EFFECT OF REDUCED EXTENSION SERVICES ON USE OF PRODUCTIVITY-ENHANCING AGRICULTURAL INPUTS IN KENYA

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF ECONOMICS IN FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTERS OF ARTS IN ECONOMICS OF THE UNIVERSITY OF NAIROBI.

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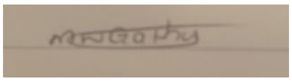
DECLARATION

This research project is my original work and it has not been submitted for the award of a degree in any another university.

Signed  Date 20/11/2021

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This project has been submitted for examination with my approval as the university supervisor.

Signed:  Date: 23 November, 2021

DR. JOHN KAMAU GATHIAKA

DEDICATION

I dedicate this work to my husband Edison Mochiemo, my daughters Angela and Alysha, parents and brothers for their support and encouragement that has always inspired me to work hard with determination in life.

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I wish to sincerely register my gratitude and appreciation to School of Economics of the University of Nairobi for giving me the opportunity to pursue my studies in masters' degree in this institution. I thank my supervisor Dr. John Kamau Gathiaka for his professional advice and creating time to guide me in this study. I wish to appreciate the support provided by my friends and classmates Esther, Joseph and Victor for your support and encouragement throughout my study period.

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LIST OF ABBREVIATIONS AND ACRONYMS

FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
KNBS	Kenya National Bureau of Statistics
OLS	Ordinary Least Square technique
R&D	Research and Development
T&V	Training and visit

ABSTRACT

The agricultural sector contributes significantly to economic growth in Kenya. However, the sector's impact in the country's economic growth has been declining over the years. In Kenya, farm production has either stagnated or declined over time, according to Vision 2030. At the same time, there are constraints impacting on the extension service delivery that include declining human resource, uncoordinated pluralistic extension service delivery mode and low funding. This study examined the effect of reduced extension services on usage of productivity enhancing agricultural input of fertilizer in Kenya. It was informed by two theories namely: diffusion of innovations theory and theory of production. The research used time series data from the Kenya National Bureau of Statistics (Production Statistics Database) for the period between 1980 and 2019. The data was analyzed using regression method and time series procedures. The findings indicated that extension services and labor had positive and significant effect on use of productivity-enhancing agricultural inputs represented by fertilizer. The government of Kenya should review policies relating to agricultural extension services. The government should particularly develop a comprehensive extension service program that will address extension-service issues that undermine agricultural productivity and output. The government should increase budgetary allocations to agricultural extension services so that more farmers could participate in extension service programs. Finally, the government should invest in agricultural training so as to build skillful labour force in the agricultural sector in a bid to raise productivity in the sector.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Kenya's agricultural sector accounts for 51% of the country's GDP (direct and indirect), 60% of jobs and 65% of exports (World Bank, 2018). Small-scale agriculture dominates the industry, accounting for 78 percent of total agricultural production and 70 percent of industrial output, with ownership of 0.2 to 3 hectares (World Bank, 2015). Horticulture and grazing are driven by agriculture, but production is modest, particularly for wheat (World Bank, 2015). Because the bulk of the poor work in agriculture, productivity is also vital for poverty reduction. Between 2005 and 2015, the agricultural sector's expansion contributed the most to poverty reduction (World Bank, 2018).

Kenya was one of the few countries in Sub-Saharan Africa with sustained, if low, long-term growth between 1961 and 2008, according to a historical assessment of total factor productivity in agriculture (Fuglie & Rada, 2013). There are fears, however, that productivity is declining: in 2014, maize yields per hectare were lower than in 1994 (World Bank, 2018). Kenya was one of the few states in Africa to experience an overall decline in maize yields between 1990/92 and 2014/16 (Wiggins, 2018). More positively, Kenya’s horticulture sub-sector continues to record dynamic growth (Matchmaker Associates, 2017).

Table 1 provides select data from Kenya, Ethiopia and Uganda, illustrating changes in government expenditure, employment and cereal yield over time in Ethiopia, Uganda and Kenya.

Table 1.1: Agricultural sector indicators in Kenya, Ethiopia and Uganda

	1995			**2005**			**2016**		
	Kenya	**Ethiopia**	**Uganda**	**Kenya**	**Ethiopia**	**Uganda**	**Kenya**	**Ethiopia**	**Uganda**
Government expenditure on agriculture (% total outlays)	0	0	0	3.9	15.9	3.1	1.5	17.5	4
Employment in agriculture (%)	45.9	89.4	81.3	41.4	80.2	82.1	38.1	69	75.8
Cereal yield (Kg/Hectare)	1,753	1,034	1,571	1,646	1,361	1,574	1,628	2,325	2,019

Source: http://www.fao.org/faostat

Some striking features are the scale of government expenditure in Ethiopia, compared with Kenya and Uganda, and that both Ethiopia and Uganda have overtaken Kenya in terms of cereal yield. Further, the government expenditure on agriculture in 2016 was higher in Ethiopia and Uganda compared to Kenya. This is likely to contribute to reduction in agricultural productivity in Kenya. For instance, Table 1 shows that cereal yield in Kenya was 1,753 Kg/HA in 1995, in 2005, the yield declined to 1,646 Kg/HA. The yield further declined to 1,628 Kg/HA in 2016. This is a clear indication that there is a serious problem in the agricultural sector.

In Kenya, agriculture is considered the backbone of the economy. However, the sector's contribution to the country's economic growth declined from 40% in 1963 from 33% in the 1980s to 27% in 2014, which was calculated using gross domestic product (GDP) (KNBS, 2015). However, industry remains dominant in the economy as a whole, accounting for around 60% of the country's foreign exchange and around 16% of employment in the formal sector (KNBS, 2015). Evidently, there exist a high relationship between agricultural development and economic growth.

According to Vision 2030, agricultural productivity in Kenya is still a major concern. The productivity has either stagnated or decreased over the past few years (Government of Kenya, 2015). Kenya's agriculture sector is largely dependent on rainfall. The influence of climate change and the occurrence of natural disasters, including drought and flooding, have raised major concerns. There is a high correlation between rainfall and agricultural production in many counties in Kenya, as it affects productivity. According to the World Bank (2015), only about a third of Kenya’s land is productive in terms of agriculture.

Extension services play a vital role in agricultural output by disseminating information, technology, and inventions. The services are important for improving efficiency. Constraints influencing the reliable and successful delivery of extension and advisory services need to be addressed in this respect. However, due to diminishing human capital, uncoordinated pluralistic extension service delivery and low funding, there are constraints affecting the delivery of the service (Thakur & Chander, 2018).

The reduced provision of extension services is likely to influence the usage of agricultural productivity enhancing inputs such as fertilizer. The real yearly increase in fertilizer consumption rates in Sub-Saharan Africa was just 5% per year from the early 1960s to the late 1980s, compared to 13% in South Asia and 9% in Southeast Asia (Larson & Frisvold, 1996). If the average import level of inorganic fertilizers in Sub-Saharan Africa climbs to 50 kg/ha, this could contribute to an increase in agricultural production. According to data from other locations and field trials conducted by the Food and Agriculture Organization (FAO), increasing fertilizer use can make a significant contribution to development. Studies showing that fertilizer usage results in a 50-75 percent increase in food crop yields in Latin America and Asia are cited by Byerlee and Heisey (1992).

Irrigation is another agricultural productivity enhancing input. While the mean annual rainfall tends to increase/decrease with climate change, rainfall variability is expected to be more significant for agricultural production (Bryan et al., 2011). Ochieng, Kirimi and Mathenge (2016) suggest that temperature has a greater impact on production than rainfall. Climatic impacts are likely to impact differently on various crops. Ochieng, Kirimi and Mathenge (2016) found in his analysis of small-scale maize and tea production that rising temperatures have a positive impact on tea revenues, but a negative impact on harvest income. Measures to reduce climatic risks in the agriculture sector could improve growth and productivity (D'Alessandro et al., 2016). Irrigation, which comprises applying a controlled amount of water to crops at predetermined times, is a critical measure. Irrigation is important in crop growing, maintenance of landscapes and revegetation of disturbed soils (Becerra, Cruz, Ríos & Castelli, 2013).

Land management practices are also likely to be affected by reduced extension services. Bryan et al. (2011) found that soil nutrient management (combining inorganic fertilizers, mulch and manure) is a three-pronged strategy that increases carbon sequestration in soil, increases yields and increases income. This has not only advantages for climate adaptation and protection, but also for productivity. However, the authors note potential trade-offs as new practices are introduced and caution that the most effective strategies of productivity enhancement are specific to different crop types, planting calendars, and agro-ecological zones. Zougmoré, Jalloh and Tioro (2014) noted that sustainable land management practices need to be promoted to increase food production.

As such, agricultural extension programs have been one of the key drivers of rising agricultural production. It is a technology transfer tool and helps farmers solve problems and actively engage them in the information system of agriculture (Diesel & Miná Dias, 2016). Expansion, according to FAO (2011), is a program that assists farmers, their organizations, and other market players in gaining access to knowledge, information, and technology; establishing cooperation in the fields of research, education, agriculture, and other related institutions; and assisting them in developing their own skills in science, organization, and management.

Extension service provision in Kenya has been in a poor state since the advent of structural adjustment programs of the 1980s. It receives low budget allocations which mean that farmers get poor agricultural information and consequently adopt poor agricultural practices that result in low harvests. The research and extension department in Machakos County, for instance, notes that currently one extension officer supports 1500 farmers (Mutiso, 2015). Furthermore, budgets for extension services have been reduced to less than 2% of the national budget. It is possible that the collapse of government sponsored extension services have contributed to decline in agricultural production.

Having access to expansion services, according to Emmanuel et al. (2016), encourages the usage of chemical fertilizers. The advent of chemical fertilizers and access to expansion services has enhanced agricultural productivity. To increase the use of chemical fertilizers and access to agricultural extension services, political alternatives such as promoting farmer participation in irrigation systems and cultivation technology, facilitating access to educational facilities and credit, raising awareness among women farmers and leasing agricultural land. required land. According to Ragasa and Mazunda (2018), this measure becomes statistically significant if access to improved services is expanded to include indicators for farmers' interests and satisfaction. Farmers who received a lot of helpful agricultural advice were more productive and safer on food than those who said they received advice they thought was useless.

1.2 Statement of the Problem

An analysis by Behaghel *et al.* (2018) showed that while agriculture provides employment for more than 50 percent of the Sub-Saharan Africa labor force and contributes an average of 15 percent of GDP, nations in the region face major challenges related to agricultural development. Restricted extension service is one big obstacle. In Kenya, agricultural sector is the most important, with a huge multiplier impact on the economy. There is a need to continuously increase its competitiveness considering the rise in Kenyan populace that was 47.6 million in 2019 (KNBS, 2019). The contribution to economic growth of the agricultural sector has reduced with time from 40% in 1963, 33% in the 1980s to 27% in 2014 (KNBS, 2015). This could be due to declining productivity. Extension services have also been dwindling. The effect of dwindling extension service to declining agricultural productivity is an issue that calls for research.

The number of farmers in Kenya who access extension services is poor. Wanyama, Mathenge and Mbaka (2016) established that in 2013-14, just 21 percent of the sampled households accessed extension services in a survey across 38 of the 47 counties in Kenya, but most (59 percent) farmers relied on the public extension system. A key barrier is a lack of skilled personnel: the national extension staff to farmer ratio is 1:1,000, compared to the recommended ratio of 1:400 (Wanyama et al., 2016). Extension services in Kenya also benefit the wealthier farmers. Wanyama *et al.* (2016) found that public extension providers and private for-profit providers were better represented among higher income groups, with the distribution of private non-profit extension-service providers slightly more equal. These issues call for further research to evaluate the impact of reduced extension services on agricultural productivity in Kenya.

Omache (2016) examined factors affecting Kenya's agricultural productivity in Kiambu County. The survey aimed, in particular, to determine the influence of the provision of extension services on agricultural productivity. Omache (2016) research poses a conceptual gap since the impact of extension service delivery on the use of productivity-enhancing inputs such as fertilizer, cropping/land management coverage and irrigation was not explored. In addition, the study focused on a narrower scope that did not address agricultural productivity in Kenya.

The impact of Training and Visit (T&V) agricultural extension system in Kenya on land productivity was investigated by Evenson and Mwabu (2001). The information used to determine its efficiency was collected from the Government of Kenya in 1982 and 1990. The study was conducted almost two decades ago and therefore its findings may need to be updated for reliability in explaining the current situation with regard to extension services and agricultural productivity. There was need therefore to conduct a study using current data. This study thus sought to fill the above-mentioned research gaps.

1.3 Research Questions

The survey question was: How does reduced extension services influence the use of agricultural productivity-enhancing input of fertilizer in Kenya?

The specific research questions were;

i. How has fertilizer usage responded to reduction in extension services in Kenya?

ii. What is the impact of labour on use of agricultural productivity-enhancing input of fertilizer in Kenya?
iii. What is the impact of capital on use of agricultural productivity-enhancing input of fertilizer in Kenya?

1.4 Research Objectives

The main goal of the survey was to assess the effect of reduced extension services on the use of agricultural productivity-enhancing input of fertilizer in Kenya.

The specific objectives of the study are;

i. To examine how fertilizer usage has responded to reduction in extension services in Kenya.
ii. To determine the effect of labour on use of agricultural productivity-enhancing input of fertilizer in Kenya
iii. To examine the effect of capital on use of agricultural productivity-enhancing input of fertilizer in Kenya.

1.5 Justification of the Study

As mentioned in the problem statement, agriculture is essential in Kenyan economic growth and increased productivity decreases are justifiable reasons for conducting this study. Policy makers, in particular the Ministry of Agriculture, may benefit from the results and recommendations of this research in formulation of policies aimed at improving agricultural sector productivity. Further, the findings of this research may be beneficial to farmers across the country through action that the government may take in order to enhance agricultural productivity such as provision of extension services. Future scholars may find this investigation useful particularly in furtherance of related topics.

1.6 Scope of the Study

The paper evaluated the impact of reduced extension services on agricultural productivity in Kenya. The study was done in Kenya, covering the whole agricultural sector. Secondary data on the study variables was sourced from KNBS (Production Statistics Database) for the period between 1980 and 2019.

1.7 Organization of the next Sections

This study was divided into five sections. The first chapter discussed the research's context, the problem statement, the objectives, the reasoning, and the study's scope. Chapter two concentrated on the study's theoretical basis, empirical literature, and literature review. Chapter three outlined the theoretical model, the definition of the empirical model computed, the description of variables, and data sources. The data analysis and discussion were covered in Chapter 4, and the research conclusion and policy recommendations were covered in Chapter 5.

CHAPTER TWO: LITEREATURE REVIEW

There are two parts to the section: the study of theoretical and empirical literature. The theoretical literature review offers a summary of the theoretical basis on which the study's subject matter is based, whereas the empirical literature review is based on previous scientific findings relating to the research variables. There's also a summary of the chapter's literature review.

2.1 Theoretical Literature Review

The research is informed by the following theories: The diffusion of innovations theory and theory of production.

2.1.1 The Diffusion of Innovations Theory

Rogers (2003) was the proponent of this theory, postulating that interpersonal relations and the media are responsible for reaching conclusions, giving opinions and supplying information. Rogers argues that certain factors must be in play for innovation to occur; technology or innovation, communication networks, time periods, and individual interrelationships. Human capital is heavily dependent upon here. For it to be self-sustaining, technology must be immensely embraced.

In this principle, the element of contact falls into play, which states that it can be told to a certain group of people over time for an idea to be approved. The extension service providers contact the farmers in this situation. For correspondence, the medium should be accurate and timing is crucial. The adoption process depends heavily on human capital. Therefore, in order for the technologies to be efficiently delivered, sufficient and necessary energy should be poured into the personnel docket. With specific agricultural messages to farmers, it is possible to send personalized brochures.

Farm extension officers may conduct agricultural seminars where either a filmed audiovisual or one-on-one may teach specific agricultural messages. Farmers would not be able to access the vital information needed to promote agricultural production in the absence of adequate and qualified planning. The messages should be written in straightforward English so that farmers may understand them quickly. Information can be broadcast over the radio, on television, or on tapes that can be duplicated in the farmer's home. The contact feedback feature ensures that extension officers get feedback from farmers on what they've been told and informed about. This can be used to assess whether or not learning has taken place as a benchmark.

2.1.2 Theory of Production

The production theory describes the concept by which businesses decide how much of each commodity they sell (outputs or products) they will produce and how much (inputs or production factors) they will use of each type of labor, raw material and fixed capital goods. Some of the most basic notions of economics are used by the theory. These two considerations include the relationship between the costs of the goods and the prices of the productive factors used to produce the goods (or wages or rents) and on the other hand, the relationship between the prices of the goods and the productive factors and on the other hand, the quantity and the productive factors used to produce the goods.

The theory describes the technique through which corporations decide how much of every commodity they will produce and how lots input they will use of every source of labor, raw material and fixed capital goods. The principle uses some of the greater crucial notions of economics. Both include the relationship between the expenditure of the goods and the expenditure of the productive elements used to manufacture the goods (or the profits or rent of the goods) and the link between the prices of the goods and the productive elements and on the other hand, the amount of the goods produced or used and the productive factors produced or used. With this study in mind, the goal of farmers is to optimize agricultural productivity. It is expected that provision of extension services to farmers will enhance agricultural productivity.

Infrastructural development contributes to agricultural production (Li, & Liu, 2009). Roads, telecommunications, powers and irrigation systems, education and medical services that enhance the quality of workers help agricultural production. According to Fakayode, Omotesho, Tsoho and Ajayi (2008), providing appropriate infrastructure is often diagnosed as the key to agricultural advancement, because infrastructure is known to contribute to economic improvement, poverty alleviation, and green development.

Training and development to farmers has the following benefits; increased local food availability and improved productivity (Davis, 2008). It provides local markets with enough food, increases farmer revenue and also enhances agricultural strategies. By increasing availability of local food directly, this addresses hunger and poverty problems. Increasing sustainability of agricultural practices ensure food security for the future. Training and development ensures increased job satisfaction as well as morale among employees. It guarantees employee motivation and effectiveness, resulting in reduced turnover of employees.

Better agricultural methods, according to Simtowe et al. (2011), are still considered as a key way out of poverty in most developing nations. Agricultural innovations, on the other hand, are typically sluggish to be seen, and some aspects of their introduction are still poorly understood, as Bandiera and Rasul (2006) point out. The scientific literature has identified extreme weather, liquidity limits, technology awareness (Diagne & Demont, 2007), risk aversion (Koundouri et al., 2006), institutional constraints, a lack of human and financial resources, and a lack of infrastructure (Foster & Rosenzweig, 1995). They are seen as a possible explanation for the low acceptance of better agricultural technologies.

Technology, according to Rehmann et al. (2016), can be used in a variety of facets of agriculture, including the administration of herbicides, pesticides, fertilizers, and improved seeds. The technology has shown to be quite useful in agriculture throughout time. Farmers can now grow crops in locations where they previously thought they couldn't, but this is only feasible because to agricultural biotechnology. For example, genetic engineering has enabled the introduction of specific features into the genome of other plants or animals. This technique increases crop resistance to pests and drought. Through technology, farmers can electrify every process for efficiency and increased production.

The impact of agricultural technology on food productivity is enormous. Agricultural technology encompasses a wide range of improved procedures and practices that have an impact on the expansion of agricultural productivity (Jain, Arora & Raju, 2009). According to Loevinsohn et al. (2013) the most common problems in technology development and crop promotion are new varieties and agricultural systems, soil and soil fertility management, weed and insect control, and irrigation and water management. According to Challa (2013), with an increase in the input-output relationship, new technologies tend to increase production and lower average production costs, leading to significant gains in agriculture.

According to Kariyasa and Dewi (2013), improved technology leads to increased productivity, which contributes to socioeconomic progress. The introduction of better agricultural technology is associated with higher incomes and lower rural poverty in farming households; improvement of nutritional status; lower prices of staple foods; better employment and income opportunities for landless workers. In Asian countries, improved technology is viewed as a critical aspect in the green revolution's success (Chen & Ravallion, 2004). According to Jain et al. (2009), agricultural technologies outside the host country have a harder time sustaining their marginal lifestyles and are more susceptible to socio-economic stagnation, which often leads to hardship.

2.2 Empirical Literature Review

Wee and Ahnaish (2012) observed that training is mandatory and appropriate in order to boost workers' productivity and increase production. In Libya, public agriculture project managers pay less attention to training and, as a result, the productivity of workers on such farms is very poor. The study also showed that there are multiple problems facing the agricultural sector in Libya, including the misuse of human and material capital, low productivity, high costs and a continuing decrease in production levels.

Emmanuel, Owusu-Sekyere, Owusu, and Jordaan (2016) studied the impact of agricultural development on chemical fertilizer use and rice production in Ghana. The selectivity and endogeneity effects were controlled for using a parametric method. The results have shown that the use of chemical fertilizers is commonly encouraged by access to extension facilities. In addition, rice cultivation benefits from proximity to extension installations and the usage of chemical fertilizers.

The influence of agricultural extension on agricultural development in Uganda's rural areas was investigated by Lee, An, and Kim (2017). The findings revealed that, with the exception of maize production, the agricultural extension service had a substantial positive effect on the yield of beans and rice, gross farm income and benefits. A number of agricultural extension achievements were presented in the report: both the worker and the effect of the allocation on beans and rice provide a substantial contribution to agricultural efficiency; the extension program has a positive impact on each crop through the allocation rather than the impact on the worker.

Zikhali (2017) analyzed the effect of training and development on agricultural productivity in Zimbabwe. The study opted for a mixed approach: the quantitative and qualitative methods. Research instruments were questionnaires, interview guides and focus group discussions. Findings revealed that some extension workers were not receiving training and those trained, training was inadequate. The government had failed to invest fully in personnel development programmes to enhance agricultural productivity. To the cluster being trained, information was not fully disseminated to the farmers and this had a negative impact on agricultural productivity.

Ahmad, Jadoon, Ahmad and Khan (2007) investigated the influence of training on agricultural production in Pakistan. Training in agriculture, livestock and business growth has been granted to a number of representatives of community organizations. Owing to these training courses, individuals began to farm on scientific lines. The findings showed that the yield of crops extended after the training; the production of greens and fruits additionally showed an upward trend and cattle ailments and mortality rates declined.

In the Arbegona Region, Southern Ethiopia, Girma, Beyene and Biazin (2017) evaluated the impact of the usefulness of natural and inorganic fertilizers on soil phosphorus equilibrium and phosphorous uptake and potato use effectiveness. The effect on tuber production, nitrogen uptake and Irish potato consumption productivity of single and mixed usefulness of farmyard manure and inorganic fertilizers was assessed in an area experiment. Regulation (without fertilizers) and farmyard compost, the recommended nitrogen and phosphorus, were the studied nutrient management practices. Results showed that soil modifications help to boost the status of soil fertility and potato yield in single or mixed inorganic and organic fertilizers.

Seck (2017) explored the possible effect of fertilizer subsidies on the productivity of farmers in Senegal. The study of data envelopment was used to produce efficiency ratings, which were then connected to the subsidy program using an endogenous model of treatment-regression that accounted for possible problems of endogeneity and self-selectivity. The findings showed that the subsidy scheme seemed to be related to enhanced productivity, thereby providing empirical evidence for the political will to revamp the scheme.

Evenson and Mwabu (2001) examined the effect on land development of the agricultural extension coaching and visitation (T&V) procedure in Kenya. The T&V method used to be applied into the countrywide agricultural extension system of Kenya in 1982 as an approach for developing farm yields. In 1982 and 1990, Kenya's authorities accrued the records used to assess its performance. The productivity benefit of agricultural extension for farmers used to be largest towards the extreme end of the yield residual distribution, according to the study. The effect of education on agricultural yields was positive, but statistically insignificant.

2.3 Overview of Literature Review

The review of past literature presented research gaps that warrant the need to carry out the current study. Most of the studies reviewed were conducted in other economies which are different from Kenyan context. Some of these studies include; Lee, An and Kim (2017) research in Uganda, Zikhali (2017) research in Zimbabwe, Ahmad, Jadoon, Ahmad and Khan (2007) study in Pakistan, and Seck (2017) research in Senegal. Despite the fact that the mentioned studies focused on effect of extension services on agricultural productivity, but they were conducted in different contexts, hence could not be generalized to the Kenyan context.

Another concern is that the studies reviewed did not focus on the effect of reduced extension services on the use of inputs that increase agricultural productivity, such as fertilizer, cropping/land management coverage and irrigation. As such, there exists an empirical gap. This research, therefore, sought to fill the void by determining the effect of reduced extension services on the use of the three agricultural productivity-enhancing inputs in Kenya, where the dependent variable (agricultural productivity-enhancement) was measured using fertilizer usage.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines theoretical structure, which included theories anchoring the study, model specification and description of variables, data type and sources, and analysis techniques.

3.2 Theoretical Framework

3.2.1 Cobb-Douglas Production

The Cobb-Douglas production model describes total output (Y) as a function of total factor productivity (A), capital inputs (K), labor inputs (L), and the output share of the two inputs (where is the capital input share of the contribution and 1 - is the proportion of contributions to work). Increasing one or both of A and K and L would result in increased production. While capital and labor inputs are measurable, the efficacy of the overall component appears to be more subjective, depending on infrastructure or worker experience (human capital). The Cobb-Douglas equation shows constant returns to scale (α + 1- α =1).

Output is doubled by doubling inputs (Ekborn, 1998; Enu & Attah-Obeng, 2013; and Muraya & Ruigu, 2017).

$$Y = AK^{\alpha}L^{1-\alpha}$$

Where:

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

L= labor input (monetary value of labor in a year)

K = capital input (monetary value of capital in a year)

A = total factor productivity

The production elasticity of labor and capital is α and β, respectively.

3.3 Analytical Model

The analytical model specification was based on the Cobb Douglas production model. The study adopted the following production function as shown in equation 1. Previous studies (Ahmad, Jadoon, Ahmad & Khan; 2007; Emmanuel et al., 2016; Lee, An & Kim, 2017) also adopted similar model.

$$y = f(x_1, x_2) + u \qquad (1)$$

Where;

y= fertilizer usage (q))

x_1= Extension services

x_2= other inputs

u=error term

The following model was estimated:

$$Y_t = \beta_{0t} + \beta_{1t}X_{1t} + \beta_2 X_{2t} + \beta_{3t}X_{3t} + \varepsilon t \qquad (2)$$

Where;

Y_t= Fertilizer usage

X_{1t}=Extension services

X_{2t} =Capital

X_{3t} =Labor

β_0 = Constant; β_1 β_2 and β_3= regression coefficients, ε = error term

3.4 Description and Measurement of Variables

A summary description of the variables used and their measurement is outlined in this section.

Table 3.1: Description and Measurement of Variables

Variable	Description	Measurement	Source
q	Fertilizer usage	Kilograms per hectare of arable land	Seck (2017)
x_1	Extension services	Agricultural budgetary allocation that goes to extension services (as a percent)	Emmanuel, Owusu-Sekyere, Owusu and Jordaan (2016)
x_2	Labour Capital	Labour- Annual increase in agricultural workforce (as a percent of population) Capital-Annual increase in fixed farm assets (machinery)	Muraya and Ruigu (2017) Yego, Keror, Bartilol, Samoei and Jeruto (2018).

Source: Author (2020)

3.5 Data Type and Source

The research collected time series data from the KNBS (Production Statistics Database) for the period between 1980 and 2019. Annual data on the study variables - Fertilizer usage (Kilograms per hectare of arable land), extension services (agricultural budgetary allocation that goes to extension services), labour (annual increase in agricultural workforce as a percent of population) and capital (annual increase in fixed farm assets) was obtained. The survey utilized EVIEWS version 9 to analyze the data.

3.6 Diagnostic Tests

The following diagnostic tests were checked to ensure accuracy and reliability of the study findings.

3.6.1 Stationarity Test

This study conducted Augmented Dickey-Fuller (ADF) root test to determine whether the data were stationary. The ADF test is performed to ensure that the regression results are reliable and unerring, which must indicate that the mean values and other important statistical parameters remain constant over time according to the regression assumptions. The ADF test for stationarity is significant since it accounts for probable autocorrelation in error terms as well as applicability.

3.6.2 Co-integration Test

Co-integration is used to examine whether the dependent and independent variables have a long-term relationship when variables are not integrated in the same order. The Johansen test was used to see if there was more than one co-integration relationship between the variables in the study.

3.6.3 Normality Test

Normality is critical for understanding the structure of the distribution and predicting dependent variable ratings (Paul & Zhang, 2009). Normality testing was done to look for anomalies in the results. The Jarque– Bera test was used to determine normalcy. The probability value has to be greater than 0.05 for the null hypothesis of normal distribution to be accepted, and vice versa.

3.6.4 Multicollinearity Test

Correlation matrix was used to test for multicollinearity. A correlation coefficient of 0.8 and above is indicative of serious multicollinearity that would result in biased estimates.

3.6.5 Heteroscedasticity Test

Heteroscedasticity implies a condition in which the variance varies with the information of the dependent variable, meaning that the variation of the error term (homoscedasticity) is constant. Because certain regression analysis procedures are predicated on an equivalent expectation of variance, heteroscedasticity hampers analyses. It was decided to use the Breush-pagan-Godfrey Test (Breusch & Pagan, 1979). The decision rule stated that if the probability value was larger than 5%, the Ho of constant error term variance would be accepted, and vice versa.

3.6.6 Autocorrelation Test

The relationship of a time sequence with its own history and future meanings is alluded to by autocorrelation (Monti, 1994). Autocorrelation is a coefficient of correlation that is commonly Xi and Xi+k between two values of the same variable, rather than being a correlation between two independent variables. The LM test was used to perform the first order autocorrelation test. The rule of thumb is that the Ho of no autocorrelation is accepted if the probability value is larger than 0.05, and vice versa.

CHAPTER FOUR: DATA ANALYSIS AND DISCUSSION

4.1 Introduction

Data analysis and discussion are presented in this chapter. The main goal of the survey was to determine the impact of reduced extension services on the usage of agricultural productivity enhancing inputs in Kenya. The findings presented include descriptive summary, diagnostic tests, Johansen Co integration and regression analysis.

4.2 Descriptive Statistics

Summary statistics of the research constructs: fertilizer usage, extension services, labour and capital presented in Table 4.1.

Table 4.1: Descriptive statistics

	Observations	Mean	Maximum	Minimum	Std. Dev.
Fertilizer usage	40	26.729	43.58207	14.41707	7.301473
Extension services	40	15.95	31	10	4.679196
Labour	40	8.00656	98.52855	1.168317	15.67421
Capital	40	8071.9	12200	4904	2284.408

Source: Author (2021)

Table 4.1 indicates that the mean of fertilizer usage was 26.729. This implied that the average fertilizer usage per hectare of land was 26.729 kilograms over the study period from 1980 to 2019. Results also indicated that annually, about 15.95% of agricultural budgetary allocation that goes to extension services. Further, the findings showed that the average change in agricultural labour force was 8% per year. Finally, the results revealed that the average number of new agricultural machinery in Kenya per year is 8071.

4.3 Diagnostic Tests

4.3.1 Stationarity Tests

The ADF test was utilized to determine stationarity of the data. The aim was to avoid erroneous regression results from the use of non-stationary series. Table 4.2 shows the outcome.

Table 4.2: Unit Root Tests at Level

Variable	ADF TEST	Level (Prob)	1st differencing (Prob)
Fertilizer usage	-1.524332	0.5107	0.000
Extension services	-5.097393	0.0002	-
Labour	2.484087	1.000	0.0001
Capital	-0.435995	0.8928	0.0000

Source: Author (2021)

Table 4.2 revealed that data for extension services was stationary at level. However, data for fertilizer usage, labour and capital was non-stationary at level. Following first differencing, data for all the variables was stationary.

4.3.2 Multicollinearity Tests

Multicollinearity test was checked using correlation matrix to establish the level of association between the independent constructs. In correlation analysis, an r correlation coefficient of 0.8 and above is indicative of serious multicollinearity that would result in biased estimates.

Table 4.3: Correlation Matrix

	Fertilizer usage	Extension services	Labour	Capital
Fertilizer usage	1			
Extension services	0.556635	1		
	0.0002			
Labour	0.422611	0.043709	1	
	0.0066	0.7888		
Capital	0.493202	0.557029	0.309295	1
	0.0012	0.0002	0.0521	

Source: Author (2021)

The findings in Table 4.3 revealed that there was no multicollinearity among the predictor factors. This was indicated by correlation values less than 0.8.

4.3.3 Normality test

The normality test was based on Jarque-Bera. The null hypothesis was that data was normally distributed. If the probability of JB is greater than alpha (α = 0.05), all data are normally distributed. Results are shown in Figure 4.1.

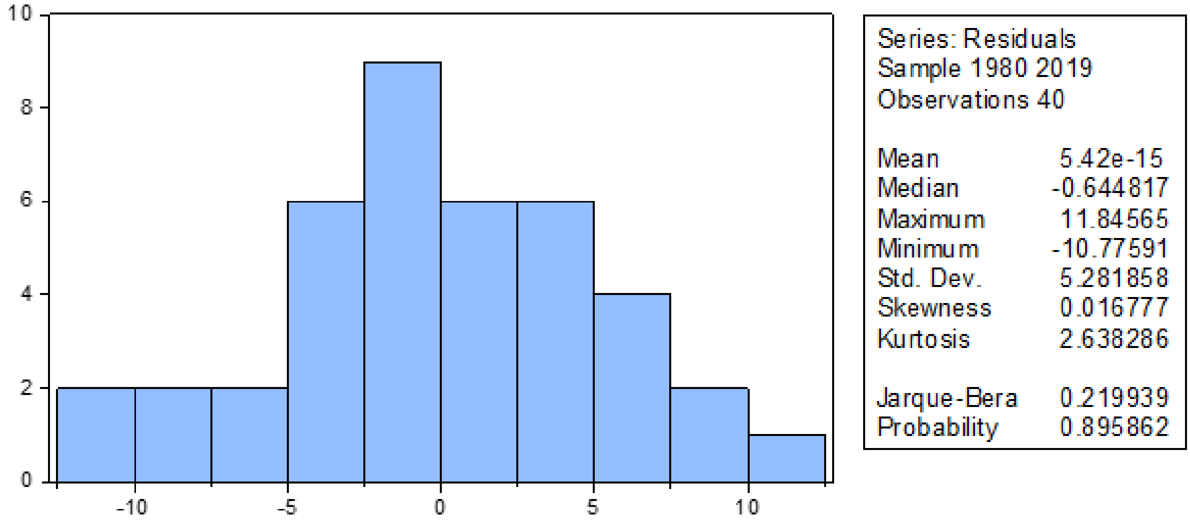

Figure 4.1: Normality test using Jarque– Bera Test

Source: Author (2021)

Figure 4.1 showed a probability value of 0.895 >0.05. This meant that the Ho of was accepted implying that all data have a normal distribution.

4.3.4 Heteroscedasticity Test

The heteroscedasticity test was used to see if the error term in time series data was connected to the observations. The null hypothesis stated that there was no heteroscedasticity. Table 4.4 shows the outcome.

Table 4.4: Breush-pagan-Godfrey Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.649366	Prob. F (3,36)	0.5885
Obs*R-squared	2.053435	Prob. Chi-Square (3)	0.5614
Scaled explained SS	1.362466	Prob. Chi-Square (3)	0.7144

Source: Author (2021)

Table 4.4 showed a probability value of 0.5885>0.05, therefore the null hypothesis that the data does not suffer from heteroscedasticity was accepted. Hence the data did not suffer from heteroscedasticity problem.

4.3.5 Autocorrelation Test

The autocorrelation testing was based on Breusch-Godfrey test. Results are shown in Table 4.5.

Table 4.5: Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.675551	Prob. F (1,35)	0.2040
Obs*R-squared	1.827431	Prob. Chi-Square (1)	0.1764

Source: Author (2021)

The findings in Table 4.5 indicated a probability of 0.2040>0.05, hence the Ho that the data does not suffer from autocorrelation was accepted implying that there was no autocorrelation.

4.4 Lag length Selection Procedure

Before carrying out the Johansen cointegration test, the optimal length of analysis delay was determined. The Akaike Information Criterion was used to determine the appropriate lag length in this investigation. The model with the lowest information criteria value was chosen. Table 4.6 shows AIC values for lag 1, 2 and 4 respectively.

Table 4.6: Lag Length Selection

LAG	AIC
Lag 1	16.53550
Lag 2	16.59652
Lag 4	16.69708

Source: Author (2021)

Based on the findings in Table 4.6, lag 1 gave the lowest AIC value; hence the analysis used lag1 as the optimal lag length.

4.5 Johansen Co integration

Johansen test was used to determine the presence or absence of co integrated equations. This study used the Johansen cointegration test because it is known to be more accurate and better than Engel's test for greater integration.

Table 4.7: Johansen Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.60853	56.2754	47.8561	0.0067
At most 1	0.32621	20.6371	29.7971	0.3806
At most 2	0.08834	5.63351	15.4947	0.7383
At most 3	0.05424	2.11901	3.84147	0.1455

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* Denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Author (2021)

Table 4.7 indicated that the null hypothesis of a maximum of 1 cointegration equations for the linkage model of reduced extension services and usage of agricultural productivity enhancing inputs in Kenya was not rejected at 5% significance level. The trace statistic for the null hypothesis is that a maximum of 1 cointegration equation is smaller than the set critical value of 5%. This suggested that there was one cointegrating equation.

4.6 Regression Analysis

Regression analysis was conducted to determine the effect of extension services, labour and capital on Fertilizer usage in Kenya. Table 4.8 shows the regression results.

Table 4.8: Regression Analysis Results of the effect of extension services, labour and capital on fertilizer usage in Kenya

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Extension services	0.744382	0.229594	3.242159	0.0026
Labour	0.170707	0.059857	2.851888	0.0072
Capital	6.931666	9.387935	0.738359	0.4651
Constant	-13.47831	34.40779	-0.391723	0.6976
R-squared	0.476698			
Adjusted R-squared	0.433089			
F-statistic	10.93130			
Prob(F-statistic)	0.000030			

Source: Author (2021)

Model

Fertilizer usage =0.744382 Extension services+0.170707 Labour

The findings in Table 4.8 revealed an R square of 0.476, which implied that 47.6% of variations in fertilizer usage, could be explained by changes in extension services, labour and capital. The F test of 10.93130, with p value of $0.00003<0.05$, implied that the study model was significant. This suggested that the independent variables were good predictors of the dependent variable (fertilizer usage).

The findings also indicated that extension services had a positive and substantial influence on fertilizer usage ($\beta=0.744382$, p value $=0.0026<0.05$). This implied that a unit improvement in extension services would lead to rise in fertilizer usage by 0.744382 units. This also suggested that a reduction in provision of extension services by a unit, would result to decline in fertilizer usage by 0.744382 units.

The findings also revealed that labour had a positive and substantial influence on fertilizer usage ($\beta=0.170707$, p value $=0.0072<0.05$). This implied that a unit rise in labour would lead to improvement in fertilizer usage by 0.170707. units. This also suggested that a decline in labour by a unit, would result to decrease in fertilizer usage by 0.170707 units.

The results further showed that capital had a positive but insignificant effect on fertilizer usage ($\beta=6.931666$, p value $=0.4651>0.05$). This denoted that change in capital does not significantly influence fertilizer usage.

The study findings supported those of Emmanuel, Owusu-Sekyere, Owusu, and Jordaan (2016) who established that use of chemical fertilizers is commonly encouraged by access to extension facilities. Similarly, the study outcomes were similar to those of Lee, An, and Kim (2017) who found out that the agricultural extension service had a substantial positive effect on the yield of beans and rice, gross farm income and benefits. Further, the study findings mirrored those of Seck (2017) who established that subsidy scheme was related to enhanced productivity. The outcomes were consistent with Ahmad, Jadoon, Ahmad and Khan (2007) findings who concluded that the yield of crops extended after the training.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSION AND POLICY IMPLICATION

5.1 Introduction

This chapter presents a summary of the findings, conclusion and policy implications of the study. The study used secondary data covering 1980-2019. The main aim of the study was to determine the effect of reduced extension services on the use of agricultural productivity enhancing input of fertilizer.

5.2 Summary of Findings

5.2.1 Extension Services

The research intended to determine the impact of reduced extension services on use of agricultural productivity enhancing inputs as represented by fertilizer usage in Kenya. The regression analysis output indicated that extension services had a positive and significant effect on use of fertilizer. This suggested that reduced extension services significantly lower the use of productivity-enhancing agricultural inputs in Kenya.

5.2.2 Labour

The research aimed to find out the impact of labour on fertilizer (an agricultural productivity enhancing input) in Kenya. The regression analysis output indicated that labour had a positive and significant effect on use of fertilizer. This suggested that increase in labour significantly enhances the use of fertilizer and other productivity-enhancing agricultural inputs in Kenya.

5.2.3 Capital

The research intended to determine the influence of capital on use of agricultural productivity enhancing input of fertilizer in Kenya. The regression analysis output indicated that capital had a positive but insignificant effect on fertilizer usage. This suggested that change in capital has minimal effect on use of fertilizer and other productivity-enhancing agricultural inputs in Kenya.

5.3 Conclusion

Based on the findings, the study concluded that extension services significantly influence the use of agricultural productivity enhancing input of fertilizer in Kenya. This has the implication that reducing extension services would significantly lower the use of fertilizer and other agricultural productivity enhancing inputs in Kenya. The study also concluded that labour had a positive and significant effect on use of fertilizer. Therefore, having more labour would significantly increase the use of fertilizer and other productivity-enhancing agricultural inputs in Kenya.

5.4 Policy Implications

The study determined that extension services had a positive and significant impact on use of productivity-enhancing agricultural input of fertilizer. Therefore, the government of Kenya should review policies relating to agricultural extension services. The government should particularly develop a comprehensive extension service program that will address all agricultural-related issues. The government should increase the budgetary allocations to agricultural extension services. The government should further educate farmers on the importance of participating in extension service programs. Finally, the government should invest in building skillful labour force, especially in the agricultural sector.

5.5 Recommendation for Further Research

The research researched on the impact of reduced extension services on the use of agricultural productivity enhancing inputs in Kenya. Other researchers could conduct similar studies but in other East African Countries such as Tanzania, Rwanda, and Uganda for the purpose of comparison.

REFERENCES

Ahmad, M., Jadoon, M. A., Ahmad, I., & Khan, H. (2007). Impact of trainings imparted to enhance agricultural production in district Mansehra. *Sarhad Journal of Agriculture*, *23*(4), 1211.

Bandiera, O., & Rasul, I. (2006). Social networks and technology adoption in northern Mozambique. *The Economic Journal*, *116*(514), 869-902.

Becerra, P. I., Cruz, G., Ríos, S., & Castelli, G. (2013). Importance of irrigation and plant size in the establishment success of different native species in a degraded ecosystem of central Chile. *Bosque*, *34*(1), 103-111.

Behaghel, Luc, Jérémie Gignoux, Rick Kamugisha, Jane Kugonza, Karen Macours, & Margaret Najjingo Mangheni (2018). Dissemination of new agricultural technologies in Africa: making extension work.

Breusch, T. S., & Pagan, A. R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica: Journal of the econometric society*, 1287-1294.

Bryan, E., Ringler, C., Okoba, B., Koo, J. Herrero, M. & Silvestri, S. (2011). Agricultural management for climate change adaptation, greenhouse gas mitigation, and agricultural productivity: Insights from Kenya. IFPRI Discussion Paper 01098.

Byerlee, D. and Heisey, P. (1992) Strategies for Technical Change in Small-Farm Agriculture, with Particular Reference to Sub-Saharan Africa.

Challa, M. (2013). Determining factors and impacts of modern agricultural technology adoption in West Wollega. *Munich. GRIN Publishing GmbH. Retrieved May*, *15*, 2019.

Chen, S., & Ravallion, M. (2004). How have the world's poorest fared since the early 1980s? *The World Bank Research Observer*, *19*(2), 141-169.

D'Alessandro, S. P., Caballero, J., Lichte, J. & Simpkin, S. (2015). Kenya: Agricultural sector risk assessment. World Bank Group Report No. 97887.

Davis, K. (2008). Extension in sub-Saharan Africa: Overview and assessment of past and current models and future prospects. *Journal of International Agricultural and Extension Education*, *15*(3), 15-28.

Diagne, A., & Demont, M. (2007). Taking a new look at empirical models of adoption: Average treatment effect estimation of adoption rates and their determinants. *Agricultural Economics*, *37*(2-3), 201-210.

Diesel, V., & Miná Dias, M. (2016). The Brazilian experience with agroecological extension: a critical analysis of reform in a pluralistic extension system. *The Journal of Agricultural Education and Extension*, *22*(5), 415-433.

Ekborn, A. (1998). Some Determinants of Agricultural Productivity - an Application of Kenyan Highlands. Washington D.C. 20433 U.S.A: World Bank, African Region, Environmental group (J3-141), 1818H St.

Emmanuel, D., Owusu-Sekyere, E., Owusu, V., & Jordaan, H. (2016). Impact of agricultural extension service on adoption of chemical fertilizer: Implications for rice productivity and development in Ghana. *NJAS-Wageningen Journal of Life Sciences*, *79*, 41-49.

Enu, P., & Attah-Obeng, P. (2013). Which Macro Factors Influence Agricultural Production in Ghana. *Academic Research International*, *4*(5), 333-346.

Evenson, R. E., & Mwabu, G. (2001). The effect of agricultural extension on farm yields in Kenya. *African Development Review*, *13*(1), 1-23.

Fakayode, B. S., Omotesho, O.A, Tsoho, A. B. & P.D Ajayi (2008). An Economic Survey of Rural Infrastructures and Agricultural Productivity Profiles in Nigeria, *European Journal of Social Sciences*, *7* (2), 158-171

Food and Agriculture Organization (FAO) of the United Nations. Ethiopia Country Brief; 2010. Retrieved from www.fao.org/countries/55528/en/eth/.

Foster, A. D., & Rosenzweig, M. R. (1995). Learning by doing and learning from others: Human capital and technical change in agriculture. *Journal of Political Economy, 103*(6), 1176-1209.

Fuglie, K. O. & Rada, N. E. (2013). Resources, policies and agricultural productivity in SubSaharan Africa. Economic Research Report 145, U.S. Department of Agriculture, Economic Research Service.

Girma, T., Beyene, S., & Biazin, B. (2017). Effect of organic and inorganic fertilizer application on soil phosphorous balance and phosphorous uptake and use efficiency of potato in Arbegona District, Southern Ethiopia. *Journal of Fertilizers & Pesticides*, *8* (3), 1-6.

Government of Kenya. (2015). Kenya Vision 2030. Nairobi, Kenya: Government press.

Jain, R., Arora, A., & Raju, S. (2009). A novel adoption index of selected agricultural technologies: Linkages with infrastructure and productivity. Agricultural Economics Research Review, 22(1), 109-120.

Kariyasa, K., & Dewi, Y. A. (2013). Analysis of factors affecting adoption of integrated crop management farmer field school (icm-ffs) in swampy areas. *International Journal of Food and Agricultural Economics*, *1*(2), 29-38.

Kenya National Bureau of Statistics (2019). Economic Survey. Nairobi: Kenya National Bureau of Statistics.

Koundouri, P., Nauges, C., & Tzouvelekas, V. (2006). Technology adoption under production uncertainty: theory and application to irrigation technology. *American Journal of Agricultural Economics*, *88*(3), 657-670.

Larson, B. A., & Frisvold, G. B. (1996). Fertilizers to support agricultural development in sub-Saharan Africa: What is needed and why. *Food Policy*, *21*(6), 509-525.

Lee, Y., An, D., & Kim, T. (2017). The Effects of Agricultural Extension Service on Farm Productivity: Evidence from Mbale District in Uganda. Retrieved April, 25, 2017.

Li, Z., & Liu, X. (2009). The effects of rural infrastructure development on agricultural production technical efficiency: evidence from the data of Second National Agricultural Census of China (No. 1005-2016-78948).

Loevinsohn, M., Sumberg, J., Diagne, A., & Whitfield, S. (2013). Under what circumstances and conditions does adoption of technology result in increased agricultural productivity? A Systematic Review. Retrieved November, 17, 2013.

Matchmaker Associates (2017). Horticulture study Phase 1: Mapping of production of fruits and vegetables in Kenya. Kingdom of the Netherlands. Retrieved March 18, 2017. https://www.agroberichtenbuitenland.nl/

Monti, A. C. (1994). A proposal for a residual autocorrelation test in linear models. *Biometrika*, *81*(4), 776-780.

Muraya, B. W., & Ruigu, G. (2017). Determinants of agricultural productivity in Kenya. *International Journal of Economics, Commerce and Management*, *5*(4), 159-179.

Mutiso, F. M. (2015). *Determinants influencing sustainability of agricultural projects: a case of Mwala Sub county, Machakos county, Kenya* (Doctoral dissertation, University of Nairobi).

Ochieng, J., Kirimi, L. & Mathenge, M. (2016). Effects of climate variability and change on agricultural production: the case of small scale farmers in Kenya. NJAS - Wageningen Journal of Life Sciences, *77* (5), 71-78.

Omache, N. (2016). Factors influencing agricultural productivity in Kenya: A case of Nyathuna ward in Kabete Sub-County, Kiambu County. Doctoral dissertation, University of Nairobi.

Paul, S. R., & Zhang, X. (2010). Testing for normality in linear regression models. *Journal of Statistical Computation and Simulation*, *80*(10), 1101-1113.

Ragasa, C., & Mazunda, J. (2018). The impact of agricultural extension services in the context of a heavily subsidized input system: The case of Malawi. *World Development*, *105*, 25-47.

Rehman, A., Jingdong, L., Khatoon, R., Hussain, I., & Iqbal, M. S. (2016). Modern agricultural technology adoption its importance, role and usage for the improvement of agriculture. *Life Science Journal*, *14*(2), 70-74.

Rogers, Everett (2003). Diffusion of Innovations, 5th Edition. Simon and Schuster.ISBN 978-0-7432-5823-4. New York.

Seck, A. (2017). Fertiliser subsidy and agricultural productivity in Senegal. *The World Economy*, *40*(9), 1989-2006.

Simtowe, F., Kassie, M., Diagne, A., Asfaw, S., Shiferaw, B., Silim, S., & Muange, E. (2011). Determinants of agricultural technology adoption: The case of improved pigeonpea varieties in Tanzania. *Quarterly Journal of International Agriculture*, *50*(892-2016-65202), 325-345.

Thakur, D., & Chander, M. (2018). Social media in agricultural extension: Benefits and challenges under Indian context. *Asian Journal of Agricultural Extension, Economics & Sociology*, 6(2), 1-8.

Wanyama, R., Mathenge, M. W. K. & Mbaka, Z. S. (2016). Agricultural information sources and their effect on farm productivity in Kenya. Tegemeo Institute of Agricultural Policy and Development, WPS 62/2016.

Wee, S., & Ahnaish, M. (2012). The impact of training on performance and production efficiency in agricultural projects in Libya. *Australian Journal of Basic and Applied Sciences*, *6*(8), 373-376.

World Bank Group (2018). Kenya Economic Update, April 2018, No. 17: Policy options to advance the Big 4. World Bank, Nairobi. Retrieved April, 13, 2018. https://openknowledge.worldbank.org/handle/10986/29676.

World Bank Group. (2015). World Bank Group. Retrieved June, 30, 2015. https://www.worldbank.org/en/about/annual-report-2015.

Yego, H. K., Keror, S. J., Bartilol, M. K., Samoei, S. K., & Jeruto, C. (2018). Effects of Agricultural inputs on Agricultural Productivity in Kenya: A Johansen Co-Integration Approach. *Development*, *51*(4), 566-593.

Zikhali, W. (2017). Impact of agricultural staff training and development on agricultural productivity: A case of Bubi district, Zimbabwe. *International Journal of Academic Research and Reflection*, *5*(3), 11-20.

Zougmoré, R., Jalloh, A., & Tioro, A. (2014). Climate-smart soil water and nutrient management options in semiarid West Africa: a review of evidence and analysis of stone bunds and zaï techniques. *Agriculture & Food Security*, *3*(1), 16.