ASSESSMENT OF HOUSEHOLD LAND SIZE AND USES FOR SUSTAINABLE FOOD AND LIVELIHOOD SECURITY IN MAIZE FARMING SYSTEMS: CASE STUDY OF MATETANI SUB-LOCATION, KANGUNDO SUB-COUNTY, MACHAKOS COUNTY

BY

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DECLARATION

This thesis is my original work and has not been presented for any degree in any other University.

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ABSTRACT

Despite the concerted efforts at global and national levels to fight food insecurity, undernourishment and deplorable livelihoods are still rampant in the world and particularly in developing countries Kenya included. Food insecurity in Kenya is estimated at over 25 percent of the total population, with about 1.5 million people requiring emergency food assistance annually. While agricultural productivity in general appears to be increasing in Kenya, rising land pressures in the more densely populated areas is a major threat to future household farm land sizes and uses, food, nutrition and livelihood security. This study (i) determined the current household land size and uses and their impact on food and livelihood security, (ii) analyzed the factors that influence the size and uses of household land in the sub-location, (iii) interrogated inter-generational transmission of land rights and (iv) proposed planning interventions that can create sustainable land size for food and livelihood security in maize farming systems of Matetani Sub-location. The study used a descriptive survey design. The number of households in each village formed the sampling frame and stratified random sampling method was used to select households from each village. Extreme case sampling was also done to identify five farmers with the largest land sizes and five with the smallest land sizes. Inter-generational lineage sampling was done by identifying the three oldest men and the three oldest women in the sub-location. Key informants were selected using purposive sampling. The total number of households interviewed in the sub-location was 140. Data analysis was by use of SPSS software and descriptive methods. Data representation was through charts, cross tabulations and narratives. The findings revealed average household land size of 2.19 acres with the majority of the households having 2 acres. Agricultural land uses were categorized into three; cash crop, food crops and pasture with cash crop and food crop land use found to have positive and significant relationship with the household food security. Hypothesis test results showed that household land size had a positive and significant effect on household food security as supported by a P value of 0.009 which is less than 0.05. The study concluded that, household land size had been diminishing while the population has been growing tremendously causing to low productivity and a mean household food security index was 0.822 which implies that the most households were food insecure. The study further concluded that, other than the current small farm sizes and inappropriate land uses in the area, food security in Matetani Sub-location had been compounded further by, adverse environmental conditions such as soil erosion, water logging and unreliable weather patterns; poor land management practices; low adaptation of technology; lack of access to credit; lack of secure land tenure; unregulated culture of inheritance and inefficient extension services. The study thus recommends implementation of policy through the National Land Commission that discourages land subdivision in farms below 3.42 acres. However, the policy should be reviewed as land productivity increases through use of appropriate technologies making it possible for the land to support more people per hectare. For intergenerational land transmission, the study recommends that, the government through the Ministry of Education should ensure that each child gets quality education as a substitute for land inheritance so as to break away from the culture of land inheritance. Through Multiple Regression Model the study found out that, the combined effect of the predictor variables (household land size, age of household head, household size, off farm income and land management practices) explains 56.42% of the variations in household food security in the study area. Thus for further research, the study recommended that, a more explicit research should be carried out to explain the remaining variables contributing to 43.58% of household food security so as to give conclusive measures.

DEDICATION

I dedicate this work to my loving and supportive family.

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To God our creator, father and fountain of life and wisdom, who gave me the strength to complete this work,

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ABBREVIATIONS AND ACRONYMS

ACD	:	Agricultural Census Data
ADR	:	Institute of Development Research, Addis Ababa University
AFDB	:	Africa Development Bank
ASAL	:	Arid and Semi-arid Land
BASIS	:	Broadening Access and Strengthening Input Market Systems
CAADP	:	Comprehensive Africa Agriculture Development Programme
CGIAR	:	Consultative Group on International Agricultural Research
DAP	:	Di-Ammonium Phosphate
DEA	:	Data Envelopment Analysis
FAO	:	Food and Agriculture Organization
FEA	:	Food Economy Approach
GDP	:	Gross Domestic Product
GOK	:	Government of Kenya
HEA	:	Household Economy Approach
KLA	:	Kenya Land Alliance
LCA	:	Land Control Act
LCB	:	Land Control Board
LPA	:	Land Planning Act
MASS	:	Million Acre Settlement Scheme
NLC	:	National land Commission
NLP	:	National Land Policy
NSP	:	National Spatial Policy
SDGs	:	Sustainable Development Goals
STISA	:	Science, Technology and Innovation Strategy of Africa
UNDP	:	United Nations Development programme
WHO	:	World Health Organization

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CHAPTER ONE

INTRODUCTION

1.0 Background to the Study

Ferreira (2016) estimates global poverty to be at 40 percent with most of them living in Sub-Saharan Africa while Livingston, et al., (2001) adds that, many of them engage in agriculture as their main source of livelihood. Therefore, understanding land productivity is central component of Sustainable Development Goals aiming at reducing poverty, nutrition and food security and development of the economy. A 10 percent increment in productivity of a farmland has been found to cause a 7 percent decrease in the number of people suffering from poverty in Africa (Irz, Lin, Thirtle & Wiggins, 2001). Ali and Deininger (2015) alluded that, in as much as land productivity is an important factor in the determination of the wellbeing of households' food security, nutrition and livelihood globally, the relationship between the descriptive characteristic of household farmland size and land productivity has remained a puzzle over the years.

1.1 Importance of Agriculture to the National Economy

Agriculture is the backbone of Kenya's economy. According to the economic outlook of 2016, and 2017 Deloitte and Touche (2017), Kenya's agriculture sector contributes immensely to the national economy. Its direct contribution to Gross Domestic Product (GDP) in 2016 and 2017 was 25% and 26% respectively. Indirectly through linkages with manufacturing, distribution and other service sectors agriculture's contribution to GDP was 27%. The sector contributes 45% of government revenue and provides 75% of the industrial raw materials. Kenya's export earnings from agriculture are over 50%. Up to 75% of the total of Kenyan population working part-time in the agriculture sector and it also provides 60% total employment. Overall, it provides livelihood opportunities for over 80% of the rural population.

Trend analysis of the National GDP and Agricultural GDP growth rates from 1986 to 2014 shows that when agriculture performs well, the national GDP improves proportionately. This calls for sufficient attention and investment in the sector. FAO (2005), Marani (2012) and Bremner (2012) revealed that, domestic and international agriculture provides food for direct consumption and for raw materials for refined and packaged foods. Sustained growth of the agricultural sector therefore will strongly influence the overall national economic performance and also contribute to food, nutrition and livelihood security. Knowledge of how different factors of production particularly land, relates with food and livelihood security can greatly contribute to the type of strategies that can be adopted in different farming systems for sustainable rural land utilization.

Despite importance of agriculture in the livelihood of the people and its potential, agricultural sector in Kenya has remained subsistence, low input, low level of productivity, heavily rain relied and unable to adequately feed its own population sufficiently and the country is not self-sufficient in food production and prevailing both chronic and transitory food security (MoARD, 2010 and Degefa, 2002).

While investigating farming systems in Kenya, Mantel and Van Engelen (1997) pointed out that maize crop is one of the staple foods in Kenya thus it should be considered of great importance to agricultural policy decisions, food and livelihood security as well overall growth of the economy. Jayne et al., (2001) noted that, in Kenya's maize played an important role in the production patterns and accounted for 28 percent the small scale farming sector gross farm output.

Despite maize's importance in the country, its national gross productivity has not paced up with consumer needs. Its supply has thus not kept up with demand caused by the rapid growth in

population (GOK, 2015). Annual consumption of maize is estimated have been in excess 30 million bags. Nyoro et al., (1999) accentuated that, in attempt to bridge this gap between supply and demand, Kenya opted to import maize from Tanzania, Uganda, Malawi, South Africa and United States of America through formal and informal ways.

1.2 Impacts of household land fragmentation on food, nutrition and livelihood security

McPherson (1982) pointed out that, land fragmentation has been a major concern among policymakers and economists alike since the emergence of land reforms across Europe in the Mid-Nineteenth Century. Recently the renewed concern on land fragmentation is as a result of the alarming decline agricultural productivity, farm inefficiency and persistent food security problem in especially in developing countries Kenya included. Land fragmentation has been defined and understood differently within different countries with different economic contexts resulting to; several methods and approaches have been developed and used to analyze the phenomenon (Van Dijk, 2003). Contradicting views and conclusions regarding whether land fragmentation should be considered as a problem or not (Demetriou, 2013) have risen due to the lack of a single conventional approach. A contested causation developed due to the varied multidisciplinary treatment and measurement land fragmentation causing persistent scientific disagreement and debate (King & Burton, 1982).

Fragmentation of land has therefore been defined as the condition in which a single farm contains numerous parcels which are separated spatially (Van Dijk, 2003). He went ahead to distinguish the types of fragmentation of land as: (i) Ownership fragmentation showing the land owners using a piece of land; (ii) Use fragmentation showing the numbers of tenants using the land; (iii) Internally fragmented land showing the number of parcels controlled by each user and

takes into consideration shape, size, and distance of the land parcel and (iv) Ownership and use separation which brings out the discrepancy between use and ownership of land.

As much as land fragmentation definitions vary from place to place, Bentley (1987) and Demetriou (2013) agree on the following factors as triggers to fragmentation: growth in population, land inheritance, land markets, and history of land. Various policies have been adopted based on the causes so as to limit fragmentation of land and have been categorized into three: legislation, land protection policies/programmes and approaches to land management.

Several studies have discussed in depth the effects of land fragmentation on agricultural productivity however; most of these studies have not investigated the sustaining factors of land fragmentation in spite of its negative effects on food and livelihood security of the farming households (Kiplimo & Ngeno, 2016). Studies by Bizimana (2006) suggested that more research has to be done in the area of cultural land inheritance system in African societies to establish the reason for its persistence even when it is uneconomical to sub divide land further.

Although land fragmentation has negative connotations, (Bentley, 1987; Van Dijk, 2003) bring out a counter point of view of its benefits which include; optimization of crop schedules especially where parcels are spatially scattered at different altitudes and locations giving the crops different maturity rates, management of climatic and natural disasters by dispersing parcels to reduce the risks and exploration ecological variety of crops by formulating a natural mosaic of the land shapes, and crop colors.

Currently, the declining farm sizes in both ownership and use has become a major policy concern especially in Sub-Saharan Africa and specifically in Kenya since logically it implies dis-economies of scale in food production (Kiplimo & Ngeno, 2016).

A recent study in Iringa and Njombe regions in Tanzania, (Kamau*et. al.*, 2017) positively related land fragmentation and productivity results from interactions between the supply factor (food) and a demand factor (population), where the dominating factor is depended on the prevailing environment supporting farming in a particular place.

However, numerous researchers and authors have overtime showed the negative effects of land fragmentation which have brought land reforms such as consolidation processes in different countries like Vietnam. Land fragmentation is a critical rural spatial challenge and concerns mainly farms whose land is systematized poorly across different spatial locations, as characterized by (King & Burton, 1982). Several researchers and authors view land fragmentation as a huge hindrance to efficient agricultural development since it hampers use of machines, causes inefficient production and increases the costs to assuage the adverse impacts resulting from reduced farmers' income thus, with the current increased competitive agricultural markets and industrialization, the situation is worse in the present day (Yates, 1960; Thompson, 1963; Karouzis, 1971 and Blaikie & Sadeque, 2000).

According to Mwabeza and Gaynor (2002), land fragmentation might also increase disputes among neighbors as well as hinder development of infrastructural facilities including roads, communication and drainage. Rahman & Rahman (2008) bring out effects of land fragmentation as leading to small sizes plots which are economically hard to operate, increased transportation costs between plots as well as time consuming, difficult to manage and supervise and therefore requiring more land for fencing as well as developing paths and roads.

Farmers occupying and tilling small and fragmented plots are left with no choice but to grow certain crops deemed to be not profitable such as maize since more profitable one require more land and space as it the case with fruit crops. They are also faced with lack of access to credit

facilities for agricultural investments since banks are not willing to take small sized pieces of land which are scattered at different places as collateral (World Bank, 2005). Natalia (2013) reported that in Bulgeria, land fragmentation hindered achievement of meaningful socio-economic growth, and is responsible for poor evolution of land markets, discouraged public and private investment and has led to poor utilization of land resources.

It is noted that over 75% of the agricultural output in Kenya is from small scale rain-fed farming or livestock production. In as much as general agricultural productivity in Kenya appears to be rising, the increasing land pressures in the more densely populated areas is threatening future household farm land size, food, nutrition and livelihood security (Tegemeo Institute, 2014). In a recent study in Vihiga County, (Kihima, 2017) found an average household land holding of one acre (0.41 ha.) and a Simon's Index of 0.65 reflecting a significant level of land fragmentation. Kihima reports that the small land holdings lead to low farm yield, low household food availability, low income, high population due to migration and land related conflicts reported as 54% at households and 90% at community level. Land conflicts arising from land subdivision in Narok County are on the rise as reported by Gicheru et al., (2010), since the grazing land units have diminished over time and can no longer sustain the pastoral life conflicts arise between different groups especially the pastoralist Maasai and the sedentary population, largely recent migrants. A study carried out in eight agro-ecological zones covering 26 districts found that, more than 30% of the smallholder household farms of the sample population controlled less than one acre of land (Tegemeo Institute, 2014). The total land owned and cultivated had declined over the 20 year assessment study period and was related to the tremendous population growth and high rate land fragmentation for inheritance purposes in many rural areas of the country.

Mahanta and Daisy (2012), have observed that because rural peoples' livelihood is dependent on land as private or communal property, any change that leads to reduction of the land quantity and quality will end up reducing their livelihood. The study adds that high population density in areas with high ecological degradation and scarcity of cultivable land results in surplus labor and unemployment. Affected populations tend to diversify household income generating activities or tend to move to the near-by small and medium sized urban areas in such for livelihood opportunities. The Government of Kenya (GOK), (2008) and GOK, (2016) cites land fragmentation in high potential agricultural areas to have resulted to economically unviable land holdings with a major challenge of ensuring food security in Kenya.

1.3. Statement of the Research Problem

Despite the concerted efforts at global and national levels to fight food insecurity, undernourishment and deplorable livelihoods is still rampant in the world and particularly in Kenya. Food insecurity in Kenya is estimated at over 25 percent of the total population, with about 1.5 million people requiring emergency food assistance annually. Cornia (1985) noted that the issue of farm land productivity varying with farm size has become a subject of interest to many researchers as well as an important policy decision such as its potential benefit to land reforms. Declining household farm sizes and changes in land uses in maize farming systems as a result of land fragmentation are among major causes of food insecurity as cited by available literature.

The government of Kenya (GOK) has undertaken a number of institutional and policy measures to address the perceived negative impacts of land subdivision on food security. Such measures include the provision of extension services and formulation of a number of legal and policy documents, including the constitution, to guide the process of curbing the menace of land

fragmentation. For example, Article 60 of the Kenyan Constitution calls for efficient and sustainable land management practices.

Article 68(c) of the Constitution mandates the government to regulate the size of privately owned land by prescribing the minimum and maximum acreages. The development of a land use master plan which includes the master plan for agricultural land is among the main flagship projects for attainment of Vision 2030 by the Kenyan government. This project is expected to boost the efficiency of utilizing all forms of land in Kenya. However, the government efforts to address land fragmentation have been hampered by lack of adequate and reliable research-based information to guide policy formulation on land size and use and its impact on food security.

The results from previous studies, which have been conducted to evaluate the impact of farm size on household food security and farm productivity in maize farming systems, have been found to be inconclusive. The studies have two main shortcomings: their failure to evaluate the impacts of current household sizes and uses on maize farming systems which are the common farming systems for subsistence farmers and failure to determine the minimum farm size that can ensure household cut-off food security status, nutrition and livelihood in these households. It's for this reason; the current study has been conducted to assess the effect of household land sizes and uses in maize farming systems in Matetani Sub-Location of Machakos as a case study which is among the most populated Sub-County in Machakos.

Various studies as indicated above have been undertaken on the effect of land size on food, nutrition and livelihood security however, at local level, a systematic and scientifically conducted study has not been carried out in recent times Machakos County. As such, the County as well as the country lacks sufficient quantitative and qualitative data on land size and uses in

maize farming systems to guide policy and investment in agriculture for food and livelihood security.

The key information gaps that this study sought to fill included generation of data on:

(i) the implication of current land size and uses on food, nutrition and livelihood security in the densely populated rural area of Matetani Sub-Location in Machakos County,

(ii) estimates of the land holding that can sustain an average rural household in the maize farming systems of the study area,

(iii) sustainable alternative human settlement patterns for the maize farming systems,

(iv) Policy directions on land sizes and tenure rights transmission for food and livelihood security in the maize farming systems in the study area.

1.4. Research Questions

i. What are the current household land size and uses and how do they impact on food and livelihood security in the study area?

ii. Which are the factors that influence the size and use of household land in the study area?

iii. How have land rights been transmitted inter-generationally in the study area?

iv. What are the planning interventions for sustainable food and livelihood security inMatetani Sub-location?

1.5. Research Objectives

Overall Objective

To assess household land size and uses for sustainable food and livelihood security in Maize farming systems of Matetani Sub-location

Specific Objectives

1. To determine the current household land size and uses and their impact on food and livelihood security in Matetani Sub-Location,
2. To examine the factors that influence the size and use of household land in the Sub-location,
3. To interrogate inter-generation transmission of land rights and use in the study area,
4. To recommend planning interventions that can create a sustainable household land size, food and livelihood security in Matetani Sub-location.

1.6. Research Hypotheses

Ho_1: Household land size has no significant effect on household food security.

Ho_2 Household land use has no significant effect on household food security.

1.7. Geographical and Theoretical Scope

This study assessed how household land size and uses had changed over time in the maize farming systems of Matetani sub-location in Machakos County. The area is an administrative division located in Kangundo Central Ward of Machakos County. Its coordinates are 1°19'0" S and 37°19'60" E in DMS (Degrees Minutes Seconds) or -1.31667 and 37.3333 (in decimal degrees).

Conceptually, the study covered aspects of land size and uses that have direct bearing on food security, nutrition and livelihood of the community. The research drew its backing from different theoretical frameworks which present the main factors affecting people's food security, nutrition and livelihoods and the typical relationships between them.

1.8. Justification and Significance

Decreasing land size as a result of land fragmentation and subdivision is affecting food nutrition livelihood security of people especially in the rural areas across Sub-saharan Africa and specifically Kenya. Promotion of sustainable land management requires a thorough understanding of key decisions; drivers, processes and effects of change in land size and uses. According to the Agricultural Sector Development Strategy, about 75 percent of the total agricultural production in Kenya comes from smallholder farmers (GOK, 2010b) thus the formulation of land reforms that aim at ensuring food security and efficiency among small-scale farmers in Kenya is critical. It is thus important to examine how household farm size and uses impacts on the maize farming systems. Determination of the factors that influence the current, unsustainable land size and uses thus offers insights to considerable measures that should be undertaken in developing appropriate policy interventions for improving food security, nutrition and live hoods for households in these farming systems.

The findings are useful to the planning professions by informing them on the implication of current household land size and uses on sustainable food and livelihood security. A planning process, where communities and various stakeholders are involved through effective public participation, can strengthen and speed the decision making process of allocation and utilization of land resources for maximum productivity.

The institutions to benefit on this study include: the policy making institutions such as the National Land Commission in developing the policy on the minimum land size that can sustain a household, making it food secure; providers of extension services; institutions of higher learning and research; farmers and farmers' organizations.

It aimed in aiding the design of strategies to promote efficient and sustainable land resource management for food security, nutrition and improved livelihoods in line with Vision 2030 and in accordance to the Kenya 2010 Constitution. The findings also build into the existing body of knowledge as well as point out gaps in the findings for future research on farm size and food security in maize farming systems.

1.9. Definition of operational terms

The following terms were used in the course of research;

Land use change

In this research, it refers to alteration of natural, physical character of land over time by human action through human settlement patterns, migration pattern, in light of social, economic, environmental and technological developments over space as defined by (FAO, 2003).

Sustainable household livelihoods

Sustainable household livelihoods comprise of the assets and capabilities such as resources, stores, activities and claims required for a means of life with the capability to recover from or cope with stress and shocks, enhance and maintain its opportunities and capabilities for both present and future generations (Chambers and Conway 1992).

Ownership rights

These are conceived as the full package of rights that are inclusive of right to alienate or transfer, manage or make enhancements, exclude others and regulate the proceedings; right to alienate or transfer viewed as the most essential one (FAO, 2003).

Household food security

In this study, it refers to access by all people at all times to enough food for an active, healthy life, which includes at minimum; the ready availability of nutritionally adequate and safe foods as well as an assured ability to acquire acceptable foods in socially acceptable foods (FAO, 2000

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter covers the studies reviewed related to the current research. The review is done based on the objectives. Pertinent issues covered in this study include: The concept of food security, land holding sizes and its effects on food and livelihood security, factors influencing current land sizes and uses, intergenerational transmission of land rights and policy interventions. The study also presents the theoretical and conceptual framework.

2.2 The concept of food security

The World Food Summit WFS (1986) and Food and Agricultural Organization of the United Nations (FAO, 2015) identifies four dimensions of food security which capture different but at times overlapping features of food security. These are availability, access, stability and utilization. The quantity, quality and diversity of food available to the people are the aspects of food security described in the availability dimension. The adequacy of calorie and protein available in the food intake are the main indicators of food availability. Food access captures the peoples' physical and economic access to food. The main indicators of food access are domestic food price index and physical infrastructure (roads, railways, storage facilities) that make food available to people.

Food stability captures peoples' exposure to risk of food insecurity due to incidences of shocks, such as domestic food price volatility, fluctuations in domestic food supplies, political instability and peoples' loss of income. Food utilization dimension focuses on peoples' ability to utilize food as indicated by stunting, underweight, anaemia and vitamin A deficiency among children under five, and prevalence of iodine deficiency among pregnant mothers. The severity of food insecurity depends on the extent to which any of the four dimensions of food security are

violated (FAO, 2009). The Kenyan government has food security among the big four agenda towards development. Food security has its roots on the specific type of farming system carried out by a particular group for its dietary requirements. Household farm size and uses further dictate the quantity and quality of food to be obtained from a particular farming system.

2.3 Current land holding size and uses and their impact on food and livelihood security

According to King and Burton (1982), land fragmentation is evidenced by: size of land, number of parcels in the holding, size and shape of the parcel of land, distance between the parcels and the size of the various parcels. These indicators have thus become determinants of the land uses and also highlight the complexity of representing and measuring current land sizes. According to Bentley (1987) a measure of land sub-division should be measured by looking at the following parameters: spatial distribution, land size, shape and plot number. This study uses farm size as a proxy for measuring land fragmentation since the dimension of land fragmentation that is of greatest concern in Kenya is the declining farm sizes which in turn influences its use.

The criteria for categorizing land sizes globally vary from place to place according to Baldev, (1974). For example in Europe, economic size of the farms is used to compare between different productions systems. The standard gross margin is calculated as a five years average of the mean gross margin of each production at the regional scale, multiplied by each production of the farm. The economic size of the farms is then classified depending on the country e.g. a small farm in Romania is economically smaller than a small farm in Germany. In France, a small farm has less than 25,000 Euros standard gross margin per year; a medium farm has between 25000-100000 Euros standard gross margin per year while a large farm has more than 100000 Euros standard gross margin per year. Table 2.1 shows the main indicators for farm holdings, by physical size of farm in Europe.

Table 2.1: Main indicators for farm holdings, by physical size

	Number of farm holdings (thousands)			Utilised agricultural area (thousand hectares)			Standard output (million EUR)			Farm labour force directly working on the farm (thousand AWU)			Livestock units on holdings with livestock (thousand LSU)		
	All farms	Very small and small	Large farms	All farms	Very small and small	Large farms	All farms	Very small and small	Large farms	All farms	Very small and small	Large farms	All farms	Very small and small	Large farms
EU-28	10 841	9 353	337	174 614	32 276	90 966	331 105	107 887	110 792	9 509	6 471	1 188	130 174	40 046	40 609
Belgium	38	17	2	1 308	150	320	8 407	2 316	1 170	57	23	5	3 584	1 080	385
Bulgaria	254	239	6	4 651	350	3 891	3 336	1 027	1 968	320	253	44	1 025	721	167
Czech Republic	26	14	5	3 491	107	3 065	4 447	631	3 480	105	20	72	1 728	480	1 131
Denmark	39	17	8	2 619	158	1 808	9 580	1 441	6 393	54	15	25	4 133	669	2 883
Germany	285	128	35	16 700	1 257	9 514	46 252	7 301	20 440	523	147	158	18 407	2 938	6 802
Estonia	19	14	2	958	92	704	676	111	491	22	8	11	310	88	192
Ireland	140	60	5	4 959	658	1 152	5 013	652	887	164	53	9	5 929	899	795
Greece	710	676	1	4 857	2 049	1 689	8 103	6 217	320	464	413	3	2 143	1 627	59
Spain	965	758	52	23 300	3 559	12 939	35 979	16 129	9 049	814	484	134	14 502	7 409	3 051
France	472	202	98	27 739	1 164	17 170	56 914	10 977	24 481	725	211	221	21 871	2 787	9 741
Croatia	157	147	1	1 571	557	629	2 029	1 080	427	175	152	6	864	545	108
Italy	1 010	880	15	12 099	4 171	3 259	43 794	20 066	7 608	817	563	53	9 374	3 340	1 911
Cyprus	35	34	0	109	58	19	495	337	45	17	14	0	175	126	10
Latvia	82	67	3	1 878	406	996	990	206	536	82	52	14	486	125	203
Lithuania	172	150	5	2 861	801	1 334	1 919	576	900	145	98	24	839	353	260
Luxembourg	2	1	0	131	4	70	314	27	162	4	1	1	165	3	93
Hungary	491	461	8	4 657	708	3 001	5 578	1 790	2 852	434	316	71	2 259	1 058	925
Malta	9	9	0	11	11	0	97	96	0	4	4	0	35	35	0
Netherlands	67	38	2	1 848	255	369	20 498	9 216	2 066	153	80	11	6 602	2 983	446
Austria	140	98	3	2 727	724	448	5 671	1 941	389	111	60	5	2 439	829	69
Poland	1 429	1 295	11	14 410	6 943	3 044	21 797	11 394	3 565	1 919	1 616	53	9 165	4 569	1 139
Portugal	264	241	6	3 642	814	2 107	4 509	2 196	1 152	323	266	22	2 036	947	612
Romania	3 630	3 591	13	13 056	5 675	6 300	11 990	7 848	3 278	1 553	1 445	65	4 975	4 049	495
Slovenia	72	69	0	486	334	34	1 009	661	70	82	73	2	488	321	25
Slovakia	24	19	2	1 902	80	1 719	1 812	266	1 424	51	13	34	645	159	452
Finland	54	20	5	2 282	218	705	3 398	563	991	58	13	10	1 173	128	422
Sweden	67	37	8	3 036	334	1 677	4 679	627	2 789	59	19	19	1 715	262	962
United Kingdom	185	71	41	17 327	639	13 003	21 819	2 196	13 859	275	59	116	13 106	1 516	7 270
Norway	43	25	1	996	242	94	3 410	1 099	275	44	19	2	1 241	429	63

Note: very small and small farms are defined by a utilised agricultural area < 20 hectares; large farms are defined by a utilised agricultural area ≥ 100 hectares.

Source: Farm structure survey 2013

Ciani (1992) brought out a categorization of land sizes based on employment where he argued that, small landholdings have the farm activities being performed by a single family while large farms require resources and employment outside the family.

The current landholding size and uses differ among researchers from place to place. In Haryana state in Northern India, Baldev (1974) classified farms as small, marginal, big and large when the operational holding is up to 3 hectares, 3-6 hectares, 6-12 hectares and above 12 hectares respectively.

Baldev, (1989) raised concern that, the definitions of these categories marginal, small, medium and big in terms of area should not be taken as uniform, regardless of varying conditions that are

material for agricultural productivity. He further noted that when the associated parameters change, land size values of these categories may also change. A person who cultivates on one hectare of near a wet land should not be considered as a marginal farmer. On the other hand, a person who cultivates 10 hectares of land in an arid zone may not qualify to be called as big farmers. It therefore evident, there are broad differences between the farms of the same size class in different regions.

Murphy et al (2009) used the Data Envelopment Analysis (DEA) model to examine the impact of farm size on tomato production in India. They found that, among the three farm size categories (small, medium and large) examined, the medium scale farms were found to be most technical efficient. The small farms were, however, found to be the most allocative and economically efficient than all the other farm size categories. These results however, are not conclusive because it was used on one farm enterprise.

The Agricultural Census Data by FAO (2013) estimates that, globally, there are over 570 Million land holdings that are 2 hectares and below in terms of size and accounts for up to 70% of global farming land and produce more than half the world's food. From the above data it's clear that, smallholding agriculture is the most common economic activity globally which supports huge populations by providing food and nutritional security as well as economic empowerment. However, the main challenge is there is awareness of where they are located which renders estimation of their numbers extremely difficult. The little information available also makes it hard to develop and implement policy guidelines on land use and development.

The agricultural sector of many African countries is characterized by smallholder farmers thus small scale farming is the main sector that drives economic development in many countries across the world (Quan (2011). East African countries like Kenya, Ethiopia, Uganda and

Tanzania, are agriculture-based countries and agriculture is the backbone of these economies where small scale farming is contributes three quarters of agricultural production (Salami et al., 2010). In Ethiopia, small farms dominate agriculture. Negatu (2005) in his study indicated that in the year 2000, 87.4 % of farmers in the rural Ethiopia had less than 2 hectares of land under cultivation and only eight percent had less than 1ha of land under cultivation. Further findings indicated that 4.6% of farmers in the rural areas had ½ or less hectares of land under cultivation.

In Kenya as well as Ethiopia the agricultural productivity of smallholder farmers are low and their farms are often fragmented and produce mostly for farmer's own consumption and generate only very small marketed surplus (Alemayehu, 2012). The majority of these farms do not produce enough food to sustain the household throughout the year in terms of food, nutrition and financial security. This is because the farm produce is too low due to small size of arable land. The key longstanding challenge of the smallholder farmers are mainly related to poor agricultural practices stemming from agricultural land fragmentations, lack of access to modern agricultural technology, agricultural inputs, lack of access to better agricultural markets and credits, high population pressure, low level of education among smallholder farmers and poor infrastructure (AFDB, 2010).

Negatu (2005) noted that, farm size is major constraining factor that negatively affects food security and income. Decline in the size of land significantly reduces household income and food security level implying that small scale agriculture cannot be productive even if agricultural technologies are adopted. It can therefore be concluded that smallholder farming cannot be applied in eradicating rural poverty through agricultural extension services that mainly concentrate on dissemination of new agricultural technologies. Smallholder farmers therefore do not have sufficient income generated from farm activities for purposes of investing in other

ventures or buying farm inputs. In order to fill the gap, smallholder farmers turn to sale of livestock manure and crop residues which are sources of energy for domestic use. Such byproducts would have rather been used in improving soil fertility as inorganic fertilizers.

In Kenya, land subdivision began during decolonization of British Empire when Kenyans were granted permission to own land through purchasing from the Europeans (Njonjo, 1981). The Rift valley region which is popularly known as Kenya's bread basket was wholly owned by the British colonialists who were practicing large scale agricultural production and ranching which was commonly known as white highlands. Immense exchange of land from British took place where over 1 million acres of land was given to Kenyans to practice small scale farming (Leo, 1978).

Among these reforms was the Million Acre Settlement Scheme which saw settlers who were leaving the country transfer land rights to Kenyans. The Kenyan government bought land using proceeds generated from sale of land belonging to the white settlers leaving the country and then subdivision would take place so that small parcels would be sold to Kenyan families (Leo, 1978; Harmsworth, 1974). Half a century after the scheme, the land sizes in acres for Trans-Nzoia and Uasin-Gishu which are the main maize and wheat farming counties, stands at average of 7 and 10 acres respectively (Kenya Land Alliance, 2001). In Kenya, the minimum size of land which is considered to be viable economically is not stipulated in the Land Control Act in Kenya but their viability is usually determined by the Land Control Boards. It is imperative upon government to formulate policy informing sustainable use of land resources in Kenya in the wake of increased population and reduction in the level of farm output. Kenya's 2009 National Land Policy outlines the rationale in using land resources in an economical, environmentally sustainable and socially equitable manner.

Review of empirical evidence suggests that there are no conventionally acceptable methods of measuring land fragmentation but various indicators, which can be used in developing proxies for measuring land fragmentation. Having all these considerations in place the main question is how small or big a farm should be so as to sustain a household. This is what this study sought to find out, the minimum land holding size that can comfortably sustain a household.

2.4 Factors that influence current land size and uses and their impact on food and livelihood security

Human activities can alter the attributes of land size and uses while some of the activities can maintain such attributes. Such activities are therefore considered to be immediate cause of land change (Schimel et al. (1991) and Turner (1989). Human activities that alter land size and uses include; deforestation to create croplands and management of grassland using activities such as regulating the number of livestock in grazing grounds, intensity of fires and farm productivity.

Many academicians and researchers have studied the underlying and immediate causes of changes in land size and land uses in a bid to understand the decisions undertaken in arriving at the appropriate land use (Lambin et al., 2006; EPA, 1999; Chrysoulakis et al., 2004: Allen and Barrel, 1985; Baulies and Szejwach, 1998).

According to Farrell (1957), a landholding that can sustain a household can only be defined based on consideration of numerous factors such as the size of the house hold, the income of the household which influences the technologies adopted, the education level of the house head, environmental conditions of the land owned which includes the geographical location and land tenure exercised by the household. This briefly characterizes farm size productivity based on technical, economical and allocative measures.

Contiguous factors contributing to changes in land size and land use include direct physical exploit of land at community, household and individual level (Ojima et al., 1994; Lambin et al., 2006). The factors affecting use and size of land are the basic activities that change the immediate causes of changes in land size and uses and function on a global and regional scale (Lambin et al., 2006). The basic factors affecting land uses and size are categorized into the following: demographic, economic, institutional, political, technological and cultural factors (Geist et al., 2006).

Defries et al., (2004) noted that, decisions on the use of land eventually have consequence on the interplay between meeting the inherent human needs and the accompanying effects to the environment on the basis of values of the society where the knowledge on ecosystems is essential in evaluating the effects on land use decisions. Destructive land uses impose a huge economic cost on water supply, land productivity and water resources infrastructure and ecological damage to ecosystems.

2.4.1 Population

FAO (2009) projects that, the global population will by the year 2050 increase by close to 2.3 billion people with sub-Saharan Africa expected to record the fastest growth. Given the fact that world population is growing by close to 80 million people yearly, food insecurity is a major threat to millions of people living in least developed and developing countries.

The main challenge facing world's agricultural sector is how to increase farm production that will match food demands of the increasing population. The limited land resources are constrained by the increasing world population which leads to overexploitation of land and water. According to FAO (2009), global demand for agricultural products including animal feeds is projected to exceed three billion tones from the current two billion tones. In addition to

demand for food, there is an increase in demand for feedstock as a result of increase in the use of bio-fuels (Popp et al., 2014). The demands exerted on the land are determined by population density. According to recent (UN, 2010) projections, Kenyan population has increased by 50% over the last quarter of a century to reach over fourty million people. The fast growth in population is projected to increase by 1 million yearly and reach 85 million in the next 40 years. The report further notes that, approximately 10% of land in Kenya is good for agricultural production and the present population of over 40 million exert considerable pressure on land hence the increased land subdivision/fragmentation.

The present debate on food security has focused on Africa's food security issues due to inconsistent agricultural production. Food security in the continent of Africa continues to be a major challenge in spite of it being well endowed with land resources and huge parcels of arable land in addition to water that can be used for irrigation (UNDP, 2012). In her latest work, Jayne, (2014) raised concern that the areas that are likely to face threats of food and livelihood insecurity are those that are highly populated and characterized by levels of poverty and small land sizes. Such areas experience low agricultural production which cannot support household food demands leading to unstable livelihoods.

Buttel and Raynolds, (1989) carried out a study 93 third world countries focusing on population increase and food demands and recorded no concrete findings on the relationship between population growth and food insufficiency. However, they did find out that in poor countries where the masses contributed small portion of the GDP experienced food scarcity implying inequality and poverty led to food shortage.

Comparative assessments of population and land use and size (Bilsborrow and Geores 1991; Bilsborrow and Okoth-Ogendo 1992) suggest that:

(i) population growth is positively correlated with the expansion of agricultural land, land intensification, and deforestation, but

(ii) These relationships are weak and dependent on the inclusion or exclusion of statistical outliers.

An examination of how an increase in population density affects agricultural activities and household income in rural Malawi demonstrated that households end up with smaller land sizes, lower incomes and higher off-farm enterprises (Ricker-gilbert, 2014). In Nigeria, (Agbo et al 2014) found that increased population density in rural areas increases the proportion of land used for settlement. This reduces land allocated to food production leading to food insecurity and the associated sufferings. In Ethiopia, (Menberu, 2014) found that increased density of rural population has led to a reduction in land for cultivation and an increase in vegetation clearance, which is accompanied by increased soil erosion. A study by (Muyanga and Jayne, 2014) estimated that in Kenya, 40% of the rural population resides on 5% of its rural land implying that higher populations will require more land for settlement. Under business as usual scenario, this will result in less land being available for cultivation. The same study reported a reduction of household farm size and income with increasing population density.

2.4.2 Technological advancement

Bedassa (1998) indicated that, technology influences the intensity of exploitation of Land resource that is possible. It is obvious that technological development alters the usefulness and demand for different natural resources. It is that thus seen as a substitute for land area. He further

noted that, in order to apply technology profitably on a farm, a household needs to possess a farm of adequate size. He thus advocated for consolidation of the very small and fragmented farm holdings into more viable larger ones so that a farm household can be sustainable food secure and be a user of modern improved productive technology.

During the Green Revolution new practices of crop production were formulated which included; use of fertilizers and application of genetic engineering to crop research which increased food production enormously. Back in 20th century in the United States large tracts of land were set aside for production of grains, this large-scale farming increased the grain production in quantity and quality. Within the same century nations such as Argentina and Brazil employed the same technique and yielded the same results-large quantities and improved quality. Likewise, through the same practices rice production and population increase were experienced in East and Southeast Asia in the 1960s and 1970s, during this period numerous modern technologies were employed for effective distribution of food. In addition, natural resources were found in much of the world and new agricultural technologies were developed.

Despite the fact that increase of various crops yields was as result of technological advancement and use, quite a large segment of the world population is still lacking adequate supply of food. This scenario is attributed to poor distribution of food and farming in small farms which cannot exploit modern farming technologies profitably.

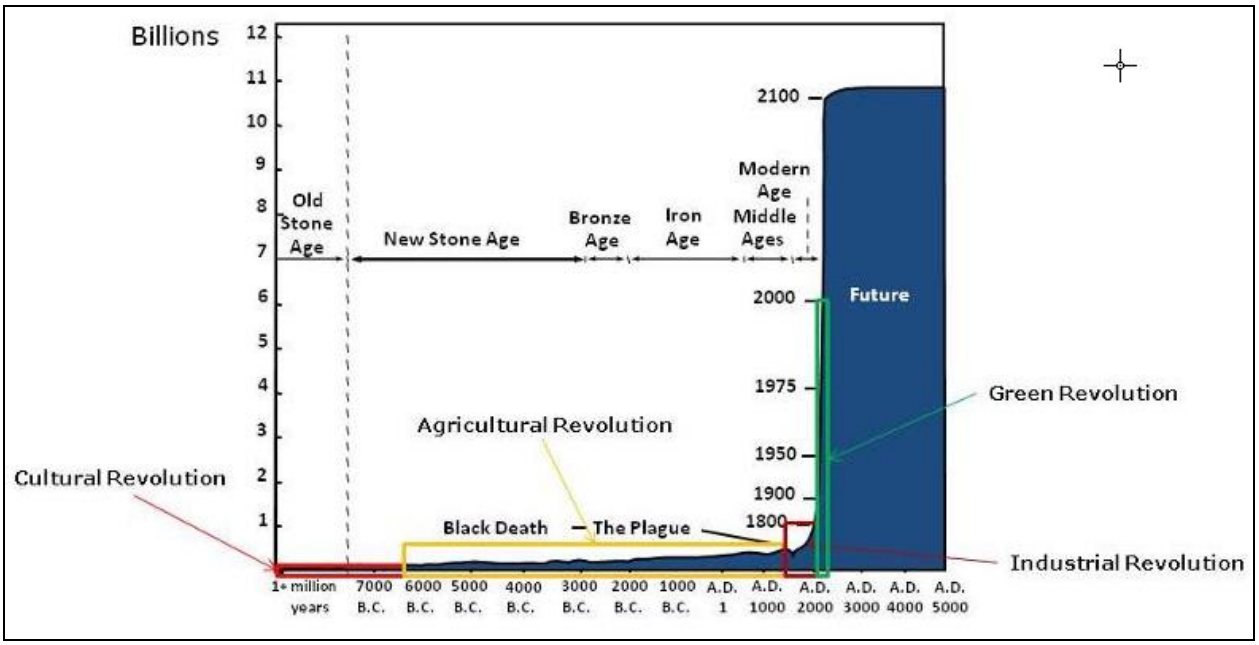


Figure 1: Impacts of technological revolutions on development

Source: Population Reference Bureau (2003) and United Nations Population Division (1998)

In extensive studies in Asia, (Hayami and Ruttan, 1987) showed that, land scarcity has led to development of new high yielding seed varieties and more intensive fertilizer use thus increasing food output by 2.9% per annum between 1963-1993.

The persistent food security challenge in Africa can be solved by adoption and utilization of agricultural technologies which will lead to increased farm output. Empirical evidence suggests that the countries which have embraced modern agricultural technologies have more food secure. Hofstrand (2012) argued that to increase farm production, there is need to amplify production per unit land size or increase land under cultivation. It is imperative to note that increasing land under cultivation may prove difficult due the limited nature of arable land and therefore increasing production per unit area remains the only option available. Increasing food production per hectare necessitates increased use of inputs which poses threat to the environment. Such inputs may include agrochemicals and inorganic fertilizers which affect the ecosystem.

Brouwer and Chadwick (1991) indicated that adoption of modern agricultural technologies (such as improved ways of creating energy from biomass, use of ICT in pest and crop management and plant and animal breeding through biotechnology research) may result to alteration size and use of land in both developing and developed world.

However, empirical evidence indicates that the likelihood of technological adoption such as use of improved seed varieties and application of fertilizer declines with the reduction of the size of farm (Mulat, 1999; Croppenstedt, et al., 1998). A study by BASIS/ADR in Ethiopia established that the size of land significantly affected the application of fertilizer in the farm. The relationship between size of land and technology adoption was determined by grouping the land holdings into three: large size, greater than 2.0 hectares, medium size, 0.51 ha - 2.0 hectares and small size, 0.50 hectares and below. The farmers who practiced large scale farming were found to use fertilizers, manure and improved seed varieties. It was therefore concluded that the size of farm is an important in intensifying small scale farming systems.

Negatu et al (2003) indicated that the size of land is one of the factors affect the food and livelihood security of many rural households. Landholding decline is directly proportion to individual farmer's income and food production levels meaning that the relationship between land holding size and per capita farm income and food production is inversely related. It indicates the solution to rural poverty doesn't lie on smallholder agriculture which is largely reliant on technology adoption and utilization. The emphasis on extension programs cannot offer sustainable solution to poverty issues of small scale farmers. Smallholder farmers do not have excess food crops for sale or investing in other businesses hence are highly prone to food security problems.

Negatu, (2003) further adds that, other factors remaining constant, a unit change in size of land implies more than 2½ times probability of applying chemical fertilizers. Households with bigger sizes of land enjoy the advantage of economies of scale through the use of chemical fertilizers which they can comfortably afford. On the other hand, small farm households have low income levels, inaccessibility to extension and credit services and limited coping mechanisms to persevere risks of rain shortage, low-profit technologies attributed to high acquisition costs and application of fertilizers per unit land.

In the Ethiopian highlands, Masefield, (2000) observed that, the average land holding size would not be enough to sufficiently supply food to a household of 5 members even if the farm output was multiplied by three using modern agricultural technologies. It was therefore concluded that land subdivision was one of the major challenge facing smallholder farming in Ethiopia. A national survey carried out in 2004 indicated that land was fragmented into 2.3 plots each measuring an average of 0.86 acres.

The reduction in the size of land due land fragmentation has affected the use of technology, farm profitability as well as food and livelihood security of rural households. The national survey showed that in Ethiopia, the mean land size can only produce a half of the farm income necessary for an average family to live a live devoid of poverty holding the price and land productivity constant.

2.4.3 Legislative Factors

Land-use activities are driven by the need to improve agricultural production and livelihoods (Reid et al., 2004). Berry (1973) noted that, tax policy system promotes increased concentration of landholdings as it is the case in Brazil, agricultural income is virtually free of taxation and agricultural land can be used to shelter non-agricultural income, thus the larger the farm the more

the progressive land tax. He also added that, in many countries tax policies favor directly/indirectly land ownership.

Land reforms increase a share of family farm for instance, in Russia after 1905 revolution, United Kingdom during the 1920s to 1930s, South Korea after world war 11 and India in the 1980s the fear of heavy taxation reform forced large land owners to sell their land. The effect of state intervention on farm sizes amidst other factor policies led to land size augmenting/ consolidating policies.

Land tenure affects land uses and farm sizes in different ways. A case study in Woreda, Ethiopia by (Negatu 2002) showed that, land tenure systems that are not secure limit the adoption of modern agricultural techniques. Own plots usually receive better technological treatment than leased plots e.g. DAP fertilizer was applied 19.3% in own plots as compared to 14.9% in leased plots.

A study by Benin (2002) indicated that plots that are operated by the owners are more likely to be characterized by stone terracing, contour ploughing and crop rotation thus the need for secure land tenure in small holding lands and land transaction system, may ensure farmers benefit from investment on land. He further added that, rationalizing land tenure policies and institutions dealing with land matters with the aim of ensuring secure ownership of land enhance prudent land management, technology adoption and sustainability of livelihoods.

The land tenure system that is operational in Kenya is categorized into four: customary/communal, modern/private, open access and state/public (Republic of Kenya, 2004; Kameri-Mbote, 2005). The entities that are allowed to own land in Kenya are the national government, county government, groups as well as individuals.

Individual tenure is a regime in which land and land-based resources are owned by individuals (Akech, 2006); this is the common land ownership practice in the country. According to Leach, Mearns and Scoones (1998), the socially discriminated groups including the rural poor have less negotiating power as compared to other agents. Land tenure which is acquired through intergenerational transfer of land rights or buying of land at market rates are the secure ways of land acquisition.

Formal laws on land ownership transfer; customs and traditions regulate and facilitate change of property ownership from generation to generation. The constitution of Kenya promulgated in 2010 allows married daughters to inherit their parents' land which further aggravates the situation as it leads to land fragmentation. The donors over the years have come up with policies and programs that support small scale farmers who have for a very long time remain poor due to lack of economies of scale and lack of mechanization.

2.4.4 Political Factors

According to Blaikie and Brookfield (1987), political factors include; political structure, comprised of the institutions of governance, political economy comprising of exchange systems, control and ownership of land resources, and values and attitudes of groups or individuals that utilize the land.

According to Mundia and Aniya, (2005), access to and control of land resources is influenced by power structures and property ownership rights whether at international or local level. It should also be noted that limited knowledge on land rights, poor governance, ownership documents and inadequate regulatory bodies do guarantee secure land tenure (Deininger et al., 2008) and are the factors affecting land size and land use which in turn affects food and livelihood security of the rural poor.

2.3.5 Social Factors

Social factors discussed below include; land inheritance, education status, age, gender, household income and off-farm employment, dependency ratio, caste, historical and cultural issues. According to World Bank (1997), inheritance rules determine the number of claimants on income from land and therefore, with increased rural population, unfretted partible inheritance is bound to reduce farm size and affect the general land uses in a household farm.

Equitable division of land among heirs (fen-chia) is widely considered the main cause of disappearance of large estates and the ensuing fall of share in rented land in Imperial China. In Europe, large estates survived because land owning families had enacted from the late middle ages, strategies to restrict the effect of partible inheritance and reduced the number of claimants to the sharing of land estates. Kabeer, (1990) noted that cultural restrictions on resource ownership, particularly land, imposed on women are likely to limit the size and use of land at their disposal which in turn reduces the production of food by such female headed households.

Bembridge, (1984) established that education status plays a crucial function in the implementation of agricultural production technologies and chances of securing off-farm income generating activities thus reducing dependency on land inheritance. Land inheritance has hence been replaced by formal education. While Macours et al,(2010), notes that social class and asset position affects and determines access to land, size and type of farming system, (World Bank 1997), demonstrated that, efficient land utilization of family land comprises of emphasis on secure land tenure and access to land resources particularly for the rural households and other socially marginalized groups. Mitiku, et al., (2012), found that household wealth, credit access, risk bearing capacity and household income are influenced positively by the size of the landholding.

The age of a household head as noted by Bogale and Shimelis (2009), has been found to have an impact on the size of farm owned and the food produced. This can be explained that, the head of the house gains more experience and accumulates more wealth to purchase more land and uses better farming methods as years increase thus older farmers have been found to own more land as well as produce more as compared to their younger counterparts. However, Haile et al, (2005) observed that older household heads are less likely to undertake farm innovations that have high risks.

Older household heads may also be less educated and thus less likely to adopt the technologies that boost small farm productivity (Babatunde, 2007). In Bulgarian peanut producers, a study of influence of farm size on technological efficiency, (Ligeon et al 2013) found out that farmer's age and gender had a significant effect on the productivity.

The causes of changes in land size and land use in Kenya include: access to resources as a result of changes in organizations dealing with land issues, changes in social structures, urban sprawling, lack of awareness among the public on land rights, increase in materialism and individualism, and inadequate flow of information about the environment.

2.4.6 Economic Factors

Land resource is a primary production factor whose reward is rent and since the beginning of human history it has been associated with economic growth and development (Richards 1990). Consequently access to and control over land resources have remained central to human survival necessitating land use policies and decisions such as agricultural pricing policies (Kummer, 1992). FAO, (2003) indicated that economies with properly developed land ownership laws and agricultural markets imply that they have complete package of land ownership rights including the rights to transfer ownership of land from one individual or group to another. In India,

Agarwal, (1994a) indicates that, many households possess smaller pieces of land that can guarantee food and livelihood security. The owners therefore generate additional income from off farm activities.

Presently, small scale farmers in Africa are progressively becoming reliant on the markets for income and access to food. The rise of assimilation of smallholder farmers into cross boarder markets has however exposed them to the ever changing market prices and other uncertainties of the global market. Smallholder farming essentially constrains sustainability of agricultural production consequently giving rise to reliance on underdeveloped and uncertain markets for livelihoods.

According to Singh (1990), land resources should be equitably distributed to create a balance demand patterns which lead to development of rural off farm sectors and eliminate unfairness in marketing, credit and research organizations that is occasioned by lack of equitable distribution of power and assets. This is corroborated by current evidence that indicates that economies with equitable distribution of land are characterized by rapid economic development (Deininger & Squire, 1996).

In Ethiopia, Negatu (2002) indicated that, in large farms farmer's choice on farm enterprises, improved input use, modern agricultural practices is reliant on factors that influence farm income and profits such as land tenure systems, production cost and prices of produce. Such factors affect returns on investment on household resource provision of assets such as labor, land and oxen, farmers' access to market, credit, transport infrastructure and other services that influence activities of the farmers.

According to Kiita (2013), various prospects provided by land markets, particularly in road infrastructure such as Thika Super Highway is another great influencer of land use and size. This

raises the value of land along the developed area leading to massive land subdivision as each person yarns for a share of it in such a prime area thus the expansion of primary road infrastructure such as airports, roads and railways can increase the value of land resources leading to their overexploitation rendering them unproductive.

2.4.6 Environmental Factors

Land use is clearly limited by environmental factors such as vegetation cover, weather and climate, topography and soil types. In addition, land use illustrates the value of land and its limited nature for use by human beings for settlement, agriculture, energy production, industry, forestry, water catchment, water storage and recreation (Richards 1990).

Only 17.5% of the total land mass is arable land of medium and high farming prospective with enough and dependable rainfall. The most productive land available is characterized by both smallholder farming and large scale/plantation farming (Republic of Kenya, 2004). The report adds that, topography and soil type also influences the ease of providing passable road infrastructure and hence affects the marketing of agricultural produce in a particular farming system.

The underlying causes of vegetative clearance for farming activities and especially in Kenya is mainly due to population growth, economic development and changing government policies on land use (Republic of Kenya, 2006). The general belief that high population pressure contributes to severe environmental degradation was disputed by Tiffen et al., (1994) who stated that high population does not necessarily lead to environmental degradation. However, the study also did not consider the issue of poverty, which tends to make farmers get preoccupied with land use survival engagements and give little attention to conservation practices.

Campbell et al., (2003a) looked at diversity in land use and development issues and found that, majority of rural farmers expressed the view that agricultural productivity had worsened overtime as a result of soil erosion, infertile soils, lack of pasture, vegetation removal, and declining access to water. The study revealed that 60% of farmers interviewed reported that soil erosion had increased, where 75% of farmers interviewed reported soil fertility had decreased and 66% of farmers interviewed reported that the area under vegetation cover had declined. The study also noted that 81% of farmers interviewed reported as having a problem with access to water mainly due to drought and land use activities.

Numerous studies have been carried out on environmental factors that influence the impact of farm size on different farming system productivity (Tedesse & Krishna-Moorthy, 1997; Helfand & Levine, 2004; Gorton & Davidova, 2004). These studies point out rainfall, land quality, soil type, humidity, temperature, soil erosion and vegetation clearance as environmental factors which stress farm productivity in different farm size categories.

2.5 Intergenerational transmission of land rights

According to Baland (2000) the main form of acquiring land in most of Sub-saharan Africa is through heritage. Essentially land tenure is largely customary which controls access to and utilization of land resources. However, many of these customary laws governing land are discriminatory in terms of gender, age and other social aspects. Most of the agricultural land in many parts of Africa lack formal documentation of owner and are largely not registered even in cases where there is law providing for registration of all types of land ownership such as customary land. It can therefore be concluded that land rights is one of the fundamental factors affecting individuals, households, nations and communities food and livelihood security which in turn affects economic growth of a country (Deininger, 2004).

The land tenure systems in Africa are in three categories; those that allow various land ownership such as public land, customary and individual land rights (Sierraleone & Uganda); those where state hold land in trust and individuals are granted rights to utilize the land (Tanzania, Ethiopia and Nigeria); countries that allow individuals and groups to own land with restrictions on some rights being applied (Malawi and Kenya), (Feder & Noronha, 1987).

Inheritance as a way of property ownership mostly takes effect following occurrence of death, birth, divorce or marriage. Similarly land transfer through inheritance can also take place among the living at certain points in life. Fafchamps and Quisumbing (2008) indicated that transfer of property from parents to children can occur before the children get married. Arguing in the same line, Shipton (2007) and Cheater (1983) indicated that children may inherit properties when parents are ready to withdraw from the labour market.

The Sustainable Development Goals (SDGs) adopted of 2015 propose that alleviation of poverty (goal 1), shall require provision of equality in property ownership and control of land resources and equitable inheritance of land resources. The goals also advocate for gender equality and women and girls empowerment (goal 5), legal reforms are important in ensuring that women rights to access and control of land other economic resources is upheld and entrenched in the law.

Deininger, Goyal, and Nagarajan (2013) in their study indicated that women's rights to own and control land resources is significantly correlated with improved livelihood for women and their families. Women who have access to and control of land resources were found to have higher bargaining power in their families (Deere, Oduro, Swaminathan, & Doss, 2013), well-nourished children (Allendorf, 2007), low prevalence of HIV-AIDS and low incidences of gender based violence (Strickland, 2004).

Goldstein & Udry (2008) carried out a study in Ghana and found at secure tenure systems reduced losses of agricultural output on plots owned by women. It was also observed in Rwanda that formalization of women land rights by issuance of titles led to adoption of modern land management practices in land own by women (Ali, Deininger, & Goldstein, 2014). These findings provide recommendations on how women land rights can help women alleviate poverty and empower women economically. A survey by USAID (2003) estimated that the land owned by women who have title deeds globally ranges between 1 and 2 acres. According UN Habitat (2006), most women in Africa acquire or gain access to land through land inheritance.

2.6 Policy interventions

2.6.1 Vision 2030 on Agriculture Sector

Vision 2030 aims to maintain a sustained economic growth of 10% over the next 25 years. This will be achieved through efficient use of resources, tracking of land use pattern, raising human resource productivity to international levels, transforming key institutions in agriculture to promote household and private sector agricultural growth, improving yields in key crops, increasing small holder specialization in the cash crop sector to at least 2-3 key crops per plot and increasing productivity of crops and livestock.

Other strategies will include introducing of new land use policies through better utilization of high and medium potential lands by farmers. One of the agriculture flagship projects is developing an agriculture land use master plan while the environment flagship project is mapping land use pattern in Kenya. This study has revealed the exact situation on the ground in the maize farming systems such as the current overall productivity level of the farm enterprises, the land being utilized and possible ways of ensuring profitable and efficient ways of utilizing

the rural land resources. The information generated aimed at contributing to improvement of land use policies.

2.6.2 Sustainable Development Goals

The aim of Sustainable Development Goal number 2 seeks to promote sustainable agriculture, finish hunger, ensure food nutrition and food security. According to the SDG review report of 2017, efforts to hunger and poor nutrition have improved considerably over the last two decades. According to the report, promoting sustainable agriculture, ending hunger, ensuring food nutrition and food security needs collective efforts particularly in the continent of Africa and Asia. There is need for more funds to be channeled in agriculture, comprising of government expenditure and aid, so as to increase agricultural productivity.

This study has contributed to generation of information that will be useful for guiding investments in revolutionizing agricultural productivity in rural Kenya. This includes data such as the optimal land size to sustain a household in the different farming systems, the land uses and practices that are positively correlated to food, nutrition and livelihood security, the land tenure transmission rights procedures that can lead to sustainable management of land resources and settlement patterns that enhance efficient land utilization.

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

According to the African Union (2014), persistent lack of sufficient food affects 239 million people in Africa with children under 5 years old comprising of 30 to 40%. Children under the age of 5 years are the most affected because they are at an important stage for survival and cognitive development. To reduce poverty and promote economic and social change in Africa, AU has put emphasis on the improvement of agriculture to spur rural economy by use of programmes such as Comprehensive Africa Agriculture Development Programme (CAADP).

In January 2013, Declaration to end hunger in Africa by 2025 was adopted by Presidents of AU countries, jointly with civil society organizations, cooperatives, academia, farmers, youths, international organizations, private sector and other partners. As part of the strategy to end hunger, the African Union has formulated the Science, Technology and Innovation Strategy of Africa (STISA 2024) which has six priority areas of intervention.

The aim of this study was to generate information that will contribute to ensuring food and nutrition security in a sustainable manner. This study therefore has contributed to generation of information that feeds into priority area No. 1 which is eradication of hunger and achieving food security. Its associated research and innovation areas include agriculture/agronomy in terms of cultivation techniques, seeds, soil and climate.

2.6.4 Devolution and the County Government

Agriculture, County planning and development and implementation of specific national government policies are among the functions devolved to county governments by Schedule 4 of the Kenya Constitution 2010.

This study worked with the County National Land Commission Secretariats together with other line agencies to identify the most critical land sub-division and fragmentation challenges that need to be addressed and the most affected geographical areas that need attention. It also ensured sufficient stakeholder participation by involving them in analyzing the land sub-division and fragmentation challenges, generating the possible solutions and recommending strategies for implementing the solutions.

2.6.5 Evolution of the National Spatial Policy 2015-2045

a) The Swynnerton Plan of 1954 was a land policy used to redistribute ownership of land in Africa. The policy offered progressive African farmers chance to farm cash crops. It was then

that land tenure system similar to that of Europe was adopted where secure land ownership was granted to Africans. The programme provided farm inputs and infrastructure in agriculturally productive areas in order to boost agricultural production. However, the plan failed because of marginalization and bias towards Arid and Semi-arid Lands (ASAL) which led to unequal development between different areas.

b) The development and use of land (Planning) regulations of 1961 were a supplementary law of the Land Planning Act Cap 303. The aim of the law was to issue guidelines on land use and development plan. Land use and development plans need to have regard to community convenience, health facilities and development density of the area. The regulations were used in guiding land subdivision in former European farming areas, land use along major trunk roads and in the peri-urban areas. It also created a central authority to guide use and development of land.

This study was in line with the National **S**patial Policy particularly on two objectives that include, to optimize utilization of natural resources including land for prosperity and to create livable human settlements in rural and urban settings.

2.6.6 National Land Policy

This policy guides the country on equitable, efficient and sustainable land use for prosperity and generations to come. National land policy was developed to deal with the fundamental issues of land management and administration including dealing with past land injustices. The Sessional paper was formulated following the proposals made by the Commission of Inquiry into Kenya's system of land laws in Kenya in 2004. Equal access to and control of land resources for subsistence and commercial farming, settlement and other development is one of the principles that guide the policy. Therefore the policy tried to address the problem of squatters in various

parts of the country. The sessional paper took notice of the need to embark on land reforms in Kenya due to various limitations in the constitution prior to the constitution of 2010. The reforms were necessitated by the shortcomings of 1969 constitution which failed to address

Inefficient land allocation and lack of accountability by the institutions dealing with matters land administration and management. Some of the proposals were that the constitution should take into consideration equal distribution of land resource to eliminate discrimination, solving past and present genuine land atrocities and formalization of use of various types of land for public good. The formation of National Land Commission (NLC) was recommended formed under National Land Commission Act of 2012 as set out in the constitution of Kenya 2010.

Just like in the provisions of Njonjo Commission report on the issue of administration of property rights, the National Land Policy recommends that the definitive ownership of land in Kenya shall rest with citizens either individually, as communities or collectively as a nation. Land ownership rights are to be obtained as succinctly expressed under the law. The policy consequently categorized land as either private, public or community land. Given that policy comes before legislation, the requirements of the law were expressed in the constitution and the latest land legislation.

The gist of this sessional paper is that the recommended reforms are not adequate in solving the problem of squatters in the country. It is therefore important to take into consideration the provisions of the constitution pertaining issues of land.

2.6.7 The Constitution 2010 and land classification/ categorization

Articles 60 to 68 of the constitution of Kenya 2010 deal with the issues of environment and land. The principles underlying the policy have been set out and indicate that land shall be owned and

controlled in an efficient, equitable, sustainable and productive manner among others. These principles are in tandem with the provisions of National Land Policy Act of 2012.

According to the constitution, land has been classified as community, private and public land. The land tenure systems have been in existence since independence where initially the land was categorized as either private, trust or government land. Land tenure refers to the ways the ownership and control of land resources can be acquired, maintained or transferred.

2.6.8 Land use planning in Kenya

According to Masakazu (2003), the appropriate design, planning and management of land resources needs a keen trade off of many objectives and the exploration of the best land uses accompanied by efficient land management practices complicated by the interplay between the community/society, economy and the environment. Hence land use planning is a practice concerning the developing and implementing spatial frameworks for systematic management of human activities. The policies and rules developed are set to ensure prudent land uses therefore proper planning for land uses is crucial to effective use and allocation of land endowments. In Kenya, however, there are minimal efforts put in place to guarantee that such policies are fully developed and executed. Kiita (2013) observed that this is because there is a clear gap between the agencies developing the plan, inadequate institutional and technical capabilities of implementing agencies, lack of proper skilled manpower in the planning ministry, poor coordination in the development and execution of the plan and inappropriate regulatory framework.

The challenges are evident by unregulated land use, land degradation, land disputes among others. Additionally, control of development (often referred to as the power of the police) is the power vested on the state to control rights to own land, has not been widely utilized to

standardize and normalize land use and to make obligatory sustainable land management practices all over the country. In addition the power of police applied by different implementing agencies whose functions are not coordinated leads to the regulatory framework being defective (GOK, 2010). It is also important to note that, Kenya does not possess an updated land use plans and development control guidelines.

2.7 Theoretical Framework

This study was based on numerous theories which enriched it and provide a backing for the statements and facts arrived at.

2.7.1 Development and underdevelopment theories

a) Dualism model Theory

The Dutch Economist Boeke (1953) and his followers Haggins distinguish between countries where capitalism is indigenous and highly developed and others where it's retarded. In the latter, most people live in the rural areas with livelihoods characterized by subsistence farming; low productivity where part of the harvest is confiscated for rent or tax in the case of a leased farm land and external interference stimulating population growth without fostering structural change.

Boeke, (1953) thus coined the phrase "static expansion" where commercialization of agriculture is hampered by a deficient organization of market and the rural populations do not succeed in applying capitalistic principles in agricultural production but experience detrimental effects of capitalism elsewhere. The dualism concept places much emphasis on prevailing lack of employment opportunities in agriculture as opposed to growth of employment in the modern sector. (Lewis, 1954) expounded the dualism view that, the traditional rural sector is characterized by open and hidden employment and therefore can and must provide labor for the modern sector thus the reason for massive rural to urban migration.

This theory is a basis of policy theme that, rapid progression of industrialization should not be at the expense of the agricultural sector but should be carried out simultaneously.

b) Modernization theory

The proponents of this theory (Rogers, 1962) and his followers (Eisenstadt, 1966) and (Deutsch, 1964) developed it from the views and ideas of the dualism model though their attention was on socio-cultural aspects of development.

They distinguished between two levels of social change as development and modernization. Modernization being the process at which people change from their traditional way of life to a more complex, rapidly changing and technologically advanced stage of life. Communication and diffusion are seen as the basic mechanism to spread development. However, the spread of development is thought to be hampered by the resistance of the traditional peasant producers towards application in agricultural production process. These universal traits were seen to be antagonistic and irrational towards modernization even if this is economically advantageous.

However, (Dasgupta 1974) discredited this view by actual observations that, peasants often have very good reasons for not adopting certain innovations for instance when this implies more risk. On the other hand, peasants have rapidly adopted modern production methods when certain conditions are met. The most spectacular example has been the widespread acceptance of new inputs by Asian farmers, leading to green revolution.

This theory notes that the rural agriculturist communities are crippled by the absence of a fully developed system of centers and markets which hinders diffusion of farming innovations which could otherwise make them food secure. Poverty especially in the agrarian communities has far reaching influences on the farming systems and on the ability of small agricultural producers to

modernize their production techniques thus leading to food insecurity, failure to meet dietary requirements and unstable livelihoods.

c) Dependency Models

Dos Santos (1969) coined the core of the dependency theory. He argued that, inequalities between countries bring about phenomenon like export dependency, deterioration in terms of trade and import substitution. This explains poverty and stagnation in underdeveloped countries and depicts inequalities in development. In this case the small and marginalized farming households provide cheap local labor for the large farms which also employ capital intensive technology.

d) Redistribution and basic needs theory

Adelman (1977) observed that, average income per head in the third world has grown more rapidly in the last two decades than ever before but, so have unemployment, famines, malnutrition, abject poverty and hunger. He further added that, in each stage of economic growth the people who benefit are those who have access to the most important factors of production which are land, capital and skill thus in order to achieve a more equal distribution of these benefits it is necessary to redistribute the most dominant factor of production before measures are instituted to achieve rapid production.

However, Bardhan (1996), indicated that, when market systems fail in the redistribution process in the developing countries;

i. The capital market is restrained. This means that, capital is cheaper for individuals/firms, who own collaterizable assets which favor large farms,

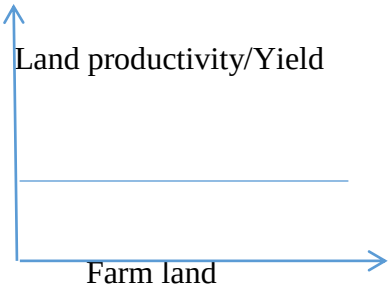
ii. Self-employed labor is cheaper than hired labor as it avoids search and supervision costs favoring the small farms,

iii. Insurance may not be available, implying that, poor farmers who are more risk averse will have to self-insure by sacrificing expected income for lower risk. They may not adopt high yielding but more risky technology as large insured farms.

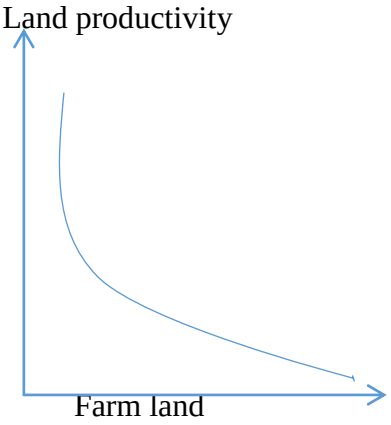
iv. Access to land rental contracts may be available to farmers who belong to the same social circles as large land owners, while the landless may lack referrals a may be seen by landlords as a riskier case of conflict.

Bardhan (1996) concluded that, even in redistribution, asset position and social class determines access to land, size and the type of farming system.

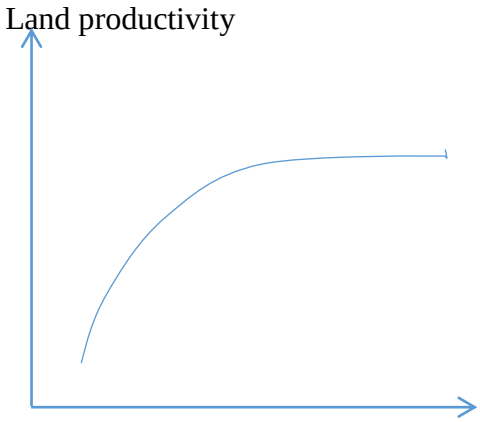
a) Perfect markets, no economies of scale; constant relationship neither efficient nor equity hold



b) Imperfect labor market, no economies of scale; inverse relationship: - equity is efficient



c) Imperfect capital or insurance markets, positive relationship: - efficiency-equity trade off



According to World Bank (2005a) for policy interventions, equity gains do not always have to be achieved at an efficient cost. Carter (1996) also added that, developing initiatives such as microfinance, micro-insurance and public extension can play a role in improving productivity in small farms.

2.7.2. Livelihood theory approach

FAO (2006) argues that the livelihood theory approach categorizes persons into various livelihoods according to their right to use resources (social capital and material resources) and their capacity to integrate them to livelihood strategies for support their day to day lives. Access to resources as postulated in this approach is broken down into 5 capital flows as follows:

i. Human capital which considers individual skills to labor, knowledge, education and good health,
ii. Natural capital which looks at land, physical features like water bodies and mountains,
iii. Financial capital comprises of access to credit and sources of income,
iv. Social capital which includes community networks and reciprocity,

v. Physical capital considers infrastructural components like markets, shelter, water supply and roads.

The capacity to coalesce these resources to livelihood strategies is affected by the existing changing institutions and structures and the context of susceptibility. The changing institutions, processes and structures are the policies, organizations and regulations which influence access to various types of capital, exchange terms amongst the capital types and other economic returns from livelihood strategies. The context of susceptibility come in three categories which include; shocks, trends and seasonality which influence resources and livelihood strategies and affect the level of susceptibility.

A livelihood strategy is said to be sustainable if it has the ability to deal with the shake ups and retain its capabilities and resources presently and times to come devoid of deflation of the natural endowments. The advances of projects such as measures to mitigate disaster and emergency response are progressively being influenced by livelihood framework. Livelihood profiles are developed to act as the benchmark information providing answers to the basic questions of the source of livelihood of people in majority of the years (Umair, 2009).

Save the children UK in association with FAO Global Information and early warning system, built a methodology from experiences over the past 10-20 years, in 1992. This methodology is for hunger forecasting, monitoring and evaluation also referred to as Food Economy Approach or Household Economy Approach by turning livelihood interpretations into quantifiable and practical information to interpretation of the influence that a risk poses on household food and nutrition security.

Monitoring the food economy is aimed at recognizing food insecure or susceptible livelihood groups when a peril such as lack of rainfall occurs. Even though it is grounded on foods, general approach helps the approach to obtain a complete analysis of how populations are able to manage their livelihoods and how communities are differentiated within.

2.7.3. Economic production Theories

a) Production Function

Production is the process that transforms inputs or resources into outputs or commodities (Webster, 2003). According to Webster, a firm or a producer is an organizational unit that transforms factors of production or productive inputs, into outputs of goods and services that satisfy human wants. The scarcity of these resources demands that resources should be allocated in such a way that they maximize returns. The theory of production provides the basic economic principles and concepts that guide the firms on how to optimize production of goods and services from the available resources.

According to Pindyck & Rubinfield (2001), a production function shows how the inputs affect the output in a production process. It also indicates the maximum amount of output that a farm can obtain for every unique combination of inputs (Pindyck & Rubinfield, 2001). A production function utilizing capital, labor and land inputs shows the maximum amount of input that can be produced using alternative combination of the three inputs (Nicholson &Snyder, 2008).

This study was a production study of the small-scale farmers who produce food and cash crops with the key objective of maximizing farm output from scarce resources for attainment of food security, nutrition and livelihood. The principles and concepts of the production function is applied to guide farmers on how to allocate resources to maximizing farm output from available

scarce resources especially land that is the most constraining due to massive land subdivision coupled by population growth.

b) The law of diminishing returns

The law of diminishing returns states that, when one productive resource is increased while at least one other productive input is held constant, output will also increase but by successively smaller increments. The law of diminishing marginal product is a short-run concept in production which refers to that period of time during which at least one factor of production is held fixed in amount. This law limits the use of a variable input while other resources are fixed, for example, the use of fertilizer on a fixed land size.

This theory shows that, we can intensify production using purchased inputs. However, improved technology can relax the constraint imposed by a fixed resource base (mainly land), making technological adoption and extension a key factor in food production.

2.7.4 Integrative theories-The proponent Theory

Systems Theory of Planning

General systems theory was first propounded by Bertalanffy (1969) in a bid to understand the systems behavior as the results of interplay among the actors and the interactions. CGIAR (1978) described Farms as open systems having a framework which consists of building blocks (technologies, soil and livestock) that are related together by interactions (land management practices and strategy) and they relate with the social, economic and natural environment (Norman, 2002). In addition, farms are systems since the output are products which are used by the farmers to meet their food and economic needs (Crouch, 1981). Since changes in climate involve an alteration of the natural environment, then farm structure should be changed accordingly if the land as a resource is to manifest the attributes that are desirable to the farmers.

To satisfy the need for food by the populace globally by year 2050, the current agricultural land must produce abundantly to feed the rapidly increasing population, economically empower the rural poor who are solely dependent on agriculture for their survival and minimize environmental degradation. Consumption of food is determined by various factors such as food choice, availability and accessibility which are also affected by demography, urbanization, socio-economic class, geography, consumer attitude, religion, marketing, globalization and culture. There is abundance of studies indicating the cost of nutrition to the environment, livelihood and society at large.

Food systems include all the steps involved in feeding the populace which include the yield obtained given a specific unit of inputs in the production process (Goodman, 2010). Food system is affected by environmental, economic, political and social context in which it operates. Increase in food demand is occasioned by shifting consumption patterns and rapidly growing population. The major issue in the agricultural sector is to produce food in the quality and quantity so as to meet the food and nutritional needs of the population sustainably.

In order to address the problem of hunger, food must be made abundantly available by being produced in large quantities. It is however important to note that food production in large quantities alone cannot address the food and nutritional needs of the population because there is need to ensure that food is easily accessible throughout the year. In general, sufficient food is being produce for the citizens globally. However, malnutrition and food and livelihood security (under-nutrition, over-nutrition, and micronutrient malnutrition) issues are rampant. It can therefore be concluded that the food system is inefficient as it is characterized by negative social, economic and environmental impacts.

Planners have the necessary skills and interdisciplinary acumen can help in strengthening food systems planning. Given their professional expertise, planners' involvement in food system planning can take the following processes to address food related problems into day to day activities:

i. Collect data on the community food system,
ii. Examine the relationship between planning issues and food
iii. Investigate the effects of present planning on food and nutrition security
iv. Incorporate food security into community objectives

2.8 Conceptual Framework

From the previous studies reviewed, the relationship between household land size and use as well as other factors affecting household food security, nutrition and livelihood in different farming systems are conceptualized as shown in the Figure 2.1. It is thus clear that, agricultural production operates within a tightly woven fabric of interrelated constraints. It is for this reason in most cases the landless and near landless are likely to become victims rather than recipients of Agricultural productivity. Planning for policy interventions must thus take into consideration all major constraints and search for ways to remedy them. As much as there is need to integrate policies on Agricultural development, there is also greater to promote off-farm activities generating income and employment so as to reduce dependency on land for livelihood in rural areas.

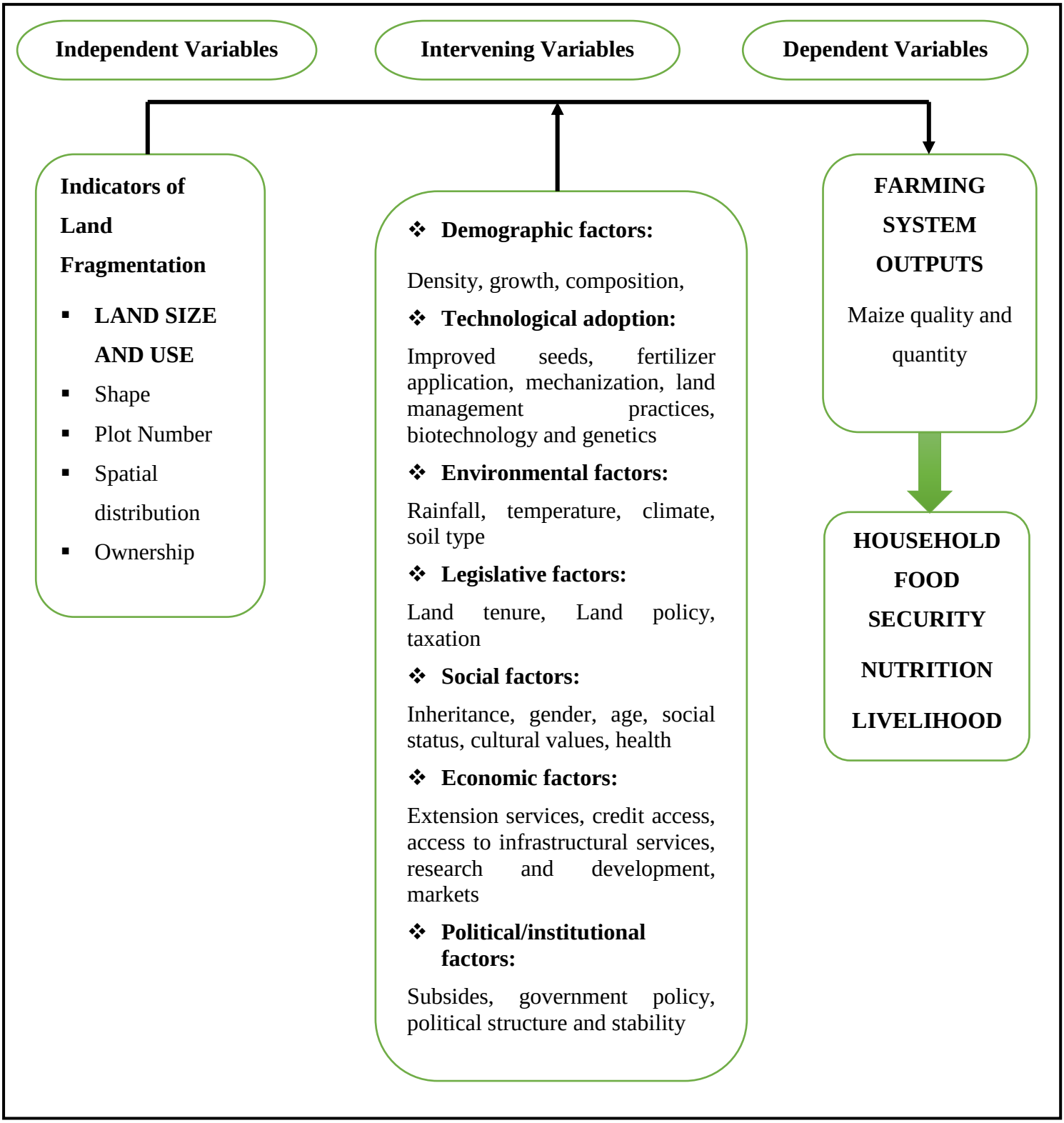


Figure 2.1: Conceptual Framework
Source: Synthesis by authorbased on literature reviewed, (2018)

CHAPTER THREE

METHODOLOGY

3.1 Study area

The study was carried out in Matetani sub-location covering 9 villages. The sub-location was selected based on targeted farming systems found in the County. The use of the village administrative unit for the study was because of the required population data which was organized based on villages as opposed to households. The actual sub-location for the study was selected considering either the most densely populated rural in the Sub-County, the sub-location having the highest challenges of land sub-division and fragmentation in the Sub-county or the sub-location with the farming system of interest to the researcher.

3.2 Research design

The study adopted descriptive survey design. This is because the study sought to collect quantitative and qualitative data. A descriptive survey design is defined by Kombo and Tromp (2006) as an attempt to collect data from a sample of a population in order to answer questions concerning the current status of the population with respect to one or more variables. Hence the descriptive survey design was appropriate since the aim of the study was to assess household land size and uses for sustainable food and livelihood security on maize farming systems in Matetani Sub-location, Kangundo Sub-County of Machakos County.

3.3 Study approach

Step 1: The first step involved proposal preparation and resource mobilization. This step consisted of research concept preparation that was spearheaded by the researcher, identification of suitable supervisors and preparation of the full proposal by the student researcher and other

collaborators. The key output from step 1 was the complete proposal from student and collaborating researchers and complete pairing of students with supervisors.

Step 2: The second step involved conducting the research in the area of study. The key output was a study report covering all the objectives.

3.4 Design and sampling plan

The target populations for the study consisted of the households, community leaders, opinion leaders, political leaders, administrators, professionals and religious leaders in Matetani Sub-location, Machakos County. A representative sample was picked from each category of the target population.

According to Census Report 2009, Matetani Sub-location has 1,664 Households. The village headmen provided a list of households in each village which made the sampling frame from which the households to be interviewed was sampled. The sample size was calculated according to Cochran (1977) formula;

$$N = \frac{Z^2pq}{d^2}$$

Where:

N is the desired sample size

Z is the standard deviation at the required confidence level (1.96)

P is the proportion in the target population estimated to have characteristics to be measured (90%/0.9)

q is 1-p which is the proportion of the population without the characteristic being measured (1-0.9)

d is the level of statistical significance level (95%) or 0.05

$$N = \frac{(1.96)^2(0.9)(1-0.9)}{(0.05)^2}$$

= 138 approximately 140

Thus, the provisional sampling plan for households/farmers gave a sample size of 140 households.

The number of households interviewed from each village was established using the formula;

M= (n/N) 140

Where;

M is the number of households to be interviewed

n is the total number of households in a village

N is the total number of households in the Sub-location

Stratified random sampling method was used to select the households to be sampled in each village. Stratification was based on household headship of i.e. male-headed, women-headed and widow-headed. From the three strata, proportionate random sampling was used to establish the number to be interviewed in each stratum.

In addition, extreme case sampling was also done in order to identify five farmers with the largest land sizes and five with the smallest land sizes for the farming system to compare and contrast their experiences and opinions on future land size and land use practices.

Inter-generational lineage sampling was done purposively by identifying the three oldest men and the three oldest women in the sub-location. This was followed by all their sons and daughters and all their grandsons and grand-daughters being interviewed. Those not living in the homes were interviewed by phone. This was done to enable the researcher to document inter-

generational land use practices, land size change and transmission of land rights. It also gave hints on the likely future trends under business as usual scenarios.

Administrators that were interviewed included: The area Assistant County Commissioner, Chief and Assistant Chief and the Member of County Assembly of Matetani Sub-location. The key informants included the County Lands Officer, Physical Planner, Agricultural Officer, and who were selected using non-random sampling methods.

Appropriate gender sensitive Focus Group Discussions were held in accordance to Patton (1990) recommendations. The proposed community groups consisted of representative from all adult ages: Over 65 years; 35-65 years and 18-35years. The other groups consisted of religious leaders, professionals, business persons and physically challenged members of the communities. A round table discussion was conducted with the administrators who included; Chiefs and Assistant Chiefs.

3.5 Data collection methods

Both quantitative and qualitative data was collected from multiple sources, using multiple methods by multiple investigators. This was to allow for triangulation hence improved validity of the findings. The sources of data was primary and secondary while the methods included document examination, case study reviews, individual and group interviews, round table discussions, observation, oral history and instrument administration.

3.5.1 Interviews

Data from members of households, administrators, professionals and religious leaders on land sub-division, fragmentation and use allocation and their impact on food, nutrition and livelihood security was collected using an unstructured questionnaire through face to face interviews. Group interviews, key informant interviews and round table discussions were also conducted

using open ended customized interview guides. The idea for both individual and group interviews was to get responses in respondents' original words (thoughts). Round table discussions with Chiefs and Assistant Chiefs provided information on food and livelihood trends, institutional memory on land issues including nature and prevalence of land related conflicts and resolution mechanism in the study areas.

3.5.2 Instrument administration

Actual measurement of the household land size and land allocations for different land uses was done using appropriate methods.

3.5.3 Document reviews

Land use change data was gathered from analysis of aerial photographs since 1956, remotely sensed image data of land sat, spot images of land use and land cover changes over the last 60 years. Other documents reviewed included studies undertaken on the subject and also in the study area. Others included population census reports, population structure maps, rainfall maps, temperature maps, dominant crop maps and soil maps.

Case studies from other countries that have had high population growth, land subdivision and fragmentation problems in the rural areas will also be reviewed to gather information on how they solved the problems. Interviews of the older members of the community both as individuals and in groups also provided additional information on land use change.

3.5.4 Observation

An observation checklist was formulated to ensure that all the data that needed to be gathered through observation is captured. This consisted of key and relevant features in the study areas such as forests, landscape, type of houses and materials used for house construction, farm

boundary markers among others. Photography was also used to amplify evidence of study phenomena.

3.6 Data analysis and presentation

Various methods were used to analyze the collected data. They include use of tools like the SPSS to generate frequency distributions and measures of central tendency. Statistical tests such as Chi-square and Correlations were conducted using appropriate data sets. Document analysis and analysis of maps and photographs was also undertaken. Qualitative data was analyzed using both case analysis and cross-case analysis depending on the variable in question. The findings were reported both descriptively and graphically using, tables, bar charts, pie-charts and graphs as determined by the team.

3.7 Ethical considerations

The researcher ensured the respondents confidentiality of the data collected. The results were solely used for study purposes and any publication adhered to consent regulations that guide research globally. The research was based on honesty, objectivity, and respect for intellectual property, social responsibility, confidentiality and no-discrimination.

3.8 Data Needs Matrix

Table 3.1: Data Needs Matrix

Research objectives	Data needs	Data sources	Data collection methods	Data analysis methods	Data presentation methods	Expected output
To examine the current household land sizes and uses the study area	Original household land sizes current household land sizes agricultural production pattern	Secondary sources. Field survey	Literature review Observation Interviews Instrument administration	Ms EXCEL / SPSS Spatial analysis through GIS Descriptive analysis Statistical tests and correlations	Maps Photographs Descriptive texts Report	A report on the trends of household land sizes and the effect of diminishing land sizes on agricultural production
To examine the factors influencing the use and size of household land in the study area.	Factors influencing land size Factors affecting land use allocations Existing policies, theories and concepts on land holdings	Secondary sources Field survey	Literature review Observation Interviews Photography	Ms EXCEL / SPSS Descriptive analysis Statistical tests and correlations	Maps Descriptive texts Report Photographs Graphs	A report on explaining on the factors/actors contributing to the diminishing land sizes
To Document inter-generational transmission of land rights in the study area	Historical trends on land transfers, land rights and access to land	Secondary sources Field survey	Literature review Observations	Descriptive analysis	Report Tables Descriptive texts	A report on the changes in land size since 1956 inter-generational transmission of land

			Interviews Discussions			rights
To Propose planning policy interventions in farming systems that will make the households food secure and with stable livelihoods.	Minimum land sizes Appropriate land use allocations Alternative possible scenarios	Study findings from above	Synthesis of findings	Spatial analysis through GIS	Reports Maps	Appropriate physical proposals that enhances food security ingenuities for Stable livelihoods

CHAPTER FOUR

MATETANI SUB-LOCATION

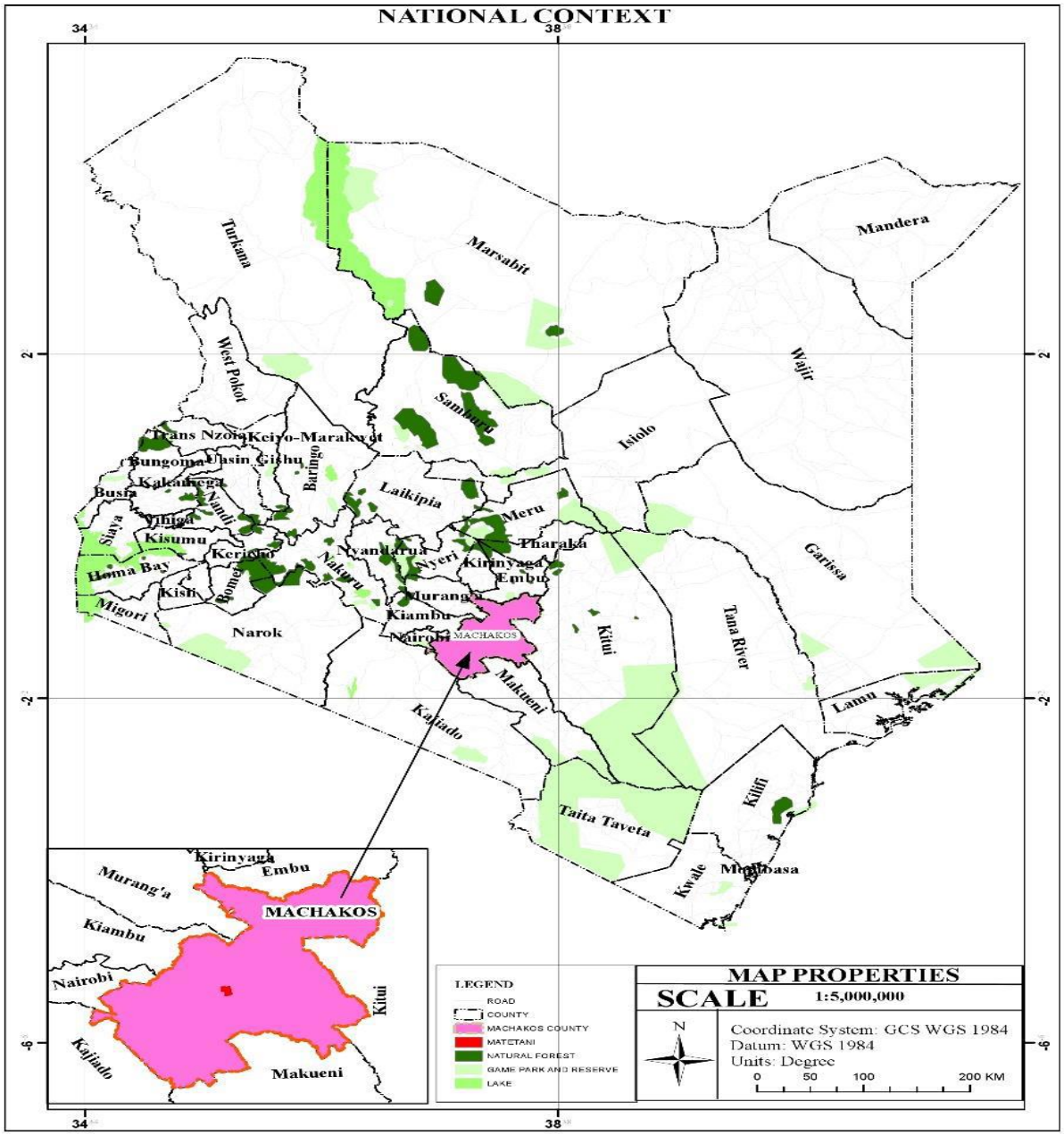
4.0 Introduction

This chapter covers the location of the study, demographic information, physical and topographical features, socio-economic factors, socio-cultural factors and physical infrastructure of Machakos County and Matetani sub-location in specific.

4.1 Location

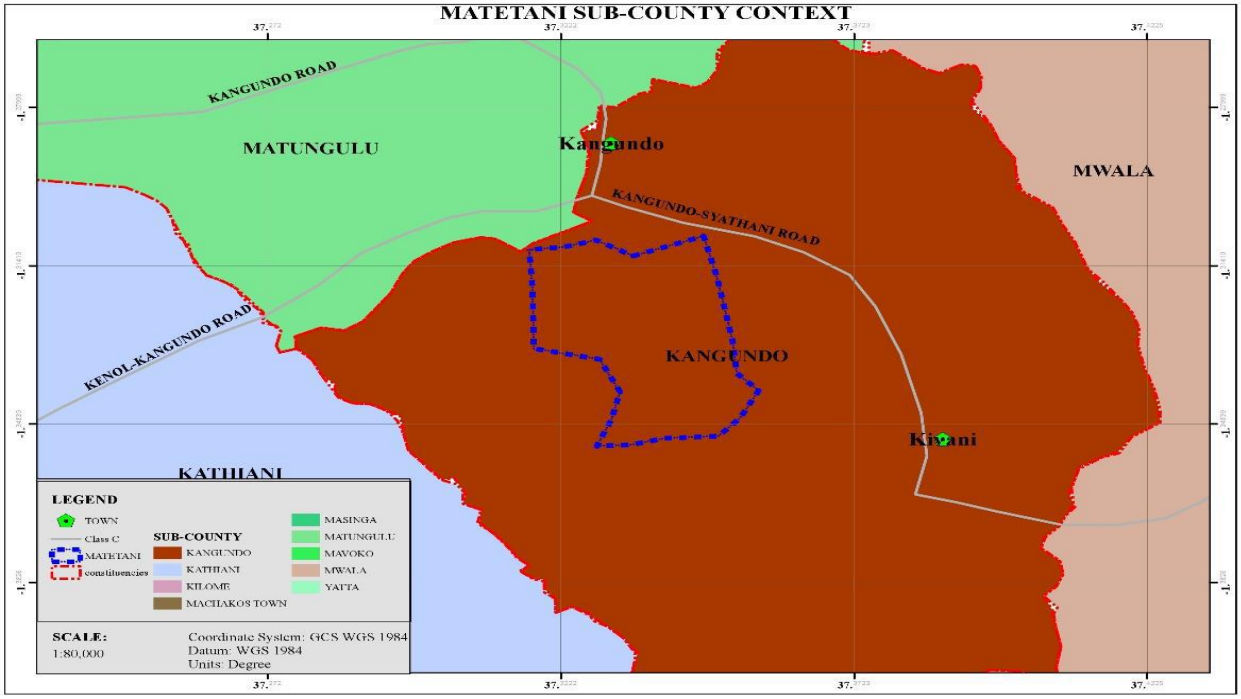
Machakos County is an administrative County in the eastern part of Kenya. The County has 8 constituencies which are; Machakos Town, Masinga, Yatta, Kangundo, Matungulu, Kathiani, Mavoko and Mwala. This study was conducted in Matetani sub-location in Machakos County. The area is an administrative division located in Kangundo Central Ward of Machakos County. It lies on Latitude $1^0$19' (1.31670) South and Longitude 37^0 20' (37.33330) East. It is headed by a chief, assisted by two sub-chiefs, all of whom are appointed by the national government. Conceptually, the covered aspects of land size and use change that has direct bearing on food security, nutrition and livelihood of the community. The research drew its backing from different theoretical frameworks which present the main factors affecting people's food security, nutrition and livelihoods and the typical relationships between them. The national, regional and local contexts of the study area are as show below:

Map 1: Study area at a national context



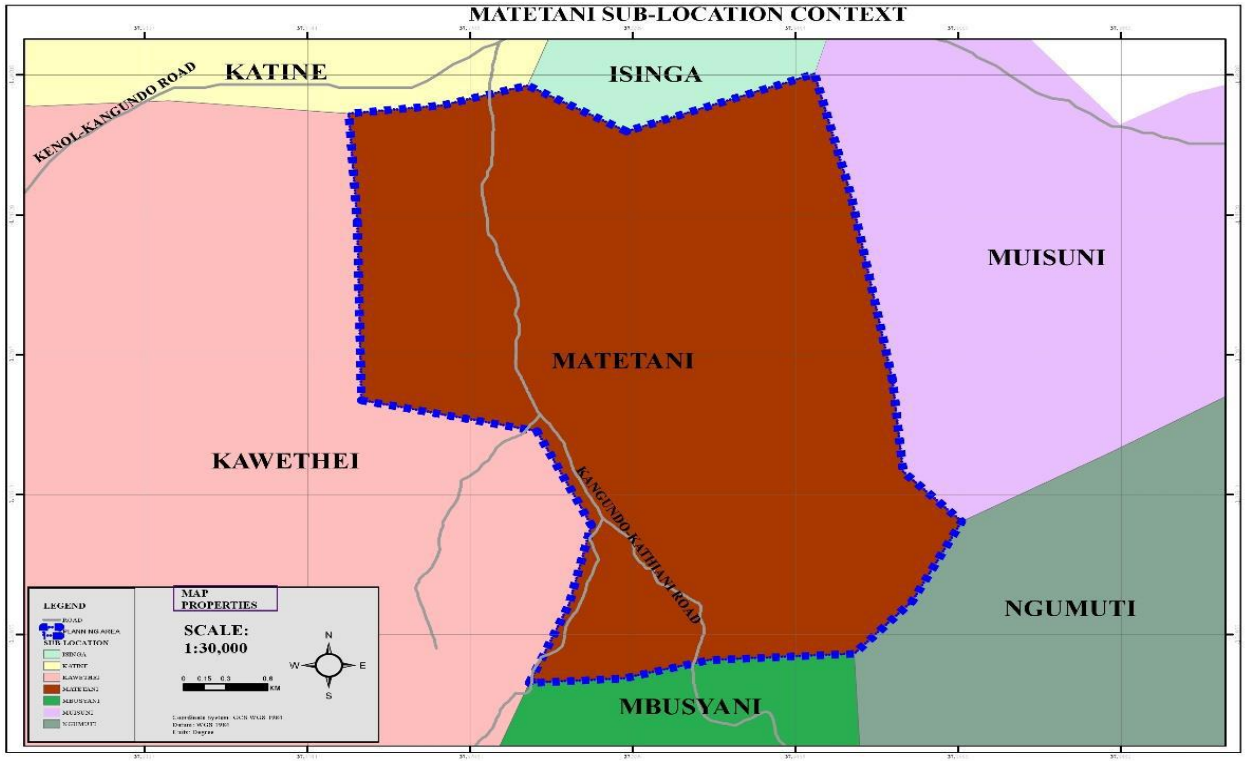
Source: Kenya GIS data

Map 2: Sub County context



Source: Kenya GIS data

Map 3: Sub location context



Source: Kenya GIS data

4.2 Demographic dynamics

4.2.1 Population size

The population demographics of Machakos County depict a shift from a population largely composed of children (0-14 years) are 39% beginning to decline while those over 15 years constituting 34% starting to increase progressively. This concurs with the statistics by KNBS, (2013) that households with 3 members and less stands at 42.3% and those with between 4 and members stands at 42.6%. Matetani sub-location has a population of 7,722 and an estimated area of 11 Km^2.

4.2.2 Population density and distribution

The distribution and concentration of population in Machakos County is influenced by the sources of livelihood in every sub county. As at 2009 the County had a population density of 177 per Km^2, it was projected at 188 per Km^2 as at 2012, 200 per Km^2 as at 2015 and 212 per Km^2 as at 2017. The population density in Matetani sub-location which is located in Kangundo sub-county has also increased over time overstretching the social amenities available hence the need for social infrastructure to support the growing population. Kangundo sub-county where Matetani sub-location lies has a high population density per 600 Km^2, because it has fertile soil that is good for agriculture hence attracting people who would like to engage in agricultural activities.

Table 4.1: Population Density per Sub-county

Constituency/ Sub County	**2009 (Census)**		**2012 (Projections)**		**2015 (Projections)**		**2017 (Projections**	
	Population	Density (Km^2)	Population	Density (Km^2)	Population	Density (Km^2)	Population	Density (Km^2)
Masinga	125,940	90	133,728	95	141,997	101	147961	160
Yatta	147,579	140	156,705	148	166,395	157	173384	978
Kangundo	94,367	532	100,202	565	106,398	600	110867	535
Matungulu	124,736	216	132,449	229	140,639	244	146546	174
Kathiani	104,217	503	110,661	535	117,504	568	122439	116

Mavoko	139,502	165	148,128	176	157,288	187	163894	117
Machakos town	199,211	215	211,530	229	224,610	243	234044	405
Mwala	163,032	160	173,113	170	183,818	181	191538	188
Total	**1,098,584**	**177**	**1,166,516**	**188**	**1,238,649**	**200**	**1290672**	**208**

Source: Kenya National Bureau of Statistics, 2013

4.3 Physiographical Features

The physiographical features covered in this section include the climatic conditions as well as the ecological condition.

4.3.1 Physical and Topographical Features

Matetani sub-location has very outstanding landscape and physical sceneries. Plateaus and small hills standing between 1800 and 2100 meters above sea level form the main part of the sub-location. Because these hills have gentle slopes, they are all cultivated to the forest reserve demarcation line.

The soils in the area can be characterized as shallow, well drained dark red clay especially in the plateaus. The vegetation cover however is dependent on the height above sea level of any area within the sub-location. The distribution of rainfall depends on the topography of the areas. Given that some of the places are arid and semi-arid while others are hilly or plains, the rainfall broadly distributed across the sub-location. For example the plains experience low levels of rainfall and therefore the main vegetation cover is grassland and sparsely populated acacia trees.

Plate 1: Hilly terrain with shallow soil

4.3.2 Climatic conditions

The rainfall patterns are uneven and generally not reliable. On average the area receives between 500mm and 1300mm. October and December experiences the short rains while March and May receives the long rains. The lowland areas receive an average of 500mm while the highlands receive an average of 1000mm. It can therefore be concluded that the sub-location's rainfall patterns is influence by the latitude. Temperature varies with October and March being the hottest while July is the coldest. The temperature ranges between 18˚C and 29˚C annually. The sub-location experiences few months of drought because the rainfall is not experienced throughout the year. The months when dry spell is experienced are: August, September, February and March

4.3.3 Ecological conditions

Machakos County is where Yatta plateau is found in Yatta Sub County. Yatta Sub County has an area of 1,057 Km² which is the second biggest in Machakos County. The county has many hills including: Ekalakala, Kangonde, Komarock, Mavoloni, Nzii, Iveti, Lukenya, Kavilakoli, Kamuthamba and Ithanga. There are two permanent rivers which are the main sources of water in the Machakos County: Rivers Athi and Tana. There also exists Masinga dam in Masinga Subcounty. Masinga Sub County is the largest Sub County with with an area of 1,402.8 Km². Matetani sub-location is categorized under Upper midland (UM) 2-3 ecological zone.

4.4 Socio-economic / cultural profiles

Due to the tendency of the residents of Machakos County to engage in other income generating activities other than farming, the County has seen a reduction in land under cultivation due to abandonment of agricultural production.

The people earning a salary are few because of the low levels of formal employment within the sub-location and generally Machakos County. There are chances of employment rate increasing with the development of new city of Machakos and the initiation of the investment projects once underway. Presently the people earning wages and salaries account for only 11% of the total population in employment. The farms and construction industry offers employment to majority of the youths in the county. Sources of water include: boreholes, springs, piped water, wells, collected rain water, rivers/streams and water vendors.

4.5 Social Infrastructure

The social infrastructure covered in this section includes; educational and health facilities found in Machakos County and in Matetani sub-location.

4.5.1 Educational Facilities

In Machakos County, there are more than 896 public primary schools, 301 public secondary schools, 147 private primary schools, 73 private secondary schools, village polytechnics, colleges and universities such as Daystar University. The schools found in Matetani sub-location includes; Syanthi, Kathaana, Tala, Kikambuni and Matetani secondary school.

4.5.2 Health Facilities

Machakos County has one Level 5 hospital located at Machakos Town and four Level 4 hospitals in Kathiani, Mwala, Matuu and Kangundo. Other health facilities by ownership include 193 under the County Government, 32 owned by FBOs, 9 owned by NGOs and 128 private-owned. The total health facilities in the County are 367. Most of the health facilities are found in the urban areas. Patients/clients in rural areas travel longer distances to access health services. In response, the County Government has instituted measures to ensure access to well-equipped health centers within the wards. The health centers in Matetani sub-location included; Miumbuni, Kakuyuni and Mitamboni.

4.6 Physical Infrastructure

Physical infrastructure includes transportation, water and sanitation, energy and telecommunication facilities.

4.6.1 Transportation

The County has an averagely good road network. Major roads include the Mombasa Highway, Machakos– Kitui, Machakos– Wote, Garissa and Kangundo roads, among others. The County has successfully constructed the following roads among others, the Mwala– Kithimani road, Kathiani– Kangundo road and Athi river road. It has also upgraded most access roads within the County. There are ongoing road initiatives in the County through partnership with the national government and other development partners. These include dualing of Mombasa road (Namanga

road interchange to Makutano Kyumbi), Koma – Konza, Matuu – Ekalakala, Kenol – Kaseve, Tala – Ol-donyo Sabuk roads, among others. Matetani sub-location has fairly good roads as shown in the picture below.

Plate 2: Tarmacked Kathiani – Kangundo road

4.6.2 Water and sanitation

4.6.2.1 Water Supply

Machakos County has water supply schemes managed by water companies; these are Machakos Water & Sewerage Company (MACHWASCO) whose source of water is Maruba dam and various boreholes. Matetani is supplied water by Matungulu-Kangundo Water & Sanitation Company (MAKAWASCO). Climate change factor has played a major role in increasing the average distance to the nearest water source especially in rural areas. The prolonged dry season for instance, has led to drying up of rivers, springs, boreholes, wells and dams subsequently increasing the average distance to the nearest water source.

4.6.2.2 Sewer Systems

The County Government of Machakos has improved sanitation through provision of super clean and free toilets in public places such as bus parks and market centers across the County. This aims to make Machakos County an open defecation free County. There are two sewer lines in Machakos and Athi River towns. Given that Matetani Sub location is a rural setup, the area lacks a sewerage system and rural households largely depends on pit latrines.

4.6.3 Energy

Masinga dam is one of the Seven Folks dams located in, which produce hydroelectric power for the national electricity grid. There is increasing connectivity to the national grid across Machakos County because of the implementation of "last mile" power project by the national government. The main source of energy for cooking and lighting is wood and electricity respectively. Other sources of energy across the County are solar, wind, biogas, gas, charcoal and paraffin.

4.6.4 Posts and telecommunications

The County has estimated mobile network coverage of about 85% with good internet connectivity supported by both the mobile network and fibre optic cable. According to 2009 Kenya population and Housing census, Machakos County was ranked position 11 out of 47 with 67.7% of households owning mobile phones. The residents of Matetani sub-location own mobile phones and are able to access internet in the many cybercafés spread across the location. The residents also enjoy of Posta courier service located in Kangundo.

4.7 Land and land use characteristics

The location has a large area suitable for agricultural activities. Therefore agricultural production is the major income generating activity in Matetani Sub-location. Farm and farm activities is the main source of employment opportunities. The main cash crops grown in the area include:

sorghum, coffee, bananas, French beans among others. The main food crops include: pigeon peas, beans, maize and cassava produced in small quantities. Crop production in the area depends on rainfall with minimal irrigation being practiced hence the land productivity is low leading to food and nutrition insecurity. The residents of Matetani sub-location practice mixed crop farming, fish farming, poultry keeping and livestock rearing.

4.8 Settlement patterns

The density of population throughout much of Ukambani where Matetani is located surpasses the population that can be sustainably be supported by land under both commercial and subsistence farming by applying the current land management practices. Intensification has remained behind while the population is rapidly increasing and in-migration continues to escalate from farming communities living in the uplands. This has seen the increase in off farm income generating activities to fill the production gap. The disparity in the capabilities of households to deal with the challenge has seen increased migration of people which affects land sizes and land use. Rural settlement patterns in Matetani reflect the productive potential of the Agro-ecological zones noted earlier. The higher-potential upland areas are much more densely populated than the dry lowlands.

CHAPTER FIVE

RESEARCH FINDINGS

5.1: Introduction

The study had set to achieve four objectives. They include establishing the current household land size and uses and their impact on food and livelihood security in maize farming systems of Matetani Sub-Location, to analyze the factors that influence the size and use of household land in the Sub-location, to interrogate inter-generational transmission of land rights and use in the study area and to recommend planning interventions that can create a sustainable household land size, for food and livelihood security in Matetani Sub-location. To achieve these objectives, the study had 140 questionnaires for data collection. The 140 questionnaires were distributed to the heads of households in Matetani Sub-Location.

5.2: Questionnaire rate return

Detailed questionnaires were designed and distributed to assess household land size and uses for sustainable food and livelihood security in Matetani Sub-location. To make the analysis more comprehensive a total of 140 questionnaires were administered where all the questionnaires were satisfactorily filled and returned. This is a 100% response rate which was excellent. This response rate conforms to Mugenda and Mugenda, (2003) stipulation that a response rate of 50% is adequate for analysis and reporting; a rate of 60% is good and a response rate of 70% and over is excellent.

5.3 Respondent's profile

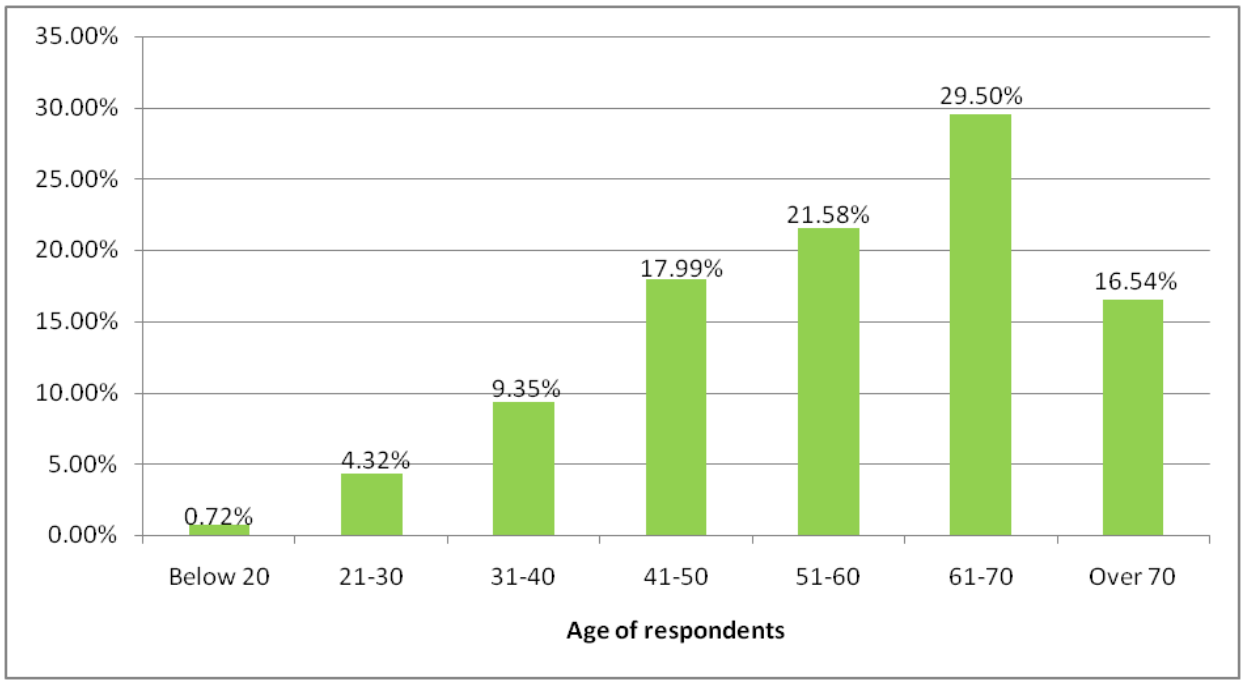
Households are important institutional units for most development processes including agricultural extension services delivery. Thus, discussing the demographic features and economic conditions of respondents would have a vital role in seeing the extent of variations of

land productivity model as a result of land fragmentation parameters vis-a-vis socioeconomic variables. The respondents profile discussed include: age, marital status and gender.

5.2.1 Age of respondents

The study sought to establish the age of the respondents so as to determine whether it affects household land size and uses. Based on the findings, the majority (29.5%) of the respondents were between the age of 61 and 70 years followed by 21.58% who were between 51 and 60 years. Further findings indicated that 16.54% were over 70 years while 32.38% of the respondents were 50 years and below as shown in Figure 5.1.

Figure 5.1: Age of respondents



Source: Field data, 2018

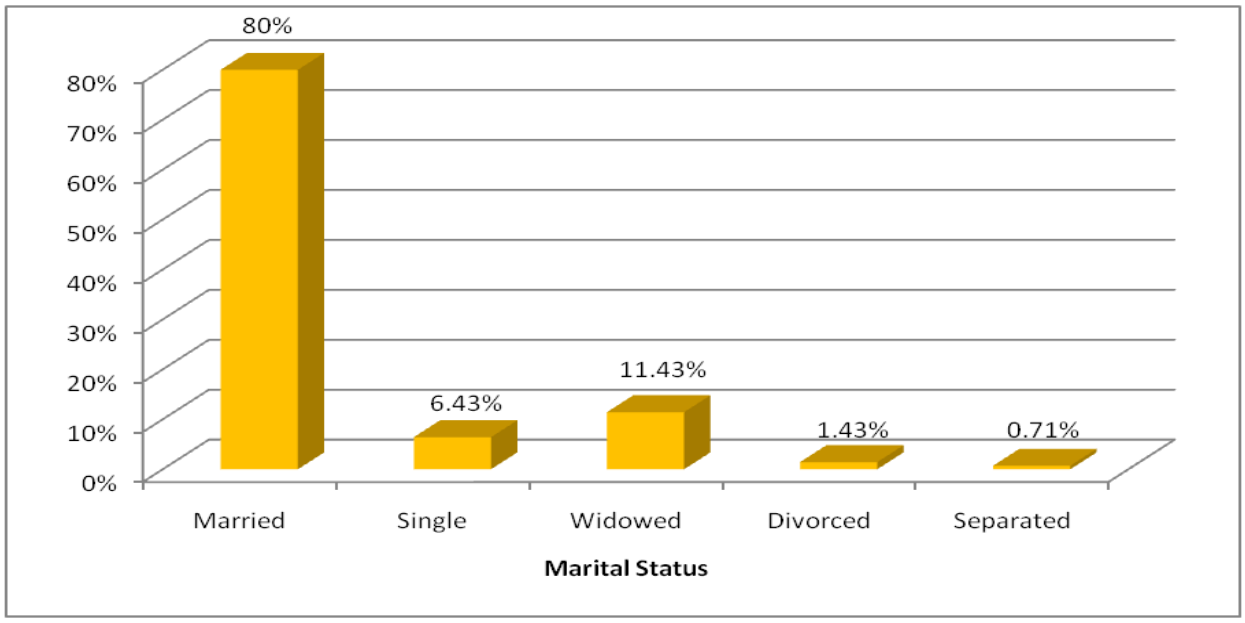
The findings are consistent with previous study as noted by (Bogale and Shimelis, 2009) that household age has an impact on the size of farm owned and the food produced. This can be explained that, the head of the house gains more experience and accumulates more wealth to purchase more land and uses better farming methods as years increase thus older farmers have

been found to own more land as well as produce more as compared to their younger counterparts. However, for Matetani Sub-location this age denotes high dependency levels, limited labor for land preparation as well as poor land management practices since majority of the population is incapacitated by the advanced age which is not very productive meaning they are not strong to per take farming activities.

5.2.3 Marital status

One of the social factors affecting the household land size and land uses is the marital status of the household head. The findings in Figure 5.2 show that 80% of the respondents were married and were living with their partners. Further findings indicated that 11.43% were widowed which can be attributed to the advanced age of the household heads. It was also established that 6.43% were single, 1.43% divorced and 0.71% were separated. Since the majority of the respondents were married, it implies that the household heads had a responsibility of providing for their spouses and/or children.

Figure 5.2: Marital status



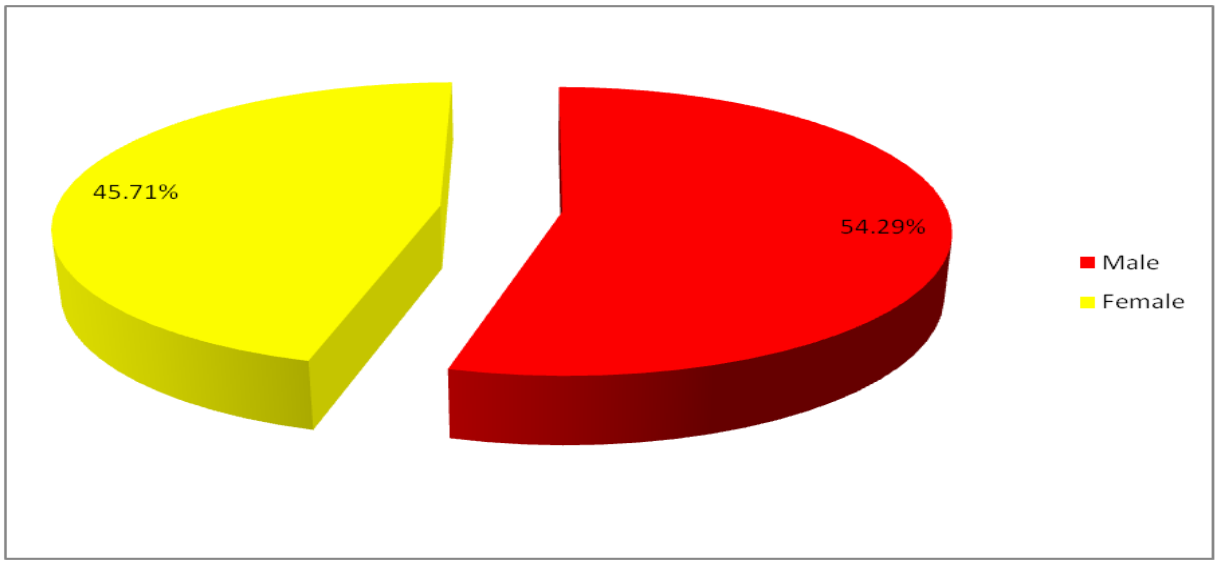
Source: Field data, 2018

Empirical evidence such as Chege et al., (2012) indicated that the married household heads were more food secure compared to the households headed by unmarried which is consistent with the results of the present study. The findings imply that joint effort of husband and wife plays a great role in food security improvement compared to a single attempt by one person. The improved food security in married households can be attributed to increased household members who engage in income generating activities hence increased income.

5.2.4 Gender

Women's land ownership and property rights impact a range of outcomes relevant to the well-being of women and their families and communities at large. Therefore this study sought to establish the gender of respondents by looking into gender perspectives of land ownership and its effect on food and livelihood security. According to the analysis of findings 54% of the respondents were male while 45.71% were female. The findings imply that there are more male headed households than female headed households. However the disparity is very small.

Figure 5.3: Respondents gender



Source: Field data, 2018

Women play a critical role in enhancing food and livelihood security but they are faced with a myriad of challenges such as lack of access to education, biased social cultural practices and diminished land rights which hinder their ability to participate fully in the agricultural food chains. Women also have limited access to credit facilities that would improve agricultural productivity because land is normally owned by men. Male headed households therefore have easy access to agricultural credit as compared to female headed households.

Women also face different forms of discrimination, such as greater reluctance on the part of input providers to provide credit for fertilizer purchases for female headed households as compared to male headed households and less scope to borrow money or to buy food on credit. A study by Pauline (2010) suggests that patterns of inheritance favor men in most of the world. The rights of widows to retain access to or ownership of land owned by their husband may be limited.

5.3 Household data

5.3.1 Household size

The size of the household determines the number of heirs of family land which may lead to land sub-division. The mean household size was found to be 6 members with a standard deviation of 2.837. In terms of household size, the study established that most of the families consisted of 4 as shown by the mode in Table 5.1. The median and range statistics was 6 and 14 respectively. It was established that only 2 (1.4%) of the households was made up of 1 member. The other findings of the study are shown in Table 5.1.

Table 5.1: Household size

Mean	6.38
Median	6.00
Mode	4
Std. Deviation	2.837
Variance	8.050
Range	14

Source: Field data, 2018

5.3.2 Number of sons and daughters

The study further sought to determine the number of sons in each household. Based on the analysis of the findings, all households had sons with an average of 3 per household. Having sons implies that the transmission of land rights can be carried out without a lot of constraints. The household that had many sons recorded having 9 sons while some households had only one son.

Table 5.2: Number of sons

Mean	2.66
Median	2.00
Mode	1[a]
Std. Deviation	1.523
Variance	2.319
Range	8
a. Multiple modes exist. The smallest value is shown	

Source: Field data, 2018

In terms of the number of daughters, the average number of daughters in a household was two. One household had 10 daughters making it the household with the highest number in Matetani sub-location. Table 5.3 shows the findings of the study.

Table 5.3: Number of daughters in the household

Mean	2.56
Median	2.00
Mode	1
Std. Deviation	1.807
Variance	3.265
Range	10

Source: Field data, 2018

5.3.3 Level of education

Education level influences farmers' or household heads' access to information as well as their ability to understand technical aspects of innovations which largely affect production decisions. This in turn influences productivity, access to food and living standards. The respondents were therefore asked to indicate their level of education on the following scale: 1.00 = None; 2.00 = Pre-primary; 3.00 = Primary; 4.00 = Secondary and 5.00 = Tertiary.

Based on the findings, majority of the respondents had secondary education as follows: Fathers (49.44%), Mothers (54.95%), Sons (71.55%) and Daughters (73.83%). Many of the respondents with tertiary education were daughters 14 (13.09) and sons 10 (8.62%). Further findings indicated that 10 (10.99%) of the mothers had no education while 6 (6.74%) of the fathers also had no education. Table 5.4 shows the summary of the findings.

Table 5.4: Level of Education

	Father's education		Mother's education		Son's education		Daughters education	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
None	6	6.74	10	10.99	0	0.00	0	0.00
Primary	39	43.82	23	25.27	20	17.24	11	10.28
Preprimary	00	00	5	5.49	3	2.59	3	2.80
Secondary	44	49.44	50	54.95	83	71.55	79	73.83
Tertiary	0	0	3	3.30	10	8.62	14	13.09
Total	89	100	91	100	116	100	107	100

Source: Field data, 2018

Bembridge (1984) established that education status plays an important role in adoption of agricultural production technologies and chances of securing off-farm employment thus reducing dependency on land inheritance. Quality education has become a substitute for land inheritance. The level of education also influences the occupation of the household members. Majority of the respondents were farmers, formally employed or in business.

5.3.4 Number of brothers at the time of inheritance

The study sought to find out the number of brothers at the time of land inheritance so as to determine the number of times the land will be sub-divided in case of inheritance. The mean number of brothers was 2 as evidenced by the mean and the median. Many of the respondents had only one bother at the time of land inheritance.

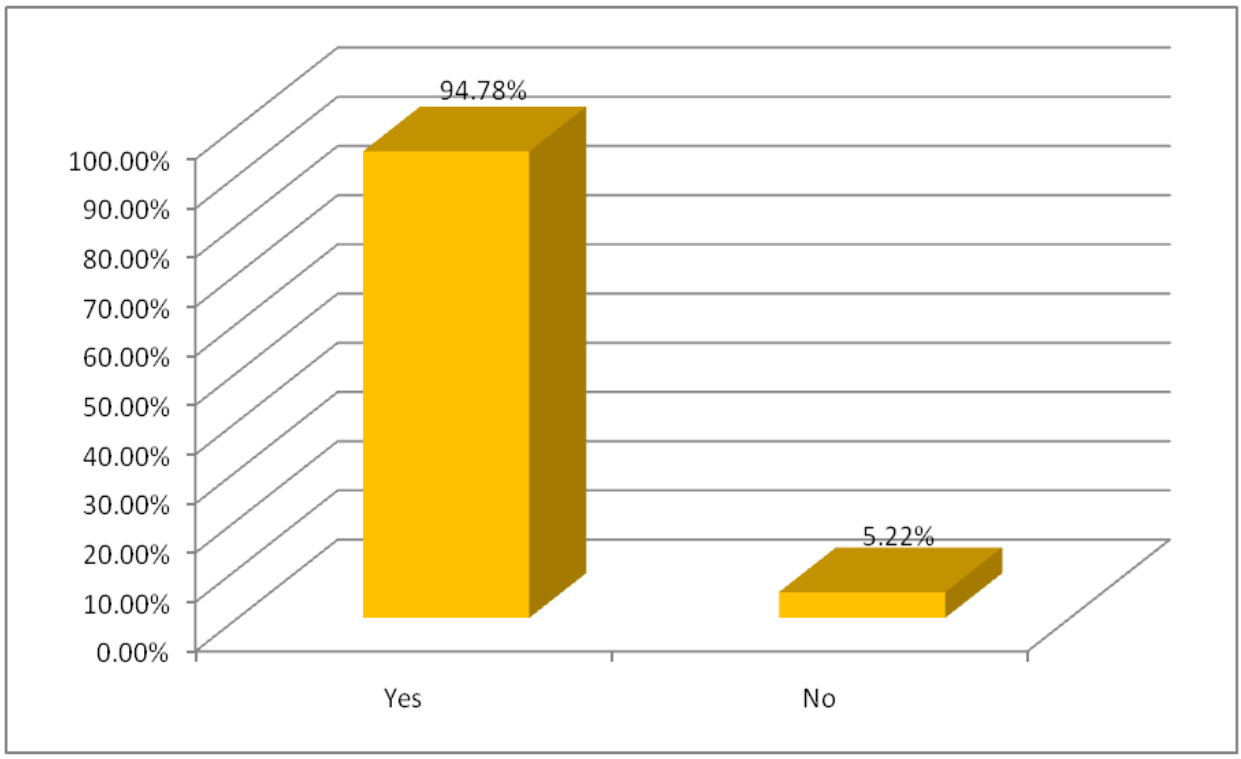
Table 5.5: How many brothers did you have at the time of land inheritance?

Mean	2.56
Median	2.00
Mode	1
Std. Deviation	1.807
Variance	3.265
Range	10

Source: Field data, 2018

The study also sought to find out whether the brothers inherited equal share of their parents land and the results are shown in Figure 4.5. The findings indicated that majority (94.78%) of the parents shared their land equally among their sons. Only 5.22% of the respondents indicated that the brothers did not equally inherit their parents land.

Figure 5.4: Equal inheritance of land among brothers



Source: Field data, 2018

The findings imply that according to inheritance laws, parents divide their land equally among their sons which leads to land fragmentation. These findings corroborate Khan (2004) who observed that population pressure coupled with cultural practices related to land which encourage subdividing land equally amongst sons and occasionally to daughters promotes the tendency to increased land sub-division.

5.3.5 Number of sisters at the time of inheritance

The findings indicated that majority of the respondents had 2 sisters at the time of land inheritance with the average number of sisters in the households being 3. Further analysis indicated that some of the respondents had no sisters at the time of land inheritance. Table 5.6 shows the summary of the findings.

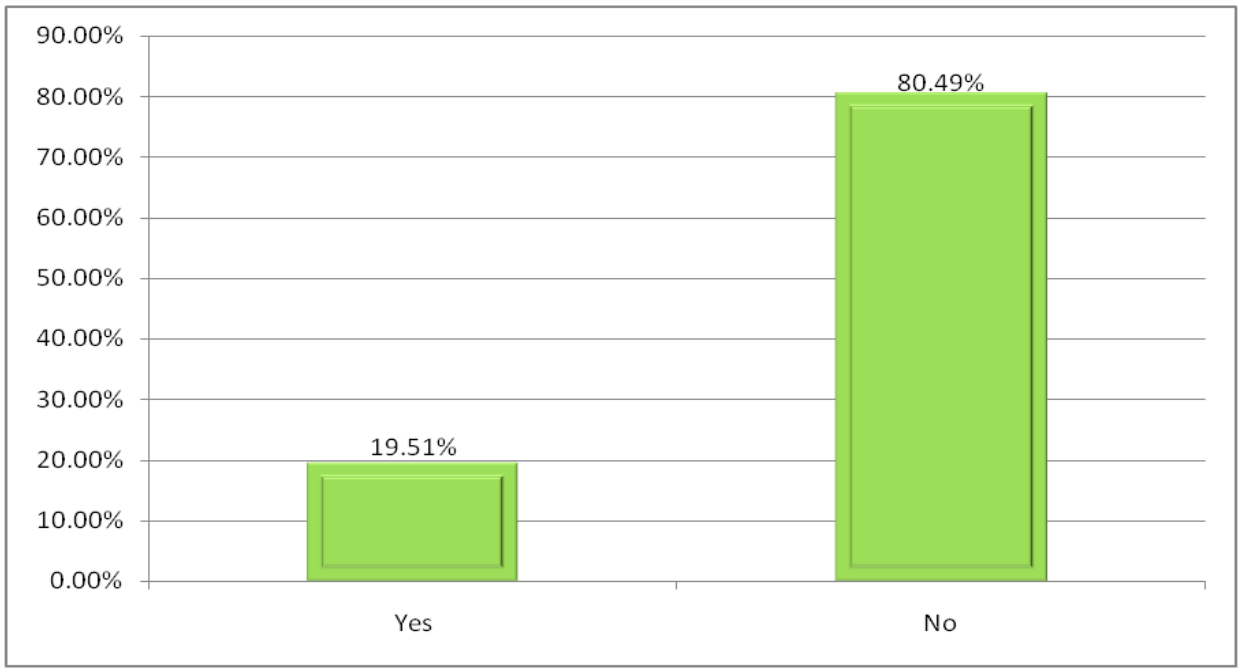
Table 5.6: Number of sisters did you at the time of land inheritance

Mean	3.03
Median	3.00
Mode	2
Std. Deviation	1.913
Variance	3.661
Range	7

Source: Field data, 2018

In addition, the study sought to establish whether any of the sisters inherited land from their parents. Results indicated that 80.49% of the respondents did not inherit any land while only 19.51% inherited land. This implies that females are discriminated against when it comes to inheritance of land because women often have fewer rights over land than men, they may not be seen as the owner by people in their household or their community.

Figure 5.5: Whether the sisters inherited land



Source: Field data, 2018

The low levels of land inheritance among sisters imply that women are culturally discriminated against owning land. Cultural laws leave gaps that are exploited by unscrupulous relatives in

discriminating women against land ownership. The findings concurs with Ashiro (2010) who indicated that in customary law, all areas of land holding, women are excluded as land passes from the father to the male children. She indicated that daughters would only be allowed to cultivate but not own land hence reducing access of land by women which affect agricultural production. Ownership of property by women raises their bargaining rights, improves economy of the household and promotes family stability (Copeland & Guertin, 2013).

5.3.6 Cultural practices around the use and inheritance of land

The study sought to establish the cultural practices around inheritance of land in Matetani sub location. The common cultural practices reported by the respondents was that the parents were the custodians of family land and children were only allowed to utilize land resources without claiming land ownership. This implies that the children did not have control on the utilization of land resources until ownership is transferred to them by way of inheritance. It was established that sons are only allocated land by their parents if they are married and dowry fully paid for their wives. This according to the respondents deters the sons from selling the land as they are deemed more responsible.

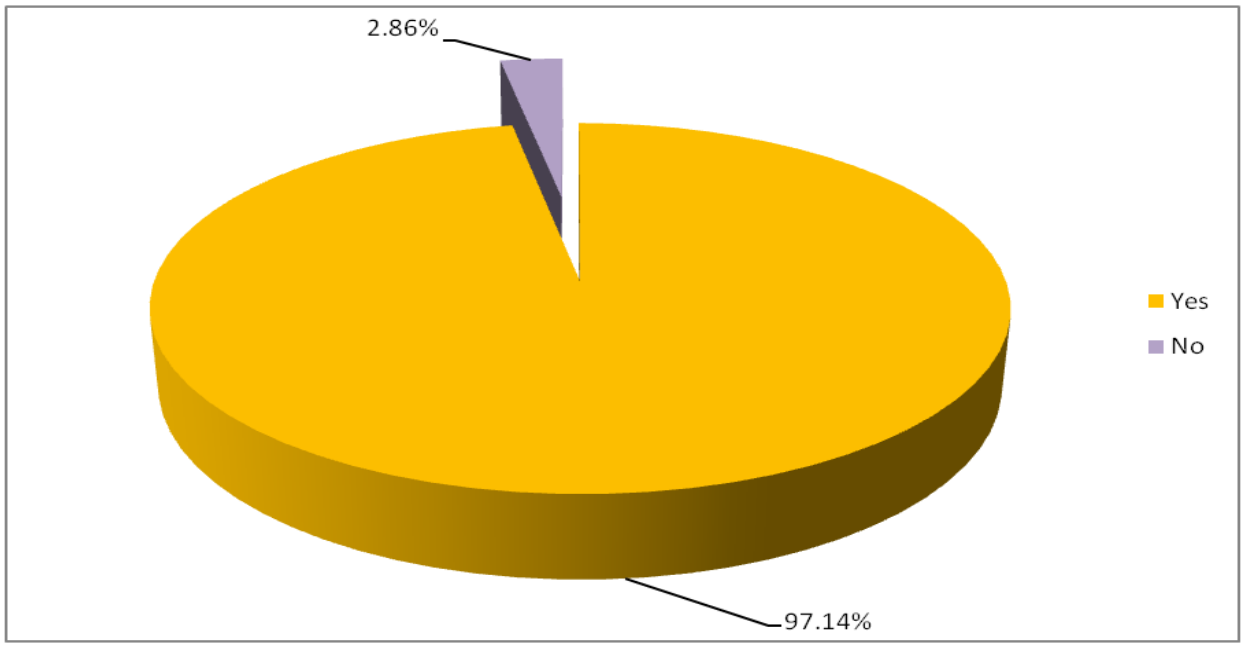
It was also established that the women were in most cases not allowed to own land and that the married women were only allowed to till their husband's land. Majority of the women also indicated that they did not inherit land from their parents especially those who were married. It was also established that the people are not allowed to sell land that they inherited from their parents as dictated by their culture. As part of the culture of the inhabitants of Matetani sub location, farm products are meant for subsistence only and are not allowed to sell. Only a few respondents indicated that they sell the surplus to the neighbors and nearby markets.

5.4 Household land size and uses

5.4.1 Land ownership

The study sought to find out if the respondents owned land. Majority of the respondents (97.14%) mostly men owned land while only 2.86% did not own land. This can be attributed to the fact that the respondents were the household heads most of whom owned land.

Figure 5.6: Ownership of land



Source: Field data, 2018

The finding is supported by a study conducted by Copeland and Guertin, (2013) who observed that the right to access, control and own land is essential to food and livelihood security because it ensures that agricultural land is utilized to produce food and cash crops for household consumption and sale. The proceeds from sale of surplus food crops and cash crops can be used to buy other foodstuffs and meet other livelihood needs such as education and healthcare.

The study further sought to determine the number of pieces of land owned so as to establish the extent of land fragmentation. Based on the findings, most of the households had only one piece of land with a mean of 1.94.

Table 5.7: Pieces of land owned

Mean	1.94
Median	2.00
Mode	1
Std. Deviation	1.020
Variance	1.040
Range	5

Source: Field data, 2018

5.4.2 Cross-tabulation between gender and Land Ownership

The findings in table 5 show that 96.1% of male respondents owned land while only 3.9% did not. It was further established that 96.9% of female respondents owned land. It was however established that generally the male respondents owned land as compared to the female respondents.

Table 5.8: Cross tabulation results between land ownership and gender

			Gender of the respondent		Total
			Male	Female	
Do you own land?	Yes	Count	73	62	135
		% within Do you own land?	54.1%	45.9%	100.0%
		% within Gender of the respondent	96.1%	96.9%	96.4%
		% of Total	52.1%	44.3%	96.4%
	No	Count	3	2	5
		% within Do you own land?	60.0%	40.0%	100.0%
		% within Gender of the respondent	3.9%	3.1%	3.6%
		% of Total	2.1%	1.4%	3.6%
Total		Count	76	64	140
		% within Do you own land?	54.3%	45.7%	100.0%
		% within Gender of the respondent	100.0%	100.0%	100.0%
		% of Total	54.3%	45.7%	100.0%

Source: Field data, 2018

5.4.3 Household land size

The study sought to find out the household land size in order to determine whether the land available is enough for the household utilization for food production. The average household land size was 2.19 acres with a standard deviation of 2.252. Majority of the households had 2 acres of land which is considerably low for agricultural production. This implies that many households are food insecure due to low production hence they are forced to engage in off farm income generating activities to cater for the deficit. Table 5.9 shows the findings of the study.

Table 5.9: Household land size in acres

Mean	2.19
Median	1.50
Mode	2
Std. Deviation	2.252
Variance	5.070
Range	10

Source: Field data, 2018

The findings of the study are consistent with a study done by Alemayehu, (2012) who noted that in Kenya the agricultural productivity of smallholder farmers are low and their farms are often fragmented and produce mostly for farmer's own consumption and generate only very small surplus for the market. The majority of these farmers do not generate sufficient income from agriculture to provide basic nutrition, health or living condition of their families almost throughout the year. The agricultural sector of many African countries is characterized by smallholder farmers thus smallholder agriculture remains to be the key and leading sector in overall economic development.

Decline in the size of land significantly reduces household income and food security level implying that small scale agriculture cannot be productive even if agricultural technologies are adopted. It can therefore be concluded that smallholder farming cannot be applied in eradicating

rural poverty through agricultural extension services that mainly concentrate on dissemination of new agricultural technologies.

5.4.3 Main crop and livestock activities

Results of the study showed that 98.6% of the respondents planted maize as it was the main staple food for residents of Matateni sub-location. It was also established that 86.4% grow beans while 54.3% planted cow peas in their farmland. Further findings revealed that 53 (37.9%) planted coffee, 21 (15%) planted bananas while 16 (11.4%) had planted vegetables in their farmland. Other crops planted though in very small quantities include; sorghum, cassava, sweet potatoes and mangoes.

Table 5.10: Main crop grown

Crop	N	Frequency	%
Coffee	140	53	37.9
Maize	140	138	98.6
Beans	140	121	86.4
Peas	140	76	54.3
Bananas	140	21	15.0
Vegetables	140	16	11.4

Source: Field data, 2018

The study also sought to find out the livestock land use activities in Matetani sub-location where it was established that the majority 108 (77%) reared poultry, 91 (65%) reared cattle while 31 (22%) kept goats. It was further established that 28 (20%) reared sheep while 10 (7%) engaged in rabbit keeping.

Table 5.11: Type of livestock

Type of livestock	N	Frequency	%
Poultry	140	108	77
Cows	140	91	65
Goats	140	31	22
Rabbit	140	10	7
Sheep	140	28	20

Source: Field data, 2018

Plate 3: Land under maize

Plate 4: Land under coffee trees intercropped with bananas and pawpaw

The study established that majority of the respondents engaged in farming as their main economic activity. Others engaged in business while some were in formal employment. However all respondents engaged in farming. Those engaged in farming were asked whether they apply modern agricultural technology in their farmland where the majority (54.3%) indicated that they did not while only 40.7% of the respondents agreed to applying modern technology in farming. The low level of adoption of agricultural technology was attributed to lack of capital and the small size of the plots.

5.5 Factors affecting land size and uses

5.5.1 Modern agricultural technology

The findings in Table 5.12 show that majority 76 (54.3%) of households did not apply modern agricultural technology on their farmland while 57 (40.7%) applied. Many of the respondents cited lack of capital, low literacy levels, lack of information about new technologies and low access to extension service as the main reasons for low adoption of modern agricultural technologies such as improved maize pollinated varieties, intensive tillage, monoculture, genetic manipulation of crops, application of inorganic fertilizer and chemical pest control.

Table 5.12: Application modern of agricultural technology on farmland

		Frequency	Percent	Valid Percent
Valid	Yes	57	40.7	42.9
	No	76	54.3	57.1
	Total	133	95.0	100.0
Missing	System	7	5.0	
Total		140	100.0	

Source: Field data, 2018

Kenya requires sustainable and efficient utilization of technology in order to increase agricultural productivity thus addressing persistent food security threat. Bedassa (1998) indicated that technological development alters the usefulness and demand for different natural resources. It is that thus seen as a substitute for land area. He further noted that, in order to apply technology profitably on a farm, a household needs to possess a farm of adequate size.

5.5.2 Constraints facing adoption of modern technologies

The respondents were further asked to indicate the constraints facing adoption of modern technologies in their agricultural practices so as to make recommendations on the mitigation measures. Based on the findings, the major constraints was lack of information about new technologies as supported by 73.6% of the respondents. It was established that lack of education (62.1%) and lack of credit facility (57.1%) also hindered adoption of modern technologies. A considerable few respondents (12%) indicated that lack of interest among farmers on adopting modern technologies was a constraint facing. Land fragmentation may partly be responsible for the slow and uneven diffusion of modern technology in Matetani sub-location.

Table 5.13: Constraints facing adoption of modern technologies

Constraints	**Yes**		**No**	
	Frequency	**%**	**Frequency**	**%**
Lack of credit facility	80	57.1	26	18.6
I have owned many plots of land	9	6.4	70	50
Lack of education	87	62.1	13	9.3
Lack of information about new technologies	103	73.6	8	5.7
Lack of interest among farmers on adopting modern technologies	17	12.1	69	49.3

Source: Field data, 2018

The key longstanding challenge of the smallholder farmers are mainly related to poor agricultural practices stemming from agricultural land fragmentation, lack of access to modern agricultural technology, agricultural inputs, lack of access to better agricultural markets and

credits, high population pressure, low level of education among smallholder farmers and poor infrastructure (AFDB, 2010). This is consistent with the findings of the current study.

5.5.3 Use of irrigation as an agricultural practice

The study also sought to find out whether the farmers were using irrigation as an agricultural practice. Results indicate that majority (88.6%) did not use irrigation and only depended on rain fed agriculture. Only 7.9% agreed to using irrigation in their farmland. This is attributed to the fact that the current demand for water is more than the supply hence making use of water for irrigation inefficient. It was established that those using irrigation technology had adopted traditional system of irrigation such as using buckets and watering cans to distribute water. Despite the traditional irrigation methods being advantageous in terms of lo capital requirements, their being labour intensive and low levels of delivery make them ineffective hence less favorable.

Dependence on rain fed agriculture leads to low agricultural production hence affecting household food security. The reasons for not using irrigation included lack of water for irrigation, lack of technical skills, lack of interest and land plots being located at different areas.

Table 5.14: Use of irrigation as an agricultural practice

		Frequency	Percent	Valid Percent
Valid	Yes	11	7.9	8.1
	No	124	88.6	91.9
	Total	135	96.4	100.0
Missing	System	5	3.6	
Total		140	100.0	

Source: Field data, 2018

Some of the farmers are practicing irrigation along the riparian zone because of the close proximity to water resources. It was therefore evident that there was serious encroachment into the riparian environment. The farmers clear the vegetation close to the river to create land for smallholder irrigation farming. The chemical fertilizers and pesticides used in such land close to the river have potential to negatively affect the riparian ecosystem.

Plate 5: Kales grown along riparian zone

According to Kay (2000), the lack of affordable, well adapted and simple irrigation technologies appropriate to the needs of smallholder farmers in Africa, is a serious impediment to measures of dealing with food insecurity. Reliable supply of water all year round is an important factor considered by farmers in adopting irrigation technologies.

5.5.4 Agricultural land management

In relation to agricultural management, 82.9% of the respondents agreed that they practice agricultural land management in their farmland while 3.6% disagreed. The land management practices included use of organic manure and fertilizers, crop rotation, inter-cropping and fallowing.

Table 5.15: Practicing agricultural land management

		Frequency	Percent	Valid Percent
Valid	Yes	116	82.9	95.9
	No	5	3.6	4.1
	Total	121	86.4	100.0
Missing	System	19	13.6	
Total		140	100.0	

Source: Field data, 2018

Agricultural management practices are geared towards replenishing soil fertility and therefore it is necessary for farmers to apply them so as to increase their farm output. The respondents agreed that they carry out the following practices: use of chemical fertilizer 138 (98.6%), use of organic manure 126 (90%) and crop rotation (75%). However the respondents indicated that they did not practice fallowing (field rotation) because of the size of the land and the nature of the crops grown.

Table 5.16: Land management practice

Land management practice	Yes		No	
	Frequency	%	Frequency	%
Use of organic manure	126	90	14	10
Use of chemical fertilizer	138	98.6	1	7
Crop rotation	105	75	33	23
Inter-cropping	123	87.9	15	10.7
Fallowing (field rotation)	13	9.3	125	89.3
Using modern farming techniques	5	3.6	133	95

Source: Field data, 2018

Soil nutrients are being exhausted because of insufficient replenishment. The outcome is reduced soil fertility leading to decline in crop production, land degradation and food security. The main concern on how to improve crop production in Matetani sub-location and the entire country at large is how to build up soil nutrients so as to improve soil fertility. This would increase the crop yield per unit area considering the diminishing land sizes.

5.5.5 Constraints facing the farmland

The study also sought to find out the constraints facing the farmers. The main constraint was soil fertility and soil erosion as supported by 80% of the respondents respectively. The other constraint facing farmers was water logging. The constraints were further aggravated by poor farming practices, population growth and reduced vegetation cover. Table 5.17 shows the summary of the findings.

Table 5.17: Constraints facing the farmland

Constraints	Yes		No	
	Frequency	%	Frequency	%
Poor soil fertility	112	80	19	13.6
Water logging	106	75.7	26	18.6
Soil erosion	112	80	23	16.4

Source: Field data, 2018

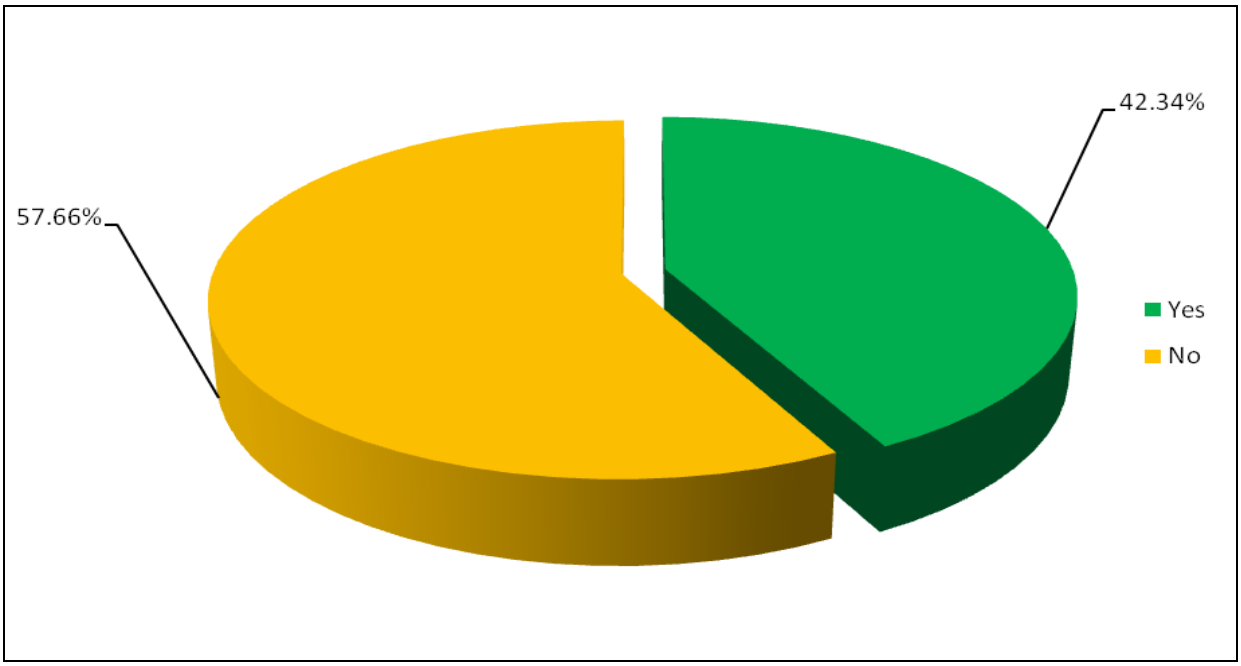
Plate 6: Damaged crops due to poor soil fertility caused by water logging

The study findings are in agreement with Campbell et al., (2003a) who looked at diversity in land use and development issues and found that, majority of rural farmers expressed the view that agricultural productivity had worsened overtime as a result of soil erosion, infertile soils, lack of pasture, vegetation removal, and declining access to water.

5.5.6 Agricultural extension services

The respondents were asked whether they had attended agricultural field days in their area where it was established that 57.66% had never attended while 42.34% had attended. Of those who had ever attended agricultural field days, 68% had attended the field days within the last six months while 32% had attended the field days within the last one year.

Figure 5.7: Attending agricultural field days



Source: Field data, 2018

The findings imply that access to information from extension officers is limited since many farmers had not attended agricultural field days or farmer training. Since the extension service

providers might not be able to disseminate information to individual farmers in remote areas, field days are recommended.

Further findings indicated that slightly more than half (52.1%) of the respondents agreed that their farm or farmer group had been visited by an agricultural extension officer. It was also established that majority (77.9%) of the respondents had never had of soil testing or tested their soil. This could be the reason why the household yields per unit area was low because of lack of soil nutrients or wrong application of chemical fertilizers.

Table 5.18: Extension services

Extension services	**Yes**		**No**	
	Frequency	**%**	**Frequency**	**%**
My farm or farmer group has been visited by an agricultural extension officer	73	52.1	51	36.4
I have ever heard of soil testing or tested my soil	9	6.4	109	77.9

Source: Field data, 2018

The respondents were further provided with statements regarding extension service in order to rate on a five point likert scale where; Strongly disagree (SD) = 1 [ ] Disagree (D) = 2 [ ] Agree (A) = 3 [ ] and Strongly Agree (SA) = 4. The respondents agreed that farmers who adopt the improved agricultural practices realize higher yields as shown by a mean of 4.352 and a standard deviation of 0.49605. The respondents also agreed that extension visits play a significant role in influencing the use of fertilizers (M=4.2177, SD=.69330. The respondents further agreed that given the limited availability of arable land, increase in maize yields can only be achieved by use of modern technologies (M=4.0480, SD=1.02277). Even with all these, there is a lower limit of land size beyond which growing maize doesn't yield sufficiently.

Table 5.19: Extension services and use of modern technologies

	N	Minimum	Maximum	Mean	Std. Deviation
Extension visits play a significant role in influencing the use of fertilizers	124	2.00	5.00	4.2177	.69330
Farmers who adopt the improved agricultural practices realize higher yields	125	3.00	5.00	4.3520	.49605
Given the limited availability of arable land, increase in maize yields can only be achieved by use of modern technologies	125	1.00	5.00	4.0480	1.02277

Source: Field data, 2018

FAO (2011) observed that there is a significant potential of raising agricultural productivity through new technologies and improved extension but, these gains will not materialize without increased investment in agricultural extension services. Extension officers influence the farmers in adopting new agricultural technologies by disseminating information on emerging technologies and their advantages to the farmers.

5.5.7 Role of extension workers

The respondents were of the view that extension workers can help farmers in identifying where to buy their inputs and calculate their farm input needs as supported by 86.4% and 82.1% of the respondents respectively. It was also established that 60% of the respondents indicated that extensions workers cannot help farmers in organizing group transport while only 40% agreed. Majority (83.6%) of the respondents were of the view that extension workers cannot help farmers obtain credit as shown in Table 5.20.

Table 5.20: Role of extension workers

What extension workers can help farmers in doing	Yes		No	
	Frequency	%	Frequency	%
Calculate their farm input needs	115	82.1	3	2.1
Identify where to buy their inputs	121	86.4	4	2.9
Organize group transport	56	40	84	60
Obtain credit	5	3.6	117	83.6
Save	6	4.3	115	82.1

Source: Field data, 2018

Empirical evidence suggests that the role of extension officers is to aid farmers in exploiting their potential. In addition new farming systems and technologies are shared by farmers, gain access to relevant information from variety of information sources, evaluate and interpret this information for their own situation, and to learn from their experiences (Quion, et al., 2001). Extension agents tend to work very closely with middle income farmers and pay little attention to resource-poor (Dixon, 2010).

5.5.8 Agricultural infrastructure

5.5.8.1 Presence of feeder roads

The study sought to find out if there were any feeder roads that connect farmers in Matetani sub-location to the market area. This is some of the agricultural produce is highly perishable hence the need for feeder roads that connects to the market. The results show that 89.3% of the respondents agreed that there are feeder roads that connects to the market while only 3.9% disagreed. Despite being in place, the state of the feeder roads was rated to be poor hence causing delays of the produce getting to the market.

Table 5.21: Presence of feeder roads that connect farmers to the market

		Frequency	Percent	Valid Percent
Valid	Yes	125	89.3	96.9
	No	4	2.9	3.1
	Total	129	92.1	100.0
Missing	System	11	7.9	
Total		140	100.0	

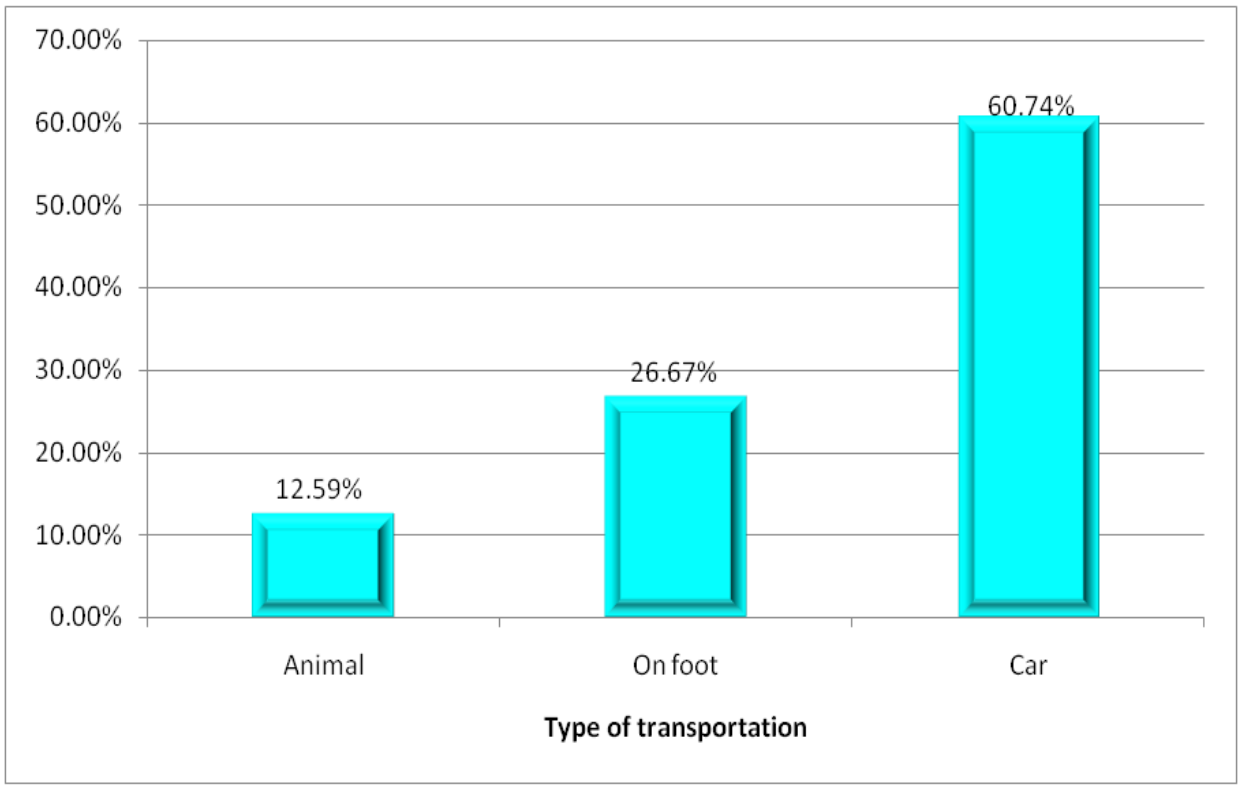
Source: Field data, 2018

Most of the feeder roads in Matetani sub-location are in deplorable condition therefore, some of the rural areas are inaccessible. The lack of good roads hinders access to markets for agricultural production. Due to delay in reaching the market some produce such as milk, fresh vegetables and coffee deteriorate quickly leading to losses. This has a serious impact on food security because agricultural yields will not be increased if produce cannot be taken to the market.

5.5.8.2 Types of transport service

All respondents agreed that they had access to transport service to take their products to the markets which are located in the shopping centers and nearby towns. The most common type of transport used to go to town was car as supported by 60.74%. Those close to town and those who cannot afford the cost of road transport indicated that they walk to town (26.67%). Only 12.59% indicated that they take their produce to the market using animal transport. It was established that lack of adequate transport service and local market have a negative impact on agricultural activities of the farmers. Figure 5.8 shows the findings of the study.

Figure 5.8: Types of transport for agricultural produce

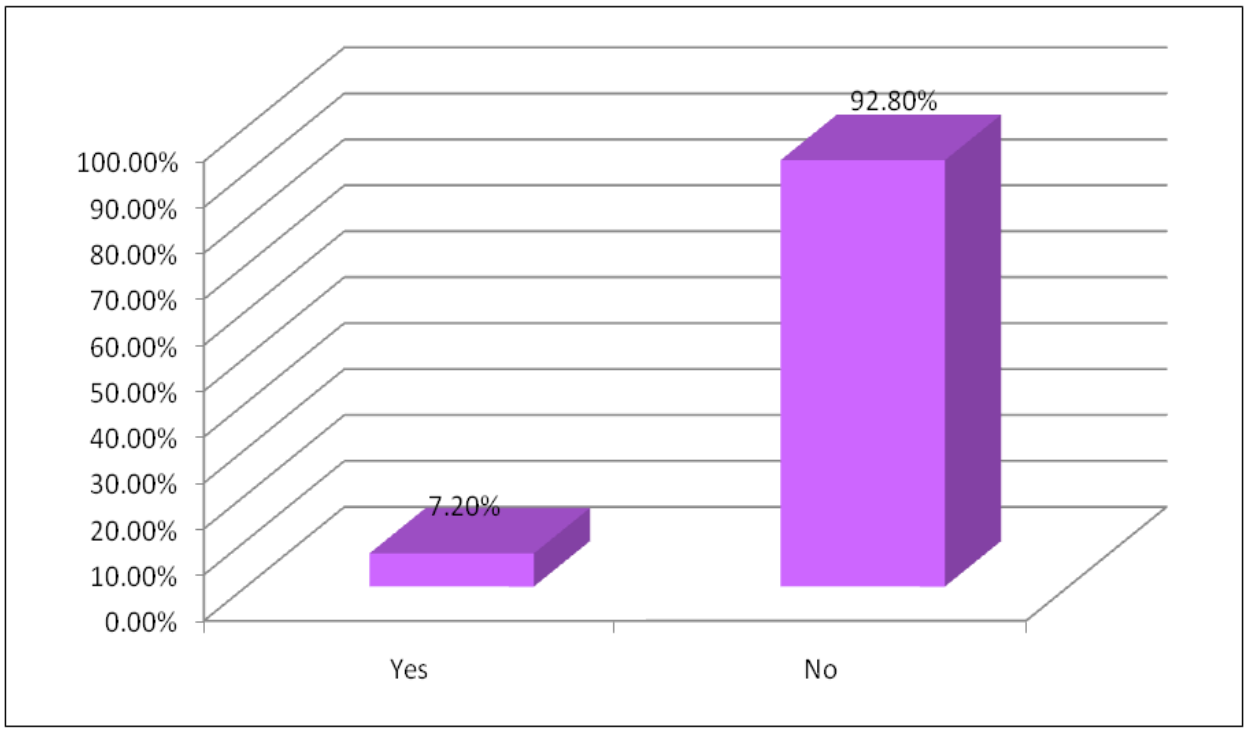


Source: Field data, 2018

5.5.8.3 Credit facilities

The findings revealed that 92.8% of the respondents did not have access to credit facilities while only 7.2% indicated that they had access. The sources of credit for farmers included: Microfinance institutions, Sacco's, Government loans, Self-help groups and other Community Based Organizations.

Figure 5.9: Access to credit facilities



Source: Field data, 2018

5.5.8.3 Constraints in accessing credit

The constraints in accessing credit from formal institutions included limited capacity of the formal institutions in reaching all farmers (63.6%) especially those in the rural areas. The other constraint was the high interest rates (14.3%) and unfavorable repayment period (11.4%). Table 5.22 shows the summary of findings.

Table 5.22: Constraints in accessing credit from formal institutions

		Frequency	Percent	Valid Percent
Valid	High interest	20	14.3	16.0
	Limited capacity to reach all	89	63.6	71.2
	Unfavorable repayment period	16	11.4	12.8
	Total	125	89.3	100.0
Missing	System	15	10.7	
Total		140	100.0	

Source: Field data, 2018

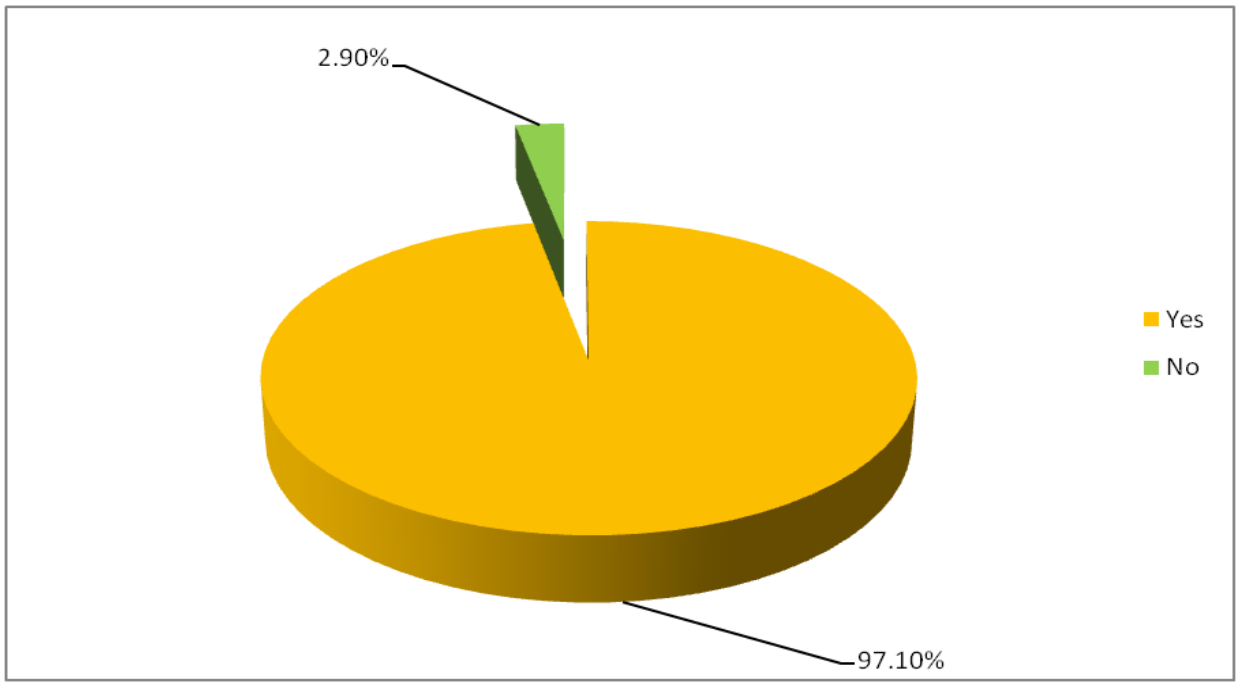
Amoako, (2002) observed that agricultural loans attract very high interest rates and are availed to loanees (farmers) when production processes are almost completed. Findings showed in figure 5.8 above indicated that, many farmers had no access to agricultural loans due to lack of collateral. The farmers also shied away from taking loans because they are given on condition that they pay immediately after harvest when prices of agricultural produce are at their lowest. The smallholder farmers are therefore at a loss of gains that might have accrued from price appreciation by selling their produce at their own appropriate time.

5.6 Inter-generation transmission of land rights and use

5.6.1 Land holding arrangements

The results showed that 97.1% of the respondents owned land through inheritance or purchasing. Notably, majority of the women reported not owning land due to cultural issues that limits women's access to, ownership of, and control over land.

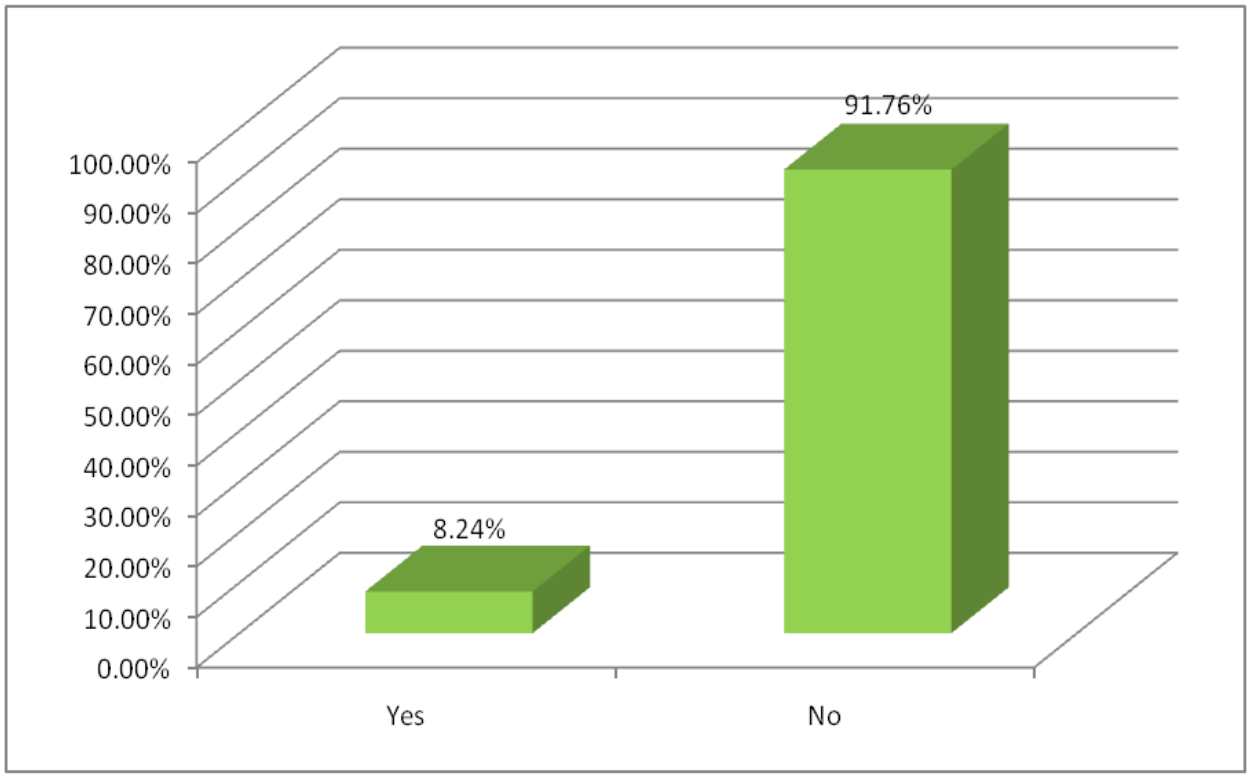
Figure 5.10: Land holding arrangements



Source: Field data, 2018

The study further sought to find out whether the respondents rented land where it was established that majority (91.76%) indicated that they did not rent any land. Only 8.24% of the respondents indicated that they rent land. Many of the respondents engaged in subsistence farming hence did not see the need to rent more land. This can also be attributed to lack of land for leasing because they are small in size and no household has idle land for leasing.

Figure 5.11: Renting of land



Source: Field data, 2018

5.6.2 Parcel of land before sub-division

The land before sub division ranged between 0.25 acres to 104 acres and on average the land before sub-division was 11.98 acres. Majority (76.4%) of the respondents agreed that their land had been sub-divided while 26.4% indicated that their land had not been sub-divided as shown in Table 5.23 below.

Table 5.23: Whether the land has been sub-divided

		Frequency	Percent	Valid Percent
Valid	Yes	103	73.6	73.6
	No	37	26.4	26.4
	Total	140	100.0	100.0

Source: Field data, 2018

The respondents were further asked to indicate how many heirs inherited the land after sub-division so as to determine how many times the land was sub divided. The findings revealed that the number of heirs ranged from 1 to 7. Majority indicated that the heirs were 5 as shown by the mode of 5. The mean number of heirs was 4. It is accepted that inheritance is the primary cause of land subdivision particularly when farmers desire to provide each of several heirs with land (Olayiwola & Adeleye, 2006).

Table 5.24: Number of heirs or beneficiaries

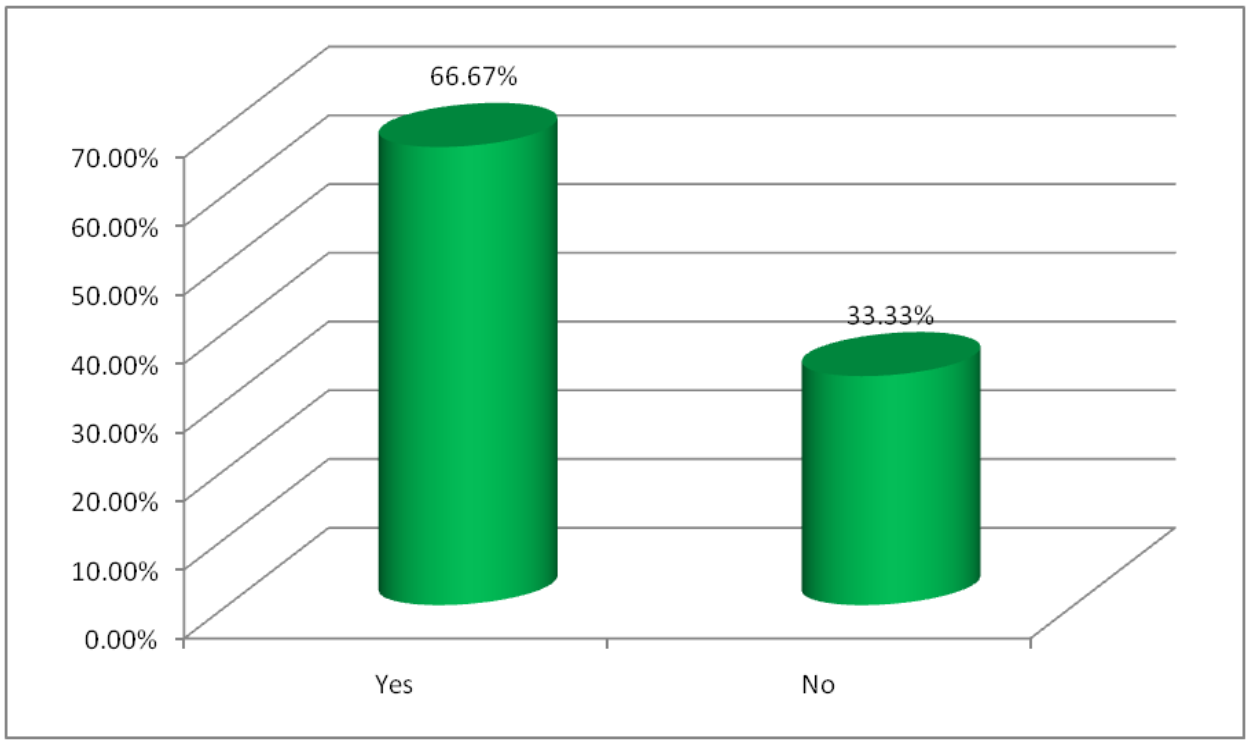
Mean	3.96
Median	4.00
Mode	5
Std. Deviation	1.943
Variance	3.776
Range	6

Source: Field data, 2018

5.6.3 Whether country should continue sub-dividing land

In terms of whether the country should continue sub-dividing land, 66.67% of the respondents supported subdivision while 33.33% did not support. Land sub-division was supported for various reasons including: equal distribution of family land, to ensure every person owns a piece of land since land has become smaller and to avoid land disputes among others.

Figure 5.12: Whether country should continue sub-dividing land



Source: Field data, 2018

In order to avert land sub-division, the respondents made the following suggestions: creation of job opportunities for the youth to avoid over reliance on land, education of children as a way of empowering them, ensuring that each piece of land has a title deed, expediting land disputes to guarantee ownership, supply of adequate water to all areas to create more arable land and increase productivity, government settling of the poor and squatters and expanding more land for farming through such practices as land reclamation and use of modern agricultural technologies such as improved maize pollinated varieties, intensive tillage, monoculture, genetic manipulation of crops, application of inorganic fertilizer and chemical pest control.

The study further sought to find out the problems of land sub-division to a farmer. The respondents stated that land disputes among heirs were the commonest of them. It was also established that land sub-division reduced the size of land making it not fit for agricultural

production. This therefore meant that agricultural production was reduced significantly due to land subdivision. The findings further revealed that the heirs tend to sell off part of their land after sub-division further reducing the size of land available for farming. It is important to note that respondents indicated that the land they owned was not enough and would prefer more land for farming, dividing among heirs and building their homesteads.

5.7 Food and nutrition security

The overall objective of the study was to assess household land size and uses for sustainable food and livelihood security on maize farming systems in Matetani sub-location. It was therefore important to determine the average maize yield per acre in the sub-location. The findings in Table 5.25 indicate that the average yield is 428.13kg/acre. This implies that the current maize yield is considerably low given the agricultural potential of the area of 526 kg/acre.

Table 5.25: Average maize yield per acre

Mean	428.13
Median	377.80
Mode	400
Std. Deviation	7.229
Variance	52.252
Range	50

Source: Field data 2018

The low crop yield can be attributed to poor crop management practices, use of low quality seeds, low adoption of agricultural technologies and land fragmentation. The findings are consistent with the results of a study carried out by Murton (1999) who indicated that maize production per acre had dropped from 526 kg/acre in 1940 to 445kg/acre in 1996 in Machakos County.

The findings of the study have shown that land sub-division has negative effects on crop productivity. Muyanga and Jayne (2014) in their study indicated that small pieces of land hinder application of modern agricultural technologies hence the inverse farm size-productivity relationship. The land size per household is declining in Matetani sub-location fueled by the cultural practice where male children are entitled to land inheritance.

The respondents were asked to compare yields they get currently in their farm and the yields that used to come from their father's farm before sub-division. Based on the findings, 80.9% of the respondents indicated that the yields were lower while 10.6% indicated that the yields were the same. Only 8.5% of the respondents indicated that the yields were more as shown in Table 5.26.

Table 5.26: Current yield compared to yield from father's farm before sub-division

		Frequency	Percent	Valid Percent
	Yields are the same	15	10.6	10.6
	Currently yields are lower	114	80.9	80.9
	Currently yields are more	12	8.5	8.5
	Total	141	100.0	100.0

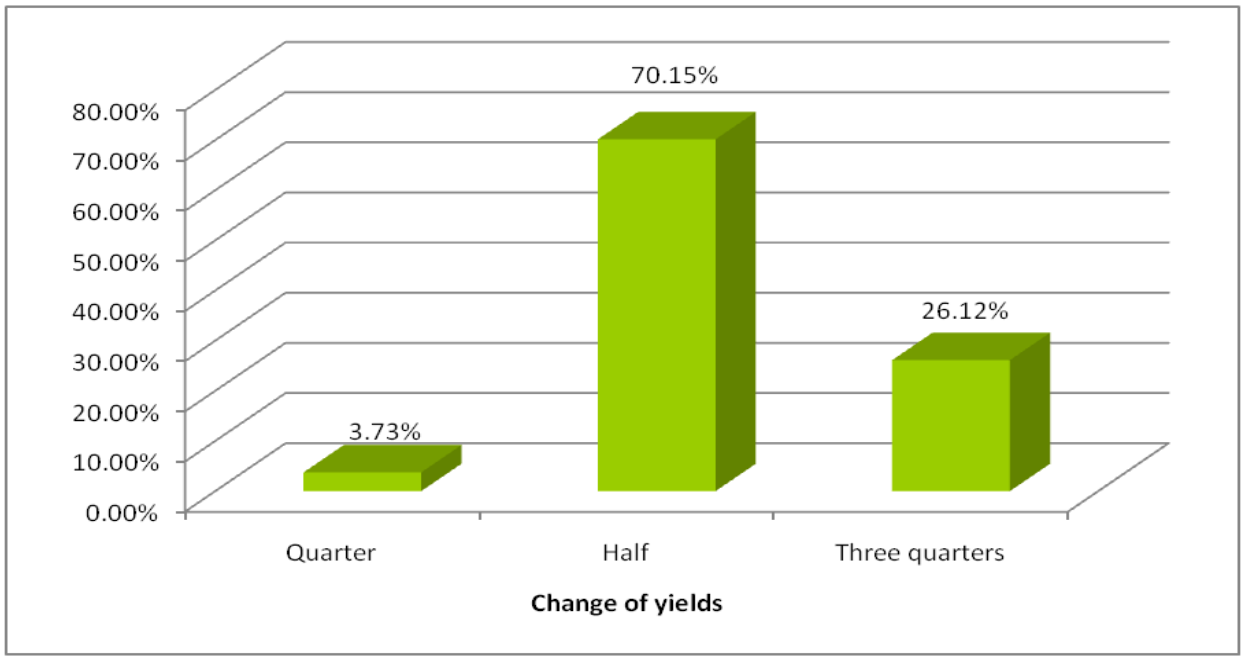
Source: Field data, 2018

The findings concur with Wan and Cheng (2001) who indicated that land subdivision causes resource dis-utilization and underutilization; where it's hard to apply some new technologies of agricultural modernization and reap the economies of scale when farms are small and subdivided. Therefore, simply stated the impact of land subdivision is related to the number of plots and may be viewed to have an economic cost in terms of lower agricultural productivity and prohibiting proper land management and sustainable agricultural development. As the plot sizes steadily decrease with every land subdivision, it becomes crucial to discuss how a reduced parcel size influences agricultural productivity and profitability.

In line with the change of yields, 70.15% of the respondents indicated that the yields had changed by half. A further findings 26.12% of the respondents indicated that the yields had

changed by three quarters. Only 3.731% of the respondents were of the view that the yields had changed by a quarter.

Figure 5.13: Extent of change of yields



Source: Field data, 2018

The change in the yields could be attributed to several factors including; significant reduction of land size, climate change, reduced vegetation cover leading to soil erosion, depletion of soil nutrients hence poor soil fertility, water logging, lack of finances to adopt modern agricultural technology, laxity among the youths in undertaking agriculture as an economic activity and that heirs have intensified agricultural activities among others.

5.7.1 Views on land subdivision

The findings indicated that 114 (81.4%) of the respondents agreed that land fragmentation exists due to population pressure while 24 (17.1%) were not sure. Only 2 (1.4%) did not agree to the statements. It was also established that the respondents agreed that small subdivided land leads to low crop yield as supported by 108 (77.13%) of the respondents, 26 (18.59%) disagreed while 6

(4.28%) were not sure. The respondents also disagreed that small subdivided parcels leads to high crop yield as supported by a majority 130 (92.86%) of the respondents. Majority 104 (74.29%) of the respondents agreed that modern farming techniques can easily be applied on small land sizes while 28 (20%) disagreed. Further findings indicated that with small land sizes, the number of cattle kept has gone down as supported by 76.43% of the respondents. The results also revealed that 65 (46.43%) of the respondents agreed that land fragmentation has made people adopt new farming techniques and skills while 46 (32.86%) disagreed. Table 5.27 shows summary of the findings.

Table 5.27: Effects of land fragmentation

Statements	**Agree**		**Disagree**		**Not sure**	
	Frequency	%	Frequency	%	Frequency	%
Land fragmentation exists due to population pressure	114	81.4	2	1.4	24	17.1
Small subdivided land leads to low crop yield	108	77.13	26	18.59	6	4.28
Small subdivided parcels lead to high crop yield	130	92.86	5	3.57	5	3.57
Modern farming techniques can easily be applied on small land sizes	104	74.29	28	20.00	8	5.71
With small land sizes, number of cattle kept has gone down	107	76.43	22	15.71	11	7.86
Land fragmentation has made people adopt new farming techniques and skills	65	46.43	46	32.86	29	20.71

Source: Field data, 2018

Blarel et al., (1992) suggests that the supply-side causes of land sub-division include land scarcity, population growth and inheritance laws. Land subdivision may hider cultivation of

various crops and may deter farmers from shifting into high value crops. Some high value commercial crops such as flowers needs huge plots, therefore the farmers with small pieces of land can only grow crops with which are less profitable. Land subdivision also limits mechanization and farmers do not enjoy the advantages of economies of scale.

5.7.2 Human settlement patterns

The average number of houses in the compound was 3 with an average total homestead area of $400M^{2.}$ Majority of the houses had cemented floors, brick walls and iron sheet roofs. Some of the houses had walls made of stones, plastered, iron sheets, tins, while a few were mud walled. Some of the roofs were made of tiles, asbestos sheets, grass, makuti and tin. The floor was either cement floor or earth floor.

Plate 7: A typical homestead compound with a main family house and 3 other houses
Source: Field Survey 2018

Plate 8: A house made of brick walls with a roof made of corrugated iron sheets

The respondents were also provided with possible human settlement patterns so as to rank them in order of preference where 1=most preferred and 4=least preferred. Clustered low density human settlement patterns was the most preferred as shown by a mean of 1.4272 and a standard deviation of 0.9862. Linear along the roads was ranked second (M=2.3220, SD=1.26547) because residents prefer staying in close proximity to the road. Scattered human settlement patterns was ranked third (M=3.1719, SD=1.16230) while clustered high rise human settlement patterns was ranked fourth hence being the least preferred pattern (M=3.6048, SD=1.00259). Table 5.28 shows the findings of the study.

Table 5.28: Human settlement patterns

	N	Minimum	Maximum	Mean	Std. Deviation
Scattered human settlement patterns	64	1.00	4.00	3.1719	1.16230
Linear along the roads	59	1.00	4.00	2.3220	1.26547
Clustered low density human settlement patterns	103	1.00	4.00	1.4272	.98620
Clustered high rise human settlement patterns	124	1.00	4.00	3.6048	1.00259

Source: Field data, 2018

In terms of how farms should be organized in future, the following proposals were made: building of clustered houses on one side of the farm land to save on space and create more space for farming activities, adoption of clustered low density as opposed to the present scattered human settlement pattern, increased public awareness on land related laws, public should be discouraged from encroaching the riparian zone, land consolidation and ensuring that all land have title deeds to ensure secure land tenure.

5.8 Household food security situation

Household food security was measured using household food security index obtained by computing the daily calorie intake of a household against the required daily calories. Household calorie intake was determined by collecting data on the types and quantities of food items taken by each household. The mean household food security index was 0.822 which implies that the households are food insecure. This is because a household is food insecure if its HFSI is less than one. Table 5.29 shows the summary of the main household food security measures.

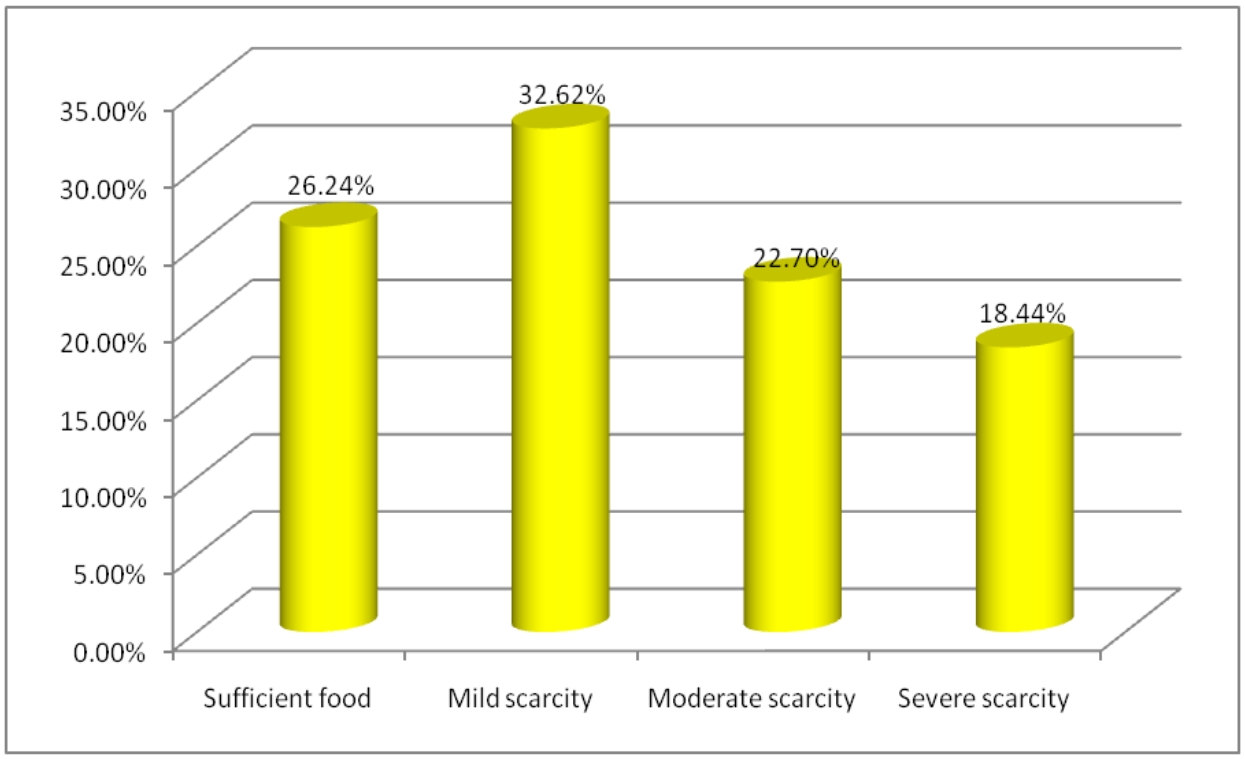
Table 5.29: Food security measures

Food security measures	N	Minimum	Maximum	Mean	Std. Deviation
HH food security index	140	0.18	1.96	0.822	0.410
HH daily energy requirement (kcal/day)	140	1620	18605	7112	2937
HH daily energy intake (kcal/day)	140	1044	25942	4603	2005
HH size (No.)	140	1	15	6.38	2.837

Source: Field data, 2018

The study also sought to determine whether the current yield from the farm can feed the family adequately. The following key was used: Sufficient food-at least 12 months, mild scarcity-9 months, moderate scarcity-6 months and severe scarcity-3 months. Based on the findings, 32.62% of the respondents indicated that the yield from the farm could feed the family for at least 9 months. Those who were food sufficient throughout the year represented 26.24% of the respondents. It was also established that 22.7% of the respondents were experiencing moderate scarcity as the yield was only sufficient to feed the family for 6 months. Further findings indicated that 18.44% of the respondents were experiencing severe scarcity as the yield from the farm could support them for a maximum of 3 months. Figure shows the findings of the study.

Figure 5.14: Food security

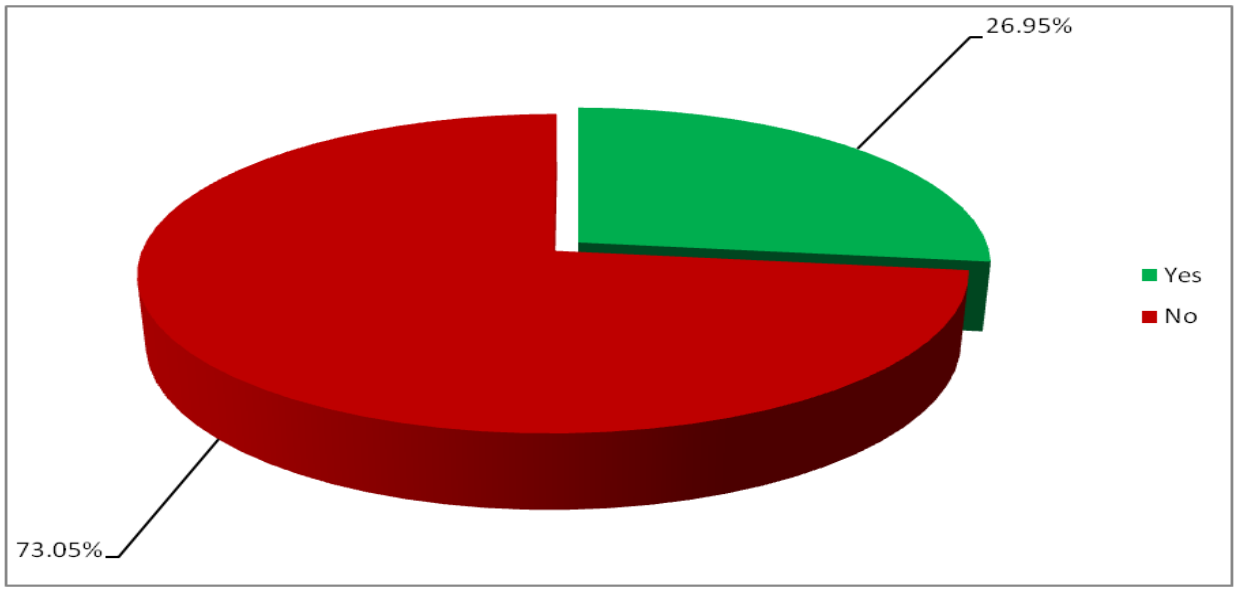


Source: Field data, 2018

Households with sufficient food and those who had experienced mild scarcity (1-3 months) were grouped together and categorized as food secure. The households experiencing moderate scarcity and severe scarcity were grouped as food insecure households. Going by the above explanation, majority (58.86%) were food secure while 41.14 were food insecure. Household food security was affected by the change in household size, household income, farm size, access to extension services, access to credit facilities, road infrastructure, adoption of modern technologies, land tenure and access to market.

The respondents were asked whether the family skipped meals because of food shortage in the last 3 months in an attempt to determine if whether the household was food secure. Analysis of the findings indicated that majority (73.05%) of the respondents had not skipped meal in the last 3 months while 26.95% had skipped meal because of food shortage.

Figure 5.15: Whether the family skipped meal due to food shortage



Source: Field data, 2018

5.9 Hypothesis testing

5.9.1 Household land size and food security

The following null hypothesis was tested in terms of the household land size and food security.

Ho: Household land size has no significant effect on household food security. The findings shown in Table 5.30 shows that household land size had a positive and significant effect on household food security as supported by a P value of 0.009 which is less than 0.05. Therefore the null hypothesis is rejected.

Table 5.30: Household land size and food security

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	111.718[a]	93	.0090
Likelihood Ratio	125.342	93	.014
N of Valid Cases	141		
* Significant at ≤ 0.05			

Source: Field data, 2018

The study evaluated socioeconomic continuous variables in relation to food security status by carrying out a t-test. The mean difference in land size was found to statistically at 99% confidence level. It was established that the food secure households had a mean household land size of 3.42 acres while the food insecure had a mean land size of 0.822 acres. The findings concurs with a study done by Haile et al., (2005) who indicated that household land size affects significantly affects food security positively.

Table 5.31: Continuous variables and food security

Variable	Overall mean **(N=140)**	**Mean**		**t- Test**
		Food secure (N=82)	Food Insecure (N=58)	
Household land size	2.19	3.42	0.973	0.0000***
Age of household head	57.04	52.04	38.96	0.0000***
Household size	6.38	6.530	0.822	0.0000***
Off farm income	8,850	3,482.02	858.18	0.0000***

Source: Field data, 2018

5.9.2 Household land use and household food security

The following null hypothesis was tested in terms of the household land use and food security.

Ho: Household land use has no significant effect on household food security.

Agricultural land uses were categorized into three; cash crop, food crops and pasture/Napier grass. The findings indicated that cash crop farming and food crop farming were found to have significant relationship with the household food security.

Table 5.32: Chi square results of household land use and household food security

Land use	**Chi square**	***n***	***p***
Food crop	8.3695	140	0.002*
Cash crop	18.1671	140	0.000*
Pasture	7.6109	140	0.265
* Significant at ≤ 0.05			

Source: Field data, 2018

Food crop had a chi square value of 8.3695 and a p value of 0.002 hence significantly related to household food security because P value was less than 0.05. On the other hand, cash crop farming had a chi square value of 18.1671 and a p value of 0.000 hence having significant association to food security. Pasture was found not to be significantly related (P=0.265) to food security in Matetani sub-location.

Based on the findings, food crop farming led to improved household food security in the location. This is because more land allocated to food crop farming means improved household production of food crops hence guaranteeing food security. Production of food crops reduces the amount used in purchasing food crops hence the savings can be channeled back to agricultural activities.

It was further established that there was a significant association between cash crop farming as a form of land use and household food security. Cash crops boost household income that can be used in purchasing food for the family. The income can also be used to purchase farm inputs that can increase agricultural production making the household food secure. This implies that the farmers should concentrate on producing cash crops and use the proceeds to purchase food for

the household. It would also be argued that the higher the amount of food from own production the higher the likelihood of food security.

5.9.3 Multiple Linear Regression Model

Multiple Linear Regression Model was explored to identify the factors that determined household food security in the study area. The multiple linear regression models was estimated using the ENTER method. The dependent variable was the food security index, which was measured using household food security index obtained by computing the daily calorie intake of a household against the required daily calories. The dependent variables identified from the regression analysis include; household land size, age of household, household size, off farm income and land management practices.

The regression equation took the following form.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Where

Y = Food Security (as measured by the food security index)

X_1 = Land size

X_2 = Age of household head

X_3 = Household size

X_4 = Off-farm income

X_5 = Land management practices

In the model, $\beta 0$ = the constant term while the coefficient β_S= 1….4 are the regression coefficients for the explanatory variables and ε – Stochastic error term estimate which captures the unexplained variations in the model. The findings shown in Table 5.33 indicate that the

coefficient of determination also (R^2) is 56.42%. This implies that the combined effect of the predictor variables (household land size, age of household head, household size, off farm income and land management practices) explains 56.42% of the variations in household food security in the study area. Other factors that are not considered in the study contribute approximately 43.58% of household food security.

Table 5.33: Regression Model Summary

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0.7511201	0.564181	0.631974	0.79820

Source: Field data, 2018

Predictors: (Constant), household land size, age of household head, household size, off farm income and land management practices

The study further carried out ANOVA analysis as displayed in Table 5.34. According to Mugenda & Mugenda, (2003), ANOVA is a data analysis procedure that is used to determine whether there are significant differences between two or more groups or samples at a selected probability level. Analysis of variance (ANOVA) shows that the combined effect of household land size, age of household head, household size, off farm income and land management practices was statistically significant in explaining changes in household food security. This is demonstrated by a p value of 0.000 which is less that the acceptance critical value of 0.05.

Table 5.34: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	58.582	5	12.334	93.581	.000
	Residual	49.458	135	2.194		
	Total	108.04	140			

a. **Predictors: (Constant),** household land size, age of household, household size, off farm income and land management practices

Source: Field data, 2018

The procedure of obtaining the coefficients of the independent variables was carried out as shown in table 5.35.

Table 5.35: Regression Coefficients

Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	1.962	1.2038		0.762	.000
Household Land Size	4.8157	0.2169	0.126	1.088	.000
Age of Household	1.2416	0.1540	0.108	0.671	.049
Household Size	-1.736	0.1018	0.164	-0.860	.032
Off Farm Income	0.8809	0.2209	0.122	0.490	.036
Land Management Practices	1.8267	0.3422	0.054	0.361	.020

Source: Field data, 2018

Substituting the *Beta* values, the regression model is as follows:

$Y = 1.962 + 4.8157X_1 + 1.2416X_2 – 1.736X_3 + 0.8809X_4 + 1.8267X_5 + \varepsilon$

According to the regression equation established, taking all factors (household land size, age of household head, household size, off farm income and land management practices) constant at zero, food security will be 1.962 as shown by the constant term. The data findings also show that taking all other independent variables at zero, a unit increase in land size will lead to a 4.8157 increase in food security; a unit increase in age of household head will lead to a 1.2416 increase in food security, a unit increase in household size will lead to a 1.736 decline in household food security; a unit increase in off farm income will lead to a 0.8809 increase in food security. Similarly, a unit increase in land management practices will lead to a 1.8267 increase in food security.

The variables were tested and the findings indicated that land size had a positive and significant relationship (p=.000) with household food security. The other determinants that had positive and significant relationship with food security included: age (p=.049), off-farm income (p=.036), access to market (p=.025), access to extension service (p=.032) and land management practices (p=.02). Household size was found to have a negative but significant relationship (p-=.032) with food security. This implies that an increase of household size reduces the chance of being food secure. Age of household head was weakly correlated to food security though positive. It was also established that household size was moderately and negatively correlated to food security. The findings shows that at 5% level of significance and 95% level of confidence, all the P values were less than 0.05 hence all the variables were statistically significant. Generally all the variables tested were important in influencing household food security.

5.9.4 Correlation analysis

Spearman's rank correlation was conducted in order to determine how well the variables correlate. The Spearman's (r) correlations among the seven measures are generally quite strong,

are associated in the expected direction, and are all significant at the $p<0.05$ level, as shown in the table of pooled correlations (all rounds). Household land size was highly correlated to food security ($r=0.983$) followed by access to market 0.893. Overall, the measures correlate quite strongly, and yet there is enough unexplained variance to suggest that each metric might be capturing a different aspect of food security.

Table 5.36: Correlation Analysis

	House hold land size	Age of house hold age	House hold size	Off farm income	Access to market	Access to extension service	Land management practices	Food Security
Household land size	1							
Age of household head	0.862	1						
Household size	0.564	0.861	1					
Off farm income	0.853	0.440	0.308	1				
Access to market	0.532	0.958	0.856	0.69	1			
Access to extension service	0.672	0.871	0.85	0.78	0.63	1		
Land management practices	0.494	0.562	0.48	0.63	0.92	0.88	1	
Food Security	0.983	0.396	-0.510	0.605	0.893	0.551	0.748	1

Source: Field data, 2018

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter makes conclusions on the study topic based on the findings and discussions made in chapter five. The recommendations are made to inform the stakeholders who include the farmers, extension workers, non-governmental organizations and the policy makers in Matetani sub-location and Kenya at large.

6.2 Summary of Findings

The main objective of the study was to assess household land sizes and uses for sustainable food and livelihood security on maize farming systems in Matetani Sub-location. Therefore detailed questionnaires were designed and distributed to 140 respondents all of whom filled and returned the questionnaire. Majority (67.62%) of the respondents were over 50 years old with 80% being married. The mean household size was found to have 6 members while the average number of sons and daughters was 3 and 2 respectively.

Based on the findings, majority of the respondents had secondary education as follows: Fathers (49.44%), Mothers (54.95%), Sons (71.55%) and Daughters (73.83%). At the time of inheritance, the mean number of brothers was 2 same as that of sisters. It was established that majority of the sisters did not inherit land from their parents because of limitations of cultural practices. The summary of findings based on each objective is discussed in the following subsection.

6.2.1 Household land sizes and uses and their impact on food security

Majority of the respondents (97.14%) mostly men owned land while only 2.86% did not. This can be attributed to the fact that the respondents were the household heads most of whom owned land. The average household land size was 2.19 acres with majority having 2 acres of land. The

main crop grown was maize (98.6%), beans (86.4%) and cowpeas (54.3%). In terms of poultry, the majority of respondents 108 (77%) reared poultry, 91 (65%) reared cattle while 31 (22%) kept goats. The study established that the majority of the respondents engaged in farming as their main economic activity. Others engaged in business while some were in formal employment. It was further established that application of modern technology in farming was very low as only 40.7% agreed to applying modern agricultural technology.

The average maize yield per acre was found to be at 428.13kg/acre. This implies that the current maize yield is considerably low given the agricultural potential of the area of 526 kg/acre. The low crop yield can be attributed to poor crop management practices, use of low quality seeds, low adoption of agricultural technologies and the diminishing land sizes.

It was established that the food secure households had a mean household land size of 6.530 acres while the food insecure had a mean land size of 0.822 acres. The mean household food security index was 0.822 which implies that the households are food insecure. This is because a household is food insecure if its HFSI is less than one.

6.2.2 Factors affecting land size and uses and their impact on food security

The second objective of the study was to examine the factors that influence the size and use of household land in the Sub-location. Technology is one factor that affects land size and use because it is seen as a substitute for land area. However the findings indicated that majority 76 (54.3%) of households did not apply modern agricultural technology on their farmland. This may be attributed to small sizes of land.

Empirical evidence suggests that in order to apply technology profitably on a farm, a household needs to possess a farm of adequate size. The respondents indicated that the constraints to adoption of modern technology include lack of information about new technology, lack of

education and lack of credit facilities. Land fragmentation may partly be responsible for the slow and uneven diffusion of modern technology in Matetani sub-location.

Environmental factors such rainfall and soil condition were found to affect land use. The study further sought to find out whether the farmers were using irrigation as an agricultural practice. Results indicated that majority did not use irrigation and only depended on rain fed agriculture. Dependence on rain fed agriculture leads to low agricultural production hence affecting food security. In relations to agricultural management practices, 82.9% of the respondents agreed that they practice agricultural land management in their farmland.

The respondents agreed that they carry out the following practices: use of chemical fertilizer, use of organic manure and crop rotation. It was evident that the main constraint facing the farmlands in Matetani sub-location was loss of soil fertility through soil erosion and water logging. The constraints were further aggravated by poor farming practice, population growth and reduced vegetation cover.

Further findings indicated that majority of the farmers had never attended agricultural field days in their area implying that access to information from extension officers was limited. However, slightly more than half of the respondents agreed that their farm or farmer group had been visited by an agricultural extension officer. The respondents were of the view that extension workers can help farmers in identifying where to buy their inputs and calculate their farm input needs.

Access to infrastructural services and credit also affect land use. Agricultural infrastructure such as feeder roads were found to be present but in poor state hence causing delays of the produce getting to the market. The constraints in accessing credit from formal institutions included limited capacity of the formal institutions in reaching all farmers, high interest rates and unfavorable repayment period.

Taking all other independent variables at zero, a unit increase in land size will lead to a 4.8157 increase in food security; a unit increase in age of household head will lead to a 1.2416 increase in food security, a unit increase in household size will lead to a 1.736 decline in household food security; a unit increase in off farm income will lead to a 0.8809 increase in food security. Similarly, a unit increase in land management practices will lead to a 1.8267 increase in food security.

6.2.3 Inter-generation transmission of land rights and use

Inheritance is the major mode of land acquisition as it is ownership of family land is transferred from generation to generation. This is however affected by gender, age, social status and cultural values. The findings indicated that majority of the respondents owned land through inheritance while a few through own purchasing. In terms of renting, it was established that majority did not rent any land due to unavailability of land to for lease.

Majority (76.4%) of the respondents agreed that their land had been sub-divided with land before sub division ranging between 0.25 acres to 104 acres and on average the land before sub-division was 11.98 acres. The land was being subdivided for inheritance purposes with the number of heirs ranging from 1 to 7. The mean number of heirs was 4. In terms of whether the country should continue sub-dividing land, 66.67% of the respondents supported subdivision for various reasons including: equal distribution of family land, to ensure every person owns a piece of land since land is become smaller and to avoid land disputes among others.

6.2.4 Planning interventions that can create a sustainable household land size, food and livelihood security

In order to avert land sub-division, the respondents made the following suggestions: creation of jobs opportunities for the youth to avoid over reliance on land, education of children as a way of empowering them, ensuring that each piece of land has a title deed as a mode of secure land

tenure as a mode of creating incentive for proper land management practices, expediting land disputes to guarantee ownership, supply of adequate water to all areas to create more arable land, government settling of the poor and squatters and expanding more land for farming through such practices as land reclamation and use of other modern agricultural technologies.

Given the conceptual and practical reasons for planners' involvement in community food issues, they could take the following steps to better integrate food-related concerns into their everyday activities:

i. Compile data on the community food system in relation to land sizes and use,
ii. Analyze connections between food and other planning concerns,
iii. Assess the impact of current planning on the local food security and
iv. Integrate food security into community goals.

6.2 Conclusions

The study sought to assess household land sizes and uses for sustainable food and livelihood security in Matetani Sub-location. Based on the findings, the following conclusions were drawn. The variables that were found to greatly influence food security were: land size, age of household head, off farm income access to market, access to extension service and land management practices.

That land size had significantly reduced due to land fragmentation hence affecting food and livelihood security. The mean household land size in Matetani was 2.19 acres. The shrinking land size also has a serious impact on household income due to reduced agricultural production which in turn affects the overall national development since development stems from the household unit. The study further concluded that majority of the residents owned land albeit

small and did not rent land for purposes of agricultural activities. Land ownership was through inheritance which encourages land sub-division. From the above observation, this study concludes that household land size affects agricultural production and in turn affects food security.

This study observed that the residents of Matetani sub-location used agricultural land for mixed farming (crop production and animal rearing). Findings of the study revealed that households use a large part of their land in cultivating food crops most of which is used for subsistence. On the contrary, the findings indicated that the households engaging in cash crop farming are likely to be food secure as they can use the proceeds from the sale of cash crops in purchasing food for the household. The households rearing livestock were also moderately food secure because of the diversified stream of income from sale of milk, eggs and even animals.

The study concluded that, other than the current small farm sizes and inappropriate uses in the area, food security in Matetani Sub-location has been further compounded by, adverse environmental conditions such as soil erosion, water logging and unreliable weather patterns; poor land management practices; low adaptation of technology; lack of access to credit; unregulated culture of inheritance and inefficient extension services.

The study adduced that land as a resource had been transmitted through the culture of inheritance for seven successive generations since the time the community settled in Matetani Sub-location in 1850 from Mbooni hills. The assets are also controlled by men and in some instances widows are only allowed to cultivate and not own land belonging to their deceased husbands. Women may also have insecure land rights because they married under customary practice or because they are in a polygamous marriage.

In conclusion, the planning interventions at National and County context for ensuring food security in the area, a land use plan of Matetani Sub-location should be carried out to determine the most productive areas for farming, appropriate location for a dam to support irrigation, settlement plan for the community so as to increase the area under agriculture as well as create a commercial center to serve as a market for the produce.

6.3 Recommendations

Based on the findings of this study the following recommendations are made:

i. The study revealed that, farm size of 3.42 acres was found to attain the highest level of food security in Matetani Sub-Location. The study thus recommends implementation of policy through the National Land Commission that discourages land subdivision in farms below 3.42 acres. However, the policy should be reviewed as land productivity increases through use of appropriate technologies making it possible for the land to support more people per hectare.

ii. The agricultural land use types that were significantly related to household food security were those that generate household income. The study recommends need for investment in projects that enhance commercialization of small-scale farming. For instance, improving the productivity of livestock sector and the coffee cash crop land use which has an immense impact to improving the household income so that food security status at household level would be above threshold level.

iii. Access to credit is necessary to encourage technological innovations and application so as to improve productivity in the small land sizes, thus the study recommends farmer awareness programs to encourage them to form and register groups that serve as collateral and leverage in accessing agricultural credit facilities and consequently increasing productivity per hectare in the study area.

iv. The study further recommends improvement of access to extension services through the Ministry agriculture by training farmers on the appropriate land uses, technologies, agronomic practices and best land management practices in relation to individual farmers' land resources for maximum land productivity.

v. It was established that many land owners did not have title deeds for their land and this prevented the farmers from carrying out proper land management techniques. It is therefore recommended that the government through the National Land Commission should ensure that all lands are properly documented to reduced disputes and act as an incentive for proper land management practices thus promoting agricultural productivity in the area.

vi. Kinship systems and gender roles are integral to the ways in which inheritance in Matetani Sub-location is practiced thus influencing land transmission practices in the area. The study recommends that women should be allowed by socio cultural norms to inherit land from their parents and spouses and have individual tenure. This calls for widespread change of cultural norms that constrains women in inheriting land. Policy makers should pursue reform to secure gender equity in inheritance systems. The government through the Ministry of Education should ensure that each child gets education as a substitute for land inheritance so as to break away from the culture of land inheritance. These efforts should focus on legal reform, institutional implementation, and socio-economic empowerment and follow up programmes to ensure each child has access to education since education is a substitute to land inheritance.

6.4 Recommendations for further research

The study through Multiple Regression Model found out that, the combined effect of the predictor variables (household land size, age of household head, household size, off farm income

and land management practices) explains 56.42% of the variations in household food security in the study area. Other factors that are not considered in the study contribute approximately 43.58% of household food security. This implies that, more research should be carried out to explain the variables 43.58% of household food security so as to give conclusive measures.

The study was carried out in Matetani sub-location only and the sample size was relatively smaller. A more robust study covering the entire county is therefore recommended.

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APPENDIX 1: HOUSEHOLD QUESTIONNAIRE

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

Sub-location Name.……...……..……..

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 of 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 Sources 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, given the crops grown and livestock reared in this sub-location, how

much land would be enough for your household?.....

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 do you have applying modern agricultural technology on your farm land? A) Yes B) No

4.4 If your answer for Question 4.3 is no please explain the

reasons_____

4.5 Do you use irrigation during your agricultural practice? A) Yes B) No

4.6 If your answer for question 4.5 is „No" what might be the reasons behind?

A) Because I do not have the capacity to use B) Lack of water source for irrigation

C) Lack of interest D) because I have a small plot of land and is not suitable for such practice

E) Because my farm lands are fragmented and are found at different areas

F) Because I do not know the importance of these practices

G) Lack of technical skills

H) If any other reason, please specify_____

4.7 Do you apply modern agricultural techniques like terraces (soil bund, soil terraces) and vegetation in your farmlands?

a. Yes b. No

4.8 If your answer for question number 4.7 is „**No'**, what might be the reasons behind?

A) Because I have a small plot of land and is not convenient for such practices

B) Because my farmlands are fragmented and found at different areas that made difficult to apply such techniques

C) Because I do not know the importance of these practices

D) Because there is information gap between the agricultural experts and farmers how they can be constructed and implemented making their relevance poor.

E) Because they create insects and affect crops

F) Because they make plowing difficult

G) They are laborious to be made, but I am working alone so that I cannot do such activities

H) Because they results extravagancy on my farmlands

I) If any other reason, please specify

4.9 Do you have practice agricultural land management for your farm land? A) Yes B) No

If your answer is „Yes" for question 4.9 which of the following agricultural land management practice do you carry out in order to maintain and replenish the soil fertility of your farm land?

No	**Management practice**	**Yes**	**No**
1	Use of organic manure		
2	Use of chemical fertilizer		
3	Crop Rotation		
4	Inter –cropping		

5	Fallowing (field rotation)		
6	Using modern farming techniques		

5.0 What are the main constraints for your farm land? Identify the four main bottlenecks according to the order of hindrance?

No	Constraints	A) Yes	B) No	Rank in Order
1	Poor soil fertility			
2	Water logging			
3	Soil erosion			
6	Others			

5.1 What do you think caused/aggravate the problem?

A) Poor farming practice C) Removal crop /vegetation cover

B) Population Growth D) Others (Specify)

5.2 What constraints you not to adopt modern Technologies in your Agricultural practices?

No	Constraints	Yes	No
1	Lack of credit service facility		
2	I have owned many plots of land		
3	Lack of education		
4	Lack of information about new technologies		
5	Lack of interest among farmers on adopting modern technologies		

Agricultural Extension Service

5.3 Have you attended Agricultural field days in the area? Yes [ ] No [ ]

If yes when was the last one attended?

i. Within the last six Months

ii. Within the last one Year

iii. Within the last two Years

5.4 Do you agree with the following statements; tick (√) appropriately.

	Yes	**No**
Your farm or farmer group has been visited by an agricultural extension officer		
You have ever heard of soil testing or tested your soil.		

5.5 Tick (√) to indicate the level you agree with the following statements.

	Strongly agree	**agree**	**Uncertain**	**Disagree**	**Strongly disagree**
Extension visits play a significant role in influencing the use of fertilizers					
Farmers who adopt the improved agricultural practices realize higher yields					
Given the limited availability of arable land, increase in maize yields can only be achieved by the use of modern technologies					

5.6 Extension workers can help farmers do the following; tick (√) appropriately.

ITEM	**YES**	**NO**
Calculate their farm input needs		
Identify where to buy their inputs		
Organize group transport		

Obtain credit		
Save		

Agricultural Infrastructure

5.7 Is there any feeder road that connects your area to the market area? A) Yes B) No

5.8 If yes how well it is? A) Poor B) Good C) Very good

5.9 Do you have access to transport service? A) Yes B) No

6.0 What are the types of transportation you use to go to town? A. Animal B. On foot C. Car

6.1 Do you have access to convenient markets for your agricultural outputs and inputs? A) Yes B) No

6.2 If your response for question No.1 is „no" please specify the reasons?

6.3 How do you rate the impact of lack of adequate transport service and local market have in your agricultural activities? A) Low B) Medium C) High D) Very High

6.4 Do you have access to credit services that facilitate your agricultural practice such as giving loan? A) Yes B) No

6.5 What are your sources of credit?

6.6 Do you have access to credit services from micro-finance institutions to support your livelihood?

6.7 What are the constraints accesses to credit from formal institutions?

6.8 High interest rate B) limited capacity to reach all C) unfavorable repayment period D)other, specify

6.9 What are the main crop and livestock land use activities on the farm?

Activity	**Area (Acres or Sq. Metres)**	**Yield (kgs) (other units) in Seasons**		**Used (Kgs)** **(Other Units)**		**Normal 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								
6								
7								
8								
9								
10								

LIVESTOCK TYPE	No. Animals	Yield/Animal/Year	Use (Kgs) (Other Units)		Value (Ksh)	Average income to the Family (Ksh)
			Consumed	**Sold**		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

7.0 What is your main source of cooking energy?

a. Firewood b. Charcoal c. Gas d. Crop residues e. Kerosene f. Electricity g. Other – specify

7.1 What is the cost of the cooking fuel per (i) Day? (ii) Week? (iii) Month? (iv) Year?

Food and nutrition security

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

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

Currently yields are more ( ) I`m not sure ( )

7.3 If yields have changed in 4.6. above, by how much has the yield changed?

A Quarter ( ) Half ( ) Three Quarters ( )

7.4 What do you think is the reason for the change in yield?

……

……

7.5 For how many months in a year does the current yield from your farm feed your family?

.....

7.6 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	

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

Yes ( ) No ( )

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

	Foods	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Mornin	a.							
	b.							
	c.							
Lunch	a.							
	b.							
	c.							
Supper	a.							
	b.							
	c.							

7.9 How often do you take the following meals?

Type of Meal/Food	Frequency of intake:(Daily, Weekly, Monthly, Annually, Other specify)
Milk	
Beans	
Chicken	
Fish	
Beef	
Pork	
Mutton	
Goat meat	
Fruits	
Beans	
Green/Yellow grams	
Njahi	
Ugali	
Rice	

Chapati	

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.

8.0 Land fragmentations exists due to population pressure

Agree ( ) Disagree ( ) Not sure ( )

8.1 Small sub-divided parcels lead to low crop yield

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

8.2 Small sub-divided parcels lead to high crop yield

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

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

Agree ( ) Disagree ( ) Not sure ( )

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

Agree ( ) Disagree ( ) Not sure ( )

8.5 If you agree in 8.4 above, the change in this sub-location is from an average of what number to what number of cattle

…….....

8.6 Land fragmentation has made people adopt new farming techniques and skills

Agree ( ) Disagree ( ) Not sure ( )

8.7 Human Settlement

8.8 Sketch the current arrangement of the homestead – Use attached plain paper?

8.9 Fill the following table appropriately.

Home compound parameters	**Remarks**		
a. Total area of homestead compound (Sq. metres)			
b. Main house - total area (Square metres)			
c. Main house number of rooms			
d. Main family house construction materials	Floor	Wall	Roof
e. Indicate the total **number** of other houses in the compound			
f. Estimate total **area** of the other houses in the compound (Square meters)			
g. List other structures in the homestead and their estimated area in square metres.	Food granary…….…..…. Hay store……. Firewood store…….……... Cowshed……. Chicken house…… Dog house…….. Other……..		

10.1 Given the way land is being sub-divided among heirs - what is your proposal on how

farms should be organized in the future?...……..……..

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

a. Scattered

b. Linear along the roads

c. Clustered low density

d. Clustered high rise

e. Others - Specify

10.3 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 the most common tenure arrangement in this Sub-location?

b) What is your opinion on the increasing land subdivision in this sub-location?

c) In your opinion what do you see as the main effects of land subdivision in this sub-location?

d) What are the most common forms of land uses in this Sub-location?

e) What is the most common form of human settlement? Scattered, Clustered, Linear, Other

f) What do you think should be done to solve challenges associated with excessive 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

Thanks 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 discussion, 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.

Record of FGD participants

Name	**Age (Years)**	**Gender**	**Marital status**	**Land owned acres (if any)**
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Discussion Guiding 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) Has the land/farm sizes changed overtime, what brought about these changes?

c) What were the main land uses then? What are the current land uses?

d) Has farm productivity been changing over time? Why is it so?

e) Is productivity dependent on ownership of land?

f) Is the farm produce sufficient? How long does it last?

g) And how come we settled to plant the crops we plant 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 up, does this affect land size and use?

APPENDIX 4: OBSERVATION LIST

The following were observed during the field survey for primary data collection

- Land sizes
- Settlement patterns
- Housing structures
- Field crops and farm sizes allocated to each crop
- Type of livestock and numbers (Many verses Few)
- Demarcation of farm sizes

APPENDIX 5: PHOTOGRAPHY LIST

The photographs of the following items were captured during the field survey

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

APPENDIX 6: NACOSTI PERMIT

THIS IS TO CERTIFY THAT:
MS. EUNICE MUENI MBITHI
of UNIVERSITY OF NAIROBI, 0-100 GPO, NAIROBI,has been permitted to conduct research in *Machakos County*

Permit No : NACOSTI/P/18/15669/24017
Date Of Issue : 24th July,2018
Fee Recieved :USD 9.55

on the topic: *ASSESSMENT OF HOUSEHOLD LAND SIZES AND USES FOR SUSTAINABLE FOOD AND LIVELIHOOD SECURITY ON MAIZE FARMING SYSTEMS; CASESTUDY OF MATETANI SUB-LOCATION, KANGUNDO SUB-COUNTY, MACHAKOS COUNTY*

for the period ending:
24th July,2019

.....
Applicant's Signature

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