RURAL ROADS DEVELOPMENT AND MARKETED AGRICULTURAL PRODUCTION IN KENYA: A TIME SERIES ANALYSIS (1973-2021)

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X50/79268/2015

A RESEARCH PAPER SUBMITTED TO THE DEPARTMENT OF ECONOMICS AND DEVELOPMENT STUDIES, UNIVERSITY OF NAIROBI, IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF A MASTER OF ARTS DEGREE IN ECONOMICS.

NOVEMBER 2023

DECLARATION

This research project is a reflection of my original work and and has not been presented for any award of in any other institution.

Signature…… Date 30th NOVEMBER, 2023

Emily Marei

APPROVAL

This research project has been forwarded for presentation, with my approval as the supervisor.

Signature… Date: 30th NOVEMBER, 2023

Daniel Abala

DEDICATION

I dedicate the project to my family for their support while pursuing my postgraduate course.

ACKNOWLEDGEMENT

I am very grateful to God for guiding me through this. I also wish to acknowledge University of Nairobi for enabling me with a favourable environment for studying. I appreciate my supervisor Dr Abala for guiding me accordingly.

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ACRONYMS AND ABBREVIATIONS

ADF: Augmented Dickey–Fuller test

CLRM: Classical Linear Regression Model

FGLS: Feasible Generalized Least Squares

GDP: Gross Domestic Product

KeRRA: Kenya Rural Roads Authority

KNBS: Kenya National Bureau of Statistics

KRB: Kenya Roads Board

RRD: Rural Roads Development

RRE: Rural Road Expenditure

WB: World Bank

WDI: World Bank development Index

DEFINITION OF TERMS

Rural road: A road that is classified in the first schedule of the Kenya Roads Act (2007). For this study, rural roads refer to Class D and E that is the Secondary roads and Minor roads (paved and unpaved) linking local centres to each other, to other centres or to other roads of a higher category.

Rural Area: This is a region whose population is less than 2000 persons and is mainly reliant on agriculture, small and has fewer infrastructural resources, KNBS 1999 Census.

Rural Population: People living in the rural parts of Kenya.

Rural Road development: The opening of rural areas by constructing and maintenance of roads to link the areas with mainstream road network of a country. In this study, road development refers to the construction of the annual secondary and minor roads in kilometres and the expenditure in construction as well as maintenance of the roads.

Agricultural production: refers to the quantity yield/output of farm related activities based on the amount of input. In the context of this study, agricultural production defines the value of marketed agricultural goods in the rural areas of Kenya.

ABSTRACT

The marketed agricultural production had been on the increase despite the decline in the number of kilometres of newly constructed rural roads. Thus, the objective of the study was to investigate the responsiveness of marketed agricultural production to rural roads development in Kenya. This study used secondary data from the Economic Surveys of the Kenyan Bureau of Statistics Economic Survey (KNBS). The analysis section employed a multiple regression model to estimate the effect of rural roads and other variables on the marketed agricultural production in Kenya. The study found a positive and significant relationship between rural roads development and marketed agricultural production (β=0.4171, p=0.000). In addition, there is a positive relationship between road maintenance and marketed agricultural production in Kenya (β=0.5644, p=0.000). The study found that agricultural inputs are positively and significantly related to marketed agricultural production (β=0.1162, p=0.0010). Expenditure on water supplies and related services exhibited a significant and positive relationship with marketed agricultural production (β= 0.2370, p=0.0070). Moreover, credit facilities showcased a significant positive relationship with marketed agricultural production (β=0.0900, p-value= 0.0490). Labour, measured in terms of agricultural wage payments, revealed a positive and insignificant effect on marketed agricultural production (β=0.0002, p=0.9100). The study concludes that expenditure on rural road construction, maintenance, and rehabilitation of all roads, agricultural inputs, expenditure on all water supplies, commercial loans, and agricultural wage payments play a significant role in Kenya's agricultural landscape and can account for 56.06% of the variations in marketed agricultural production in the country. The study recommends the expansion and maintenance of rural road networks. Infrastructure should be developed with an eye towards future needs, involve local communities, and minimize environmental disturbances. Furthermore, an all-encompassing approach is necessary for the consistent maintenance of rural roads, utilizing technology and international collaboration to ensure road longevity. There is a need for increased investments to ensure the consistent availability of crucial agricultural inputs. Strategies should be established to make these inputs affordable and accessible to all farmers. Training sessions can educate farmers on efficient utilization and sustainable agricultural methods. Improving water infrastructure in agricultural areas is vital. Investing in water conservation techniques, irrigation systems, and education programs about water efficiency can address challenges from changing rainfall patterns. Financial institutions are advised to offer better credit solutions tailored to farmers' needs, making loans more accessible and manageable. Lastly, the study highlights the need for a holistic approach in utilizing labour in agriculture. Training programs, mechanization, partnerships with educational institutions, and worker welfare programs can adapt the workforce to technological changes and boost productivity.

CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture plays a major role in the Kenyan economy and especially the rural economy. The sector account for 51 percent of Kenya's Gross Domestic Product (GDP) and contributes to 65 percent of exports and 60 percent of employment (World Bank, 2018). In 2021, Agriculture contributed to 22% of the country's GDP, this decline was attributed to corona virus pandemic. Further, the rural population was estimated at 71% in the year 2022(World Bank 2022).

The growth of the agricultural sector is a prerequisite for the growth of the economy and for the reduction of poverty levels in the rural areas. There exist many factors contributing to the growth rate of the agricultural sector in Kenya. Most of the agricultural production is limited to subsistence due to a variety of limiting factors. These factors include poor rural roads, amongst other factors (Bargellos, Gaki-Papanastassiou, Skilodimou, Skianis & Chousianitis 2013). The other factors include poor weather patterns, small land sizes, lack of advanced agricultural technologies and lack of information in modern agricultural practices due to lack of investments in infrastructure.

As noted by Kiprono and Matsumoto (2014) the road network in Kenya is poor and hinders the transportation of agricultural supply input from the market to the farms and farm produce from the farmers' place to the market. Lack of well-developed rural roads, which is a problem for both large and small producers make it difficult for rural farmers to ferry any agricultural surpluses for sale (Karani & Wanjohi, 2017).

Rural Kenya has only 24 percent (16,886 km of road network) of road infrastructure as compared to 76 percent (49,620 km of road network) urban roads infrastructure (KeRRA report, 2018). The role of developing the rural roads is entrusted to the Kenya Rural Roads Authority (KeRRA) by Kenya Roads Board (KRB). According to KeRRA (2020), 13,400 Km were to be constructed in rural areas of Kenya, yet only 5,780 km of rural roads have been constructed since 2013. Rural roads enable the ferrying of the agricultural inputs to the farms and the transportation of the farm produce to the markets.

Rural roads development and agricultural production is major global issue. As of 2015, 362,000 of India's 929,000 rural areas lacked rural roads accessibility (Shamdasani, 2016).

The roads that existed in the villages were unpaved and were filled with potholes which were usually filled with water caused by the monsoon rains due to poor drainage systems. This consequently hindered the ferrying of the agricultural produce to the market.

However, as of 2019, government of India had constructed a total of 480,000 kilometres of rural roads in India. In Brazil, rural transport connectivity plays an exceptionally large role and accounts for approximately 40 percent of the total agricultural production, representing US$61 billion in the 2018-2019 agricultural year (Hissa, *et al.*, 2019). However, many Brazilian rural farmers face challenges in transportation of their farm produce to the markets and experience high costs due to underdeveloped rural road infrastructure (Arias, Vieira, Contini, Farinelli & Morris, 2017).

Poor roads limit the expansion of agricultural production in Nigeria. Rural settlements in Nigeria have expansive agricultural lands and high agricultural production but are difficult to access (Usman, Adefila and Musa (2013).More than 48 percent of the Ethiopia's GDP comes from agriculture (Tamene & Megento, 2017). However, rural roads development has continued to be of importance to the country's government. Most of the rural roads in the country have deteriorated, and this has resulted to increased transportation costs for agricultural produce and longer travel durations.

1.1.1 Rural Roads Development and Marketed Agricultural Production in Kenya

Rural roads are considered as the basic forms of road network. They provide increased access to agricultural inputs and markets for the agricultural produce and also access for the rural population.

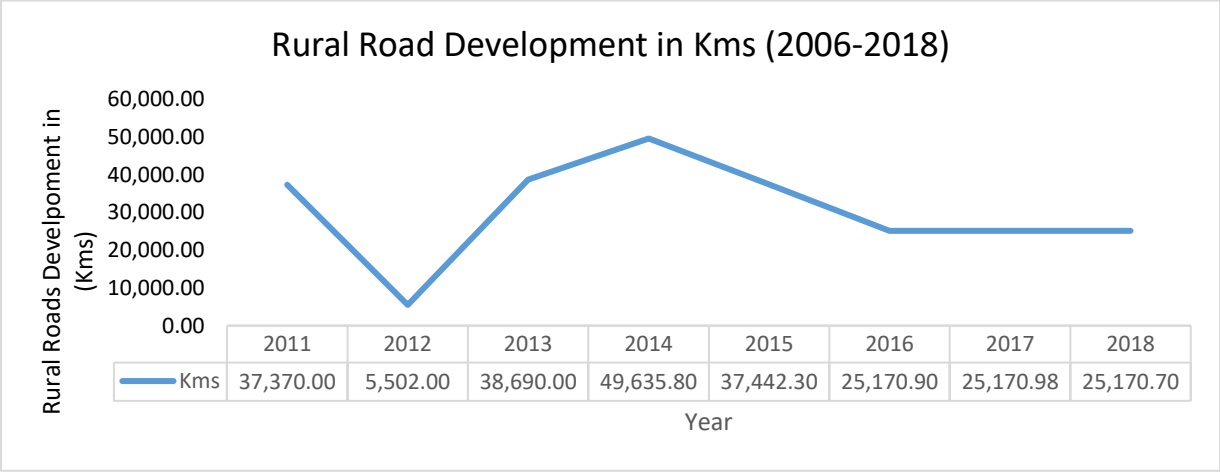
There are various classes of Roads in Kenya. Class A, Class B and Class C consists of the National roads. Class A links international centres and boarder points. Class B roads link national centres to each other and Class C roads connects Provincial centres to each other.

Rural roads serve rural communities, farms, agricultural areas, and remote regions. These are classified as Class D to Class W in the first schedule of the Act of the Kenya Roads Act (2007). The roads are further classified as paved, that is, of Bitumen standards or unpaved, that is gravel or earth (KNBS). This study will focus on class D roads, that is, secondary roads and Class E which are roads that are links to minor centres.

In the year 2017/2019, KeRRA developed over 406km of rural roads to bitumen standards (paved) with a projection of 4,738km of rural roads by 2020/2021.

Lack of maintenance of the rural roads, leading to deterioration is a prevalent issue in developing countries (Laurance, Clements, Sloan, connell, Mueller, Goosem & Van Der Ree 2014). Developing rural roads in Kenya has experienced numerous challenges especially its lack of funds to develop road and rely on donors for funding (Burgess, Jedwab, Miguel & Morjaria, 2015). The Kenya Government established the Kenya Rural Roads Authority (KeRRA) in order to address the problems of rural road development by establishing the to oversee the improvements of rural roads in the country as well as the Roads 2000 programme whose aim is to train local contractors in the continuous maintenance of roads using labour-based methods and improve rural roads. Figure 1 shows rural roads development in Kenya from 2011-2018

Figure 1: Rural Roads Development between 2006 and 2016 in Kenya

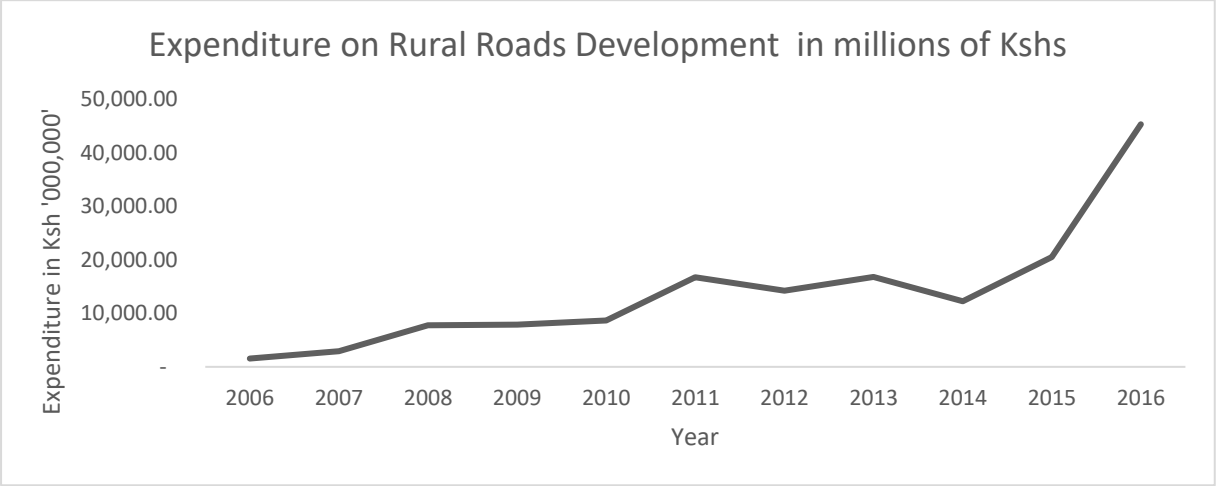


Source: KNBS Economic surveys 2011-2018

Figure 1 indicates that rural road development has been increasing over the years. The increasing rural road development could be attributed to the creation of the KeRRA to oversee over development of roads in Kenyan rural settings. There was a sharp decline in the construction of roads which was attributed to the on-going upgrading of various rural roads. In 2012, total rural road infrastructure was 5,502km and grew gradually to 38,690km of rural roads in 2013. The increase in the rural roads developments can also be attributed to the Roads 2000 programme, where 5,000 kms of rural roads were rehabilitated against a target of 1,950 kms as at the year 2013(Kenya Vision 2030 reports). It is also attributed to the increase budgetary allocations. However, constructed rural roads were on a decrease between 2014 and 2018 because of further rehabilitation of existing roads.

The Kenyan government has embarked on intensive road development since 2010. Given the potential of rural areas in terms of agricultural production, the Kenyan Government is opening the rural setting by buildings more feeder roads linking up to major roads and highways in Urban Centres.

Figure 2: Expenditure on Rural Roads Development between 2006 and 2016 in Kenya

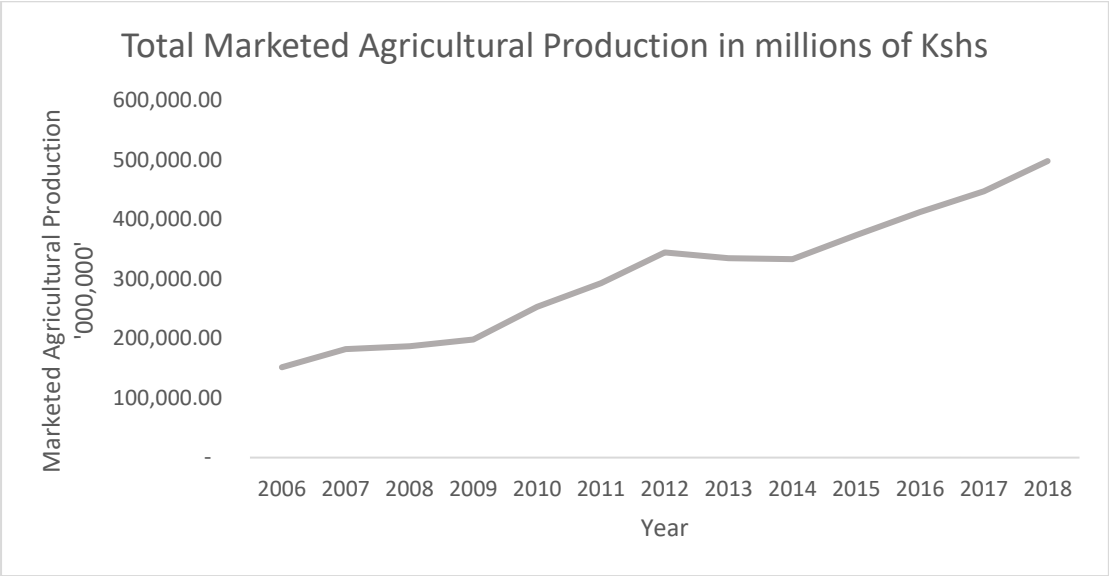


Source: KNBS Economic surveys 2006-2016

Figure 2 shows that the expenditure on the development of rural roads has been increasing over the years in Kenya. However, in 2013/2014 there was a decline in the expenditure. In 2015/2016, the country devolved into counties and there was an increase in the expenditure as a resort of the collaboration between the County, National Governments and the relevant stakeholders. This translates to significant road rehabilitation, upgrading and periodic maintenance under the 2000 programme. (KNBS Economic survey 2015).

Agriculture is recognised by Government of Kenya as the engine of economic growth. It has been considered the backbone of the economy for a long time. The aim of the Government is to exploit its potential to reduce poverty levels, ensure food security, promote economic growth, and create employment. (KNBS Economic Survey, 2019). The agriculture sector in Kenya contributes over 80% of employment and 57% of GDP, directly and indirectly (KNBS Economic Survey, 2019). Figure 2 illustrates the growth of rural agricultural production for the years 2006 to 2016.

Figure 3: Rural Marketed Agricultural Production in KES 2006-2016



Source: KNBS Economic surveys 2006-2016

Figure 3 shows that marketed agricultural production has been increasing over the years in Kenya. However, in 2013/2014 there was a slight decline in marketed agricultural production. In 2015/2016, there was an increase in marketed agricultural production which again declined in the subsequent years of 2017 and 2018. It should be noted that agricultural activities are practised largely in Kenyan rural areas as compared to urban areas owing to the available arable land in rural and less in urban centres. Small scale farmers are also found in rural areas compared to urban.

Rural agriculture has been found to reduce rural poverty report on economic analysis in Kenya. Agriculture is considered the largest source of income for most of the households (poor and non-poor) in rural Kenya. In the years 2013 and 2018, the agriculture sector in Kenya contributed to 21.9 percent of the GDP, with at least 56 percent of the total labour force employed in the sector, World Bank (2019). Agriculture sector was therefore important in achieving the Kenya's Big 4 Agenda of attaining 100% food and nutritional security for the Kenyan population.

1.2 Statement of the Problem

The marketed agricultural production in Kenyan rural areas has been on a gradual increase despite the declining total kilometres of the constructed rural roads. Rural roads facilitate transportation of agricultural inputs and produce to the markets. The constructed total kilometres have declined by 49% between 2014 and 2019 despite the gradual increase of the

total expenditure on the development of rural roads in Kenya. *(KNBS Economic surveys 2014-2018).* By opening of the rural areas through increased rural roads development, we expect an increase in the marketed agricultural production in Kenya which will translate to higher GDP of the Kenyan economy.

A well-developed rural roads system is necessary for the improvement of agricultural production. A poor roads system is associated with high market costs, inaccessibility to markets, and perishability of farm produce as well as non-expansion of production. The Kenyan government has continuously faced some challenges in the development of the rural roads, mainly due to constraints of funds. Rural areas in Kenya have vast agricultural productive lands with high agricultural production but remain inaccessible.

Several studies have been conducted on the effects of rural roads development on agricultural production. For example, Llanto (2012) did an investigation on the impact of infrastructural investment on agricultural production. They found out that there was a positive relationship between the rural areas that have good roads and accessibility to electricity and higher growth rates of agricultural production. However, the study only focused on electricity as the only infrastructure. This study will consider the effects of rural roads development and electricity connection to rural households on marketed agricultural production.

Lack of better access to education, health facilities, and markets for agricultural produce through rural roads for residents in Swaziland Residents hindered them from improving their lifestyles, Lindsay and Kongolo (2014). Although this study was done in Swaziland, a different contextual setting from the Kenyan situation, it forms a basis for highlights that there is exists a positive correlation between well-developed rural roads and marketed agricultural produce. This study will hence establish as to whether the results of their study are also applicable to the Kenyan setting.

With increased access to improved rural roads, households in India are able to expand their crop portfolio and they begin to grow hybrid crops with higher returns, (Shamdasani (2016). This study will investigate as to whether an improved and well-developed rural road infrastructure will have the same effects on agriculture as studied in India.

Very few studies have been done to account for the impact of rural road development and marketed agricultural production in Kenya. Kiprono and Matsumoto (2014) conducted a study on the effect that infrastructure improvement in Kenya has on use of agricultural inputs, agricultural production and access to markets by farmers. The results show that land allocated

to agricultural production and access to markets increase more in areas with better road access. Although this study was done in Kenya, it focused on selected crops and not the entire agricultural production, which includes animal produce and crop produce. This presents a gap in knowledge that this study is intended to bridge the impact of rural roads development on the entire marketed agricultural production in Kenya.

Karani and Wanjohi (2017) conducted a study on factors influencing marketing of sorghum among small-scale farmers in a location in Meru County Kenya. The findings were that the farmers use unpaved roads when marketing their produce and hence there was need to improve on the roads infrastructure for increase in the marketed sorghum. However, the study focused solely on Sorghum hence the need to undertake the study and establish a link between rural roads development and other agricultural produce.

Development on both paved and unpaved rural roads has been found to have a positive effect on the marketed horticultural production in Kenya, (Olwang, 2019 and Mbae2014). The two studies only focused on the effects of all roads and only on horticultural production in Kenya.

There exists limited literature on the effects of the development of rural roads on the marketed agricultural production in Kenya. The available few studies have focused on the impact of rural roads infrastructure on specific crops (Olwang, 2019, Mbae2014, Karani and Wanjohi (2017). There is no study that has been done to establish the responsiveness of the entire marketed production to rural roads development in Kenya.

1.3 Research Questions

i. How does the marketed agricultural production respond to construction, rehabilitation, and maintenance of rural roads in Kenya?
ii. What is the impact of the rural road expenditure on marketed agricultural production in Kenya?
iii. What policy implication can be derived from our study findings?

1.4 Study Objectives

The main objective of the study was to investigate the responsiveness of marketed agricultural production to rural roads development in Kenya. The specific objectives were:

i. To establish the effects of expenditure on the construction, rehabilitation, and maintenance of rural roads on marketed agricultural production in Kenya.

ii. To estimate the impact of rural road expenditure on marketed agricultural production in Kenya.
iii. To offer policy recommendations based on the findings of the study.

1.5 Justification of the Study

This study focused on rural roads constructed in the rural areas of Kenya and their impact on marketed agricultural production. It was posited that the information from this study could guide policy makers, especially in relevant sectors, in investing more in rural roads development. This could, in turn, boost the marketed agricultural production of the country, leading to improved economic growth. Agriculture is a pivotal driver of the Kenyan economy. When examining the performance of marketed agricultural production in Kenya, it's evident that it has been on an upward trajectory, even though there's been a reduction in the number of kilometres of constructed rural roads.

Moreover, there's been an uptick in expenditure on maintenance and rehabilitation of these roads. This study can be important to policy makers. If the government takes initiatives in increasing expenditure on construction, rehabilitation, and maintenance of both paved and unpaved rural roads in Kenya, it could lead to a surge in marketed agricultural production, potentially catalyzing further economic growth. However, there is a noticeable dearth of empirical evidence about the effect of rural roads development on the entirety of Kenya's marketed agricultural production. This study sought to bridge that knowledge gap. The results of this study could be valuable to future researchers and scholars. It can serve as a seminal source of empirical literature on the nexus between rural roads development and marketed agricultural production. Furthermore, this study could augment the existing body of literature and pave the way for future research directions.

1.6 Structure of the project

The project's structure is outlined in sections. The introductory chapter serves as an introduction to the subject under consideration. This is followed by Chapter two, which is a comprehensive literature review. The organization of this chapter ensures a comprehensive overview: beginning with theoretical literature to glean relevant variables, moving to empirical literature that further delineates variables and identifies suitable empirical models, and concluding with a summary that critiques previous works, highlighting their merits and flaws, and highlighting the gaps this study seeks to fill. The subsequent section delineates the study's methodology in detail. It clarifies the theoretical underpinnings, variables under

examination, their metrics, and hypothesized relationships with the dependent variable by providing a solid theoretical framework. Embedded within the report is a meticulous discussion of the data, their origins, and relevant diagnostic tests, with justifications for specific diagnostics. The fourth chapter is data analysis, results and discussion. Lastly, the fifth chapter is the summary, conclusion, and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presented the theoretical literature review, the empirical literature review, as well as an overview of the literature. A critique of the empirical review was also conducted to highlight knowledge gaps that warranted the current study.

2.2 Theoretical Literature Review

There exist various theories that link infrastructure development to economic growth. In literature, production theory is used to provide a link between development in infrastructure and agricultural production (Aggarwal, 2015; Dell et al ..., 2008). Production is the process of converting inputs to outputs. The theory provides a relationship between the inputs and outputs. The inputs in the production processes include capital, land, labour and climatic conditions whereas the outputs refer to services or volume of goods. Various studies have used the production theory in different geographical areas with infrastructure as one of the inputs (Donaldson & Hornbeck,2016; Delcon et al…,2007).Hine et al...,2016 held that availability of infrastructure such as roads, electricity and irrigation contribute to improved farming in rural areas.

Several theories attribute the economic growth to the development of infrastructure. Rostow (1960) argued that social overhead capital which is a foundation upon which economic activities can be increased through cost reduction ensuring increased production. He further argued that an investment in the social capital especially in the areas of energy and transport ensures the development and growth of an economy. The theory therefore highlights that well developed roads and road connectivity is important in the growth of economic activities and specifically in enhanced agricultural production. In addition, an increase in the factors of production can be because of a progress in technology or as a development in an infrastructure such as connectivity in roads, Solow (1956).

It was also established that transport services and telecommunication allow for innovation and an improvement of technology lowers the cost production costs of new inputs which translates to increased production Agenor, (2013).

Infrastructure is conceptualised as comprising of communication, irrigation, transport, and drainage systems by Hirschman (1958).He highlighted these to be the foundations of economic activities. In his theory of unbalanced growth on the Least Developed Countries (LDC's), the countries lack enough resources to invest in many sectors and realise a balanced growth at the same time. His concept revolved around energy and transport, and he held that these countries needed to invest in important sectors such as transport for the expansion of the economic activities.

Investment on infrastructural facilities such as capital and machinery supplemented by other infrastructure such as water, roads communication, electricity is essential for the growth of economic activities, Todaro (1981). This view is underscored by Banjo et al (2012) who argued the importance of a well-developed transportation system in the rural areas and its influence on agricultural production. He highlighted that transport influences market accessibility and price fluctuations which influence agricultural growth.

The reviewed theories show the nexus between investment into infrastructure and how it translates into economic growth through various economic activities. Agriculture is a main economic activity in Kenya and since rural roads are a part of infrastructure, the study findings of the reviewed theories are key in assessing how the development of rural roads influences marketed agricultural production in Kenya.

2.3 Empirical Literature Review

Severa; studies have been undertaken to establish the relationship between the development of rural roads and agricultural production. In Japan, Andersen and Shimokawa (2006) using data that was collected by Fan and Zhang (2004) from 44 countries from three regions: Asia, Africa, and Latin America on rural infrastructure and Agricultural Development conducted an econometric analysis to identify the relationship between infrastructure investments on agricultural output. The results were that there existed positive effects of investment on infrastructure on agricultural output. They highlighted that rural roads were a tool for economic growth through agricultural produce marketing and that lack of investments in roads infrastructure would negatively impact agricultural production and the growth of developing economies as whole. However, their study only relied on expenditures as a measure of roads development. This study will therefore aim to cure the gaps by using an additional measure of roads development, which is the length (in kilometres) of roads constructed and will also factor in irrigation, in Water expenditure variable and electricity as an agricultural input.

Rural transport includes dusty terrains which tend to be costly and difficult making small scale farmers in Meru County Kenya result to using middlemen to market their produce, Karani and Wanjohi (2017). They found out that the rural roads in the district were not in a proper condition which negatively affected the marketing of the sorghum produce. Although their findings are relevant to this study, they only focused on the effects that rural road had sorghum marketing in a district in Meru County. This study will on the contrary focus on the impact of rural road development has on the entire agricultural production in Kenya. Their study did not also have a descriptive measure of the road developments and instead relied on the responses from a sample of 133 respondents who are dwellers of the district. On the contrary this study will measure roads development using expenditure and kilometres constructed.

Road transport had an impact on agricultural development. Poor road conditions affect transportation costs of farm produce which as a result affect the farmers' income, Tunde and Adeniyi (2012).On their investigation in Nigeria area of Kwara State, they selected one hundred and fifty respondents using a systematic sampling technique and held discussions with the respondents on how the roads in the area affect agricultural production and the overall economic growth. The findings of the study from the responses showed that poor road transport negatively impacted agricultural production in the area. The study did not however attempt to analyse the effect of road transport on aggregate agricultural production which this study will do.

While studying the impacts of infrastructure investments; specifically, roads and electricity on agricultural production in Philippines, Llanto (2012) found that rural areas that have improved roads and connectivity of electricity experience higher rates of growth in agricultural production compared to areas with poor infrastructure.

Rural roads in Africa are inadequate in terms of coverage and quality. Using survey data, Obare, et al. (2012), investigated the effects of rural roads on small farm production structure. They established that poorly developed roads impact the agriculture sector which as evidenced by high costs of delivery of farm produce to the market, high farming input costs; low prices of the produce, low production, and volatility of the markets.

In a study on the effects of rural infrastructure on agricultural development, Pinstrup and Shimokawa (2012) indicated that there was a need to invest in construction and also maintenance of rural infrastructure in developing and low-income economies as it affects

agricultural production positively. The study did not highlight the linkages of rural infrastructure that impacts agricultural production presenting conceptual gap.

Poor roads result to high costs of agricultural inputs .A study done in Nyandarua district by Njuguna on the relationship between rural roads and agricultural development revealed that lack of improvement and rehabilitation of the existing roads are the leading inhibit the agricultural resource development in the district. However, the study was only concerned at investigating agricultural resource development without linking it to marketed agricultural production.

Government expenditure on agricultural production of rural households of China revealed that rural investment on infrastructure such as transportation, telecommunication, and electricity are crucial for agricultural development, Yuen (2013). However, the study did not indicate how rural public investment in transportation affects agricultural production output. Also, while studying the nexus between rural road transport and agricultural production in Nigeria, Usman, Adefila and Musa (2013) indicated that the size of the farm, distance to a main market, farming experience, age, and the available transport services available are important in predicting agricultural production in the area.

Land allocated to agricultural production and access to markets increase more in areas with improved roads system. This is according to a study by Kiprono and Matsumoto (2014) on use of agricultural inputs, agricultural production, use of farm inputs and markets accessibility in Kenya .This study was done in Kenya but on a different topic. This presents a gap in knowledge that this study is intended to bridge the effects of rural roads development on marketed agricultural production in Kenya.

In North Central Nigeria, Abur, et al. (2015) investigated the relationship between rural roads infrastructure and rural households' income. They established that the cost of inputs as well as access to farm inputs, size of farms and availability of good roads have a direct effect on agricultural output and rural incomes. Feng et al (2004) conducted a study on the effects of infrastructural development on agriculture and found out that the agricultural sector can grow because of investing in infrastructure in the rural areas.

Households can cultivate higher return and hybrid crops when they gain access to improved rural road infrastructure. Using a difference –in –difference framework, Shamdasani (2016) established the relationship by conducting a study using panel and established that paved roads

increase market accessibility and access to complimentary inputs. The study did not however indicate the effect brought by rural roads on aggregate agricultural output.

Using cross-section survey research design, Yeboah (2016) set out to establish the impact that road transport infrastructure has on agricultural development in Ghana. He established that the delivery of farm output to the market was highly affected by high transportation costs as well as the distance of the rural roads to the market or a main road.

In Western Ethiopia, Tamene and Megento (2017) studied the effect of rural road transport infrastructure on small-scale farmers' agricultural output and found that the average distance to market the farm produce is a major factor in predicting the farm output of the farmers.

Rural roads in Swaziland are critical in rural and agricultural development as well as improved socio-economic conditions of the rural population, Lindsay and Kongolo (2014). This study did not however indicate how rural roads affect agricultural production output. The study revealed that the residents can improve their livelihood by access to education, health facilities, and markets through rural roads.

Other studies opine that good roads results to profitable commerce through increased agricultural production and those roads are important for the growth of agriculture in rural areas of Africa, the World Bank (2005) and Gregory and Bumb (2008) .Similar sentiments were held by Khachatran et al, (2005) whose study findings were that better rural roads improve both non-agricultural and agricultural activities in the rural areas.

Poor rural roads connectivity affects agricultural production. A study conducted in South Africa revealed that poor rural roads connectivity affected the prices of agricultural produce compared to areas with better rural roads connectivity. This was based on the ability to transport the produce and easy access to wider markets, Chakwizira et al.(2010).Another study conducted in Greece with the use of time series data by Mansan and Chatterjee(2003) established that an increase in one percent in rural roads connectivity led to a near proportionate increase in agricultural production.

According to the Rural Infrastructure in Africa,Development Support Monitor - Paper series No.1, 2012, Inadequate and unreliable infrastructure services are evident in many African communities. Between 2008-2010 Poverty hearings were conducted in five sub-Saharan countries, i.e., Kenya, Liberia, South Africa, Mozambique and Senegal .Grassroots communities were invited to identify areas in which urgent action by the government was

required to fight poverty. The communities identified the major problem being the government incapability of development of the rural infrastructure which has effect on access to amenities as well as affecting agricultural production negatively. They realized that there was need for entrepreneurs to invest in rural infrastructure and set proper government policy frameworks on road development. Need for the countries to Utilise community resource and more work should be done on contributions of investments in infrastructure.

Rural roads provide the first link to market access by farmers. They ensure that agricultural produce is marketed by allowing faster delivery of the produce to the market, access to market centres, access to farm inputs, increased margins, increased crop diversification as well as increased agricultural production ,Tegebu and Seid,2017.Through rural roads expansion, farmers are also able to commercialize agriculture as a result of expansion of markets (Narteh ,2012).

Rural roads accessibility translates to increased agricultural production. Poor rural transport therefore could lead to low agricultural production, Hine and Wililo, 2015.Similarly,Gill and Kharas (2007) conducted an investigation in East Asia and discovered that the main contributor to agricultural growth is rural road nfrastructure. A similar study done in India on agriculture found out that investment in roads led to an increase in agricultural output, employment as well as increased wages (Khandker 1989).

2.4 Overview of Literature

The reviewed literature recommends that that a positive relationship exists between investment in roads infrastructure and agricultural production. Most studies indicate that development of rural roads results to growth of economies where agriculture is dominant. Although the literature is applicable to this study; most of the studies reviewed were conducted outside Kenya. The studies conducted in Kenya focused on as specific crop production. This study therefore addressed these challenges by using time series data and investigating the impact of rural roads expenditure on the entire of marketed agricultural production in Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlined the theoretical framework, empirical model, data type and source, and finally, pre-estimation tests.

3.2 Theoretical Framework

This study was based on a production function to inform marketed agricultural production output. The function, through a combination of various inputs, explained the outcome of an economic activity. The production function expresses output Y as a function of technically possible input combinations (Nicholson and Synder, 2008) as follows:

$Y=F(A, K, L)$ ……..……. (i)

Where in equation (i):

A is used to measure technology, K represents physical capital and L is the amount of labor.

The Cobb-Douglas production function is widely used to represent the relationship of an output to inputs (Ghoshal & Goswami, 2017). Expressing Y in the Cobb-Douglas production function yields equation (ii) as follows:

$Y = A K^{\alpha} L^{\beta}$……(ii)

Equation (ii) expresses Y as a function of two production inputs, K and L. The two inputs are imperfect substitutes, in Lokesha and Mahesha, (2016) and Nastis et al, (2012). The Augmented Cobb Douglas production function is as follows:

$Y = A K^{\alpha} L^{\beta} (ifdev)^{\rho} Z^{\sigma}$……..……(iii)

In the equation (iii), marketed agricultural production Y (value in Kenya Shillings), K is Physical capital (Kshs) and L is Labour (Kshs/hour). *A* represents the capital effectiveness or the technological progress. It measures the output that can be produced from a combination of various inputs. Typically, the change in *A* represents an improvement in efficiency. *ifdev* represents vector of rural road development (length of constructed roads in Kilometres and the cost of rural roads development in Kshs), while Z is a vector of the other variables that affect marketed agricultural production such as irrigation, electricity, farm inputs and credit access. Expanding the Cobb-Douglas production function based on the context of this study;

Marketed agricultural production =f (rural roads expenditure, value of agricultural inputs, expenditure on water supplies, value of commercial loans to the agricultural sector, Wages paid in the agricultural sector) ……(iv)

Using Johansen-Granger co-integration procedures, Abugamea, 2008, estimated the long-term relationship between agricultural production and other parameters like labour employed in agriculture, farm inputs, and land under cultivation. The study established that a negative relationship existed between agricultural inputs and agricultural production. In addition; they established that agricultural production reacted positively towards an increase in labour force.

Manasan et all (2007) argued that electricity, irrigation and roads have a positive implication on farm production. Education was also found to impact agriculture production positively. Farmers who have years of training in agricultural courses are able to apply agricultural innovations which translates to increased agricultural production. They are also able to adopt innovations that allow for an increase in the overall marketed production, Narman (1994).

The inaccessibility to formal financing has led to a slow growth of the agricultural sector in Kenya. Most farmers are unable to access commercial loans hence do not engage in modern farming practises that could potential lead to increased marketed production, Othieno (2010). This model was used to determine the effect of rural roads development on marketed agricultural production in Kenya. The Cobb-Douglas production is a general production function which can be expanded to include other factors influencing production. Thus, more factors were introduced in the model specification section 3.4.

3.4 Empirical Model

This study used a modified Cobb-Douglas production function to include other factors that affect marketed agricultural production. Other control variables were included in the model. In the equation, a is the constant function, while the coefficient β_i is used to examine the responsiveness of marketed agricultural production (AP) to unit change in Rural Roads Development (RRD). There are other factors influencing agricultural production. Njuguna (2012) identified low prices, high incidence of perishability of farm produce; high costs of farm inputs and insufficient cooperative societies to oversee management of crops. According to Yuen (2013), telecommunication, electricity infrastructures and presence of irrigation schemes influences agricultural production investment. In Nigeria, Usman, Adefila and Musa (2013) identified the size of farms, distances to the produce market, farming experience; credit facilities, household income and mode of transport services available are important factors of

agricultural production. Tamene and Megento (2017) identified ownership type, Farm Diversification, and cost of firm inputs (fertilizers and agrochemical) as a determinant of agricultural production in Ethiopia. Combining the other factors affecting marketed agricultural production, the new Model Specification of the study was;

$$AP = a + \beta_1 3RRD + \beta_2\, RM + \beta_3 INPTS + \beta_4 WTR + \beta_5 CRDT + \beta_6\, LA + \mu \ldots\ldots\ldots\ldots (v)$$

Where:

a =constant term, *AP* represents the Marketed Agricultural Production, *RRD* is the expenditure on the construction of rural roads, RM is the expenditure on maintenance and rehabilitation of all roads which is measured in Kshs ,*INPTS* is the value of agricultural inputs in the period(Kshs), *WTR* is the value of the total expenditure on all water supplies that is used in agricultural production(Kshs), *CRDT*, is the value of commercial loans advanced to the agricultural sector (Kshs), LA is the total value of agricultural wage payments paid in the agricultural sector in the period(Kshs) .t=time (1973-2021),μ= error term of the model and $\beta_1 \ldots . \beta_6$ are the model variables (see table 1).

3.5 Definition and Measurement of Variables

Marketed agricultural production (AP) was the dependent variable that was contributed to by rural roads development (RRD). The other control variables affecting marketed agricultural production included agricultural inputs, expenditure on water supplies, credit facilities, and labour. These were included in the model. Table 1 showed the definition and measurement of the study variables.

Table 1: Summary of Definition and Measurement of variables and Expected Apriori Expectation

Variable	Definitions and measurement	Measurements	Apriori Expectation
Dependent Variable			
Marketed agricultural Production (AP)	The total value of the marketed Agricultural production	Kenya Shilling (Kshs)	
Independent variables			
Rural Roads Development (RRD)	The value of the total expenditure on construction of rural roads	Kenya Shillings (Kshs)	+ve
Roads Maintenance (RRM)	The value of the total expenditure on rehabilitation and	Kenya Shillings (Kshs)	+ve

	maintenance of rural roads		
Agricultural inputs (INPTS)	The value of the agricultural inputs required in agricultural production. Includes chemicals, fertilizers, fuel power and service inputs excluding labour	Kenya Shillings (Kshs)	±ve
Expenditure on Water Supplies and Related Services (WTR)	The value of the total expenditure on all water supplies including irrigation, water conservation and rural water supplies	Kenya Shillings (Kshs)	±ve
Credit facilities (CRDT)	Total value of financial assistance in terms of commercial loans advanced to the agricultural sector particularly in the purchase of farm inputs	Kenya Shillings (Kshs)	+ve
Labour (LAB)	The total value of agricultural wage payments	Kenya Shillings (Kshs)	+ve

3.6 Data Sources and Type

This study made use of time series data covering the years between 1973 and 2021. This was because the data on marketed agricultural production in rural areas, data on rural roads development, and other control variables were readily available for the years under scope. The source of the data was the Economic Surveys for the years 1973 to 2021 from the Kenya National Bureau of Statistics. The study used Stata for the analysis.

3.8 Pre-estimation tests

Diagnostic tests were conducted before the regression model was estimated. These tests included:

3.8.1 Normality Tests

Most statistical procedures assume that the residuals follow a normal distribution which is always not the case (Ghasemi & Zahediasl, 2012). If the error terms are non-normally distributed, the confidence intervals may become too narrow or too wide. This leads to difficulty in estimating co-efficient based on minimization of least squares. It is important to

undertake the normality test as in order to make accurate statistical inferences (Field, 2009). Skewness and Kurtosis test was applied to check for normality of the variables under study. The null hypothesis was that observations are not normally distributed. If p-value is below 0.05, then the null of normality, at 5% confidence level, is not accepted.

3.8.2 Stationarity Test

There is need to test for stationarity since the data collected are time bound in nature. Time series has features like trend, seasonality, and residual which are highly reliant on time. Stationary time series is not dependant on time. Time series is stationary if it does not seasonal effects or a trend, does not have a change in the mean, autocorrelation, or variance over time. Time series data is nonstationary when the variance, mean and autocorrelation change over time which makes the predictability difficult. In non-stationary data, there is a chance that the variables will vary over time leading to inaccurate results. To check the non-stationarity of the data, unit tests will be used. This is as:

$$Y_t = \alpha Y_{t-1} + \beta X_e + \epsilon$$

In the equation, Yt refers to time value at time‘t’ and the exogenous variable is represented by Xe.

To check for stationarity, an Augmented Dickey-Fuller (ADF) test was utilized. The null hypothesis, H_0, tests whether a unit root exists in the series. If the p value is less than a specified significance level, then the null hypothesis was rejected. If H_0 is rejected, then stationarity has been detected in the time series. The alternative was that there is non-stationarity in the time series. The ADF test was hence represented as following:

$$y_t = c + \beta t + \alpha y_{t-1} + \phi \Delta Y_{t-1} + e_t$$

If it was established that the time series is non-stationary, subsequent differencing is employed to eliminate the bias.

3.8.3 Heteroscedasticity

Bearing in mind that some of the data to be used in this study is monetary in nature, there exists worries that the conditional variance in the data is not constant, therefore bringing about a variability in the dependant value, Y for each value of the explanatory variable, X or each value of time, t. If the data is heteroscedastic;

Variance (y/x) =f(x). That is the variance increases with X.

In the Classical Linear Regression model (CLRM), the error term is homoscedastic, that is, it has consistent fluctuation. If the data is homoscedastic;

$Variance(\boldsymbol{y}|\boldsymbol{X}) = \sigma^2$ *…a constant value.*

If the the error variance is not steady, at that point, heteroscedasticity exists in the data. When running a regression model, the effects of heteroscedasticity should be considered to avoid t to unbiased prediction of parameters. Breusch-Pagan/Godfrey test was utilized to check for heteroscedasticity. The null hypothesis stated that error terms are homoskedastic (have constant variance). If the p-value is below 0.05, the null hypothesis is rejected. In the event that the null hypothesis is rejected and it is concluded that heteroscedasticity is present in the time series, the model to be represented by running a General Linear model (GLM).

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This section encompasses the comprehensive analysis of the collected data, presentation of the obtained results, and a detailed discussion thereof. The findings are presented and discussed in distinct sections, providing a thorough exploration and interpretation of the outcomes. This allows a comprehensive understanding and evaluation of the research findings, ensuring a comprehensive and informative presentation of the research outcomes.

4.2 Descriptive Statistics

Descriptive statistics involves summarizing and presenting data in a meaningful and interpretable manner. It provides a concise and comprehensive overview of the main characteristics of time series data, such as the mean, median, range and standard deviation. Descriptive statistics plays a crucial role in research studies as it allows researchers to understand and communicate the key features of the data, identify patterns, detect outliers, and gain insights into the distribution and variability of variables. By providing a quantitative summary of the data, descriptive statistics enables researchers to make informed decisions, compare different variables, assess the validity of assumptions, and draw meaningful conclusions. Table 2 presents a summary of the descriptive statistics.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
INPUTS	49	16895.65	23431.33	25.54	77490
WATER	49	10674.37	16932.93	6.694	65165
ROADSDEVEL~T	49	7313.27	14141.91	.9	59106
ROADSMAINT~E	49	11756.14	19195.11	6.99482	66653
COMMERCIAL~S	49	25693.41	32436.6	3.8	96990
EARNINGS	49	32726.88	42065.03	20.5	133065.9
MARKETEDAG~N	49	126622.7	172758.8	123.303	527025.2

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Source: Author computed using data from KNBS, Economic surveys (1973-2021)

The study depicted in Table 2, covering the span from 1973 to 2021, offers a detailed examination of the agricultural trends and expenditures in Kenya over nearly five decades. The table reveals an average expenditure of Ksh. 16,895.65 million on agricultural inputs between 1973 and 2021.These inputs, encompassing chemicals, fertilizers, fuel, power, and other service-related components, form the foundation of agricultural productivity. The value

emphasizes the importance of providing farmers with the necessary tools and materials to optimize yields. The vast range between the minimum (Ksh. 25.54 millions) and maximum (Ksh. 77,490 millions) over the period might be indicative of changing agricultural practices, fluctuating prices, and evolving governmental subsidies or policies. The shift in input costs over the years could also have been influenced by global market dynamics, supply chain disruptions, or changing local demand due to factors like population growth or urbanization.

The average expenditure on water supplies and related services was found to be Ksh. 10,674.37millions between 1973 and 2021. Water, being a critical resource, has a direct impact on crop yield and quality. The expenditure range, from Ksh. 6,694,000 to a high of Ksh. 65,165 millioms, might reflect periodic investments in significant irrigation projects, water conservation efforts, or infrastructure development in drought-prone areas. Over the 49 years, challenges like climate change, periodic droughts, and increasing demand from a growing population have likely necessitated adaptive strategies and investments to ensure sustainable water use for agricultural purposes.

The average investment in rural roads development stands at Ksh. 7,313.27 millions. Roads are vital conduits, linking farms to markets, ensuring timely access to essential inputs, and reducing post-harvest losses. The variation in values, from a low of Ksh. 900,000 to a peak of Ksh. 59,106 millions, could correlate with periods of significant infrastructural development, be it through governmental initiatives, external funding, or response to emerging logistical challenges. Over the years, as agricultural hubs expanded and markets evolved, the need for improved and expanded road networks would have grown, reflecting in the expenditure trends.

Moreover, an average outlay of Ksh. 11,756.14 millions on roads maintenance underscores the on-going commitment to sustaining the quality and efficiency of transportation networks. Beyond just building roads, their upkeep is paramount to ensure longevity and consistent usability. The discrepancy in expenditure, with a minimum of Ksh. 6,994,820 and a maximum reaching Ksh.66,653 million , could signify varying maintenance needs over the years, influenced by factors like climatic conditions, usage intensity, or technological advancements in road construction and repair methodologies.

The agricultural sector witnessed an average credit facility of Ksh. 25,693.41 million from commercial banks. Financial support is crucial in agriculture, allowing farmers to adopt newer technologies, purchase essential inputs, or expand operations. The wide span from Ksh.

3,800,000 to Ksh. 96,990 million could be indicative of evolving economic landscapes, policy changes in lending, or responses to specific challenges or opportunities in the agricultural sector. Access to credit plays a pivotal role in determining the pace and direction of agricultural growth, and the fluctuations over the 49 years might reflect the changing financial dynamics and needs of the Kenyan agricultural community.

The expenditure on labour in the agricultural sector over the period exhibits an average value of Ksh. 32,726.88 million. This statistic underscores the importance of human capital in Kenya's agricultural realm. Throughout the 49-year span, agriculture has remained a cornerstone of employment, providing livelihoods to a significant portion of the Kenyan population. The consistency in labour expenditure hints at the sector's enduring labour-intensive nature, especially given the primary reliance on manual farming techniques and practices. The variation between the minimum value of Ksh. 20.5 million and the towering maximum of Ksh. 133,065.9 million might indicate fluctuations due to factors such as changes in wage rates, shifts in employment dynamics, or even the introduction of mechanization in certain agricultural segments. Seasonal demands, especially during planting and harvesting periods, could have led to peaks in labour costs. Moreover, over the five decades, there might have been changes in labour laws, regulations, or union negotiations that influenced wage structures and subsequently, the overall expenditure on agricultural labour.

The marketed agricultural production provides a snapshot of the output value from Kenya's agricultural sector over the near half-century period, boasting an average of Ksh. 126,622.7 million. This piqa votal metric indicates the total value of agricultural goods that were ready for sale, showcasing the sector's immense contribution to Kenya's economy. The considerable difference between the lowest recorded value at Ksh. 123.303 million and the highest at Ksh. 527, 025.2 million offers insights into the ebb and flow of agricultural production over the years. Factors such as climatic variations, pest infestations, global market demand-supply dynamics, and technological advancements in farming could have influenced these figures. Periods of drought or excessive rainfall might have seen dips in production, while years of favourable weather or the introduction of high-yield crops could have resulted in production booms. Additionally, changing governmental policies, international trade agreements, and domestic consumption patterns would have also played a role in shaping the overall marketed agricultural output value during this extended study period.

4.3 Pre-estimation tests

The pre-estimation tests conducted encompassed the normality test to check the distribution of residuals, the stationarity test to ensure data stability over time, and the heteroscedasticity test to verify the consistency of variance in the residuals. These tests are essential to validate the assumptions of the model and ensure the reliability of subsequent estimations.

4.3.1 Normality Test

Skewness and Kurtosis test was applied to check for normality of the variables under study. The null hypothesis was that observations are not normally distributed. If p-value is below 0.05, then the null of normality, at 5% confidence level, is not accepted. Table 3 is a presentation of normality test.

Table 3: Normality Test

Variable	Observation	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
Agricultural inputs	49	0.0012	0.5821	9.1000	0.1050
Expenditure on Water Supplies and Related Services	49	0.0002	0.0965	13.3200	0.1300
Rural Roads Development	49	0.0000	0.0018	23.4700	0.0871
Roads Maintenance	49	0.0000	0.0219	17.8400	0.0609
Credit facilities	49	0.0047	0.8107	7.2000	0.2730
Labour (Agricultural wage payments)	49	0.0035	0.8687	7.5700	0.2270
Marketed agricultural Production	49	0.0025	0.9942	8.0000	0.1830

Source: Author computed using data from KNBS, Economic surveys (1973-2021)

The results indicate that the data used is normally distributed since the p values for all variables were higher than 0.05.

4.3.2 Stationarity Test

To check for stationarity, an Augmented Dickey-Fuller (ADF) test was utilized. The null hypothesis, $H_{0,}$ tests whether a unit root exists in the series. The null hypothesis, $H_{0,}$ tests whether a unit root exists in the series. If the p value is less than a specified significance level, then the null hypothesis is rejected. If H_0 is rejected, then stationarity has been detected in the time series. The alternative is that there is non-stationarity in the time series. Table 4 presents the findings of the stationarity test.

Table 4: Stationarity Test

Variable name	Test Statistic	P-value	Comment
Agricultural inputs	4.307	0.0004	Stationary
Expenditure on Water Supplies and Related Services	3.975	0.0015	Stationary
Rural Roads Development	2.545	0.0104	Stationary
Roads Maintenance	2.915	0.0436	Stationary
Credit facilities	6.241	0.0000	Stationary
Labour (Agricultural wage payments)	7.175	0.0000	Stationary
Marketed agricultural Production	4.649	0.0001	Stationary

Source: Author computed using data from KNBS, Economic surveys (1973-2021)

The results in table 4 indicate that all the variables are stationary as the p-value for all of the variables was less than 0.05. Therefore lacking unit roots at 0.05 significance level.

4.3.3 Heteroscedasticity Test

To check for heteroscedasticity, Breusch-Pagan test was applied. The null hypothesis stated that error terms are homoscedastic (have constant variance). If the p-value is below 0.05, the null hypothesis is rejected. The results of heteroscedasticity test are depicted in table 5

Table 5: Heteroscedasticity Test

Breusch-Pagan test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of Marketed agricultural Production
chi2 (1) = 1.88
Prob > chi2 = 0.1699

Source: Author computed using data from KNBS, Economic surveys (1973-2021)

Based on results in table 5, the p-value was 0.1699, which is more than 0.05. The null hypothesis was therefore not rejected, confirming absence of heteroscedasticity in the data used.

4.4 Correlation Analysis

Correlation analysis illustrates the association between the variables and the results are presented in Table 6

Table 6: Correlation Analysis

	logagr~n	LogAg~ss	logExp~s	LogRur~T	Logroa~e	Logcre~s	loglab~r
logagricul~n	1.0000						
LogAgricu~ss	0.3275	1.0000					
logExpendi~s	0.4096	0.5386	1.0000				
LogRuralRo~T	0.1158	-0.4442	-0.2977	1.0000			
Logroadmai~e	0.5149	0.0531	0.1015	-0.1425	1.0000		
Logcreditf~s	0.2485	0.0774	0.1117	-0.0610	0.4024	1.0000	
loglabour	0.0593	-0.0326	-0.0137	0.0033	0.0535	0.0322	1.0000

Source: Author computed using data from KNBS, Economic surveys (1973-2021)

The correlation analysis reveals that there is a positive correlation of 0.3275 between agricultural inputs and marketed agricultural production. This recommends that as the investment in agricultural inputs such as chemicals, fertilizers, fuel, and power increases, there is a corresponding increase in the value of agricultural produce ready for sale. Investing in quality and adequate agricultural inputs can significantly enhance the output of the agricultural sector, making it imperative for stakeholders to prioritize and support farmers in accessing these inputs. The data exhibits a correlation value of 0.4096, signifying a positive association between spending on water supplies/services and marketed agricultural production. This underscores the importance of water as an essential resource in boosting agricultural yields. Emphasizing water conservation, irrigation projects, and ensuring consistent water supply can lead to increased agricultural production, catering to the growing demand for food and other agricultural products.

With a correlation value of 0.1158, rural roads development shows a positive but relatively weak link to marketed agricultural production. Roads play a crucial role in connecting farms to markets and ensuring timely access to essential inputs. This implies that while road development is essential, its direct impact on agricultural output might be moderated by other factors, suggesting that a holistic approach, integrating road development with other infrastructural and agricultural support systems, could be more effective. The correlation between roads maintenance and marketed agricultural production stands at 0.5149, indicating a strong positive relationship. This emphasizes the significance of not just constructing but also maintaining roads for efficient transportation. Regular maintenance of roads can lead to reduced transportation costs, timely delivery of products to markets, and minimized post-harvest losses, thus driving up the marketed agricultural production.

The study shows a positive correlation of 0.2485 between credit facilities and marketed agricultural production. Financial support aids farmers in purchasing necessary inputs, adopting new technologies, and expanding operations. Facilitating easier access to credit and financial support for farmers can substantially boost agricultural productivity by empowering them to capitalize on available resources and opportunities. The correlation value of 0.0593 between labour expenditure (agricultural wage payments) and marketed agricultural production is positive, but it is relatively low. This implies that while labour is crucial for agricultural operations, other factors might have a more pronounced effect on the marketed output. While ensuring fair wages and supporting the agricultural workforce is essential, it's equally vital to integrate labour with technological advancements, training, and other support mechanisms to realize a notable increase in marketed agricultural production.

4.5 Regression Analysis

The regression Analysis was used to examine the relationship of the variables. The study results are presented in Table 7

Table 7: Regression Analysis

Source	SS	df	MS	Number of obs	=	49
				F(6, 42)	=	8.93
Model	1.24377791	6	.207296319	Prob > F	=	0.0000
Residual	.975071258	42	.023215982	R-squared	=	0.5606
				Adj R-squared	=	0.4978
Total	2.21884917	48	.046226024	Root MSE	=	.15237

logagriculturalProduction	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logRuralRoadsDevelopment	.417083	.1102845	3.78	0.000	.1945198	.6396462
Logroadmaintance	.5644479	.1306473	4.32	0.000	.300791	.8281048
LogAgriculturalinputss	.1162016	.0341352	3.40	0.001	.047314	.1850892
logExpenditureonwatersupplies	.2370333	.0838552	2.83	0.007	.0678066	.4062599
Logcreditfacilities	.089954	.0443233	2.03	0.049	.000506	.1794019
EarningLabour	.0001619	.0014293	0.11	0.910	-.0027224	.0030463
_cons	-1.540314	1.460153	-1.05	0.298	-4.487023	1.406395

Source: Author computed using data from KNBS, Economic surveys (1973-2021)

The model specification of the study was;

AP=-1.5403+0.4171RRD+0.5644 RM+0.1162INPTS+0.2370WTR+0.0900 CRDT+0.0002 LA

Where:

AP=Marketed Agricultural Production

RRD=Expenditure on the construction of rural roads

RM=Expenditure on maintenance and rehabilitation of all roads

INPTS=Agricultural inputs

WTR=Expenditure on all water supplies

CRDT=Commercial loans (Credit facilities)

LA=Agricultural wage payments

The study results have indicated that the factors including expenditure on rural road construction, maintenance and rehabilitation of all roads, agricultural inputs, expenditure on all water supplies, commercial loans, and agricultural wage payments play a significant role in Kenya's agricultural landscape. Combined, these factors account for 56.06% of the variations observed in marketed agricultural production in the country. The high F-statistic value of 8.9300, with a probability close to zero (Prob (F-statistic) = 0.0000), further reaffirms the statistical significance of these findings, emphasizing the crucial interplay of these determinants in shaping the agricultural output that is ready for sale in Kenya.

The study indicated a significant and positive relationship between rural roads development and marketed agricultural production in Kenya, as evidenced by the coefficient of 0.4171, p value of 0.000 and a t-statistic of 3.7800. This highlights that a unitary augmentation in rural roads development can potentially amplify marketed agricultural production by 0.4171 units, holding other variables constant. Rural roads play a cardinal role in facilitating seamless transportation of agricultural produce from farms to markets, ensuring timely access to agricultural inputs, and reducing post-harvest losses. Therefore, substantial investments in rural road development can significantly enhance agricultural productivity and the overall efficiency of the agricultural supply chain in Kenya.

In addition, there is a positive regression between roads maintenance and marketed agricultural production in Kenya, represented by a coefficient of 0.5644, p value of 0.0000 and a t-statistic value of 4.3200. This denotes that a unit increase in roads maintenance can result in an increase in marketed agricultural production by 0.5644 units, other factors remaining unchanged. While the construction of roads is essential, their maintenance is paramount to sustain their utility over time. Regular maintenance ensures that roads remain usable, minimizing transportation disruptions and ensuring the timely movement of agricultural produce, which is crucial for maximizing marketed agricultural production.

Moreover, the study found that agricultural inputs are positively and significantly related with marketed agricultural production in Kenya (β=0.1162, p=0.0010). This was supported by a calculated t-statistic of 3.4000. This meant that a unitary increase in agricultural inputs could lead to an increase in marketed agricultural production in Kenya by 0.1162 units holding other

factors constant. Agricultural inputs, including chemicals, fertilizers, fuel, and power, form the backbone of agricultural productivity. The results highlight the crucial role they play in enhancing the overall yield and, subsequently, the marketed agricultural produce. Therefore, it is imperative for stakeholders, both public and private, to facilitate farmers' access to high-quality and affordable agricultural inputs. This could mean supporting research into more effective farming inputs, subsidies to make them more affordable, or training programs to help farmers utilize them more effectively. Such initiatives can lead to a substantial improvement in agricultural yield and the overall growth of the agricultural sector in Kenya.

Further, the study indicated that expenditure on water supplies and related services exhibited a significant and positive relationship with marketed agricultural production in Kenya, represented by a coefficient value of 0.2370 and p value of 0.0070. The calculated t-statistic of 2.8300 confirms the significance of this relationship. This means that for every unit increase in the expenditure on water supplies and services, marketed agricultural production in Kenya is predicted to rise by 0.2370 units, all other factors being equal. Water is a fundamental resource for agricultural activities, and as such, targeted investments in water supplies, including irrigation and water conservation, are pivotal. Ensuring consistent and enhanced water availability can lead to improved crop yields, thus boosting the marketed agricultural production in Kenya.

Moreover, credit facilities showcased a significant positive relationship with marketed agricultural production in Kenya, as denoted by a coefficient of 0.0900, p value of 0.0490 and a t-statistic of 2.0300. This recommends that a unitary increment in credit facilities could enhance marketed agricultural production by 0.0900 units, keeping other variables constant. Access to credit is vital for farmers, enabling them to procure essential inputs, adopt innovative technologies, and potentially expand their operations. Financial institutions and policymakers should prioritize offering competitive credit facilities to farmers, as this can serve as a catalyst for growth in marketed agricultural production.

Labour, measured in terms of agricultural wage payments, revealed a positive coefficient of 0.0002, p value of 0.9100 with a t-statistic of 0.1100, indicating a negligible and statistically insignificant effect on marketed agricultural production. While labour is an integral component of agricultural operations, its direct impact on marketed agricultural production might be moderated by various other factors, including technology adoption, training, and mechanization. It recommends the need for a comprehensive approach that integrates labour with other strategic interventions to optimize agricultural productivity.

4.6 Discussions of the Findings

The descriptive statistics indicate an apparent evolution over the years in various economic facets. Agricultural input expenditures have shifted, reflecting changing agricultural practices and input prices. Spending on water supplies and related services has experienced fluctuations, possibly due to variations in water availability and infrastructure development. Investments in rural road development have seen changes, indicating varying governmental and sectoral priorities. Similarly, funds allocated for road maintenance have witnessed adjustments, signifying changing infrastructure needs and budgetary considerations. Credit facilities, essential for farm expansion and modernization, have also shown alterations over time, hinting at shifts in financial accessibility for farmers. Additionally, the expenditure on labour, quantified as agricultural wage payments, reveals changing wage patterns and perhaps labour market dynamics. Lastly, the finances concerning marketed agricultural production have varied, capturing the changing landscape of agricultural output and market dynamics.

The correlation analysis shows the association between various factors and their impacts on the marketed agricultural production in Kenya. A positive correlation of 0.3275 between agricultural inputs and the marketed agricultural production indicates that an increase in essential inputs such as chemicals, fertilizers, fuel, and power leads to a proportional rise in the agricultural produce ready for sale. The provision and utilization of quality agricultural inputs can significantly increase the agricultural output. Similarly, water's role as an indispensable resource for agriculture is highlighted by a positive correlation of 0.4096 between expenditure on water supplies/services and marketed agricultural production. Investments in water infrastructure, such as irrigation systems and conservation projects, directly translate to increased agricultural yields, meeting the escalating demand for food and agricultural commodities.

Further, on the infrastructure front, rural roads development, with a correlation value of 0.1158, demonstrates a positive correlation with marketed agricultural production. This recommends that while constructing new roads is beneficial, the maintenance and quality of these roads, as indicated by a correlation of 0.5149, have a more pronounced impact on agriculture. Well-maintained roads reduce transportation costs and ensure timely delivery, boosting the overall marketed agricultural output. Meanwhile, the role of financial instruments becomes evident with a positive correlation of 0.2485 between credit facilities and marketed agricultural production.

Facilitating easy and affordable credit access can empower farmers to leverage modern farming techniques, purchase essential inputs, and expand their operations. Lastly, while labour, as represented by agricultural wage payments, is undeniably vital for agricultural activities, its correlation value of 0.0593 recommends that other factors may have a more direct and substantial effect on the marketed output. This emphasizes the need for a balanced approach, combining fair labour practices with technological integration, skill enhancement, and continuous training to maximize the sector's potential.

The regression results showed that factors including expenditure on rural road construction, maintenance and rehabilitation of all roads, agricultural inputs, expenditure on all water supplies, commercial loans and agricultural wage payments can account for 56.06% of the variations observed in marketed agricultural production in the country. The high F-statistic value of 8.9300, with a probability close to zero (Prob(F-statistic) = 0.0000), further reaffirms the statistical significance of these findings, emphasizing the crucial interplay of these determinants in shaping the agricultural output that is ready for sale in Kenya.

The study found that agricultural inputs are positively and significantly related with marketed agricultural production in Kenya (β=0.1162, p=0.0010). This meant that a unitary increase in agricultural inputs could lead to an increase in marketed agricultural production in Kenya by 0.1162 units holding other factors constant. Agricultural inputs, including chemicals, fertilizers, fuel, and power, form the backbone of agricultural productivity. The results highlight the crucial role they play in enhancing the overall yield and, subsequently, the marketed agricultural produce. Further, the study indicated that expenditure on water supplies and related services exhibited a significant and positive relationship with marketed agricultural production in Kenya, represented by a coefficient value of 0.2370 and p value of 0.0070. This means that for every unit increase in the expenditure on water supplies and services, marketed agricultural production in Kenya is predicted to rise by 0.2370 units, all other factors being equal.

Moreover, the study indicated a significant and positive relationship between rural roads development and marketed agricultural production in Kenya, as evidenced by the coefficient of 0.4171, p value of 0.0000 and a t-statistic of 3.7800. This highlights that a unitary augmentation in rural roads development can potentially amplify marketed agricultural production by 0.4171 units, holding other variables constant. In addition, there is a positive regression between roads maintenance and marketed agricultural production in Kenya, represented by a coefficient of 0.5644, p value of 0.0000 and a t-statistic value of 4.3200. This

denotes that a unit increase in roads maintenance can result in an increase in marketed agricultural production by 0.5644 units, other factors remaining unchanged.

Moreover, credit facilities showcased a significant positive relationship with marketed agricultural production in Kenya, as denoted by a coefficient of 0.0900, p value of 0.0490 and a t-statistic of 2.0300. This recommends that a unitary increment in credit facilities could enhance marketed agricultural production by 0.0900 units, keeping other variables constant. Labour, measured in terms of agricultural wage payments, revealed a positive coefficient of 0.0002, p value of 0.9100 with a t-statistic of 0.1100, indicating a negligible and statistically insignificant effect on marketed agricultural production.

The study results concur with the findings of Andersen and Shimokawa (2006) who stressed the importance of roads for economic growth, especially through agricultural produce marketing. Karani and Wanjohi (2017) revealed challenges faced by small-scale farmers due to the poor state of rural roads, leading them to depend on middlemen for marketing their produce. Tunde and Adeniyi (2012) reported that bad roads inflated transportation costs, directly affecting farmers' income. Llanto (2012) observed that areas with improved road infrastructure and electricity saw faster growth rates in agricultural production compared to regions lagging in infrastructure development. Yuen (2013) indicated that investments in rural infrastructure, including transportation and electricity, were pivotal for agricultural development. Kiprono and Matsumoto (2014) found that regions with improved road systems allocated more land for agricultural production and enjoyed better market access. Rural roads play an indispensable role in fostering agricultural growth, offering better market accessibility, and enhancing the socio-economic conditions of the rural populace.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter outlines the summary of findings and conclusions drawn from analysis of the data. The section further includes the recommendations, limitations and suggested area for further research.

5.2 Summary of Findings

The study demonstrated that on the infrastructure front, rural roads development has a positive correlation with marketed agricultural production, with a correlation value of 0.1158. The study indicated a significant and positive relationship between rural roads development and marketed agricultural production in Kenya, as evidenced by the coefficient of 0.4171, p value 0.0000 and a t-statistic of 3.7800. This highlights that a unitary augmentation in rural roads development can potentially amplify marketed agricultural production by 0.4171 units, holding other variables constant. Rural roads play a cardinal role in facilitating seamless transportation of agricultural produce from farms to markets, ensuring timely access to agricultural inputs, and reducing post-harvest losses.

The study showed road maintenance has a positive correlation with agricultural production indicated by a correlation of 0.5149. In addition, there is a positive regression between roads maintenance and marketed agricultural production in Kenya, represented by a coefficient of 0.5644, p value of 0.0000 and a t-statistic value of 4.3200. This denotes that a unit increase in roads maintenance can result in an increase in marketed agricultural production by 0.5644 units, other factors remaining unchanged. While the construction of roads is essential, their maintenance is paramount to sustain their utility over time. Regular maintenance ensures that roads remain usable, minimizing transportation disruptions and ensuring the timely movement of agricultural produce, which is crucial for maximizing marketed agricultural production.

The correlation analysis shows a positive correlation of 0.3275 between agricultural inputs and the marketed agricultural production indicates that an increase in essential inputs such as chemicals, fertilizers, fuel, and power leads to a proportional rise in the agricultural produce ready for sale. The provision and utilization of quality agricultural inputs can significantly increase the agricultural output. Moreover, the study found that agricultural inputs are

positively and significantly related with marketed agricultural production in Kenya (β=0.1162, p=0.0010). This meant that a unitary increase in agricultural inputs could lead to an increase in marketed agricultural production in Kenya by 0.1162 units holding other factors constant. Agricultural inputs, including chemicals, fertilizers, fuel, and power, form the backbone of agricultural productivity. The results highlight the crucial role they play in enhancing the overall yield and, subsequently, the marketed agricultural produce.

Similarly, water's role as an indispensable resource for agriculture is highlighted by a positive correlation of 0.4096 between expenditure on water supplies/services and marketed agricultural production. The study further indicated that expenditure on water supplies and related services exhibited a significant and positive relationship with marketed agricultural production in Kenya, represented by a coefficient value of 0.2370 and p value of 0.0070. This means that for every unit increase in the expenditure on water supplies and services, marketed agricultural production in Kenya is predicted to rise by 0.2370 units, all other factors being equal. Water is a fundamental resource for agricultural activities, and as such, targeted investments in water supplies, including irrigation and water conservation, are pivotal.

In addition, facilitating easy and affordable credit access can empower farmers to leverage modern farming techniques, purchase essential inputs, and expand their operations as the correlation coefficient was 0.0593. Moreover, credit facilities showcased a significant positive relationship with marketed agricultural production in Kenya, as denoted by a coefficient of 0.0900, p value of 0.0490 and a t-statistic of 2.0300. This recommends that a unitary increment in credit facilities could enhance marketed agricultural production by 0.0900 units, keeping other variables constant. Access to credit is vital for farmers, enabling them to procure essential inputs, adopt innovative technologies, and potentially expand their operations. Financial institutions and policymakers should prioritize offering competitive credit facilities to farmers, as this can serve as a catalyst for growth in marketed agricultural production.

The correlation value of 0.0593 between labour expenditure (agricultural wage payments) and marketed agricultural production is positive, but it is relatively low. Besides, regression results showed labour, measured in terms of agricultural wage payments, revealed a positive coefficient of 0.0002, p value of 0.9100 with a t-statistic of 0.1100, indicating a negligible and statistically insignificant effect on marketed agricultural production. While labor is an integral component of agricultural operations, its direct impact on marketed agricultural production might be moderated by various other factors, including technology adoption, training, and

mechanization. It recommends the need for a comprehensive approach that integrates labor with other strategic interventions to optimize agricultural productivity.

5.3 Conclusions

The study concludes that there is a positive relationship between rural roads development and marketed agricultural production. Rural roads are not just pathways but lifelines that connect the heart of agricultural regions to broader markets. Their presence or absence can significantly impact the ease with which farmers can sell their produce. Good road networks reduce transportation costs, ensure timely delivery of goods, and reduce post-harvest losses due to delays. Moreover, they facilitate the movement of essential inputs to farming regions, ensuring that farmers have what they need when they need it. Rural roads also play a role in reducing the isolation of rural communities, allowing for better access to education, healthcare, and other essential services. Investing in the development and maintenance of these roads can lead to multifaceted benefits, not just for the agricultural sector but for rural development as a whole.

The study concludes that the maintenance of roads holds significant importance in the realm of agricultural production. While constructing roads lays the foundation, maintaining them ensures their longevity and functionality. Roads that are not well-maintained can become unusable over time, leading to disruptions in the transportation of goods. These disruptions can result in delays, increased costs, and even post-harvest losses for farmers. Furthermore, poor road conditions can lead to increased vehicle maintenance costs and can deter transportation services from accessing certain areas. It is essential to understand that the utility of a road doesn't end once it's built. Regular check-ups, repairs, and upgrades are necessary to ensure they serve their purpose effectively.

The study concludes that there's a positive relationship between the use of agricultural inputs, such as chemicals, fertilizers, fuel, and power, and the volume of agricultural produce ready for sale. These inputs, undeniably, are the pillars of agricultural productivity in Kenya. Their significance can't be overstated, especially when considering the intricate web of factors influencing agricultural outputs. By ensuring farmers have consistent access to these vital inputs, it's possible to drive consistent growth in produce that's ready for the market. Their role in improving soil fertility, combating pests, and facilitating mechanization makes them indispensable. Moreover, the emphasis on these inputs highlights the need for strategies that

ensure their affordability and accessibility. As agriculture remains a backbone of many economies, especially in countries like Kenya, these findings are crucial.

The study concludes that water is an integral component in agriculture, evidenced by the positive relationship between expenditure on water supplies/services and marketed agricultural production. Not only is water a basic necessity for crops; it's the lifeblood that ensures their growth and sustenance. The emphasis on water-related expenditure highlights the importance of irrigation systems, water conservation methods, and efficient water management practices. As climate change continues to impact weather patterns, the reliability of rainfall becomes uncertain. This makes investments in water infrastructure even more pivotal. Moreover, efficient water use ensures that crops get the optimum amount they need, leading to better yields. Proper water management can also prevent issues like waterlogging and salinization, which can harm crop yield. In essence, the role of water in agriculture is multifaceted and extends beyond just hydration.

The study concludes that there is a strong positive relationship between access to credit facilities and marketed agricultural production. Credit acts as a catalyst, enabling farmers to enhance their farming practices, invest in modern technologies, and expand their reach. For many farmers, especially small-scale ones, upfront capital is a challenge. Access to credit can bridge this financial gap, allowing them to make necessary purchases at the start of planting seasons. Financial institutions play a pivotal role here, and their policies can significantly impact agricultural output. Offering competitive interest rates, understanding the unique challenges of agricultural cycles, and providing training on financial management can further enhance the positive impact of credit.

The study concludes that labour, while essential, has an insignificant effect on marketed agricultural production. The impact of labour on marketed agricultural production is not direct and can be influenced by various factors. The introduction of technology, for instance, can alter the traditional labour landscape, possibly reducing manual tasks while introducing new specialized roles. Training, too, plays a crucial role. Skilled labour can lead to better crop management, more efficient use of inputs, and overall higher yields. Mechanization, on the other hand, can reduce the demand for certain labour types while elevating the need for machine operators and maintenance personnel. In essence, while labour remains integral, its role and impact are ever-evolving, necessitating continuous evaluation and adaptation.

5.4 Recommendations

The study recommends that there should be greater investments made to ensure the reliable and uninterrupted availability of crucial agricultural inputs. Considering their crucial role in enhancing agricultural productivity, it is imperative to establish strategies that guarantee the affordability and accessibility of these resources for all farmers. One possible approach is to provide financial support for these resources, particularly for farmers operating on a small scale. Another option is to establish collaborations with manufacturers to obtain these resources in large quantities. It is advisable for the government and stakeholders to arrange training sessions for farmers regarding the efficient utilization of these resources. This not only guarantees enhanced efficiency but also promotes ecologically sustainable agricultural methods. Partnerships with global agricultural organizations can additionally facilitate the implementation of sophisticated inputs and methodologies. Moreover, utilizing technology can assist in forecasting the necessary amounts of these inputs, thereby preventing unnecessary waste. Exploration and innovation in this field can also result in more productive and economical resources, further enhancing the agricultural industry.

The study recommends a strong emphasis on improving water infrastructure, particularly in agricultural areas. Considering the crucial significance of water in agriculture, it is imperative to make significant investments in water conservation techniques, optimize water management strategies, and enhance the scope of irrigation systems. Given the growing uncertainties in rainfall patterns caused by climate change, it is crucial to prioritize the development of rainwater harvesting systems and reservoirs. Furthermore, the implementation of farmer education programs regarding water conservation techniques and efficient irrigation methods can play a crucial role. Engaging in partnerships with international organizations can introduce superior methods and advancements in this field. It is crucial to guarantee that water utilized in agriculture remains uncontaminated in order to preserve the health of soil and crops. Efforts aimed at encouraging the recycling and reutilization of water in agricultural contexts can enhance the efficiency of water utilization. Periodic evaluations of water consumption in farming areas can offer valuable information for on-going enhancement.

The study recommends making substantial investments in the development and expansion of rural road networks. A well-designed strategy for infrastructure development can have a significant positive impact on rural regions. The construction should also take into account future expansion, ensuring that roads are constructed to accommodate higher volumes of traffic and increased weight capacity. Proactive maintenance involves conducting regular

inspections to promptly identify and resolve issues before they worsen. Engaging local communities in road development projects can guarantee that the roads effectively cater to their specific requirements and simultaneously create job prospects. Engaging in partnerships with infrastructure specialists, both domestically and globally, can introduce cutting-edge construction methodologies that guarantee long-lasting quality. Funding can be obtained through a combination of government allocations, grants, and collaborations between public and private entities. Stakeholders should also take into account the environmental ramifications during the construction process, ensuring that there is minimal disturbance to the local ecosystems.

The study proposes an all-encompassing approach to ensure the regular upkeep of rural roads. Acknowledging that the worth of a road does not cease upon its completion, consistent maintenance guarantees durability and continued usefulness. Annual allocation of maintenance budgets should be ensured to prevent any financial constraints during repair needs. Local communities can participate in the monitoring of road conditions, offering immediate updates on necessary interventions. The utilization of technology, such as sensors and satellite imaging, can facilitate the prompt identification of deterioration and damage. Conducting workshops and training programs for local personnel on maintenance best practices can enhance the quality of work. In areas susceptible to severe weather conditions, specific precautions and construction methods can be utilized to minimize harm. By engaging in collaboration with international infrastructure organizations, it is possible to implement sophisticated maintenance techniques that guarantee roads are maintained in the best possible condition.

The study recommends that financial institutions should greatly improve their credit offerings specifically designed to meet the distinct requirements of farmers.To acknowledge the profound impact of credit in agriculture, policies should guarantee convenient, cost-effective, and prompt availability of funds. These measures may include lowered interest rates, adaptable repayment schedules that coincide with harvest seasons, and minimal demands for collateral. Financial literacy programs can enhance farmers' comprehension of credit intricacies, thereby guaranteeing that they make well-informed choices. Engaging in partnerships with agricultural specialists can assist in formulating credit packages that are tailored to the specific requirements of farming. The government has the ability to offer support or assurances for agricultural loans, thereby mitigating risks for financial institutions. Utilizing digital platforms can streamline and accelerate the loan application and approval

procedure. Regular feedback from farmers can offer valuable insights for enhancing the credit system, thus ensuring its continued focus on the needs and interests of farmers.

The study recommends adopting a holistic approach to fully exploit the labour potential in agriculture. Given the changing nature of work due to technological progress, it is necessary to enhance the skills of the workforce. Training programs can acquaint individuals with novel machinery, sophisticated farming techniques, and optimal methodologies. Gradual implementation of mechanization should be prioritized to mitigate the risk of substantial employment reduction. Partnerships with educational institutions can facilitate the implementation of specialized agricultural programs, resulting in the development of a highly competent workforce from the beginning. Implementing worker welfare programs that prioritize favourable working conditions, equitable remuneration, and additional perks can significantly enhance productivity. It is essential to establish feedback mechanisms that enable workers to express their concerns and provide suggestions. With the increasing integration of technology in agriculture, it is crucial to establish programs that not only prevent the existing workforce from being left behind, but also equip them with the necessary skills to succeed in this new technological environment.

5.5 Limitations of the Study

This research predominantly relied on secondary data, indicating that the data was not directly gathered by the researchers specifically for this study. However, it was obtained from preexisting records, publications, or databases. Exclusively depending on secondary data can introduce biases or inaccuracies, as the original data may have been collected under dissimilar conditions, for different objectives, or may not be entirely comprehensive or current.

5.6 Suggestions for Further Research

The study suggests conducting additional research to investigate additional factors relating to marketed agricultural production in Kenya. It is essential to analyse the significance of technology adoption, specifically digital platforms for connecting markets and managing farms, along with the influence of extension services that offer training and information to farmers. Furthermore, it is important to take into account the impact of land tenure systems, as they can have an influence on investments in land and agricultural practices. Investigating the role of cooperative societies in resource pooling, value addition strategies like processing and branding, and the impact of international trade policies on market access are crucial areas to focus on. Additionally, considerations such as pest and disease management,resilience

strategies against the impacts of climate change, and socio-cultural practices that influence farming can offer a comprehensive perspective on the factors that determine agricultural production for sale in Kenya.

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