INFLUENCE OF ROAD INFRASTRUCTURE ON AGRICULTURAL DEVELOPMENT IN LAMU COUNTY, KENYA

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DECLARATION AND APPROVAL

Declaration

I declare that this thesis is my own work and has not been presented in any other University for the award of any degree.

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Approval

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

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ABSTRACT

Roads are essential to the world's economic and transportation systems. In addition to promoting economic growth and development in the impacted areas, well-established road infrastructures allow for market integration and the creation of job possibilities. For Kenya to advance economically, ensure food security, and combat poverty, agricultural development is essential. As one of Kenya's neglected regions, Lamu County frequently faces issues related to high rates of poverty, unemployment, and food insecurity. In order to open Lamu County to investments and unite the County with other regions, the administration has emphasized the construction of road infrastructure through the implementation of the social and economic programs outlined in the Vision 2030 economic strategy. Low agricultural development in the county, however, exacerbates food security issues and slows commerce expansion and rural development. The purpose of this study was to examine how road infrastructure, which makes it easier to obtain agricultural inputs, provide agricultural extension services, and market agricultural goods, affects agricultural development in Lamu County. The high payoff input model, which used a mixed-method research technique to create a comprehensive knowledge of the relationship between study variables, served as the foundation for the study. In order to collect quantitative data, a descriptive survey approach was employed, employing questionnaires from 391 agricultural households in Lamu County. Eleven road infrastructure and agriculture specialists participated in Key Informant Interviews, which were guided by the findings. The quantitative results were triangulated with the theme analysis of the qualitative data. The quantitative data was statistically analysed using SPSS 25.0, and descriptive statistics such as means, standard deviations, frequencies, and percentages were used to show the findings. By ensuring that participants signed informed consent, volunteered voluntarily, and had their identities safeguarded, the study complied with ethical standards. The study had 333 participants who completed it, yielding an 85% response rate. A reliability analysis was conducted to verify the reliability of the research instruments. The results showed that the study tools were reliable, with a Cronbach's Alpha value of 0.864 across 45 items. According to the study, every independent variable that was looked at showed a positive and statistically significant link with the dependent variable. According to an analysis of correlations between study variables, road infrastructure and agricultural development are strongly positively correlated, particularly when it comes to marketing agricultural produce (r=.73**), providing agricultural extension services (r=.194), and facilitating access to agricultural inputs (r=.75**). Agricultural development was not significantly impacted by the moderating variable. The results of the study demonstrated that road infrastructure has a major impact on agricultural growth in Lamu County by making it easier to access produce marketing, extension services, and agricultural inputs. On the other hand, it was discovered that water transportation had no discernible impact on the region's agricultural development. In light of these findings, the study recommends enhancing road infrastructure to facilitate farmers' access to market possibilities, extension services, and agricultural inputs, thus fostering agricultural development in Lamu County.

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LIST OF ABBREVIATIONS

AfDB	African Development Bank
CAADP	Comprehensive African Agricultural Development Program
URAA	Uruguay Round Agreement on Agriculture
GATT	General Agreement on Tariffs and Trade
CGIAR	Consultative Group on International Agricultural Research
CIDP	County Integrated Development Plan
DW	Durbin-Watson's
FAO	Food and Agriculture Organization
GNP	Gross National Product
GRSP	Global Rice Science Partnership
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
KNBS	Kenya National Bureau of Statistics
KII	Key Informants Interview
LAPSSET	Lamu Port South Sudan Ethiopia Transport corridor
NACOSTI	National Commission for Science, Technology and Innovation
SSTP	Scaling Seeds and Technologies Partnership
UNDP	United Nations Development Program

US	United States

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Road infrastructure is vital element of the terrestrial transport network globally. Established roads infrastructure fosters market integration and the growth of local production units besides stimulating economic growth and creation of job opportunities (Skorobogatova & Kuzmina-Merlino.,2017). Moreover, road infrastructure connects individuals to economic prospects across the regions thus underpinning growth of various factors of production within the society, improving the societal well-being by enhancing economic opportunities (Sow,.2021). In Europe, presence of a robust road infrastructure network propels growth of trade across various sectors of the economy (Skorobogatova & Kuzmina-Merlino, 2017). The elaborated road infrastructures network bolster business efficiency which by large attracts investment opportunities in the agricultural sector. For instance, while Russia was encountering an episode of economic uncertainty owing to sanctions, the state undertook to expand the road infrastructure to integrate regions and fast track economic recovery (Morkovkin et al., 2017). These endeavors have diversified the economy and reduced reliance on extractive industries, notably the oil and gas sector.

The influence of road transport infrastructure extends to the agricultural sector by promoting the integration of production units. This integration fosters market stability, competition, and better pricing for agricultural products, resulting in improved income prospects for agricultural producers (Sow, 2021). Furthermore, in Europe, roads infrastructure projects have facilitated the unification of member states, yielding heightened cross-border integration and streamlined business operations (Flyvbjerg et al., 2010; Sow, 2021). This aspect has enabled the flourishing of a capitalist economy, leveraging market forces of supply and demand for agricultural goods among member states.

In the pursuit of fostering economic growth, numerous developing countries are placing significant emphasis on enhancing road infrastructure, particularly in underdeveloped areas (Ng et al., 2019). The importance of road infrastructure extends beyond the facilitation of the movement of people and goods; it also grants access to a wide range of commercial and social activities, enabling the delivery of technology and resources essential for agricultural productivity. Nevertheless, a comprehensive approach to sustainable economic growth entails more than just road infrastructure development. Matyushok, Baranova, and Sorokin (2020) emphasize the significance of sustainable economic growth that encompasses societal and environmental considerations. This integrated approach underscores socio-economic development and the overall well-being of society, especially in vulnerable areas experiencing climatic variability and potential hazards like food insecurity. Transport infrastructure projects play a pivotal role in integrating marginalized regions, facilitating trade and people's mobility, thereby contributing to the accumulation of human capital, which is crucial for industrial growth, innovation, education, and the development of a skilled workforce. Ultimately, a nation's development hinges on its ability to foster growth across various social determinants, including food security, education, road infrastructure, healthcare, industrial production, and trade (Al-Zyoud et al.,2021).

Similarly, transportation infrastructure provides access to educational resources, creating opportunities for skill and knowledge enhancement, which in turn contributes to improved human capital. Substantial research substantiates that higher levels of productivity, income, and overall quality of life are intrinsically linked to human development. The growth of markets and trade further amplifies these benefits. In the Indian context, Mohanty, Nayak, and Chatterjee (2016) underscore the integral role of communication and transportation in the process of industrialization, emphasizing infrastructure investment as a catalyst for socio-economic empowerment. They also stress the significance of health and education as essential

components of human development. Health, alongside education, plays a pivotal role in shaping human development by acting as a robust predictor of life expectancy. Like education, transportation infrastructure also facilitates access to educational resources, fostering skill and knowledge development to bolster human capital. A body of research reinforces the notion that higher levels of productivity, income, and overall quality of life are intrinsically linked to human development. These multifaceted benefits are further magnified by the growth of markets and trade, creating a cycle of positive reinforcement in the development process.

In the context of India, Mohanty, Nayak, and Chatterjee (2016) underscore the critical role of communication and transportation in the process of industrialization, highlighting how infrastructure investment contributes to the socio-economic progress of societies. They also emphasize the significance of health and education as pivotal factors in advancing humanity. Health, in particular, serves as a crucial determinant of human development due to its robust predictive power for life expectancy. Notwithstanding investments in transport infrastructure, instances exist where the actual performance falls significantly short of expectations, and immediate economic benefits remain elusive (Flyvbjerg, Bruzelius, & Rothengatter, 2010). Flyvbjerg et al. (2010) shed light on recurrent cost overruns and failures to achieve projected profits, casting doubts on the viability of projects and reframing once-praised programs as potential hindrances to economic advancement. A prime example is the case of China's new Chek Lap Kok airport, which encountered operational issues upon its 1998 opening, leading to adverse financial impacts on both the airport and the wider Hong Kong economy, subsequently affecting GDP growth. In the realm of developing economies, Herrero& Xu., (2019) express skepticism about the impact of massive investments in developmental infrastructure projects, arguing that these countries often fail to reap substantial benefits. Contrarily, they tend to experience reduced trade compared to their counterparts in more advanced economies.

As a response to evolving indicators of development, the United Nations Development Program (UNDP) has transitioned from emphasizing a nation's gross national product (GNP) to prioritizing the provision of tangible goods and services to marginalized populations. The focus has shifted to human development, as highlighted by Hirway and Mahadevia (2004) in the work of Mohanty et al. This approach has gradually emerged as a global development paradigm. UNDP (1995) defines human development as a framework that expands people's choices and improves their quality of life, fostering an environment conducive to longevity, health, creativity, and active engagement in various endeavors.

In developing countries, particularly within the African context, agriculture serves as the predominant economic activity, contributing an estimated average of 15% to the GDP (Kamara, Conteh, Rhodes, and Cooke, 2019). This sector directly employs approximately 65% of the African workforce, playing a vital role in socioeconomic development. Over time, the agricultural sector has significantly impacted societal well-being by enabling agrarian communities to produce food, sell surpluses, achieve food security, and generate income for farmers. Agriculture holds the potential to alleviate vulnerability to extreme poverty by promoting agricultural investment and trade, thus fostering employment opportunities. However, as highlighted by Kamara et al. (2019), lack of access to proper road infrastructure poses a substantial obstacle for farmers in transporting agricultural inputs, goods, accessing information, and adopting technology. Moreover, scholars underscore that many smallholder farmers struggle with inadequate storage and post-harvest processing facilities, resulting in challenges distributing and marketing their produce and leading to significant post-harvest losses.

Projections by the World Bank (Sow, 2021) indicate that African countries are anticipated to allocate 95 percent of their public sector share towards financing road infrastructure projects in rural areas. Bonga & Sithole (2020) emphasize that this investment plays a pivotal role in fostering growth and development within African states. Improved accessibility enables efficient transportation of agricultural inputs and products to consumers. However, in underdeveloped and marginalized areas, the absence of proper road infrastructure leads to delays or even complete inaccessibility to markets for agricultural inputs and outputs, hampering agricultural development (Kamara et al., 2019). This results in inefficient utilization of road infrastructure, reflecting a mismatch between capital investments and low production outcomes. Despite recent economic growth oscillations caused by external shocks, Africa's economic development trajectory has shown upward movement (Sow, 2021). Nonetheless, given the persistent underdevelopment in rural Africa, Asongu and Nwachukwu (2018) predict in Nchofoung, Asongu, Njamen Kengdo, and Achuo (2022) that economic growth will not be equitably distributed on a per capita basis.

These perspectives are echoed by Nouman (2019), who proposes an endogenous growth model for rural infrastructure projects aimed at revitalizing long-term production in rural areas and enhancing living standards. The author categorizes road infrastructure as a capital assets that leverage labor and inputs to provide essential services. Similarly, Bonsu (2014) asserts that enhancing agricultural output and the well-being of rural African farmers is a central objective of road development. Notably, USAID (2022) emphasizes the pivotal role of agriculture in Kenya's economy, contributing over a quarter of the country's GDP and employing more than 75% of the population. However, despite its significance, Kenya's agricultural sector has predominantly operated at a subsistence level, with limited growth in productivity over the years, despite population increases. The Kenyan government has recently increased funding for road infrastructure projects in Lamu, aiming to connect this area with other parts of the country

and stimulate economic growth. This enhanced accessibility has led to the conversion of previously inaccessible hinterlands in Lamu, fostering increased food security, expanded agricultural land use, and positive growth in household income and consumption.

However, as highlighted by Crescenzi, Di Cataldo, & Rodríguez-Pose (2016), accessibility changes resulting from new road infrastructure projects can sometimes disproportionately benefit existing economic hubs at the expense of less developed regions. In Lamu, the expansion of transportation infrastructure has contributed to rapid growth in institutions and centers within Lamu West Sub- County, greatly outpacing progress in areas within Lamu East Sub- County. While infrastructure typically improves local accessibility, reduces production costs, and enhances productivity, the resulting developmental disparities across the region can offset economic advantages and even precipitate social conflicts. This imbalance may lead to food insecurity and heighten vulnerability among communities already facing marginalization and impoverishment in the marginalized areas.

1.2 Statement of the Problem

Agriculture is the cornerstone of Kenya's economy, yet Lamu County is one of the country's poorest areas encountering myriads of food insecurity and high poverty levels. The potential of agriculture to change the lives of residents in Lamu County although, the county has been hindered by inadequate road infrastructure, occasioning low agricultural development whereby about thirty-five percent of the population in Lamu County is food insecure. Actualization of the Lamu Port South Sudan Ethiopia Transport (LAPSSET) corridor under the Kenya vision 2030 economic blueprint program has witnessed an increase in government investment in on roads infrastructures thus awakening hopes for stimulated growth in agriculture and related commodity markets.

Despite these investments, Lamu County is confronted with distinct challenges arising from food insecurity and extreme poverty which ravage the population in Lamu County. This situation is aggravated by low agricultural growth which increase the County expenditure on food to 56% to cater for the 35.4% proportion of the food insecure population. Moreover, there is limited accessibility to markets with the Rural Access Index being 13% and only eighty kilometers of paved road infrastructure thus limiting farmers access to markets to buy or sell agricultural commodities.

There is scant knowledge on the influence of road infrastructure investment on Agricultural development in Lamu County. This gap exists in both theoretical and empirical understanding, with limited research conducted on the status agriculture and food security within the County. This study aimed to fill the knowledge void by uncovering the interactions of the road infrastructures that can be enhanced to influence agricultural development in Lamu County. The study sought to reveal insights that can guide policy decisions and strategic interventions to stimulate agricultural development, sustainable economic growth, food security, and improved well-being of residents in Lamu County.

1.3 Purpose of the Study

To purpose of this study is to analyze the influence of road infrastructure on agricultural development in Lamu County, Kenya

1.4 Objectives of the Study

i. To examine the influence of road infrastructure on access to agricultural inputs in Lamu, county, Kenya.
ii. To determine the influence of road infrastructure on the provision of agricultural extension services in Lamu county, Kenya.

iii. To investigate the influence of road infrastructure in the marketing of agricultural produce in Lamu county.

1.5 Research Questions

i. What is the influence of road infrastructure on access to agricultural inputs in Lamu county, Kenya?

ii. What is the influence of road infrastructure on the provision of agricultural extension services in Lamu county, Kenya?

iii. What is the influence of road infrastructure in the marketing of agricultural produce in Lamu county, Kenya?

1.6 Significance of the Study

The study's findings have important ramifications for decision-makers and development practitioners who are key in assigning funds and prioritizing development programs in rural and marginalised areas such as Lamu County. Highlighting significance of the road infrastructures on agricultural development is essential to stimulate growth of the agricultural economic sector, improve agricultural production and the food security status. By enhancing the connectivity of farmers in agricultural areas, road infrastructure projects unlock opportunities within the agricultural landscape leading to a considerable expansion of the agricultural sector and also allowing economic growth. Importantly, the results of the study augment the existing literature on the intricate relationship between road infrastructure and agricultural development. This academic contribution hoped to provide valuable insights for future researchers, scholars, and students, and also broaden the scope of research in this field.

1.7 Scope of the Study

This study is confined to the geographical boundaries of Lamu County, primarily focusing on exploring the influence of infrastructure on agricultural development. The selection of Lamu County as the research site stems from its notable array of road infrastructure initiatives, rendering it an opportune setting to scrutinize their influence on the development and growth of the agricultural sector. The investigative purview is centered squarely on agricultural development, given its pivotal role as the principal source of livelihood for the residents of Lamu County. The study's population comprises farmers households whose agriculture is their economic mainstay and relies on the availability and access to quality road infrastructure.

1.8 Limitations of the Study

This study was not exempted from the potential challenges associated with inadequate respondent participation, which potentially constrained the pool of available data. The demanding agricultural schedules of the respondents in Lamu County impeded their availability for participation in data collection activities. Moreover, some respondents had apprehensions regarding breaches of confidentiality thus discouraging them from engaging in the research process. Despite their willingness, respondents exhibited hesitancy towards active participation in data collection endeavors. In order to mitigate these limitations, the researcher adopted a proactive approach by diligently arranging appointments with participants to accommodate their schedules and alleviate their concerns. The communication of unwavering commitment to upholding ethical standards, coupled with the acquisition of a research permit, was pivotal to reassure the respondents about the stringent preservation of their privacy and confidentiality throughout the study duration.

1.9 Delimitation of the Study

The study aimed to establish the influence of road infrastructures on agricultural development in Lamu County, Kenya. This study thus delimited itself to Lamu county which has witnessed rapid road infrastructural initiatives undertaken by the governments under the vision 2030 economic blueprint. The study was anchored on the pragmatic research approach which takes into consideration inputs from the agricultural households and views from experts in the agricultural value chain mainly agricultural entrepreneurs, extension officers and agricultural professionals in Lamu County. The researcher focused on studying the significance of road infrastructure functionalities which included, enabling access of agricultural inputs, agricultural extension and marketing of agricultural products influence on agricultural development in Lamu County.

1.10 Assumptions of the Study

The study was based on the following assumptions:

i. The study assumed that sufficient data would be available to examine the relationship between Lamu County's agricultural development and transportation infrastructure. Both primary and secondary data sources were used, and the results depended on how reliable and high-quality the data was.

ii. The research posited that a causal link exists between transportation infrastructure and agricultural development in Lamu County. It sought to discern patterns and connections, while recognizing the possibility of other variables affecting the outcomes.

iii. The research posited that its conclusions are pertinent to Lamu County, offering significant insights into how transportation infrastructure influences agricultural progress in the area. Although these findings might not extend to other areas or nations,

they present an important case study on the correlation between road infrastructure and agricultural growth.

iv. The study shoulders the examination of the connection between road infrastructure and agricultural development is relevant over a specific period. The findings might not indicate long-term patterns or temporal shifts, although they offer significant understanding of how road infrastructure correlates with agricultural progress in Lamu County throughout the designated timeframe.

1.11 Operational Definition of Terms

Agricultural Development — Agricultural development refers to the improvement of factors advancing growth of the agricultural sector occasioning an increase in agricultural productivity, agricultural farm sizes, agricultural markets and the status of food security in the study area.

Agricultural Extension Services — Agricultural extension services entail the transfer of knowledge through training to build the capacity of individuals practicing agriculture to better their skills and also communicate technologies that can be adopted to improve production and market linkages of agricultural commodities.

Agricultural Inputs — Agricultural inputs encompass the resources utilized by farmers in day-to-day farm activities to better agricultural productivity in Lamu County. These include seeds, fertilizers, pesticides, labor and farm machinery.

Agricultural Produce — Agricultural produce encompasses outputs from farming activity. they include range of crops, livestock, and other farming-related outputs that are cultivated or raised by farmers within Lamu County.

Marketing — In the scope of this study, marketing pertains to a range of activities that facilitate the buying and selling of agricultural products within Lamu County. These include merchandise of agricultural inputs, distribution of

agricultural goods and services and also selling and buying of agricultural produce.

Road Infrastructures

Road infrastructures comprise the intricate network of roads, encompassing paved roads, gravel roads and earth roads, which collectively facilitate the smooth movement of farmers to access inputs, services and linking of markets across Lamu County. Within the framework of this study, the emphasis on road infrastructures revolves around their pivotal function in establishing efficient linkages between areas of agricultural production, markets, suppliers of inputs, and crucial services. This interconnectivity fundamentally molds the terrain of agricultural development within the locality.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter delves into an exhaustive literature review concerning the influence of road infrastructure on agricultural development. The exposition commences with an empirical expedition through the pertinent literature to highlight the research gaps, subsequently navigating the theoretical frameworks that informs diverse approaches within the study's scope. Additionally, a conceptual framework is proffered, accompanied by a harmonious amalgamation of the reviewed literature, meticulously aligned with the study's research objectives. The presentation of the scrutinized literature is organized to align the study, address the research objectives and the research questions.

2.2 Empirical Literature Review

A substantial portion of the global population residing in remote and isolated rural areas, largely depends on agriculture as their primary economic activity and source of livelihood. Globally, many countries have remained with expansive portions of fertile agricultural land that is underdeveloped and untapped for any economic usage (Shamdasani, 2021). This happens despite the growing global population and the rising demand for food occasioning an urgent need for states to adopt policies to stimulate agricultural development and food security policies to meet the global demand. This need has prompted states to increase budget allocations to support agricultural endeavors, including the expansion of road infrastructures to networks enable access of underutilized agricultural frontiers.

This prioritization aims to increase efficient use of agricultural land, training and capacity building of farmers in remote settings, and enhance accessibility of market efficiency for agricultural products. Kiprono and Matsumoto (2018) notes that the benefits of road infrastructure extend beyond stimulating development of agriculture, rather it drives expansion

of other economic opportunities in agricultural areas, thus allowing economic empowerment of agricultural households in rural and marginalized lands.

Road infrastructure critical role in agricultural development is marked by enabling linkages to various markets where farmers access inputs for agricultural use and also sell surplus agricultural produce (Pflomm, 2022). In the Sub Sahara Africa, poor-quality road networks in most states, hinders the desire to propel agricultural progress with vast tracks of agricultural potential land remaining inaccessible and thus underutilized (Pflomm, 2022). This constrains, agricultural growth and the ability of residents to produce adequate agricultural produce to meet food demand (Shamdasani, 2021). Presence of good road network in rural areas spearhead widespread adoption of modern farming inputs. Wudad et al (2021), study to assess the influence of road infrastructures on marketing of vegetables and households' income in Dedo district in Ethiopia using multiple linear regression models, found that, 58.5% of agricultural household income was earned from the produce sale which accounted for significant share of households' annual income. This affirms the inherent opportunities of the economic benefits that is derived by expansion of road infrastructures in agricultural areas (Asher & Novosad, 2020).

In Kenya, Ouya et al., (2020) analyzed the role of agricultural intensification on smallholders' poverty and food security on subsistence agricultural households in Makueni and Nyando Sub Counties using a multivariate analysis. The study findings affirmed the significance of cultivated agricultural land size, trainings, and the farm's location to influence agricultural development, food security and economic wellbeing of the agricultural households. This cements many of Africa's poverty reduction strategies which hinge on agricultural growth, a prospect which is mainly anchored on the ability of farmers to access and utilize farm inputs, improved seed varieties, adoption of improved skills in the agricultural value chain, and the refinement of production technologies (Sheahan & Barrett, 2017).

2.2.1 Road Infrastructure and Access to Agricultural Inputs

The pivotal role of road infrastructure in the movement of agricultural inputs from manufacturers to farmers is indisputable. This foundational role emerges from its status as the primary conduit for transporting vital agricultural supplies ranging from seeds, fertilizers and agrochemicals from the producers to the markets and to the farms. Thus, road infrastructures is vital in global agricultural development whereby it connects the agricultural households to the diverse agricultural commodities for farmers to buy inputs and sell surplus agricultural produce to earn income and livelihood (Ben, 2019).

Access to agronomic inputs results to improvements of agricultural yields, securing food demand for the increasing global populations while the sale of surpluses earns income to the farming households leading to structural and economic changes in the agricultural regions (McArthur & McCord, 2017). This state is further supported by Mbataru, (2018) who posits availability of road infrastructures as occasioning economic growth which is derived from reduced costs of transport and enhanced accessibility of the agricultural inputs which increase their demand. In the western countries for instance Mbataru, (2018) argues that road infrastructures attract private investments, specialization and also widen the markets for the agricultural produce. Thus, road infrastructure fortifies the spatial economic links of agricultural lands, catalyzing growth of the agricultural marketplaces and nurturing development of vibrant economic regions.

However, this may not be the case in development of all areas. In views of Chome, (2020), development of roads infrastructure in some areas provokes conflicts over the land use where various social groups assigns differing cultural meaning on land. The divergent opinion inextricably affects investments in land and realization of its economic value thus assisting to persist the underlying societal problems mainly food insecurity needs and high poverty levels in the affected region.

Globally, the symbiotic relationship between road infrastructure and agricultural inputs engenders profound transformations within rural landscapes. However, De Graef, P. (2018) study on subsistence farming of fruits in Inland Flanders declined contention that availability of road infrastructures increased demand for agricultural inputs. The findings asserts Chome, (2020) that there are other factors triggering demand for the inputs use and agricultural development within the community. This delays an increase in agricultural output to produce adequate commodity that is sufficient to cater the food security needs.

Critical insights from empirical research further accentuate the strategic imperative of road infrastructure within the agricultural tapestry. An exhaustive study conducted by the World Bank in 2016 underscored the transformative potential of road networks. This research unveiled that improved road infrastructures augment market accessibility, curtailed transaction costs, and elevated agricultural output. Conversely, agricultural inputs, comprising fertilizers, insecticides, herbicides, seeds, and machinery, represent the cornerstone upon which elevated crop yields, minimized losses, and heightened product quality converge. These inputs collectively converge to secure sustainable agricultural expansion and underscore the bedrock of food security (Kochore, 2016).

In certain contexts, various studies highlight the potential surge of up to 32 percent in agricultural output ensuing from infrastructure enhancements. Moreover, the research deftly illuminated the reciprocal dynamic between road infrastructure and agricultural inputs. The former facilitates the seamless conveyance of the latter to farmers, a synergy that empowers farmers to elevate productivity and bolster yields, effectively catalyzing agricultural advancement (Kochore, 2016). This explains the synergy between road infrastructure and agricultural inputs that reverberates across diverse dimensions.

Hemming et al., (2018) assessed the influence of agricultural input subsidies on agricultural households, farm laborers and food consumers using the experimental and quasi-experimental studies in developing countries held that enabling access of agricultural inputs alone does not guarantee effective use of inputs in the agricultural production thus not guaranteeing improvements in agricultural production. The author however, contends the need of enhancing agricultural productivity as a vital component for improving food insecurity and stimulating economic growth in agriculture-based economies (Hemming et al., 2018). This finding is substantiated by the Food and Agricultural Organization (FAO) in Tanzania, where Kandiero (2009) expounds the significance of road infrastructure to usher enhanced private sector operations. Accordingly, by lowering production costs, forging new markets for agricultural produce and nurturing trade, existence of a robust road networks is instrumental in reshaping the agricultural landscape. Evidently, the amplification of output prices for producers and the reduction of production costs stands as conspicuous outcomes of improved road infrastructure (Kiprono & Matsumoto, 2014).

An effective network of infrastructure not only enhances agricultural output but also unfolds a tapestry of commercial dynamism and overarching economic expansion. Insights from a World Bank study in 2018 underscore the multifaceted opportunities for commerce, investment, and employment catalyzed by improved infrastructure. Furthermore, the study highlights the pivotal role of public-private partnerships in driving economic advancement (Khanani et al., 2021). However, the landscape of road infrastructure in developing nations is riddled with challenges, as expounded upon by existing research. The integrity of roads, coupled with insufficient maintenance and inadequate infrastructure investment, collectively contribute to elevated transportation costs, delays, and losses of perishable agricultural goods. Moreover, the dearth of road infrastructure restricts access to vital agricultural inputs, notably fertilizers, seeds, and equipment, consequently limiting farmers' production capacities (Khanani et al., 2021).

The undeniable correlation between access to agricultural inputs and amplified productivity, intricately intertwined with road infrastructure, underscores the symbiotic synergy that underpins agricultural growth. Drawing upon the International Food Policy Research Institute (IFPRI), it is substantiated that access to agricultural inputs—ranging from fertilizers and improved seeds to pesticides—can elevate crop yields by a significant fifty percent. However, this access is not an isolated pursuit; it necessitates a convergence of factors, encompassing seamless access to loans, extension services, and vibrant markets, as emphasized by Kiprono and Matsumoto (2018). The pivotal role of enhancing the accessibility and availability of agricultural inputs is further emphasized by the Food and Agriculture Organization (FAO) in South Africa. The organization highlights the role of governments and developmental stakeholders in fortifying rural infrastructure, amplifying extension services, and facilitating financial avenues, thereby propelling farmers' productivity and input accessibility (FAO, 2015). This directive holds particular relevance in the Trans-Saharan region, where the arduous quest for securing agricultural inputs poses challenges for smallholder farmers.

The intricacies of agricultural input accessibility in the study area are underscored by Holden (2019), who highlights the dual challenges of limited availability and compromised quality of essential inputs, including seeds and fertilizers. Moreover, the report accentuates the formidable barrier posed by exorbitant input costs, constricting farmers' capacity to procure requisite resources. A parallel challenge surfaces in the form of constrained financial access for farmers (Kiprono & Matsumoto, 2018). This portrayal underscores the critical juncture at which the quest for enhanced agricultural inputs and effective road infrastructure converges.

In response to the challenges outlined above, a spectrum of initiatives has been mobilized within the Trans-Saharan region to alleviate the burdens of acquiring agricultural inputs and optimize agricultural production. Notably, the African Development Bank (AfDB) has undertaken efforts to foster success among youth agribusiness entrepreneurs through its ENABLE Youth

program. This multifaceted initiative integrates credit access, technical support, and contemporary agricultural practices to empower and equip young agripreneurs (Holden, 2019). Concurrently, the International Fertilizer Development Center (IFDC) plays a pivotal role in orchestrating the Scaling Seeds and Technologies Partnership (SSTP). This initiative is tailored to enhance the accessibility and availability of premium seeds and fertilizers across the region, thus contributing to bolstering agricultural productivity (Holden, 2019). The criticality of robust road infrastructure surfaces as a pivotal underpinning in this realm. Adequate road networks bear the potential to seamlessly link farmers to markets while mitigating transportation costs. Notably, inadequate road infrastructure in regions like Africa manifests as a substantial impediment to agricultural expansion. Gatauwa and Murungi (2015) underscore the transformative effects of investments in rural roads, unraveling substantial gains for agricultural output, crop yields, and post-harvest loss reduction.

The Asian landscape echoes this narrative, where the construction of new road infrastructures has emerged as an instrumental catalyst in agricultural growth. Fungo et al. (2017) expound on the substantial impact of investments in rural roads in Indonesia, translating into augmented agricultural output and diminished poverty rates. A comparable trajectory unfolds in South America, wherein investments in road infrastructures constitute linchpins for agricultural expansion and poverty alleviation. However, a stark dichotomy arises for smallholder farmers globally. Fungo et al. (2017) shed light on the challenges faced by Indian smallholder farmers in accessing quality seeds and fertilizers, impeding agricultural productivity and profitability.

The intricate interplay between road infrastructure, agricultural inputs, and transformative land use changes comes into focus through a comprehensive analysis of empirical studies. Asher and Novosad (2020) unearth profound insights in their research on the relationship between road access and land use alterations in Ethiopia. Their findings underscore that improved road infrastructure fosters agricultural growth and catalyzes the transition of woodlands and

grasslands into arable lands. The facilitation of market access and seamless transportation of vital inputs like seeds and fertilizers stand as pivotal outcomes of robust road networks. Echoing this paradigm, Birch (2018) delves into the dynamics of land use shifts in developing countries, elucidating the catalytic role of augmented access to agricultural inputs, notably fertilizers and pesticides. Their study unfurls a nexus wherein intensified agricultural production and land expansion converge. Remarkably, the availability and accessibility of agricultural inputs emerge as twin fulcrums underpinning these pivotal transformations (Birch, 2018).

However, the influence wielded by multifarious variables, including land tenure systems and governmental regulations, introduces a layer of complexity to the intricate fabric. The study by Asher and Novosad (2020) sheds light on the interplay between land certification, land use changes, and road infrastructure in Ethiopia. The research unravels a cascade of effects, unveiling heightened investments in land and the adoption of ecologically responsible land use practices consequent to land certification. This underlines the interdependence of regulatory frameworks, land dynamics, and road infrastructure (Asher & Novosad, 2020).

The plight of smallholder farmers in Africa, grappling with limited access to high-quality agricultural inputs, constitutes a pressing concern resonating across continents. Constrained input supply and accessibility accentuate the substantial barrier to agricultural growth in Latin America, echoing global trends (Asher & Novosad, 2020). Emanating from this context, a mosaic of concerted efforts permeates the global arena, aimed at elevating smallholder farmers' access to essential inputs and augmenting agricultural productivity. The Consultative Group on International Agricultural Research (CGIAR) galvanizes the Global Rice Science Partnership (GRSP) to fortify rice production, bolster food security, and transform agricultural landscapes across Asia and Africa (Beuran et al., 2015). Mirroring this drive, the World Bank pioneers the Agricultural Productivity and Diversification Project in Zambia, propelling high-quality

agricultural input accessibility and fostering agricultural production within the nation's borders (Beuran et al., 2015).

2.2.2 Road Infrastructure and the Provision of Agricultural Extension Services

The crucial role of road infrastructure in facilitating the delivery of agricultural extension services constitutes a vital nexus for enhancing farmers' knowledge and practices. In the context of agriculture, "agricultural extension services" refer to the dissemination of information, expertise, and techniques to empower farmers and elevate their agricultural endeavors. According to Njura et al., (2020) study on the influence of approaches used to teach agriculture in secondary schools on skills and agricultural development. The researcher finding using a descriptive survey approach averred that agricultural training has a positive influence on food security. The assertion thus posits lack of agricultural information and technology as a significant hinderance to agricultural development whereby farmers lack the requisite skills for agricultural production to improve the crop yields.

This gap can be bridged through agricultural extension services, providing a pathway for current insights into crop productivity, pest management, soil fertility, and various farming aspects (Binswanger-Mkhize et al., 2016). By enabling farmers to access agricultural extension, road infrastructure eases the interaction between the agricultural experts and the end users of these skills who in this case are the agricultural households (Umar & Daniel, 2023). Concurrently, empirical investigations conducted within the United States by Fungo et al. (2017) reveal the symbiosis of road infrastructure, broadband internet access, and the adoption of precision agricultural technologies. Their findings highlight a virtuous cycle in which improved access facilitates the spread of technological awareness, empowering farmers to engage with and harness novel methodologies (Fungo et al., 2017).

However, the intricate interplay between these dynamics and additional variables such as input costs, financial accessibility, and governmental policies remains pivotal. Gashu et al. (2019) navigate this terrain through a study on agricultural technology adoption in Bangladesh, positing that governmental interventions, including subsidies and training initiatives, foster the uptake of technological innovations (Gashu et al., 2019). Thus, education emerges as a cornerstone for agricultural advancement, equipping farmers with the acumen to navigate intricate farming techniques and technological paradigms. Multiple inquiries underscore that farmers with higher educational attainment exhibit greater receptivity to novel technology, translating into amplified agricultural productivity (Lee et al., 2023).

In contrast, farmers with limited educational exposure tend to exhibit resistance towards road-enabled connectivity and technological novelties, potentially impeding the adoption of advanced practices and hampering output. Shiferaw et al., (2015) discern the profound resonance of road infrastructure in this context, investigating its impact on farmers' access to extension services. Their study accentuates the catalytic relationship, elucidating that heightened access to such services empowers farmers with enhanced knowledge, enabling them to embrace progressive agricultural methodologies more readily (Shiferaw et al., 2015).

Despite the potential importance of road access in the provision of agricultural extension services, Lee et al., (2023) study in Malawi argues existence of negative and inverse relationship between access to paved roads and extension services with farms in far flung areas away from the road infrastructure having a 14.1 percent decrease chance of accessing extension services. This give credence to the fact that, where roads connectivity is well elaborated to access agricultural households, more farmers stand to benefit from the skills and thereby improving the agricultural production, improve food security and be more economically endowed.

Further, Lee et al., (2023) contends access to extension services as an interplay of multiple other factors mainly the farmers ability to comprehend and implement the skills, gender, age and the use modern communication gadgets particularly the internet and the smart mobile phones. Besides, farmers located in far flung areas away from any road infrastructure are less likely to access the extension services. Moreover, Lee et al., (2023) posits that lack of road infrastructure increased the operational cost for extension officers thus limiting the agricultural area that can be effectively covered to educate and transform agricultural production.

The complementarity of rural roads and agricultural expansion underscores the need for holistic investigations, as demonstrated by a quantitative study in Nigeria (Fungo et al., 2017). The efficacy of agricultural extension services hinges upon effective communication and dissemination of pertinent information to farmers. For instance, Thakur et al., (2024) argues that demand for certain crops vegetables is driven by the number of people inquiring about its availability owing to the increased awareness of the crop benefit. Thus, in Thakur et al., (2024), Edeme et al., (2020) optics, educating famers on production and benefits that can be derived by growing certain crops varieties which are required by the consumers influence demand and production by farmers to meet the market demand.

While agricultural extension services aim to promote innovation and technological adoption, they may not always be effective in addressing the complex challenges faced by small-scale farmers in Africa. According to Lee et al., (2023) limited resources, cultural barriers, and environmental constraints can hinder the adoption of new technologies, even with extension support. Moreover, the focus on technological solutions may overshadow the importance of traditional farming practices that have been adapted to local conditions over generations (Welteji, 2018).

On the other hand, Welteji, (2018) posits that extension services harbors potential to implant advances of agricultural technology for adoption by the farmers thus expanding opportunities for growth by increasing innovations and emergence of cottage industries in the agricultural value chains. However, diffusion of improved technologies has cost implications which in some instances may be unaffordable for nations to effectively actualize. In Ethiopia for instance, agricultural production is mainly reliant on the traditional farming methods due to the high cost involved in modernization of agriculture (Welteji, 2018). This fallback augments Edeme et al., (2020) study using simple linear regression to determine significant factors influencing agricultural productivity in west Africa states. The findings negate the significance of agricultural research and extension on improving farms productivity and the agricultural development (Edeme et al., 2020).

Although scholars of the agricultural extension hold multifaced views on its influence at advancing agricultural development, majority agrees that enabling proving of extension services to farmers helps in capacity building of the farmers skills and adoption of improved farming technologies. However, the effectiveness of the skill gained is dependent on other societal factors which are not clearly elucidated in this study. Arguably, the cost of implementing on farms technology may be high and thus unaffordable farmers mainly in marginalized areas where poverty levels are relatively high.

2.2.3 Road Infrastructure and the Marketing of Agricultural Produce

Road connectivity's pivotal role in facilitating the marketing of agricultural produce is underscored in the literature, as it enables farmers to access markets to buy agricultural inputs and also sell agricultural produce. Roads brings about integration of various global markets Borsellino et al., (2020) where there are huge demand for various agricultural produce. This by large stimulate growth in the agricultural sector whereby farmers produce more as they are certain of accessing market.

Globally, the Uruguay Round Agreement on Agriculture (URAA) laid ground for the inclusion of agriculture in the framework of General Agreement on Tariffs and Trade (GATT) thus ensuring commitment of states to make policies which were geared toward agricultural development (Borsellino et al., 2020). Furthermore, Borsellino et al., (2020) argues the inclusion led to growth of markets, while the enhanced regional connectivity through the roads network opened up unexploited rural areas for agricultural investments and agricultural trade opportunities.

In Europe, development of road infrastructure, beside benefiting the large-scale producers in the delivery of produce to the markets, some firms in lowly developed regions contract subsistence farmers to buy their crops and connect it to the markets. This view advance Liverpool-Tasie et al.,(2020) review to investigate the significance of large firms contractual engagement with the subsistence agricultural production sector through resource provision. The authors established advancement of the agricultural enterprises largely benefit the subsistence sector growth through provision complementary services mainly inputs, loans, agricultural information and also market logistics for the farm produce (Liverpool-Tasie et al., 2020), (Borsellino et al., 2020). This in the end encourage more subsistence farmers participation in the agricultural value chain, producing enough agricultural produce to meet the food security needs of the population and also marketing of the surplus to earn income and reducing the poverty levels.

Government policies advancing the development of road infrastructures, boost supply farm inputs to the farmers. The growth of agro-industries and trade enterprises following the increased road connectivity lower the inputs prices such that more farmers can access and afford the use to boost on farm productivity (Borsellino et al., 2020). While the influence of road development on agricultural marketing is emphasized, there is room for a more nuanced

exploration of how road connectivity interacts with other factors, such as market dynamics, trade policies, and technological advancements, to shape agricultural marketing outcomes.

In remote areas particularly in the developing countries, Nugroho, (2021) posits existence of a proper road infrastructure network as force influencing farmers access to market information and also physically connect agricultural producers to the markets where they sell their produce. Moreover, in remote areas such as the Andes mountain in Peru, roads availability facilitate the farmers to access markets in the urban areas where they sell their produce and also gather information on various agricultural produce on demand by the consumers thus informing their crops season (Nugroho, 2021).

In Ethiopia, Usman & Callo-Concha, (2021) used multivariate regression analysis to examine the nexus between market access, agricultural productivity and consumption of the subsistence farmers in Yayu area. The findings implied an inverse relationship with households that are located in far flung areas away from market access utilizing less products from the markets than those which easily access the markets. The author further held views that household located far away and which lacked access to the markets, tended to produce more than those which could near and easily access the markets. Although the scholars are positive on the influence of market access on agriculture, the finding blind on the type of agricultural practice by the subsistence located away from the markets.

However, Lee et al., (2023) and Usman & Callo-Concha., (2021) contend that expansion of rural road infrastructures improves farmers access to the market, reduce transportation cost of procuring and delivery of produce to the markets and also lowering the prices of agricultural inputs. This augments World Bank (2012), UNDP (2012), views that improving smallholders' efficiency to access agricultural inputs induce agricultural productivity, thus improved food security status and increased income for the agricultural households.

Despite various studies investigating the nexus between markets and the agricultural productions, various scholars failed to address the knowledge gap in literature to give insights into the differential impact of accessing markets on various types of agricultural produce. Noteworthy, Usman & Callo-Concha., (2021) posited the relevance of market access distance in relation to the crop type produce. Arguably, the author portends that subsistence farmers located further from the markets tend to produce more food crops while those easily accessing the markets can diversify their crops with the high value agricultural products on demand which fetch good prices.

Nevertheless, enhancing markets access is critical for the growth and development of agricultural trade positively impacting on the livelihood of subsistence farmers (Carletto et al., 2017). Thus, the Africa Union (AU) states initiatives to institute policies and programs through the Comprehensive African Agricultural Development Programme (CAADP) will most likely augments growth of the agricultural sector as a key economic pillar, earn income for the million subsistence farmers in rural areas and also reduce the poverty levels (African Union.,2014, Kamara et al., 2019).

While the literature acknowledges the implementation of policies and programs to enhance agricultural marketing, a more in-depth examination is necessary to critically evaluate the efficacy, limitations, and unintended repercussions of these interventions. Gaining insight into how different policy approaches influence the interplay between road infrastructure and agricultural marketing can yield valuable perspectives for optimizing strategies towards sustainable rural development. Moreover, investigating the interrelationship among policies, road infrastructure, and market dynamics can provide a comprehensive comprehension of how these components collaboratively shape the landscape of agricultural marketing and impact the livelihoods of farmers.

2.3 Theoretical Framework

This study is underpinned on the high pay off input model which was developed in 1964 by T.W. Schultz. This theory to provide a holistic understanding of the complex interactions between road infrastructure and agricultural product marketing. Schulz study theorized intervention measures that could possibly transform traditional agricultural production to modern and more efficient agricultural production. He opined incorporation of research in development of improved seeds, trainings to build farmers capacity to incorporate new technologies in agricultural productions and creating linkages between industries to facilitate use of inputs such as fertilizers, agrochemicals and improved seeds by farmers thus leading to agricultural development. This theory provides insights into how a road networks can shape the distribution patterns of agricultural inputs and produce across different regions. Furthermore, this theory contributes to understanding the concentration of production in well-connected areas, highlighting the role of road infrastructure in facilitating efficient agricultural product marketing.

2.3.1 High Input Payoff Model

T.W. Schultz's high payoff input model, created in 1964, serves as the foundation for this study. According to Schultz, the reason traditional cultures' peasants remained impoverished was the lack of technological and economic opportunities available to them. According to the model, agricultural growth can be improved by implementing interventions that change conventional agricultural production techniques, both by changing traditional production elements and by doing so at a significant cost. According to Schultz (1964), the goal of turning the traditional sector into a productive engine of economic growth is to use high-yield, contemporary inputs that farmers can access. The model breaks down the high-payoff inputs into three primary categories: the capacity of public and private research institutions to produce new technical knowledge; the capacity of the industrial sector to create, manufacture, and sell new technical

inputs; and the capacity of farmers to acquire new knowledge and effectively utilize new inputs (Ruttan, 1988).

The importance of Schultz's high-payoff input model for highlighting the rationality in resource allocation and guaranteeing efficiency in the use of input geared toward agricultural development was highlighted by Rajasekaran's (2020) study to ascertain the impact of area-specific technology on the applicability of diffusion model in a resource-diverse nation. The study examined the effectiveness of input utilization for a variety of crops in a range of agroclimatic zones with differing degrees of development at different phases of crop production. The findings conferred that as much as inputs contributed to increase output in the already developed areas, significant crop production change is also realized in the less developed areas arising from, increased maturation and efficiency in inputs.

However, one of the model's shortcomings is that it does not consider research funding as a source of novel, lucrative ways. Furthermore, it does not explain how development initiatives designed to promote economic expansion lead to farmers' adaptation and modification of a productive set of technology. Similarly, it fails to specify the processes by which linkages between product prices and input factors spur investments to move development in a specific direction (Udemezue & Osegbue, 2018). The theory also lacks a comprehensive framework to elucidate how infrastructures empower farmers although its relevance lies in its capacity to provide guidance in comprehending how changes in road infrastructures influence agricultural development in Lamu County.

All in all, this theory applies within the context of Road Infrastructures and Agricultural Inputs by examining the interconnections of the sectors' inputs and outputs. In the realm of road infrastructures, "inputs" encompass elements like input labor, labor costs, fuel, and maintenance expenses (Gashu et al., 2019). Outputs entail the movement of goods and people, with the latter

serving as inputs in various economic activities. For instance, the transportation of agricultural goods is an input for the agriculture industry. In contrast, "inputs" in agriculture encompass items such as seeds, fertilizers, machinery, etc. The produced goods include crops, livestock, and other agricultural products, which are then transported to different parts of the economy through road infrastructure (Gashu et al., 2019).

Analyzing the inputs and outputs of both sectors yields insights into the potential impacts of changes within the road sector on agricultural development. For example, a fuel shortage in the road infrastructure sector could increase transport costs for agriculture, potentially leading to higher prices for agricultural products (Farooq et al., 2018). Similarly, a drought affecting agricultural productivity might reduce the demand for transportation services offered by the road infrastructures industry. Studying inputs and outputs provides valuable insights into the intricate interdependencies between the two studied phenomena (Farooq et al., 2018).

This model therefore is consistent with the structure of this study in that, road infrastructure is an intervention in the agricultural sector growth by enabling farmers to access agricultural inputs which are delivered from the manufacturers and delivered to markets within the reach of farmers in Lamu county. The payoff are benefits derived from the agricultural development particularly increased agricultural production as a results of efficiency inputs use, capacity building by enabling agricultural extension, food security and marketing of surplus produces which raise income levels for the populations, reduced poverty levels and also better the food security situation in the region. The theory includes giving users—farmers in particular—the information and resources they need to adjust to the new infrastructure or environment. It's still difficult to pinpoint the abilities required to handle upcoming risks and difficulties and make sure people have the authority to carry out these changes and accomplish the intended results. In order to maximize the advantages of road infrastructures for furthering farmers' agricultural development, this study is crucial.

2.4 Conceptual Framework

The relationship between the independent variable, "Road Infrastructures," and the dependent variable, "Agricultural Development," is represented in an organized and visual manner by the conceptual framework (Van der Waldt, 2020). This study's conceptual framework encompasses these two fundamental variables, employing precise and measurable indicators for a systematic analysis of their interrelationships. The independent variable, "Road Infrastructures," was operationalized across three distinct classifications: Paved Roads, Gravel Roads, and Earth Roads. The investigation will assess the diverse impacts of these road categories on agricultural development within Lamu County.

The dependent variable, "Agricultural Development," encompasses three pivotal dimensions: 1) Access to Essential Agricultural Inputs, 2) Delivery of Agricultural Extension Services, and 3) Access to Markets. The framework employs respondents' perceptions to comprehensively evaluate these dimensions, integrating specific and measurable indicators. Within the first dimension, "Access to Agricultural Inputs," respondents' perspectives will assess the availability and affordability of crucial inputs. Indicators encompass respondents' viewpoints on the ease of obtaining seeds, fertilizers, and pesticides, along with their perceived cost-effectiveness. For instance, respondents will offer insights into whether they find essential inputs easily obtainable locally and financially viable based on their income levels. In the second dimension, "Delivery of Agricultural Extension Services," respondents' perceptions will gauge the efficacy of extension programs. Quantifiable indicators include respondents' feedback on the frequency and quality of extension visits, the utility of disseminated information, and the extent of adoption of recommended practices. This dimension sheds light on farmers' perceptions of how extension services impact their methods and yields. The third dimension, "Access to Markets," employs respondents' viewpoints to assess their market connectivity. Indicators entail respondents' opinions on transportation expenses, travel duration

to markets, and their perceived ability to access diverse markets. By capturing respondents' perceptions, the study delves into the obstacles farmers encounter in market access and their viewpoints on how road infrastructure influences market reach.

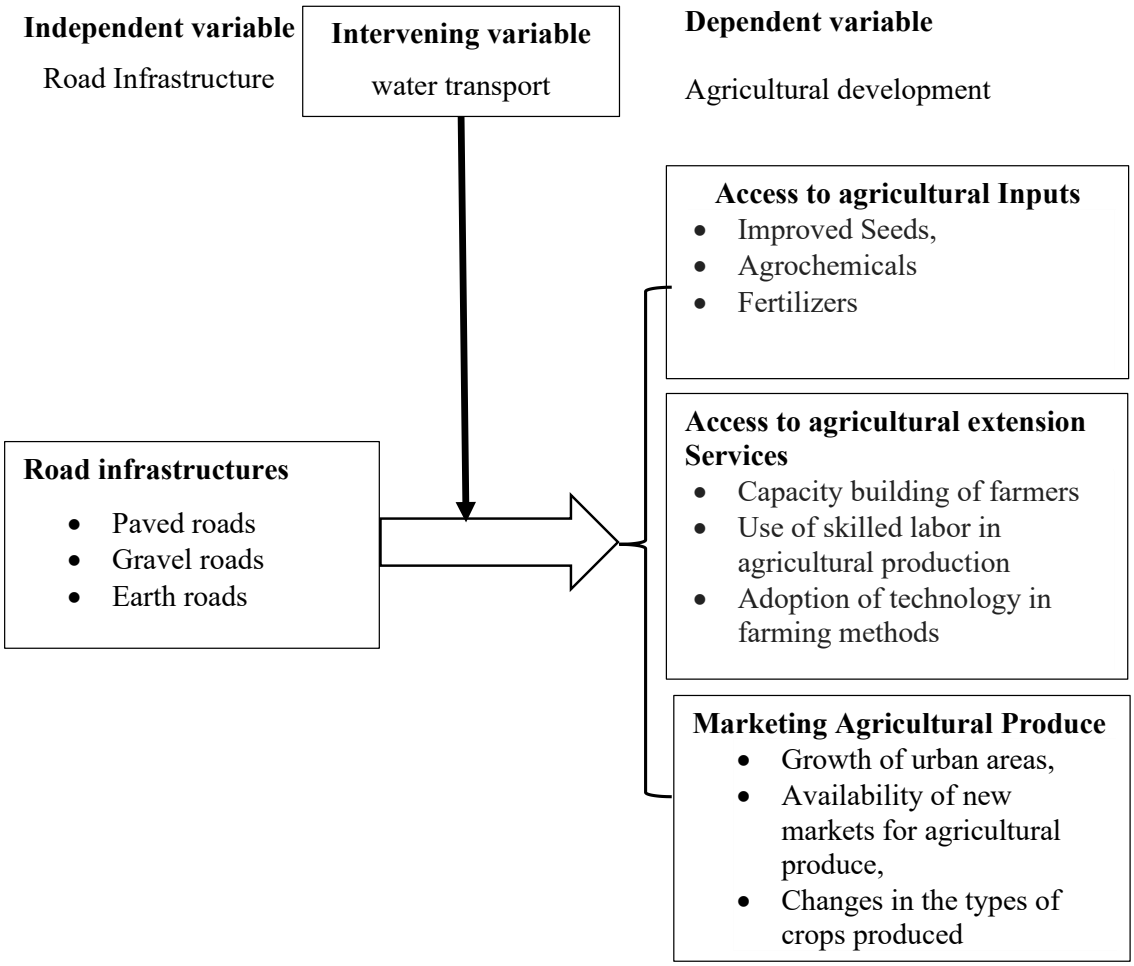

Figure 1. Conceptual Framework

Source: Author 2023

2.5 Recap of Literature Review

Synthesis of the literature review, encompassing both empirical and theoretical viewpoints, along with the conceptual framework, highlights existing knowledge gaps within the roads

infrastructure and the agricultural development paradigm. Scrutiny of the various scholars' articles does not articulate the best development policies approach to stimulate agricultural growth in rural areas despite government investments on roads infrastructure networks especially in sub-Saharan states in Africa. Nevertheless, various scholars affirm the pivotal role of road infrastructure in the delivery agricultural inputs easing access of the commodity by the farmers, marketing of the farm produce. The studies are however silent on mechanisms through which farmers embrace roads infrastructures to stimulate agricultural development. Notably, may challenges for agricultural development moreso in situations where the developing of road infrastructure attracts immigrants to affected against the norms of the indigenous community thus triggering series of conflicts where the indigenous population does not practice agriculture.

Additionally, salient factors such as poor budgetary policies for roads infrastructure development in rural areas, isolate populations which in some instances may not be very pro-government thus slowing the rate of agricultural development beside other issues such as road quality and lack of road maintenance. Insufficient road networks can further impede access to crucial agricultural resources, including fertilizers, seeds, and equipment, ultimately hindering overall production for farmers (Khanani et al., 2021).

In regards to the agricultural extension, various scholars contend that capacity building of the agricultural stakeholders embrace use of improved technologies and increased agricultural productivity. However, they differ on the influence of roads infrastructure ability to increase the farmers income and the reducing the poverty levels whereby some scholars opine existence of other factors as trigger of farmers participation in agriculture rather than training alone. Thus investigations in Africa indicate mixed results, with some studies showing limited influence of road infrastructure on knowledge and technology (Edeme et al., 2020; Fungo et al., 2017). The theoretical foundations of this study are grounded on the high input pay off theory. Additionally,

the study presents a conceptual framework that visually maps the interrelationship between the independent variable and the dependent variable.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a comprehensive overview of the research methodology, outlining the strategies, instruments, and protocols that was utilized throughout the study. It elaborates on the research design, the target demographic, the sample selection framework, the determination of sample size, and the sampling techniques to be employed. Furthermore, it discusses the procedures for data collection, including pre-testing measures. Additionally, it addresses the nature of the collected data, along with the methods for data processing and analysis. The statistical measurement model to be applied during the analysis is also detailed.

3.2 Research Methodology

According to Van der Waldt (2020), the conceptual framework offers an organized and graphic depiction of the connection between the independent variable, "Road Infrastructures," and the dependent variable, "Agricultural Development." The mixed method approach was preferred in this study since it allowed for the collection of both quantitative and qualitative data which is imperative to examine the complex phenomenon of social and natural contexts (Creswell, 2014; Maxwell, 2019). Moreover, this approach supports the call for methodological diversity in social research (Omware et al., 2020; Creswell, 2018; Kern, 2018) and recognizes the benefits of combining methods to gain deeper insights (Denzin, 2012; Hesse-Biber, 2010).

By adopting this approach, the researcher comprehensively investigated the study variables to demystify the influence of road infrastructure in advancing agricultural development, realization of food security status and the economic wellbeing of population in marginalized areas such as Lamu, county.

3.3 Research Design

The study employed the sequential explanatory design with emphasis on the descriptive survey method which the statistical findings informed the basis for the collection and analysis of qualitative data. Results derived from the descriptives statistics were used to figure the key informant interviews forming the basis for the qualitative data. The descriptive survey offered a comprehensive overview of prevailing conditions and relationships within a specific population or context (Abutabenjeh & Jaradat, 2018). This approach aligned seamlessly with the study's multifaceted objectives and allowed for the triangulation of findings from various data sources, enhancing the validity and reliability of research outcomes (Creswell, 2018). Triangulation of the quantitative and qualitative datasets enabled a deeper investigation into the complex interplay between road infrastructure and agricultural development while also identifying patterns, trends, and correlations (Kern, 2018; Denzin, 2012). Besides, the design unraveled areas of agreement and divergence between qualitative and quantitative datasets, thus making of research inferences and unveiling potential relationships between road infrastructure and agricultural development (Hesse-Biber, 2010).

3.4 Location of the Study

The research was conducted in Lamu County, a geographical area situated on the north coast of Kenya along the Indian Ocean. Lamu County's selection as the study location is grounded in its significant historical context and recent roads infrastructural projects which are being implemented in the county. Over the years, the county has faced challenges related to limited road infrastructure, which has hindered its agricultural potential occasioning the population in the county to episodes of food insecurity, underdevelopment and extreme poverty levels. However, the landscape has undergone a transformative shift in the last decade due to substantial investments made in the county which are anchored on the realization of the Vision 2030 economic blueprint whereby the Kenyan government is undertaking implementation of

various roads in to integrate the region, increase business opportunities and actualize the Lamu Port South Sudan Ethiopia Transport Corridor projects (LAPSSET). These developments shifts made Lamu County an ideal location to investigate the influence of road infrastructure on agricultural development.

Lamu County was established in 2010 as a result of constitutional changes. It covers an approximate area of 6,607 km² and features a coastline of about 130 kilometers along the Indian Ocean and shares the borders with Tana River and Garissa counties, to the northeast, it shares its border with the Federal Republic of Somalia. The county's agricultural land mass accounts for 87.3% of its total land surface area, showcasing its potential for agricultural activities. Despite this potential, only a fraction of the arable land is utilized for agricultural production, partly due to limited accessibility caused by inadequate road infrastructure (Lamu County Integrated Development Plan [CIDP], 2021).

The county's road infrastructure consists of approximately 688.8 km of classified roads, with varying surfaces such as paved, gravel, and earth roads. This network is largely concentrated in Lamu West, with Lamu East having limited access through a single trunk earth road. The existing road network has been a historical constraint to agricultural productivity, resulting in high transportation costs that are transferred to farmers and contribute to the increased cost of agricultural inputs. With the recent investments in road development, Lamu County offers a unique setting to explore the dynamic relationship between improved road infrastructure and agricultural development, addressing the previously prevalent limitations in accessibility and transportation costs (CIDP, 2021).

3.5 Target Population

Target population is the total group of study subjects or people who have similar characteristics in one or more ways and form the study subject (Pandey & Pandey, 2021). The target population comprised all the 18, 678 households in Lamu County that practice agricultural activities (Kenya National Bureau of Statistics [KNBS], 2019). Also, to enrich the statistical findings, key informant interviews were conducted from key stakeholders in the agricultural sectors to provide rich information about the influence of road infrastructure on agricultural development. They included Lamu county director of Agriculture, agricultural extension officers, Agrovet stockiest traders and agro-market traders.

Table 1: Target population

Sub-county	Target population	Percentage (%)
Lamu East	1,831	9.8
Lamu West	16, 847	91.2
Total	18, 678	100

Source: (KNBS, 2019) Report

Furthermore, Lamu County's agricultural officials from both the national and county governments were integral to this study as primary informants. These officials possess vital insights into how road infrastructure intricately impacts agricultural development. This category encompasses individuals such as the Lamu County Director of Agriculture, extension officers, agrovet traders, and agricultural market traders, as detailed in Table 3.2.

Table 2: Key Informants

Key informant	Lamu East	Lamu West	Target population
Extension officers	1	1	2
Agrovet traders	2	2	4
Agri Market traders	2	2	4
County director of Agriculture		1	1
Total	5	5	11

Source: Source: Researcher (2023)

3.6 Sampling Procedures & Technique

Sampling procedure is the technique of selecting participants for a research study from the study population who are subject of the research problem using the research study's criteria **(**Rahman.,2023). The aim of sampling is drawing the sample of the participants from the broader population and the procedure entails careful considerations to minimize bases of bias and allow drawing of inferences about the study population (Creswell & Creswell, 2023). The concept of a sampling frame, as emphasized by Gopinath (2019), involves a comprehensive listing or coverage of all the sampling units present within the targeted population. In alignment with this perspective, the sampling frame for this study encompassed the entire population, comprising 18,678 households actively engaged in agricultural activities within Lamu County.

The sampling techniques constitutes the methodological framework that a researcher employs to select a specific subset from the larger target population for study purposes **(**Rahman.,2023). In this study, stratified simple random sampling technique was employed to ensure a comprehensive and representative sample of the 18,678 farmers engaged in agricultural activities within Lamu County. The stratification was be based on administrative units, specifically sub-county levels, with the aim of capturing the diversity and nuances present within each sub-county. The target population of each sub-county was divided into clusters,

and a proportionate sample was drawn from each cluster using the probability proportionate to size (PPS) formula (Yamane's.,1997). Yamane's., (1997) formula takes into account the nexus between the sample size, the target population, and the population size within each stratum. The formula, ensures that the sample selection is proportional to the size of each sub-county, thereby minimizing bias and enhancing accuracy of the sample.

To finalize the sampling process, the study utilized stratified random sampling to select households from each sub-county. This technique ensured that every farmer within a particular sub-county stood an equal chance to being included in the sample, thus reducing the risk of sampling bias and allowing for more accurate inferences to be drawn. This aimed to construct a robust and inclusive sample that effectively captures the perspectives and experiences of farmers in Lamu County related to road infrastructure and agricultural development. In interviewing of the key informants, the study used the purposive sampling to select seven key informants who are rich in information about the study phenomenon in order to enrich the statistical findings.

3.7 Sample Size

The sample population in research denotes a subset of individuals, elements, items, or groups selected from the larger target population, with specific attributes relevant to the research objectives (Pandey & Pandey, 2021). To ensure statistical robustness, a sample size must strike a balance between precision and representation, yielding a level of confidence in estimating population attributes. In consideration of variability within a heterogeneous population, the selection of an appropriate sample size aims to facilitate valid and reliable conclusions about both the study and the broader population characteristics. In this study, Yamane's (1997) formula is employed to calculate the sample size, taking into account the target population size, precision level, and the confidence level.

$n = N / [1 + N (e)^2]$

Where;

n= Sample Size

N= Population Size (18, 678)

e= Level of Precision (0.05)

$18678/ (1+ 18678(0.05)^2)$

18676/ 47.695

n= 391

The formula yields a sample size of 391 respondents, given a population size of 18,678 and a precision level of 0.05. Furthermore, the study planned to incorporate eleven (11) key informants, resulting in a final sample size of 402 respondents, ensuring comprehensive coverage of the research objectives. In determining the sample population, specific inclusion and exclusion criteria are applied to maintain the relevance and accuracy of the study findings. Inclusion criteria encompass households directly involved in agricultural activities within Lamu County, aligning with the study's focus on agricultural development and road infrastructure. These households should have been practicing agriculture for a minimum period, ensuring an adequate understanding of the influence of road infrastructure on their agricultural activities. Exclusion criteria involve households engaged in non-agricultural activities, as their experiences and perspectives may deviate from the research objectives. Furthermore, households with incomplete or inconsistent data was excluded from the analysis to maintain data integrity and reliability, ultimately contributing to a more precise and comprehensive representation of the sample population.

Table 3: Sample size

Sub-county	Target population	Sample size to each stratum (sub-county)
Lamu East	1,831	38
Lamu West	16, 847	353
Total	18, 678	391

Source: Researcher (2023)

3.8 Construction of Research Instruments

Research instruments facilitate the collecting measures of variables from study participants to address the research objectives (Kothari, 2004; Pandey & Pandey, 2021; Creswell & Creswell, 2023). The precision and reliability of the gathered data depend significantly on the instruments and techniques utilized for data collection (Sarker & AL-Muaalemi.,2022). This study used questionnaires to gather information from both the agricultural households and Key Informant in the study area. The questionnaires served as the primary tool for collecting quantitative data from the respondents. The structured nature of questionnaires allowed for the systematic data collection on variables related to road infrastructure and agricultural development. Additionally, interview guides were used during in-depth interviews with key stakeholders across the agricultural value chain, including county-level officials, sub-county representatives, and market traders. These interview guides provided a flexible framework to explore specific areas of interest, enabling the researcher to seek detailed explanations and clarifications from the interviewees. The use of interview guides aligned with the principles of qualitative research, promoting in-depth exploration and understanding of participants' perspectives (Creswell, 2014).

The incorporation of both questionnaires and interview guides in data collection offered several advantages. Questionnaires provide a structured approach to gather quantifiable data, enabling efficient collection from a large number of respondents. On the other hand, interview guides facilitate deeper insights by allowing open-ended conversations with stakeholders involved in the agricultural value chain. This mixed-method approach ensures a comprehensive and well-rounded exploration of the relationship between road infrastructure and agricultural development in Lamu County, aligning with the study's multifaceted objectives.

3.8.1 Questionnaires

The researcher utilized structured survey questionnaires comprising four sections to effectively collect data aligned with the study's objectives. Section A will focus on capturing respondents' demographic information, enabling a comprehensive understanding of the sample characteristics. Sections B, C, and D will delve into the main study variables, exploring the influence of road infrastructure on different aspects of agricultural development in Lamu County. In Section B, respondents was presented with Likert-scale questions that assess the impact of road infrastructure on access to essential agricultural inputs in the county. This section will also include open-ended questions, allowing participants to provide detailed insights into their experiences and perceptions. Section C will similarly employ Likert-scale questions and open-ended questions to examine the influence of road infrastructure on the delivery of agricultural extension services within Lamu County.

In Section D, the questionnaire will focus on the influence of road infrastructure on the entire marketing ecosystem of agricultural produce in the county. Respondents will again engage with Likert-scale questions to rate their perceptions, supplemented by open-ended questions that encourage respondents to share qualitative information. This multifaceted approach ensures a comprehensive exploration of the relationships between road infrastructure and various aspects

of agricultural development. The use of structured survey questionnaires is particularly suitable for this study due to their efficiency in data collection and analysis. The Likert-scale questions enable quick coding and transcription, fostering a high response rate and facilitating quantitative analysis. Additionally, the inclusion of open-ended questions allows for the capture of nuanced qualitative insights, ensuring a comprehensive understanding of participants' perspectives and experiences. This methodology aligns with the study's objectives and will contribute to a robust analysis of the impact of road infrastructure on agricultural development in Lamu County (Krosnick, 2018). A detailed questionnaire is provided in Appendix II for reference.

3.8.2 Interview Guide

The research will employ a structured interview guide to gather qualitative insights from key informants, specifically officials from the agricultural line ministry in Lamu County. This guide, aligned with the study's objectives and thematic areas, will consist of nine questions, with three questions dedicated to each objective. The purpose of the interview is to gather detailed and information-rich data directly from stakeholders involved in the agricultural value chain, such as the Lamu County Director of Agriculture, extension officers, agro market traders, and agrovet stockiest. Conducted through face-to-face interactions at the respondents' workplaces, the interviews aim to delve deeper into the various dimensions of the study's objectives.

The interview guide will facilitate one-on-one verbal communication with the key informants, allowing for a comprehensive exploration of their insights. This qualitative approach will provide a deeper understanding of the relationships between road infrastructure and agricultural development in Lamu County. The interview guide serves as a complement to the quantitative data analysis, enabling the extraction of nuanced and contextually rich information (Denzin,

2012). By using the interview guide, the research intends to capture the expressions, viewpoints, and experiences of the interviewees, ensuring a comprehensive and detailed understanding of the research topic (Hilton, 2017).

The decision to employ the interview guide is driven by the need for in-depth probing, clarification, and comprehensive data collection. This methodology enables the researcher to thoroughly explore key areas of interest and revisit aspects that might have been overlooked by other data collection instruments (Creswell, 2003). The attached interview guide in Appendix III provides a structured framework to facilitate effective communication with key informants and gather qualitative insights that will contribute to a well-rounded analysis of the impact of road infrastructure on agricultural development in Lamu County.

3.9 Testing for Validity and Reliability

3.9.1 Pilot Testing

According to Truong (2017), a pilot study is a small-scale exploratory investigation carried out before a full-scale research project is carried out in order to assess feasibility, time, cost, adverse events, and enhance the study design. For high-precision pilot studies, a sample size of 1% to 10% is usually regarded as suitable (Tseng & Sim, 2021). 39 respondents from Tana River County, or 10% of the sample population, participated in a pilot study. This county was chosen because it shares similarities with Lamu County, the main study area, in terms of its transportation system and agricultural terrain. The pilot study's primary goal was to ensure that accurate and trustworthy data would be gathered for the main investigation.

The purpose of pilot testing is to improve the general validity and dependability of the tools used to collect data. It is noteworthy that the pilot study strengthens the validity and reliability of the research tools rather than determining them (Mbugua & Omagwa, 2017). The supervisor and researcher collaborated closely during the pilot testing phase to improve the data gathering

tools based on pre-testing findings. For the primary study, this collaborative effort aims to ensure that the final data collecting instruments are efficiently designed to capture accurate, dependable, and error-free data. The project aims to improve the caliber and accuracy of the subsequent data gathering attempts by conducting a comprehensive pilot study and incorporating feedback-driven improvements.

3.9.2 Instrument Validity

Validity, as Grégis (2019) defines, relates to how accurately a measurement reflects the intended attribute, providing assurance that the measurement serves its purpose. This study utilized both construct validity and content validity to guarantee measurement precision. Construct validity was supported by organizing the questionnaire into sections, each focusing on different research objectives, ensuring alignment with the study's conceptual framework (Kothari et al., 2020). Content validity was verified through a comprehensive review of the questionnaire, allowing respondents to evaluate the items' relevance, clarity, transparency, and inoffensiveness. The feedback obtained was instrumental in refining the instrument before its final use in data collection, with participant input significantly contributing to content validity.

The study employed construct validity to verify that the questionnaire's design accurately reflects the constructs of the research objectives. This involved creating a solid connection between the items of the questionnaire and the foundational theoretical concepts. Content validity was crucial in that, it guarantees that the items of the questionnaire fully cover the subject matter of the study and are clear and pertinent to the participants. By meticulously ensuring both construct and content validity, the research strives to guarantee the precision and dependability of the gathered data, thereby strengthening the integrity of the study's conclusions.

3.9.3 Instrument Reliability

As highlighted by Mueller and Knapp (2019), reliability refers to the extent of consistency in the scores that an individual would obtain when taking a test on multiple occasions, under diverse circumstances, or across different test versions or items. Ensuring reliability contributes to impartiality and credibility by minimizing potential bias and fostering transparency in measurement (Mohajan, 2017). The assessment of reliability often involves examining the correlations among items that measure the same underlying construct to determine if these items consistently yield comparable results (Kothari et al., 2020).

This study used Cronbach's Alpha Coefficient, a widely used reliability metric, to evaluate the internal consistency of the questionnaire's components. The consistency of responses across items was also assessed using the reliability coefficient. The range of Cronbach's alpha (r) is -1 to +1. The study evaluated construct dependability using existing benchmarks: excellent reliability ($r > 0.9$), good reliability ($r > 0.8$), acceptable reliability ($r > 0.7$), dubious reliability ($r > 0.6$), and poor reliability ($r > 0.5$) (Adeniran, 2019). The researcher strengthened the study's conclusions by ensuring the data's quality and dependability through a thorough reliability review. The overall validity of the research is increased by reliability, which is essential to ensuring that the findings appropriately reflect the phenomenon under study.

The Cronbach's alpha reliability analysis indicated that access to agricultural inputs scored 0.94, access to agricultural extension services scored 0.85, marketing of agricultural produce scored 0.93, and agricultural development in Lamu County scored 0.93. Given that a Cronbach's Alpha coefficient of 0.7 or higher is regarded as acceptable and reliable, these findings suggest that the data collection instrument was dependable (Ingle & Mahesh, 2020). As a result, the questionnaire's constructs were accepted for statistical analysis. The researcher pre-tested the

tool during the data collection methods, which may have contributed to the high response rate. The surveys were also distributed through interviews, which gave the researcher the opportunity to address any queries. The respondents' confidence in taking part in the study was probably influenced by adherence to ethical and informed consent guidelines.

3.10 Data Collection Procedures

The data collection procedures constituted the systematic steps involved in approaching respondents and gathering data using selected tools and predetermined methodologies (Sileyew, 2019). In this study, the data collection process was rigorously monitored to mitigate the potential for omission biases and transcription errors. To ensure consistency and quality control, regular meetings was convened between the principal investigator and the trained research assistants. These meetings will serve as platforms to address any emerging queries, clarify procedures, and uphold the integrity of the data collection process. Thorough training was provided to the research assistants, acquainting them with the study's objectives and ethical considerations for interacting with study participants. Importantly, the data collection will involve face-to-face interviews administered by the research assistants.

To enhance the reliability and accuracy of data collection, a drop and pick method was adopted, allowing the research assistants to drop the questionnaires at respondents' locations and then subsequently retrieve them after completion. This method ensures minimal disruption to the respondents' routines and provides them with sufficient time to thoughtfully respond to the questions. Moreover, the research assistants were well-trained to clarify any doubts or questions that respondents might have during the process, further enhancing the quality of the collected data. Before the commencement of data collection activities, all necessary permits and approvals was obtained from relevant authorities. This commitment to obtaining the required permissions underscores the study's adherence to ethical guidelines and legal requirements in

the data collection process. The comprehensive approach to data collection, combined with the use of trained research assistants and adherence to ethical considerations, is geared towards generating robust and trustworthy data that will underpin the study's analysis and conclusions.

3.11 Data Analysis Techniques

A comprehensive analysis was performed on the gathered data in order to derive significant insights that support the study's goals. Frequencies and percentages were computed for the quantitative data in order to clarify the opinions and experiences of the respondents. Tables and graphs were used to show these results, giving a visual representation of the patterns and trends found in the data. As stated in the study's objectives, the quantitative results were then evaluated and debated in light of the body of current research, improving knowledge of the relationship between road infrastructure and agricultural development.

The qualitative data, gathered through key informant interviews, was analyzed thematically. This approach involves identifying recurring patterns, themes, and categories within the responses provided by the interviewees. The data was coded, categorized, and grouped based on shared ideas, opinions, and experiences. By delving into the qualitative responses, the study aims to uncover nuanced perspectives and rich contextual information that may not be captured by quantitative methods alone. The thematic analysis will enable the extraction of key insights from the interviews, which will then be synthesized with the quantitative findings to provide a comprehensive and well-rounded interpretation of the study results.

3.12 Ethical Considerations

Ethical considerations are a fundamental aspect of this research project. The study maintained the highest respect for participant autonomy and rights. Participation was completely voluntary, with no coercion involved, informed consent was obtained to ensure participants were fully aware of the study's aims, methods, and their right to participate or not. Participants had the

liberty to decline answering any questions without repercussions, affirming their voluntary participation. The study's priority was to prevent any emotional or physical harm to the participants. The study was carried out with fairness, honesty, and equality, treating all participants with dignity and integrity. Although no material incentives were offered, participant contributions were greatly appreciated and recognized. Strict confidentiality of data was upheld, with all information treated with the utmost discretion, and no personal or identifiable details were revealed in any reports or publications. Prior to data collection, all required approvals were acquired in accordance with ethical norms. A research authorization from the National Commission for Science, Technology, and Innovation (NACOSTI) and ethical clearance from the institution were obtained, guaranteeing compliance with legal and moral requirements. In addition to being told how to get in touch with the primary investigator for any issues or additional questions, participants had the opportunity to ask questions regarding the study.

CHAPTER FOUR

RESEARCH FINDINGS, ANALYSIS AND PRESENTATION

4.1 Introduction

According to the goals of the study, the results are presented in this chapter. As described in chapter two, the findings are understood, examined, and connected to earlier related efforts. The response rate and the dependability of each construct come first. The chapter also covers descriptive statistics, such as the study variables and respondent profiles' means, frequencies, percentages, and standard deviations. Prior to inferential statistics, diagnostic tests such normality, autocorrelation, homoscedasticity, multicollinearity, and singularity tests are carried out. Analysis is done using multiple linear regression and Pearson-product moment correlation. The study's results are shown in frequency tables.

4.2 Research Presentation, Interpretation and Discussions

4.2.1 Response Rate

The response rate is crucial in a quantitative study as it impacts the credibility, validity, dependability, and reliability of the findings due to the representativeness level and the choice of statistical analysis techniques (Pandey & Pandey, 2021). In Lamu County, 391 structured questionnaires were distributed, out of which 333 were completed, yielding an 85% response rate. This rate was considered representative of the population. A response rate above 70% is deemed representative (Wang & Cheng, 2020). Story and Tait (2019) suggest that the minimum sample size for a quantitative study should be 30 subjects (Mongan, Moy & Kahn, 2020). With a sample size of 333 responses, the study exceeded this requirement, making it sufficient for statistical analysis.

Table 4: Response rate

Study population	Response rate	Non-response rate	Comment
391	85% (n=333)	15% (58)	Representative

Source: Researcher (2023)

Further, key informants interview (FII) was administered on seven (7) key stakeholders in the Agricultural sector who included extension officers, a prominent farmer and an agro-market trader in Lamu to qualitatively garner the experts' opinions. Response from the key informants represented 64% of the respondents thus agreeing with Mugenda and Mugenda (2008), argument which considered in social research, a response rate of 50 percent as being fair, 60% good, and 70% very good while the rest scores excellent. By attaining 64 percent, response rate from the key informants was therefore considered good for this study.

4.2.2 Demographic data

Descriptive statistics were used in the study to determine the makeup and traits of the study population. The demographic distribution of the farming population by sub-county was ascertained through the analysis of frequencies, percentages, means, and standard deviations. In Lamu County, the respondents were asked to name the subcounty in which they engage in agricultural activities. The findings are displayed in table 5 below.

Table 5: Respondents per sub-county

Sub county	Number of respondents	Percentage
Lamu East	35	10.5%
Lamu West	298	89.5%
Total	333	100%

Source: field data (2024)

Analysis showed that, majority of the respondent reported Lamu west (89.5%, n=298) while 11.5% (n=35) came from Lamu East. Lamu west has Loamy soil which is conducive for coconut-palm and mango tree farming compared to Lamu east where the soil in parts in clay thus making farming unfavorable safe for the livestock and fishing activities.

4.2.3 Gender

The study established the gender of the study participants. The results provided in table 6.

Table 6: Gender distribution

Gender	Frequency	Percent
Male	199	59.8
Female	134	40.2
Total	333	100.0

Source: Field data (2024)

According to table 6's findings, the bulk of respondents were men (59.8%, n=199) and women (40.2%, n=134). During the survey, the head of the home was interviewed by the study. This suggests that men make up the majority of Lamu County's house heads. The results of the study agreed with those of Abongo (2015), who assessed the impact of settlement scheme initiatives on the socioeconomic well-being of Lamu County residents. According to the report, 20.8% of respondents in Lamu County identified as female, while 79.2% of respondents as male. It is evident that men make up the majority of Lamu's household heads, community/county leaders, and religious leaders who participate in agricultural decision-making. These findings concur with previous agricultural studies, which have shown that land used for farming and tree planting is predominantly owned by men (Koech, 2020; Kansiime, Girling, Mugambi, Mulema, Oduor, Chacha & Garratt, 2021). In contrast, a study by Kirugumi (2022) in Solio Ranch, Laikipia County, revealed that the majority of farmers are women, accounting for 52.1%, as opposed to 47.9% who are men.

4.2.4 Level of Education

The subjects were asked to indicate their educational level. The results provided in table 7 below.

Table 7: Education level

Education level	Frequency	Percent
Primary	91	27.3
Secondary	167	50.2
Diploma	56	16.8
Bachelors	14	4.2
Postgraduate	5	1.5
Total	333	100.0

Source: Field data (2024)

The findings showed that, slightly half of the respondents had attained secondary education (50.2%, n=167), followed with those attained primary level (27.3%, n=91). Further, 16.8% of participant had diploma level (n=56). Who reported to have attained bachelor degree were 4.2% (14) while only 1.5% had attained postgraduate level (n=5). This indicated that farmers in Lamu county have secondary education and capable of making critical agricultural decisions. Education is connected with the quality of agricultural development. Education plays a crucial role in agricultural development as it shapes the understanding of the phenomena being studied. The research aligns with Nyairo's (2020) findings, which indicate that most rural farmers complete secondary education before seeking employment due to poverty. Additionally, the lack of funds for tertiary education means many in the rural populace only attain primary or secondary schooling before pursuing work to support themselves, as noted by Fafunwa & Aisiku (2022).

4.2.5 Age

The respondents' ages were determined by the researcher. The outcomes are shown in table 8 below.

Table 8: Age group

	Frequency	Percent
18-25	59	17.7
26-35	73	21.9
36-45	114	34.2
46-55	64	19.2
56 and above	23	6.9
Total	333	100.0

Source: Field Data (2024)

The majority of participants were 36-45 years (34.2%, n=114) followed by 26-35 (21.9%, n=73). Who reported 56 and above were very few (6.9%, n=23). Therefore, majority of the population in agriculture in Lamu county are in the prime of their lives, hence energetic and productive. The findings concurred those of Maritim (2020) who determined that, youthful farmers are concentrated more in agricultural production than old farmers. Conversely, the findings were in odds with those of Pello et al.,(2021) who established that most adopters of agroforestry in Kenya are aged 46 or older, with much smaller variances.

4.3.5 Type of farming

The study examined the type of farming practiced in Lamu county. Results are presented table 9 below.

Table 8: Type of farming

Type of farming	Frequency	Percent
Subsistence farming	316	94.9
Commercial farming	17	5.1
Total	333	100.0

Source: Field Data (2024)

Subsistence farming is mainly practice in Lamu county (94.9%, n=316) with few farmers practicing commercial farming (5.1%, n=17). The findings married those of Jeruto (2021) who established that subsistence farming still predominates in Kenya, with crops and livestock being integral key components of subsistence farming practiced generally by smallholder farmers.

4.3.6 Type of crops

The study investigated the type of crops grown in Lamu county. results showed in table 9.

Table 9: Type of crops

	Frequency	Percent
Cash crops	26	7.8
Food crops	307	92.2
Total	333	100.0

Source: Field Data (2024)

Food crops are the mainly crops grown in Lamu county (92.2%, n=307) while 7.8% of farmers grow cash crops (n=26). The findings agreed to those of Mbuvi et al., (2020), who opined that, Mijikenda communities in coastal Kenya mainly grow food for consumption rather than for commercial use. They grow food crop in small portions of land to feed the families (Mbuvi et al., 2020).

4.3.7 Road infrastructure and agricultural activities

Table 11 presents the findings of the study, which aimed to determine how respondents' agricultural operations were impacted by road infrastructure.

Table 10. Influence of road infrastructure influence your agriculture activities

Response	**Frequency**	**Percent**
Yes	311	93.4
No	22	6.6
Total	333	100.0

Source: Field Data (2024)

Mainly, the study established that, road infrastructure influences the agricultural activities in Lamu county (93.4%, n=311). However, 6.6% felt that, road infrastructure has no influence on agricultural activities (n=22).

4.3 Discussion of individual objective Results

4.3.1 Descriptive statistical analysis: Road infrastructure

Interval data on the Likert scale were used to evaluate the independent variable. Respondents indicated how much they agreed or disagreed with each construct, which was anchored to a five-point Likert scale. Analysis of responses was conducted using SPSS version 25, calculating percentages (%), means (M), and standard deviations (SD). Presenting the descriptive statistical results for the study variables, a mean value less than three (M<3) signified disagreement (Samejima, 2016), a mean value of three (M=3) denoted moderate agreement, and a mean value greater than three (M>3) represented agreement. Additionally, an aggregate standard deviation (SD) was used to indicate variability in the scores.

4.3.2 Road Infrastructure and Access to Agricultural Inputs

The first objective was to examine the influence of road infrastructure on access to agricultural inputs in Lamu, county. The access to input variable was operationalized with the farmers easiness to acquire quality of seeds, agrochemicals, fertilizers and animal health products. The researcher sought the interval data from respondents by allowing them to indicate the degree to which they agree or disagree with various statements relating to access to agricultural inputs. The response was based on a five (5) points Likert scale whereby 5= Strongly agree, 4=Agree, 3=Moderate, 2=Disagree and 1=Strongly disagree. The results are presented in table below.

Table 11: Road infrastructure and access to agricultural input

Statement	1	2	3	4	5	Mean	Std. Dev
Availability of road network enables access to fertilizers	0.0%	0.0%	9.6%	39.0%	51.4%	4.42	0.66
Road infrastructure provide convenience for farmers to access agrochemicals and pesticides thereby influencing agricultural development	0.0%	0.6%	9.6%	45.9%	43.8%	4.33	0.67
Road infrastructure has led to the convenient availability of animal health products leading to growth of the livestock sector	0.9%	2.1%	10.8%	44.4%	41.7%	4.24	0.80
Access to high quality seeds has been made easy due to availability of roads	0.6%	0.6%	17.4%	38.4%	42.9%	4.23	0.80
road infrastructure attracts investments in the agricultural sector	0.0%	1.2%	6.0%	42.0%	50.8%	4.42	0.66
Availability of road infrastructure influence agricultural growth in Lamu county	0.0%	0.3%	6.6%	39.6%	53.5%	4.46	0.63
Availability of road network has led to lowering of prices of agricultural inputs	0.0%	2.1%	17.7%	34.2%	45.9%	4.24	0.82
road infrastructure has made accessible the agricultural gears for use by farmers	0.3%	0.9%	15.3%	45.9%	37.5%	4.20	0.75
Aggregate						4.32	0.60

Source: Field Data (2024)

The analysis's overall mean value of 4.32 and standard deviation of 0.6, along with the high mean (M>3.0) and low standard deviation (S.D <1.0), suggested that most respondents agreed with the statement that input access affects agricultural development, with only minor deviations (Mishra, Pandey, Singh, Gupta, Sahu & Keshri, 2019). The study's conclusions concurred with those of Opeyemi, Olusegun, Taiwo, and Mobolaji (2021), who looked at how Nigeria's supply of agricultural inputs affected the country's agricultural growth. According to the study, the supply of agricultural inputs clearly plays a significant role on agricultural growth (Opeyemi et al., 2021).

4.3.3 Road Infrastructure and the Provision Of Agricultural Extension Services

The second objective was to determine the influence of road infrastructure on the provision of agricultural extension services in Lamu county, Kenya. The agricultural extension services were operationalized with farmers education, adoption of improved farming technology and farmers' capacity building. The researcher sought the interval data from respondents by allowing them to indicate the degree to which they agree or disagree with various statements relating to access to agricultural inputs. The response was based on a five (5) points Likert scale whereby 5= Strongly agree, 4=Agree, 3=Moderate, 2=Disagree and 1=Strongly disagree. The results are presented in table 13 below.

Table 12: Descriptive statistical analysis: Provision of Agricultural Extension services

Statements	1	2	3	4	5	Mean	Std. Dev
Road network enable provision of internet services enabling farmers to access agricultural information	0.0%	2.1%	19.2%	47.1%	31.5%	4.08	0.77
Road infrastructure eases mobility of extension officers to access farmers in remote areas	0.0%	2.7%	16.2%	55.9%	25.2%	4.04	0.72
Road infrastructure enables capacity building of farmers to improve agricultural production	0.3%	1.8%	14.4%	60.7%	22.8%	4.04	0.69
Road infrastructure enables provision of agricultural advisory services to farmers	0.0%	2.4%	22.8%	52.9%	21.9%	3.94	0.74
Road infrastructure has facilitated training on crops husbandry thus reduced farmers losses from crop pests and diseases	0.9%	1.5%	24.0%	55.3%	18.3%	3.89	0.74
Road infrastructure assists in vailing information about farming technologies thus advancing agricultural development strategies	0.3%	2.1%	19.8%	61.0%	16.8%	3.92	0.69
Road eases communication of agricultural policy issues affecting farmers	0.3%	1.5%	14.7%	59.2%	24.3%	4.06	0.69
Aggregate						3.99	0.57

Source: Field Data (2024)

From the analysis, majority of the respondents strongly agreed that agricultural extension services influence the agricultural development in Lamu County. This is confirmed by aggregate mean value greater than 3.0 (M=3.99; S. D=0.57). An aggregate mean value greater that 3.0 indicate strong agreement (Schober et al., 2021). Similarly, low standard deviation 0.57 is low and showed that there was lower variability in the respondent's responses (Amirrudin et al.,2021). These findings were in consistency with those of Brenya and Zhu (2023) who

established a positive relationship between agricultural extension services and food security in Uganda.

4.3.4 Road Infrastructure and the Marketing of Agricultural Produce

To investigate the influence of road infrastructure in the marketing of agricultural produce in Lamu county was the third goal. The production of high-value crops, the integration of produce markets, and the county's agricultural produce prices were used to gauge the marketing of agricultural products. By asking respondents to rate their agreement or disagreement with different assertions about access to agricultural inputs, the researcher was able to collect interval data from them. The response was based on a five (5) points Likert scale whereby 5= Strongly agree, 4=Agree, 3=Moderate, 2=Disagree and 1=Strongly disagree. The results are presented in table 14 below.

Table 13. Marketing of agricultural produce

Statements	1	2	3	4	5	Mean	Std. Dev
Road infrastructure enable channelling of produce to the market thus motivating growth of the agricultural sector	0.3%	1.2%	8.7%	52.6%	37.2%	4.25	0.69
Increased demand for the agricultural products attracts competitive prices for the agricultural produce in the markets leading to growth of the agricultural sector	0.3%	1.8%	10.5%	49.5%	37.8%	4.23	0.73
Access to varying agricultural produce markets reduce crop losses thereby enabling farmers to crops	0.0%	1.5%	12.0%	52.0%	34.5%	4.20	0.70
Roads Integrates various agricultural produce markets thus influencing agricultural development	0.0%	1.8%	13.8%	47.7%	36.6%	4.19	0.74
Road infrastructure lower the transportation cost of agricultural produce to the markets leading to agricultural development	0.6%	3.0%	16.2%	41.1%	39.0%	4.15	0.84
Good infrastructure has improved efficiency to transport agricultural produce to markets thus leading the agricultural growth	0.6%	1.2%	8.1%	46.8%	43.2%	4.31	0.72
Aggregate						4.22	0.62

Source: Field Data (2024)

Majority of the respondents strongly agreed that marketing influence the agricultural development in Lamu County. This is confirmed by aggregate mean value greater than 3.0 (M=4.22, S.D=0.62). An aggregate mean value greater than three (M>3.0) indicate agreement (Samejima, 2016, Vonglao, 2017). Similarly, low standard deviation less than one (SD<1) indicate there is lower variability in the respondent's responses (Mishra et al., 2019). Hence, homogenous responses were gathered for the study. According to Fan & Rue (2020), marketing is an important strategy for small farmers to sell their farm produce. Strengthening markets and

improving marketing should be a key strategy in South Africa to make agriculture more productive (Smidt & Jokonya, 2022). Fifty two (52.6%) percent of the respondents agreed that Road infrastructure enable channelling of produce to the market thus motivating growth of the agricultural sector. This finding supports a study by Shamdasani, Y. (2021) conducted in India to estimate the effects of infrastructure improvements under a large-scale rural road-building programme on agricultural production decisions. The study found that, in addition to increasing mobility and integrating markets across space, rural households that have access to roads are more likely to diversify their crop portfolio, adopt modern agricultural technologies, and use more labour.

4.3.5 Water Transport and Agricultural Development

The study determined the mediating influence of water transport on agricultural development in Lamu county. The agreement was rated on a Likert scale of 1-5 (5: Strongly agree, 4: Agree, 3: Moderate, 2: Disagree, 1: Strongly disagree). The results are presented in table 15

Table 14: Influence of water transport on agricultural development

Statements	1	2	3	4	5	Mean	Std. Dev
Availability of water transport has necessitated transportation of required farm inputs and therefore contributing to agricultural development	16.8%	24.6%	26.1%	28.5%	3.9%	2.78	1.15
Easy access to water transport has eased the cost of transportation of both agricultural inputs, marketing and extension incurred on road infrastructure in return leading to agricultural development	21.9%	23.1%	24.6%	26.1%	4.2%	2.68	1.20
Availability of water transport has resulted to efficiency in transportation of agricultural outputs to the market and thereby leading to agricultural growth and development	22.5%	24.9%	25.5%	24.3%	2.7%	2.60	1.16
Accessibility to water transport has contributed to provision of timely agricultural extension services thus affecting agricultural development	25.8%	20.4%	26.7%	24.3%	2.7%	2.58	1.19
Water transport has proven to be reliable means in facilitating dissemination of information about crop pest and disease control and therefore resulting to agricultural development	27.9%	24.0%	30.3%	16.2%	1.5%	2.39	1.10
Availability of water transport has led to easy access to markets thus linking agricultural outputs with ready market and thus agricultural development	28.8%	21.9%	26.1%	21.0%	2.1%	2.46	1.17
Agricultural development in Lamu county is as result of water transport	36.0%	26.7%	24.3%	11.4%	1.5%	2.16	1.08
Aggregate						2.52	1.06

Source: Field data (2024)

The analysis revealed that majority of the respondents strongly disagreed that water transport influence agricultural development in Lamu county. This is confirmed by low means (Mean =2.52) which is lesser that the scientifically proven value of three (M<3) also the score had a high variability on the standard deviation (S.D, 1.06) which is greater than one (SD>1) thus confirming the insignificant influence of water transport on agricultural development in Lamu county. These findings contradict Olsen, et al (2021) whose study on adaptation of remote island communities in the Russian European Arctic to dramatic socioeconomic changes conceded that development of the islands and archipelago communities depend mainly on the availability of well-functioning mobility options.

4.3.6 Agricultural development in Lamu county

The Agricultural development in Lamu county was the study's dependent variable. Eight constructs were rated in a Likert Scale. The respondents were asked to rate how much they agree to the level of agricultural development in Lamu county on twelve items measured on a five (5) points Likert scale where (1) =Strongly Disagree, (2) = Disagree, (3) = Neutral, (4) = Agree, (5) = Strongly agree. The results were presented in table 16 below;

Table 15: Agricultural development in Lamu county

Statements	1	2	3	4	5	M	S.D
Good road infrastructure has aided in increased production value	0.0%	0.9%	13.5%	33.3%	52.3%	4.37	0.75
Food security has been achieved due to the establishment and development of road infrastructure	0.3%	1.5%	15.6%	36.6%	45.9%	4.26	0.80
Agricultural sector growth has been highly affected due to the linkage between the farmers and the market by the road infrastructure	0.0%	0.9%	12.6%	41.4%	45.0%	4.31	0.72
Trade has been facilitated by the good development of road infrastructure.	0.0%	1.8%	5.7%	38.7%	53.8%	4.44	0.69
The availability of a ready market for agricultural products has enhanced agricultural sector development	0.0%	1.5%	6.0%	40.2%	52.3%	4.43	0.68
Road infrastructure has contributed to the economic growth of the farmers	0.0%	0.9%	5.1%	44.7%	49.2%	4.42	0.63
Road infrastructure has contributed to the quality of livelihood of the farmers.	0.3%	1.8%	15.9%	35.4%	46.5%	4.26	0.81
Road infrastructure has led to an increase in land use by the farmers	1.2%	1.8%	17.4%	31.8%	47.7%	4.23	0.88
Aggregate						4.34	0.61

M=Mean; S. D=Standard deviation
Source: Field data (2024)

Majority of the respondents concurred that development of road infrastructures influenced agricultural development in Lamu county (Mean =4.34; S. D= 0.61). By this they concede to the undeveloped status of agriculture's strongly opining that continued building of roads under the government program to link to integrate the region will significantly lead to increased economic opportunity through agricultural development. The analysis established that in Lamu county, agricultural development is inadequate (Mean =3.85; S. D= 0.409). Moreover, all the

statements had a mean value greater than 3.0 and low standard deviation. In agreement, the roads connectivity in Tanzania improved the agricultural growth (Berg, Blankespoor & Selod, 2020). Further, Prus and Sikora (2021) determined that road transports ensure the efficient movement of goods and people hence improved agricultural operations in regions and encourages investments resulting to economic growth. These results were echoed by majority of the key informants for instance Respondent 1 opined that, "Road infrastructure is an important thing in development of agriculture. Having good roads means that products from farms will reach market of time. Furthermore, farm inputs will reach to the area of need on time".

4.4 Correlation Analysis

4.4.1 Auto-correlation Test

The test for autocorrelation was conducted using the Durbin-Watson test. This test yields a statistic that typically ranges between 1.5 and 2.5. A Durbin-Watson value within this range indicates no violation of the autocorrelation assumption. Conversely, values outside this range may indicate potential concerns (Field, 2009). The findings are presented in Table 17.

Table 16: Durbin-Waston statistic

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.824[a]	.679	.676	2.758	.679	232.199	3	329	.000	2.072

a. Predictors: (Constant), Agricultural Inputs, Agricultural Extension, Marketing
b. Dependent Variable: Agricultural Development

Source: Field Data (2024)

The results display a Durbin-Watson value of 2.072, which ranged between 1.5 and 2.5. The study failed to reject the null hypothesis of no autocorrelation between the variables, rather rejected alternative hypothesis; these exist autocorrelation between the variables. This is because the residuals were not auto-correlated.

4.4.2 Correlation analysis

To determine the strength and direction of the relationship between the two variables, the study used correlation analysis. The link between changes in one variable and changes in another was assessed using the analysis. In particular, Pearson product-moment correlation analysis was used to assess the association between agricultural inputs, agricultural extension services, marketing of agricultural goods, and agricultural development in Lamu County, Kenya. The Pearson product-moment correlation was employed instead of the Spearman approach because the dependent variable's scores were distributed regularly. Diagnostic tests were performed to ensure that the assumptions of autocorrelation, multicollinearity, homoscedasticity, and normality were all maintained.

The results displayed in table.

Table 17: Correlation Results; road infrastructure and agricultural development

		Y	X1	X2	X3
Y	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	333			
X1	Pearson Correlation	.750**	1		
	Sig. (2-tailed)	.000			
	N	333	333		
X2	Pearson Correlation	.194**	.070	1	
	Sig. (2-tailed)	.000	.201		
	N	333	333	333	
X3	Pearson Correlation	.730**	.679**	-.002	1
	Sig. (2-tailed)	.000	.000	.966	
	N	333	333	333	333

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Field Data (2024)

Y= Agricultural Development
X1= Agricultural Inputs
X2= Agricultural Extension
X3= Marketing

The findings in Table 20 revealed that all the independent variables under study had positive and statistically significant association with dependent variable. In particular, the study found that, access to agricultural input, X1 (r =. 750**; P = .000, n=333), had a strong, positive and significant association with agricultural development in Lamu county. This implied that provisions of agricultural inputs increase agricultural development in the county. The study findings were in consistency with those of Opeyemi (et al., 2021), who examined effect of agricultural input supply in Nigeria and its implications on the growth of agricultural growth in Nigeria. According to the study, Nigeria's agricultural expansion was mostly attributed to the provision of agricultural inputs (Opeyemi et al., 2021).

Kiponda (2022) concurred, demonstrating that proper seed density, pesticide use, and fertiliser use all had a substantial impact on agricultural output. On the other hand, the results of the study were at odds with those of Nnahiwe, Hejkrlík, and Bavorová (2023), who in 2018 studied 372 smallholder cashew growers in Kenya's Coastal Province. According to the study, pesticide spraying had no influence on economic performance, while fertiliser usage and access had a negative impact (Nnahiwe et al., 2023).

Possible explanations included high prices, and access to information. The study recommended the targeted outreach of extension services should be provided to the farmers for better yields.

Further, the results revealed that agricultural extension services, X2 (r =.194**, P = .000, n=333), had a moderate, positive and statistically significant association with agricultural development in Lamu. This suggests that the more the agricultural extension services are available to the farmer, the more agriculture development increased in the county. The results were in line with those of Brenya and Zhu (2023), who discovered a link between food security in Uganda and agricultural extension services. The study also came to the conclusion that productive agricultural extension agents promote agricultural growth.

Finally, access to markets, X3 (r =0.730**, P = .000, n=333), had a strong, positive and statistically significant association with agricultural development (Y). This suggests that agricultural development in Lamu increase with marketing of agricultural produce. Therefore, road infrastructure influences the marketing of agricultural produce. The findings were consistent with those of Gbam (2017) who measured the effect of transportation on the marketing of agricultural products in Jos North. The study found that transportation contributes significantly to agricultural development by facilitating the distribution of agricultural products, fostering the growth of markets for agricultural products, and minimising agricultural product spoilage and waste.

It also demonstrates how better transportation might motivate farmers to put in more effort and boost output (Gbam, 2017). According to Gbam (2017), the study suggests that the federal, state, and local governments establish a sufficient transportation system to facilitate the movement of agricultural products from their production sites to their final destinations.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

The study's summary, conclusions, major findings, recommendations, implications for practice and policy, and future research directions are all included in this chapter.

5.2 Summary of the Findings

The study's goal was to determine how the availability of agricultural inputs, services for agricultural extension, and marketing of agricultural goods affected agricultural growth in Lamu County. Descriptive and inferential statistics were used to assess the quantitative data that was gathered for the study. The study's n=333 response rate was 85%. The reliability analysis found that the instruments used to gather the data were reliable (45 items with a Cronbach's Alpha value of 0.864). Furthermore, the research found that the majority of farmers in Lamu County were men (59.8%, n=199) and women (40.2%, n=134), with secondary education (50.2%, n=167) and ages ranging from 36 to 45 (34.2%, n=114). According to the report, food crops are the primary crop farmed in Lamu County (92.2%, n=307), and subsistence farming is prevalent there (94.9%, n=316). Diagnostic tests like autocorrelation were run to make sure no assumptions were being violated before statistical predictions were made. Correlation analysis was used to determine the strength and direction of the relationship between two independent variables and the dependent variable. There was a positive and statistically significant association between each independent variable and the dependent variable in the study.

5.2.2 Road Infrastructure and Access to Agricultural Inputs

The first objective sought to examine the influence of road infrastructure on access to agricultural inputs in Lamu, county. The quality of seeds, fertilizers, and agrochemicals was used to operationalize the access to input variable. From the analysis, the overall mean value was 3.87 and standard deviation of 0.456. With only minor variances, the high mean (M>3.0) and low standard deviation (S.D<1.0) suggested that most respondents agreed that road infrastructure positively affects access to agricultural inputs. According to the study, agricultural development in Lamu County was strongly, favorably, and significantly correlated with availability to agricultural inputs (r = 750**; P =.000, n = 333).

5.2.3 Road Infrastructure and Agricultural Extension

The second objective was to determine the influence of road infrastructure on the provision of agricultural extension services in Lamu county, Kenya. The agricultural extension services were operationalized with farmers education, adoption of technology in farming and farmers' capacity building. Majority of the respondents strongly agreed that road infrastructure influences agricultural extension services in Lamu County (M=3.87; S. D=0.581). The results revealed that agricultural extension services had a moderate, positive and statistically significant association with agricultural development in Lamu County (r =.194**, P = .000, n=333).

5.2.4 Road Infrastructure and Marketing of Agricultural Produce

The third objective was to investigate the influence of road infrastructure in the marketing of agricultural produce in Lamu county. Marketing of agricultural produce was measured on integration of produce markets, production of high value crops varieties. Majority of the respondents strongly agreed that road infrastructure influences marketing of agricultural produce in Lamu County (M=3.92, S. D=0.524).

Marketing agricultural produce had a strong, positive and statistically significant association with agricultural development (r =0.730**, P = .000, n=333).

5.3 Conclusions

The study's findings are interpreted in light of each of its objectives. In general, the study found that road infrastructure had a positive influence on Lamu County's agricultural development.

5.3.1 Road Infrastructure and Access to Agricultural Inputs

The study came to the conclusion that Lamu County's road infrastructure influences availability to agricultural inputs. Further, the study concluded that, as more farmers are able to access agricultural input, the more agriculture develops in Lamu. Also, the study concluded that, among the three predictors, access to inputs provide the greatest significant influence on agricultural development in Lamu county.

5.3.2 Agricultural Extension services and agricultural Development

The study concluded that road infrastructure significantly influences agricultural extension services in Lamu County. Similarly, the more farmers acquire the agricultural extension services, the more the agricultural development in Lamu county. Nonetheless, extensional services provide moderate influence on agricultural development.

5.3.3 Marketing of Agricultural Produce and agricultural Development

The study made the following conclusion in regard to marketing and agricultural development. That; with an increase in road infrastructure there is an increase in marketing of the produce and marketing make high significant contribution to the total agricultural development in the county.

5.4 Recommendations

Recommendations were drawn from the study findings in relation to each study objective. Generally, the study recommends road infrastructure be availed for agricultural development in Lamu county.

i. It is recommended that local government and infrastructure agencies prioritize the improvement and maintenance of roads connecting key agricultural regions in Lamu County to markets and input suppliers. By facilitating easier transportation of seeds, fertilizers, and agrochemicals, farmers can better access essential inputs, thereby enhancing agricultural productivity and development in the region.

ii. It is advisable for relevant county departments to expand road networks to remote farming areas. This will allow agricultural extension officers to reach more farmers, promoting the adoption of improved farming practices, technologies, and capacity-building programs, ultimately strengthening agricultural productivity.

iii. It is further recommended that local authorities focus on establishing and maintaining reliable roads that link farms to both local and regional markets. Improved road access will facilitate the efficient transportation of produce, enable farmers to access larger markets, and encourage diversification into high-value crops, thereby driving overall agricultural development in Lamu County.

5.5. Implications of the Findings on Theories, Practices and Policies

The study established that road infrastructure influences agricultural development in Lamu county at 67.9%. This is substantial influence which cannot be overemphasized for agricultural development. These findings support the theories and past work on road infrastructure and agricultural developments globally, regionally and nationally. The study results would imply significant contributions towards policy formulation and practices in the field of roads and agricultural growth. In terms of implications on policies, the study informs relevant

stakeholders and policy makers to focus on embracing access to agricultural inputs, agricultural extensional services and marketing of agricultural produce towards agricultural development.

Further, in terms of practices, the study informs the agricultural stakeholders like seeds, agrochemicals and fertilizers manufacturers to produce quality and quantity for agricultural development. Further, agricultural extensionists educate farmers on the best farming practices like use of technology. The results further implicate the farmers, county government of Lamu and national government of Kenya to employ the best agricultural produce marketing practices for agricultural development.

5.6 Recommendations for Further Studies

The study makes the following recommendations for further studies;

i. Future studies could examine other infrastructure factors, such as digital connectivity and storage facilities, that may also impact access to agricultural inputs in Lamu County.
ii. Further research is recommended to analyze the specific influence of road infrastructure on technology adoption within agricultural extension services.
iii. Future studies could explore how road infrastructure not only affects market access but also encourages diversification of agricultural markets, including regional and international trade.

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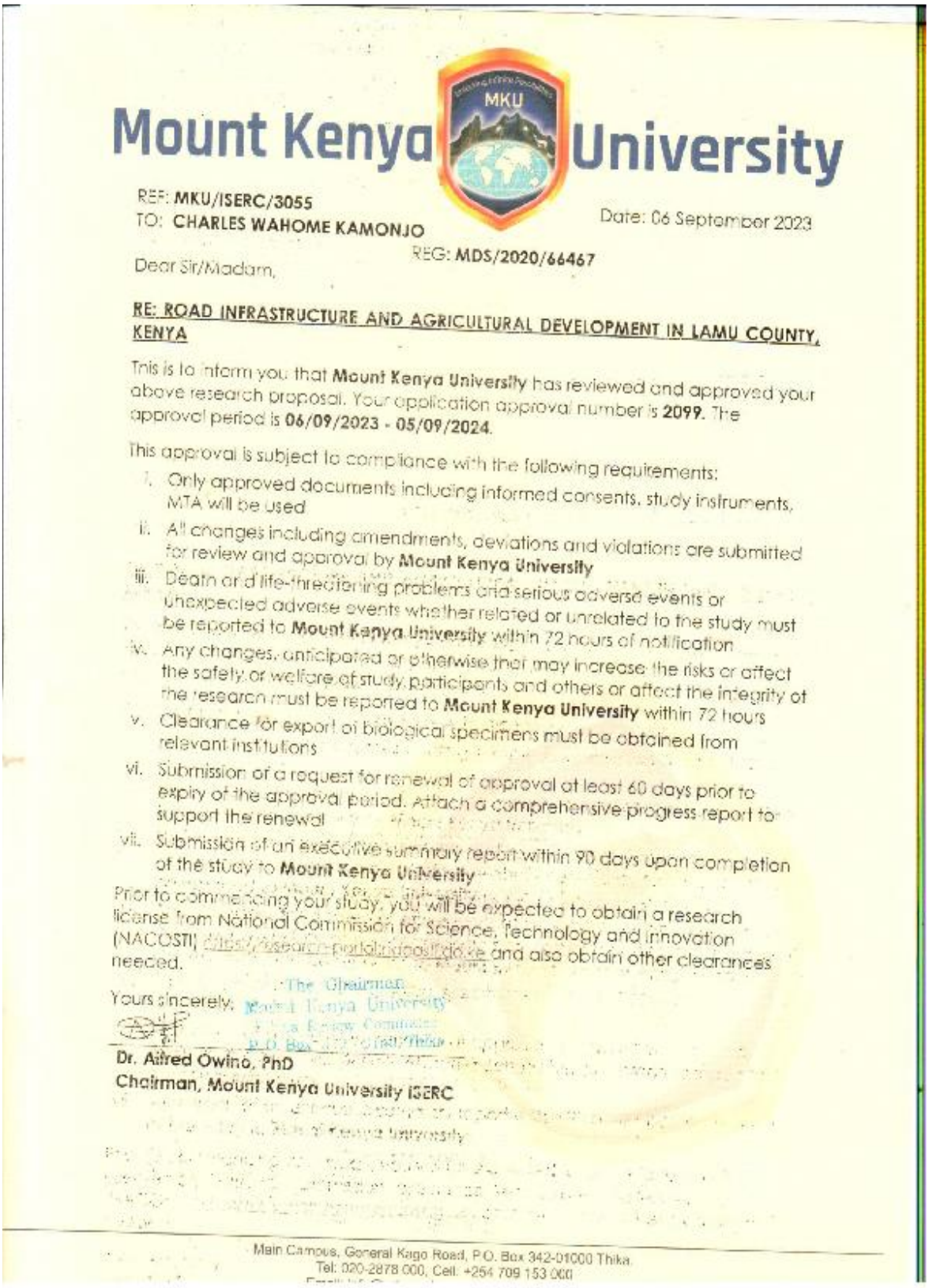
APPENDICES

Appendix II: ERC



Mount Kenya University

REF: MKU/ISERC/3055
TO: CHARLES WAHOME KAMONJO
REG: MDS/2020/66467
Date: 06 September 2023

Dear Sir/Madam,

RE: ROAD INFRASTRUCTURE AND AGRICULTURAL DEVELOPMENT IN LAMU COUNTY, KENYA

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **2099**. The approval period is **06/09/2023 - 05/09/2024**.

This approval is subject to compliance with the following requirements:

i. Only approved documents including informed consents, study instruments, MTA will be used
ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal
vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

The Chairman
Mount Kenya University
P.O. Box 342-01000 Thika

Dr. Alfred Owino, PhD
Chairman, Mount Kenya University ISERC

Main Campus, General Kago Road, P.O. Box 342-01000 Thika
Tel: 020-2878 000, Cell: +254 709 153 000

Appendix III: NACOSTI

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **905854**

Date of Issue: **26/September/2023**

RESEARCH LICENSE

This is to Certify that Mr.. Charles Wahome Kamonjo of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Lamu on the topic: ROAD INFRASTRUCTURE AND AGRICULTURAL DEVELOPMENT IN LAMU COUNTY, KENYA for the period ending : 26/September/2024.

License No: **NACOSTI/P/23/29725**

905854

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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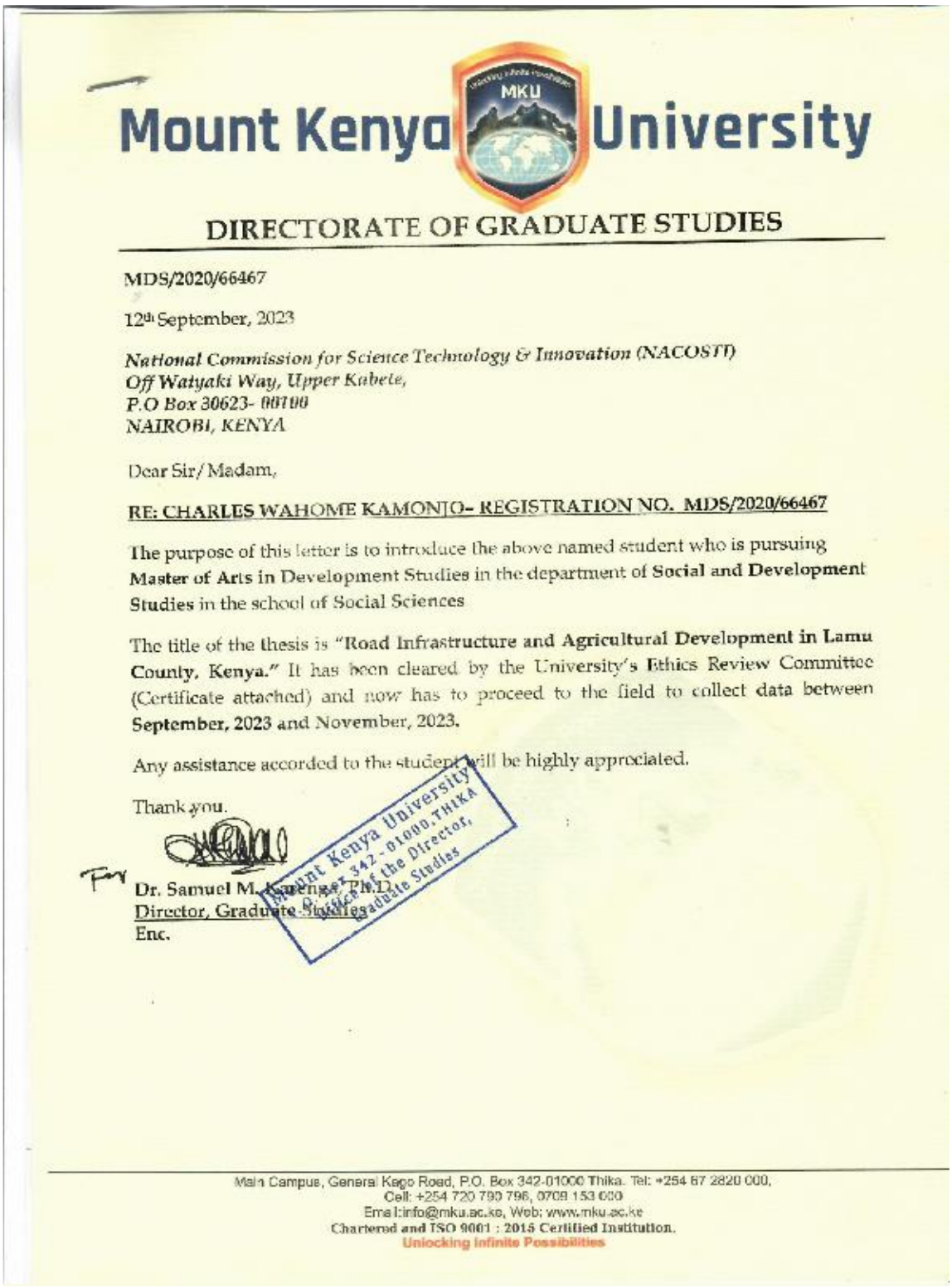
See overleaf for conditions

Appendix I: Letter of Introduction



Mount Kenya University

DIRECTORATE OF GRADUATE STUDIES

MDS/2020/66467

12th September, 2023

National Commission for Science Technology & Innovation (NACOSTI)
Off Waiyaki Way, Upper Kabete,
P.O Box 30623- 00100
NAIROBI, KENYA

Dear Sir/Madam,

RE: CHARLES WAHOME KAMONJO- REGISTRATION NO. MDS/2020/66467

The purpose of this letter is to introduce the above named student who is pursuing **Master of Arts in Development Studies** in the department of **Social and Development Studies** in the school of Social Sciences

The title of the thesis is **"Road Infrastructure and Agricultural Development in Lamu County, Kenya."** It has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data between **September, 2023** and November, 2023.

Any assistance accorded to the student will be highly appreciated.

Thank you.

Dr. Samuel M. Kamenge, Ph.D.
Director, Graduate Studies
Enc.

Mount Kenya University P.O. Box 342-01000, THIKA For: Director, Graduate Studies

Main Campus, General Kago Road, P.O. Box 342-01000 Thika. Tel: +254 67 2820 000,
Cell: +254 720 790 796, 0709 153 000
Email:info@mku.ac.ke, Web: www.mku.ac.ke
Chartered and ISO 9001 : 2015 Certified Institution.
Unlocking Infinite Possibilities

Appendix IV: Informed Consent to the Participants

Greetings,

My name is Charles Wahome Kamonjo from MT KENYA UNIVERSITY School of Social sciences studying Master of Arts degree in Development studies (MDS). he study will involve certain procedures, which include asking predetermined questions through structured questionnaires and conducting follow-up interviews with experts in agriculture using the provided interview guides. If you agree to participate, the expected duration of your involvement will be approximately 30 to 45 minutes. You will also be asked to consent to being recorded during the interview.

While the study offers no direct benefits to participants, its findings will be crucial for policymakers in crafting and funding future development initiatives, especially those focusing on agriculture, food security, and the economic well-being of Lamu county's residents.

Participation in this study is entirely voluntary, and by taking part, you allow the researcher to utilize your responses solely for this study. You have the right to decline participation or withdraw at any point without any adverse effects. There is no financial compensation for participating in the study.

Your anonymity will be preserved by the researcher and the Mt. Kenya University School of Social Sciences, and your information will not be used for any purposes beyond this study. All data collected will be securely stored during the research and subsequently archived in the university library for future reference.

Should there be any misconduct by the researcher, you can reach out to my supervisor or the Chairman of MKU IREC at P.O Box 342-01000, Thika.

Sincerely

Charles Wahome Kamonjo

Researcher

Supervisor: Prof. KENNEDY MUTUNDU email: kmutundu@mku.ac.ke

CONSENT TO PARTICIPATE

I ……..have been apprised about the study titled "THE INFLUENCE OF ROAD INFRASTRUCTURE ON AGRICULTURAL DEVELOPMENT IN LAMU COUNTY, KENYA" by researcher CHARLES WAHOME KAMONJO. I comprehend the study's aim and procedures, which are to examine the impact of road infrastructure on agricultural development in Lamu County, Kenya. I have had the opportunity to ask questions about the study and have received satisfactory answers. I declare that my participation in this study is completely voluntary and that I can withdraw at any time without affecting the study's progress.

I am aware of any compensation available should I sustain any injury while participating in this study. Should I have any further inquiries or concerns regarding the study, I understand that I can contact the researcher. If I have any questions or concerns about my rights as a participant, or if I am worried about any aspect of the study or the researchers, then I may contact the Chairman, MKU IREC, P.O. Box 342-01000, Thika.

Where applicable, I also give my consent to record my involvement in the study.

Signature…… Date……..

Appendix V: Questionnaires

Instructions

i. Do not put your personal details
ii. Fill in all the questions
iii. The data collected was treated with confidentiality

Section A: General Information/ Respondent Profile

1. What is your gender? (Tick appropriately)

(i) Male [ ]

(ii) Female [ ]

2. Age

(i) 18-25 years [ ]

(ii) 26-35 years [ ]

(iii) 36-45 years [ ]

(iv) 46-55 years [ ]

(v) 56 years and above [ ]

3. What is your level of education attained in your relevant discipline of work? (Tick appropriately)

i. Primary [ ]

ii. Secondary [ ]

iii. Diploma [ ]

iv. ii. Bachelor's degree [ ]

v. iii. postgraduate degree [ ]

4. Type of farming you practice?

i. Subsistence farming [ ]

ii. Commercial farming [ ]

5. Types of crops you grow?

i. Cash crops

ii. Food crops

6. Does road infrastructure influence your agricultural activities

i. Yes [ ]

ii. No [ ]

7. Indicate the Main way does road infrastructure affect your agricultural activities

i. Agricultural inputs [ ]

ii. Agricultural extension services [ ]

iii. Marketing of agricultural products [ ]

8. Other than access to road infrastructure, which other factors affect agricultural development in Lamu county. (tick as appropriate)
   i. Government policy
   ii. security
   iii. climatic conditions

Section B: Access to Agricultural Inputs

1. Please rate your agreement to these statements related to road infrastructure influence on agricultural development. Use the five-point Likert scale measurement

(1) Strongly disagree, (2) Disagree, (3) Moderate, (4) Agree, (5) Strongly Agree

Statements	**1**	**2**	**3**	**4**	**5**
Availability of road network enables access to fertilizers					
Road infrastructure provide convenience for farmers to access agrochemicals and pesticides					
Road infrastructure has led to the convenient availability of animal health products					
Access to high-quality seeds has been made easy due					
Access to enough inputs stimulated agricultural development in our region					
Road infrastructure has attracted investments in agricultural sector.					
The availability usable road infrastructure has been a key factor influencing agricultural growth in Lamu county.					
Availability of road network has led to lowering of prices of agricultural inputs thus impacting growth of the agricultural sector in Lamu county, Kenya.					
Road infrastructure has made accessible the agricultural gears for use by farmers thus influencing intensification of the agriculture in Lamu county, Kenya.					

Section C: Agricultural Extension Services

1. Please rate your agreement to these statements related to road infrastructure and agricultural development. Use the five-point Likert scale measurement.

(1) Strongly disagree, (2) Disagree, (3) Moderate, (4) Agree, (5) Strongly Agree

Statements	**1**	**2**	**3**	**4**	**5**
Road network is useful for the provision of internet services enabling farmers to access agricultural information thus impacting agricultural development.					
Road infrastructure eases mobility extension officers to access farmers in remote areas leading to proper crop and animal husbandry that is essential for agricultural development					
Availability of roads enables capacity building of farmers to improve efficiency in agricultural production					
Road infrastructure has enabled the provision of advisory services to the farmers, therefore, improving crop productivity.					
Road infrastructure has facilitated trainings about weeds, pests, and disease control, therefore reducing farmers losses from crop pests					
Road infrastructure assist in availing information about farming technologies thus advancing agricultural development strategies.					
Road ease communication of agricultural policy issues affecting farmers thus enabling farmers preparedness and mitigate risks posed on agricultural development					
Lack of farming knowledge significantly influences our agricultural activities					

Section D: Road Infrastructure and Marketing of Agricultural Products

1. Please rate your agreement to these statements related to road infrastructure and agricultural development. Use the five-point Likert scale measurement.

(1) Strongly disagree, (2) Disagree, (3) Moderate, (4) Agree, (5) Strongly Agree

Statements	**1**	**2**	**3**	**4**	**5**
Road infrastructure always enable channeling of produce to the market					
Increased demand for the agricultural products always attracts competitive prices for the agricultural produce in the markets					
Access to varying agricultural produce markets always reduce crop losses					
Integration of various agricultural products markets always has an effect on agricultural development.					
Pricing of agricultural products always has been made favorable due to road infrastructure					
Effective packaging of agricultural produce that highlights the quality, freshness, and sustainability always attract consumers' attention					
Effective branding of agricultural produce always attract markets					
Choosing marketing channels that align with your target market and distribution capabilities such as supermarkets, online platforms, or farm-to-table programs always support agriculture.					

Section E: Agricultural Development in Lamu County

1. Please rate your agreement to these statements related to road infrastructure and agricultural development. Use the five-point Likert scale measurement

(1) Strongly Agree, (2) Agree, (3) Neutral, (4) Disagree, (5) Strongly disagree

Statements	**1**	**2**	**3**	**4**	**5**
Good road infrastructure has aided in increased production value					
Food security has been achieved due to the establishment and development of road infrastructure					
Agricultural sector growth has been highly affected due to the linkage between the farmers and the market by the road infrastructure					
Trade has been facilitated by the good development of road infrastructure.					
The availability of a ready market for agricultural products has enhanced agricultural sector development					
Road infrastructure has contributed to the economic growth of the farmers					
Road infrastructure has contributed to the quality of livelihood of the farmers.					
Road infrastructure has led to an increase in land use by the farmers					

Section F: Water Transport and Agricultural Development

1. Please rate your agreement to these statements related to water transport and agricultural development. Use the five-point Likert scale measurement.

(1) Strongly Agree, (2) Agree, (3) Neutral, (4) Disagree, (5) Strongly disagree

Statements	**1**	**2**	**3**	**4**	**5**
Availability of water transport has necessitated transportation of required farm inputs and therefore contributing to agricultural development.					
Easy access to water transport has eased the cost of transportation of both agricultural inputs, marketing and extension incurred on road infrastructure in return leading to agricultural development.					

Availability of water transport has resulted to efficiency in transportation of agricultural outputs to the market and thereby leading to agricultural growth and development.					
Accessibility to water transport has contributed to provision of timely agricultural extension services thus affecting agricultural development.					
Water transport has proven to be reliable means in facilitating dissemination of information about crop pest and disease control and therefore resulting to agricultural development.					
Availability of water transport has led to easy access to markets thus linking agricultural outputs with ready market and thus agricultural development.					
Agricultural development in Lamu county is as result of water transport					

Thank you for your participation!

Appendix VI: Interview Guide for the Key Informants

Instructions:
I would like to ask you some questions on road infrastructure and agricultural development in Lamu county. The interview may take 1 hour. I will be writing down your responses down for analysis. Your privacy and confidentiality will be guaranteed noting that this study is for the academic purpose only. Kindly be honest and objective in answering the questions.

If you are ready, we can start:

QUESTION ONE: Discuss in detail how road infrastructure influences agricultural development in regard to farm inputs such as

- Seeds,
- Agrochemicals
- Fertilizers
- Changes in land use

QUESTION TWO: Discuss in detail how road infrastructure influence agricultural development in regard to extension services such as

- Farmers education,
- Exposure and adoption of technology in farming methods & Skilled labor
- Supplies
- Linkages between the farmer and buyer

QUESTION THREE: Discuss in detail how road infrastructure influences agricultural development in regard to marketing. Highlight any knowledge about

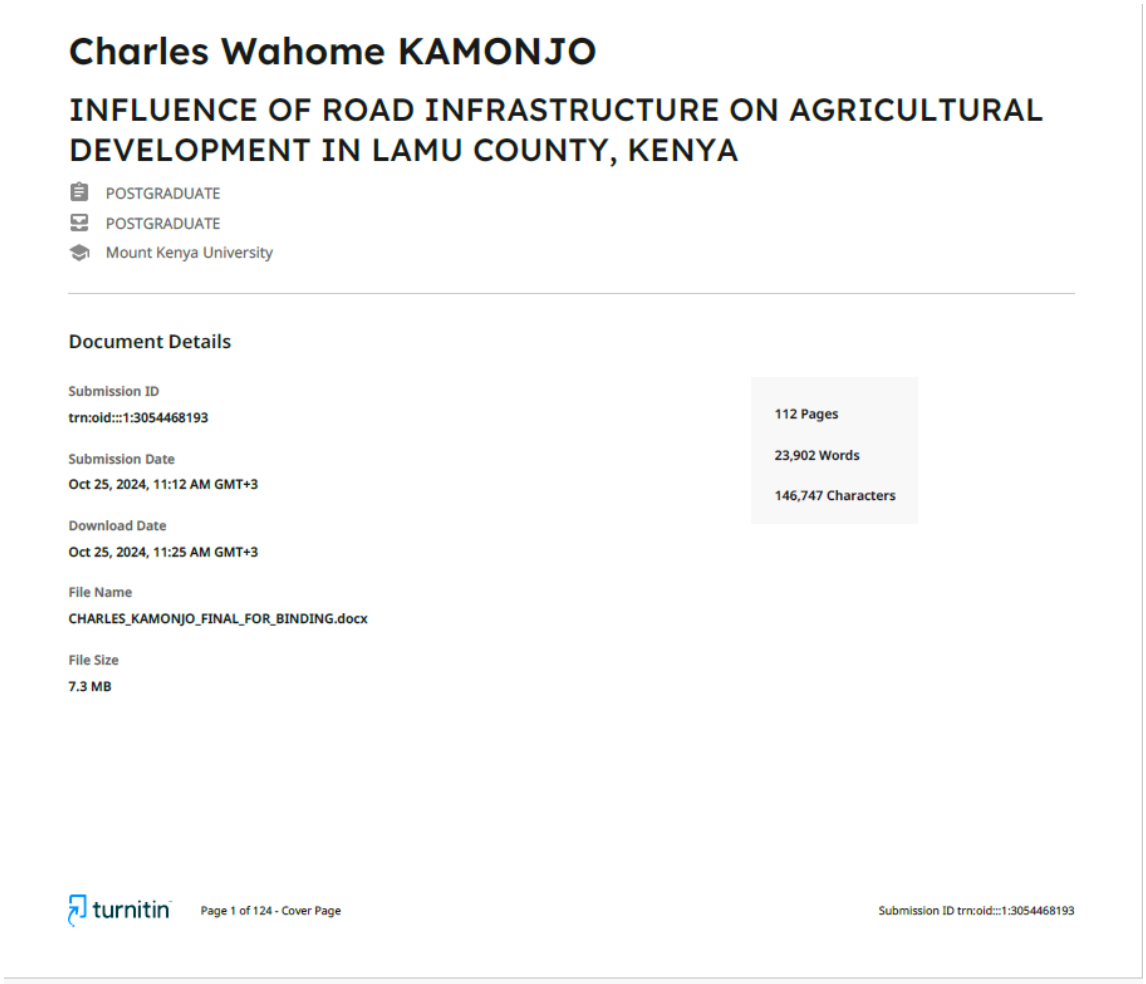
- Growth of urban areas,
- Availability of new markets for agricultural produce,
- Changes in the types of crops produced

QUESTION FOUR: Generally, let us discuss how is the agricultural development in Lamu

Ask questions to understand the level of the following parameters

- Economic growth
- Food security
- Quality livelihood
- Population growth
- Trade
- Rural development

Appendix VII: Similarity Index



Charles Wahome KAMONJO

INFLUENCE OF ROAD INFRASTRUCTURE ON AGRICULTURAL DEVELOPMENT IN LAMU COUNTY, KENYA

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Mount Kenya University

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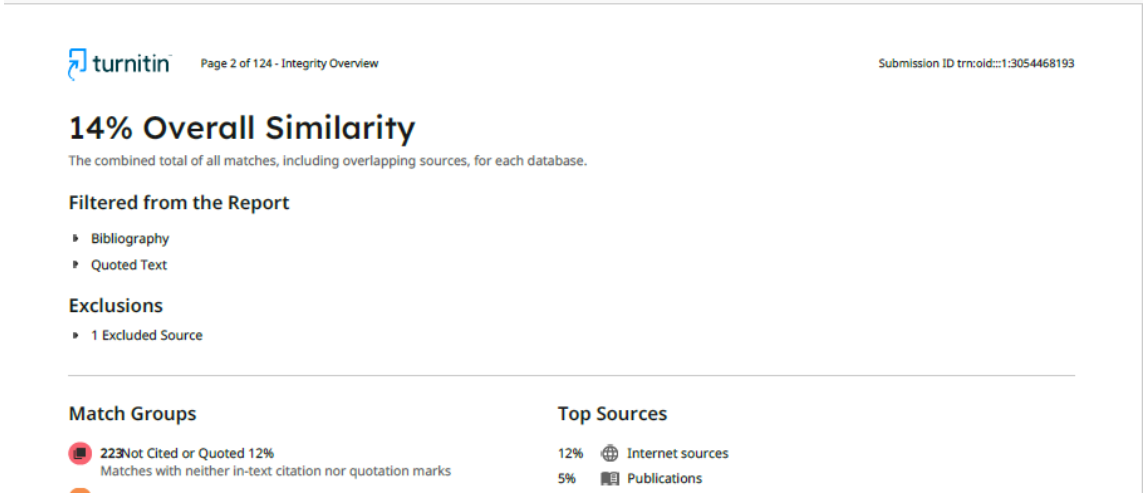

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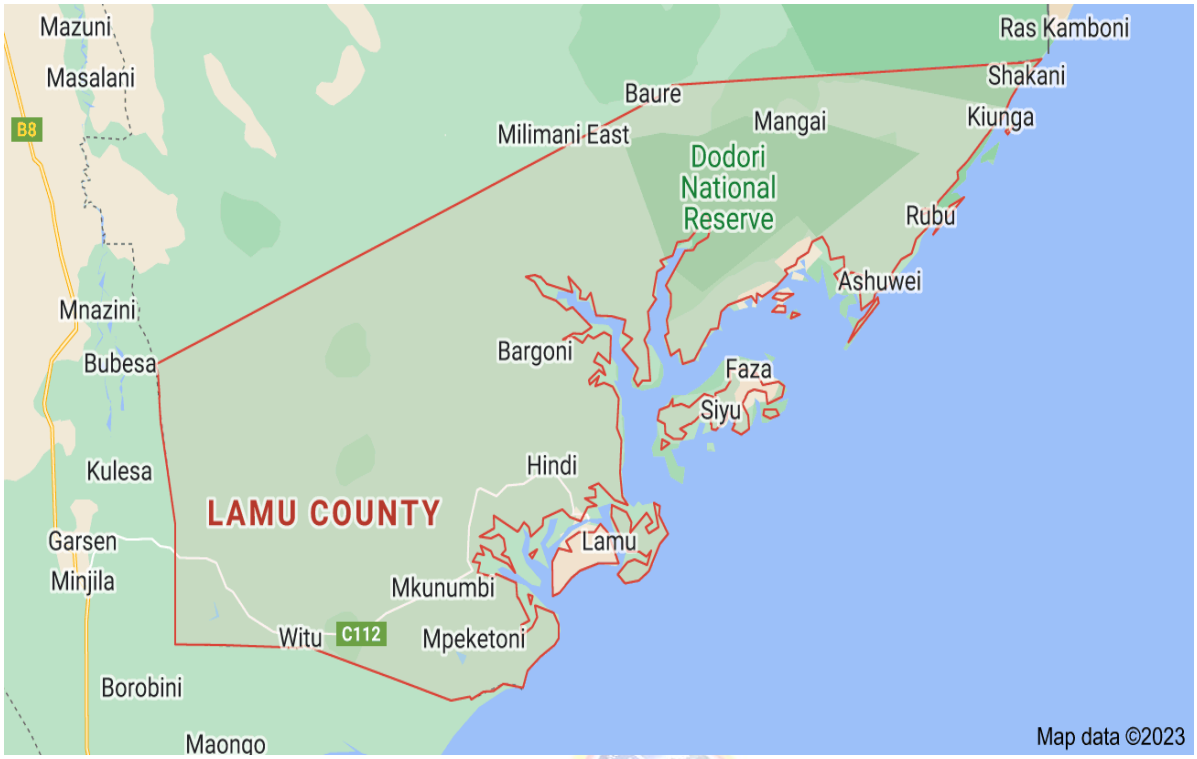
Appendix VIII: Map of Study Area



Source: Map Data (2023)