DETERMINANTS OF RICE PRODUCTION IN AHERO IRRIGATION SCHEME IN KISUMU COUNTY, KENYA

BY

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DECLARATION

This thesis is my original work and has not been submitted for the award of a degree in any other university.

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DEDICATION

This work is dedicated to my loving husband Simon Ogal and to my parents Erick Obwa and Benta Achieng’ with love and appreciation.

ABSTRACT

Rice is a staple food for more than half of Kenya's population. Its annual consumption has increased to 300,000 metric tonnes against annual production of 80,000 metric tonnes making it necessary to increase production to meet the deficit. Despite irrigation and high yielding rice varieties introduced by the Kenyan government, the deficit is yet to be bridged. As studies show, possible determinants of rice production such as fertilizer quantity, farm size, education level and age of the farmers have given conflicting results. Some give positive relationships while others negative relationships. However, within Ahero irrigation scheme there is limited information concerning the determinants of rice production. The study purposed to analyze the determinants of rice production within Ahero Irrigation Scheme in Kisumu County, Kenya. The specific objectives were to: Determine the effect of fertilizer quantity on rice output; determine the relationship between farmers' education levels and rice output; establish the relationship between farm size and rice output and determine the relationship between farmers' age and rice output. The study was based on production theory and correlation research design. The target population was 274 rice farmers. 160 farmers were selected through simple random sampling. Primary data was obtained by questionnaires administration. Instrument Validity was tested using agricultural economists while reliability using Cronbach's Alpha and the results showed a reliability coefficient of 0.709. Multiple regression analysis was used to establish the relationship between the dependent and independent variables and the results indicated that the coefficient of fertilizer quantity is statistically significant at 5% (Coefficient = 0.624; p =0) while the levels of education (Coefficient -0.029; p = 0.521), farm size (Coefficient = 0.014; p = 0.802) and age (Coefficient = 0.115; p = 0.180), were not significant at 5%. The R^2 = 0.34 meaning that 34% of the variation in output level is explained by the independent variables. F-statistics (coefficient= 19.837; p = 0.000) was significant at 5% implying that the chosen determinants are important in determining rice output. The study recommended that farmers should apply 31 to 40kgs/acre of fertilizer; more individuals with college education should join rice farming; area under rice cultivation should be increased and those with ages of 21 to 30 should be encouraged to join rice farming. This study may be significant in enhancing knowledge and understanding of the determinants of rice production which may help in prescription of policies designed to influence the efficiency of rice production.

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LIST OF ABBREVIATIONS

ASARECA	: Association for Strengthening Agricultural Research in Eastern and Central Africa
ASDS	: Agriculture Sector Development Strategy
CAADP	: Comprehensive African Agricultural Development Program
EAC	: East African Community
ECARRN	: Eastern and Central Africa Rice Research Network
ERS	: Economic Recovery Strategy
EUCORD	: European Cooperative for Rural Development
FAO	: Food and Agriculture Organization
FARA	: Forum for Agricultural Research in Africa
G.O.K	: Government of Kenya
Ha	: Hectare
IRRI	: International Rice Research Institute
K.N.B.S	: Kenya National Bureau of Statistics
MDG	: Millennium Development Goals
NCPB	: National Cereals and Produce Board
NEPAD	: New Partnership for Agriculture Development
NFNSP	: National Food and Nutrition Security Policy
NIB	: National Irrigation Board
NRDS	: National Rice Development Strategy
PRSP	: Poverty Reduction Strategy Paper
RECA	: Rural Environmental Care for Africa
WARDA	: West Africa Rice Development Association

OPERATIONAL DEFINITION OF TERMS

Production: It is a process of combining various material inputs in order to make something for consumption. It is the act of creating output, a good or service which has value and contributes to the utility of individuals.

Level of education: Refers to the stages of education i.e. primary, Secondary and university.

Determinants: These are things that decide how something happens. It can also be defined as a factor which decisively affects the nature or outcome of something.

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CHAPTER ONE

INTRODUCTION

This was a research study on the determinants of rice production within Ahero irrigation scheme in Kisumu County, Kenya. This chapter explored the background of the study, problem statement, research objectives, hypothesis, the scope as well as the significance of the study.

1.1 Background of the study

Rice is an integral part of human history. International Rice Research Institute [IRRI], (1992) asserts that rice is an annual crop and the most important staple food crop in tropical countries. They asserted that rice is the most important cereal after wheat since it is widely consumed and there is hardly any country in the world where it is not utilized in one form or the other. According to National Rice Development Strategy [NRDS], (2008-2018), annual rice consumption in Kenya is estimated at 300,000 metric tonnes against annual production estimated at 80,000 metric tonnes. At market equilibrium, the quantity of a commodity demanded should equal the quantity supplied but in this case the rice demand is far much higher than the rice supply. The government of Kenya has laid more emphasis in the provision of irrigation water and rice varieties to the farmers but still this has not helped to reduce the gap between rice demand and supply (NIB, 2008). Various studies that have been conducted in the past have given conflicting results on the possible determinants of rice production on rice output in that some give a positive relationship while others give a negative relationship between the determinants of rice production and rice output. However, within Ahero irrigation scheme there is limited information concerning the determinants of rice production. This has brought confusion to farmers regarding the exact factors that can result into an increase in rice production within Ahero irrigation scheme.

Food and Agriculture Organization [FAO], (1995) states that rice is by far the most economically important food crop in many developing countries, providing two thirds of the calorie intake for more than 3 billion people in Asia, and one third of the calorie intake of nearly 1.5 billion people in Africa and Latin America. They assert that stagnant or even declining yields, land degradation and environmental pollution in some irrigated areas have raised concern regarding the long-term sustainability of such production and productivity but recommended that the world's rice production still has space for improvement through increasing land productivity and raising its yield potential.

According to Food and Agriculture Organization Statistics [FAOSTAT], (2001), the world's rice growth rate has declined from 400 million metric tonnes to 335 million metric tonnes since 2000 and it has been less than the world rice consumption. They assumed that the world's population was projected to increase from 6.13 billion in 2001 to 8.27 billion in 2030 while rice demand was projected to increase from 571.9 metric tonnes in 2001 to 771.1 metric tonnes in 2030. According to IRRI (2006), rice consumption within South East Asia alone is projected to increase by 11 percent by 2015. They assert that, average growths in rice yields per hectare have not kept up with population increase and demand, and have in fact decreased substantially over the past 15 years. Ito, (2002) argued that rice remains the most favoured grain globally for human consumption. According to World Food Summit [WFS], (1996) development of rice therefore presents an opportunity to reduce the number of gravely food insecure people that stand at 816 million by half by 2015 - Millennium Development Goals (MDG).

According to IRRI (2010), rice production in Africa has grown rapidly but its consumption has grown even faster with the balance being met by increasing quantities of imports. The report found out that Western Africa is the main producing sub region accounting for more than 40% of African production in 2006-2008. In terms of individual countries, the leading producers of rice (2006-08) are Egypt (7.0 million tons), Nigeria (3.8 million tons), and Madagascar (3.2 million tons). Further, the report asserted that the remaining 60% of rice output is produced by other African countries but still this amount of rice produced by the African countries including Kenya is not enough for the rapidly increasing population in Africa and as a result the deficit is met by importing more rice.

In Kenya, rice is one of the few food items whose consumption has no cultural, religious, ethnic or geographical boundary. According to National Irrigation Board [NIB], (2008) the production of rice is dwindling. They assert that to increase the production of rice, the Government of Kenya through the National Irrigation Board should introduce a number of agricultural development programmes/projects to ensure that water is available for irrigation purposes. This is because about 95 per cent of rice in Kenya is grown under irrigation in paddy schemes managed by the National Irrigation Board (NIB) and the remaining five per cent is rain fed. Further they assert that the average unit production under irrigation is 5.5 tonnes a hectare for the aromatic variety and seven tonnes for non-aromatic varieties. According to them, unit yield for rain-fed rice production is slightly below two tonnes a hectare.

According to the Kenya Integrated Household Budget Survey Basic Report [KIHBSBR], (2005-06), rice in Kenya is grown on a total area of 29,510 acres out of which 26,008 acres is rural whereas 3,502 acres is urban. Government of Kenya [GOK],(2005-06) asserts that this total acreage can further be broken down as 21,474 acres in former Central Province; 5,091 acres in former Coast Province; 2,422 acres in former Nyanza and 524 acres in former Western Province .This includes rice grown both in irrigated and non-irrigated areas. West Africa Rice Development Association [WARDA], (2005) believed that rice deficit in Kenya is attributed to progressive change in eating habits. Per capita rice consumption in Kenya was estimated to be between 10-18 kg per capita per year in figures from 2005. It is expected that the demand for rice in the country will continue to rise in the future, (WARDA, 2005).

Table 1.1 Shows the national rice output and consumption trends from 2001 -2007.

Table 1.1: Rice output and consumption in Kenya, 2001-2007

Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Area (ha)	13,200	13,000	10,781	13,322	15,940	23,106	16,457
Output (Tones)	44,996	44,996	40,498	49,290	57,941	64,840	47,256
Unit price (per ton)	26,250	16,060	58,000	65,000	68,000	70,000	53,000
Average yield (tons/ha)	3.4	3.4	3.7	3.6	3.6	2.8	2.8
Consumption (tons)	238,600	247,560	258,600	270,200	279,800	286,000	293,722
Import (tons)	201,402	208,944	213,342	223,190	228,206	NA	NA
Total Value (Billion KES)	1.2	0.7	0.7	1.3	0.9	3.3	2.7

Source: National Rice Development Strategy [NRDS], (2008-2018).

According to [NRDS], (2008-2018),the total amount of rice produced in Kenya is not enough for the population due to the increased rice consumption which is as a result of increasing demand. This therefore calls for increasing the agricultural production capacity to match the population growth. In addition, Thairu (2010) stated that Kenya is a signatory to the United Nations Millennium Development Goals [MDGs] which are internationally agreed targets for tracking developmental progress in member countries. MDG goal number one talks of eradicating extreme poverty and hunger by 2015. He asserts that if Kenya is to achieve this goal, a lot of effort and investments needs to be done in the agricultural sector in order to move the country from a food deficit nation to a food surplus nation.

According to NIB (2008), Ahero irrigation scheme covers an area of 2168 acres and land holding system is by individual on small scale. The seedling varieties grown include: Basmati 370 (aromatic variety), IR 2793 and IPA 310 which are non aromatic varieties. They also stated that the factors that favored location of the scheme are: Availability of irrigation water i.e. River Nyando, fertile & suitable soils for growing crops e.g. rice, available labour to engage in agriculture, ready market for crops produced and need to control the flood waters of River Nyando. The irrigation board provides the following to the farmers: water, loans which are refunded back at the rate of 8% interest, varieties of rice seedlings, extension services. With the restructuring of NIB to provide operation and maintenance services, farmers are left with the responsibilities of paying for operation and maintenance, managing their own crops, and marketing.

Despite all these effort put by the NIB to help increase the rice output, the total rice production within the country which is estimated at 80,000 metric tonnes is still far much below the consumption level which is also estimated at 300,000 metric tonnes, (NRDS,2008-2018). This shows that there is a deficit that is taken care of by importing more rice while on the other hand Kenya has a potential of producing more rice to cater for this deficit. KNBS (2007) found out that within Ahero Irrigation scheme, rice production is estimated at below 20%. To bridge this deficit, the Government of Kenya tends to lay more emphasis on irrigation and rice varieties to help in increasing the rice output but rice production is a function of many factors not limited to just irrigation and credit facilities. This study seeks to look at other determinants of rice production so as to help increase rice output within the scheme since by increasing rice production within the scheme the rice deficit within the Nation can be catered for thus making Kenya become a food sufficient Nation.

Most of the studies conducted in the past show different relationships that exist between various determinants of rice production and rice output. Regarding the relationship between fertilizer quantity and rice output, FAO, (1981) noted that fertilizers are probably the most important input leading to increasing yields and their use expands more rapidly on irrigated land than on rain fed land. However, their study did not take into account the exact quantity of fertilizer applied per acre but instead looked at the fertilizer use which is not specific. According to Mbam and Edeh, (2011) there is a positive relationship between fertilizer quantity and rice output.

In Kenya, Omondi and Shikuku, (2013) observed that there is a positive relationship between fertilizer quantity and rice output in that when the fertilizer quantity is increased, the rice output increases. However, in their study, they did not carry out cross tabulation to find out the exact quantity of fertilizer that increases the rice output more.

Regarding the relationship between levels of education and rice output Pudasaini, (1983), observed that education level of the farmers improves agricultural production by improving the decision making ability of the farmers. On the other hand, Mbam and Edeh, (2011) found out that there is a positive relationship between years of education and rice output in that if the levels of education increases then the level of output also increase. However, in their study they looked at the years of education which might not contribute to increased rice output since an individual can spend several years in the same class resulting into many years of school.

According to Omondi and Shikuku, (2013) there is a positive relationship between levels of education and rice output. They posit that, better education promotes the adoption and use of yield-increasing technologies/inputs and encourages more efficient farm management practices. In their study, they recommended that efforts should be directed towards encouraging farmers to embrace the various forms of formal education available in the area.

Kalirajan and Shand (1985), in their case study of rice farmers from Tamil Nadu who argued that even though the level of schooling affects production, the level of education of farmers is not necessarily significantly related to the level of yield because even farmers who are illiterate or semi-illiterate can still understand the technology of modern production the same way their educated counterparts can on condition that the said technology is properly communicated However, in these studies, cross tabulation was not conducted to find out the level of education that increases rice output the most.

Concerning the relationship between farm size and rice output Pandey and Suresh, (2007) in their report on food policy in India observed that between 1971 to 1990 there was a strong growth in production of rice that was attributed to the growth of area under cultivation thus the issue of land is very important if high productivity levels are to be achieved.

According to Okoye *et. al* (2008), there is a negative relationship between farm size and rice output. They concluded that the negative relationship is as a result of differential factor use intensity. Thus if a farm is small in size, the farmers are able to combine their resources better in order to increase rice output.

Thairu, (2010) in his study on agricultural production and irrigation management in Kenya, established that farm size has a negative coefficient meaning that the smaller the plots the higher the yields. This can be understood by the labour intensity of rice production since the smaller the plot the more effort the tenant can spend per ha. In these studies, farm size shows different relationships with rice output where some studies give positive relationship of farm size with rice output while others negative relationships with the rice output.

Regarding the age of the farmers and rice output, Umeh and Ataborh, (2006) observed that young people are energetic and highly productive agriculturally. However, they subjected their study to 1% level of significance which is too high for social sciences. According to Ayoola, (2011), age influences rice output such that the older the farmer, the higher the output due to increased level of experience. According to

Omondi and Shikuku, (2013) in their study on technical efficiency of rice farmers in Ahero irrigation scheme, rice farming is mainly practiced by older farmers.

From the above studies, the results are found to be conflicting and this indicates that the discussed determinants of rice production vary from one environment to another. It is on this basis that the study focused on the determinants of rice production within Ahero irrigation scheme where rice output is low. Since by looking at these determinants of rice production within Ahero irrigation scheme, the rice output can be increased and this can help bridge the gap between the rice demand and supply in Kenya.

1.2 Statement of the problem

The domestic demand for rice in Kenya is increasing rapidly as depicted by the annual consumption growth rate of 12% which is estimated at 300,000 metric tonnes against annual production of 80,000 metric tonnes. This therefore makes it necessary to increase rice production to meet the deficit. At market equilibrium, the quantity of a commodity demanded should equal the quantity supplied but in this case the rice demand is far much higher than the rice supply. The government of Kenya has laid more emphasis in the provision of irrigation water and rice varieties to the farmers but still this has not helped to reduce the gap between rice demand and supply. Various studies that have been conducted in the past have given conflicting results on the possible determinants of rice production on rice output in that some give a positive relationship between the determinants of rice production and rice output while others give a negative relationship. This has led to confusion in establishing the factors and the magnitude of their effects on rice production within Ahero irrigation scheme. However, within Ahero irrigation scheme there is limited information concerning the determinants of rice production. It is on this basis that the study set out to identify and analyze the determinants of rice production within Ahero irrigation scheme in Kisumu County, Kenya in order to establish those factors that significantly influence rice output in the scheme for policy review.

1.3 Objectives of the study

The major objective of this study was to analyze the determinants of rice production at Ahero Irrigation Scheme in Kisumu County, Kenya.

Specific objectives

The study was guided by the following specific objectives:

1. To determine the effect of fertilizer quantity on rice output in Ahero irrigation scheme.
2. To determine the relationship between levels of education of farmers and rice output in Ahero irrigation scheme.
3. To establish the relationship between farm size and rice output in Ahero irrigation scheme.
4. To determine the relationship between age of the farmers and rice output in Ahero irrigation scheme.

1.4 Hypotheses

$H_0 : a_1 = 0$: There is no effect of fertilizer quantity on rice output

a_1 is the coefficient of fertilizer quantity

$H_0 : a_2 = 0$: There is no relationship between levels of education of rice farmers and rice output.

a_2 is the coefficient of levels of education of farmers

$H_0 : a_3 = 0,$: There is no relationship between farm size and rice output.

a_3 is the coefficient of farm size

$H_0 : a_4 = 0,$: There is no relationship between age of the farmers and rice output.

a_4 is the coefficient of age of the farmers.

1.5 Scope of the study

The study focused on the determinants of rice production within Ahero irrigation scheme namely: fertilizer quantity, levels of education of farmers, farm size and age of the farmers. The study also targeted the rice farmers within Ahero irrigation scheme in Kisumu County, Kenya. It was conducted between August 2014 and October 2014 through correlation research design. The study was conducted on 160 rice farmers selected from 274 rice farmers within the scheme. The data was collected by the researcher using questionnaires.

1.6 Significance of the study

This study is significant in that it brings on board a practical situation that requires investigation. From the investigation, it will enhance our knowledge and understanding on the determinants of rice production, such knowledge may be useful input in the prescription of policies designed to influence the efficiency of rice production. The study can also form a basis for future researchers who would like to carry out research in the same area. The farmers from the irrigation scheme will also benefit in the following ways: food security, employment creation and wealth creation thereby improving living standards (e.g. Health, Education, Shelter, and Economy). The improved rice production will lead to sustainable supply of raw materials for agro-based industries.

1.7 Justification of the study

The study provides additional insights into the way determinants of rice production affects rice output within Ahero irrigation scheme. Kenya is experiencing shortage of rice supply despite the existence of many irrigation schemes hence there is need to investigate the determinants of rice production in Ahero irrigation scheme. The knowledge obtained may then be applied by the rice farmers in increasing rice production..

1.8 Theoretical frame work

According to Oso and Onen (2011), a theoretical framework refers to a set of interrelated variables, definitions and propositions that present a systematic view of a phenomenon by specifying relations among variables in order to explain a phenomenon. The theoretical framework illustrates how the determinants of rice production influence rice output. This is modeled to illustrate two sets of variables in the rice regression model, i.e. the independent variables: fertilizer quantity, levels of education of the farmers, farm size, age of the farmers, and the dependent variable is rice output. The relationship can be expressed as shown below:

$$Y = f(X_1, ..., X_4, £) \qquad \text{……………………………..1.1}$$

Where Y - Rice output

X_1 - Age of the rice farmer

X_2 -farm size

X_3 – Levels of education of the rice farmer

X_4 – Quantity of Fertilizer applied in rice field

£ – Error term

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This section focuses on theoretical literature and empirical literature. Theoretical literature looks at the theory on which the study is based on while empirical literature looks at the previous studies that have been done by other scholars around the world on the factors that affect rice production.

2.2 Theoretical review

2.2.1 Theory of production

This theory was developed by Cobb-Douglas between 1927 and 1947. It is the study of production, or the economic process of converting inputs into outputs. Production uses resources to create a good or service that is suitable for use, gift-giving in a gift economy, or exchange in a market economy. This can include manufacturing, storing, shipping, and packaging. Production refers to all economic activity other than consumption. They see every commercial activity other than the final purchase as some form of production.

Production is a process, and as such it occurs through time and space. Because it is a flow concept, production is measured as a “rate of output per period of time”. There are three aspects to production processes: the quantity of the good or service produced the form of the good or service created and the temporal and spatial distribution of the good or service produced.

A production function defines the relationship between inputs and the maximum amount that can be produced within a given time period with a given technology. Mathematically, the production function can be expressed as:

$Q=f(X_1, X_2,...,X_k)$ …………………………(2.1)

Where:

Q is the level of output

$X_1, X_2,..., X_k$ are the levels of the inputs in the production process.

For simplicity, a production function of two inputs is often considered:

$Q=f(X, Y)$ …………………………..(2.2)

Where:

Q- Is output

X- Is Labor

Y- Is Capital

In economics, the Cobb–Douglas production function is a particular functional form of the production function widely used to represent the technological relationship between the amounts of two or more inputs, particularly physical capital and labor, and the amount of output that can be produced by those inputs. The Cobb-Douglas form was developed and tested against statistical evidence by Charles Cobb and Paul Douglas during (1927–1947). In its most standard form for production of a single good with two factors, the function is

$Y = AL^{\beta}K^{\alpha}$ 2.3

Where:

Y = total production (the real value of all goods produced in a year)

L = labour input (the total number of person-hours worked in a year)

K = capital input (the real value of all machinery, equipment, and buildings)

A = technical factor productivity

α and β are the output elasticities of capital and labour, respectively. These values are constants determined by available technology.

If $\alpha + \beta = 1$, ...2.4

the production function depicts constant returns to scale, meaning that doubling the usage of capital K and labour L will also double output Y.

If $\alpha + \beta < 1$, ...2.5

the production function depicts decreasing returns to scale, and if

$\alpha + \beta > 1$ 2.6

the production function represents increasing returns to scale. Assuming perfect competition and $\alpha + \beta = 1$, α and β can be shown to be capital's and labour's shares of output.

Taking natural logarithms of (2.3) will yield a linear functional form:

$$\ln Y = a_0 + \quad \ln L + \sim \ln K \qquad \text{...} (2.7)$$

Where: a_0 is *ln*A

L is Labour

K is Capital

Output elasticity measures the responsiveness of output to a change in levels of either labour or capital used in production, ceteris paribus. The study adopted the production theory because rice output is a function of various determinants of rice production.

The advantages of using the Cobb-Douglas function are: It allows computation of returns to scale: constant, increasing or decreasing. Second, the estimated coefficient of an input from a linearized Cobb-Douglas function is the direct elasticity of the input. It is widely used in empirical work.

Cobb and Douglas were influenced by statistical evidence that appeared to show that labor and capital shares of total output were constant over time in developed countries; they explained this by statistical fitting least-squares regression of their production function. There is now doubt over whether constancy over time exists.

2.3 Empirical Literature

Ngigi (2002) observed that in Kenya for the last 25 years, the production from agriculture has not matched the increasing population. Therefore development of irrigation is noted as one of the largest potential for addressing this challenge despite the high costs involved. According to Thairu (2010), there are several factors that affect rice production in irrigation schemes. Some of these factors include: the total area under cultivation, management structure of the scheme, age of the farmers, farm size, water availability, pesticides, herbicides, education level of farmers, fertilizer use and labour.

Availability of water plays a vital role on the performance of an irrigation project and also indirectly influences the cost of the project. Innocencio *et. al* (2007) used annual rainfall and conjunctive use of surface water and underground water as a proxy for water availability and found that in Sub Saharan Africa, the irrigation projects located in areas with more water available have a tendency of being smaller in size and don't require storage facilities. However, there is need to govern water use, as Bardhan (2000) found that water reform was crucial in building community institutions of cooperation. In his study of farmers in India, he found that Indian farmers set formal water rights opposed to customary rights which in turn increased their probability of cooperation. In addition, water availability also has an influence on the types of crops chosen and corresponding varieties and which has an impact on the performance of the irrigation project.

2.3.1 Effect of fertilizer quantity on rice output

Fertilizer quantity affects rice output. According to Mbam and Edeh (2011) in their study on determinants of farm productivity among small holder rice farmers in Anambra state, Nigeria they used a sample of 120 rice farmers which was selected using random sampling technique. They used a structured questionnaire to collect information from which they found out the coefficient of fertilizer quantity to be 2.208 which shows that there is a positive relationship between fertilizer quantity and rice output. They recommended that credit in the form of fertilizer and improved rice varieties should be made available to farmers at the appropriate time. Even though they found out that there is a positive relationship between the fertilizer quantity and rice output, they did not conduct the cross tabulation between fertilizer quantity and rice output to find out the fertilizer quantity that leads to increase in rice output by a bigger margin.

Food and Agriculture Organization [FAO], (1981) noted that “after land and water, fertilizers are probably the most important input leading to increasing yields, and they were responsible for some 55% of the increase in yields in developing countries between 1965 and 1976”. It further noted that the use of fertilizer expands most rapidly on irrigated land where the returns are greatest, and much more slowly on rain fed land, especially in low-rainfall areas. However, the study did not take into account the exact quantity of fertilizer applied per acre but instead looked at the fertilizer use which is not specific.

According to Mabe *et. al* (2012) in their study on adaptive capacities of farmers to climate change adaptation strategies and their effects on rice production in the northern region of Ghana used structured questionnaire to collect data from 150 rice farmers. In their study, they found out that the quantity of fertilizer applied is significant at 1% and that the quantity of fertilizer significantly affects rice output in the study area in that an increase in fertilizer quantity by 1% increases the rice output by 0.18%. They recommended that the quantity of fertilizer used should be increased so as to increase the rice output. However, their study was subjected to 1% level of significance which is too high for social science study while in this study 5% level of significance which is recommended for social science study was used.

According to Omondi and Shikuku (2013) in their study on Technical efficiency of rice farmers in Ahero irrigation scheme they established that there is a positive relationship between fertilizer quantity (0.085) and rice output in that when the fertilizer quantity is increased, the rice output increases. They used a sample of 220 rice farmers who were selected using stratified sampling technique and the data was collected using structured questionnaire. They also used correlation research design to establish the relationship between the dependent and the independent variables. In their study, they recommended that the policies should aim at reducing the cost of fertilizer in order to enable the rice farmers' increase their usage. However, in their study they did not conduct cross tabulation of data to determine the actual quantity of fertilizer that increases the rice output more.

2.3.2 Relationship between levels of education of rice farmers and rice output

Other studies argue that the level of education of a farmer also affects rice output. Pudasaini (1983) in his study on effects of education on agriculture in Nepal observed that education contributed to agricultural production in Nepal both through worker and allocative effects, further noting that although education improves agricultural production by making better the ability of the farmers in decision making, it differs from one environment to another.

Schultz (1975) in his study on the value of the ability to deal with disequilibrium proposed that education improves a household's ability to efficiently adjust production decisions during periods of change. Along similar lines, Welch (1970) in his study on education and production suggested that education may have two distinct effects. First, education may enhance a worker's ability to produce more with the given resources, the so-called "worker effect" (productivity effect). Second, education may improve the worker's ability to select the mix of inputs, the so-called"allocative effect."

Kalirajan and Shand (1985) in their study on the types of education and agricultural productivity in Tamil Nadu- India however makes a counter argument that even though the level of schooling affects production, the level of education of farmers is not necessarily significantly related to the level of yield because even farmers who are illiterate or semi-illiterate can still understand the technology of modern production the same way their educated counterparts can on condition that the said technology is properly communicated. Using a case study of rice farmers from Tamil Nadu, Kalirajan and Shand (1985), analyzed the various education types in relation with production in an endeavor to determine whether farmers' schooling had a bigger influence on the level of yield in comparison to non-formal education. They found that schooling (educational level) of the farmers had an independence on yield though it was insignificant, and a farmer's non-formal education had a significant and bigger influence on the yield thereby concluding that the farmers' level of schooling and production should not always be significantly related.

According to Omondi and Shikuku (2013) in their study on technical efficiency of rice farmers in Ahero irrigation scheme, they found out that there is a positive relationship between levels of education (-0.007) and rice output. According to them, as the levels of education increases, the rice output increases. In their study, they used a sample of 220 rice farmers that were selected using stratified sampling technique and they also used the questionnaires to collect the information. They also used the correlation design to establish the relationship between the dependent variables and the independent variables.

However, the findings of Mbam and Edeh (2011) in their study on determinants of farm productivity among small holder rice farmers in Anambra state, Nigeria showed that there is a positive relationship between years of education (5.339) and rice output in that if the years of education increases then the level of output also increase. According to them, better education promotes the adoption and use of yield-increasing technologies/inputs and encourages more efficient farm management practices. They used a sample of 120 rice farmers which was selected using random sampling technique and structured questionnaires were used to collect information. In their study, they recommended that efforts should be directed towards encouraging farmers to embrace the various forms of formal education available in the area. However, this positive relationship may not be a reality because an individual may spend several years in the same class resulting into many years of school, a situation which might not contribute to the increase in rice output.

Ankbile (2007) in his study on determinants of productivity level among rice farmers in Ogun state, Nigeria also argued that there is a positive relationship between levels of education of rice farmers (0.133) and rice output. In his study, he used the structured questionnaires that were administered to 120 randomly sampled rice farmers. He therefore recommended the need to enhance their knowledge of improved rice cultivation practices through extension education to help improve the productivity level achieved by rice farmers.

According to Umeh and Ataborh (2006) in their study on efficiency of rice farmers in Nigeria there is a positive relationship between levels of education of the farmers (0.20) and rice output in that rice output increases with increase in levels of education. In their study, they used a sample of 300 rice farmers who were selected using random sampling technique and the data was collected using the structured questionnaires. The data were then correlated to establish the relationship between the dependent and the independent variables. They recommended that the government should improve rice farmers' access to education. However, they subjected their study to 1% level of significance which is too high for social sciences. In the studies above concerning the levels of education of the rice farmers, cross tabulation of the variables was not done to find out which level of education affects rice output by a bigger margin.

2.3.3 Relationship between farm size and rice output

According to Mabe *et. al* (2012) in their study on adaptive capacities of farmers to climate change adaptation strategies and their effects on rice production in the northern region of Ghana in which they used structured questionnaire to collect data from 150 rice farmers. They found out that the number of hectares of land cultivated is significant at 1% implying that farm size affects rice output hence an increase in farm size by 1% increases the quantity of rice output. They therefore recommended that the farm size should be increased in order to increase the rice output. However, their study was subjected to 1% level of significance which is too high for social science study while in my study I used 5% level of significance which is recommended for social science study.

Pandey and Suresh (2007) in their report on food policy in India observed that between 1971 to1990, there was a strong growth in production of rice which was attributed to the growth of the area under cultivation. Therefore the issue of land is very important if high productivity levels are to be achieved. There is need therefore to guarantee individual secure rights to individual farmers since the attachment to land is profound. However, in their study they looked at the area under cultivation which can refer to a big area where even other crops apart from rice can be grown while this study looked at the farm size where only rice is grown.

Todaro and Smith (2009) in their study on economic development in the third world countries observed that "it is for reasons of higher agricultural output and the simultaneous achievement of both greater efficiency and more equity that land reform is often proposed as a necessary first condition for agricultural development in many LDCs. Land reform involves the redistribution of the rights of ownership or use of land away from the large owners to cultivators with limited or no holdings, for example the appropriation of large estates for new settlement in Kenya."

According to of Mbam and Edeh (2011) in their study on determinants of farm productivity among small holder rice farmers in Anambra state, Nigeria there is a negative relationship between farm size (-1.758) and rice output. In their study, they used a sample of 120 rice farmers which was selected using random sampling technique and structured questionnaires were used to collect information

On the other hand Ankbile (2007) in his study on determinants of productivity level among rice farmers in Ogun state, Nigeria found out that there is a positive relationship between farm size (0.489) and rice output. In his study, he used the structured questionnaires that were administered to 120 randomly sampled rice farmers. He therefore recommended that there is need to encourage rice farmers to open up new areas of land for rice cultivation to increase their farm size as farm size has the tendency of propelling the rice farmers to be more productive.

According to Thairu (2010) in his study on agricultural production and irrigation management in Kenya, farm size has a negative coefficient meaning that the smaller the plots the higher the yields. This can be understood by the labour intensity of rice production since the smaller the plot the more effort the tenant can spend per ha.

2.3.4 Relationship between age of the farmers and rice output

Some studies reveal that age of the farmers affect the level of rice output. According to Umeh and Ataborh (2006) in their study on efficiency of rice farmers in Nigeria there is a negative relationship between age of the farmers (-0.05) and rice output in that rice output declined with increase in age. They also argued that young people are still strong and full of energy to make meaningful impact in agricultural production. In their study, they used a sample of 300 rice farmers who were selected using random sampling technique and the data was collected using the structured questionnaires. The data were then correlated to establish the relationship between the dependent and the independent variables. . However, their study was subjected to 1% level of significance which is too high for social science study while in this study 5% level of significance which is recommended for social science study was used.

Ankbile (2007), in his study on productivity level among rice farmers in Ogun State Nigeria found that there is a negative relationship between age of the farmers and rice output. He also argued that the young people are said to be in their productive age and are able to cope with the severity of rice production and this might have a positive influence in the level of rice output. However in his study the age of the farmers regarded as young is not clear due to lack of cross tabulation.

According to Omondi and Shikuku (2013) in their study on technical efficiency of rice farmers in Ahero irrigation scheme, rice farming is mainly practiced by older farmers. In their study, there is a positive relationship between age of the farmers and rice output. In their study, they used a sample of 220 rice farmers that were selected using stratified sampling technique and they also used the questionnaires to collect the information.

The amount of labour hired is another factor that affects rice output. Noij and Niemeijer (1988) in their study of residents tenants at the Ahero irrigation scheme observed that “by varying the amount of labour hired, or optimizing the moment at which labour is hired, they can try to increase paddy yields. But most studies as stated by Noij and Niemeijer (1988) fail to take into account that apart from the amount of labour, the tenants in these schemes could still increase the level of their yields but emphasizing on the quality of labour. In other words the level of yield could still be increased by upgrading the techniques used in the cultivation of rice.’’ Wade (1989) argues in ‘Economic conditions for collective action in South India’, that the degree of scattering of the holdings also affects the performance of irrigation schemes. This is because “if holdings are not scattered, the externalities of water use are ‘uni-directional’ that is the actions of irrigators with land at the head of the block impose costs on those towards the tail, but not vice-versa, thus making there to be a clear difference of interest between top-enders and tail-enders, with the tail-enders having a stronger incentive than the top-enders to agree to strong community organization and formal rules. On the other hand, if the holdings are scattered, an irrigator with land near the top end of one block may have another plot near the bottom end of another block, which diffuses the direction of the externality and helps to create a common interest in rules and organization.”

Another important factor that largely affects production in large-scale irrigation schemes is management. Uphoff (1985) in his study on farmer organization and participation in irrigation water management observed that irrigation analysts and different agencies of development have recognized irrigation management as a very important factor affecting production and consists of a technical infrastructure and an institutional framework which determines the use of that infrastructure, which are both important in the success of the irrigation system. There is need to have institutional capacity to manage all these factors in order to ensure that the schemes operate to their full capacity. Ruigu (1988) in his study on large scale irrigation development in Kenya notes that "some degree of control and discipline is required in an organized community such as Mwea and Ahero where the well being of the tenants and of the schemes are dependent on the performance of a technically determined cycle of activities." The importance of institutions has been given emphasis by several authors, the leading one being North D. who notes that; "the growth of economies has occurred within the institutional framework of well-developed coercive policies, economic history is overwhelmingly a story of economies that failed to produce a set of economic rules of the game that induce sustained economic growth" (North, 1990).

The purpose of this study was to analyze the determinants of rice production within Ahero irrigation scheme. When this scheme was being established, tenants had to shift from subsistence agriculture to a cash cropping economy. Compared to the Mwea irrigation scheme, paddy yields are much lower in the Ahero irrigation scheme (Ruigu, 1988). Just over a year ago before FAO provided inputs to Ahero farmers to help jumpstart rice production, the scene was very different. At that time, only a fraction of the scheme's 2 168 acres were under cultivation and output was low with farmers increasingly hamstrung by the high cost of seeds, fertilizers and fuel (N.I.B., 2008). This has also been a contributing factor to low rice production. (N.I.B., 2008).To reverse the scheme's low output, FAO, in September 2008, worked closely with Kenya's National Irrigation Board (NIB), the Agriculture Finance Cooperation (AFC) and the Rural Environmental Care for Africa (RECA) to provide 540 farming families with high-yielding rice seeds, fertilizers, pesticides and technical assistance.

Research gap

Despite all these effort put by the government to ensure that the output of rice increases within Ahero irrigation scheme, the scheme has continued to produce low quantity of rice. This therefore makes it difficult for Kenya to bridge the gap between rice demand and supply which have been estimated at 300,000 metric tonnes and 80,000 metric tonnes respectively. This is why the study focused on the other determinants of rice production within the scheme except for use of credit and irrigation that have been given more emphasis by the government to help in increasing the output. This is because by increasing the rice output within Ahero irrigation scheme, the country will be able to cater for the rice deficit that they experience. It is also evident from above studies that, although most of these studies have concentrated on different determinants of rice production, they have alluded to positive and negative relationships that exist between them and rice output. This variation could have been brought about by the fact that the studies were done in different environments leading to confusion in establishing the factors and the magnitude of their effects on rice production. Although it is implied in literature that farmers who take into consideration these determinants of rice production while carrying out their farming activities can be able to increase their rice output, there is no enough empirical evidence to test this assertion. Furthermore, the context within which the study was carried out may determine the outcome of study. This study therefore acted as a confirmatory test on the relationship between determinants of rice production and rice output.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This section consists of study design, study area, study population and sampling, model specification, data collection, data analysis and data presentation.

3.2 Study Design

Oso and Onen (2008) define research design as the pattern that the research intends to follow, the plan or strategy for conducting the research. The study was conducted through a correlation research design. This is a research design which determines whether or not, and to what extent an association exists between two or more paired and quantifiable variables, (Oso and Onen, 2008). The correlation research design helped in comparing two or more characteristics from the same group.

3.3: Area of Study

The study was carried out at Ahero Irrigation scheme within Kisumu County in Kenya. The scheme is located in the Kano Plains which covers an area of about 650 square kilometers, located 24 km south east of Kisumu town in West Kenya and bordered by Nandi escarpment and the Nyabondo plateau, (NIB,2008). The scheme's latitudes and longitudes are 34^0 97'E and 0^0 16' S respectively. According to NIB (2008), the scheme is located in Nyando district and operated by farmers under NIB. It has a potential of 3,000 acres for rice production while about 2168 acres under rice cultivation. The landscape consists of a wide alluvial plain through which a number of rivers like Nyando run west toward Lake Victoria. The climate is relatively dry with high average temperatures during the day. NIB asserts that, the soils are of the black cotton type, fertile but difficult to drain, and seasonal flooding and water logging limit agricultural potential. KNBS (2009) states that the scheme has a population of 15,000 with households mostly living in scattered compounds or in homesteads on the slightly higher grounds. Accordingly, the study chose Ahero irrigation scheme since it is a place in Nyanza where more rice is grown and has a potential of producing more rice. The area of study is indicated in appendix 2.

3.4: Target Population

Oso and Onen (2008) defined the target population as the total number of subjects or the total environment of interest to the researcher. The study population comprised of 274 rice farmers within Ahero irrigation scheme.

3.5: Sample Size and sampling technique

Amin (2005) define a sample as a subset of the population under study. A sample of 160 farmers was drawn using simple random sampling technique from the target population to ensure that each farmer had an equal chance of being selected. He asserts that, when the sample size is large, it becomes difficult and impractical to conduct research within the time frame allowed and also the larger the sample, the better for a correlation. On the other hand, when the sample size is small, it will provide data which is not representative of the study population and this may lead to inaccurate results.

The sample size was computed by the formula

$$n = \frac{z^2 pq}{d^2} \qquad \text{………………………………………..} \quad 3.1$$

Source: Mugenda &Mugenda (2003)

Where

n = desired sample size if the target population is greater than 10,000;

z = the standard normal deviate at the required confidence level;

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

$q = (1 - p)$: The proportion of the population not possessing the desired characteristics

d = the level of statistical significance set.

Fisher *et. al* as cited in (Mugenda & Mugenda, 2003) stated that where the data on the proportion of respondents with characteristic being investigated is not available, $p = 0.5$ is regarded as appropriate. Therefore, at 95% confidence level, the desired sample size was;

$$n = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2}$$
$$= 384$$

Assuming a target population of more than 10,000; but since the target population was less than 10,000, the appropriate formula is

$$n_f = \frac{n}{1 + \frac{n}{N}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 3.2$$

Source: Mugenda &Mugenda (2003)

Where

n_f = desired sample for population less than 10,000;

n = desired sample size for target population of more than 10,000

N = Population size in the current study,

was used to determine the desired sample size.

$$\therefore n_f = \frac{384}{1+\frac{384}{274}} \qquad n_f = 160$$

3.6: Data types, Sources and Collection techniques

The primary data were used for this analysis which was obtained from the rice farmers within Ahero irrigation scheme through administration of the questionnaires.

3.6.1 Validity Test

Oso and Onen (2008) define validity as the extent to which research instruments measure what they are intended to measure. Before administering the questionnaires, experts in the field of agricultural economics went through the questionnaire and the appropriate changes were made where necessary to incorporate ideas.

3.6.2 Reliability Test

According to Mugenda and Mugenda (2003), reliability refers to the consistency of two measures of the same kind, that is, to what extent does the two measures produce results which have no measurement error. The Cronbach's alpha method was used and the results were as shown below:

Table 3.1: Results of the reliability test

Cronbach's Alpha	Number of Items
0.709	5

Source: Field survey 2014

From the results on table 3.1 the alpha coefficient for the four items is 0.709, suggesting that the items have relatively high internal consistency. A reliability coefficient of 0.70 or higher is considered "acceptable" in most social science research situations (Bruin, 2006). Based on this result, data collection was then undertaken.

3.7 Ethical considerations

Farmers were informed about the purpose, expected duration and benefits of the research before it started. The privacy and confidentiality of the farmers were taken care of by giving them the questionnaires to fill on their own and bring them back immediately. In case of farmers with no education, I guided each separately to fill the questionnaires and assured them that the information given will be under my own custody. I instructed them not to write their names, national identity numbers or telephone numbers on the questionnaires.

3.8 Model Specification

The study was based on production theory by Cobb - Douglas which postulates that output is a function of various factors of production such as: land, labour and capital. From the study that was carried out on the determinants of rice production, rice output is a function of the various determinants of rice production. The general form of the model can then be specified as:

$$Y = f(X_1, ..., X_4, £) \quad \text{..} \ 3.3$$

Source: Based on production theory

Where Y represents rice output

X_1, X_2, X_3, X_4 Represents determinants of rice out put

Where: X_1 - Fertilizer quantity (Kgs)

X_2 - Level of education of the rice farmers

X_3 -Farm size (acres)

X_4 - Age of the rice farmers (Years)

£ Represents the error term

Based on Cobb – Douglas production function, the model can then be specified as:

$$Y_i = A_0 X_{1i}^{a_1} X_{2i}^{a_2} X_{3i}^{a_3} X_{4i}^{a_4} e^{£_i} \quad \text{..} 3.4$$

Where Y_i represents rice output

$X_{1i}, X_{2i}, X_{3i}, X_{4i}$ Represents the determinants of rice output

$£_i$ represents the error term

a_i represents parameters to be estimated (i = 0, 1, 2, 3, 4)

Source: Based on the production theory

Taking natural logarithms of 3.4 will yield a linear function form:

$$\ln Y_i = a_0 + a_1 \ln X_{1i} + a_2 \ln X_{2i} + a_3 \ln X_{3i} + a_4 \ln X_{4i} + £_i \quad \text{............} 3.5$$

Where $a_0 = \ln A_0$

Source: Based on the production theory

Assumptions of the model:-

i. The error term has a zero mean i.e. E (ε_i) = 0.

ii. The error term has a constant variance

iii. The error term is normally distributed i.e. $£_i \sim N(0, \pm^2)$

iv. The error term is independent of the explanatory variables

v. The error term of the different observations are independent i.e. Cov (ε_i ε_j) =

E (ε_i ε_j) = 0; $i \neq j$

vi. ε is a real random variable i.e. they can assume zero, positive or negative values.

vii. All the variables are measured without errors.

viii. The relationship is correctly specified.

3.9 Data Analysis

Data was analyzed by the use of inferential statistics where correlation and regression analysis was used to analyze the determinants of rice production at Ahero irrigation scheme. Regression analysis permitted the analysis of the effects of farm size, age of farmers, fertilizer quantity and education levels of farmers on rice output. Evidence from literature suggest that rice output is related to farm size, age of farmers, water availability, education levels of farmers, pesticides, herbicides and fertilizer use. For ease of processing, analysis and interpretation, statistical package SPSS was used.

3.9.1 Correlation Analysis

Refers to a linear association of one variable on the other. This was done by regression analysis and looking at the correlation coefficients of the variables. If the correlations are high (above 0.5), then there may be severe collinearity problem.

3.9.2 Multiple Regression Analysis

It is used for testing hypothesis about the relationship between a dependent variable Y and two or more independent variables X's and for prediction. The study adopted

OLS (Ordinary Least Square) for the estimation. This is because the parameter estimates obtained by OLS has optimal properties i.e. BLUE (Best Linear Unbiased Estimator), the computational procedure of OLS is fairly simple compared with other econometric techniques and the mechanics of OLS are simple to understand. The multiple regression analysis is based on the following assumptions:

3.9.3 Normality

Refers to when the disturbances are normally distributed with zero mean and constant variance. Normality enables us to obtain several exact statistical results and it is also useful in constructing test statistics. This was tested by looking at the skewness and kurtosis of the variables. For a normally distributed variable, S=0 and K=3. Where S is skewness and K is Kurtosis. This test was based on OLS residuals.

3.9.4 Autocorrelation

Refers to a case where the error term in one time period is correlated with the error term in any other time period.

Autocorrelation is based on the following assumptions: The mean of the error term is 0. ; The error term has a constant variance i.e $E(\pounds^{2}) = \pm_{\pounds}^{2}$; The error term has a normal distribution with 0 mean and constant variance. The presence of autocorrelation was tested using Breusch – Godfrey serial correlation test.

3.9.5 Multicollinearity

Refers to a case in which two or more explanatory variables in the regression model are highly correlated making it difficult or impossible to isolate their individual effects on the dependent variable. Multicollinearity was tested by calculating the VIF (Variance Inflation Factor).

$$VIF = \frac{1}{(1-R^2)}$$

If:

R^2 =0 the there is no collinearity

R^2=1 there is a perfect multicollinearity

If the VIF of a variable exceeds 10, which will happen if R^2 exceeds 0.90 that variable is said to be highly collinear.

3.10: Data Presentation

The data was presented in form of tables. Tables are easy to understand and are able to guide the readers to make quick comparison and understand the relationship between the dependent and independent variables.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter is dedicated to the analysis of the data collected during the study, discusses the findings and presentation of the summaries. The presentation of this chapter is according to the hypotheses stated in section 1.4. In the study, 160 questionnaires were administered and all were returned. This means the response level was 100%.

4.2 Frequencies of the variables

Table 4.1 Gender of the rice farmers

		Frequency	Percent	Cumulative Percent
Valid	Male	105	65.6	65.6
	Female	55	34.4	100.0
	Total	160	100.0	

Source: Field survey, 2014

The frequencies in table 4.1 show that the majority of the rice farmers are males at 66.5% while the females were 34.4%.

Table 4.2 Age of the rice farmers

		Frequency	Percent	Cumulative Percent
Valid	<21 years	5	3.1	3.1
	21 to 30 years	28	17.5	20.6
	31 to 40 years	53	33.1	53.8
	41 to 50 years	51	31.9	85.6
	51 to 60 years	23	14.4	100.0
	Total	160	100.0	

Source: Field survey, 2014

Regarding the age of the rice farmers, the table 4.2 above indicates that majority of the respondents were 31 to 40 years at 33.1%, 41 to 50 years were 31.5%, those with 21 to 30 years were 17.5%. Respondents with 51 to 60 years were 14.4% while those with less than 21 years were 3.1%.

Table 4.3 Farm size

	Frequency	Percent	Cumulative Percent
Valid 0.1 to 1 acre	97	60.6	60.6
1.1 to2.0 acre	32	20.0	80.6
2.1 to 3.0 acre	12	7.5	88.1
3.1 to 4.0 acre	19	11.9	100.0
Total	160	100.0	

Source: Field survey, 2014

Regarding the farm size, table 4.3 shows that farmers with the farm size between 0.1 and 1 acre were 60.6%, those with farm size between 1.1 and 2 acres were 20%, those with farm size between 2.1 to 3 acres were 7.5% while those with farm size between 3.1 to 4 acres were 11.9%. This shows that most of the rice farmers own small plots of between 0.1 and 1 acre.

Table4.4 Fertilizer quantity

	Frequency	Percent	Cumulative Percent
Valid 1 to10 Kgs	46	28.8	28.8
11 to 20 Kgs	54	33.8	62.5
21 to 30 Kgs	33	20.6	83.1
31 to 40 Kgs	27	16.9	100.0
Total	160	100.0	

Source: Field survey, 2014

From table 4.4 above, the number of rice farmers who use fertilizer quantity of 1 to 10kgs were 28.8%, those who use the fertilizer quantity of between 11 to 20kgs were

33.8%, those who use fertilizer quantity of between 21 – 30kgs were 20.6% while those who use fertilizer quantity of between 31 to 40kgs were 16.9%. This shows that most of the rice farmers use fertilizer quantity of between 11-20kgs.

Table 4.5 Education level of the rice farmers

	Frequency	Percent	Cumulative Percent
Valid No education	38	23.8	23.8
Primary level	86	53.8	77.5
Secondary level	33	20.6	98.1
College level	3	1.9	100.0
Total	160	100.0	

Source: Field survey, 2014

Regarding the education level of the rice farmers, Table 4.5 shows that those with no education were 23.8%, those with the primary education were 53.8%, those with secondary education are 20.6% and those with college education were 1.9%. This shows that most of the rice farmers had more than the basic education.

Table 4.6 Rice output

	Frequency	Percent	Cumulative Percent
Valid 1 to 1000 Kgs	52	32.5	32.5
1001 to 2000 Kgs	57	35.6	68.1
2001 to 3000 Kgs	28	17.5	85.6
3001to 4000Kgs	23	14.4	100.0
Total	160	100.0	

Source: Field survey, 2014

From table 4.6 above, the rice farmers with rice output of between 1-1000kgs were 32.5%, those with an output of between 1001 – 2000kgs were 35.6%, those with an output of between 2001-3000kgs were 17.5% while those with an output of between

3001 to 4000kgs were 14.4%. This shows that most of the rice farmers have a rice output of between 1001 to 2000kgs.

Table 4.7 Descriptive statistics of the variables

	Output (kg/acre)	Age of the rice farmers	Farm size (acres)	Education level	Fertilizer quantity (kg/acre)
Mean	2.134	3.369	1.706	2.006	2.256
Minimum	1.000	1.000	1.000	1.000	1.000
Maximum	4.000	5.000	4.000	4.000	4.000
Median	2.000	3.000	1.000	2.000	2.000
Std. Deviation	1.031	1.032	1.038	0.722	1.054
Skewness	0.523	-0.164	1.265	0.295	0.352
Std. Error of Skewness	0.192	0.192	0.192	0.192	0.192
Kurtosis	-0.864	-0.592	0.232	-0.216	-1.072

Source: Field survey, 2014

Key:

Fertilizer quantity (kg/acre)

1 - 1 to10 Kgs

2 - 11 to 20 Kgs

3 - 21 to 30 Kgs

4 -31 to 40 Kgs

Level of education

1- No education

2- Primary level

3- Secondary level

4- College level

Farm size (acres)

1- 0.1 to 1 acre

2-1.1 to 2.0 acres

3- 2.1 to 3.0 acres

4- 3.1 to 4.0 acres

Age of the rice farmers (years)

1 - <21 years

2 - 21 to 30 years

3 - 31 to 40 years

4 - 41 to 50 years

5 - 51 to 60 years

Rice output (kg/acre)

1 - 1 to 1000kgs

2 -1001 to 2000kgs

3 - 2001 to 3000kgs

4 - 3001 to 4000kgs

The results in Table 4.7 shows that the minimum output of rice obtained by the farmers is 1 (1 to 1000kgs/acre) while the maximum rice output obtained by the farmers is 4(3001 to 4000kgs/ acre). The mean rice output obtained by the rice farmers is 2.134(1001 to 2000kgs/acre). The results also shows that the minimum quantity of fertilizer used by the rice farmers within Ahero irrigation scheme is1 (1 to 10kgs/ acre) while maximum quantity of fertilizer used by the farmers is 4 (31 to 40kgs/acre). The mean quantity of fertilizer used by rice farmers is 2.256 (11 to 20kgs/acre). The results further shows that the minimum levels of education of the rice farmers within Ahero irrigation scheme is 1 (No education) while the maximum level of education of the rice farmers is 4(College level). The mean level of education of rice farmers is 2.006 (Primary level) .This shows that majority of the farmers have low levels of education. This low literacy level among the respondents may affect their access to information.

The results also show that the minimum size of the farm under rice cultivation within the scheme is 1 (0.1 to 1.0 acre) while the maximum size of the farm under rice cultivation is 4 (3.1 to 4 acres). The mean farm size is 1.706 (1.1 to 2.0 acres). This shows that most of the farmers are small holders and this limits their production potential thus making them remain at subsistence level. This finding is similar to the findings of Akinbile (2007) in his study on the determinants of productivity level among rice farmers in Ogun state in Nigeria. He found out that the mean farm size under rice cultivation is 1.3 acres and thus he made a conclusion that rice farming within Ogun state is carried out on small scale. The statistics in Table 4.7 finally shows that the minimum age of the farmers who carry out rice farming within Ahero irrigation scheme is 1(< 21 years) while the maximum age of the farmers who carry out rice farming is 5(51 to 60 years).The mean age of the farmers who carry out rice farming within the scheme is 3.369 (31 to 40 years). This implies that rice farming is mainly carried out by the young people who are still in their productive age and are able to cope with the severity of rice production. This is contrary to the findings of Omondi and Shikuku (2013) in their study on the technical efficiency of rice farmers within Ahero irrigation scheme. They found out that most of the farmers who carry out rice farming within the scheme are between the age of 40-60 and that the mean age of rice farmers within the scheme is 54 years. In their study, they concluded that rice farming is mainly carried out by older farmers.

Skewness and Kurtosis in table 4.7 were used to test for the normality of the distribution of the disturbances. From the results, age of the rice farmers is skewed to the left this is because of its negative sign. On the other hand, levels of education, rice output, fertilizer quantity and farm size are skewed to the right this is because they have positive signs. The kurtosis of the variables reveals that output, farm size, fertilizer quantity, age and farm size have a thin tail/ end. From the results therefore, we accept the null hypothesis that the disturbances are not normally distributed.

4.3 Correlation coefficients results

This chapter focused on establishing whether there is a linear association of one variable on the other. This was done by looking at the correlation coefficients of the variables. If the correlations are high, then there may be severe collinearity problem. A high correlation is one with the correlation coefficient above 0.5.

Table 4.8 Correlation Coefficients results

		Age	Farm size	Education level	Fertilizer quantity	Output
Age	Pearson Correlation	1			.	
	Sig. (2-tailed)					
Farm size	Pearson Correlation	.172*	1			
	Sig. (2-tailed)	.029				
Education level	Pearson Correlation	-.087	.011	1		
	Sig. (2-tailed)	.271	.892			
Fertilizer quantity	Pearson Correlation	.277**	.679**	.006	1	.
	Sig. (2-tailed)	.000	.000	.939		
Output	Pearson Correlation	.230**	.791**	.016	.819**	1
	Sig. (2-tailed)	.003	.000	.844	.000	

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
Source: Field survey, 2014

The correlation between fertilizer quantity, education level, age of the farmers and farm size are described in table 4.8.

The results show that there is a weak but significant positive correlation (r=0.230; p=0.003) between rice output and the age of the rice farmers at 1% level. On the other hand, the rice output and farm size was also positive and significant at 1% level(r=0.791; p= 0.000). The results further show that there is a weak but positive insignificant correlation between rice output and education level(r=0.016; p=0.844). Lastly, there is a strong positive and significant correlation between rice output and fertilizer quantity at 1% level(r=0.819; p= 0.000). By looking at the correlation coefficients, it is the correlation coefficient between fertilizer quantity, farm size and output that are high, at 0.791 and 0.819 respectively. This shows that there could be a problem of collinearity as a result; the study conducted a multicollinearity test to see if there exists a serious multicollinearity. Based on these results, the study therefore rejected the null hypothesis of no correlation.

4.4 Multicollinearity Test

This section focuses on whether there is correlation between the explanatory variables. The study used the VIF (Variance Inflation Factor). If the VIF of a variable exceeds 10, which will happen if R^2 exceeds 0.90 that variable is said to be highly collinear.

Table 4.9 Results for Multicollinearity test

Sample: 160

Included observations: 160

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
Constant	0.168	301.749	NA
Age of the farmers	0.007	174.078	1.085
Fertilizer quantity	0.006	207.059	1.129
Farm size	0.003	2.062	1.089
Levels of education	0.002	22.391	1.111

Source: Field survey, 2014

A centered VIF of less than 10 shows that there is no serious collinearity. Hence from the results in table 4.9 the VIF for age of the farmers, fertilizer quantity, farm size and levels of education are all less than 10 and as a result there is no serious multicollinearity of the coefficients as all the centered VIF are less than 10.The study therefore accepts the null hypothesis of no multicollinearity.

4.5 Autocorrelation Test

This section focuses on establishing whether the error term in one time period is correlated with the error term in any other time period. Autocorrelation test is based on Breusch – Godfrey serial correlation test.

Table 4.10 Autocorrelation Test results

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.137	Prob. F(2,153)	0.872
Obs*R-squared	0.287	Prob. Chi-Square(2)	0.867

Source: Field survey, 2014

The results in table 4.10 show that the probability of the Chi- square (0.867) is greater than 5% hence it is concluded that the error term of the study variables do not exhibit autocorrelation.

4.6 Regression test results

This section shows the results that were obtained when four (independent) variables were regressed on the output level of the respondents using the equation below and results shown in table 4.11:

$$\ln Y_i = a_0 + a_1 \ln X_{1i} + a_2 \ln X_{2i} + a_3 \ln X_{3i} + a_4 \ln X_{4i} + £_i \qquad \text{………………..4.1}$$

Table 4.11 Regression test results

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Constant	4.357	0.410	10.615	0.000
Fertilizer quantity	0.624	0.077	8.161	0.000
Levels of education	-0.029	0.045	-0.644	0.521
Farm size	0.014	0.057	0.251	0.802
Age of the farmers	0.115	0.086	1.346	0.180

R-squared	0.339	Mean dependent var	7.479
Adjusted R-squared	0.322	S.D. dependent var	0.363
F-statistic	19.837	Durbin-Watson stat	1.801
Prob(F-statistic)	0.000		

Source: Field survey, 2014

4.6.1 Effect of fertilizer quantity on rice output

From the regression results in Table 4.11, Fertilizer quantity is statistically significant at 5% level of significance. The sign of fertilizer quantity also conforms to the priori expectations that there is a positive relationship between fertilizer quantity and rice output. This means that if the fertilizer quantity increases by one percent, then the output increases by 0.624. Similar findings were also reported by Mbam and Edeh (2011) in their study on determinants of farm productivity among small holder rice farmers in Anambra state, Nigeria where they found out that there is a positive relationship between fertilizer quantity and rice output. These findings conforms to the literature of FAO (1981) which stated that "fertilizers are probably the most important input leading to increasing yields, and they were responsible for some 55% of the increase in yields in developing countries between 1965 and 1976." Omondi and Shikuku (2013) in their study on Technical efficiency of rice farmers in Ahero irrigation scheme also established that there is a positive relationship between fertilizer quantity and rice output in that when the fertilizer quantity is increased, the rice output increases. These findings therefore leads to the rejection of the null hypothesis that there is no relationship between the fertilizer quantity and rice output.

Regarding the cross tabulation between fertilizer quantity and rice output in Appendix 3 and 4, out of the 46 farmers who used fertilizer quantity of between 1 and 10kgs/acre, 89% got an output of between 1 to 1000kgs/acre of rice, 9% got an output of between 1001 to 2000kgs/acre, while 2% got an output of between 2001 and 3000kgs/acre. The farmers who used fertilizer quantity of between 11 to 20kgs and got an output of between1 and 1000kgs/acre were 17%, 1001 to 2000kgs/acre were

70%, 2001 and 3000kg/acre s were 13% while 0% got an output of 3001 to 4000kgs /acre of rice. The farmers who used fertilizer quantity of between 21 to 30kgs/acre,3% got an output of between 1 to 1000kgs/acre , 42% got a rice output of 1001 to 2000kgs/acre and 2001 to 3000kgs /acre respectively while those who got the rice output of 3001 to 4000kgs/acre were 12%. Finally those who used fertilizer quantity of between 31 to 40kgs/acre, 4% got a rice output of between 1 to 1000kgs/acre, another 4% got an output of between 1001 to 2000kgs/acre, 22% got 2001 to 3000kgs/acre and 70% got a rice output of 3001 to 4000kgs/acre of rice. From the appendix 3, the highest average rice output produced by the rice farmers was 83,500kgs which came as a result of the usage of the fertilizer quantity of between 31 to 40kgs per acre. However, Mbam and Edeh (2011) in their study on determinants of farm productivity among small holder rice farmers in Anambra state, Nigeria found out a positive relationship between fertilizer quantity and rice output. In their study, they did not conduct a cross tabulation between the fertilizer quantity and rice output to show the quantity of fertilizer that increases the rice output by a bigger margin.

4.6.2 Relationship between levels of education of farmers and rice output

The results also show that the levels of education of the farmers are statistically insignificant at 5% and the sign does not conform to priori expectations. This shows that there is a negative relationship between levels of education and rice output meaning, if levels of education increases by one percent, then the level of output decreases by 0.029. This negative relationship could have resulted from the fact that as the level of education increases, the individuals tend to look for white collar jobs in the urban areas leaving rice farming for those with low levels of education. This finding conforms to the literature of Kalirajan and Shand (1985), in their case study of rice farmers from Tamil Nadu who argued that even though the level of schooling affects production, the level of education of farmers is not necessarily significantly related to the level of yield because even farmers who are illiterate or semi-illiterate can still understand the technology of modern production the same way their educated counterparts can on condition that the said technology is properly communicated.

Omondi and Shikuku (2013) in their study on technical efficiency of rice farmers in Ahero irrigation scheme where they found out that there is a positive relationship between levels of education and rice output. However, this finding is contrary to the findings of Mbam and Edeh (2011) in their study on determinants of farm productivity among small holder rice farmers in Anambra state, Nigeria where they found out that there is a positive relationship between years of education and rice output in that if the years of education increases then the level of output also increase. According to them, better education promotes the adoption and use of yield-increasing technologies/inputs and encourages more efficient farm management practices. However, this positive relationship may not be a reality because an individual may spend several years in the same class resulting into many years of school, a situation which might not contribute to the increase in rice output.

Ankbile (2007) in his study on determinants of productivity level among rice farmers in Ogun state, Nigeria also reported similar findings of the existence of positive relationship between levels of education and rice output. This therefore leads to the rejection of the null hypothesis of no relationship between levels of education and rice output.

Cross tabulated figures between education levels of the farmers and rice output in Appendix 5 and 6 shows that, the farmers with no education and got a rice output of between 1 and 1000kg/acre were 29%, those who got an output of between 1001 and 2000kgs/acre were 42%, those who got an output of between 2001 and 3000kgs/acre were 18% while those who got an output of between 3001 to 4000kgs/acre were 11%. The farmers with primary education and got a rice output of between 1 and 1000kgs/acre of rice were 36%, those who got an output of between 1001 to 2000kgs/acre were 33%, those who got an output of between 2001 and 3000kgs/acre were 15% while those who got an output of 3001 to 4000kgs/acre of rice were 16%. The rice farmers with secondary education and got a rice output of between 1 and 1000kgs/acre were 24%, those with an output of between 1001 and 2000kgs/acre were 37%, those with an output of between 2001 and 3000kgs/acre were 24% while those with rice output of 3001 to 4000kgs/acre were 15%. Lastly, farmers with college education and got rice output of between 1 and 1000kgs/acre were 67%, those with rice output between 1001 and 2000kgs were 33% while 0% with rice output of between 2001 and 3000/acre and between 3001 and 4000kgs/acre respectively. From the table, those with college education and carry out rice farming recorded the lowest rice output of 2,500kgs while those with primary education recorded the highest quantity of rice output at 139,000kgs. In this study, the relationship between level of education and rice output was negative. In this study, cross tabulation of the data was done which gave the actual levels of education, number of farmers and their rice output.

4.6.3 Relationship between farm size and rice output

The results further shows that farm size is not statistically significant at 5% although it conforms to priori expectations that there is a positive relationship between farm size and rice output and that if farm size increases by one percent, then the output level will increase by 0.014.This means that if the farmers increase the size of the farms on which they carry out rice farming, then the level of rice output is likely to increase.

This result is inconsistent with the findings of Mbam and Edeh (2011) in their study on determinants of farm productivity among small holder rice farmers in Anambra state, Nigeria in which they found out that there is a negative relationship between farm size and rice output. On the other hand, the results are consistent with the findings of Ankbile (2007) in his study on determinants of productivity level among rice farmers in Ogun state, Nigeria where he found out that there is a positive relationship between farm size and rice output. These findings therefore leads to the rejection of null hypothesis of no relationship between farm size and rice output.

From Appendix 8, the farmers with the farm size of between 0.1 and 1 acre and got rice output of between 1 and 1000kgs/acre were 51%, those who got rice output of between 1001 and 2000kgs/acre were 40%, those who got an output of between 2001 and 3000kgs/acre were 9% and 0% got an output of 3001 to 4000kgs/acre. The farmers with a farm size of between 1.1 and 2.0 acres and got an output of 1 to 1000kgs/acre were 9%, those with an output of 1001 to 2000kgs/acre were 47%, those with an output of 2001 to 3000kgs/acre were 41% while 3% had an output of 3001to 4000kgs/acre. The farmers with a farm size of between 2.1 and 3.0 acres and got an output of 1 to 1000kgs/acre was 0%, those with an output of 1001 to 2000kgs/acre were 25%, those with an output of 2001 to 3000kgs/acre were 50% while 25% had an output of 3001 to 4000kgs/acre. The farmers with a farm size of between 3.1 and 4.0 acres and got an output of 1 to 1000kgs/acre was 0%, those with an output of 1001 to

2000kgs/acre was 0%, those with an output of 2001 to 3000kgs /acre was 0% while 100% had an output of 3001to 4000kgs/acre.

4.6.4 Relationship between age of farmers and rice output

The result finally shows that the age of the farmers is statistically insignificant at 5% although the sign conforms to priori expectations that there is a positive relationship between the age of the farmers and rice output. This means that, if the age of the farmers increase by one percent, then the rice output increases by 0.115. This is because when the age of the rice farmers increase, they become more experienced in rice farming and this in turn leads to increase in rice output. This is in line with the findings of Omondi and Shikuku (2013) in their study on technical efficiency of rice farmers in Ahero irrigation scheme in which they found out that rice farming is mainly practiced by older farmers. This is contrary to the findings of Umeh and Ataborh (2006) in their study on efficiency of rice farmers in Nigeria where they found out that there is a negative relationship between age of the farmers and rice output. From their results they therefore suggested that most of the farmers are young people who are still strong and full of energy to make meaningful impact in agricultural production. This therefore leads to the rejection of null hypothesis of no relationship between age of the farmers and rice output.

From Appendix 9 and10, farmers who are below the age of 21 and got a rice output of between 1 and 1000kgs/acre were 100% while 0% had an output of between 1001 and 2000kgs/acre, 2001 to 3000kgs/acre and 3001 to 4000kgs/acre respectively. Farmers who are between the age of 21and 30 years and got a rice output of between 1 and 1000kgs/acre were 43%, those with an output of between 1001 and 2000kgs/acre were 36% , those with an output of between 2001 to 3000kgs/acre were 18% and 3%

had 3001 to 4000kgs/acre. Farmers who are between the age of 31and 40 years and got a rice output of between 1 and 1000kgs/acre were 23%, those with an output of between 1001 and 2000kgs/acre were 47% , those with an output of between 2001 to 3000kgs/acre were 17% and 13% had 3001 to 4000kgs/acre. Farmers who are between the age of 41and 50 years and got a rice output of between 1 and 1000kgs/acre were 35%, those with an output of between 1001 and 2000kgs/acre were 25% , those with an output of between 2001 to 3000kgs/acre were 24% and 16% had 3001 to 4000kgs/acre. Finally, farmers who are 51 to 60 years old and get a rice output of between 1 and 1000kgs/acre were 22%, those with an output of between 1001 and 2000kgs/acre were 39% , those with an output of between 2001 to 3000kgs/acre were 9% and 30% had 3001 to 4000kgs/acre of rice.

The R^2 in Table 4.11 shows that the explanatory variables in the rice regression model explains 34 % of the variation in the output level of the rice farmers and the remaining 66% is explained by the error term.

The regression model can therefore be written as:

$$Y_i = 4.357 + 0.624X_{1i} - 0.029X_{2i} + 0.014X_{3i} + 0.115X_{4i} \quad \ldots\ldots\ldots\ldots..4.2$$

(0.410) (0.077) (0.045) (0.057) (0.086)

R^2=0.339

Standard Errors are in parentheses.

4.7 Summary of regression results

This chapter has empirically examined the effects of various determinants of rice production on the rice output. It has employed normality test, correlation of variables, autocorrelation and multicollinearity in determining the factors influencing the rice output within Ahero irrigation scheme. The regression results have also tested the hypotheses in chapter 3. The variables like fertilizer quantity, farm size and age of the famers have priori expectations except for levels of education of farmers which shows that there is a negative relationship between the levels of education and rice output. Based on this, it can be concluded that most of the variables in the rice regression model have a positive effect on the rice output.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter looked at the summary of what the study set to investigate. Relevant inferences, conclusions and recommendations were advanced based on the results of the study.

5.1 Summary and Conclusions of Major Findings

Rice production is a critical issue in the pursuit of sustainable agricultural production in Kenya. Over the years, farmers have been considered unproductive basically because of their small-scale level of production. This assertion is erroneous considering the fact that farm production depends greatly on resource combination. From the regression results, the study looked at various determinants of rice production namely: fertilizer quantity, age of the rice farmers, education levels of the rice farmers and farm size. The results showed that the fertilizer quantity is statistically significant at 5% while age of the farmers, farm size and education level are not significant.

The first objective was to determine the effect of fertilizer quantity on rice output. It can be concluded that Fertilizer quantity is positive and statistically significant at 5% level. This means that an increase in fertilizer quantity by one percent results in a corresponding increase in rice output by 0.62. Hence the study concludes that fertilizer quantity is an important determinant of rice output.

The second objective was to determine the relationship between the levels of education of farmers and rice output. From the results, the levels of education of farmers was negative and statistically insignificant at 5% meaning that a decrease in the levels of education by one percent results to a corresponding increase in the rice output by 0.0289 while an increase in the levels of education results into a corresponding decrease in the rice output. Therefore the study concludes that levels of education are important in determination of rice output.

The third objective was to establish the relationship between farm size and rice output. Farm size is positive but statistically insignificant at 5% meaning that an increase in farm size by one percent results to a corresponding increase in rice output by 0.0144. Hence the study concludes that farm size is an important determinant of rice output.

The fourth objective was to determine the relationship between the age of the farmers and rice output. Age of the farmers is also positive but statistically insignificant at 5%. This means that an increase in age of the farmers lead to a corresponding increase in rice output by 0.115. Therefore the study concludes that the age of the rice farmers is an important determinant of rice output.

5.2. Recommendations for Decision Making and Policy Formulation

Based on the results in Appendix 3, it is recommended that farmers should apply 31 to 40kgs of fertilizer per acre in order to get the highest rice output of 83, 500kgs.

From the results in Appendix 5, it is recommended that more individuals with college education should join rice farming so as to increase rice output.

The empirical results established that an increase in farm size has the effect of increasing rice output. Since the area has a potential of 3000 acres for rice production while only 2168 acres are under cultivation, the Government of Kenya through N.I.B should complete the construction of infrastructure for an extra 900 acres so as to increase the area under rice cultivation for increased rice output.

From the results in Appendix 9, it is recommended that those with ages of between 21 to 30 years should be encouraged to join rice farming so as to increase the rice output in Ahero irrigation scheme. This is because they are still energetic.

5.3 Limitations of the study

There are certain variables that could have significantly affected the rice output like the amount of water used for irrigation by the rice farmers that was left out of the model due to the inability to determine the exact quantity that is used for irrigation and also due to budget constraint.

5.4 Suggestion for further studies

The principal focus of this study was on analyzing determinants of rice production in Ahero irrigation scheme. According to the findings, there is a positive relationship between age of the farmers, farm size, fertilizer quantity and the rice output. There is also a negative relationship between levels of education and rice output. From the results, the considered independent variables only explained 34% of the dependent variable while the remaining 66% is explained by the error term meaning that there are certain important variables that were left out of the model due to time and budget constraint. Some of these variables are water and labour. Future researchers can incorporate these factors to find out the extent by which they affect the rice output.

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APPENDIX 1: Questionnaire

INTRODUCTION

I am a Maseno University student conducting a study on the determinants of rice production within Ahero Irrigation scheme in Kisumu County in Kenya. This questionnaire consists of two sections; section 1 is for personal details and section 2 about the main objectives of the study. Respondents will be required to carefully read and answer the following questions appropriately.

QUESTIONNAIRE FOR RICE FARMERS

SECTION 1: Background information

Instructions

Tick (√) where appropriate

1. Gender : Male ☐ Female ☐

SECTION 2

To determine the relationship between age of the farmers and rice output

2. What is your age? (Use a tick (√) where appropriate)

<21 Years ☐

21 – 30 Years ☐

31 – 40 Years ☐

41 – 50 Years ☐

51 – 60 Years ☐

To establish the relationship between farm size and rice output.

3. What is the size of the farm on which you carry out rice farming? (Use a tick (√) where appropriate)

0.1 to 1 acre ☐

1.1 to2.0 acres ☐

2.1 to 3.0 acres ☐

3.1 to 4.0 acres ☐

To determine the relationship between levels of education and rice output

4. What is your level of education? (Use a tick (√) where appropriate)

No education ☐

Primary level ☐

Secondary level ☐

College level ☐

To determine the effect of fertilizer quantity on rice output

5a) Do you apply fertilizer on your rice farm? (Use a tick (√) where appropriate)

Tick appropriately Yes ☐

No ☐

b). If yes, specify the quantity of fertilizer you use(kg/acre). (Use a tick (√) where appropriate)

1 to10 Kgs/acre ☐

11 to 20 Kgs/acre ☐

21 to 30 Kgs/acre ☐

31 to 40 Kgs/acre ☐

c). How many Kgs of rice per acre do you obtain when you use fertilizer? (Use a tick (√) where appropriate)

1 to 1000 Kgs/acre ☐

1001 to 2000 Kgs/acre ☐

2001 to 3000 Kgs/acre ☐

3001to 4000Kgs/acre ☐

d) If no, how many kilograms of rice do you get per acre?

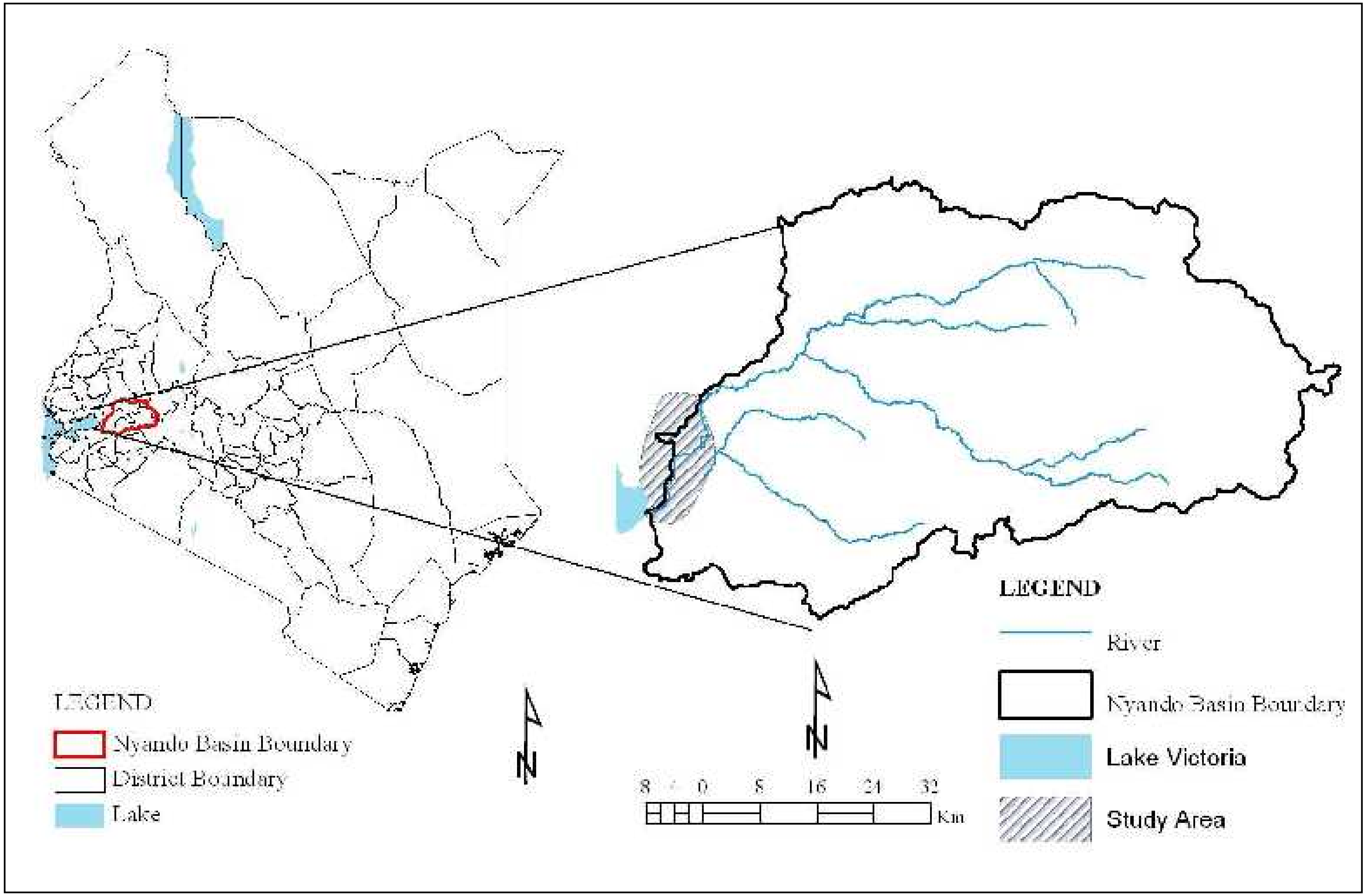
1 to 1000 Kgs/acre ☐

1001 to 2000 Kgs/acre ☐

2001 to 3000 Kgs/acre ☐

3001to 4000Kgs/acre ☐

APPENDIX 2: Map of Nyando River Basin



Source: National Irrigation Board

APPENDIX 3 : Fertilizer quantity * Rice output Cross tabulation

		Rice output 1 to 1000 Kgs	1001 to 2000 Kgs	2001 to 3000 Kgs	3001 to 4000Kgs	Total	Average rice output (kg)
Fertilizer quantity	1 to 10 Kgs	41	4	1	0	46	29,000
	11 to 20 Kgs	9	38	7	0	54	79,000
	21 to 30 Kgs	1	14	14	4	33	70,500
	31 to40 Kgs	1	1	6	19	27	83,500
Total		52	57	28	23	160	

Source : Field survey, 2014

Fertilizer quantity * Rice output Cross tabulation

		Rice output				
		1 to 1000 Kgs	1001 to 2000 Kgs	2001 to 3000 Kgs	3001to 4000 Kgs	Total
Fertilizer quantity per acre	1 to10 Kgs	89%	9%	2%	0%	100%
	11 to 20 Kgs	17%	70%	13%	0%	100%
	21 to 30 Kgs	3%	42%	42%	12%	100%
	31 to 40Kgs	4%	4%	22%	70%	100%

Source: Field survey, 2014

APPENDIX 4: Education level * Rice output Cross tabulation

		Rice output					
		1 to 1000 Kgs	1001 to 2000 Kgs	2001 to 3000 Kgs	3001to 4000 Kgs	Total	Average rice output (kgs)
Education level	No education	11	16	7	4	38	61,000
	Primary level	31	28	13	14	86	139,000
	Secondary level	8	12	8	5	33	59,500
	College level	2	1	0	0	3	2,500

Source: Field survey, 2014

Education level * Rice output Cross tabulation

		Rice output				
		1 to 1000 Kgs	1001 to 2000 Kgs	2001 to 3000 Kgs	3001 to 4000 Kgs	Total
Education level	No education	29%	42%	18%	11%	100%
	Primary level	36%	33%	15%	16%	100%
	Secondary level	24%	37%	24%	15%	100%
	College level	67%	33%	0%	0%	100%

Source: Field survey, 2014

APPENDIX 5: Farm size * Rice output Cross tabulation

		Rice output					
		1 to 1000 Kgs	1001 to 2000 Kgs	2001 to 3000 Kgs	3001 to 4000 Kgs	Total	Average rice output (kg)
Farm size	0.1 to 1 acre	49	39	9	0	97	105,500
	1.1 to2.0 acre	3	15	13	1	32	60,000
	2.1 to 3.0 acre	0	3	6	3	12	30,000
	3.1 to 4.0 acre	0	0	0	19	19	66,500

Source: Field survey, 2014

Farm size * Rice output Cross tabulation

		Rice output				
		1 to 1000 Kgs	1001 to 2000 Kgs	2001 to 3000 Kgs	3001 to 4000 Kgs	Total
Farm size	0.1 to 1 acre	51%	40%	9%	0%	100%
	1.1 to2.0 acre	9%	47%	41%	3%	100%
	2.1 to 3.0 acre	0%	25%	50%	25%	100%
	3.1 to 4.0 acre	0%	0%	0%	100%	100%

Source: Field survey, 2014

APPENDIX 6 : Age of the farmers * Rice output Cross tabulation

		Rice output					
		1 to 1000 Kgs	1001 to 2000 Kgs	2001 to 3000 Kgs	3001 to 4000 Kgs	Total	Average rice output(kg)
Age	<21 years	5	0	0	0	5	2,500
	21 to 30 years	12	10	5	1	28	37,000
	31 to 40 years	12	25	9	7	53	90,500
	41 to 50 years	18	13	12	8	51	86,500
	51 to 60 years	5	9	2	7	23	45,500

Source: Field survey, 2014

Age of the farmers * Rice output Cross tabulation

		Rice output				
		1 to 1000 Kgs	1001 to 2000 Kgs	2001 to 3000 Kgs	3001 to 4000 Kgs	Total
Age	<21 years	100%	0%	0%	0%	100%
	21 to 30 years	43%	36%	18%	3%	100%
	31 to 40 years	23%	47%	17%	13%	100%
	41 to 50 years	35%	25%	24%	16%	100%
	51 to 60 years	22%	39%	9%	30%	100%

Source: Field survey, 2014