CHALLENGES AND OPPORTUNITIES OF LAND TENURE AND LAND SUB-DIVISION TRENDS ON RICE PRODUCTION IN IRRIGATION SCHEMES IN KENYA: A CASE OF MWEA RICE IRRIGATION SCHEME

BY

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B63/81353/2012

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A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF A MASTER OF ARTS DEGREE IN PLANNING (M. A. PLANNING)

SEPTEMBER, 2019

DECLARATION

I **Cedric Kimari** hereby certify that this is my original work and it has not been presented to any other academic or professional institution for scholarly purposes or otherwise.

Signed: …… ……..

Signature Date:

Supervisor:

I do confirm that this report has been submitted with my approval as the University of Nairobi Supervisor.

Signed: …… ……..

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Dr. Fridah W. Mugo

ACKNOWLEDGEMENT

It is with the earnest sense of gratefulness to the Almighty God who has given me strength and ability to complete this thesis successfully.

I express my heartfelt gratitude to my supervisor Dr. Fridah Mugo for her dedicated guidance and untiring support. She offered me constructive critique and enlightenment throughout the conceptualization and undertaking of this work. Special appreciation for the support I received from my family members.

My heartfelt appreciation and indebtedness also goes to my family for the patience, understanding, support and encouragement during the period of my absence as I struggled to complete this study.

I also extend my gratitude to the whole fraternity of the University of Nairobi for their support throughout my learning process. I extend my thanks to my employer for giving me the opportunity to complete my studies and to all research respondents for making this study possible. To all fellow students, young and old, I say thank you. To all of you, thank you and may God bless you.

ABSTRACT

With an ever-increasing population and erratic weather patterns threatening food security, there is need to focus on increasing production of staples such as rice.in the large scale rice schemes. Globally, rice is one of the most important food crops used in the fight against hunger. Rice consumption in Kenya has been increasing annually at a rate of 12% but, despite the huge production potential in the country, there has been little growth in its production leading to a deficit of 255,000 metric tons annually. One of the factors leading to the fluctuation in the production of rice is attributed to issues related to land especially in terms of tenure and size. This study, investigated the influence of land tenure and land subdivision trends on rice production in rice irrigation schemes in Kenya, using the Mwea Rice Irrigation Scheme as a case study. The specific objectives were to examine the land tenure evolution in the last 50 years and the corresponding effect on rice production, assess the influence of household land tenancy on rice production, establish the influence of farmers' land size on rice production, establish the land-based challenges influencing rice production, and propose land tenure, land size and technological strategies that can be adopted to ensure optimal rice production in Mwea Irrigation Scheme. A Cross-Sectional study design was used. A total of 167 households selected from the rice producers in the study area were interviewed using a semi-structured questionnaire. Five in-depth key informants interviews were also conducted using unstructured interview guides. Related literature was also examined. The findings revealed that all the rice irrigation scheme land belongs to the government and is administered by NIB. Farmers are tenants and are required to grow only rice and no other crop. This is positive for rice production and is a policy that should continue to avoid change of rice land to other uses. There have been complaints on how land administration is conducted but this is being corrected through the management by the multipurpose cooperative. Each farmer was initially allocated 4 acres of land. Considering the minimum requirement of Kshs. 195,020 to sustain an average household of 5 persons, only 1.5 acres is required. The four acres can therefore sustain 2.5 households if farmed optimally. The challenge of land size, however, is that households have increased and although it is illegal to sub-divide the land, this has been done to some extent but informally. The rate of this informal sub-division

stands at 7% calculated by current average land size versus the land issued at the intial stage. The rate is fairly small and this is attributed to the close monitoring of land use and ownership by the NIB management. The sub-division among heirs reduces the per capita land unit for farming hence total production. Further sub-division can be stopped by expanding the irrigation land so that new households that wish to be full time rice farmers are given their own 2 acres to farm in new blocks. When the initial registered farmer is no longer able to farm, the 4 acres should be given to only two heirs in the family to continue farming. If no family member is interested in farming, the land should revert to NIB for allocation to other interested new farmer-tenants. Other identified challenges to rice farming include insufficient water, poor rice varieties, inadequate management and technical capacity, low capacity of processing facilities, poor research support, and unfair competition from imports. Although there have been some institutional conflicts, the government should intervene in all the challenges for the sake of food and livelihood security.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

CARD	Coalition for African Rice Development
CFC	Common Fund for Commodities
CGIAR	Consultative Group on International Agricultural Research
DEA	Data Envelopment Analysis
DMS	Degrees Minutes Seconds
FAO	United Nations' Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistical Databases
GDP	Gross Domestic Product
GOK	Government of Kenya
IEBC	Independent Electral and Boundaries Commission
IWUA	Irrigation Water Users Association
JICA	Japan International Cooperation Agency
KARI	Kenya Agricultural Research Institute
KHRC	Kenya Human Rights Commission
LANDac	Netherlands Academy on Land Governance
MDGs	Millennium Development Goals
MIS	Mwea Irrigation Scheme's
MMRG	Mwea Multi-purpose Rice Growers' Cooperative
MRGM	Mwea Rice Growers Multi-purpose Cooperative
MRFCS	Mwea Rice Farmers Cooperative Society
MT:	Metric Tons
NCPB	National Cereals and Produce Board
NIB:	National Irrigation Board
NRDS:	National Rice Development Strategy
ROK	Republic Of Kenya
SACCO	Savings and Credit Cooperative Organizations
SPSS	Statistical Package for Social Sciences
TOL	Temporary Occupation License
WARDA:	West Africa Rice Development Association

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Globally, rice is one of the most important food crops that is used in the fight against hunger. The total annual world production of milled rice currently stands at 400 million metric tons which compares favorably well with maize and wheat. The area under rice is forecast to rise by 1.5% (from 153.0 million hectares to 158.6 million hectares) and yields by close to 1%. In addition, unlike maize and wheat that are consumed as human and livestock feed, rice remains the most favoured grain globally for human consumption (NRDS, 2009). Expansion of rice yields, therefore, presents an opportunity to reduce the number of gravely food-insecure people that stand at 816 million by half by 2015 (World Food Summit, 2016).

Africa has become a big player in international rice markets, accounting for 32% of global imports in 2006, at a record level of 9 million tonnes (Eklou et al, 2010). Africa's emergence as a big rice importer is explained by the fact that during the last decade rice has become the most rapidly growing food source in sub-Saharan Africa (Sohl, 2015). Indeed, due to population growth (4% per annum), rising incomes and a shift in consumer preferences in favor of rice, especially in urban areas (Balasubramanian et al., 2007), the relative growth in demand for rice is faster in Africa than anywhere in the world (WARDA, 2005). This is occurring throughout the sub-regions of sub-Saharan Africa (SSA). In recent years (2010–2015), rice production has been expanding at the rate of 6% per annum, with 70% of the production increase due mainly to land expansion and only 30% being attributed to an increase in productivity (Fagade, 2016; Falusi, 2017; Africa Rice Center, 2017). Much of the expansion has been in the rain-fed eco-systems, particularly West and Central Africa (WCA) that making up 78% of rice land both in the upland and rain-fed lowland systems (Dingkuhn *et al.*, 2015). Nonetheless, demand for rice in western and central Africa has far outstripped the local production (Africa Rice Center, 2016).

Rice cultivation was introduced in Kenya in 1907 from Asia. It is currently the third most important cereal crop after maize and wheat. It is grown mainly by small-scale farmers as a commercial and food crop. About 80% of the rice grown in Kenya is from irrigation

schemes established by Government while the remaining 20% is produced under rain-fed conditions.

Most Kenyans living in the rural areas consume limited quantities of rice, but it forms an important diet for the majority of urban dwellers. The annual consumption is increasing at a rate of 12% as compared to 4% for wheat and 1% for maize, which is the main staple food. This is attributed to the progressive change in eating habits. The national rice consumption is estimated at 300,000 metric tons compared to an annual production range of 45,000 to 80,000 metric tons. The deficit is met through imports which are valued at Kshs 7 billion in 2008 (NRDS, 2009). Promotion of rice production will, therefore, improve food security, increase smallholder farmers' income contribute to employment creation in rural areas and reduce the rice import bill. Kenya has a potential of about 540,000 hectares of irrigable and 1.0 million hectares of rain-fed land for rice production. With improved water harvesting, storage, underground water resource utilization and innovative management technologies, the current irrigation potential can be increased by a further 800,000 ha to 1.3 million hectares.

Mwea Irrigation Scheme which is one of the major rice production area schemes in Kenya was started way back in 1956. It has a gazetted area of 30,350 acres. A total of 16,000 acres has been developed for paddy rice production. In addition to this, the scheme has a total of 4,000 acres of out-grower and juakali areas under paddy rice production. The rest of the scheme is used for settlement, public utilities, subsistence and horticultural crops farming. The scheme is developed on gazetted land and the farmers were settled as tenants each with a holding of at bout least 4 acres. This acreage is based on the minimum acreage per person sufficient for the full-time upkeep of the farmers and their financial needs. This meant that some farmers could get more but not less than 4 acres. As a result of the increase in population, most of the holdings have been subdivided among family members and in other cases transferred to new farmers (NIB, 2015). Although the management of Mwea Irrigation Scheme changed from NIB to Mwea Rice Multipurpose Cooperative Society in 1999, the landowner still remains as NIB according to the ruling in Petition 521 of 2012. It is a feudal overlord system and farmers are licensees (Majanja, 2013). The study, therefore, investigates the influence of

land tenure and land subdivision trends on rice production in Mwea rice irrigation scheme.

1.2 Statement of the Problem

There is a gap between demand and supply of food globally. This creates an increased global food crisis. In Kenya, 10 million people were estimated to be facing starvation in 2016 (World Food Summit, 2016). This calls for new ways and strategies to deal with the food security problem wholesome at international, national and local levels. For instance, Mwea Irrigation Scheme produces about 80% of the rice produced in Kenya. It is possible that the problem affecting farmers in the scheme will generally affect rice farmers countrywide.

Rice production trends in Kenya had been constant from 1985 to 1999 when it dropped by over 50% in 2001. A gradual rise of rice production was then experienced from 2002 to 2005 to over 125% and remained fairly constant since. One of the factors leading to the fluctuation in the production of rice is attributed to the issues related to land. Increase in population plays a major role in these land issues because as their families grow larger and economic pressure increases they opt to either subdivide sub-lease or sell their land. This has resulted in farmers owning smaller parcels of land when compared to the initial size at the point of allocation. The farmers don't have titles and can only be recognized by NIB as tenants with Temporary Occupation License (TOL). Selling land with TOL ownership fetches a relatively small amount of money as compared to land with a title deed. This arrangement has made the farmers dissatisfied and has led to vigorous confrontation since early 1990s reaching its peak in 1996. Consequently, these confrontations led to change of management from NIB to SACCOs. The confrontation was mainly due to the demand by rice farmers for a change of the land tenure system in the scheme.

In his study on land redistribution, Jabbar (1972) found that redistributive measures aimed at promoting owner operatorship and abolishing sharecropping helped alleviate the adverse effects on income distribution and production efficiency (Jabbar, 1972). Thus, this study sought to investigate the influence of land tenure and land subdivision trends

on rice production in rice irrigation schemes in Kenya using the case study of Mwea rice irrigation scheme.

1.3 Purpose of the Study

The main purpose of this study was to investigate the influence of land tenure and land subdivision trends on rice production in rice irrigation schemes in Kenya using the case study of Mwea Rice Irrigation Scheme.

1.4 Research Questions

The study sought to answer the following research questions:

i. How has land tenure evolved in the last 50 years in Mwea Rice Irrigation Scheme?
ii. What is the corresponding effect of land tenure evolution and land tenancy on rice production in Mwea Irrigation Scheme?
iii. To what extent does the farmers' land size influence rice production in Mwea Irrigation Scheme?
iv. What are the challenges affecting rice production in Mwea Rice Irrigation Scheme?
v. What land ownership strategies can be adopted to ensure optimal rice production in Mwea Irrigation Scheme?

1.5 Research Objectives

The study was guided by the following specific research objectives:

i. To examine the land tenure evolution in the last 50 years and the corresponding effect on rice production.
ii. To establish the influence of farmers' land size on rice production in Mwea Irrigation Scheme.
iii. To establish the challenges affecting rice production in Mwea Rice Irrigation Scheme.
iv. To propose strategies that can be adopted to ensure optimal rice production in Mwea Rice Irrigation Scheme.

1.6 Scope of the Study

The geographic scope of the study was Thiba Ward in Mwea Irrigation Scheme. Conceptually this study focused on the change of land ownership and land size over the years from the initial state when the land was allotted to the current state and its effect on rice yield levels in Mwea Rice Irrigation Scheme. The analysis was limited to the household and the main key informants in the study area. More quantitative analysis at the household level would provide more information on why households engage in selling, leasing and subdividing the land into smaller portions which might be un-economical for cultivation of rice hence help to assess the profitability of rice farming at the household level.

Some of this household-level information and characteristics included age and size of the household of rice farmers, land size (when the household gained occupation and the current land size), and land ownership documents such as title deed, land certificate or occupation license. The study limited itself to paddy rice production areas in Mwea Rice Irrigation Scheme.

1.7 Justification and significance of the study

Rice is grown by small-scale farmers for cash and food. The average area under rice has remained low over the years. Rice yield has also been declining from 42 bags/ha in 2003 to 29 bags/ha in 2007 (Emongor et. al, 2009). Approximately 84% of the rice consumed in Kenya is produced on irrigated land and the remaining 16 % is produced under rainfed conditions.

National rice consumption is estimated at about 300,000 metric tons against an annual domestic production of between 45,000 to 80,000 tons. This huge gap between consumption and production is met through the importation of rice. Knowledge on land-related constraints to rice production in Kenya will contribute to formulation of strategies to improve rice production hence food security, better household incomes and reduce the rice import bill.

Per capita rice consumption in Kenya is estimated to be between 10-18 kg per year (WARDA, 2005). Per capita rice consumption is lower in rural compared to urban areas

even though rice consumption by the rural population has been rising steadily. It is therefore expected that demand for rice in the country will continue to increase in the future. Furthermore, promotion of rice production and consumption in Kenya will help remove over-reliance on maize as a staple food hence improve rural and urban households' incomes and food security.

A large number of Kenyans in both urban and rural areas are exposed to food insecurity. Household food insecurity is attributed to various factors such as low crop outputs due to small scale farming in small un-economical land sizes, low use of inputs and climatic changes leading to frequent droughts. The current rise in food prices is also one of the compounding factors that have caused deterioration in food security, especially among the urban and rural poor households in Kenya. According to a market survey by the Kenya Food Security Steering Group (July, 2008) that focused on the impact of rising food prices on desperate livelihood groups in Kenya, the food insecure category is estimated at 5.6 million people out of a population of about 35.6 million. This is approximately 15.7% of the population.

Overwhelming, dependence on maize as the key staple crop which sometimes is grown in inappropriate agro-ecological zones has further exacerbated the food insecurity situation in Kenya. Under these circumstances, promotion of optimal rice production and consumption in Kenya will help remove over-reliance on maize as a staple food hence improve rural and urban households' incomes and food security.

Influence of land subdivisions and land tenure trends over the years in rice production will therefore provide an insight on how we can mitigate the sector to improve yields

1.8 Operational Definition of Terms

Irrigation Scheme: The term was used in the study as a system of supplying land with water by means of artificial canals, ditches, especially to promote the growth of food crops such as rice.

Land Size: This term was used in the study as the amount of land utilized by every farmer in the scheme to cultivate rice. It can either be large

or small.

Paddy Rice: The term was used to indicate rice grown in flooded parcel of land, which does not require deep-water i.e. semiaquatic rice.

Rice Production: The term was used in the study as the amount of rice produced annually in the scheme putting land tenancy and tenants' land size into consideration.

Tenancy: The term has been used in the study, meaning possession of land for rice cultivation in Mwea Rice Irrigation Scheme as a government tenant.

1.9 Organization of the Research

The research report is structured into six chapters. Chapter one introduces the research, identifies the key problem under investigation, states the general and specific objectives asks the relevant research questions. It further defines its scope, gives justification and significance for carrying out the research. This chapter is significant to the study as it puts the study into perspective and helps to check deviations.

Chapter two presents a review of relevant literature on the influence of land tenure and land subdivision trends on rice production in rice irrigation schemes in developing and developed nations. Chapter three focuses on the research design, the data requirements and the sources, the research instruments employed, instruments validity and reliability, target population, sample and sampling procedures, data collection and analysis procedures.

Chapter four offers an overview of the study area laying focus on the background of the study area in terms of its location, area, socio-economic activities and neighborhood. It articulates the historical background of the study area and its site characteristics as well. Chapter five provides the analysis and interpretation of the quantitative and qualitative data collected in the field. This chapter attempts to answer the research questions and forms the basis for the research recommendations.

Chapter six constitutes a summary of the findings, a general conclusion and recommendations for the study. The chapter provides recommendations on the subject of study and thus contributes to the body of knowledge and suggest areas for further research.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature on the influence of land tenure and land subdivision trends on irrigated rice production in Kenya. The review is organized based on the following subsections: empirical review of literature, conceptual framework and summary of review of literature. The empirical review of literature covers rice sector perspectives, paddy rice cultivation, land ownership, optimum size of the farm and economic efficiency of paddy farmers all of which are important in understanding land tenure evolution, determining the influence of land tenancy & size on rice production and the challenges rice production faces.

2.2 Rice Sector Perspectives

2.2.1 World Perspective

Rice has been gathered, consumed and cultivated by women and men worldwide for more than 10,000 years (longer than any other crop). It is the most important food crop for about half of the human race. Global production of rice has risen steadily from around 200 million metric tons of un-milled rice in 1960, to over 678 million metric tons in 2009. An increase of 339% for a period of 49 years. Today, rice represents 29% of the total output of grain crops worldwide (CFC, 2012).

Over 90% of the world's total rice crop is produced in South and East Asia. China is the leading country in the area and the world as well. Africa only accounts for 3% of global production. Global rice cultivation is estimated at 150 million ha. Rice yields recorded worldwide include 5.8 metric tons /ha in Japan, 5.6 metric tons /ha in China and 4.3 metric tons /ha Indonesia (FAO, 2007). Comparing these yields with the world average of about 3.5 metric tons /ha, it is evident that there is great potential to improve rice yields elsewhere. The development of rice therefore presents an opportunity to reduce the number of food-insecure people that presently stand at 860 million (CARD, 2010), by half in 2015, and to achieve MDG 1 (i.e., to eradicate poverty and hunger).

Some of the main factors affecting rice production level globally are increase in production cost in industrialized counties, low return in developing counties and increase in public concern for protection of environmental resources.

2.2.2 Africa Rice Sector

Rice is becoming an increasingly popular food in Africa because it is easy to store and cook, it is tasty and can be used for a large variety of dishes. It is grown in more than 75% of African countries, with a combined population of close to 800 million people (CFC, 2012). While it is already the main staple food crop in ten African countries, per capita consumption in others is rising at such a rapid pace that the figure is expected to continue rising in the coming years.

In 2008, Africa produced an estimated quantity of 23 million metric tons of un-milled rice on 9.5 million hectares (FAOSTAT, 2010). The western, northern and eastern regions of Africa had the largest shares, with 10.2 million metric tons, 7.3 million metric tons, and 5 million metric tons, respectively. These quantities of un-milled rice were harvested on 5.8 million hectares, 0.8 million hectares and 2.4 million hectares in West, North and East Africa, respectively.

Between 1961 and 2006, rice consumption in West Africa increased at a rate of 4.5% per year, while rice production grew at 3.2% per year. The high increase in rice consumption is not limited to West Africa as a high rice consumption growth rate has also been recorded in East and Southern Africa. Africa's rice production has not been able to match the growth in demand. Rapidly rising imports have been filling the widening gap between regional supply and demand. This rapid growth in imports was estimated at 3.77% per year between 2001 and 2006 (CARD, 2010).

According to the Africa Rice Center, Africa produces only a share of 3% of global rice production (or 14 million metric tons of milled rice). In 2009, Africa imported 9.8 million metric tons of milled rice with a market value of around USD 5 billion (at 500 USD/MT). This quantity represents one-third of the world market, and 40% of Africa's total rice consumption. With such high dependence on imports, Africa is highly exposed to

international market shocks. This has grave consequences for its food security and political stability, as was demonstrated by events during the 2008 food crisis.

The key contributing factors to rice production level in Africa are increase in demand for rice consumption as there is always a big deficit between consumption and production, increase in area of rice cultivation and lower returns in rice production due to market condition. For agriculture to make a significant contribution to the attainment of the goas enshrined in Agenda 2063; Africa Union's strategic framework for socio-economic transformation, a modern and transformed agriculture will be key to attaining sustainable development and inclusive growth on the continent. This transformation is anchored in the Comprehensive Africa Agriculture Development Program (CAADP). This basically constitutes the agricultural element of the first ten years implementation plan of agenda 2063. So far, there has been continental commitments in the agricultural sector. For instance, the Kenyan government has pledged to invest massively to support local agricultural businesses and small holder farmers. In Cote d'Ivoire, there has been close to 6.5 billion worth of business deals in potato, pulses, palm oil and rice by the private sector. All these efforts are aimed at improving production of key crops such as rice in the continent (African Union commission, 2015).

2.2.3 East Africa Rice Sector

The average annual milled rice production was 2.6 million metric tons in the period 2001-2005. In 2006, the milled rice production estimate for East Africa was 3.1 million metric tons, with Madagascar and Tanzania accounting for 2.3 million metric tons and 525,300 metric tons, respectively; a strong upward trend in production grew at a rate of 7.21% during the same period (CFC, 2012). All countries increased annual rice production, resulting in a higher rice production growth rate in East Africa than those of Central Africa and West Africa. The region's performance was due to increases in rice production in Kenya, Tanzania, Uganda and Madagascar.

In 2006, milled rice consumption was estimated to reach 3.1 million metric tons in East Africa. During the five-year period of 2001-2005, the average annual consumption of milled rice in East Africa was 2.8 million metric tons. Overall, sub-regional rice

consumption grew at a relatively high rate of 2.7% per year. On a per capita basis, Madagascar, Mozambique and Tanzania stand out as major rice-consuming nations in Africa. With per capita food supply of more than 100 kg/year, rice is by far the main staple food in Madagascar. Table 1 shows domestic rice supply in East Africa.

Table 1: Domestic rice supply in East Africa

Countries	**Domestic supply (MT)**	**Food supply kg/capita/year**
Ethiopia	1,050,806	0.67
Kenya	295,423	7.55
Madagascar	2,338,488	102.05
Mozambique	465,191	20.27
Rwanda	60,802	5.88
Tanzania	874,579	18.91
Uganda	158,227	4.71

(Source: FAO, 2007)

A shown in Table 1, between 2001 and 2005, East Africa became nearly self-sufficient in rice, with rice imports representing 7% of the total quantity consumed (CFC, 2012). Unlike other sub-regions of Africa, the eastern part of Africa traditionally produced most of the rice it consumed. However, with increasing rice demand in almost every country, reliance on the world market to supply rice to African consumers, even in relatively small amounts, is becoming a very risky, expensive and unsustainable strategy**,** and may lead to severe food insecurity and civil unrest. In terms of statistics, the total area brought under rice cultivation in East Africa was slightly greater than 1.7 million hectares over the period 2001-2005 and increased at an annual rate of 0.45%. In relative terms, Uganda had the highest increase in cultivated land area, with an area growth rate of 7.67% per year. East Africa recorded a remarkably high rate of increase in yield between 2001 and 2005, at 6.73% per year. Aggregate rice yield averaged 2.2 metric tons/ha during this period.

High production growth rate in East Africa is attributed to the increase in area for rice cultivation over the years. Although climate change plays a negative role production still gradually increase.

2.2.4 Kenya Rice Sector

While rice is the third most important staple cereal in Kenya after maize and wheat, the country is only able to produce 20% of its national needs (CFC, 2012). Recent years have seen rice grow in importance in Kenya as per capita consumption, particularly in urban areas, has increased far more rapidly than that for other cereal crops. For example, national rice production, most of which comes from irrigation schemes established by the government, stood at 47,256 metric tons in 2007 against a consumption of 293,722 metric tons giving a deficit of about 83.9% (CFC, 2012). Approximately 84% of the rice produced in Kenya is produced on irrigated land with the remaining 16% being produced under rainfed conditions. The irrigated areas cover approximately 13,000 ha of land and include irrigation schemes in Nyanza- West Kano and Ahero (at 3,520 ha), Western- Bunyala scheme (at 516 ha) and Central- Mwea irrigation scheme (at 9,000 ha).

Rice development is considered to be a high priority in Kenya. This is especially in view of the potential for increased production through the expansion of cultivated area and the application of more efficient production methods. Kenya set for itself a target of increasing rice production from 75,000 metric tons /year to 178,580 metric tons /year by 2018, the period set for implementing the National Rice Development Strategy (NRDS). The NRDS was prepared in line with overarching strategy documents, i.e. Vision 2030, the National Food and Nutrition Security Policy, and the current Strategic Plan of the Ministry of Agriculture.

About 80% of the required increase will be derived from the expansion and rehabilitation of irrigated rice production. The main thrust of the planned rice development addresses: technical issues, farm inputs and equipment, credit support, infrastructure and market structure improvement.

The main factors contributing to rice production in Kenya are the land tenure system, land subdivision trends, political influence, high cost of farm inputs and machinery, infrastructure and high prevalence of water borne diseases.

2.2.5 Irrigation Schemes in Kenya

All public irrigation schemes in Kenya fall under the National Irrigation Board whose mandate is to oversee their construction and rehabilitation, operation and maintenance and administration of land in the schemes. The public irrigation schemes under the Nnational Iirrigation Bboard include: Tana, Mwea, Bura, Tana, Perkerra, Bunyala, Ahero and West Kano. The Tana irrigation scheme is the oldest irrigation scheme having been established in 1953 and main crop under irrigation is maize while the other crop was cotton which was abandoned due to political influence. Mwea irrigation scheme was established in 1954 with the main crop under irrigation being basmati rice. Other crops under irrigation include; tomatoes, french beans, maize and onions. Perkerra irrigation scheme was established in 1959 with the main crop under irrigarion being seed maize.
Bunyala irrigation scheme was established in 1964 with the main crop under irrigation being rice. Ahero irrigation scheme was established in 1966 with the main crop under irrigation being the various rice varieties such as basmati, sindano, aromatic and hybrid.
West Kano irrigation scheme was established in 1974 with the main crop under irrigation being rice (National Irrigation Board, 2017).

Bura irrigation scheme was established in 1978 with the main crop under irrigation being maize. Other crops in the scheme include; green grams, cowpeas, water melons and onions.

2.2.6 Rice production in Kenya

Rice irrigation schemes were first started by the government. Out of the four schemes Mwea irrigation scheme in Central Kenya is the largest, followed by Ahero and West Kano in Nyanza Region and then Bunyala Irrigation scheme in Western Kenya. The schemes were centrally managed by the National Irrigation Board. Plots were allocated to the famers and inputs provided to them. They were expected to plant rice of which a part they would keep after the harvest for their consumption and the rest was purchased

centrally. The farmers were however not allowed to grow any other crop (Niemeijer et. al, 1985).

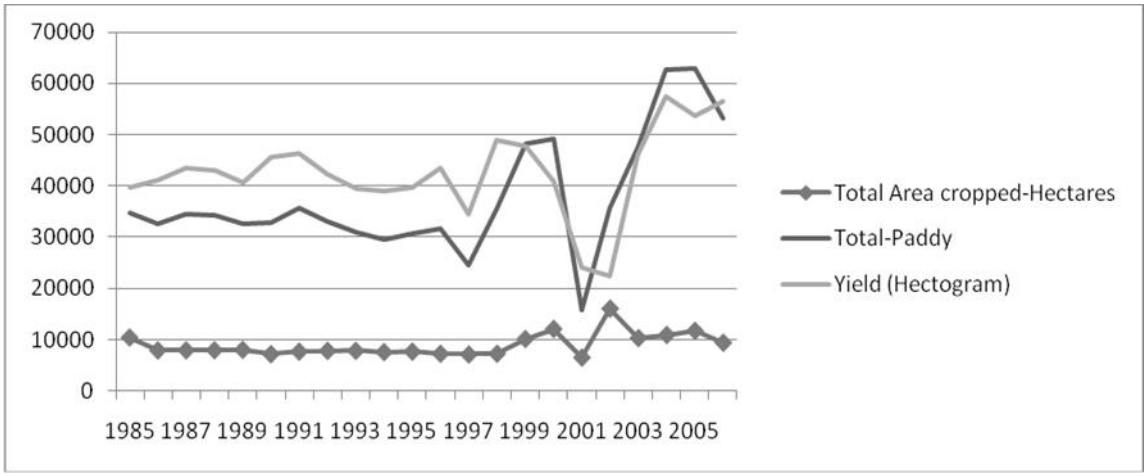

Figure 1: Rice Production in Kenya from 1985 to 2006 (*Source: KNBS, 2007***)**

The above figure shows the trend of rice production in Kenya from 1985 to 2006 based on data from the Kenya National Bureau of statistics in the four schemes under study. The total area cropped is measured in hectares, while production is the total paddy. Yield per hectogram (10Hg = 1Kg) is measured by dividing production by area cropped. Looking at the figure critically, production was decreasing slightly from 1985, but from 1997 upto 2001, several shocks were experienced. In the year 2001 particularly, the production and yield recorded a sudden decline. This can be attributed to the apparent ineffectiveness of reforms taken and implemented in the whole agricultural sector due to the disorder in the sequence of the reforms and inadequate synchronization of these agricultural reforms with other policies to bring tangible results (Odhiambo et al, 2004).

The government policy on rice farming remained largely unchanged and over time, production deteriorated over disputes on price fixing resulting in farmers lacking incentives to increase their production. This as a result led to a major rebellion in the Mwea scheme in 1999 and thereafter the farmers took charge of rice production which in turn led to the collapse of the other rice schemes in Ahero, West Kano and Bunyala (Njagi, 2009).

In the period 2002 to 2006, the management of rice had changed from fully government run irrigation schemes to community managed schemes which was done through

community irrigation associations which made farmers to have more representation in the management structure of irrigation schemes. With the NIB receiving less treasury disbursement, the community was left with a larger role to play while government retained minimal staff to help the community with management of issues of technical nature which it had inadequate capacity. The associations worked under the supervision of the NIB and had the responsibility of ensuring that water gets to the paddy rice fields. This new structure gave farmers the incentive to increase production because they were now in charge of their own production and marketing process (Njagi, 2009).

2.3 Paddy Rice Cultivation in Mwea Irrigation Scheme

Paddy rice has traditionally been the most dominant crop grown in the existing schemes of Mwea. The crop is grown in one main season in a year leaving the paddy field to go fallow in the rest of the year although a ratoon crop is often grown in between. The main rice varieties grown are the non-aromatic varieties such as BW196, ITA 310, IR2793 and 2035 series. Basmati 217 is also grown but it is not very popular. The main reason for the low uptake of basmati variety is its susceptibility to the rice blast disease and lower yields. The first paddy rice crop is planted in a staggered manner from July, August, September and latest in October as shown in Table 4. The rice crop takes about four months to mature. Harvesting of the main crop starts from October to January. A ratoon crop especially for Basmati rice is often grown from October and this matures in about one and a half months. Staggering of operations from land preparation, planting and others is practiced so as to cater for labour availability and water supply (NIB 2010).

Rice Crop	Period											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Main crop												
Ratoon crop												

Table 2 : Rice cultivation periods *(Source: NIB, 2010)*

2.4 Land Ownership

The history of the Scheme can be traced back to the emergency period, where between 1956 and 1957 the colonial government used the area as a holding ground for release of detainees. The detainees were used to clear the land and dig canals. The whole scheme was founded on the colonial agrarian regime that did not admit competition from Africans. Part of this policy was achieved by driving Africans from productive lands and settling them on marginal areas where their agricultural activities were strictly controlled so as to lessen competition with European agriculture. Under this superstructure, the Scheme was governed through regulations issued under the ordinance of the Africa District Council (Petition 521 of 2012).

The status of the Scheme is summarized in a report of the Kenya Human Rights Commission ("KHRC") commissioned in 2000 titled "Dying to be Free; The Struggle for Rights in Mwea." The report documents the history of the Scheme and concludes that, "It is evident therefore that in its philosophy, the regime established under the NIB is a replication of the colonial system.

Although the Scheme was brought under the National Irrigation Board ("the Board") established in 1966 under the Irrigation Act (Chapter 347of the Laws of Kenya) ("the Act"), the rules governing the Scheme had been enacted as By-laws under the Africa District Council Ordinance, 1950 and continued in force. Pursuant to section 27 of the Irrigation Act, the Minister via Legal Notice No. 68 of 1977 gazetted the Irrigation (National Irrigation Schemes) Regulations to apply to all areas designated as National Irrigation Schemes. The farmers remain licensees producing rice under the management and direction of the Board. It is these regulations that farmers were protesting.

2.4.1. Communal land ownership and rice production

Land tenure is methods by which groups of people or individuals hold, transmit or transfer property rights in land (Ogolla & Mugabe, 1996). The common types of land tenure include; Individual, communal and public. Individual land tenure offers absolute ownership rights including alienation, while communal land tenure bestows ownership

rights to an entire community in which members possess utilization but not rights of alienation (Okowa & Mwangi, 1996). These land tenure systems have an association with crop outputs. Communal land tenure is common in some African and Asian societies even though productivity is higher in publicly held cultivated land. In a study in Enugu State, Nigeria, there were productivity losses of 4.51% and 3.44% on communal and individual land tenures respectively while there were productivity gains of around 1.31% per hectare under public land tenure (Iorliam et al., 2017). In a study in Imo State, that analyzed and compared rice productivity in the different land tenure systems, it was found that there was a statistically significant difference in rice productivity in different land tenure systems. The findings revealed that production of rice on individual land tenure was comparatively higher and profitable than in the communal tenure system (Ben-Chendo & Joseph, 2014).

2.5 Initial Size of Household Farm

Within Mwea irrigation scheme, the average land area per household was 4 acres as in 1956 when the land was initially allocated (NIB website). Land allocation has remained static over the years, whereas population growth has increased at a high rate. As a result, there has been informal sub-divisions of land units within the irrigation scheme; land is increasingly rented out to other people by the official NIB tenant farmers, reducing some of these farms to un-economical units. Optimal size or optimal agricultural units show a combination of production factors having the highest economic efficiency in production of a certain amount of product. To obtain the optimal size of the farm, a mathematical function assessment can be used to estimate the average optimum cost of production (Boussemart et al, 2006; Hassanpour, 2002; Hosseinzad et al, 2009). According to microeconomic theory, the larger the size of the plant or farm, the more the average cost of production; and when the unit size is smaller, the average cost will decrease to some extent and then it will increase. Therefore, average production cost using multiple regression methods will come in the form of a parabola and then estimating its derivative based on economic theories, the minimum average cost of the optimal amount of land could be estimated (Ronald, 1988).

2.6 Precision Rice Production

Precision agriculture broadly describes developing practices utilizing spatial technologies to strategically manage farming systems from a paddock perspective to the whole farm. The ultimate objective is to deliver management, environmental and economic benefits. Precision agriculture has been applied in rice farming with respect to aerial crop imaging, managing crop effects using a laser guided land leveler and variable rate nitrogen application. Implementation of precision agriculture in rice has introduced additional challenges while at the same time opening up enormous opportunities. Some of the challenges include; utilizing aerial fertilizer and seedling application as well as permanent infrastructure in irrigation blueprints. Opportunities include; addressing within field variability as a result of fill and cut when forming irrigation bays, using satellite navigation systems to accurately collect elevation data across paddocks to inform re-grading, reducing overlapping incidences as a result of part width passes and increasing returns by harmonizing crop management closely with needs within each rice bay (Rural Industries Research and Development Corporation, 2014).

2.7 Policies

2.7.1 Government policy direction towards agriculture

The Kenyan agricultural sector is large and complex, with various public, private, parastatal and non-governmental actors. As a result of its significance for the nation's economic development, the institutional and policy framework governing the sector plays a sensitive role for the economy's development. Several studies have identified 3 main periods in the country's agricultural policy history. Namely; post-independence, stakeholder participatory and liberalization approach periods (Gitau et al., 2008; Ronge et al., 2005; Alila & Atieno, 2006).

Between 1963 and 1980s (post-independence period), policy aims were mainly influenced by economic growth and self-determination (ROK, 1964 and 1965). The main agenda in agricultural production being increasing productive land by catalyzing access to land for small holder farmers (Ronge et al., 2005). It was characterized by conservative monetary and fiscal policy, supported by a constant exchange rate system. It solely

implemented by the government. It set consumer and farm gate prices for all basic commodities such as maize, wheat flour, milk and sugar. Government's control over the agricultural sector was intensified by creation of various marketing and production boards and parastatals. Public investment in agricultural productive infrastructure such as irrigation schemes was common in this period. The major policy objective was to attain food self-sufficiency in the nation. However, despite the growth experienced in the sector, it was characterized by poor service and indebtedness to farmers, poor governance in parastatals, and market monopolies that resulted in price inefficiencies (Gitau et al., 2008).

Starting in the mid-1980s (liberalization period), the agricultural policy was characterized by implementation of free market policies and structural adjustment programs under the influence of the world bank and the International Monetary Fund (Gitau et al., 2008; Ronge et al., 2005). The actions enforced included deregulation and privatization of the sector, exchange rate adjustments, increase in decentralization and decreased trade barriers. This resulted in collapse of some government parastatals and boards created in the previous era as they were inefficient in a liberalized market. Additionally, the private sector didn't have the incentives or capacity to take up the role abandoned by the government (Gitau et al., 2008). Liberalization exposed the un-capitalized small scale farmers to market forces without proper support, resulting in poor performance of the agricultural sector. The policy agenda during this period exhibited bias against the sector in favor of financial and industrial sectors (Gitau et al., 2008).

While tertiary liberalization measures continued in the early 2000s, the country has been dynamic in consolidating and reforming policies in preparation for a post liberalization period. Following the economic crisis of the late 1990s and the early 2000s, Kenya began developing a national strategy for the recovery of the economy (GOK, 2003), with emphasis on stakeholder participatory approach. While majority of the support institutions existed since independence, most of them, together with the corresponding sector-wide and commodity-specific policies were to be adapted and reformed for

stakeholder administration. Consultative processes have resulted in new and reformed policies which conform to the nation's recent strategies.

In rice sector, post-independence policy mainly was characterized by allocation of land to farmers in the schemes, NIB was formed to govern the schemes of which it provided farm inputs, infrastructure and all marketing services for the farmers. Liberalization and free market policies led to the collapse of some irrigation schemes.

2.7.2 Land Ownership Policies

Tenure systems contain various rights such as rights to ownership, access, use, control and transfer. The issue of land rights can be a source of debate and conflict, for instance, it is highly contested in Kenyan politics (Kameri-Mbote & Kindiki, 2008). Land ownership, management and use were the issues addressed by Kenya's 2010 constitution. Chapter 5 of the 2010 constitution, article 62 states that "all land in Kenya belongs to the people of Kenya collectively as a nation, as communities and as individuals" (Constitution of Kenya 2010, Article 61(2)). Thus, land is classified as private land, community land or public land. Presently, different laws apply to the different categories of land. Irrigation schemes in Kenya are owned by NIB, farmers are tenants and they have certificates of ownership as TOL. Write in full

2.8 Planning Theories

2.8.1 Smart Growth Theory

Smart growth is a transportation and urban planning theory that fixates growth in concentrated walkable urban areas to avoid sprawl. At its core, it advocates for transit-oriented, compact, bicycle-friendly and walkable land use including complete streets, neighborhood schools and mixed use development having a variety of housing choices. The term smart growth is mainly used in the United States, while in Europe, the terms used to describe this concept include; compact city and urban intensification. Smart growth values regional and long-term considerations of sustainability over short-range focus. Its sustainable objectives are to achieve a rare sense of community, expand housing choices and transportation, promotion of public health, equitable distribution of

benefits and costs of development and preservation of cultural and natural resources (Kolbadi, Mohammadi & Namvar, 2015).

2.8.2 New Ruralism Theory

New ruralism seeks to alleviate various issues associated with conservation of agricultural land via creating carefully planned and agrarian based suburbs which aim to counteract the current consumerist-based sprawl. Proponents of new ruralism adjusted the terms connotation from adapting rural land utilization to sustainable growth in rural regions with urbanizing influences. New ruralism intertwines contemporary trend ideas in the smart growth, new urbanism and agricultural urbanism theories. An important element of creating new ruralism is permanently conserving farmland as both frameworks to locate new development and food sources for urban areas. While new ruralism principles are loosely drafted, its task in sustainable regional and local food supplies as well as support for farmland preservation aren't yet fully understood. The theories principles are mainly in their exploratory stage and are extremely broad (Newman & Saginor, 2016). This creates a link between sustainable agriculture and new urbanism. A framework that creates grouped settlement in the rural areas with protected farm land. The size of farming land has to be viable to deserve protection.

2.9 Previous studies

Pambazuka published by Fahamu addresses the protection and promotion of human rights amongst rural populations. The publication section on 'Dying to be free' is the story of the heroic struggle for survival, justice and dignity by rice farmers in Mwea District, Kenya. They refer to the NIB system as a 'virtual serfdom' whereby farmers worked on land for which they had no title deed and were forced to hand over their produce to the National Irrigation Board (Pambazuka, 2009). The publication also tries to demonstrate how resistance to violations of social and economic rights results in confrontations with the state that inevitably lead to violations of civil and political rights. It also demonstrates that the struggle for 'development' and rights are intimately intertwined. This publication focused on human rights and the struggle of the tenant farmer.

Glady's in her study of land tenure security among peasant farmers in Mwea Rice Irrigation Scheme, Kirinyaga County sought to understand the struggle for land rights, assess the effect of lack of titles and identify workable solutions to these problems in Mwea. She found that the insecure land tenure in Mwea impedes economic growth, vesting of excessive authority on managers in the schemes negatively affects the small holder farmers, women carry out majority of the work in the rice fields and that the law is used to marginalize farmer participation in decision making (2015). This study aims at ascertaining land ownership right as the farmers are tenants of NIB and determine the effects of land tenure on rice production.

Thabiti sought to investigate the effects of gender on rice production in Kyela district of Tanzania. He compared rice production between female and male headed households and the associated socio-cultural elements that affect production. The study found that while the time spent on rice production was almost equal, men dominated rice production activities as a result of having access and control over resources such as land and better access to credit compared to women. The study recommended that in order to increase gender balance in rice production, there needs to be equity in access and control over resources as well as improved access to education (Thabiti, 2014).

LANDac, the Netherlands Academy on Land Governance for Equitable and Sustainable Development comprises of Dutch organizations working on land governance. It conducts research, organizes training and courses to disseminate information focusing on competing claims and new pressures on land and natural resources. In its 2015 factsheet about food security and land governance in Mali, it compared land tenure systems where it was found that small holders in Office du Niger hold annual leases while large holders have contracts with the government on access to water and land rights (LANDac, 2015).

Jabbar in his study titled "Land redistribution, technological improvement, employment generation: an analysis with Bangladesh data" sought to understand the basis of Bangladesh's government decision of 1972 requiring all farm families owning 33.3 or more acres of land to surrender excess land for redistribution. After studying 300 farms in

3 districts, he concluded that redistributive measure with the objective of promoting owner-operatorship and abolishing sharecropping are likely to assist in achieving the governments' objective (1977). This study aimed at equitable distribution of land to attain optimal land size for maximum production.

2.10 Conceptual Framework

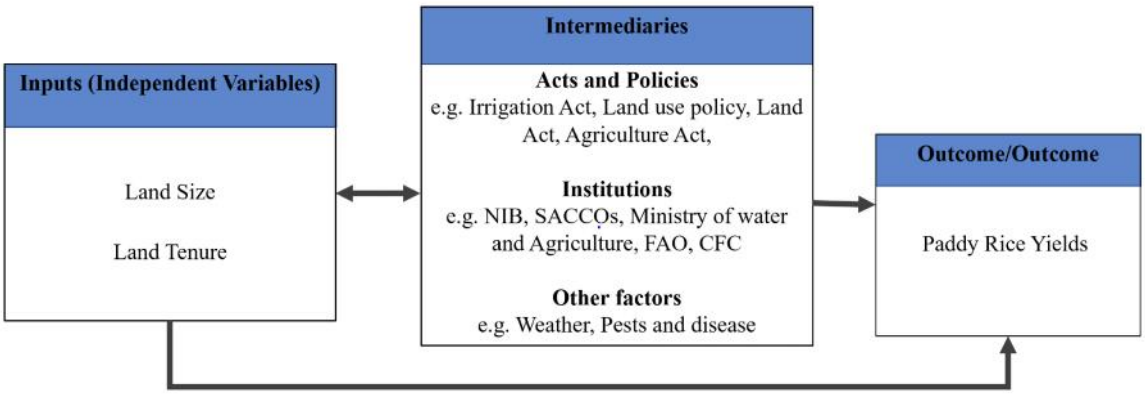

Figure 2: Conceptual Framework

Paddy rice yields in Mwea Irrigation scheme is affected by a number of factors such as farmers and farm inputs of which is attributed to the scheme irrigation institutions such as NIB and SACCOs. Farmers cultivate their farms as proprietors. They need credit to supply inputs such as seeds, fertilizers, herbicides and pesticides. Credit facilities are provided by the SACCOs such MRGM and Lainisha Sacco Limited. NIB and the Government contribute to rice production by providing infrastructure such as roads and irrigation water supply. They also provided training to the farmers on good farm husbandry. Land sizes is the amount of land owned by a farmer in the scheme while land tenure is the type of ownership such as leasehold, freehold or squatters. The Government is also involved in creating policied and Acts that governs this irrigation scheme. Figure 2 shows how these factors relate and affect each other. Farmer and farm inputs directly affects paddy rice yields, NIB and the Government responsible for the provision of infrastructure in the area which again directly affects the yields. Farmer and NIB affect land size and land tenure which in turn affects paddy rice yields.

The scheme is currently run under the participatory irrigation management approach with NIB being responsible for the primary and secondary infrastructure while the farmers are responsible for the tertiary infrastructure. Other key roles played by NIB in the scheme include land administration, capacity building, irrigation expansion and rehabilitation of the irrigation infrastructure. Key farmers organizations in the scheme include Mwea Irrigation Water Users Association (IWUA), Mwea Rice Growers Multipurpose Cooperative (MRGM), Lainisha SACCO and the Scheme Advisory Committee.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter gives a description of the methods which the researcher applied in carrying out the study. The chapter is organized as follows: research design, study target population, study site, sampling design, data collection measures, methods of analysis, data presentation and interpretation techniques, legal and ethical considerations, study limitations and chapter summary.

3.2 Research Design

McMillan and Schumacher (2001) define research design as a plan for selecting subjects, research sites, and data collection procedures to answer the research question(s). A design shows which individuals will be studied, when, where, and under which circumstances they will be studied. This study adopted a cross-sectional survey design and correlational research design, so as to enable the researcher to test the influences between independent variables and dependent variable. A cross sectional survey design is useful in describing the characteristics of a large population targeted by the study, it also enabled the researcher to use a large sample, thus making the study results more generalizable. In additionally, cross-sectional survey enabled the use of a questionnaire which was the key tool applied in the study for data collection. The correlational research design on the other had enabled the researcher to determine the extent to which the study variables i.e. independent variable and dependent variable. Thus, correlation coefficients are used to measure the strength and direction of the linear correlation between the study variables. Therefore, the study used questionnaires because they can be easily administered to a large population and analysed by the use of statistical package of social sciences (SPSS).

3.3 Study Target Population

Mugenda and Mugenda (2003) describes a population as an entire group of individuals, events or objects having common observable characteristics, while target population refers to a population which the researcher wants to generalize the results to. The targeted population is all residents of Thiba Ward Mwea Constituency who were above the age of 18 years old. The researcher made this decision because, every adult in the constituency had a probability of taking part in rice farming in Mwea Irrigation Scheme.

Therefore, the study targeted a population of 23,219 residents of Thiba Ward, Mwea Constituency (IEBC, 2017).

3.4 Study Site

Mwea Irrigation Scheme is located in Mwea division of Kirinyaga County in Kenya. It is located about 100 km South East of Nairobi, the capital city of Kenya and near the foothills of Mount Kenya. The researcher selected this scheme because it is the largest irrigation scheme in the country accounting for 80% of the rice produced (KHRC, 2000). Two main rivers Nyamindi and Thiba serve the scheme, with a link canal joining the two rivers which transfers water from Nyamindi to Thiba River which serves about 80% of the scheme. Tenancy basis is the form of land tenure operational in this scheme. The scheme started operations in 1956 and until 1998, it was being managed by different government agencies and in 1998 its management was taken over by the Mwea Rice Farmers Cooperative Society (MRFCS).

3.5 Sampling Design

3.5.1 Sampling Frame

The sampling frame for any probability sample is a complete list of all the cases in the population from which the sample was drawn (Mugenda & Mugenda, 2003). The list of households as depicted in the satellite imagery formed the sampling frame for the study.

The research targeted all residents of Thiba Ward who are 18 years and above. The targeted population for this study included both male and female who have been in the settlement before and after the Mwea Irrigation Scheme development project as they were in a better position to describe the situation before and after implementation of the development project. Farmers in Thiba were settled as tenants with each getting 4 acres of land. Due to the rise in population, most of the pieces of land have been subdivided among family members or transferred to new farmers. As such, these farmers were better placed to help investigate the impact of land subdivision trends on rice irrigation schemes.

3.5.2 Study Sample Size

A sample is any group of subjects from which information is obtained that is part of a target population. This study used Nassiuma (2000) sample size determination formula to arrive at the sample size that is used in the investigation of the influence of land tenure and land subdivision trends on rice production in rice irrigation schemes in Kenya, using the case of Mwea rice irrigation scheme.

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

Where; n = sample size,

N=Target Population

C = Coefficient of variance (30%)

e= Error Term (5%)

The sample size for this study was selected from the total target population of the study that included 23,219 individuals.

$$n = \frac{23219*0.3^2}{0.3^2 + 23219(0.05^2)}$$

$$= 224.6$$

$$\approx 225$$

However, due to time and budgetary constraints, a sample size of 167 farmers was used.

3.5.3 Sampling Techniques

A systematic random sampling procedure was used in selecting the study respondents from their respective blocks of houses in the scheme. The residents were grouped per block of houses in the scheme where the sampling interval was obtained by dividing the total number of households by the sample size from the particular block. If for example the sampling interval was 10, the first resident in the block was picked randomly from the first 10 households using simple random sampling technique. The rest followed the sequence of every 10^{th} household. In order to use this sampling technique, the researcher defined the population, listed down all the households by blocks and then selected households systematically to make the study sample.

3.6 Data Collection Methods

3.6.1 Development of Instruments

A research instrument is the general term that researchers use for a measurement device. There are two broad categories of instruments: the subject completed and researcher completed, that a researcher administers. The study used a questionnaire for households and an interview guide for key informants which falls under subject completed instruments.

Questionnaire was used as the key data collection tool. Questionnaire was used because it is friendly in terms of time. It can be self-administered and is able to reach a large number of respondents. The questionnaire is considered as the heart of a survey research design (Kothari, 2004). The questionnaire for the farmers were prepared by the researcher to collect both quantitative and quantitative data. The items in the questionnaire consisted of both open ended and close ended questions. Additionally, some of the questions were based on the likert scale. The likert scale items are grouped according to the following scale: Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D) and Strongly Disagree (SD). The scale helps the researcher to find out the extent of agreement of the respondents on various issues pertaining to the research objectives being investigated. The tool was organized based on demographic data of the respondents followed by questions from respective study objectives. The researcher with the help of research assistants distributed the questionnaires to the respondents. The respondents were given time to fill in the questionnaires. The research assistants assisted in interpreting the questionnaire to respondents who did not know how to read and write. The questionnaires were collected at the end of the solid day of data collection.

3.6.2 Pilot Testing of Research Instruments

In order to ensure everyone in the study sample understands the items in the tool in the same way, the researcher selected 10% of the sample and conduct a pilot test. The small sample of 16 respondents was deemed fit as the researcher can easily manage in conducting any adjustment on the instrument. This was conducted among the respondents of Mwea the study area and the results were not included in the final study results. From

the pilot study, some of the questions in the questionnaire were adjusted to provide a local understanding and interpretation by the target population.

3.6.3 Instrument Reliability

According to Ogula (2006), reliability of an instrument refers to the extent to which a research instrument produces measures that are consistent each time it is administered to the same individuals. Mugenda and Mugenda (2003) observe that if a researcher administers a test to a subject twice and gets the same score on the second administration as the first test, then there is high reliability for the instrument used. The split half method was used to assess the reliability of the questionnaire. This method involves dividing the tool items into two i.e. even and odd items the computing their Cronbach's Alpha values. If the average coefficient value lies between 0.7 and 0.9, then the tool is considered reliable (Ogula, 2006). In this study the value of instrument reliability was 0.75 of which it was accepted.

3.6.4 Instrument Validity

Validity refers to the extent to which a research instrument measures what it is designed to measure. According to Ogula (2006) there is content (face and sampling validity), construct and predictive types of validity. To ensure that the instruments are valid, content validity was used. Three experts in the field of the research were consulted and they reviewed the tools in order to verify whether the instruments were valid or not. Each of the experts worked independently and provided feedback to the researcher. Where there was an agreement between the experts, the instrument was considered to be valid. An independent report between experts on tools' validity was filed and based on the experts' suggestions, the content validity of the instrument was improved. In addition, the recommendations given by the peers, supervisors and research experts was incorporated in the final instruments. This strategy is used to ensure that the instruments measure the variables they are intended to measure.

3.7 Methods of Analysis

The collected data was analyzed using both quantitative and qualitative data analysis methods. The first step in quantitative data analysis is to describe or summarize data

using descriptive statistics (Nachmias & Nachmias, 2003). Descriptive statistics was used to summarize quantitative data into tables and charts, and the results were presented in frequencies and percentages. The Statistical Package for the Social Sciences (SPSS) Version 21 was used to conduct statistical analysis. Inferential statistics was used for testing hypothesis to determine whether there is a significant relationship between rice yield and land size then rice yield and land tenure. Qualitative data was derived from open-ended questions from the research questionnaires. It was processed by first categorizing and discussing responses for each item according to study objectives. The data was then edited, coded and reported using descriptive narratives of the views, experiences and opinions of the respondents. Qualitative data was then analyzed and condensed into theme categories by editing, paraphrasing, and summarizing in order to enhance and understand the meaning. Descriptive labels were used to attach meaning to different categories. Summarized data was synthesized then interpreted and presented using different presentation techniques such as verbatim or direct quotations and narratives.

3.8 Data Presentation and Interpretation Techniques

The data has been presented as frequencies and percentages and summarized into tables and figures. The data was presented as categorical or continuous data. Continuous data was represented using descriptions and line graphs while categorical data was presented as bar charts and pie charts.

3.9 Legal and Ethical Considerations

The researcher submitted the complete research proposal to the University for approval. Upon receiving approval from the University. The researcher pre-visited the selected site to familiarize and seek permission to conduct the research within their environs. In addition, the researcher sought permission from the relevant offices so as to allow research assistants to conduct the study within Thiba Ward.

Informed consent was sought from the respondents so as to ensure that no one was forced to take part in the study. Confidentiality of the information was upheld. Further, the researcher took proper security measures for data management especially those handled

by various groups such as research assistants. Additionally, the researcher acknowledged all sources of data, both primary and secondary, to avoid plagiarism.

3.10 Study Limitations

The major limitation of this study was that not all respondents in Mwea Irrigation Scheme were willing to take part in the study as some thought that the research was conducted by the government to check on the farmers who are not satisfied. Majority thought that this could lead to their eviction from the scheme. As well, majority of the farmers were so busy in their farm work and could not create time to be interviewed. This resulted in partial lack of data.

CHAPTER FOUR: THE STUDY AREA

4.1 Introduction

This chapter looks at the background of the study area in terms of its location, area, socio-economic activities and neighborhood. It articulates the historical background of the study area and its site characteristics as well.

4.2 Historical Background of the Study Area

Mwea Irrigation Scheme was started way back in 1956 and the predominant crop grown in the scheme was rice. It was started as a detention camp for Mau Mau detainees during the state of emergency. Mwea Irrigation Scheme has a gazetted area of 30,350 acres. A total of 16,000 acres has been developed for paddy production. In addition to this, the scheme has a total of 4,000 acres of out grower and 'Jua Kali' areas under paddy production. The rest of the scheme is used for settlement, public utilities, subsistence and horticultural crops farming.

The scheme is developed on gazetted land. The farmers were settled as tenants each with a holding of at least 4 acres. This acreage was based on the minimum acreage per person sufficient for the full-time upkeep of the farmers and his financial yeilds. This means that some farmers could get more but not less than 4 acres. Due to the increase in the population, most of the holdings have been subdivided among family members and in other cases transferred to new farmers (NIB website 2010).

The scheme was managed by the government through the National Irrigation Board (NIB) until 1998. Land tenure was on tenancy (TOL) basis where the NIB was the landlord and the farmers were the tenants. The landlord provided inputs, infrastructure, machinery and extension services while the tenant gave labor services at a cost determined by the landlord. The government had an elaborate structure and systems all the way from farming activities management, water management, financing arrangements, storage, processing and marketing. At the end of the harvest, each tenant surrendered the entire crop to NIB and was provided with twelve sacks of unprocessed grain for their annual consumption. With no other income, the twelve sacks were the total benefits the farmers received annually and this was expected to meet all their basic needs.

Initially the tenants started as singles but they eventually started families and the twelve sacks were no longer sufficient for feeding their families.

In the early 1990s signs of distress started to emerge culminating in 1996, at the expiry of the previous tenancy agreement, the tenants refused to sign new tenancy agreements and there were violent confrontations between the government forces and the tenants. First, on June 4 1996, Hon Martha Karua and three others representing over farmers at Mwea (almost 100% of the farm families), rejected new tenancy agreements from their bosses at the government-run National Irrigation Board (Daily Nation, 1996).

The group claimed that Mwea farmers do not accept to be tenants anymore and had a right to own the land. They ridiculed the new agreement's terms which required farmers to deliver all rice, with the exception of a much-reduced quantity of some ten bags per year, to the Irrigation Board. There were subsequent threats of eviction, but the tenants held firm in their claim to the land. Eventually in 1998, the farmers failed to deliver their harvest to the NIB stores and instead delivered it to their cooperative society. Unfortunately, the farmers' cooperative had neither the resources nor the capacity to undertake all the work required to run the Scheme effectively.

Although the management of Mwea irrigation scheme changed from NIB to Mwea Rice Multipurpose Cooperative Society in 1999, the land owner still remains to be NIB according to the ruling in Petition 521 of 2012, “in the legal framework NIB is the real owner of the land. It is feudal overlord and farmers are licensees (Majanja, 2013).

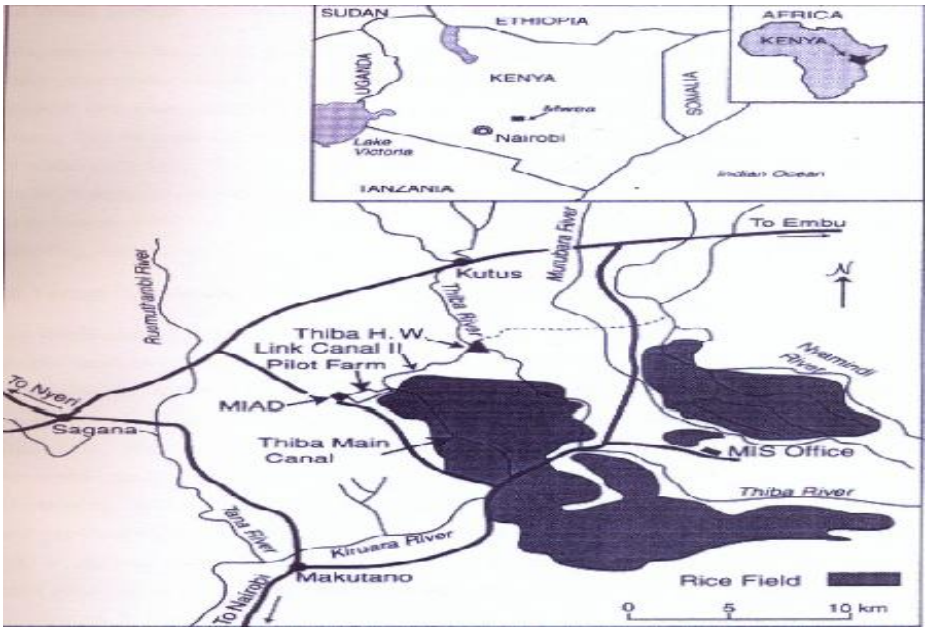

Figure 3: Area of Study

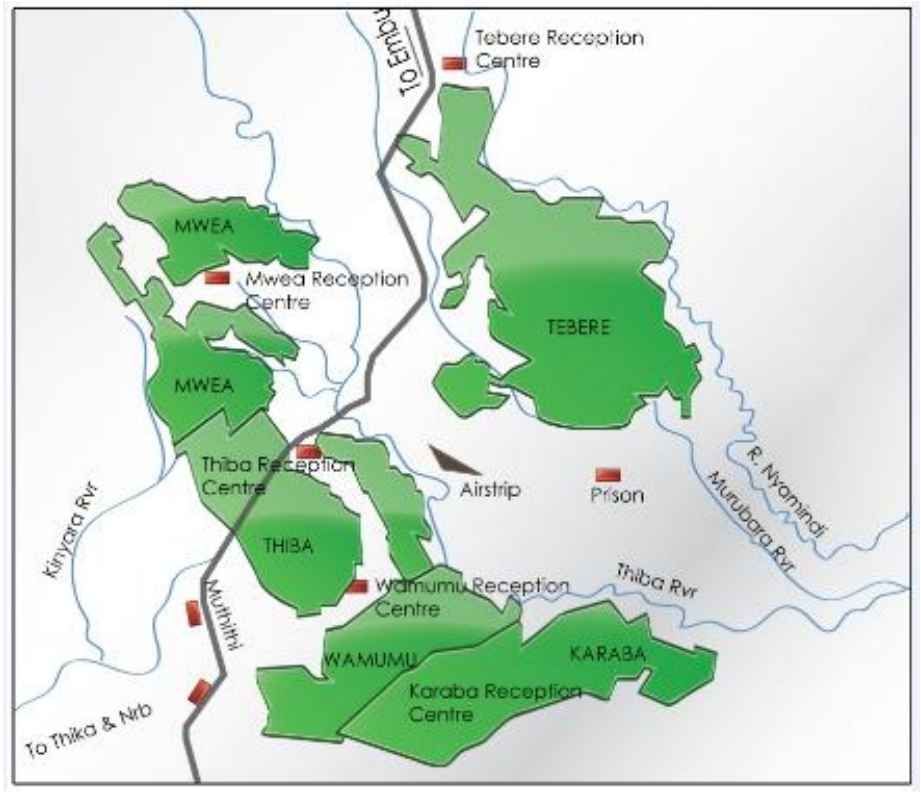

Figure 4: Mwea Irigation Scheme

Mwea Irrigation Scheme is located in Kirinyaga County in Kenya. It is located at an elevation of 1,175 meters above sea level. Its coordinates are 0°42'0" S and 37°22'0" E in DMS (Degrees Minutes Seconds) or -0.7 and 37.3667 (in decimal degrees). Its UTM position is CV12 and its Joint Operation Graphics reference is SA37-01.

4.3 Site Analysis

4.3.1 Location and Size

Mwea Irrigation Scheme is situated in Kirinyaga County of Kenya. The Scheme is about 100km North East of Nairobi. Since 1956, rice has been the predominant crop in the scheme. A total of 16,000 acres has been developed for paddy production in this scheme by use of irrigation water.

4.3.2 Land Tenure and Ownership

Mwea Irrigation Scheme Land tenure is on tenancy basis. Land in the scheme belongs to the NIB and farmers are tenants. According to Omondi (2014), the average cost of renting an acre of land was higher than the average amount of farm inputs and labor. The initial costs of renting and costs that go towards rice farming were huge in terms of land preparation, transplanting, nursery bed, spraying, weeding etc. In addition, rice farming requires continuous supply of water as well as adequate maintenance of drainage channels and water distribution. Thus rice farming consumes huge amounts of resources which can have huge impact on small scale farmers. These costs cannot be met by individual farmers but must be spread out via cooperatives or farmers' associations.

4.3.3 Population

According to IEBC 2017, the population of Mwea Constituency is 122,380. The population is growning fast, thanks to the liberalization of rice farming, which used to be controlled by the Government through the National Irrigation Board.

4.3.4 Economic Activities

Rice farming is the main economic activity of the residents living in the area. The Mwea Scheme specializes in growing two varieties of rice; the aromatic variety (basmati) and the non-aromatic variety (Sindano) within which are several varieties. The Sindano

variety has no scent, gives higher yield and is more resistant to rice blast. Basmati variety has better taste, has a good scent but is less resistant to blast and gives lower yields. It is the dominant variety in the scheme.

4.3.5 Topography

Yonemaru and Takanashi (2005) observe that external drainage is usually also poor because of the flatness of the terrain. Variable amounts of free lime are precipitated in the profile, mostly in the form of calcium carbonate concretions, which become more numerous with depth. Part of the soils seem even very poorly drained, probably due to incoming seepage from scarps and sloping upland through the subsoil and/or substratum. As inferred from pH values of 7.5 - 8.5, some of the sub soils (greater than20 cm depth onwards), show mild to moderate alkalinity.

There are two dominant types of soils in Mwea Irrigation Scheme and they are black cotton soils and red soils. Blackcotton soils are good for irrigated rice cultivation and red soils are good for maize and beans cultivation under rain fed conditions. The soils of the project area may broadly be subdivided into two groups, (1) black, cracking clay soils ("Blad: cotton soils"- pellic Vertisols) and (2) dark brown, friable, clay soils (Nitosols). The black clay soils, which are dominant in the survey area, are characterized by deep cracks and a mulchy granular structure at the surface when dry.

4.3.6 Rainfall

The average rainfall is about 850 mm with a range of 500 - 1250 mm divided into long rains (March – June with an average of 450 mm) and short rains (Mid-October to December with an average of 350 mm). The rainfall is characterized by uneven distribution in total amounts, time and space.

4.3.7 Water Resources

According to Omondi (2014), the main water sources in Mwea Irrigation Scheme is served by rivers Thiba and Nyamindi. These rivers have some small streams such as Kive, Murubara, and Nyaikungu that also run through the scheme. These small streams are partly used as minor irrigation water sources and or natural drains. Thiba, Nyamindi

and Ruamuthambi rivers have relatively large catchment area and they are available sources for irrigation intake. The scheme taps water from these rivers through two water intakes one at Nyamindi and the other one at Thiba River and supplies to the existing paddy field by gravity flow. The Nyamindi network consist of a headwork, a main canal, three branch canals and related structures, and supplies the water to Tebere section while the Thiba Irrigation comprises of a headwork, a main canal, four branch canals and related structures and distributes water to Mwea, Thiba, Wamumu and Karaba section.

4.3.8 Land Use

In Mwea Irrigation scheme, land is mainly used for rice production. This is done by various methods such as basin irrigation and furrow irrigation. Under Basin irrigation, the ground is leveled and embankments called bunks are constructed around each leveled ground. Water is then supplied to the enclosed sections. Sluices are used to control the water getting into the fields. Furrow irrigation is where water flows from the irrigation canals through sluices and into the furrows which are dug along the contours to reduce soil erosion. Other sections of the scheme have residential houses for the households living in the area.

CHAPTER FIVE: RESEARCH FINDINGS AND DISCUSSION

5.1 Introduction

This chapter presents the results of the findings of this study. It covers socio-economic profile of the respondents, describes the land tenure evolution in the last 50 years and the corresponding effect on rice production. The chapter also reports on the relationship between land size and rice production. It reports on the challenges rice farmers are facing and concludes by proposing strategies and policy interventions that can be adopted to ensure optimal rice production for food and livelihood security. The results are summarized in frequencies and percentages and presented in tables and figures.

5.2 Study Demographic Data

The researcher sought to establish gender, education level, number of years spend in Mwea Irrigation Scheme, and age bracket as each one of them has some influence on the production of rice.

Table 3: Social demographics

SOCIAL DEMOGRAPHICS		**n = 167**	**Percentage**
Sex:	Male	104	62%
	Female	63	38%
Marital status:	Single	21	12.5%
	Married	116	69.3%
	Widowed	28	17.1%
	Divorced	2	1.1%
Age bracket (years):	20-30	20%	
	31-40	30%	
	41-50	13%	
	51-60	11%	
	61-70	12%	
	70+	14%	

Household size (average household occupancy):		5
	Male	3
	Female	2
Education level;	Primary (KCPE)	22%
	Secondary (KCSE)	48%
	Diploma	16%
	Degree	12%
	Post graduate	2%
Years spent at the scheme;	0-5	14%
	6-10	42%
	11-15	38%
	Above 16	6%

The above table shows that the study sampled selectedrecruited 167 respondents of which 62% were male and 38% were female. This means that in the findings, there is sufficient representation of issues from both the male and female gender.

In terms of marital status 69.3% were married, 17.1% were widowed, 12.5% were single and 1.1% wereas divorced. Again as indicated above, issues from the four categories of marital status are represented in the findings. This has implications on recommendations on various issues of rice growing as relates to marital status of farmers.

An regular typical household in the study area had an average of 4.77 occupants of which 2.49 were male and 2.27 were female. When considering the minimum household land size for food and livelihood sustainability, the average size of the household has to be factored in the equation. For this study, it is rounded to 5 persons per household.

Close to half (48%) of the study respondents had attained secondary school education (KCSE) as the highest level of education. Up to 22% of them had attained primary school education (KCPE) as the highest level of education while those that had attended college and in attained a possession of diploma, degree and post-graduate degree/certificate were

16%, 12% and 2% respectively. This means that there are different levels of workers both skilled and unskilled in the rice production system of the study area.

Majority (70%) of the respondents had spent 6 to 15 years in Mwea Rice Irrigation Scheme. Fourteen percent (14%) of them had livedstayed in the scheme for up to five (5) years while only 6% of them had been in Mwea Rice Irrigation Scheme for a period exceeding 16 years.

In terms of age, most of the farmers in the irrigation scheme lie between 20 years to 40 years as represented by 50% of the respondents. This can be attributed to the age bracket of the youth which is between the ages of 16-35 years as defined in the draft National Youth Policy who provide labor in the farms and hence being the majority that engage in the rice farming activities which include preparing the land and letting it to fallow, planting, spraying due to diseases and harvesting which really require a lot of energy. The results also reflect the changing average age of farmers. The various categories of the individuals interviewed are as shown in the Ttable 4 below.

Table 4: Land tenure, land size and subdivision trends

LAND TENURE, SIZE & SUBDIVISION TRENDS		**n = 167**	**Percentage**
Owns land:	Yes	162	97%
	No	5	3%
Posses' land ownership document:	Yes	143	86%
	No	21	12.6%
Document in possession:	Card	18	10.7%
	Lease	2	1.3%
	Plot number	147	88%
Ownership status:	Family land	82	49.4%
	Own land	39	23.5%

	NIB	28	16.5%
	Rental land	18	10.6%
Year land was acquired:	2010-2009	43	26.1%
	2000-2009	42	25%
	1990-1999	25	14.8%
	1980-1989	19	11.4%
	1970-1979	13	8%
	1960-1969	25	14.8%
How land was acquired:	Allocation	25	14.8%
	Inheritance	98	59.1%
	Purchased	44	26.1%
Current use of land:	Farming	167	100%
Use of land in 5 years:	Leave as it is	117	70.1%
	Subdivide	33	19.5%
	Sell	2	1.1%
	Succession by inheritance	15	9.2%
Reason for subdivision:	Farming	103	61.8%
	Long term leasing	12	7.3%
	Industrial Commercial	3	1.8%
	Succession by inheritance	49	29.1%
Original size of land (Average in acres):		3.43 Acres	
Current size of land (Average in acres):		3.19 Acres	

Table 4 shows that 97% of the respondents' own land, while a meagre 3% don't own land. Majority of the respondents 87.4% possess a land document while 12.6% don't. Of those who possess a land document, 88% possess a plot number, 10.3% possess a card document and 1.3% possess a lease document. Currently, the ownership status of most farms is family land 49.4%, followed by individually owned land 23.5%, National Irrigation Board (NIB) land 16.5% and Rental land 10.6%. Majority of the respondents acquired land from the early 2000s to the present representing 51.1%, 14.8% acquired in the 90s, 11.4% acquired in the 80s, 8% acquired in the 70s and 14.8% acquired in the 60s. Most of the respondents acquired land through inheritance 59.1% termed as family land, some purchased the land 26.1% and 14.8% were allocated the land by NIB. All respondents currently use their land for farming purposes. In 5 years' time, majority of the respondents 70.1% wouldn't change the use of their land, 19.5% would subdivide their land, 9.2% would consider succession by inheritance while 1.1% would sell it. The main reason for subdividing land in future would be for farming purposes 61.8%, 29.1% for succession by inheritance purposes, 7.3% for long term leasing purposes and 1.8% for commercial purposes. The average size of land has generally decreased by 0.24 acres from an average of 3.43 acres when acquired to 3.19 acres currently, This is (reduced by 0.24 acres) decrease reduction rate of about 7% from when the land was acquired.

5.3 Rice Production

5.3.1 Growth of Rice

Rice in the scheme is grown or does well on the black cotton soils, which is one of the dominant soils. The most used tools in rice farming are sickles.

Table 5 : Rice Production

PRODUCTION		**n = 167**	**Percentage of farmers**
Rice variety:	Pishori (Basmati)	80	48%
	BW	25	15%
	Sindano	62	37%
Rice cultivation in years:		17.47 years	

	Unmilled	Processing (34%)	Total Milled
Average rice production in 2015 (Bags/ Acre)	27.11	9.22	17.89
Average rice production in 2014 (Bags/ Acre)	32.50	11.05	21.45
Average rice production in 2013 (Bags/ Acre)	28.11	9.56	18.55
Average rice production in 2012 (Bags/ Acre)	29.19	9.92	19.27
Average rice production in 2011 (Bags/ Acre)	29.20	9.93	19.27
Five years average	29.22	9.94	19.29

Price per Kg of milled Rice Kshs120	**Bag equals 100 Kg**	**@120**	**Kshs 12,000**

	Unmilled	**Milled**	**Income (Kshs)**
Average rice production in 2015 (Bags/ Acre)	27.11	17.89	214,711
Average rice production in 2014 (Bags/ Acre)	32.50	21.45	257,400
Average rice production in 2013 (Bags/ Acre)	28.11	18.55	222,600
Average rice production in 2012 (Bags/ Acre)	29.19	19.27	231,240
Average rice production in 2011 (Bags/ Acre)	29.20	19.27	231,240
Five years average	29.22	19.29	231,480

Main Crop:	Month planted	July-August
	Month harvested	December
Ratoon Crop:	Month planted	December-January
	Month harvested	February-March-April
Leaving land fallow:		March-April
Average cost of renting land per year per acre:		Kshs 44,251
Average cost of labour per year per acre:		Kshs 6,811
Average cost of farm inputs per acre per year:		Kshs 42,050
Average cost of transport per year per acre:Rate 80.00/bag		Kshs 2,320

Average cost of marketing per year per acre:Rate 58.44/bag		Kshs 1,708
Average cost of milling per year per acre:Rate 140.00/bag		Kshs 4,091
Total cost of production		Kshs 101,231
Year with best yields (%):	2015	16.7%
	2014	64.1%
	< 2013	19.2%
Year with worst yields (%):	2015	60.8%
	2014	8.9%
	< 2013	30.3%
If received farming training (%):	Yes	67%
	No	33%
Desired ideal land size (average):		6.72 Acres

Table 5 shows that Pishori (Basmati) 48 % is the most common rice variety, followed by Sindano 37% then BW 15%. The average number of years rice has been cultivated by the respondents was 17.47 years. Average rice production of unmilled rice per acre was highest in 2014 with 32.5 bags and lowest in 2015 with 27.11 bags. The average rice production per acre in the other years was 29.11 in 2011, 29.19 in 2012 and 28.11 in 2013. Processing of unmilled rice is done in two stages, the first stage is dehusking which will produce 20% husk and 80% brown rice grain. The second stage bran layer (10%), polishing (3%), broken rice and the final milled rice for marketing (66%) are produced (Njuguna, 2007). This translate to 17.89 of milled rice in 2015, 21.45 in 2014, 18.55 in 2013, 19.27 in both 2012 and 2011. Price per bag of 100 Kg milled rice is Ksh 12000. The typical planting period for the main crop is between the months of July and August while the harvesting period is in the month of December. The typical planting period for the ratoon crop is between the months of December and January while the harvesting

period is between the months of February, March and April. Respondents generally leave their lands fallow between the months of March and April.

In terms of costs, the average cost of renting land was Kshs 44,251 per acre per year, this was between 2011 and 2015. The average cost of farm inputs was Kshs 42,050 per acre per year and the average cost of labour was Kshs 6,811 per acre per year in the same period of study. Other costs such as transportation, milling and marketing were estimated at Kshs. 18,119 per acre per year. The total production cost was Kshs. 101,231 per acre. Majority of the respondents (64.1%) ranked 2014 as the year with the best yield while majority (60.8%) ranked 2015 as the year with the worst yields. A huge proportion (67%) of the respondents reported to have not received any training about farming while 33% reported to have received training about farming. Of those who received training, majority received training about planting, processing and production. Most of the trainings were conducted by the farmers' saccos and the National Irrigation Board.

"I received training about planting and rice production" - farmer, Thiba.

"The sacco organized a seminar about the rice planting and processing" -farmer, Thiba.

According to the farmers, the average optimal land size should be 6.72 acres. The reasons given for this size of land was that it would be sufficient for family and rice production needs, it would increase their incomes as a result of increased productivity and it would be big enough to be subdivided in future.

"I would generate enough produce for both selling and household use" – farmer, Thiba.

"It would be enough for subdivision during succession" – farmer, Thiba.

Table 6 : Marketing and alternative sources of income

INCOME		**n = 167**	**Parentage**
If alternative source of income is present:	Yes	66	39.8%
	No	101	60.2%
Main markets for rice:	NCPB	10	5.9%
	NIB	18	10.6%
	SACCOs	88	52.9%
	Individual buyers	51	30.6%
Average (%) contribution of alternative income source to total income:		24.13%	
Average quantity (Kgs) for household household consumption per month of unmilled rice		71.98 Kg	
Average quantity (Kgs) for selling per month of unmilled rice		323.13 Kg	
Proportion sold for income		88%	
Main months for selling rice (%):	December-January	75.9%	
	August-September	11.4%	
	October-November	8.1%	
	June-July	4.6%	

Table 6 shows that 60.2% of the respondents do not have an alternative source of income while 39.8% have. For those who have alternative sources of income, the alternative sources of income contribute 24.13% of their total income. Most of the rice produced (323.13kgs) is used as a trade commodity (88%) while the rest (71.98kgs) is used for household consumption (12%). SACCOs provide the biggest market for rice, contributing 52.9% of the market share, followed by individual buyers 30.6%, National Irrigation

Board (NIB) 10.6% and National Cereals and Produce Board (NCPB) 5.9%. Rice is mainly sold between the months of December-January (75.9%), followed by August-September (11.4%), October-November (8.1%) and finally the months of June-July (4.6%). Some of the main reasons provided for selling during these months (especially December-January) include the allure for better prices during the festive season, clearing stock in preparation for a new season, lack of storage space and to meet urgent needs such as school fees.

"I sell in December as there is a ready market and better prices" – farmer, Thiba.

According to the Kenya Integrated Household and Budget Survey, 2015/2016 (Table 7), the per-capita minimum annual adult equivalent consumption is Kshs 39,024. For an average household of five persons, this translates to Ksh195, 120.

Table 7: Rural and urban poverty (Kenya Integrated Household and Budget Survey, 2015/2016)

Category	Per Capita Minimum Monthly Adult Equivalent Total Consumption (Ksh)	Per Capita Minimum Annual Adult Equivalent Consumption (Ksh)
Rural and Peri-urban	3,252	39,024
Core-Urban Areas	5,995	71,940

As indicated in Table 5 the annual gross income per acre in the study area was Kshs. 231,480. The estimated total cost of production was kshs. 101,231 per acre per year. This leaves a net of Ksh. 130,249. Given the current yield and income, an average household of 5 persons would require a minimum of 1.5 acres of irrigated rice land for minimum survival.

Table 8 : Risks & challenges

RISKS		**n = 167**	**Percentage**
Primary risks:	Pests	78	46.5%
	Diseases	31	18.6%
	Weather	33	19.8%
	Lack of access to inputs	25	15.1%
Specific weather risks:	Drought	159	95.3%
	Temperature	8	4.7%
Risk management:	Irrigation	160	95.8%
	Proper planting time	7	4.2%

Table 8 shows that the major risks affecting rice production are pests 46.5%, weather 19.8%, diseases 18.6% and limited access to inputs 15.1%. The main weather risk affecting rice production was drought (95.3%) followed by high temperature (4.7%). Most of the respondents (95.8%) managed these risks through irrigation and proper planting time (4.2%). The dam under construction in the county will also contribute to solving the water problem.

The main challenges facing rice farmers include; farmers being unable to make decisions about their farms without getting permission from the National Irrigation Board (NIB), increasing pressure on the allocated land resulting to conflicts in some households, unfair land allocation practices by the NIB, as a result of the land tenure system farmers cannot access loans as they do not have title deeds which in most cases acts as collateral, pre-set price ceilings by the National Irrigation Board make it hard for farmers to earn more, invasion of their crops by quelea birds, occasional flooding from River Thiba and water cuts by the Water Resources Management Authority (WARMA), household food insecurity due to over dependence on rice, high prevalence rates of water borne diseases

such as malaria and bilharzia, uncoordinated marketing which has led to adulteration of rice, gender inequity in access and control of land which affects rice production, erratic weather patterns and high cost of farm inputs.

"My main challenge is always low markets and birds destroying crops" – farmer, Thiba.

"When the short rains came, the distribution was the poorest ever but the farmers planted their crop only to realise the canals that supply them with water had dried up" – NIB

Respondents suggested some of the ways to address these challenges including; restricting cheap rice imports, construction of dams, utilizing some types of organic fertilizers which minimize loss of water through transpiration, more focus on hay production from rice straws as this supplements the farmers sources of income, legal reforms especially on CAP 347 of the National Irrigation Board, mobilization of farmers in groups in order to collectively address their grievances to NIB or the government, liberalization of the scheme in 1998 affected extension and research services resulting in loss of general quality of the rice, implementing agrarian reforms that give farmers decision making autonomy, eradication of pests and diseases and provision of farming inputs and incentives for the farmers.

"I think the government should restrict the importation of cheap rice products" – farmer, Thiba.

"I would be happy if we were given incentives and assistance" – farmer, Thiba.

"Rice straws make good hay for livestock and farmers are capitalising on them. Farmers have become enlightened and are doing good business in the scheme" – Ministry of Agriculture.

5.4 Land Tenure evolution in the Last 50 years

The study sought to establish the influence of Land Tenure evolution in the Last 50 years on rice production. The researcher used the Likert scale to obtain the perceptions of the respondents towards the items listed in the data collection tool as shown in Table 8. The

scale measures include: *5-Strongly agree, 4-Agree, 3-Neutral, 2-Disagree, 1-Strongly Agree*. The variables that had a mean greater than 3.0 represented 'agree' while those, which had a mean of less than 3.0, represented 'disagree'. Standard deviation was used to indicate the extent of variability of the responses. A standard deviation of less than 1.0 shows low variability while standard deviation with 2.0 and above shows high variability among the responses. Table 8 shows the distribution of the responses on land tenure evolution in the last 50 years.

Table 9 : Response on land tenure evolution

Statement	**Mean (M)**	**SD**
Land tenure evolution in the last 50 years has contributed to increased rice production;	3.6	2.0
Increased land tenants within the last 50 years has contributed to increased rice production;	3.3	1.6
Increased household rice farmers in Mwea has increased rice production;	2.3	2.2
Reduced farm size per farmer has improved the quality and size of production;	4.1	2.4
Increased private farmers in Mwea, in the last 50 years has reduced production of rice at Mwea irrigation scheme;	3.7	1.7
n= 167		

This table reveals that majority (M=3.6: SD=2.0) of the respondents who took part in the study agreed that land tenure evolution in the last 50 years has contributed to increased rice production. This was supported by slightly more than half of the respondents, (M=3.3; SD=1.6) who indicated that increased land tenants within the last 50 years has

contributed to increased rice production. However, slightly less than a quarter (M=2.3; SD=2.2) of them disagreed that increased household rice farmers in Mwea has increased rice production.

An overwhelming majority (M=4.1: SD=2.4) of the respondents were in agreement that reduced farm size per farmer has improved the quality and quantity of production per unit area. This was supported with majority (M=3.7: SD=1.7) of them who were in agreement that increased private farmers in Mwea.

5.5 Land Tenancy and Rice Production

The study sought to establish the influence of land tenancy on rice production in Mwea irrigation scheme. The researcher used the Likert scale to obtain the perceptions of the respondents towards the items listed in the data collection tool as shown in Table 10. The scale measures include: *5-Strongly agree, 4-Agree, 3-Neutral, 2-Disagree, 1-Strongly Agree*. The variables that had a mean greater than 3.0 represented 'agree' while those, which had a mean less than 3.0, represented 'disagree'. Standard deviation was used to indicate the extent of variability of the responses. A standard deviation of less than 1.0 shows low variability while standard deviation with 2.0 and above shows high variability among the responses.

Table 10 : Rice production efficiency in the irrigation scheme

Statement	Mean (M)	SD
Tenants of Mwea irrigation scheme receive farm tools and equipments on time thus high production;	3.8	2.1
Tenants of Mwea irrigation scheme receive farm chemicals on time thus high production;	4.2	2.4
Farmers in Mwea Irrigation Scheme get their pay in advance thus improving the farmers' morale which boost rice	4.4	2.7

production;		
The amount of money paid per plot in the Mwea irrigation scheme affects rice production;	3.9	2.0
Farmers with small plots in the scheme use little inputs to produce high as per unit acrage;	3.7	2.0
Farmers with vast plots in the scheme produce low/medium amount of rice;	3.9	1.9
The farmers' source of labour in the scheme affects rice production;	4.4	2.3
Some farmers do not enrich their farms with required chemicals thus low production;	4.0	2.3
Plots owned by the individuals have high rice production;	4.1	2.1
Plots owned by the groups have high rice production;	3.7	1.8
n= 167		

The table above shows that slightly more than a third (M=3.8: SD=2.1) of the respondents were in agreement that tenants of Mwea irrigation scheme receive farm tools and equipments on time thus high production. This was supported by an overwhelming majority of the, (M=4.2; SD=2.4) who agreed that they receive farm chemicals on time thus high production.

An ovewhelming majority (M=4.4: SD=2.7) of the respondents who took part in the study indicated that farmers in Mwea Irrigation Scheme get their pay in advance thus improving the farmers' morale which boost rice production. This was supported by

slightly more than a third of them who indicated that the amount of money paid per plot in the Mwea irrigation scheme affects rice production (M=3.9: SD=2.0).

Slightly more than a third (M=3.7: SD=2.0) of the respondents agreed that farmers with small plots in the scheme use little inputs to produce high as per unit acrage and that farmers with vast plots in the scheme produce low/medium amount of rice (M=3.9: SD=1.9).

An overwhelming majority (M=4.1: SD=2.1) of the respondents were in agreement that farmers' source of labour in the scheme affects rice production. An ovewhelming majority (M=4.0: SD=2.3) of the respondents agreed that some farmers do not enrich their farms with required chemicals thus low production. Almost a similar number (M=4.1: SD=2.1) of the respondents indicated that plots owned by individuals have high rice production whereas slightly more than a third of them (M=3.7: SD=1.8). were in agreement that plots owned by groups have high rice production.

5.6 Tenant's Land Size and Rice Production

The study sought to establish the influence of tenant's land size on rice production. The researcher used the Likert scale to obtain the perceptions of the respondents towards the items listed in the data collection tool as shown in Table 16. The scale measures include: *5-Strongly agree, 4-Agree, 3-Neutral, 2-Disagree, 1-Strongly Agree.* The variables that had a mean greater than 3.0 represented 'agree' while those, which had a mean less than 3.0, represented 'disagree'. Standard deviation was used to indicate the extent of variability of the responses. A standard deviation of less than 1.0 shows low variability while standard deviation with 2.0 and above shows high variability among the responses.

Table 11 : Tenant's land size and rice production

Statement	Mean (M)	SD
Tenants with large plots of land in the scheme have low quantity of rice production;	4.1	2.0
Tenants with large plots of land in the scheme produce low quality paddy rice;	4.1	2.0
Tenants with large plots of land produce low quality paddy rice;	3.9	2.2
Tenants with large plots of land in the scheme have higher incomes compared to those with small plots;	3.9	1.9
Majority of the tenants with large plots of land may have difficulties to raise the lease fee thus affecting rice production;	4.1	2.3
Tenants with small plots of land can manage to purchase the required amount of farm inputs thus high production;	3.8	2.0
Tenants with large plots of land may have problems managing their farms druring dry season thus low production;	4.2	2.4
Tenants with large plots of land may have problems to maintain soil fertility hence low production;	3.9	2.1
n= 167		

As shown in the table above, an ovewhelming majority (M=4.1: SD=2.0) of the respondents who took part in the study indicated that tenants with large plots of land in the scheme have low rice production. A similar number (M=4.1: SD=2.0) of the respondents were in agreement that tenants with large plots of land in the scheme produce low quality paddy rice. However, slighlty more than a third (M=3.9; SD=2.2) of them agreed that tenants with large plots of land produce low quality paddy rice. This show that the amount and quality of rice produced by the tenants depended on the size plots of land in the scheme. This can be attributed to the cost of farm inputs as well as the ease of management of the plots.

Slightly more than a third (M=3.9: SD=1.9) of the respondents agreed that tenants with large plots of land in the scheme have higher incomes compared to those with small plots. This was supported by an overwhelming majority (M=4.1: SD=2.1) of the respondents who were in agreement that majority of the tenants with large plots of land may have difficulties to raise the lease fee thus affecting rice production. This is in line with the findings from a study carried out by Njagi (2009) where it was found that the government policy on rice farming remained largely unchanged and over time, production deteriorated over disputes on price fixing resulting in farmers lacking incentives to raise their production. This as a result led to a major rebellion in the Mwea scheme in 1999 and thereafter the farmers took charge of rice production which in turn led to the collapse of the other rice schemes in Ahero, West Kano and Bunyala.

Slightly more than a third (M=3.8: SD=2.0) of them who indicated that tenants with small plots of land can manage to purchase the required amount of farm inputs thus high production and that tenants with large plots of land may have problems to maintain soil fertility hence low production (M=3.9: SD=2.1). This concurs with the findings of the study done by Nguyo (2002) where it was established that Mwea irrigation scheme's (MIS) pivotal role in the 1980's when the cost of food import skyrocketed with respect to the value of the domestic currency and its expected impact on the agricultural economy then and in the future. The report established how the size of the scheme, acreage per person and the population in the scheme influenced rice production.

An overwhelming majority (M=4.2: SD=2.4) of the respondents were in agreement that tenants with large plots of land may have problems managing their farms druring dry season thus low production. This was supported by slightly more than a third (M=3.9; SD=2.1) of them who were in agreement that tenants with large plots of land may have problems to maintain soil fertility hence low production.

Further, the following figures (Figure 26 and Figure 27) shows rice of the same age, same type but planted by different farmers who own different land sizes in Mwea Irrigation scheme.

Figure 5 : Strong and healthy rice plants owned by small holder farmers (small plots)

Figure 6 : Rice plants owned by large holder farmers (large plots)

5.7 Challenges Influencing Rice Production in Mwea Irrigation Scheme

5.7.1. Insecure land tenure

When asked to indicate the challenges influencing rice production in Mwea Irrigation Scheme, one of the respondents who took part in the study indicated that farmers started leasing out land, a practice that was prohibited under the NIB management, after the community took over management of the scheme. It was also found that majority of the lessees were the children of original settlers who did not inherit land or inherited very small pieces of land. The major reason for leasing out land was the lack of capital required for rice farming for those who are leasing out. Selling of land in Mwea is uncommon, and farmers are unable to use the land and land use rights as collateral to access credit from formal sources such as commercial banks.

5.7.2. Economic exploitation

One of the respondents argued that, for instance in year 2000 the first year of operation under community irrigation management, some farmers, who tended to be endowed with less human, physical and financial capital were more vulnerable to negative production shocks, did not deliver paddy to MRGM after harvesting in that season despite the fact that these farmers received credit. Farmers who had delivered paddy to MRGM in the year 2000 were not paid on time as was anticipated.

Majority of the respondents indicated that farmers were not paid immediately after delivery by the Mwea Rice Growers Multi-Purpose Co-operative Society (MRGM), which was established as a savings and credit co-operative, was expanded to a multi-purpose credit society and took over the role of supplying farm inputs on credit from NIB. One of them added that this is because MRGM needed time to collect paddy from all farmers, sell the rice at the markets, and deduct the credit owed by farmers.

An overwhelming majority of the respondents observed that there was a possibility for farmers to receive prices that were much lower than the market price because of storage and post-harvest management costs for paddy as well as administrative costs and possibly excessively high commission. This was supported by slightly more than a third of them who indicated that MRGM is not subsidized and might not have had sufficient capacity to adequately play the role played by NIB.

Majority of the respondents indicated that the membership of farmers who did not repay what they owed to MRGM were suspended, and eventually revoked. In principle, these defaulters have permanently lost access to the credit from MRGM. It is clear that those farmers who defaulted did not expect the strict policy of MRGM and underestimated the benefit of being members, as MRGM was a new marketing and credit organization. Meanwhile, some farmers who had the ability to finance the cost of their rice farming but were dissatisfied with the MRGM's delayed payments chose to stop receiving input credit from MRGM.

5.7.3. Other challenges

Among other challenges facing rice farmers include; farmers being unable to make decisions about their farms without getting permission from the National Irrigation Board (NIB), increasing pressure on the allocated land resulting to conflicts in some households, unfair land allocation practices by the NIB, as a result of the land tenure system farmers cannot access loans as they do not have title deeds which in most cases act as collateral, pre-set price ceilings by the National Irrigation Board make it hard for farmers to earn more, invasion of their crops by quelea birds, occasional flooding from River Thiba and water cuts by the Water Resources Management Authority (WARMA), household food insecurity due to over dependence on rice, high prevalence rates of water borne diseases such as malaria and bilharzia, uncoordinated marketing which has led to adulteration of rice, gender inequity in access and control of land which affects rice production, erratic weather patterns and high cost of farm inputs. Figure 28 shows the quelea birds destroying the rice grains.

Figure 7 : Quelea birds feeding on the rice grain in the plains

5.8 Proposed Strategies that Improves Rice Production

5.8.1 Eradication of Pests and Diseases

Pest and diseases has also been noted major challenges that face rice farmers. To eradicate them, the government agricultural research institutes like Kenya Agricultural Research Institute (KARI) should innovate the best method either biological or chemical that may be suitable for control pests and diseases that destroy rice in the plains or in the stores. This will help to produce more and high quality rice.

5.8.2 Provision of Farming Inputs

Farm inputs are very vital in rice production. In most cases the government may delay to provide farm machinery, seeds, chemicals and other mechanical tools to farmers. Therefore, this can affect the amount of rice produced in a season. Where these inputs are delayed for a long time, some farmers may end up not cultivating their land thus skipping it for a season. This reduces accumulative rice production. For this and other underlying reasons, private sources of inputs should be approved at a fee which should be compensated by the government.

5.8.3 Incentives for the Farmers

It has been noted that the MRMG in most cases may delay to pay farmers. This exposes farmers to financial challenges and they may opt to do other things than rice farming. On the other hand, if the farmers are paid in advance they may be motivated to increase even the size of the land under cultivation. This accumulatively will lead to high rice production.

5.9 Discussions

5.9.1 Study demographic data

Like other studies, this study interviewed more male respondents than female respondents. This is also reflected in the average household occupancy of which shows that there are more men than women in the households. This gender dynamic reflects the involvement of each gender in the rice production value chain. Generally, men are involved in land preparation activities such as ploughing, leveling and transportation. On

the other hand, children and women are involved in planting, harvesting, weeding, bird scaring, threshing and drying. Both genders are involved in marketing although women are more dominant in the local retail chain of the rice business. Similar observations were made in Tanzania which showed that men dominated rice production activities (Thabiti, 2014). The findings in this study differ with studies conducted by the Consultative Group on International Agricultural Research (CGIAR) which found that women contribute significantly more to rice-based agriculture than men (2013). The difference can be attributed to patriarchal structures and authorities which give more resources to men, resulting in women having less access to productive resources, specifically land.

Most of the respondents in this study were married and with an average age of 46 years, which falls into the most active in agricultural activities group (Godfrey, 2010). Farmers in this age bracket are still energetic and this has a lot of positive implications for rice production. Also, the fact that majority of the respondents were married could indicate stability, command societal respect and also indicate that majority of the respondents are responsible (Effiong, et al, 2015). Similar observations were made in Tanzania and Nigeria where majority of the respondents were within the age bracket of 41-50 years and married. This could also be an indicator that, the younger and more energetic population has migrated to urban areas to search for jobs due to land pressure in Thiba.

5.9.2 Land tenure, land size and subdivision trends

Most of the respondents in this study owned land and possessed a land ownership document, with majority of the ownership status of the land being family land. The respondents, some of whom were settled as tenants in the 1960s were allocated a holding of around 4 acres and then issued with a licence of occupancy. This tenancy system has prevailed over the last 50 years. However, over the years the pieces of land have been passed on among family members and in some instances transferred to new holders. As a result of this, majority of the respondents in this study had plot numbers as the corresponding document of proof of ownership. In this study, majority of the respondents acquired land after the turn of the new millennium and most acquired it through inheritance. This group of young land owners, mostly the daughters and sons of the

original scheme tenants are commonly known as jua kali farmers. They sprung up after Mwea Multi-purpose Rice Growers (MMRG) took over running of the scheme from NIB. Although more educated than the scheme tenants, these young farmers are inexperienced in rice farming.

Similar land tenure systems can be found in other irrigation schemes in Kenya such as Ahero & Bunyala. In Kenya, the large irrigation schemes were created to provide settlement for individuals without any form of employment and to settle those without land. The tenants on these public irrigation schemes usually have no titles to claim ownership of the land as it is the state's property. They operate on agreed occupational license arrangement with the most common document proving ownership being a plot number. This form of arrangement makes these schemes a form of communal property resource (Ruigu, 1988). However, this land tenure system differs from other African countries such as Niger. In Niger's largest rice irrigation scheme, the Office du Niger, small holders have annual leases while large scale investors sign various contracts with the Niger government agencies to access water and land rights (LANDac, 2015). In Uganda, the predominant kind of land tenure in Kibimba Rice Scheme has been customary tenure with emerging cases of individualistic land ownership. The emerging cases of individualistic tenure are as a result of some natives being dispossessed from their land during the creation of the scheme as well as the increasing population around Kibimba (Farmers' Federation, 2012).

All the respondents in Thiba Ward utilize the land for farming purposes, with a majority of them intending to use the land for the same purpose in 5 years' time. This may be largely due to the farmers lacking the powers to make decisions on what to do with their land. As a result of the tenancy tenure system in Mwea, the National Irrigation Board controls every decision and leaves farmers with no power to make decisions concerning the land. The top-down approach on decision making by the scheme's management leaves farmers powerless and hence easily exploited and manipulated. Gladys (2015) also made similar findings, where the irrigation act cautions a farmer incapable of farming of allowing another person to cultivate or occupy the land without a written permission from the scheme's manager. In her study, farmers shared their frustrations on the over

dependence on rice production only. Similar observations were also made by Kabutha & Mutero (2002) where under the irrigation act, farmers remain settlers and have no holding under the law of succession act through which their kin can inherit it. This explains why there are virtually no plans to subdivide the land in future for inheritance purposes.

The average size of land in this study had reduced by only 7% from the original size of land the farmer got to the one currently being owned. This reduction can be explained by land pressure, where the land size has been the same since when it was first allocated. When the four acres of land was initially allocated, it was adequate for the small families of the tenants then. This situation has changed significantly over a span of forty years. The family sizes have more than tripled and thus overstretching how much of the land can be strictly used for farming purposes. In their study, Tsurruchi & Waiyaki the land pressure has also been contributed by livestock rearing (1995). Although there exists regulation that prohibits livestock rearing, herds of cattle and other small stock are common in the area. They found that more than half of the farmers in the scheme kept, chicken, cows and goats and thus exerting more pressure on the land. In his study of Ahero irrigation scheme, Omondi found the average cultivated land size to be 3.24 acres (2014). These findings are similar to the one in this study which found the average cultivated land size to be 3.43 acres. Although the pressure exerted on land is not the same as Mwea because, when the scheme was established, farmers had to shift from subsistence farming to cash crops. Thus some farmers in this scheme aren't restricted to growing rice only as they grow tomatoes and other crops. They also don't depend wholly on rice production as a source of income with a sizeable percentage (%) of them having other sources of income such as craftsmanship (Cheserek et al., 2012).

5.9.3 Rice Production

Pishori is one of Kenya's most popular rice varieties due to its sweet aroma and as a result it is the most common variety produced in Thiba. The other aromatic rice variety grown in this area was BW while some farmers also grew the popular non-aromatic sindano variety. Pishori is the most popular rice for household consumption especially

among the middle-class in the cities. However, due to its high cost, numerous market tricks such as mixing it with a cheaper variety affect its consumption.

The trend is similar in Tanzania, where most consumers prefer the aromatic rice variety super kilombero. This is due to its perfect grain size, colour, flavour and its cooking attributes. The non-aromatic rice variety popular in Tanzania is commonly known as IR64 (Tanzania ministry of agriculture food security and cooperatives, 2009). However, in Bunyala irrigation scheme, farmers have had to ditch growing the aromatic varieties of rice as a result of poor markets and their susceptibility to diseases. Focus has then shifted to sindano, a non-aromatic rice variety with good market returns and with much less production costs (Business daily, 2014). This difference can be attributed to Bunyala irrigation scheme being far away from any city, which would guarantee them ready markets. Farmers in Thiba had cultivated rice for an average of 17 years. This can be attributed to most of them having acquired land at the turn of the millennium. Similar results were also reported in Ahero irrigation scheme where farmers had grown rice for an average of 18 years (Omondi, 2014).

The average rice production was highest in the year 2014 with 32.5 bags per acre while lowest in 2015 with 27 bags per acre. The long rains season towards the end of 2013 could have influenced the high production in 2014 while the short rains towards the end of 2013 could have influenced the poor rice production in 2014. River Thiba, which supplies water to the irrigation scheme registered significant declines in water volumes and thus affected farming patterns and rice production. The main crop seed is usually sown in July-August and harvested in December in a practice referred to as short rain paddy cultivation. The Ratoon crop, which farmers benefit from after the main harvest is usually sown between the months of December and January then harvested towards the end of February, March and April. Similar cultivation trends are also present in West Kano, Ahero and Bunyala irrigation schemes where the main crop is grown between the months of July and August then harvested in December (Nyang'au et al., 2014). Since most of the rice grown in Africa is rainfed, only one rice crop is grown per year. Thus, for the case of Thiba, land is usually let fallow between the months of March and April. After harvesting, the practice has been that the fields are left fallow for up to six months.

This practice has been contested by young farmers, mostly the children of scheme tenants, as being irrational (Kuria, 2004). Similar trends have been observed in West Kano where farmers let their land fallow for six months. Leaving land fallow is a general practice across Africa as rain fed rice growing is associated with rainfall and thus the duration and timing of the cultivation cycle has to be adjusted accordingly.

The average cost of renting an acre of land was higher than the average amount of farm inputs and labor. The initial costs of renting and costs that go towards rice farming are huge in terms of land preparation, transplanting, nursery bed, spraying, weeding etc. In addition, rice farming requires continuous supply of water as well as adequate maintenance of drainage channels and water distribution. Thus rice farming consumes huge amounts of resources which can have huge impact on small scale farmers. These costs cannot be met by individual farmers but must be spread out via cooperatives or farmers' associations. The average costs in this study are quite different from the average costs in Ahero Irrigation Scheme where the labor costs account for 50 percent of the total costs. However, the labor costs in Thiba per acre were lower compared to the labor costs in Ahero. On the other hand, the average costs of farm inputs in Ahero were lower compared to Thiba. This can be attributed to the vibrant agricultural extension services in Ahero which are diminishing in Thiba (Omondi, 2014).

Less than half of the respondents in this study reported to have not received any training in rice farming. These results are similar to those in West Kano, where farmers ranked farming training as there second most important incentive with an almost similar percentage. While there is no general universal optimum land size, the optimum land size in this study was 6.72 acres. In subsistence oriented economies primarily based on family labor, land size that permits full utilization of family labor as well as giving a reasonable standard of living can be said to be optimum. In economic terms, optimal land size is a size that gives optimal return to resources both purchased and family supplied (Jabbar, 1977).

5.9.4 Income

As with most families in Kenya, some respondents in this study stated that they have an alternative source of income. In addition to rice farming being the main source of income, some of the households have invested in other productive assets that enable them diversify their income options as well as cushion themselves against shocks related to losses of rice production and reduced yields. These alternative sources of income supplement nutritional and dietary needs and assist in meeting family responsibilities such as social obligations, investments and education. Other than rice farming, livestock and poultry keeping as well as business activities contribute to nearly a quarter of the household incomes in Thiba. Similar trends were observed in West Kano and Ahero irrigation schemes where households supplement their incomes by exploiting wage labor opportunities such as craftsmanship and fishing (Cheserek et al., 2012). The average quantity for selling was more than the average quantity for self-consumption in all the schemes.

Mwea multi-purpose rice growers' cooperative (MMRG) society oversees the day to day running of Mwea's rice irrigation scheme's rice production, processing and marketing activities. This explains why the main market for rice in Thiba was SACCOs. Although MMRG oversees the running of the scheme, there exist MMRG independent farmers who sell their rice to individual buyers, National Cereals and Produce Board and NIB (Kuria, 2004). In West Kano irrigation scheme, the NCPB is the main market for rice, followed by individual rice buyers. Although farmers get meagre incomes from individual buyers who turn out to be shady middlemen (Amos, 1987). The general rice production pattern in Thiba has been that of having a single crop a year and leaving the land fallow for the rest of the year. After harvest, the common practice has been to leave the fields fallow for up to six months. After harvesting, farmers store the rice with majority of them selling it between the months of December to January. These two months is when there is increased demand for rice in the market as they coincide with the festive season.

Across the world, land ownership and size play a vital role in terms of rice production. Specifically, when compared to farmers who have leased land and land fragmentation,

which are less productive. Other factors that may significantly influence rice production include labor cost and farming techniques. In this study, it was found that land size as well as ownership did significantly affected rice production. This is similar to some studies which found that land size and ownership have a significant effect on rice production. In a study to find out the impact of land ownership on productivity and efficiency in Bangladesh, found that land ownership and size had a detrimental effect on rice production. It was found that reducing the size of land through fragmentation reduces rice production while ownership significantly increases efficiency (Rahman & Rahman, 2009). In a different study in the Philippines, land ownership was found to have a significant impact on rice production compared to farmers who lease land (Koirala & Mohanty, 2014).

5.9.5 Risks & challenges

Regarding the challenges influencing rice production in Mwea Irrigation Scheme, it was established that farmers started leasing out land, a practice that was prohibited under the NIB management, after the community took over the management of the scheme. It was also found that the majority of the lessees were the children of original settlers who did not inherit land or inherited very small pieces of land. The major reason for leasing out land was the lack of capital required for rice farming. Selling of land use rights in Mwea is uncommon, and farmers are unable to use the land use rights as collateral to access credit from formal sources such as commercial banks.

The study also established that the membership of farmers who did not repay what they owed to MRGM was suspended, and eventually revoked. In principle, these defaulters have permanently lost access to the credit from MRGM. It is clear that those farmers who defaulted did not expect the strict policy of MRGM and underestimated the benefit of being members, as MRGM was a new marketing and credit organization. Meanwhile, some farmers who had the ability to finance the cost of their rice farming but were dissatisfied with the MRGM's delayed payments chose to stop receiving input credit from MRGM.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.0 Conclusions and recommendations

This chapter provides the conclusion and recommendations of the study that includes land tenure evolution in the last 50 years and the corresponding effect on rice production in Mwea Rice Irrigation Scheme, the influence of farmers' land size on rice production in the scheme, the challenges affecting rice production and strategies that can be adopted to ensure optimal rice production in the Scheme. It also makes recommendations that can lead to increased rice production in the scheme and the country as a whole.

6.1 Conclusions

a. Land tenure evolution in the last 50 years and the corresponding effect on rice production

The land tenure in Mwea Rice Irrigation Scheme has prevailed for years which resulted in the rebellion of 1999 where farmers sought liberalization of the scheme. Selling of land use rights in the irrigation scheme was uncommon until after the community takeover in 1999, where the farmers started leasing out land in contradiction to NIB regulations. Leasing became popular as the farmers were unable to sell the allocated land or use it as collateral to access credit from microfinance institutions and commercial banks. The main reason for leasing the land according to the findings was the lack of capital needed for rice farming. This has resulted in the official average land size in the scheme reducing by 7 percent, with majority of the lessees being children of the original owners who inherited small pieces of land.

Prior to the 1999 revolt by farmers, the land tenure system was such that the farmers were licensees of the NIB and they cultivated the land for the sole benefit of NIB. The NIB monopolistic production and marketing structures meant that the board was the sole provider of farm inputs on credit as well as the buyer of all the paddy rice. The tenant farmers had no motivation to produce optimally. After the change, farmers could lease part of their land in exchange for farming capital which in turn resulted in increased rice production. Overall, while productivity has not changed much due to other technical

reasons, the tenant farmers are incharge of all their produce and are getting comparatively higher incomes. However, the tenant farmers still have the risk of loosing the land on which they grow rice through re-allocation to other persons.. In several cases, the names of lease agreements of the land are in the hands of men. This disadvantages women in making key decisions and controlling resources during rice production resulting in many of them being actively involved mainly in the latter stages of the rice value chain.

b. The influence of farmers' land size on rice production in the scheme,

The farmers were each allocated 4 acres of land that was to be dedicated to rice growing only. There was a statistically significant association between tenant's land size and rice production in the scheme. However, this association was mostly negative as rice production reduced with increase in land size. This was evident whereby tenants with small plots of land could manage to purchase the required quantities of farm inputs resulting in high rice production while the farmers with large plots of land had problems to maintain soil fertility hence low production. However, tenants with large plots of land in the scheme had higher total yields and incomes compared to those with small plots.

The study found the annual yield per acre to be 29.22 bags/acre translating to an annual gross income of Kshs. 231,480 per acre per year. The estimated total cost of production was Kshs. 101,231 per acre per year. This leaves a net income of Ksh. 130,249. Given the current yield and income, an average household of 5 persons would require a minimum of 1.5 acres of irrigated rice land for minimum survival of Kshs. 195,120 per year. If the yield can be increased, to 40 bags/acre the minimum land size can come down to 1.1 acres. This can accommodate more farmers in a small area of land. There should therefore be sufficient attention on increasing productivity through research, for high yielding seed varieties, enhancement of inputs supply and marketing.

c. Other challenges of rice production

Other challenges included social issues such as waterborne diseases such as bilharzia and malaria, high cost of farm machinery and inputs, increased pressure on land resulting to frequent household conflicts, invasion of crops by quelea birds, high dependency on rice

resulting in food insecurity, low technical knowhow among rice production extension staff, harsh weather conditions and uncoordinated marketing which has resulted in rice adulteration.

d. Strategies for increased production of rice in Mwea Irrigation Scheme

The main factors responsible for increased rice production are having sufficient land size, secure land tenure, sufficient supply of inputs, effective management of pests and diseases, efficient management of the marketing process to ensure optimal returns to the farmers.

6.2 Recommendations

This study recommends the following to respond to the challenges faced by rice farmers from Thiba, Mwea with regards to land tenure and land size.

a. Land tenure and rice production

A definite lease period e.g. 55 years to cover an active farming life of an adult (from 20 - 75 years) could help in creating tenure security for the tenant farmers. Intergenerational transmission of land use rights should also be clearerly defined to minimize conflicts among potential heirs. Once the minimum land size is agreed on, transmission of land use rights should be to only one heir. The government should acquire and open new blocks of land to ensure that those who want to be full-time farmers (as an employment) have access to their own minimum size of land. In addition, efforts should be made to address the gender disparity in accessing the land for rice production. The gender land access approach used for tea farmers in the upper zones could be applied where by for a household, either both the man and the woman are registered or half of the land is registered under the man the other half under the woman.

NIB should remain to be the sole owner of the land but have regulations that will aim at reducing land-related conflicts. Systems and structures for managing the Mwea irrigation Scheme require a change so that can participate more in making decisions. The farmers should change from just being passive recipients of instructions to key stakeholders in matters that concern rice production. Through changing regulations, customs and laws

concerning land ownership, farmers will put their land to better use leading to increased productivity.

b. Household land size for rice production

An acceptable income level for the households should be worked out. This will then guide the process of determining the minimum land size for rice production in Mwea Rice Irrigation Scheme.

c. Other challenges

The relevant departments like health should be actively engaged to address the health problems in the scheme. In addition, input supply should be coordinated to ensure optimal and sustainable production of rice.

d. Strategies for optimal rice production

The crop production policies, the Irrigation Act and regulations and associated institutions should all be revised to facilitate implementation of the above recommendations to ensure increased production of irrigated rice. The current farmer cooperatives should catalyze reforms to ensure appropriate production and marketing environment for paddy rice while the government should invest in capacity building of all the involved institutions for efficient delivery on their mandates.

6.3 Areas for Further Research

This study, found that land tenure systems and land size affect the production of rice. What should be the ideal land tenure for irrigated rice production? What should be the minimum per capita land size? What should be done to maintain the optimal land size for households. Should there be only one heir for the household land or should the government set up other new schemes to accommodate new farmers? Should farmers treat farming as a full time job and forget about running multiple enterprises?

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APPENDICES

APPENDIX I: QUESTIONNAIRE FOR HOUSEHOLDS

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

URBAN REGIONAL PLANNING THESIS

Analysis of land tenure and land subdivision trends on rice production in rice irrigation schemes in kenya: A case of Mwea Rice Irrigation Scheme, Thiba.

By: Kimari Cedric Reg No.: B63/81353/2012

Declaration: ***This information is confidential and it will be used purely for the academic purpose.***

GENERAL INFORMATION

Name of Interviewer ……Tel: …….

Date……

Place of interview……..…….. Time of interview……..…….……

PERSONAL INFORMATION

1. Name of Respondent (Optional)...…… Tel: …….
2. Sex

    a) Male ☐
    b) Female ☐

3. Age (Years)……

4. Marital status

    a) Single ☐
    b) Married ☐
    c) Widow/widower ☐
    d) Divorced ☐

5. House hold size …….

    a) Number of Male ……
    b) Number of Female ……..

6. What is your highest education level?

KCPE [ ] KCSE [ ] Diploma [ ] Degree [ ] Post-graduate [ ]

7. How many years have you been in Mwea Irrigation Scheme?

0-5 years [ ] 6-10 years 11-15 years [ ] Above 16 years [ ]

LAND TENURE, LAND SIZE AND SUBDIVISION TRENDS

1. Do you own land? Yes ☐ No ☐ ,
2. If yes, what size is your land in acreage?
   .....
3. If yes do you have any land ownership document? Yes ☐ No ☐
4. If yes to (3) which document do you have?
   ……
5. What is the ownership status of the land that you farm?
   a) Family land ☐
   b) Own land ☐
   c) National irrigation board land ☐
   d) Rental land ☐
6. Which Year did you acquire your land?
   ……..
7. What was your size of land in acreage when you acquired it? …… and what is the size now? ……
8. How did you acquire the land?
   ……
9. How do you use your land? (indicate the breakdown in acres)

	Farming (Crops)	Acres	Animal rearing	Acres	Renting out	Acres	Idle	Acres

1								
2								
3								

10. How are you likely to use your land in the next 5 years?
    a) Leave as is ☐
    b) Subdivide ☐
    c) Sell ☐
    d) Succession by Inheritance ☐
    e) Other……..

11. If you are intending to subdivide your land, what is the reason for the subdivision?
    a) Agriculture ☐
    b) Long term leasing ☐
    c) Industrial /commercial ☐
    d) Home occupancy business ☐
    e) Succession by Inheritance ☐
    f) Other
    specify……

12. Are there any uses, or plans for, adjacent lands that especially concern you (i.e. subdivisions, developments, commercial use, etc?)

    If any, please briefly describe:

13. What do you think should be done about the diminishing household land size as subdivision is done among households?

PRODUCTION (Rice)

1. What are the rice varieties most commonly planted in the area?

2. For how long have you cultivated rice?
   (Years)……..

3. Estimate your rice production in the last 5 year?

Year	Production (Bags/ Acre)
2014	
2013	
2012	
2011	
2010	

1 bag = _____kg

4. What is the typical planting period for rice for the different varieties (month(s)/ week(s))?

Main Crop	Month Planted		Notes
	Month Harvested		

Ratoon Crop	Month Planted		Notes
	Month Harvested		
Leaving the land Fallow			

5. What is the average cost of production in the area (in total costs of inputs per acres or other area unit—if different, specify)?

	Cost (Ksh)
Land (Rent)	
Labour	
Farm Inputs	

6. In which of the last 10 years do you recall having the best yields?

Year	Size Of Land	Yield	Notes (possible reasons)

7. In which of the last 10 years do you recall having the worst yield?

Year	Size Of Land	Yield	Notes (possible reasons)

8. Have you received any training on farming? Yes ☐ No ☐
9. If yes, which kind of training?

   ……

10. Who provided the training?

    ……

11. What would you consider to be the optimal land size for rice production for your household? ……(Acres)
12. Why this particular size? (Reasons)

INCOME

1. Do you have alternative sources of income? Yes ☐ No ☐

2. If yes mention and give the fraction they contribute to your total income?

	Source of income	Fraction of income
1		
2		
3		
4		

3. Is rice produced for commercial purposes or for self-consumption?

		Quantity in kg
1	Proportion Self-Consumptions	
2	Proportion Sell	

4. What are the main sales markets for rice?

		Quantity in kg
1	National Cereals Board	
2	National Irrigation Board	
3	SACCO (Rice farmers)	
4	Others	

5. During which month do most farmers normally sell their produce?

RISK

1. What are the primary production risks?

	Type(s)
a. Pests?	
b. Diseases?	
c. Weather?	
d. Lack of access to inputs?	
e. Other?	

2. What are the specific weather risks that rice production faces?

a. Drought?	
b. Excess rain?	
c. Temperature?	
d. Other?	

3. If farmers are exposed to weather risks, how do they currently manage them?
4. What are the current challenges facing the rice farmers?

Land Tenure evolution in the Last 50 years (Please tick (√) where applicable)

Please indicate the level of agreement that you have with the following statements on influence of Land Tenure evolution in the Last 50 years on rice production. *Key: 5-Strongly Agree; 4-Agree; 3-Undecided; 2-Disagree; 1-Strongly Disagree.*

Statement	**Mwean**	**SD**
Land tenure evolution in the Last 50 years has contributed to increased rice production;	3.6	2.0
Increased land tenants with in the last 50 years has contributed to increased rice production;	3.3	1.6
Reduced farm size per farmer has improved the quality and size of production	4.1	2.4
Increased household rice farmers in Mwea has increased rice production;	2.3	2.2
Increased private farmers in Mwea, in the last 50 years has reduced production of rice at Mwea irrigation scheme;	3.7	1.7

Land Tenancy and Rice Production (Please tick (√) where applicable)

6. Please indicate the level of agreement that you have with the following statements on influence of land tenure on rice production in Mwea irrigation scheme. *Key: 5-Strongly Agree; 4-Agree; 3-Undecided; 2-Disagree; 1-Strongly Disagree.*

Statement	**5**	**4**	**3**	**2**	**1**
Tenants of Mwea irrigation scheme receive farm tools and equipmwnts on time thus high production;					
Tenants of Mwea irrigation scheme receive farm chemicals on time thus high production;					
Farmers in Mwea Irrigation Scheme get their pay in advance thus improving the farmers' morale which boost rice production;					
Farmwers with small plots in the scheme use little					

inputs to produce high as per unit acrage;					
Farmers with vast plots in the scheme produce low/medium amount of rice;					
The amount of money paid per plot in the Mwea irrigation scheme affects rice production;					
The farmers' source of labour in the scheme affects rice production;					
Some farmers do note enrich their farms with required chemicals thus low production;					
Plots owned by the individuals have high rice production;					
Plots owned by the groups have high rice production;					

Tenant's Land Size and Rice Production (Please tick (√) where applicable)

7. Please indicate the level of agreement that you have with the following statements on influence of tenant's land size on rice production. *Key: 5-Strongly Agree; 4-Agree; 3-Undecided; 2-Disagree; 1-Strongly Disagree.*

Statement	**5**	**4**	**3**	**2**	**1**
Tenants with large plots of land in the scheme have low rice production;					
Tenants with small plots of land in the scheme have low rice production;					
Tenants with large plots of land in the scheme produce low quality paddy rice;					
Tenants with large plots of land produce low quality paddy rice;					
Tenants with large plots of land in the scheme have higher incomes compared to those with small plots;					

Tenants with large plots of land may have problems to purchase amount of required farm inputs thus low production;					
Tenants with small plots of land may can manage to purchase the required amount of farm inputs thus high production;					
Majority of the tenants with large plots of land may have difficulties to raise the lease fee thus affecting rice production;					
Tenants with large plots of land may have problems to maintain soil fertility low production;					
Tenants with large plots of land may have problems managing their farms druring dry season thus low production;					

AOB

1. Do you have any other information that would assist in this study?

Thank you for your time

APPENDIX II: QUESTIONNAIRE FOR MINISTRY OF AGRICULTURE

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

URBAN REGIONAL PLANNING THESIS

Analysis of land tenure and land subdivision trends on rice production in rice irrigation schemes in kenya: A case of Mwea Rice Irrigation Scheme, Thiba.

By: Kimari Cedric Reg No.: B63/81353/2012

Declaration: ***This information is confidential and it will be used purely for the academic purpose.***

Key informant questionnaire – Ministry of Agriculture

1. What is the name of the department in the county that deal with agriculture?
2. List key rice farming/production projects underway in the area:
3. List major rice farms in the area with their acreage:
4. What are the value adding activities to rice in the area?
5. How do you help rice farmers in area?
6. List any rice production subsidies offered to the farmers:
7. List the common types of diseases affecting the rice:
8. What is the level of access to agricultural loans?
9. What are some of activities do you organize for rice farmers?

10. What proportion is rice revenues for household incomes in the area?
11. What are the main sales markets for rice?
12. Which area is experiencing major subdivision on the rice farms?
13. What are the procedures of classifying/categorization of land in the area?
14. Are there ongoing projects in terms of titling and adjudication of land in the area?
15. Comment on emerging trends in rice farming?
16. List any probable opportunities:
17. List challenges facing rice production:

Thank you for your input

APPENDIX III: QUESTIONNAIRE FOR MINISTRY OF WATER

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

URBAN REGIONAL PLANNING THESIS

Analysis of land tenure and land subdivision trends on rice production in rice irrigation schemes in kenya: A case of Mwea Rice Irrigation Scheme, Thiba.

By: Kimari Cedric Reg No.: B63/81353/2012

Declaration: ***This information is confidential and it will be used purely for the academic purpose.***

Key informant questionnaire – Ministry of Water

1. What are the various sources of water in the scheme?
2. What is the current amount of water for irrigation supplied to the scheme?
3. State Current demand (2015) for water?
4. Challenges facing storm water drainage system?
5. The number of water projects in the scheme?
6. Number of projects completed and uncompleted?
7. Mention any Upgrading plans of any water projects?
8. Other potential water sources and locations?
9. Challenges facing water resources?

Thank you for your input

APPENDIX IV: QUESTIONNAIRE FOR NIB

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

URBAN REGIONAL PLANNING THESIS

Analysis of land tenure and land subdivision trends on rice production in rice irrigation schemes in kenya: A case of Mwea Rice Irrigation Scheme, Thiba.

By: Kimari Cedric Reg No.: B63/81353/2012

Declaration: ***This information is confidential and it will be used purely for the academic purpose.***

Key informant questionnaire – National Irrigation Board

1. What is your input in the rice irrigation scheme?

2. What are data available for residents on irrigation schemes or projects :

Irrigation Scheme or Project	Type of Data available

3. Is there a need for more data?
4. How do the rice farmers participate in decision making on water management?
5. Apart from rice irrigation, which others ways is the irrigation water used?
6. What policies and legal frame work are in place to improve the impact of irrigation in the area?
7. Any recommendation?

APPENDIX V: QUESTIONNAIRE FOR PPD

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

URBAN REGIONAL PLANNING THESIS

Analysis of land tenure and land subdivision trends on rice production in rice irrigation schemes in kenya: A case of Mwea Rice Irrigation Scheme, Thiba.

By: Kimari Cedric Reg No.: B63/81353/2012

Declaration: ***This information is confidential and it will be used purely for the academic purpose.***

Key informant questionnaire – Physical planning department

1. Do the rice farms have plans?

If yes which year were they prepared?

2. What are the areas that experience major subdivisions within the area?
3. What do you think is causing the subdivisions?
4. What is the optimal yield in the area?
5. What is the average yield in the area?
6. Explain the trend of development on the agricultural land over the years?
7. How relevant are rice revenues for households' incomes in the area?
8. What are the main sales markets for rice?
9. Give procedures and offices involved in subdivision approval in the area?

10. What are some of tools used to regulate subdivision of rice farms in the area? Are the tools efficient?
11. Mention current programs underway to improve rice production in the area?
12. Mention potential/ opportunities you see in the area?
13. What are the land based challenges facing rice farming in the area?
14. Any measures to mitigate these challenges?

Thank you for your input

APPENDIX VI: QUESTIONNAIRE FOR SACCOs

UNIVERSITY OF NAIROBI

DEPARTMENT OF URBAN AND REGIONAL PLANNING

URBAN REGIONAL PLANNING THESIS

Analysis of land tenure and land subdivision trends on rice production in rice irrigation schemes in kenya: A case of Mwea Rice Irrigation Scheme, Thiba.

By: Kimari Cedric Reg No.: B63/81353/2012

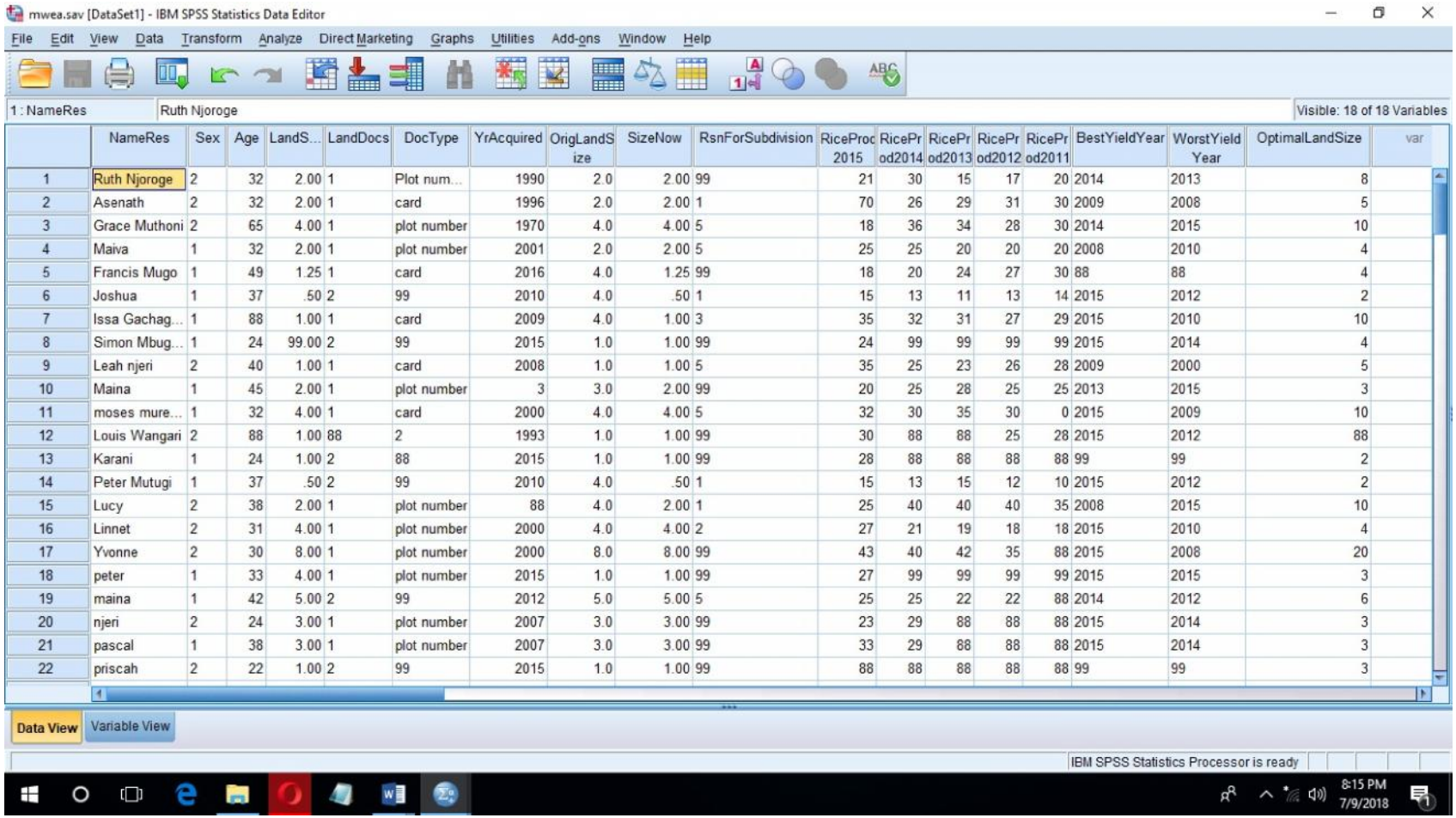
Declaration: ***This information is confidential and it will be used purely for the academic purpose.***

Key informant questionnaire – rice production SACCOs

1. What is the total number of members?
2. What is your legal status?
3. Brief history
    a) How did it form?
    b) Main facilitators to form the group?
4. What is the number of saccos in the area?
5. Comment on adherance of farming rules in the area by the farmers?
6. Comment on security in the rice farming?
7. Challenge facing the sector?
8. Mention recommendations to address above challenges?

Thank you for your input

APPENDIX VI: SPSS DATA



mwea.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Direct Marketing Graphs Utilities Add-ons Window Help

1 : NameRes | Ruth Njoroge | Visible: 18 of 18 Variables

	NameRes	Sex	Age	LandS...	LandDocs	DocType	YrAcquired	OrigLandSize	SizeNow	RsnForSubdivision	RiceProd2015	RiceProd2014	RiceProd2013	RiceProd2012	RiceProd2011	BestYieldYear	WorstYieldYear	OptimalLandSize	var
1	Ruth Njoroge	2	32	2.00	1	Plot num...	1990	2.0	2.00	99	21	30	15	17	20	2014	2013	8	
2	Asenath	2	32	2.00	1	card	1996	2.0	2.00	1	70	26	29	31	30	2009	2008	5	
3	Grace Muthoni	2	65	4.00	1	plot number	1970	4.0	4.00	5	18	36	34	28	30	2014	2015	10	
4	Maiva	1	32	2.00	1	plot number	2001	2.0	2.00	5	25	25	20	20	20	2008	2010	4	
5	Francis Mugo	1	49	1.25	1	card	2016	4.0	1.25	99	18	20	24	27	30	88	88	4	
6	Joshua	1	37	.50	2	99	2010	4.0	.50	1	15	13	11	13	14	2015	2012	2	
7	Issa Gachag...	1	88	1.00	1	card	2009	4.0	1.00	3	35	32	31	27	29	2015	2010	10	
8	Simon Mbug...	1	24	99.00	2	99	2015	1.0	1.00	99	24	99	99	99	99	2015	2014	4	
9	Leah njeri	2	40	1.00	1	card	2008	1.0	1.00	5	35	25	23	26	28	2009	2000	5	
10	Maina	1	45	2.00	1	plot number	3	3.0	2.00	99	20	25	28	25	25	2013	2015	3	
11	moses mure...	1	32	4.00	1	card	2000	4.0	4.00	5	32	30	35	30	0	2015	2009	10	
12	Louis Wangari	2	88	1.00	88	2	1993	1.0	1.00	99	30	88	88	25	28	2015	2012	88	
13	Karani	1	24	1.00	2	88	2015	1.0	1.00	99	28	88	88	88	88	99	99	2	
14	Peter Mutugi	1	37	.50	2	99	2010	4.0	.50	1	15	13	15	12	10	2015	2012	2	
15	Lucy	2	38	2.00	1	plot number	88	4.0	2.00	1	25	40	40	40	35	2008	2015	10	
16	Linnet	2	31	4.00	1	plot number	2000	4.0	4.00	2	27	21	19	18	18	2015	2010	4	
17	Yvonne	2	30	8.00	1	plot number	2000	8.0	8.00	99	43	40	42	35	88	2015	2008	20	
18	peter	1	33	4.00	1	plot number	2015	1.0	1.00	99	27	99	99	99	99	2015	2015	3	
19	maina	1	42	5.00	2	99	2012	5.0	5.00	5	25	25	22	22	88	2014	2012	6	
20	njeri	2	24	3.00	1	plot number	2007	3.0	3.00	99	23	29	88	88	88	2015	2014	3	
21	pascal	1	38	3.00	1	plot number	2007	3.0	3.00	99	33	29	88	88	88	2015	2014	3	
22	priscah	2	22	1.00	2	99	2015	1.0	1.00	99	88	88	88	88	88	99	99	3	

Data View | Variable View

IBM SPSS Statistics Processor is ready

8:15 PM 7/9/2018