Determinants of Agricultural Productivity in Kenya.

By

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DECLARATION

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

……………………………………..   ……………………………………...

Signature   Date

Beth Wanjiru Muraya

This project was submitted for examination with my approval as University Supervisor

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Signature   Date

Dr. George Ruigu

DEDICATION

To God Almighty, from whom all good things come.

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Special thanks to everybody who has played a role in the coming to fruition of this project.

I am thankful to my supervisor, Dr. George Ruigu. I thank you for your endless guidance, unyielding support and relentless efforts to always hold me to a higher standard of output and for tapping into my intellectual curiosity.

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Above all, to Almighty God, I bow in adulation.

To you all, I salute in appreciation.

ABBREVIATIONS

ASALs	Arid and semiarid lands
TFP	Total factor productivity
PFP	Partial factor productivity
Trans log	Transcendental logarithm
OLS	ordinary least square technique
KALRO	Kenya Agricultural and Livestock Research Organization
SRA	Strategy for Revitalizing Agriculture
ASDC	Agricultural Sector Development Strategy

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ABSTRACT

This study sought to identify the determinants of agricultural productivity in Kenya. The study used partial factor productivity given by physical output over factor inputs. It explored inflation, real exchange rate, labour force, government expenditure and climate/rainfall as the factors determining agricultural productivity. The study utilized secondary data for the period of 1980 to 2013. The study employed Cobb-Douglas production function and ordinary least square (OLS) estimation technique as the method of analysis. The independent variables were labour force, inflation, real exchange rate, government expenditure and climate/rainfall while the dependent variable was agricultural productivity.

From the regression results, an increase of one percent in government expenditure, annual rainfall, labour force caused an increase in agricultural productivity by 0.0639032%, 0.0917103%, 0.1984402% respectively. An increase of one percent in inflation rate, exchange rate in caused a decrease in agricultural productivity by 0.0193286% and 0.405422% respectively. Overall the model is statistically significant at 5% level of significance.

The study also employed Johansen-Granger Cointegration procedures and Error Correction Model (ECM) to forecast long-run relationships and to check for short-run relationship respectively among the study variables. The long run relation highlights the negative impact of exchange rate (E) and inflation (I) on agricultural productivity (Y), while Labour force, rainfall, and government expenditure impact agricultural productivity positively.

From the results of Error Correction Model, labour, rainfall and government expenditure have a high explanatory power, as indicated by R^2 of 0.9105, 0.7181 and 0.6613 respectively. Exchange rate and inflation rate have a relatively low explanatory power given by R^2 of 0.3231 and 0.3204 respectively. This implies that in the short run Labour, rainfall, and government expenditure are the main determinants of agricultural productivity in Kenya.

CHAPTER 1

1.0 INTRODUCTION

1.1 Background

Agriculture is the backbone of Kenya's Economy. The contribution of the sector to the country's Gross Domestic Product (GDP) has been declining over the years from 40 percent in 1963, 33 percent in the 1980s to 27 percent in 2014, (KNBS, 2015). The sector, however, remains the dominant sector in the overall economy. The sector accounts for about 60 percent of the foreign exchange in Kenya, about 16 percent of the formal sector employment (KNBS, 2015) and also provides self-employment. There is, therefore a high correlation between the growth of the national economy and development in the agricultural sector.

About 15 percent of the Kenyan total land area is fertile and has sufficient rainfall to support farming but only about a third of the land is grouped as first-class land for agriculture purpose. Subsistence production accounts for almost half of the total agricultural production which is both marketed and non-marketed.

According to the economic pillar of Vision 2030, Kenya seeks to achieve a sustainable growth of 10 percent annually. This will be crucial in generating more resources so as to achieve the sustainable development. Vision 2030 identified agriculture as a critical sector to achieve the 10 percent growth rate (Government of Kenya, 2007).

In 2004 the government of Kenya launched the Strategy for Revitalizing Agriculture (SRA). This provided a guide to both private and public sectors on how to overcome the challenges in the agricultural sector. This strategy was largely successful as the agricultural sector achieved a growth of 6.1% in 2007 (Government of Kenya, 2010). The Agricultural Sector Development Strategy

(ASDS) succeeded SRA. It aims at achieving annual growth rate of 10% in the agricultural sector thus complementing Vision 2030. Under ASDS agricultural sector should employ contemporary methods and technologies so as to modernize agriculture and enhance productivity. The government should also ensure that institutions providing services to farmers are more effective and efficient.

According to Vision 2030, Productivity is still a cardinal challenge in the agricultural sector. The level has either remained nearly constant over the last five years or is on decline. The production level of most crops over the last five years has almost stagnated or has been declining. Fish and livestock products output levels are below potential. Population growth has been steadily increasing while the area covered by the forest has been sharply reducing. Over the years tree productivity has been dwindling (Government of Kenya, 2007).

Land use is another challenge in the agricultural sector. The land available for crop production is overexploited especially the small-scale farmers in Kenya. Arid and semi-arid lands (ASALs) and land in high and medium potential areas remain underexploited for agricultural production in Kenya.

Kenyan Agricultural sector has continued to rely heavily on rain-fed agriculture. However, this has been an area of concern, due to the effects of global warming; climate is not very predictable coupled with natural disasters like drought, floods, and mudslides. There is a close relationship between rainfall and agricultural output as it affects productivity in many counties in Kenya. Only about a third of Kenyan land is agricultural land (World Bank Group, 2015). Agricultural land, in this case, is described as the share of land that is arable and under permanent crop and pasture. Thus there is a huge variability in production by region in Kenya based on whether the region receives adequate rainfall or not. However, if irrigation is adopted across the country this could greatly reduce the regional variability of productivity. This is, however, subject to irrigation potential of different regions as well as budget constraints due to the high costs involved in establishing irrigation schemes. The climatic condition affects policies as well as the use of inputs which has a direct impact on productivity.

Planned irrigation in the agricultural sector in Kenya began in 1946. This was at the time when African Land Development (ALDEV) was trying to contain people from encroaching on the white settlements. The National irrigation board (NIB) was consequently established in 1966. The NIB is currently managing Bunyala, Hola, Mwea, Ahero, Bura, Perkerra and West Kano irrigation schemes. The government has also recently embarked on Galana-Kulalu Food Security Project in Kilifi and Tana counties. All these projects aim at enhancing food security.

Value addition is critical to making agricultural products more competitive in the global market as well as earn farmers the maximum returns. Farmers in Kenya export semi-processed agricultural products which are often low in value. These semi-processed exports form a significant percentage (about 91%) of the entire agricultural related exports. Relatively high production costs and inability to add value to the agricultural output makes Kenyan agricultural exports less competitive globally.

Government expenditure can directly or indirectly affect agricultural incomes. Government expenditure that is complementary to private investments will to some extent affect the productivity in the agricultural sector. This may include spending on health, education, and transport & communication infrastructure. Expenditure which has a significant influence on agricultural performance and productivity include; credit provision to farmers, expenditure on animal health, veterinary and extension services, research, and access roads in rural areas.

Government policies in agricultural sector also affect the productivity in the sector. Kenya has continued to formulate policies which are in line with increasing the productivity in the agricultural sector and making it more competitive globally especially for the export crops. In the 1980s the government moved from controlling the sector to liberalizing the sector.

The poor are concentrated in rural areas especially in sub-Saharan Africa. It is of importance to facilitate the growth and productivity of agriculture so as to reduce poverty and facilitate the achievement of the Vision 2030. Most economies in sub-Saharan Africa are agricultural based, it is therefore very important to ensure agricultural development in order to reduce poverty. However, productivity has substantially lagged behind that of transforming economies (North Africa, Middle East, East & South Asia), and urbanized economies (Europe, Latin America, Central Asia). The transforming economies do not depend largely on agriculture, however, agriculture is still important in enhancing rural development which consequently reduce poverty as well as reduce the rural-urban divide. In the urbanized economies, agriculture only contributes modestly to economic growth, and poverty is no longer localized in the rural areas (World Bank, 2011).

Agriculture in Kenya is the source of income, employment, food security and supports about 60% of the population. It is also a significant source of foreign exchange through exports.

The agricultural sector in this study refers to crop production and livestock farming.

The key questions in this study are; what are the determinants of agricultural productivity in Kenya? What needs to be done to improve agricultural productivity in Kenya?

1.2 Statement of the problem

It is critical to continually study the factors that determine agricultural productivity so as to make necessary policy recommendations, to ensure there is continued improvement in enhancing agricultural Productivity. This will increase income, employment opportunities, and ensure food security in Kenya as well as increase exports which earn the country the much needed foreign exchange. Agricultural production as a percentage of total GDP has been declining over the years. This can partly be attributed to structural transformation among other factors.

There is need to underscore the importance of continually increasing productivity in the agricultural sector given the rapidly increasing population in Kenya which stood at 45.55 million in 2014 (World Bank Group, 2015). The agricultural sector is currently the single most significant sector in the economy with a huge multiplier effect on the entire economy.

1.3 Research question

i. What are the determinants of agricultural productivity in Kenya?

1.4 Objectives

1.4.1 Main objective

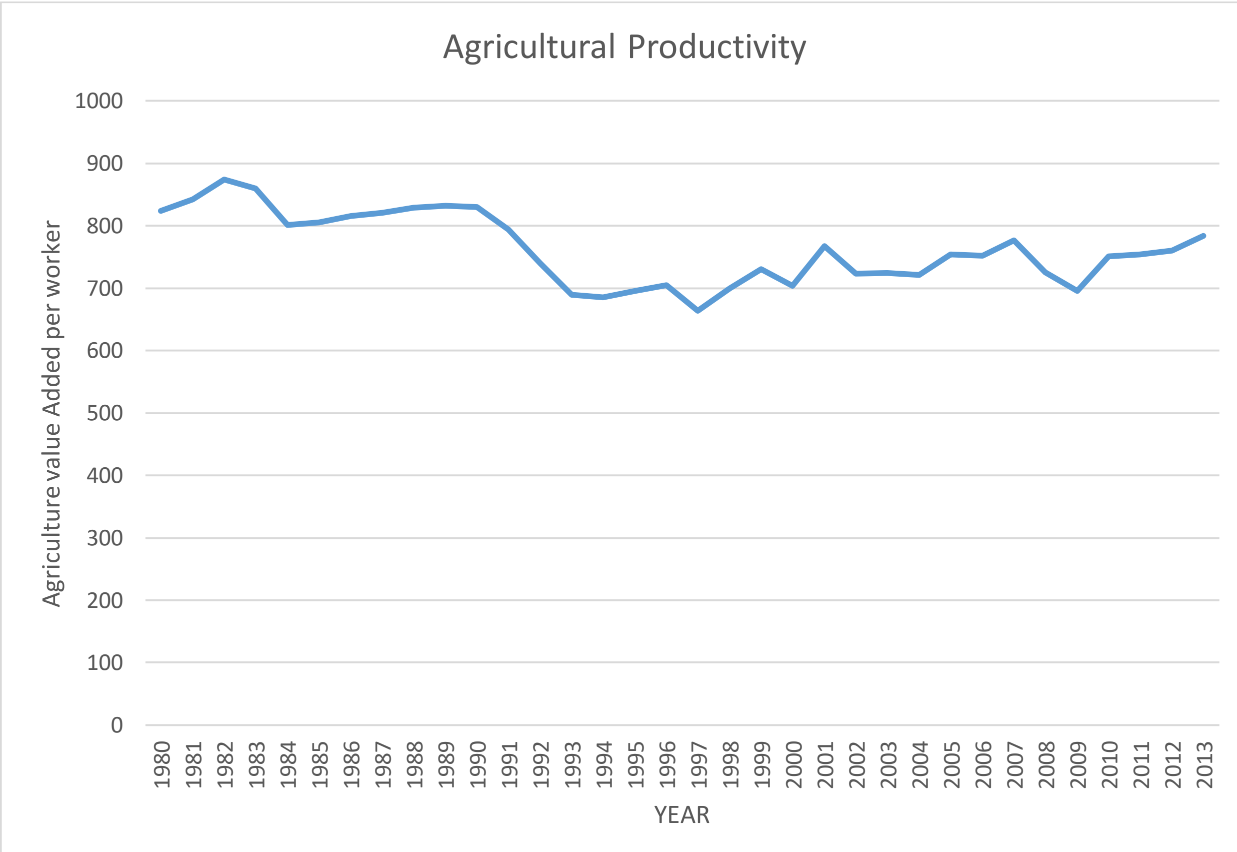
To establish the determinants of agricultural productivity in Kenya and give some policy recommendations.

1.4.2 Specific Objectives

i. To establish the determinants of agricultural productivity in Kenya.
ii. To make necessary policy recommendations.

1.5 Justification

Agricultural productivity in Kenya has either remained stagnant over the years or is on decline. This can be partly attributed to continued reliance on rain-fed agriculture which has been adversely affected by global warming. In general agricultural sector is performing below potential. There is need, therefore, to continually analyze the determinants of agricultural productivity so that they can be well addressed by appropriate policies and programmes which are up to date. The agricultural sector is a key sector in Kenyan economy.



Source: Author, compilation from World Bank database 2016.

The Strategy to Revitalize Agriculture (SRA) succeeded by Agricultural Sector Development Strategy (ASDS), Kenya Vision 2030, Comprehensive African Agricultural Development Program (CAADP) and Alliance for Green Revolution in Africa (AGRA) have all emphasized the need to continually increase agricultural productivity in efforts to fight poverty. Vision 2030 is a road map to make Kenya a middle-income country which provides its citizens with high quality of life by 2030. It identifies agricultural productivity as a key challenge to the achievement of the economic pillar as envisioned.

This study will also generate literature for future scholars.

1.6 Scope

This project studied determinants of agricultural productivity in Kenya. The study utilized data from 1980 to 2013.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Introduction

Literature review comprises of an in-depth analysis of literature that informs agricultural productivity. It provides a review of the individual factors affecting agricultural productivity.

2.2 Theoretical Review

Total factor productivity (TFP) divides the value of output and the value of inputs used. Partial factor productivity (PFP) is often used as TFP are tough to formulate as it is difficult to value all inputs when markets are not operating optimally. PFP is given by physical output (Q) over physical factor input (X) that is (Y=Q/X).

2.2.1 The Cobb-Douglas Production Function

To establish the individual or joint contribution of inputs to output it is necessary to establish a production function. The general neoclassical production function: $Y = F(X_1, X_2, X_3, \ldots X_n)$ or $Y = AK^{\alpha}L^{\beta}$ where Y is the output level, Xs are the inputs; A, α & β are positive constants; K & L are capital and labour input respectively. A is the total factor productivity, α & β are capital and labour elasticities respectively. The factors are constant and determined by the available technology (Koutsoyiannis, 2006).

The Cobb-Douglas production function is of degree one if $\alpha + \beta = 1$. A production function of degree one has constant returns to scale. If $\alpha + \beta < 1$ then the production function exhibits decreasing returns to scale. If $\alpha + \beta > 1$ the production function exhibits increasing returns to scale. The value of α and β determine what degree of returns to scale a Cobb-Douglas production function can exhibit. Since the values of α and β are not limited, Cobb-Douglas production function can exhibit any degree of returns to scale (Koutsoyiannis, 2006).

To eliminate the bias in Cobb-Douglas production function, the equation can be transformed by taking the logarithms of both sides. Comparing the transcendental logarithmic function (trans-log) and Cobb-Douglas production function, the former is relatively more flexible, thus it is more appropriate especially when estimating a production relationship which is not well understood. This transformed function can be estimated through ordinary least square technique (OLS). Thus the Cobb-Douglas production function can be written as $\ln Y = \ln A + \alpha \ln K + \beta \ln L$. Ordinary least square (OLS) can be used to estimate the model as it is now linear in parameters. With all the variables in logs, this is now a log-linear model.

Generally, Cobb-Douglas production function can be generalized to many inputs to take the following function; $Q = \Pi^{n}_{i=1} X^{\beta i}_{i}$. This function can exhibit any degree to scale depending on the value of summation of βi. In this study, the Xs are labour force, climate (rainfall), real exchange rate, government expenditure and inflation.

The logical basis for choosing Cobb-Douglas production function is based on the fact that it is relatively simple and convenient to specify and interpret. Moreover, application of Cobb-Douglas production function has been found applicable in similar settings to this one. For instance, (Enu & Attah-Obeng, 2013) and (Ekborn, 1998).

2.3 Empirical Literature review

2.3.1 Labour input

Enu & Attah-Obeng (2013), set out to establish the macro determinants of agricultural production in Ghana for the period 1980 to 2011. The study used a Cobb-Douglas production function and ordinary least squares estimation technique to analyze the data. Agricultural output was the dependent variable. Labour force, real GDP per capita, inflation, and real exchange rate were the independent variables. The study found that apart from inflation all the other factors that is Labour force, inflation, real exchange rate, real GDP per capital, were significant in determining agricultural productivity.

Anyanwu (2013), carried out a study on agricultural productivity determinants in Nigeria. He formulated an econometric model to analyze his data as follows:

$$Q = F(X_1, X_2, X_3 \ldots\ldots X_{12}, e)$$

Where Q is the aggregate agricultural productivity and X_1, X_2, X_3 TO X_{12} are farm size, labour input, expenditure on planting material, non-farm income, capital input, expenditure of fertilizer, number of crops in the mixture, distance to the market, level of education of the farmer, age of the farmer, size of households, experience of the farmer and *e* is the error term. That study found farm size, labour input, expenditure on planting material, non-farm income, capital input, the number of crops in the mixture, distance to the market, the level of education of the farmer, experience of the farmer were statistically significant determinants of aggregate agricultural output. Labour despite having a negative coefficient was statistically significant.

Ahmad (2012), sought to find out what determines the growth of agricultural productivity in Pakistan. The study employed autoregressive distributed lag model. The period considered in the study was from 1965 to 2009. From the study, it was concluded that in the short run and the long run fertilizer input, human capital, and agricultural credit were significant. The area under crop was found to be insignificant in the short run as well as the long run.

Abugamea (2008), in estimating the long-run relationship between agricultural production to variables like cultivated land, labour force and capital (purchased input cost) the study employed Johansen-Granger cointegration procedures. The study found a significant negative relationship between capital and agricultural production. Over a long period, the cost of inputs impacted agricultural production negatively. Additionally, the study found a positive correlation between labour force and agricultural production. Error Correction Model(ECM) was used to check for short-run dynamics, which indicated clearly that capital and labour were the main determinants of agricultural productivity in Palestine.

Odhiambo *et al* (2004), studied sources and determinants of agricultural growth and productivity in Kenya between 1965 and 2001. The study used growth accounting procedure to determine the respective factors followed by econometric technique to analyze the factors. The study concluded that 90% of agricultural sector growth is accredited to factor inputs; land, capital, and labour. Labour by itself contributed 48% of agricultural growth. The study further established that factors which affect agricultural productivity include; climate, trade policy in Kenya and government expenditure on agriculture.

Ekborn (1998), employed Cobb-Douglas production function with agricultural productivity as the dependent variable. The independent variables used were labour input, materials, physical resource endowment, human capital and physical capital investment. The results from ordinary least square regression indicated that soil conservation quality, the cost of agricultural inputs and labour availability were positively correlated to agricultural productivity and statistically significant. Farm size and distance from key resources and major infrastructures such as water and roads were negatively correlated to agricultural productivity and were statistically significant. Soil capital investments, capital assets, access to credit, off-farm nonagricultural income also contributed positively to productivity.

2.3.2 Real exchange rate

Brownson *et al* (2012), set out to establish evidence-based relationship between value of agricultural GDP as a ratio of total GDP and macroeconomic variables; inflation rate, nominal exchange rate, external reserves, interest rates, savings, real GDP per capita, index of energy consumption, index of agricultural production, index in manufacturing production, non-oil exports and average industry capacity utilization rate, in Nigeria. Real exchange rate affects both prices for inputs which are imported and output prices for outputs which are exported.

In the short run and long run, the empirical results revealed that; there was a positive relationship between nominal exchange rate, capacity utilization rate of the industry and agricultural productivity. There was a significant negative relationship between agricultural productivity and inflation rate, external debt, real total exports, and external reserves.

The study recommended that relevant economic policies should be formulated and implemented so as to increase investment in the agriculture so as to increase the percentage of agricultural output in the total exports of the country. The country's economy should be diversified to ensure that the country is not solely dependent on the oil sector. There should be efforts to drastically reduce external debt. Also, an incentive program should be put in place to promote industrialization so as to enhance production and ensure capacity is fully used and consequently encourage backward integration. Policies to ensure inflation rates are stabilized should be implemented. All these are critical to promoting agricultural productivity.

2.3.3 Inflation

Olatunji *et al* (2012) employed Granger causality method and descriptive statistics in the analysis agricultural production and inflation in Nigeria. From the study, the variation in the agricultural output (the inventory change) resulted in changes in inflation for the years 1970 to 2006. Agricultural output and inflation rate are directly related. Moreover increase in agricultural output from the preceding year resulted in an increase in the inflation rate. The study indicated that there is variation in both trends of agricultural output and rate of inflation. The study recommended that policies should be put in place to ensure surplus agricultural output is absorbed in order to ensure stability in food prices and inflation rates.

Oyinbo *et al* (2012) used descriptive and inferential statistics in the analysis of the trends of inflation, agricultural productivity, and economic growth. The study used time series data. There was a one-way relation between agricultural productivity and economic growth. There was one-way causality between inflationary trend and agricultural productivity. However, there was no causality between trends in the inflation rate and economic growth. The study thus recommended that inflation should be maintained at single digits by the Central bank of Nigeria.

2.3.4 Government Expenditure on Agriculture

Benin *et al* (2009), carried out a study on agricultural productivity and public expenditure in Ghana. The results from the different zones differed marginally. The study used household production data and public expenditure data. From the study health, education, roads and supply of public goods and services in relation to agriculture had a significant impact on agricultural productivity.

From the study,a unit increase in agricultural public spending resulted in a 0.15 percent increase in agricultural labour productivity. The benefit-cost ratio of public spending on agriculture was 16.8. Spending on rural feeder roads followed with a benefit-cost ratio of 5. Health followed at a distant third. However, formal education had a negative effect on agricultural productivity. This could be connected to more skilled labour which is associated with more educated people, being allocated away from farms.

Selvaraj (1993), analyzed how variation in government expenditure affected growth in agriculture sector in India. Agricultural development had relied significantly on financing by the government for a long time. Over the years, the share of agriculture spending out of the public finance has been declining. This can be attributed to the economic reforms, milestones achieved in agriculture, as well as industrialization. This trend, however, affects the performance of agricultural sector negatively. The study used time-series data. The results of the study clearly demonstrated the importance of government expenditure on agriculture. Reduction in the portion allocated to agriculture has adverse effects on performance of the agricultural sector. There was an inverse relationship between fluctuation in government expenditure in agriculture and agricultural sector growth.

Mutuku (1993), studied the impact of government expenditure and the structural adjustment programmes on the agricultural sector. He noted that agricultural output can be increased through land use intensification which includes the use of hybrid crops, farm machinery, use of fertilizers to improve soil productivity as well as improved animal husbandry practices. He also noted that small-scale farmers account for a significant percentage of the total agricultural output. The infrastructure needed to raise agricultural productivity is a public good provided by the government via government expenditure. Adequate government expenditure to the agricultural sector would fast track agricultural development. The study found that instability in government expenditure adversely affects agricultural sector performance. Government expenditure is important in improving agricultural sector performance.

2.3.5 Climate/rainfall

Ayinde *et al* (2011), carried out a study in Nigeria on how changes in climate affected agricultural productivity. The study used descriptive and co-integration model approach to analyze time series data. The study concluded that during the period from 1981 to 1995, there was a steady and high rate of agricultural productivity. However, during the period from 1996 to 2000, the rate was very low. It was observed that the amount of rainfall and temperature had fluctuated in the later period. Agricultural productivity and annual rainfall results from Augmented Dickey-Fuller unit root test were not stationary but became stationary after the first differencing. Temperature (annual), however, was stationary at its level. Temperature change was negatively related to agricultural productivity. However, rainfall change was positively related to agricultural productivity. The study also revealed that previous year's rainfall had a negative effect on the productivity of the current year. The study thus recommended that to increase and sustain agricultural productivity there was a need to encourage innovations and technologies that are environmentally sensitive so as to mitigate fluctuations in the climatic conditions.

Kumar & Sharma (2013), used an econometric model and the regression analysis which revealed that extreme climate variation adversely affects the quantity and value of production for majority of the crops. This indicates that food security is greatly threatened for most of the small scale farming households. This is because agricultural productivity and food security are interrelated. The study also generated food security index which revealed that it was also adversely affected by the climatic fluctuations.

Edame *et al* (2011), noted adverse climate change is a major threat to food security in the 21st century. Agriculture is very sensitive to climate change. Since the world population is growing agricultural production should also increase to ensure food security. To successfully boost food security, agricultural productivity needs to be boosted.

2.4 Overview of literature

From the above literature, some studies have employed Cobb-Douglas production function with agricultural output as the dependent variables while the independent variables varied in different studies. This study employed the Cobb-Douglas production function with the independent variables being: labour force, climate/rainfall, real exchange rate, government expenditure and inflation.

Research in the agricultural sector has and continues to be carried out. This can be attributed to the significant role agricultural sector plays in the economy, especially in the developing economies. Since agricultural sector continues to be a very significant sector of the Kenyan economy, there is need for vigorous and extensive research so as to provide updated data to enable the relevant authorities to formulate policies and programmes which are up to date and relevant to the current trends.

This study will, therefore, serve the purpose of expanding the body of literature available to enable policy makers to formulate relevant policies.

2.5 Research gaps

Further research needs to be done on individual determinants of agricultural productivity so as to have an in-depth understanding of the contribution of individual factors without aggregating them in a study.

CHAPTER 3

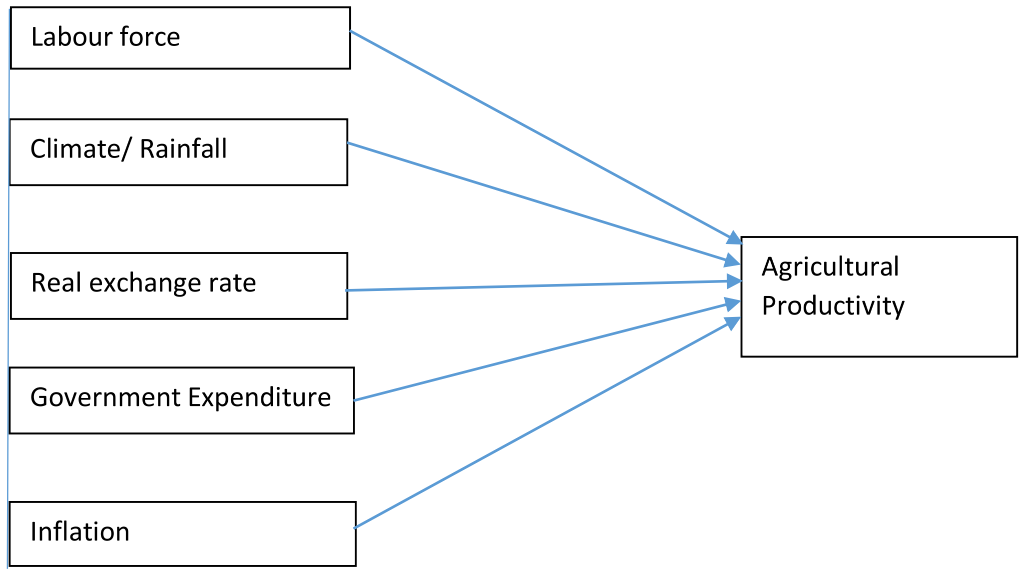
3.0 METHODOLOGY

3.1 Research design

This study applied quantitative research design where empirical data was analyzed.

Cobb-Douglas production function was estimated by ordinary least squares (OLS) to evaluate the determinants of agricultural productivity in Kenya. Generally, productivity encompasses varied likely combinations of measures of inputs and output. The widely used productivity measure, combines value added which is used as a metric for output, with a proxy for labour input, which is applied to the entire economy. This gives value added per worker, which is a partial measure of productivity because it only considers on input ie labour input. This however is preferred as it allows comparisons across different countries and sectors.

3.2 Conceptual framework



Independent Variables Dependent variable

Agricultural productivity(Y) was regressed against; labour force (L), rainfall(R), real exchange rate(E), government expenditure on agriculture(G) and inflation(I).

$$LnY_t = \beta_0 + \beta_1(\ln Lt) + \beta_2(\ln Rt) + \beta_4(\ln Et) + \beta_3(\ln Gt) + \beta_5(\ln It) + \mu_t$$

Where

Y_t is agricultural productivity measured as agriculture value added per worker

L_t is labour force measured in terms of population growth rate at time t

R_t in the rainfall measured in terms of annual rainfall in Kenya at time t

E_t is the real exchange rate measured as real effective exchange rate at time t

G_t is the government expenditure on agriculture at time t

I_t is the inflation rate measured using annual consumer price index at time t

μ_t is the random error term.

Definition of variables

Labour Force (L)

The labour force is proxied by total population growth rate. The relationship between labour force and agricultural productivity is expected to be negative. This is due to the pressure on the agricultural land with an increase in population.

Inflation (I)

Inflation is the sustained general increase in price levels of goods and services. Inflation is measured in terms of consumer price index over time. When we consider the prices of outputs, the relationship between price level and agricultural productivity is expected to be positive. When inputs are considered the relationship between price levels and agricultural productivity is expected to be negative.

Rainfall (RF)

Rainfall is a variable indexed by total annual rainfall in different counties in Kenya. It is used to represent climate as a determinant of agricultural productivity. From theory, a positive relationship is expected between rainfall and agricultural productivity.

Real exchange rate (E)

The real exchange rate is the purchasing power of a currency relative to another currency. In this project, it is used as a policy variable to bring in the effect of a country's macroeconomic and trade policies. The real exchange rate is a macro price and affects both the prices of imported inputs and tradeable outputs. The relationship between exchange rate and agricultural productivity is rather uncertain.

Government expenditure in agriculture (G)

This is used to represent government direct involvement in agriculture. From theory, we expect a positive relationship between government expenditure on agriculture and agricultural productivity. This is attributed to increased investment by the government in the agricultural sector from input subsidies, extension services, provision of infrastructure and research which all contribute positively to enhancing agricultural productivity.

Agricultural productivity (Y)

Agricultural productivity proxied by agriculture value added per worker is a measure of agricultural productivity. Value added in the agricultural sector is considered as measures the output of the agricultural sector less the value of intermediate inputs. Agriculture comprises value added from forestry, hunting, and fishing as well as cultivation of crops and livestock production. This is the dependent variable in the model.

3.3 Data sources

The study utilized annual time series data for the period from 1980 to 2013. The data in this study was obtained from various sources: The Kenya National Bureau of Statistics (KNBS); statistical abstracts and economic surveys, and from the World Bank development indicators.

3.4 Data processing and Analysis

The study used the ordinary least squares method of estimation to estimate the parameters of the model. To test the statistical significant of the parameters t-test was used, by comparing the t-test critical estimates and t-test estimated values.

The study also employed Johansen-Granger Cointegration procedures and Error Correction Model (ECM) to forecast long-run relationships and to check for short-run relationship respectively among the study variables.

Dickey–Fuller test for unit root was used to test for stationarity. Non-stationarity is solved through first differencing.

CHAPTER 4

4.0 DATA ANALYSIS, FINDINGS, AND DISCUSSION

4.1 Method of Analysis

This study employed the ordinary least square estimation method to estimate the parameters of the model. To test the statistical significance of the parameters the study employed t-test. T-critical value (from t distribution table) and t-statistic were compared at 5% level of significance. When the magnitude of t-statistics is great the more reliable the value of the coefficients are to predict the dependent variable. When the magnitude of the t-statistics are close to zero the less reliable the value of the coefficients are to predict the dependent variable.

R-squared which is the coefficient of multiple determination and F statistics were employed to determine the overall significance of the regression equation. R-squared is a statistical measure of how close the data are to the fitted regression line. It explains the extent to which the independent variables affect the total variation in the dependent variable. The higher the R-squared, the better the model fits the data.

To show the overall significance of the model specified, we used the F – test. The F statistic is defined as (explained variation k /unexplained variation k – 1). If the F-statistic is greater than the F critical value, then we conclude that the overall model is statistically significant or otherwise (Shim et al., 1995). To establish whether the model is acceptable or otherwise we compared the value of the Durbin-Watson (DW) Statistic from the multiple regression results with the value of the R-squared. If the value of the DW statistics is greater than the value of the R-squared, then our model is not spurious and can be accepted or otherwise (Gujarati *et al,* 2009).

We tested for autocorrelation which is detected by using the Durbin-Watson statistic. If the value of the DW statistics lies between 1.5 to 2.5, this indicates that there is no problem of autocorrelation

(Shim *et al*, 1995). Heteroscedasticity in our specified model which is detected by using the Park test. According to the Park test, if a statistically significant relationship exists between the log of the error term and the explanatory variable, then, the null hypothesis (H_0: no heteroscedasticity) can be rejected.

Source of Data

Data was collected from the World Development Indicators 2014 and statistical abstracts and economic surveys from KNBS.

Econometric Package

The econometric software used in this study was Stata.

4.2 Empirical Findings

Presentation of the results

Test for the Presence of Autocorrelation Using DW Test

Hypotheses: Null hypothesis H_0: no autocorrelation. Alternative hypothesis H_1: autocorrelation

DW test statistic: DW = 1.8309091

Decision rule

According to (Shim & Siegel, 1995), if the DW test statistics fall between 1.5 and 2.5 there is no autocorrelation. If it falls below 1.5 there is positive autocorrelation. If it falls above 2.5 there is negative autocorrelation.

DW Statistic Conclusion

Since the DW test statistic figure of 1.8309091 falls between 1.5 and 2.5 then there is no autocorrelation.

Test for stationarity

Table 4. 1 Dickey-Fuller test for unit root

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t) – E	-2.828	-2.453	-1.696	-1.309
Z(t) – I	-4.225	-2.453	-1.696	-1.309
Z(t) – R	-5.772	-2.453	-1.696	-1.309
Z(t) – Y	-1.804	-2.453	-1.696	-1.309
Z(t) – L	-1.707	-2.453	-1.696	-1.309
Z(t) – G	0.128	-2.453	-1.696	-1.309
Z(t) - G - Lag (1)	-5.073	-3.702	-2.980	-2.622

From the results above we can conclude that exchange rate (E), inflation rate (I), rainfall (R) are stationary at all levels of significance. Whereas labour force given by population growth rate (L) is stationary at 5% and 10% level of significance. Government expenditure (G) was only stationary at all levels of significance after lagging once. Thus we can conclude that the model is a stable predictor of the independent variable at 5% level of significance.

Test for the Presence of Heteroscedasticity

According to (Koutsoyiannis, 2006), effects of heteroscedasticity is greatly lessened by transforming the data into logs. All the variables in the model were consequently transformed into logs.

Test for cointegration

Table 4. 2 Cointegration Rank for determinants of agricultural productivity, (1980-2013)

Sample: 1980 – 2013

Test assumption: linear deterministic trend in data
Series Y, E, I, L, R, GE Lags 2

Eigenvalue	Likelihood Ratio (Trace statistics)	5% Critical Value
0.93144	134.0323	68.52
0.82152	80.6100	47.21
0.73523	39.4140	29.68
0.57533	12.8645	15.41
0.27513	2.8898	3.76

Normalized Cointegrating Coefficients: 1 cointegrating Equation

Y	E	I	L	R	GE	Constant
1	-.0866485	-.1143693	.0560059	.3787262	.0985152	-4.221326

The eigenvalues are presented in the first column, while the likelihood ratio gives the trace statistic are presented in the second column:

The analysis is restricted to one cointegrating equation,

From Table (4.2) it can be seen that likelihood ratio test implies the choice of r=1 that is we have one cointegrating relation. We can interpret this cointegration vector based on economic theory as the agriculture productivity determinants.

Under the assumption of r=1 cointegrating relationship, we have one normalized Y cointegrating equation.

We interpret this equation as agricultural productivity determinants equation. This leads to the following long run relation:

$$Y = -4.221326 - 0.0866485E - 0.1143693I + 0.0560059L + 0.3787262R + 0.0985152GE$$

This long run relation highlights the negative impact of exchange rate (E) and inflation(I) on agricultural productivity (Y). One percent increase in exchange rate and inflation reduces agricultural productivity by 0.0866485% and 0.1143693% respectively. One percent increase in labour force, rainfall, and government expenditure increases productivity by 0.0560059, 0.3787262, & 0.0985152 respectively.

Cointegration analysis concludes a long-run relationship between agricultural productivity and exchange rate, inflation, labour force, rainfall and government expenditure.

Table 4. 3 Error Correction Model Equations (ECM)

For the Variables, Y, E, I, L, R & GE Estimated by OLS based on Cointegrating

Regressors	Y	E	I	L	R	GE
ce1 L1	**-.125832**	**-.1887736**	**8.313998**	**.018942**	**1.477493**	**1.446446**
	(.1339856)	**(.3945599)**	**(2.016857)**	**(.0237973)**	**(.478928)**	**(.9542383)**
Dlog_Y	**-.1328605**	**-.447267**	**-6.175272**	**.0233853**	**-.2633606**	**-.4661141**
	(.2385087)	**(.7023588)**	**(3.590221)**	**(.0423617)**	**(.8525431)**	**(1.698646)**
Dlog_E	**-.0939236**	**-.0214892**	**1.354942**	**-.0150012**	**.5009989**	**.2410367**
	(.0843108)	**(.2482779)**	**(1.269113)**	**(.0149745)**	**(.3013668)**	**(.6004571)**
Dlog_I	**-.01209**	**-.0072875**	**.0243545**	**.0024236**	**.1383145**	**.1928541**
	(.0115335)	**(.0339637)**	**(.1736107)**	**(.0020485)**	**(.041226)**	**(.0821407)**
Dlog_L	**.4395862**	**-.5597813**	**-15.77305**	**.8384065**	**-3.595226**	**-4.612638**
	(.5042627)	**(1.48495)**	**(7.590561)**	**(.0895625)**	**(1.802474)**	**(3.591333)**
Dlog_R	**-.00474**	**-.082685**	**1.010865**	**.0007271**	**-.13592**	**.1259666**
	(.0561423)	**(.1653275)**	**(.8450984)**	**(.0099715)**	**(.2006792)**	**(.3998426)**
Dlog_GE	**.0106732**	**-.0652335**	**-.8052844**	**-.0035869**	**.0588106**	**-.4606834**
	(.0312009)	**(.0918802)**	**(.4696605)**	**(.0055416)**	**(.1115268)**	**(.2222111)**
C	**.0024814**	**.0537807**	**.0044054**	**.0000209**	**-.0176118**	**-.0000966**
	(.0104631)	**(.0308117)**	**(.15749890**	**(.0018584)**	**(.0374001)**	**(.0745177)**
R^2	**0.1480**	**0.3231**	**0.3204**	**0.9105**	**0.7181**	**0.6613**

Equation 1

Y= -4.221326 -0.0866485E - 0.1143693I + 0.0560059L + 0.3787262R + 0.0985152GE

From Table 4.3 the values of Standard errors are in brackets.

From the results of Error Correction model, labour, rainfall and government expenditure have a high explanatory power, as indicated by R^2 of 0.9105, 0.7181 and 0.6613 respectively. Exchange rate and inflation rate have a relatively low explanatory power given by R^2 of 0.3231 and 0.3204 respectively. This imply's that in the short run Labour, rainfall, and government expenditure are the main determinants of agricultural productivity in Kenya.

Table 4. 4 OLS estimates 1980-2013

Variable	Coefficient	Standard error	t-statistics	t-critical
log_E	-.0405422	.0430437	-3.94	
log_I	-.0193286	.0139671	-2.38	
log_L	.1984402	.2132522	1.93	2.052
log_R	.0917103	.0683248	2.34	
fdlog_GE	.0639032	.0402303	2.59	
Const	6.021043	.5973901	10.08	

Unadjusted R2 = 0.7658; Adjusted R2 = 0.7039; F-statistic F(5, 27) =10.76] (p-value < 0.00001); Dwcfdurbin-Watson statistic = 1.8309091

Using the 33 observations

Dependent variable: log_Y (Agricultural Productivity)

4.3 Discussion of results

The value of DW statistics (1.8309091) is greater than that of R-squared (0.7658) thus the regression result is not spurious. This model for agricultural productivity in Kenya can, therefore, be accepted and meaningful conclusions drawn based on the results. Statistically, the model is a good fit as the values of unadjusted R-squared is 0.7658. This implies that 76.58% of total variation in agricultural productivity in Kenya can be explained by the inflation rate, government expenditure on agriculture, exchange rate, labour force and climate (rainfall). Overall the model is statistically significant as the value of F-statistics (10.76) is greater than the f-critical value (2.07298) at one percent level of significance.

From the above tests, it could be seen that regression results are not affected by the problems of autocorrelation, non-stationarity, and heteroscedasticity.

From the regression results, a one percent increase in exchange rate will cause a 0.405422% decrease in agricultural productivity. From literature the relationship between exchange rate and agricultural productivity is uncertain. Exchange rate affects both the prices of imported inputs and tradeable outputs. In this case, we can conclude the impact of exchange rate on imported inputs outweighed the effect on agricultural outputs. An increase in exchange rate affect inputs which are imported negatively which consequently adversely affects productivity. Thus an increase in exchange rate resulted in a decrease in productivity. The findings contradict those of (Brownson *et al*, 2012).

A one percent increase in annual rainfall resulted in an increase of 0.0917103% in agricultural productivity. This is due to the fact that agriculture in Kenya is still largely dependent on rain-fed agriculture, despite the government effort in investing in irrigation schemes as only a small percent of land is under irrigation. This is within expectation as an increase in rainfall was hypothesized to cause an increase in agricultural productivity. It is consistent with the findings of (Ayinde *et al*, 2011).

A one percent increase in government expenditure on agriculture resulted in an increase in agricultural productivity by 0.0639032%. From theory Government investment in the agricultural sector is critical in boosting agricultural productivity. Thus the results of the regression results conform to expectations. This finding is consistent with (Benin *et al*, 2009) and (Selvaraj, 1993).

A one percent increase in annual inflation rate results in a decrease in agricultural productivity by 0.0193286%. We hypothesized that there will be a positive relationship between inflation and agricultural productivity in Kenya. However, a negative relationship was realized. This can be explained by the fact that inflation affects the price levels of both output and inputs. Thus if the price level of inputs is too high this will impact agricultural productivity negatively. This finding is consistent with (Brownson *et al*, 2012).

A one percent increase in labour force causes an increase in agricultural productivity by 0.1984402%. This can be attributed to the fact that agricultural sector in a significant source of employment in Kenya thus increase in labour force will result in an increase in agricultural productivity. This finding is consistent with (Abugamea, 2008), (Odhiambo *et el*, 2004) and (Ekborn, 1998).

CHAPTER 5

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study set out to examine the factors that influence agricultural productivity in Kenya. This study applied quantitative research design to analyze empirical data. The main objective of the study was to establish the factors which influence agricultural productivity in Kenya. The Cobb-Douglas production function and Ordinary Least Square estimation technique were employed as the method of estimation. The dependent variable in the model is Agricultural productivity while the independent variables were inflation rate, exchange rate, government expenditure, climate (rainfall), and labour force. Apart from labour force, all other independent variables in the model; inflation rate, exchange rate, government expenditure, climate (rainfall) are statistically significant. The study utilized annual time series data from 1980 to 2013.

The study also employed Johansen-Granger Cointegration procedures and Error Correction Model (ECM) to forecast long-run relationships and to check for short-run relationship respectively among the study variables. The long run relation highlights the negative impact of the exchange rate (E) and inflation (I) on agricultural productivity (Y), while Labour force, rainfall, and government expenditure impact agricultural productivity positively. In the short run Labour, rainfall, and government expenditure are the main determinants of agricultural productivity in Kenya.

5.2 Conclusion

From the regression results, one percent increase in agricultural expenditure caused an increase of 0.0639032%. One percent increase in annual rainfall caused an increase of 0.0917103% in agricultural productivity. One percent increase in labour force caused an increase of 0.1984402% in agricultural productivity. One percent increase in inflation rate caused a 0.0193286% decrease in agricultural productivity. Finally, one percent increase in exchange rate caused 0.405422% decrease in agricultural productivity.

From the results of Error Correction Model, labour, rainfall and government expenditure have a high explanatory power, as indicated by R^2 of 0.9105, 0.7181 and 0.6613 respectively. Exchange rate and inflation rate have a relatively low explanatory power given by R^2 of 0.3231 and 0.3204 respectively. This implies that in the short run Labour, rainfall, and government expenditure are the main determinants of agricultural productivity in Kenya.

This long-run relation highlights the negative impact of exchange rate (E) and inflation (I) and agricultural productivity (Y). One percent increase in exchange rate and inflation reduces agricultural productivity by 0.0866485% and 0.1143693% respectively. One percent increase in Labour force, rainfall, and government expenditure increases productivity by 0.0560059, 0.3787262, & 0.0985152 respectively. Cointegration analysis concludes a long-run relationship between agricultural productivity and exchange rate, inflation, labour force, rainfall and government expenditure.

Productivity is a critical attribute in the agricultural sector. Improvement in productivity will foster food security, increase foreign exchange inflow as well as contribute to poverty reduction especially in the rural areas.

5.3 Policy Recommendations

From the findings of the study, the following policy recommendations are suggested:

1. The government should continually ensure inflation rates are maintained at single digits both in the short-run and long-run.
2. Efforts should continually be made to expand and modernize existing irrigation schemes and establish new ones to ensure the country is not too reliant on rain-fed agriculture.
3. The government should continue to invest in agriculture through budgetary allocation to the sector as agriculture is still a very significant sector in Kenya's Economy.

5.4 Areas of further study

This study combined the effect of five factors and their effect on agricultural productivity in Kenya. Further research needs to be done on individual determinants of agricultural productivity so as to have an in-depth understanding of the contribution of individual factors without aggregating them in a study.

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