizes to uneconomical levels (17 percent), they hinted the indirect effect was a reduction in the farm yields. This was agreed upon by the county physical planning office, the sub county agricultural office and the elderly key informants of the sub location. Family disputes were reported to arise as a result of the need to inherit by heirs the small portions of land that remained. In one of the focus group discussions, it emerged that a time bomb was in the waiting as there remained no more large lands that could be subdivided further. They noted that, with continued population growth, conflicts are just about to increase with children demanding their right of share of land from their parents, deemed to have inherited from their parents as well. The demand would be occasioned by the fact that, since they inherited the land they should as well give to their sons. Low soil fertility was attributed to over cultivation of the same piece of land over a long time and continued application of chemical fertilizers that made the soil weak hence infertile.

Chart 10: Effects of Land Subdivision to a Farmer



Source: Field Survey, 2018

The interpretation is that low incomes were inevitable since production had come down as a result of declining farm sizes. The impact was a food insecure sub location. The professionals FGD was quoted as reporting that cases of absenteeism in classes were on the rise and more prevalent on the third time or children reported to school with no food or incomplete meals of pure boiled rice for lunch. The religious focus group adduced the same issue with exception to the fact that most families skipped meals due to lack of food. A vicious circle of some sort was reported where despite a dim in productivity and need to feed the family, majority of the residents lived on credit year in year out owing to inability to afford farm inputs, failure to use the right rice varieties, inability to maintain their farms against pests and diseases and small uneconomical farm sizes. Something that was confirmed by the adult and young FGDs.

The sub county agricultural office noted that the current average land holdings were inadequate for sustainable food production occasioned by growth in population which puts pressure on land sizes. The effect on the reduction of farm sizes also contributed to renting of farms to supplement the dismal insufficient production of owned household land.

5.3.9 Land and Household Food and Livelihood Security

A majority, estimated at 87 percent, of the respondents reported not to have missed a meal in the last three months preceding the data collection exercise. However, approximately 13 percent of the respondents had missed a meal or meals due to lack of food in the household the three months prior to data gathering. This was confirmed as

true during the FGDs with professionals and religious leaders describing the situation as dire and needing immediate intervention. The key informants, led by the assistant chief's office confirmed the reports noting that subdivision of land, high cost of inputs, leasing of the small parcels to able farmers had aggravated the situation with a portion of the little harvested food having to be disposed of to cater for other household needs including school fees and purchase of food stuffs to complement the rice. This was considered the greatest challenge to households forcing them to skip meals. The young FGD was at it as well, many arguing that they skipped meals or had gone to bed hungry due to lack of food whilst majority had skipped lunch by taking late breakfast, mostly the previous night's remains, to cover for the absence of lunch for the day.

Table 9: Food Sufficiency Table

	FS (12 Months)	**FIS (6-11 Months)**	**SI (Below 6 Months)**
Number	70	58	38
Av. Crop 1 Land size	2.12	1.44	0.92
No. of those skipped meals last 3 Months	2	3	12
Av. Farm Income (Annually) in KES	589,239.00	326,741.00	199,866.00
Key: FS – Food Security**; FIS –** Food Insufficiency**; SI –** Severe Insufficiency			

Source: Field Survey, 2018

The average household food sufficiency for the study area was reported at 8.5 months, farm harvest lasted that period for majority of the households as shown in Table 8. This concurred with the reports of FGD that, for teachers, the third term of school calendar presented a nightmare for them as the challenges of concentration, especially in the afternoon were completely low. The government school feeding program wasn't available in the area due to the presumption that the County was food secure. The reports by the religious, professionals and the adult FGDs implied an aspect of negligence by the government with majority arguing that it was common for people to go hungry and skip meals only that they were skeptical to speak about it. The assistant chief's office was quoted as reporting that it was a nightmare sharing the relief food to the thousands of villagers since the relief food was availed once in a while and in very

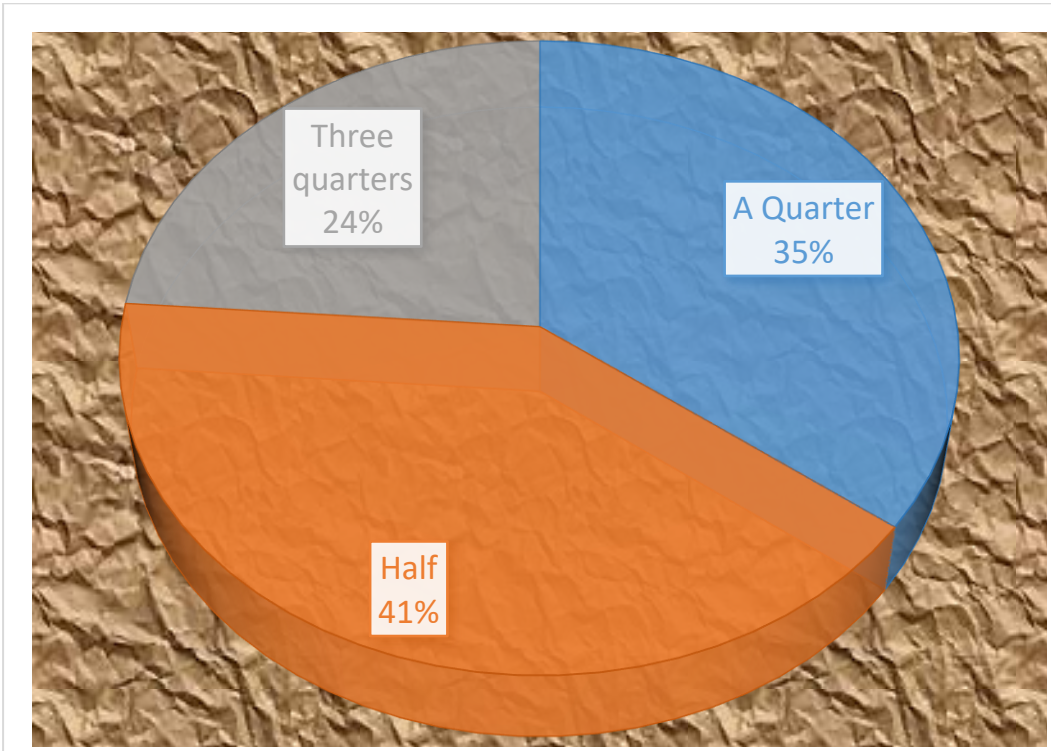
low quantities. The argument was that people were food secure and needed no relief food however the opposite was reported to be the correct situation.

All the arguments pointed to a ballooning population, diminishing land sizes and high cost of inputs which resulted to low harvests/farm production as key determinants of household food and livelihood security. Selling of harvests to buy food compliments and to meet other household budgetary requirements ranked high in the build up to food insufficiency. With this kind of situation, households had developed mechanisms to cope and largely depended on off farm incomes as the farm incomes were largely insufficient as discussed later.

5.3.10 Land Subdivision and Yield Changes

The continued land subdivision had already greatly impacted on productivity of the land parcels. The respondents reported that production had already significantly reduced with time with over 40 percent of the respondents acknowledging to have been hit by almost half the initial production before land subdivision. It can be deduced from Chart 11 that majority of the respondents, approximately 65 percent, reported that the current yields were lower by more than half of the produce before the land was subdivided. This was an indication of the adverse effects of land subdivision to household food and livelihood security. FGDs and all key informants interviewed noted that farm production had dimmed due to decrease in the land sizes as a result of land subdivision. The County Physical Planning office reported that the minute land sizes of 40 by 50ft were unable to produce as much compared to larger land sizes ten years ago. The assistant chief's office reported that leasing of farms, majorly due to inability to maintain it through out a season, and high population were contributors to household food insufficiency.

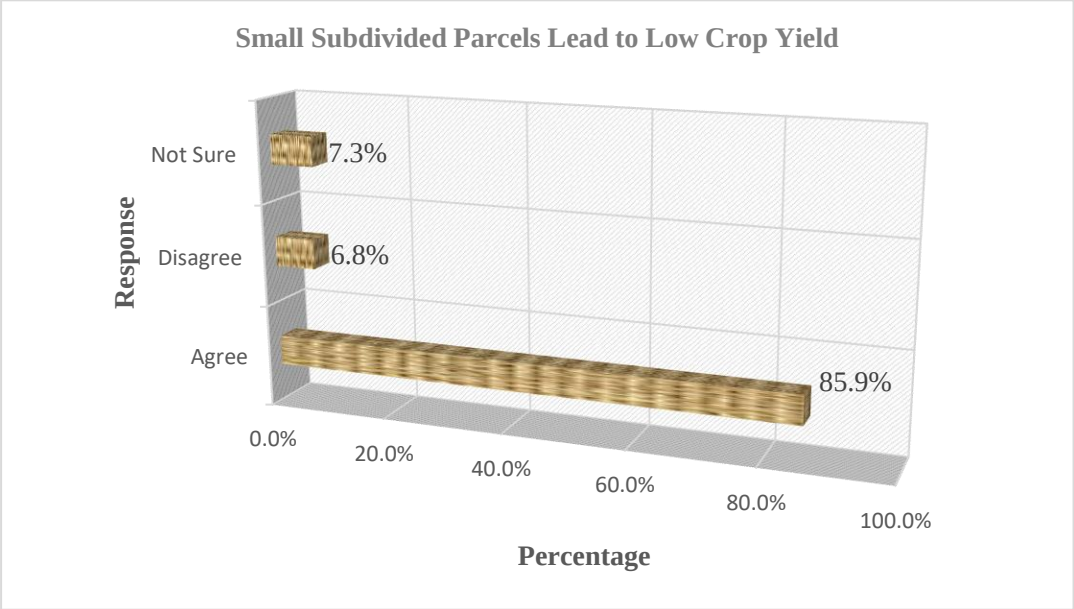
Chart 11: Yield Variations over Subdivision of Land



Source: Field Survey, 2018

Additionally, a whopping 88 percent of the respondents were in agreement that land productivity had decreased as a result of land subdivision with 6 percent being unsure while 6 percent others disagreeing that land subdivision was not the major reason for decline in productivity. Asked whether small subdivided parcels resulted to low crop yield, approximately above 86 percent agreed as per Chart 12. This was an indication that land sizes were amongst the key determinants to household food production and hence impacted on livelihoods and food security.

Chart 12: Effects of Small Subdivided Parcels on Crop Yield



Source: Field Survey, 2018

5.4 Impacts of Land Uses on Household Food and Livelihood Security

Agriculture and human settlement were observed as the dominant land uses in the study area. Approximately 79 percent of the respondents reported that they practiced agriculture as compared to a paltry 21 percent who didn't practice agriculture. This makes agriculture the major land use in Kiratina sub location. Other land uses such as transportation, public utilities (water and electricity reticulation systems), educational, entertainment (playground), commercial (local shops), and public use (administration, cemetery, churches etc.) were observed.

5.4.1 Owned Land Uses

Agriculture was the dominant land use in the study area. Mono-cropping was practiced with rice farming being the dominant land use at approximately 91 percent whereas maize farming was reported at 9 percent as seen on Chart 13 in Plate 2.

Vegetable crops were grown at very small subsistence level. Rice was reported as the dominant crop due to the fact that the entire study area was a rice farming zone, a rice irrigation scheme regulated and managed by the NIB. Even those that grew maize, it was learnt through focus group discussions that they grew maize outside the scheme where they have let or bought land for farming a variety of crops other than rice. The

reporting that rice was the dominant crop at 91 percent is totally in agreement with the sub county agricultural office which reported rice as having occupied 95 percent of the entire land area with the remaining 5 percent being used for human settlement. The assistant chief's office reported that the entire agricultural land was occupied by rice. The reporting was supported by FGDs with participants confessing that they use their land for rice production. Rice is in this context considered both a food crop and a cash crop.

Plate 2: Rice Farm

Source: Field Survey, 2018

5.4.2 Mono-cropping and Household Food and Livelihood Security

Is mono cropping a sure way to achieving food security? It is argued that mono-cropping among other demerits results in easy spread of pests and diseases. The Guardian on "Monoculture is Failing Nicaragua's Farmers," published on September 14, 2014 observed that extensive amounts of land dedicated to maize and beans threatened smallholder's livelihoods and food security and thus advocated for diversification of crops for higher margins.

This was totally in agreement with Grace Communications Foundation Publication on "Food Security & Food Access," where on solutions to food security challenges advocated for agricultural biodiversity as one of the major solutions. They postulated that, "Mono-cropping increases crop susceptibility to both pests and diseases; several historical famines and crop decimations were due to a pest or disease devastating mono-cropped agricultural plants". They further noted that mono-cropping comes with the need to increase use of chemicals and fertilizers which in the long run affect soil fertility resulting to low yields.

This was totally agreed upon in the focus group discussions where it was noted that the cost of inputs had soared to unacceptable levels. This was attributed to the need for constant use of pest and disease control chemicals and fertilizers application which contributed to weak and low fertile soils affecting farm productivity. One of the participants was quoted as saying decrease in productivity was due to adoption of technology, he was seconded by another who noted that the farms had been infested by pests.

In a different FGD, a participant said that currently, the input was a lot since the soil was weak and its fertility was low. He further was quoted as saying, "Now the size has changed completely to quarter and halves". And yet in a different FGD all participants unanimously agreed that the cost of inputs was so huge that tenants were in a constant debt cycle where they farmed for the middlemen and the rich business people as they obtained inputs on credit. This was confirmed by the assistant chief and the office of the sub county agriculture. The sub county agricultural officer noted that the greatest challenge that threatened household food and livelihood security was the high cost of inputs and a pest crisis which was getting out of control. A common phenomenon in mono cropping farming systems.

The effect of mono-cropping was the need to compliment dietary requirements. The majority of FGD participants reported that tenants sold rice to purchase other types of food stuff and to cater for basic belongings critical of them being clothing and education. This was reported to put a strain on the little harvest managed owing to the high cost of inputs to maintain the rice farms. The situation was reasoned out by the sub county agricultural officer and several other key informants who noted that middle men and business people had benefited largely from the tenants especially at harvest

time. They reported that rice prices steadily came down due to high supply and low demand. Bowing to pressure to pay for the costs and debts incurred during the farming period and other creditors requirements, the farmers were left with no choice than to dispose of the harvest at a throw away price a recourse whose effects were felt later in the year.

5.4.3 Rent Land Main Use

A majority 56 (89 percent) of the 63 respondents who rented land used it for rice farming with the remaining 11 percent of the respondents reporting that they used their rented land for other farming. This implies that all rented land was purposely for farming. The sole major reason for this was reported as a coping strategy in the focus group discussions with aid to supplement food production from the small and uneconomical owned land sizes as well as a remedy for them that didn't own any farm at all within the sub location.

Human settlement was observed as the other major land use followed by transportation land use. The sub location adopted a cluster type of human settlement with twelve villages in place. Social amenities including cemetery, social hall (under construction) and open space as playground together with administrative land were observed as other land uses though largely insignificant.

5.5 Household Head Main Economic Activity

Approximately 64 percent of the respondents interviewed reported that the household head engaged in rice farming. As it can be seen from the table below, about 15 percent of household heads were casual laborers while employment and business occupied 21 percent of them. An important aspect for consideration was the reporting from FGDs that casual laborers actually worked for wages on other people's rice farms while its deduced from the table that agriculture is the core economic activity employing 79 percent of the household heads.

Table 10: Main Economic Activity of the Household Head

		Frequency	Percent
Valid	Rice farming	132	64
	Casual Laborer	30	15
	Business	25	12
	Employed	18	9
	Total	206	100
Total		206	

Source: Field Survey, 2018

The household head was reported in all FGDs as having the sole responsibility on farm land use decisions albeit mostly in consultation with their spouses. The begging question was whether land use decisions impacted on the household food and livelihood security. FGDs revealed that truly farm based decisions had impacted on household food and livelihood security. This was attributed to the argument that despite being under management of NIB, the choice of the variety of rice to plant was solely the role of the household leaders.

Therefore, as a result to increase yield for household consumption, most farmers allocated high yielding Sindano or BW varieties small proportions of their land and low yielding Pishori Basmati the largest proportion. It was reported that Sindano earned very little if sold but rather produced so much, a minimum of 35 bags an acre per season whereas Pishori Basmati variety produced little, a maximum of 28 bags an acre per season but yielded more income once sold. Farmers were reported to have adopted the mechanism if the farm sizes allowed to aid in the fight against hunger and malnutrition. This was the clearest indication that land use decisions impacted on household food and livelihood security.

It was reported that the average food sufficiency period was eight months with 13 percent of the respondents admitting they skipped a meal due to lack of food. The situation was reported to be messier through the FGDs and although most of the key informants were people in authority who disagreed with the argument citing a food secure sub location, all other key informants were totally in agreement. A number of strategies were reported to have been employed to cater for the household food and

other requirements. These were the coping strategies after exhaustion of farm produce which included off farm incomes to the household.

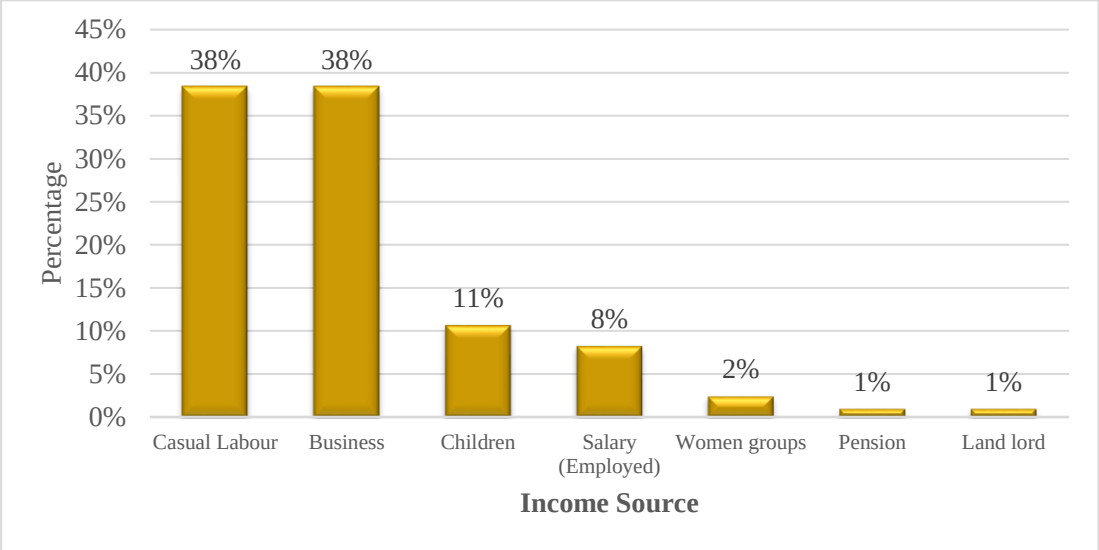
5.5.1 Coping Strategies for Food Insufficient Households

At an average eight months state of food sufficiency, majority of the households were hurting due to lack of food and had employed mechanisms to cope with the situation. Wages from casual labor was the greatest support to majority of households with food scarcity challenges. These were approximately 67, 51 and 14 percent for severe – harvested food lasted maximum three months, moderate – farm produce fed the family for a period of six months and mild scarcity – where harvested food sustained the family for a period not exceeding nine months respectively. Other coping strategies employed by residents included salary from employment, business incomes from shop keeping and boda boda, obtaining food on credit, remittances from adult children as well as women groups and merry go rounds. The dangerous path of acquiring food on credit was reported as a continuous exercise of a vicious circle that kept majority of the tenant's debt trodden year in year out and only farming for wealthy business people.

5.5.2 Off Farm Household Income

Off farm household income was the other way household heads employed to cater for the needs of their household, especially to meet dietary requirements of their families. Business and wages from casual labor at approximately 38 percent each as per Chart 14 were the greatest off farm contributors to household income. The off-farm income was a boost to household income and a significant coping strategy to maintain food and livelihood security as well as meet other household needs. FGD participants reported hustling through casual labor and merry go rounds to eke a living. The off-farm activities contributed on average Kshs. 120,000 annually per household being a greatest support to household requirements. Casual labor wages and business proceeds were received mostly on a daily basis while salary, rent collection and children remittance were on monthly basis.

Chart 14: Off Farm Income Sources



Source: Field Survey, 2018.

5.5.3 Farm Productivity

The minimum and maximum rice yield per acre per season was reported as 20 and 28 bags of 100kgs each with an average productivity of 22.5 bags per season per acre for Pishori Basmati variety of rice. The FGDs revealed that other high yielding rice varieties such as Sindano and BW yielded as high as 40 bags per acre per season. Maize yields could not be out rightly verified owing to the fact that most of the farmers did it away from the study area and thus a few reported to have harvested between one and twelve bags of 90kgs a season for just one season in a year depending on the farm size. With the average mean holding size of 1.48 acres, the average farm produce per household could be determined as 35.5 bags of Pishori Basmati rice. Most importantly, farm production was not dependent on household farm size since variance on productivity depended on use of farm inputs, the type of rice variety planted, farm maintenance and pests and diseases control over the season.

5.6 Human Settlement and Food and Livelihood Security

Human settlement was observed as the second largest form of land use in the study area. According to FGD, a Mau Mau detainee was allocated a 50 by 100m piece of land in it erected a simple house as in Plate 4 at inception of the irrigation scheme in 1956. This was confirmed by a letter by Mr. Ian Michael Wright who noted that as of 1962, there were only 1,246 tenants who lived in the entire Mwea Rice Irrigation Scheme

(MRIS) with the then manager responding that there were actually about three or more families in each house. The letter reported that the entire scheme had 18 villages which hosted the tenants and an extra land for growing vegetables. This was confirmed in the focus group discussions however, at inception, Kiratina sub location had only six villages each with extra land for vegetables and open spaces for recreation to serve the entire sub location.

The arguments were echoed by the chief's office while FGD participants posited that at inception, they grew vegetables and even cereals including maize and beans in the open lands which had been allocated to the tenants for such purposes. However, with growth in population, inability for the sons to move out since they had no place to go, other villages came up. Owing to lack of space for settling, the additional villages, occupying children, grandchildren and great grandchildren of the original tenants, sprang up in the open spaces set aside for growing vegetables and other crops. The seven more villages grew up gradually from scratch as they grew adjacent to the existing villages.

The effect was that, there was no more land for growing vegetables and cereal crops pushing food and livelihood security challenges a notch higher. It was reported that most of the tenants grew vegetables at the edges of the farms as on Plate 3 which was obviously not sufficient to sustain them and thus for access of vegetables and cereals, one must buy or else they would have to do without. Perhaps, this explained why 53 percent of the respondents could not tell how often they took fruits compared to 47 percent who were certain of taking fruits either daily, weekly or monthly. The threat to food and livelihood security was therefore noted to include incomplete diet where cereals, vegetables and fruits were largely unavailable. Perhaps an explanation why most participants of the professional FGD decried the state of affairs with children having only boiled rice for lunch with no other accompaniment, not even vegetables, a recipe for malnourishment.

Plate 3: Vegetable Growing on Edges of Rice Farms

Source: Field Survey, 2018

5.7 Factors that Influence Household Land Size and Use

The study delved in determining the key factors that influenced land size and use decisions in the study area.

5.7.1 Household Land Size Determinants

Table 11: Household Land Size Variations (acres)

	Minimum	Maximum	Mean	Std. Deviation
How many acres did you inherit?	.00	5.00	1.1113	1.24297
How big was your parents' land parcel before any sub-division?	.00	29.00	3.9116	3.08704
Total owned family land size	.00	10.00	1.4825	2.11491

Source: Field Survey, 2018

A number of factors were deduced as leading contributors to the variations in household land size. The mean holding land size before land subdivision was 3.9 acres, say 4 acres. The findings showed that this was the initial number of acres allocated to an individual Mau Mau detainee in 1956, at the onset of the state of emergency in Kenya when the scheme took shape. This was verified in FGDs and key informant interviews.

Therefore, government land allocation was seen to have influenced the number of acres a household held, including to date for those who never subdivided their land.

However, since the government allocation was done decades ago, a number of other factors have greatly impacted on the land sizes. At approximately 87 percent, land subdivision was reported as the leading contributor to changing land sizes. The pressure behind land subdivision was for a number of reasons. Population pressure or growth in population contributed largely to land subdivision for purposes of inheritance with approximately 67 percent of respondents agreeing that land subdivision was for inheritance reasons. Majority, almost 99 percent of all FGD participants were not the original holders of the land where they settled with approximately 95 percent noting that they acquired their land via inheritance from their parents while a few, mostly the professionals and business people, bought the land they farmed or settled on. One of the participants reported that, “the acres are now being divided due to the growth of population”. Approximately 89 percent of the respondents agreed that land subdivision

existed as a result of population pressure hence influencing the household land holding sizes. The County Physical Planning office and that of the Sub county agriculture attributed the changes in household land sizes to population growth and migration, with other communities, majorly Kikuyu and Kamba, acquiring through purchase and settling in the sub location.

Selling was identified as the other major contributor to decreasing household land sizes with them that purchased likely to have increased their household land sizes while those who sold had their farm sizes decreased.

These were reported as the three major influencers to household land sizes in Kiratina sub location. However, despite reporting that population pressure was influencing the land sizes via subdivision, the key informants, especially the county and government ones, couldn't verify if subdivision of parcels was happening as the NIB land was strictly to be maintained and not subdivided arguing that the happenings were illegal and didn't follow the due process. The arguments were totally supported by the FGDs who noted that land subdivision for whatever reason was prohibited by NIB and those did it did so in disguise as transferring to next of kin and losing rights of land ownership thereof were contrary to NIB regulations.

5.7.2 Household Land Use Determinants

The household land uses were strictly regulated by the NIB with rice farming being the only household farm use allowed. It was observed that all farms had rice planted in them, the only variance household heads had was to decide on the variety of rice to plant which otherwise had impact on the household food and livelihood security.

Population pressure affected household land use. The increase in villages to twelve and most recently, after the data was collected, to thirteen was the clearest indication that human settlement was critically essential. As noted through FGDs and a few key informants, the growth of the new villages was occasioned by the need to settle and the impractical policy of children moving to unknown world at 18 by NIB resulted to disputes witnessed as late as in 1998. A participant in one of the FGD was quoted as saying, "All the open space land had been reserved for growing maize and beans. It is this land in Kasarani, Gakungu, Huruma which they took the land for human settlement".

This surge in the number of villages occupied the land allocated to growth of vegetables and manageable cereals forced adaptation mechanisms for households as there was no more space for such activities. It resulted to planting vegetable along the edges of the rice farms, next to the canals but unfortunately, cereals like maize couldn't be grown. It was reported that maize attracted birds which would eventually feed on the rice and impact hugely on the produce. In so doing, human population growth was reported as a contributor to land use decisions.

Additionally, households have had to adopt to sharing the homesteads which initially were intended for a single household. Due to consistent population growth compounded by the need to accommodate more within the smallest available space, the homestead size for the new villages was determined to 60 by 70ft, much smaller than the original 50 by 100ft homesteads at the inception of the scheme. This was necessary to accommodate the many upcoming families that needed their own place to settle. These two scenarios were elaborated as the major determinants of household land uses with need to identify different sites for other land use requirements being inevitable.

5.8 Intergenerational Transmission of Land Rights and Uses

At inception, all land belonged to the government which allocated 4 acres to each of the Mau Mau detainees settled in the area as a punishment to work in the farms. They were later allowed to bring in their families while others got married. The initial land rights transfer happened in 1956 when these detainees were settled in the area. They were later issued with a NIB card which indicated ownership of the four one-acre units allocated with the NIB holding the title deed for the entire scheme.

The data collection showed that land rights transfer was reportedly taking place albeit illegally as the NIB didn't permit land rights transfers. Majority of the respondents, approximately 69 percent of all respondents inherited land which was a direct transmission of land rights from parents to children. Additionally, inheritance ranked as the main mode of land acquisition together with buying, allocation, gift and leasing at 53, 15, 12, 12 and 8 percent in that order. Chart 15 provides an explanation to the happenings on land rights transfers.

Chart 15: Mode of Land Acquisition

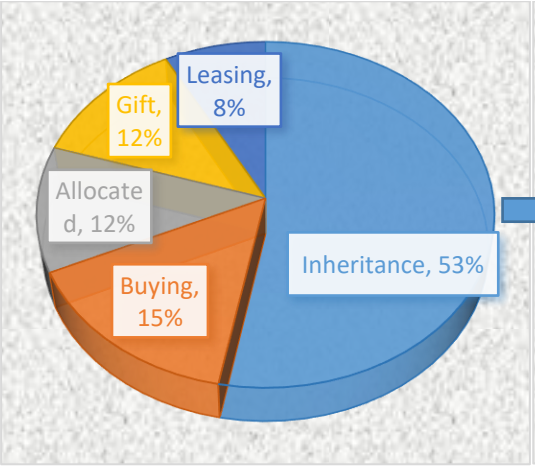
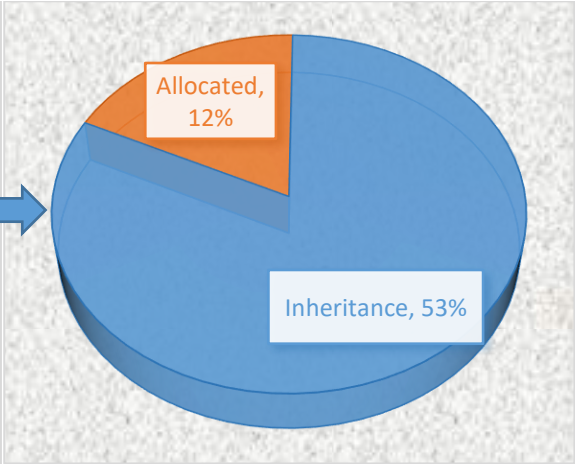


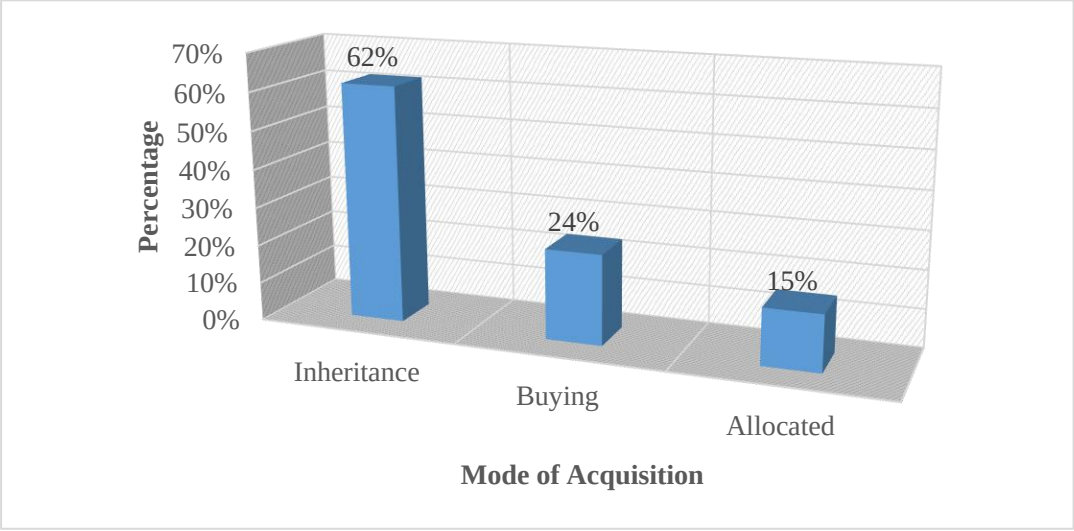
Chart 16: Allocated vs Inherited Ratio



Source: Field Survey, 2018

Inheritance, the dominant mode of land acquisition was the surest explanation to the intergenerational transmission of land rights. As can be seen from the right Chart 16, allocation stands at 12 percent which is an indication that only 12 percent of the households retained the 4-acre allocation by the government and that their land had remained intact over the years. This was the clearest indication that land rights had been transmitted from the original holders, parents, to their children, the newest generation. The case was similar to the FGD participants whose response showed that 62 percent of them acquired the land by inheriting from their parents and a paltry 15 percent as per Chart 17 had been allocated their land by the NIB Board.

Chart 17: FGD Participants Mode of Land Acquisition



The two provide a complete explanation of the intergenerational transfer of land rights from parents to children. Majority of the participants in FGDs were third generation people save for the youths who were mostly fourth generation since 1956.

The land uses have remained the same overtime. However, in 1998, it was reported their emerged differences between the tenants and NIB and since then a few livestock are kept. Approximately above 70 percent of the respondents couldn't explain on the changes in livestock kept with 36 percent agreeing that a change in the number of cattle kept had reduced to an average of one per household just for family milk production. This was occasioned by lack of grazing space with FGDs reporting that even the rice husks were sold and farms cleared with no room for rearing livestock. Majority of respondents, key informants and FGD participants reported that rice had been the dominant land use since 1956 with a few elderly informants reporting the entire area was a ranch where the European settlers had kept their livestock prior to conversion into a rice farming scheme with settlements in 1950s. FGD participants reported that they were born and found their parents farming rice, a practice which they confessed to have sustained to date. Maize and horticultural production had its allocated space per village but the major land use change witnessed was the occupation of such land for settlement purposes negating vegetable farming to the now narrow edges of the rice farms.

The use of photography and GIS indicated the said consistent growth of the settlement areas and an increase in the rice paddies. The paddies were the new boundaries as NIB would not allow physical boundaries to be erect within the scheme. The plate numbers 4, 5, 6 and 7 depict the changing scenario of both structuring and human settlement since inception of the scheme to date with growth in population impacting both land sizes and uses from generation to generation.

Plate 4: Human Settlement; Structuring Trends

Source: Field Survey, 2018

The clockwise view of Plate 4 shows the changes on the structure for human settlement from simple earth iron roof house to modern stone houses. Some, not in Plate 4 are mansions with gal sheets as the roof and the picturesque is rapidly changing with current generation demolishing the initial houses and replacing them with ultramodern homes. Homestead size has changed dramatically with more houses emerging within a single homestead, “intensified settlement”, so as to accommodate as many heirs as possible. The trend has been happening overtime and likely to continue across generations.

Plate 5: Human Settlement Trends 2005

Source: Google Earth, 2018

Plate 6: Human Settlement Trends 2011

Source: Google Earth, 2018

Plate 7: Human Settlement Trends 2018

Source: Google Earth, 2018

The plates on trends on human settlement indicate that the intensity of settlements has been on the rise since 2005. The built-up area to accommodate humans has increased over the years. Were it not for financial limitations, earlier maps show the magnitude upon which the intensity has varied over the years. This is a clear reflection of the integrational transfer of land use and ownership rights with impacts on uses of land and agricultural productivity.

Case Scenario 1

Plate 8 was captured on 6th October, 2018 from the study area. The case of subdivision of rice farms in the sub location was not by physical boundaries but rather the number of rice paddies that can be seen. In the case scene below, the original holder of the parcel was allocated four acres. He was a father of four sons and without daughters. The sons inherited each one acre.

Plate 8: Case Scenario: Intergenerational Land Rights Transfer

The above plate is a one-acre parcel allocated to one of the sons. The son bore two sons and three daughters. He shared his one acre with his two sons while all daughters were married and did not inherit any share of the grandfather's land. The father to the two sons retained half of the acre as shown by Boundary 4 and 1 while he shared the remaining half acre between the two sons with each inheriting a quarter of an acre as indicated by Boundary 1, 2 and 3. This was the most classic example of intergenerational transfer of land rights and use in the study area. Now, the sons have born other sons and the trend of transfer of land rights is expected to continue unless viable and workable interventions are implemented.

Case Scenario 2

A participant in one of the FGDs narrated the actual state of land rights transfer in form of land subdivision for inheritance.

Father to Participant – 5 acres

Participant & Nine Brothers – Half acre each

Participants 2 sons – A quarter acre each

The father to participant didn't retain any share after subdivision.

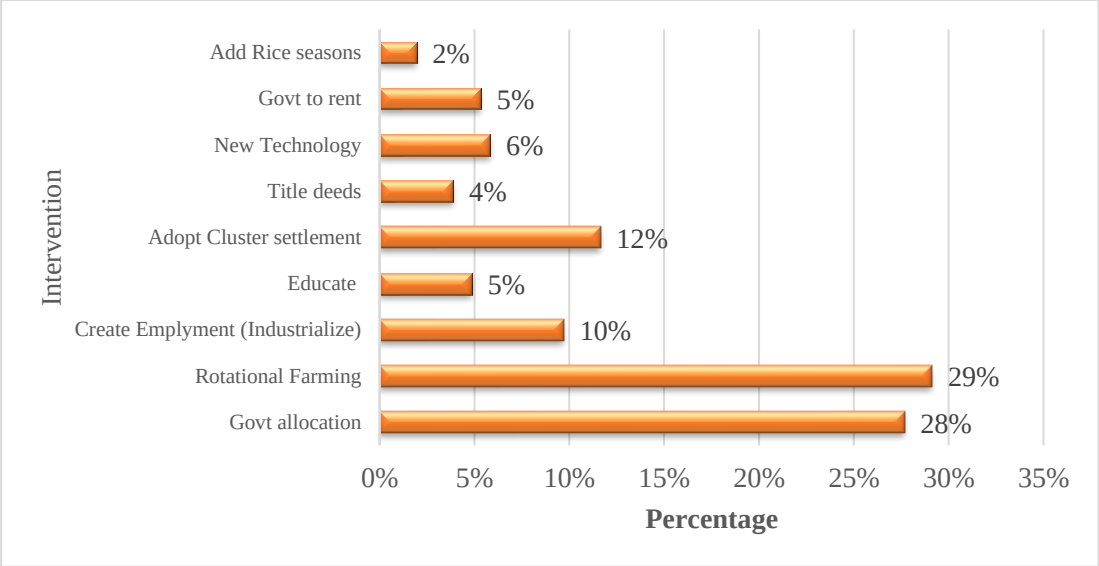
This was anticipated to go on since the sons to the participants were married and expecting sons soon who ideally should inherit their grandfather's land.

5.9 Proposed Planning Interventions

Majority of the respondents, roughly 81 percent argued that land subdivision should continue despite the adverse effects on productivity while just a few thought otherwise. The few thought that an intervention was necessary to combat the negative effects of land subdivision. Asked on the solutions to the challenges of land subdivision, majority of the respondents, around 29 percent reported that the country and their scheme should adopt rotational farming. About 28 percent others felt that the government should allocate more land especially in form of acres that can be divided while a 5 percent others wanted the government to rent land to her citizens and in so doing abolish land ownership which would reduce the land disputes and also ensure that those who did not use their parcels maximally were not guaranteed renewl of their tenancy.

An estimated 10 percent intimated that industrialization to create employment was the only solution while 5 percent others noted educating children was the surest way to have them get better jobs and afford land elsewhere. A paltry 6 percent reported adoption of new farming technologies like green houses and mechanized farming as the best solution to increase farm yields and meet household food needs without having to subdivide land. Only 2 percent of the respondents proposed an increase in rice seasons. FGD and key informant interviews indicated that increasing the number of rice seasons to two a year, practising rotational farming and educating children not to be dependent on land for their living or to be able to buy their own land were the key and viable solutions to challenges of land subdivision and food and livelihood security.

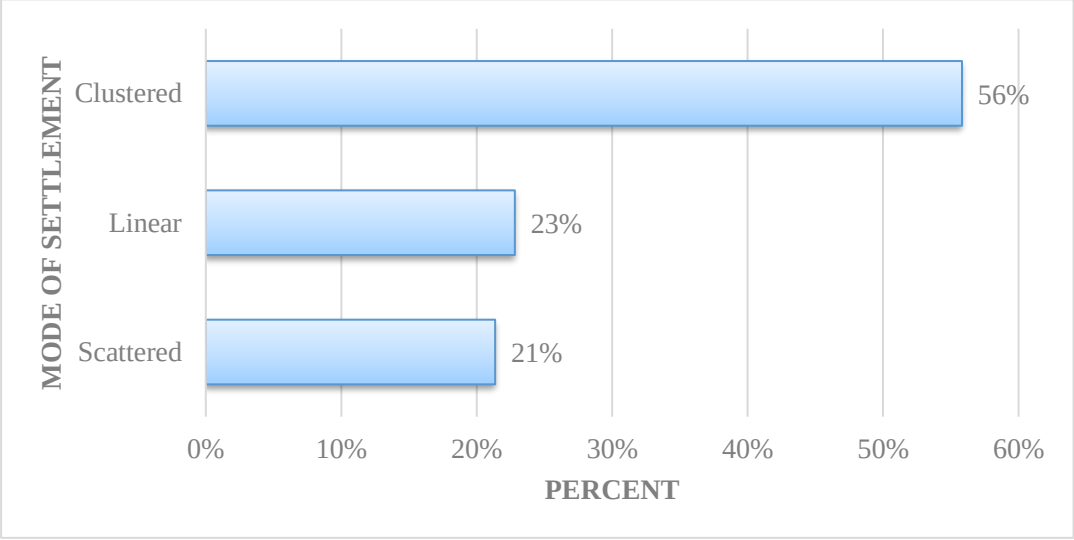
Chart 18: Proposed Interventions



Source: Field Survey, 2018

On human settlement, majority of the respondents preferred clustered high-rise settlement within the villages. This was proposed as a way to reduce land used on human settlement.

Chart 19: Preferred Mode of Human Settlement

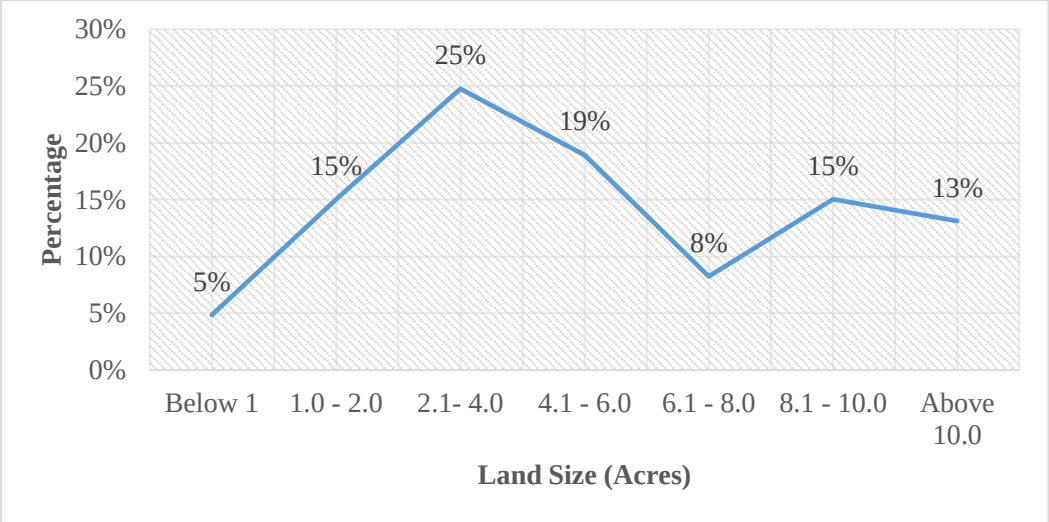


Source: Field Survey, 2018

5.9.1 Field Survey Based Ideal Household Land Size

The average proposed ideal land size per household was 7 acres with a minimum and maximum of 0.25 and 30 acres respectively. Majority of the respondents at almost 25 percent proposed an ideal size of 2 to 4 acres while another estimated 19 percent proposed ideal sizes of 4.1 to 6 acres. Nearly 59 percent of the respondents proposed ideal household land sizes of between 1 and 6 acres which in this context is contrary to the mean most likely distorted by extreme values. These perceptions were seconded in the FGDs who on average proposed ideal household land size of 5 acres. The key informants including the County Physical Planning Office, the sub county agricultural office and the sub location assistant chief's office recommended 4 acres as ideal household land sizes with the County Physical Planning Office suggesting a minimum land holding size of a quarter an acre per household.

Chart 20: Proposed Ideal Household Land Sizes



Source: Field Survey, 2018

5.9.2 KIHBS Based Ideal Household Land Size

Based on the Kenya Integrated Household Budget Survey (KIHBS) 2015/2016 estimates released by the Kenya National Bureau of Statistics, a rural household with an average of five members must earn an average net income of Kshs. 195,120 per annum with a per capita requirement of Kshs. 39,024 per household member. In regards to optimal yield from the farms in Kiratina sub-location, an ideal household land size for the average household of 4.4 (5) members in the sub-location is estimated as follows.

An acre of land produces on average 22.5 bags of 100 kgs of paddy Pishori Basmati rice a season. The average price of unprocessed kilogram of paddy Pishori Basmati rice is sold at Kshs. 69. This indicated that on average, a household earns a gross income of Kshs. 155,250 from an acre of Pishori Basmati rice. Further, the total cost of inputs per acre is averaged at Kshs. 50,000. This gives a net household income from an acre of Pishori Basmati rice of Kshs. 105,250. This means that a household of five members will need a minimum 1.85 acres if it is to meet its per capita budget requirements of Kes 195,120. This computation is based on the understanding that each member of the household survives by a total Kshs. 106.92 a day since Kshs. 195,120 is equivalent to Kshs. 534.58 a day for a household of five members. Based on this finding, the study recommends an ideal minimum household land size of 2 acres for the residents. This is clearest indication that the initial allocation of 4 acres a household was very ideal to aid in creation of wealth as it was far beyond the optimum minimum household land size. Additionally, it must be noted that with adoption of proper technology and intensive farming, the yields per acre can even be higher to even 30 bags of 100kgs of paddy Pishori Basmati rice and thus additional income to the household.

5.10 Hypothesis Testing

The study sought to test several hypotheses. The findings were as presented below.

H1: Households that are food secure have significantly larger land sizes than households that are food insecure

The first objective sought to examine the effect of household land size on food and livelihood security in the irrigated rice farming system of Kiratina sub-location in Kirinyaga County. To meet this objective an independent t-test was performed which examined whether there existed a significant difference in land size of those who were food secure and those who were not. A Levene's T-Test for Equality of Variances were conducted and mean land sizes used to compare the outcomes. The units of test included comparisons on the duration a household was food secure, and the mean household land sizes. The results were presented in Table 12.

Table 12: T-test Comparison of Means between Food Secure and Food Insecure Groups

Duration a household was Food Secure (Comparisons in Months)	t-test results	sig	Average Land Size (Acres)			
			12 months	9 months	6 months	3 months
12 vs 3 months	2.952	0. 004	3.2464			1.0417
12 vs 6 months	1.444	0.152	3.2464		2.4265	
12 vs 9 months	-0.426	0.671	3.2464	3.5000		

The results indicate a significant relationship between household land size and food security for households that were food secure for 12 months as compared to those whose food lasted only 3 months where t=2.952 and sig = 0.004. The rest of the tests were not significant. This shows that households with large land sizes had higher chances of being food secure holding as opposed to those with smaller land sizes.

A correlation test was carried out to determine if a significant relationship between the household land size and number of months a household farm harvests lasted the household. The results were found to be positive and significant at 0.01 and r = 0.392. This indicates that there indeed exists a relationship between the size of the land a

household holds and the duration farm harvests last a household holding constant other factors such as the variety of rice grown, the size of household and other sources of household income.

These findings were in agreement with the descriptive statistics. The findings indicated that households with small land sizes dependent on household head's decision on the variety of rice to plant, type of farm inputs used and the ability to manage the farm free from pests, diseases and other pathogens. Planting of high yield less profitable Sindano or BW variety is the best explanation to the negative t-test results for six- and nine-months food secure households. Additionally, the variance in land sizes was highly contested with an average one and half acres a household, it was rather cumbersome to draw a clear line boundary between larger land sizes and smaller ones. The difference was largely insignificant and thus unreliable to provide statistical data that would have gone the hypothesis way. Perhaps the explanation can be verified by Table number 13.

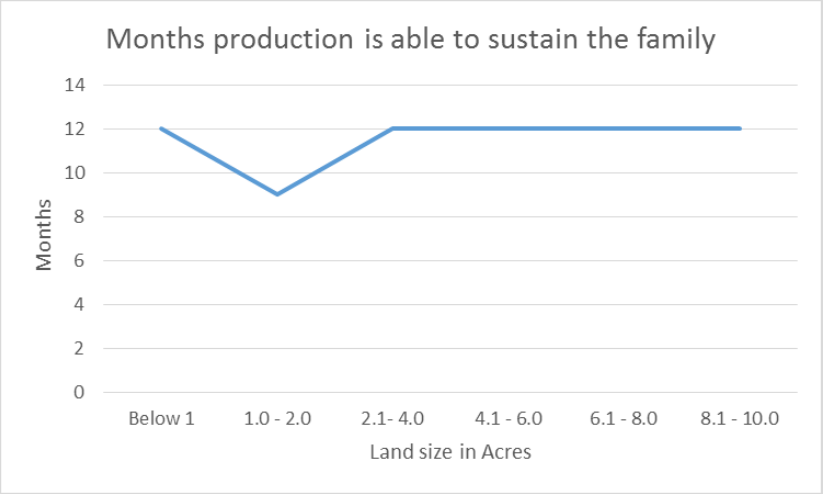
Table 13: Variance in Farm Productivity

HH Land Size	Yield (Kgs)	Skipped a meal (last 3Months)	Food Security Status (Months)	Average Annual Farm Income (KES)
0.5	1,500	Yes	5	91,000
0.5	3,000	No	12	195,000
2.0	4,000	No	5	260,000
2.0	12,000	No	12	780,000
4.0	7,200	No	12	468,000
4.0	11,200	No	12	728,000

Source: Field Survey, 2018

The variance in productivity is thus a key determinant of household food and livelihood security as opposed to household land size as it can be seen equal land sizes with different production levels explained by above reasons. Chart 21 gives the strongest indication that household land size was not the sole determinant of household food and livelihood security but rather a combination of multiple factors cited earlier.

Chart 21: Number of Months Farm Production Sustains a Family



Source: Field Survey, 2018

CHAPTER SIX

Summary of Findings, Conclusions and Recommendations

6.0 Introduction

This chapter provides a brief discussion of findings, conclusions drawn from the study and the recommendations based on results of the field work. In addition, it also identifies recommended topics for further research.

6.1 Summary of Findings

The summary of findings was based on objectives of the study. The findings are summarized as follows: -

6.1.1 Household Land Sizes and Uses in Kiratina Sublocation

The household land size in the irrigated rice farming system of Kiratina sublocation was initially determined by the National Irrigation Board (NIB). Each household was initially allocated four acres of land for rice farming. The study found that land subdivision has resulted to tremendous changes in household land size. Currently, majority of the households, (55%), own less than two acres of land. The current household land size was found to range from 0.13 acres to 10 acres with the average household size for all respondents standing at 1.48 acres. Further, the average household land size arising from land subdivision is 1.1 acres. This indicates a great change on size of household land from the initial 4.0 acres to the current 1.48 acres. This represents a 63% change in household land size. The change from generation one to two is 72.5%.

Land is mainly used for agricultural purposes in Kiratina sublocation. Rice is the dominant crop, occupying up to 95 percent of the entire land size. Human settlement occupies the remaining five percent. Public use, recreation, transport and mixed commercial use occupy insignificant percentage of the entire land size of the sub-location. Other food crops are farmed in areas outside the irrigation scheme while a few farmers squeeze vegetables within the rice paddies. At the onset of the scheme, land had been set aside for vegetables and other staples including maize and beans but this

land has since been taken by the growing population and is currently used for settlement purposes.

6.1.2 Impacts of Land Size on Household Food Security

In the rice irrigated system of Kenya, household land size impacted on household food and livelihood security albeit not independently. The study established that farm productivity depends on multiple factors that include the household head's decision on the variety of rice to plant, access to farm inputs, farm management practices and the household land size. The size of household land was determined as affecting total farm production with low total yields for small land sizes and high total yields for large farm sizes under similar management practices. These findings that household land size impacted on household food and livelihood security is in agreement with scholars of a similar opinion like Tegemeo Institute's, Kassie et al (2012) among others.

The findings indicated that land subdivision affected household food and livelihood security especially because of the low total produce due to their small land sizes. These findings correspond with the findings by Obonyo et al. (2016), Gurung, et al (2016), Kiplimo B. and Ngeno V. (2016) amongst others that, generally, large landholding sizes were an assurance of food security as compared to small household land holdings. Farm income was found to increase with increase in land sizes an indication of the critical role of farm sizes. Those with large farm sizes had reported high farm proceeds as compared to those who had smaller farm sizes.

Those with larger land sizes were food secure when compared to majority of those with smaller land sizes who reported to have skipped a meal, ate strategically or little and their harvests lasted on average eight months. This agrees with Tittonell, (2007) and Bogale, A and Shimelis, A., (2009) that farmers with relatively large farm sizes had longer periods of food security as compared to those who had small land sizes as a result of having better chances to produce more.

Casual laborer, self – employment and business (boda boda and shopkeeping), employment, merry go rounds (women SHGs), obtaining food on credit were the major coping mechanisms adopted as well as leading off farm income methods that supported majority of households particularly the food insecure ones.

6.1.3 Impacts of Land Uses on Household Food Security

The choice of land use directly impacted on household food and livelihood security. In the irrigated rice farming systems in Kenya, cluster village like mode of settlement is highly adopted. However, owing to growth in population, new villages uncontrollably come up with need to settle upcoming generations. All land set aside for other alternative agricultural produce to make a complete meal ends up becoming human settlement land. This extension of human settlement into farming land has been noted to contribute to household food and livelihood challenges with dietary challenges growing daily. Household land use decisions impacted on household food and livelihood security. Although no literature had anticipated that, scholars argued that household land use decisions were context specific and thus permitting the kind of findings reported.

With high yielding rice varieties of BW and Sindano being the preference of majority with small farm sizes due to their high yields as opposed to high value Pishori Basmati variety which has low yield per unit area and largely preferred by majority in the entire sub location. The net effect on household farm income was almost equal, however those with high variety low value type having to part with more as opposed to those with low yielding highly valued variety.

The findings showed that farmers had no control over farm use decisions with the only option of government regulation to plant rice in the entire region. They lacked the opportunity for diversification as there was no room for such with human settlements occupying the only available land that could have been utilized for crop diversification. They missed the benefits of crop diversification and rather suffered the pain of mono cropping which had been identified by literature (Pitakpongjaroen and Wiboonpongse, (2015) and others) as having inconsequential effects on productivity resulting to low yields and affecting household food and livelihood security. In the study area, the findings indicated unregulated sell of the rice harvests to purchase complimentary food stuff to complete nutrition and dietary requirements, low prices at harvest time due to flooding the market with high supply against low demand and increased use of pesticides attributed to crop susceptibility to pests all which impacted on the overall yield and negatively on the household food and livelihood security.

6.1.4 Factors Influencing Household Land Size and Use

Population pressure was the single largest contributor of land subdivision with selling, leasing, gifting of land, divorce, family disputes and for obtaining credit (commercial purposes) being the other major contributors to land subdivision. The combination of the factors, largely endogenous to the household contributed to food and livelihood security of the household. Households with large land sizes were to a greater extent food secure with majority of those with small land sizes being highly prone to food insecurity and livelihood challenges. Notably, with other factors remaining constant, land subdivision posed a threat to household food and livelihood security. The findings agreed with literature on the household land size and use determinants and the cause of the variances.

6.1.5 Intergenerational Transfer of Land Rights and Uses

Population growth in the Mwea rice irrigated schemes is the one major factor that affects household land size and use. Growth of population forced subdivision for inheritance as well as extension of human settlement to all open spaces. There is a major challenge on where to settle the upcoming generations with the previous generations having occupied all available open spaces in the study area. Other factors such as leasing of land, government regulation, selling of land and gifting of land as well as household size influenced household land size and use decisions.

In the rice irrigated farming system of Kiratina sub location, intergenerational land rights transfer was rampant owing to the growth in population. The Government allocated land has seen intergenerational rights transfer, albeit illegal, from the allotted to their sons and daughters and grand sons and daughters on to the current third generation. This won't stop anytime soon unless functional planning interventions are identified and implemented. Inheritance was reported as the leading driver to the intergenerational land rights transfer, something that agrees with literature that customs, traditions and formal succession of land rights resulted to reduced farm sizes. Majorly, inheritance by sons with the eldest one having preference for the lion's share with women not inheriting their parents land were reported as leading contributors to transfer of land rights ownership with selling, leasing, gifting and allocation following closely. This, in tandem with scholar's arguments on gender and land inheritance, resulted to

reduced household land sizes and hence posed a threat to household food and livelihood security.

6.2 Conclusion

In the rice irrigated systems of Kenya, households with smaller land sizes are highly vulnerable to food and livelihood insecurity as compared to those with large land sizes. Households with large land sizes have relatively longer periods of food security than those with small farm sizes. Household food and livelihood security did not necessarily depend on household land size and use but rather on combination of other multiple factors including use of farm inputs, household size, rice variety, farm maintenance and pests and disease control. Household land use decisions and human settlements as the other factors that affected household food and livelihood security. Population growth is the single largest determinant of household land size and use contributing to land subdivision for agricultural and settlement use. The net effect is decrease in farm sizes and hence low yields as minute farm sizes can't be mechanized resulting to low production as compared to larger farms.

Intergenerational transfer of land rights is prevalent in the irrigated rice farming system of Mwea which greatly impacts on land sizes as the transfer from one generation to the next demands subdivisions to the number of heirs of that one unit resulting to small land sizes. With land subdivision for purposes of inheritance, selling, gifting, for settling family disputes and for leasing set to continue, the threat of household food and livelihood security will continue to haunt the families and hence impact on future generations. The need for workable interventions is past due and the proposed interventions must be implemented so that their net effect to the household land size and use can be realized.

6.3 Recommended Planning Interventions

Owing to the outcomes of the study, the following several planning interventions, if effectively implemented would turn around household land size and use for food and livelihood security.

Planning policy interventions that are in place already ought to be implemented in order to regulate land subdivision, use, ownership, transfer and succession procedures including a ban on land subdivision for inheritance by heirs.

Adopt high rise cluster form of settlement. This form of settlement will reduce the size of land occupied by settlement structures as well as accommodate high number of residents. The adverse effects of land for human settlement on productivity and other agricultural use would be avoided and younger generations will be accommodated within the same compound. There is need to ease regulations on construction and funding of such projects that would easily see the mode of settlement shift noting that currently, the villages are burgeoning with growing population with no further room for expansion for human settlement.

The government should remain the custodian of land. It should rent out the land and restrict subdivision and regulate use. This recommendations link to the second one in that, if the government remains custodian of all land, it would regulate land use, ensure no transfer of land rights and maintain the land sizes thus resulting to a parallel high peak plateau in production. If the government owns the land, the developments on it would be easily regulated and standardized, and letting would be only to those that have utilized profitably their existing rented land. It would ensure no idle land and easily create transitions on land use and management resulting to increase or sustenance of productivity.

The county should invest sufficiently in agro-industrialization. Industrialization means transforming the country's dependence on agriculture production-based economy to an industrial one. There is need to grow local industries and increase opportunities for employment. This would be critical in eradicating the need for land inheritance. With a quality education system in place, industrialization would be a better solution in addressing challenges of land subdivision.

Promote family farming enterprise system. Family farming enterprises would be the best way to achieve industrialization and a competitive functional economy would be the driver of this recommendation. When family based agro-industries arise and ensure intergenerational employment history, heirs would inherit the enterprises with well-set institutional and managerial systems to ensure a thriving business environment and succession hence achieve the intended goal of eradicating land subdivision.

Adoption of modern technology such as Systems of Rice Intensification (SRI) would be a better way to increasing farm efficiency hence increased productivity at economical water consumption. The system, if adopted would reduce water use in

paddies by over forty percent and thus would aid in the establishment of two seasons a year proposed above at the same time increasing productivity per acre.

Finally, it is essential for households to determine alternative household incomes especially through supporting education of children. These alternative livelihoods mechanisms would in effect reduce pressure on land and overdependence on agriculture as the only means of survival. Other possible options would be engaging in entrepreneurial activities, civil service engagements, private sector employments and even involvement in Jua kali sector. As a result, further, alternative modes of bequeathing wealth and inheriting children would eventually be identified like insurance policies, shares in companies, government bonds, business entities amongst others. These mechanisms would in return manage land subdivision as need for inheritance of land is reduced.

6.4 Recommendations for Further Research

The following topics for further research are highly recommended. This with the belief that if well studied, they would contribute to the body of knowledge as well as expand the solutions of challenges bedeviling irrigated rice farming systems in the country.

i. The cause, level, effect and solutions to debt cycle on irrigated rice farming systems and ways of eliminating the debt cycle among rice farmers.
ii. Possible benefits of introducing a legume and or a livestock enterprise for nutritional security.
iii. To determine ways the government can use to obtain more land and lease to more and younger farmers to manage land subdivision.
iv. How can the government can be the sole holder and trustee of all land?
v. How can middlemen be organized to deliver their services fairly?
vi. Explore opportunities for high rise housing development for purchase by rice farmers.

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Appendix 1: Household Questionnaire

HOUSEHOLD QUESTIONNAIRE

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

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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 Are there any cultural practices around 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 owned family land size in acres? .....

3.4 Owned land characteristics

No.	**Spatial Location and distance (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 (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 Have they done any sub-division? .....

3.12 If there has been any sub-division then to how many heirs or beneficiaries? ….

3.13 Do you think as a country we should continue sub-dividing land among heirs?

3.14 If yes to 3.13 why do you think so? .....

3.15 If no to 3.13 what do you think we should do as a country?

.....

3.16 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 ( ) Current 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 farm yield availability (months)**	**Coping Strategies Employed**
a	Sufficient food	At least 12 Months	
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**	**Wednesday**	**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 Land fragmentation has made people adopt new farming techniques and skills

Agree ( ) Disagree ( ) Not sure ( )

5.0 Human Settlement

5.1 Sketch the current arrangement of the homestead?

Home compound parameters	**Remarks**		
Total area of homestead compound (Sq. Meters)			
Main house total area (Square meters)			
Main house number of rooms			
Main house construction materials	Floor	Wall	Roof
Total **number** and Total **area** of other houses (Square meters)			
List other structures in the homestead (granary, firewood store, cowshed, chicken house, dog house etc.			

5.2 Given the way land is being sub-divided among heirs - what is your proposal on how farms should be organized in the future

……

5.3 Given the following possible patterns of human settlement – rank them in your order of preference.

a. Scattered

b. Linear

c. Clustered

d. Others - Specify

5.4 Do you have any question for us?

…….....

Appendix 2: Key Informant Interview Schedule

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

Name of respondent……..……...

Position of respondent……...

Gender of respondent……...

Name of Interviewer…….

Schedule Number…….

Interview Guide Questions

a) What is your opinion on land subdivision?
b) What is the most common tenure arrangement in Kiratina Sub-location?
c) What are the effects of land subdivision in the area?
d) What are the most common forms of land use patterns in Kiratina Sub-location?
e) What is the most common form of human settlement?
f) What do you think should be done to solve challenges associated to land subdivision?

Appendix 3: Focus Group Discussion Guide

Focus Group: Demographic Details Questionnaire

Age……...

Gender Male ☐ Female ☐

Name (Optional)…….

Occupation …….....

How long have you resided in this locality?

Years…….

Months……...

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*
- *If you have any questions now or after the discussions, feel free to contact me or any other team member through the contacts provided below*

- *We may have to tape the discussions so as to be able to capture the thoughts, ideas and opinions we hear from the group*
- *Please check below box to confirm you agree to participate*

☐ This is to confirm that I give my consent to voluntarily participate in the group discussions as long as the stated above consent details are strictly adhered to and that I was not coerced to participate in the discussions but voluntarily decided to partake in its deliberations.

Introduction

- Introduce myself and my team, issue the demographic details sign in sheet. Review details of who we are and what we are doing, the purpose for the information, and why we asked you to participate.
- Explain the process of the discussions, find out if any member has participated in FGD before.
- Give logistics of the discussions like details of expected length of discussions, freedom of participants, details of cloakrooms, refreshments etc.
- **Set ground rules to guide the discussions**
- Turn on tape recorder
- Probe for any questions or concerns from participants before starting
- Participants to introduce themselves
- Discussions begin, sufficient time to be allocated to members to think before responding to questions, be able to probe further for more details.

Questions

a) Let's start the discussion by talking about our history of origins and when we settled here, what brought us here and what size were our farms
b) Have the land/farm sizes changed overtime, what brought about these changes?
c) Has productivity been changing overt time? Why is it so?
d) Is productivity dependent on ownership of land?
e) Is the farm produce sufficient? How long does it last?
f) Considering the time, we settled here and now, has our land uses changed?
g) And how come we settled to plant rice as opposed to the other crops?
h) What settlement patterns have come up since we settled, are the same houses enough or many others have come, does this affect land size and use?

Appendix 4: Observation List

The following will be observed during the field survey for primary data collection

- Land sizes
- Settlement patterns
- Housing structures
- Field crops and sizes allocated to each
- Demarcations of farm sizes

Appendix 5: Photography List

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

- Housing structures
- Cropped farms
- Non-cropped farms
- Demarcations of boundaries
- If possible, aerial photographs showing the land sizes and well delineated boundaries
- The people at their natural state as much as possible (with their consent)

Appendix 6: Document Reviews

The following documents shall be reviewed

- Maps in time intervals of 10years beginning 1954
- Photographs indicating historical changes in the land size and use in the study area since 1954
- Hospital/dispensary/clinic record sheets on dietary related diseases such as marasmus, kwashiorkor and malnourishment

Appendix 7: Inter-generational Land Rights Changes Interview 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……...

Name of Interviewer……

Schedule Number…….

Interview Guide Questions

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

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

c) Do you still own the same size of land/farm?

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

g) What other major crops were grown?

h) What determined the kind of crop one planted?