



Research Paper

Significance of Access to Agricultural Inputs on Agricultural Development in Lamu County, Kenya

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ABSTRACT : Agricultural development is vital for economic growth, food security, and poverty reduction. Lamu County faces challenges such as droughts, food insecurity, and poverty. The national government has prioritized improving road infrastructure to enhance accessibility and market integration. However, agricultural development in Lamu County remains stagnant, with many people relying on relief food aid. This study investigated the impact of access to agricultural inputs on agricultural development in Lamu County, Kenya, using the high input payoff model. A mixed-methods approach was employed, collecting both quantitative and qualitative data. A cross-sectional survey targeted 18,678 agricultural households, with 333 participants in the quantitative study. Statistical results informed collection of qualitative data from interviews with seven key informants in the agricultural sector. Data was collected through structured questionnaires and face to face interviews. Descriptive and inferential statistics were performed using SPSS 25, and results were triangulated with thematic analysis of the qualitative data. Pearson correlations and linear regression techniques were used to draw inferences. Ethical considerations included voluntary participation, informed consent, and confidentiality, with an 85% response rate. Reliability analysis showed dependable data collection tools, with a Cronbach's Alpha value of 0.94 for 45 constructs. The independent variable (access to agricultural inputs) showed a positive and statistically significant association with the dependent variable (agricultural development), explaining 53.9% of the variance ($R^2 = .539$). The study suggests that sustained development of road infrastructure is essential to enhance access to agricultural inputs and promote agricultural development in Lamu County.

KEYWORDS: Accessibility, Agricultural inputs, Agricultural development, Lamu County

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I. INTRODUCTION

A pendulum is a weight suspended from a pivot so that it can swing freely. When a pendulum is displaced sideways from its resting equilibrium position, it is subject to a restoring force due to gravity that will accelerate it back toward the equilibrium position [1] and [2]. When released, the restoring force combined with the pendulum's mass causes it to oscillate about the equilibrium position, swinging back and forth. The time for one complete cycle, a left swing and a right swing, is called the period. The period depends on the length of the pendulum and also on the amplitude of the oscillation. However, if the amplitude is small, the period is almost independent of the amplitude [3] and [4].

Double pendulum is a mechanical system that is most widely used for demonstration of the chaotic motion. It is described with two highly coupled, nonlinear, 2nd order ODE's which makes it very sensitive to the initial conditions [5] and [6]. Although its motion is deterministic in nature, sensitivity to initial conditions makes its motion unpredictable or 'chaotic' in the long run. In this paper, the first part discusses the purpose of the double pendulum [7], in the second section, the system of coordinates is presented and in the third section, the equations of motion and its numerical solutions are investigated by using ODEs [45]. Whereas in the final section, behavior of the system and simulation of the double pendulum are discussed by this paper and explain how to linearize the double pendulum investigate modeling the Linearization Error.

This paper is not only analyzed the dynamics of the double pendulum system and discussing the physical system, but also explain how the Lagrangian and the Hamiltonian equations of motions are derived, we will analyze and compare between the numerical solution and simulation, and also change of angular velocities with time for certain system parameters at varying initial conditions.

II. INTRODUCTION

Road infrastructure constitutes a fundamental component of the global transportation network in all countries. A well-established roads infrastructure not only fosters market integration, employment and marketing for local produce but also play a pivotal role in accessibility of agricultural inputs (Giller et al., 2021). However, overtime, lack of access to proper road infrastructure poses a substantial obstacle for farmers in transporting agricultural inputs to their farms. The situation has prompted governments and donors to use input distribution programs as a means of rapidly increasing food supply for the poor.

Agriculture holds the potential to alleviate vulnerability to extreme poverty in Africa by promoting agricultural investment and trade, thus fostering employment opportunities (Post et al., 2021). Due to the high poverty rate among the rural population in Malawi, agricultural inputs strategies were employed as an instrument of promoting agricultural growth by ensuring access to inputs, and access and availability of food to vulnerable groups (Walls et al., 2023). In the pursuit of fostering economic growth and alleviating food insecurity, numerous developing countries are placing significant emphasis on enhancing road infrastructure (Kinda, 2021). 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 agricultural inputs, enabling the agricultural productivity

Notably, Yılmaz and Njora (2021) 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 (Lesutis, 2020). 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, while road 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 heightened vulnerability among communities already facing marginalization and impoverishment in the marginalized areas.

A. *Statement of the problem*

Agriculture stands as the backbone of Kenya's economy, yet Lamu County remains among the nation's impoverished regions. Agriculture holds the potential to transform the fortunes of its inhabitants. For an extended period, the county suffered from a lack of adequate road infrastructure. However, in the past decade, the government has made significant investments in road development.

Agricultural development plays a pivotal role in driving economic growth, improving rural livelihoods, ensuring food security, and reducing poverty in Kenya. The advancement of agriculture has the potential to expedite the achievement of millennium development goals, unlocking trade opportunities and access to national capital markets. However, Lamu County faces unique challenges, including recurring droughts that devastate livelihoods and heighten vulnerability to natural disasters, particularly food insecurity and severe poverty. In response, the Kenyan government has undertaken the strategic implementation of road infrastructure to enhance the county's resilience against droughts, alleviate food insecurity risks, expand trade possibilities, and alleviate poverty.

Despite the widely acknowledged significance of road infrastructure in catalyzing agricultural development, the instances of food insecurity, high unemployment rates, limited trade opportunities, and slow rural progress, are highlighted (Lamu County Integrated Development Plan, 2018-2022) report. Nonetheless, limited knowledge exists regarding how this substantial investment in road infrastructure has impacted access to agricultural inputs as a resultant factor for agricultural development in Lamu County. Therefore, this study aims to address this knowledge gap which, if left unaddressed, these issues could lead to elevated poverty rates, subpar economic growth, and persistent food insecurity not only within Lamu County but also across Kenya.

B. *Purpose of the study*

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

C. *Research Question*

What is the significance of agricultural inputs on agricultural development in Lamu County, Kenya?

II. LITERATURE REVIEW

The pivotal role of road infrastructure in the movement of agricultural supplies—ranging from seeds, fertilizers, to agrochemicals—from production centers to farms, markets, and urban localities is indisputable. This accessibility, amplified by efficient road networks, translates to heightened productivity and amplified crop

yields. 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 (Newman et al., 2023). These inputs collectively converge to secure sustainable agricultural expansion and underscore the bedrock of food security (Kochore, 2016). 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.

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 road infrastructure investment, collectively contribute to elevated transportation costs, delays, and losses of perishable agricultural goods (Oruma et al., 2021). Dilapidated road infrastructures, and in some areas lack of it restricts access to agricultural inputs such as fertilizers, seeds, and chemicals for agricultural use thus limiting agricultural production (Rafael, 2023). Enhancing access to agricultural inputs bolster agricultural production in Africa thus influencing the food security situation and also stimulating economic growth through agricultural led initiatives (Aragie et al., 2023; Sheahan & Barrett, 2017).

Ineffective use of inputs in agricultural production has had its implication on the development of rural families often encountering, low agricultural production and crop losses arising from various biotic factors mainly crop diseases and pests (Begna, 2020). Lack of transport infrastructure and the subsequent inaccessibility of agro-products markets by the affected farmers discourages farmers from the inputs use and also adopting improved practices in the agricultural production (Begna, 2020; Opeyemi et al., 2021; Wudad et al., 2021). Noteworthy, access to agricultural inputs is not an isolated pursuit; it necessitates a convergence of factors, encompassing seamless access farmlands, extension services, and vibrant markets (Food and Agricultural Organization [FAO], 2015).

Mitigating the myriads of challenges, Berhane et al., (2019) highlights provision of rural roads infrastructures accounts for 3% while access to inputs particularly improved seeds, pesticides and fertilizers had a 21% influence on crop output growth in Ethiopia for the decade between 2004/05–2013/14. The variation on the input use is variably dependent on the time taken to reach the farming households with farmlands close to the marketing adopting the use much effectively than those in remote areas (Berhane et al., 2019). Further, a spectrum of initiatives has been mobilized within the Trans-Saharan region to alleviate the burdens of acquiring agricultural inputs and optimize agricultural production. The African Development Bank (AfDB) initiated the ENABLE youth program to foster success and growth of youth entrepreneurs in the agribusiness sectors through capacity building of youths to acquire the vital entrepreneurial skills (Sanginga et al., 2023). The program approach integrates a multiplicity of remedy actions to inspire agricultural practices and equip young entrepreneurs in the agricultural sector is biased to areas with proper road infrastructure network and an insignificant influence in marginalized inaccessible agricultural lands which remain unattractive for potential agri-preneurs due to high cost of production (Sheahan & Barrett, 2017; Wudad et al., 2021).

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 (Begna, 2020). The plight of smallholder farmers in Kenya grappling with limited access to high-quality agricultural inputs, constitutes a pressing concern resonating across Africa. Constrained input supply and accessibility accentuate the substantial barrier to agricultural (Neglo et al., 2021).

The comprehensive empirical review on the intricate relationship between accessing of agricultural inputs and its impact in the growth of production in the agricultural sector presents a valuable synthesis of existing research, shedding light on multifaceted interactions that underpin agricultural development. While the review effectively outlines the pivotal role of road networks in enhancing farmers access to markets to procure agricultural inputs, it could be enriched through a more critical assessment of the strengths and limitations of prior studies. Engaging in a deeper analysis of methodologies employed, potential biases, and contextual variations would lend greater nuance to the understanding of this complex nexus.

III. MATERIALS AND METHODS

A pragmatic paradigm-based study was conducted in Lamu County utilizing both descriptive surveys and sequential explanatory designs. The target population comprised all the 18, 678 households in Lamu County that practice agricultural activities (Kenya National Bureau of Statistics [KNBS], 2019). Also, 7 key informant interviews were conducted from key stakeholders in the agricultural sectors; Lamu county director of Agriculture, agricultural extension officers, Agrovet stockiest traders and agro-market traders. A sample size of 391 respondents were reached through the Yamane's (1997) formula taking into account the target population size, precision level, and the confidence level. Additionally, 7 key informants were purposively sampled. A stratified sampling approach was employed to group the population into the two administrative units in the

county, where the proportionate sample was achieved through probability proportionate to size formula and then, simple random sampling to obtain individuals. The questionnaires were used to collect data. Interview schedules were applied as data collection for farmers while interviews guides for key informants. A pilot study was conducted with 39 respondents, representing 10% of the sample population, from Tana River County. This county was selected due to its agricultural landscape and transportation infrastructure, which are similar to those of Lamu County, the primary area of study. For the quantitative data, frequencies, percentages, mean and standard deviation were calculated to summarize the characteristics of the respondents while correlation and multiple regression was used to draw conclusions. These findings were presented via tables. The qualitative data, gathered through key informant interviews, was analyzed thematically and presented verbatim.

IV. RESULTS AND DISCUSSION

A total of 391 structured questionnaires were distributed, out of which 333 were completed, yielding an 85% response rate. This rate was considered representative of the population (Holtom et al., 2022).

Table 1

Response Rate

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

Response from the key informants represented 64% of the respondents thus agreeing with Hollin et al. (2020) argument which considered a 60% response rate in qualitative study is sufficient.

A. *Reliability Test*

The reliability test was conducted using Cronbach's coefficient Alpha to assess the internal consistency of the constructs within the instrument. Cronbach's Alpha was utilized to check if the tools were reliable. A Cronbach's alpha coefficient of 0.94 was obtained and was termed as good and reliable. Cronbach alpha coefficient of 0.7 and above is described as dependable and satisfactory (Tentama & Anindita, 2020).

B. *Descriptive Statistics: Access to agricultural inputs and Agricultural Development in Lamu County, Kenya*

The study analysed the respondents' opinion on access to agricultural inputs and agricultural development in Lamu County in regard to quality of seeds, agrochemicals, fertilizers and animal health products.

Table 2

Respondents' Opinion on Access to Agricultural Inputs

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	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	0.9%	2.1%	10.8%	44.4%	41.7%	4.24	0.80
Road infrastructure made it to access to high quality seeds	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
Road infrastructure influence agricultural growth in Lamu county	0.0%	0.3%	6.6%	39.6%	53.5%	4.46	0.63
Road infrastructure 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	0.3%	0.9%	15.3%	45.9%	37.5%	4.20	0.75
Aggregate mean & SD						4.32	0.60

1=Strongly disagree 2=disagree 3=moderate/neutral 4=agree 5=strongly agree

The analysis (aggregate mean =4.32, sd=0.6) implied that the respondents agreed access to agricultural input influence the agricultural development (Mishra et al., 2019). The respondents highly opined ($M \geq 4.32$) that road infrastructures enhanced farmers to access agricultural inputs particularly fertilizers and agrochemicals and also influenced investments into the agriculture leading to improved agricultural productivity and development of the agricultural sector. On the other hand, they lowly perceived ($M \leq 4.32$) road infrastructure impact in lowering prices of agricultural inputs and also enabling accessibility of animal health products, quality seeds and agricultural gears. These results agreed to 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. The study indicated evident that agricultural input supply contributes in great measure to agricultural growth (Opeyemi et al., 2021).

These views were echoed by the key informants' interviews whereby the informants echoed the significant of road infrastructure as enhancing integration of the markets allowing exchange of goods including agricultural inputs whom the usage the usage among the farmers has increased leading to growth of the agriculture and improved harvest in the recent years. Additionally, high prices associated with the improved/quality seeds impend farmers from the usage and rather opting traditional seeds which are sometimes obtained from the open markets and other informal arrangements from the conservatists farmers networks. These finding arguments Hlatshwayo et al.,(2021) study using mixed method to evaluate the significance of informal seed systems in promoting food production in rural smallholder agricultural households in South Africa. The study acknowledged inaccessibility of the rural farmer to mainstream markets only confine them to the local markets where prices are within their affordable range (Hlatshwayo et al., 2021).

C. Discussion

Normality test was assessed using the skewness and kurtosis statistics. The scores on dependent variable were normally distributed guiding the study to apply parametric techniques. There was no violation of assumptions on homoscedasticity, autocorrelation and multicollinearity. Correlation analysis assessed the degree and direction of the association between the two variables as well the significant at 95% confidence level. The study found that access to agricultural inputs had a strong, positive and significant association with agricultural development in Lamu county ($r = .750^{**}$; $P = .000$, $n=333$). 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 et al. (2023) concurred, demonstrating that proper seed density, pesticide use, and fertiliser use all had a substantial impact on agricultural output. Conversely, the results of the study were at odds with those of Nnahiwe et al. (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). Multiple regression provided in-depth investigation of the link between the independent and dependent variables (Boateng & Abaye, 2019). The model explained 67.9 per cent of the variance on agricultural development ($R^2 = .679$). the analysis of variance indicated the model was statistically significant and good fit in explaining the data ($P=0.000$). Therefore, the predictor variable made the unique contribution towards the total variance in dependent variable. For every unit increase in access to input, there is .532 increase in agricultural development in Lamu County ($\beta = .532$; Std. Error = .051; $t=10.498$; $P=0.000$).

V. CONCLUSION

The use of quality seeds, agrochemicals, and fertilizers has significantly influenced agricultural development in Lamu. These inputs have led to increased crop yields, improved crop quality, and enhanced efficiency in farming practices. Farmers who have adopted improved seed varieties have experienced better germination rates, resilience to pests and diseases, and overall improved productivity. Quality seeds have led to the production of crops with better nutritional value and market appeal resulting in higher income for farmers and better food security for the community. Agrochemicals have enabled farmers to manage their fields more effectively, leading to higher productivity with less manual labor. This has been particularly beneficial in managing large-scale farms. Additionally, the application of fertilizers has improved soil fertility in Lamu, leading to enhanced crop growth and higher yields. Balanced use of fertilizers has replenished essential nutrients in the soil contributing to better food security and income stability.

VI. RECOMMENDATIONS

The county should establish programs to promote the use of high-quality seeds and ensure their accessibility to all farmers, particularly smallholders. This could include subsidies, seed fairs, and partnerships with seed companies. Farmers should be trained on the benefits and proper use of quality seeds. Educate them on seed selection, storage, and planting techniques to maximize crop yields. Further, Lamu county should promote the adoption of Integrated Pest Management practices to reduce the reliance on chemical pesticides. This approach combines biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. This could be through provision of comprehensive training programs on the safe handling, application, and disposal of agrochemicals to prevent environmental contamination and health hazards. Finally, the county should educate farmers on the importance of balanced fertilization, emphasizing the use of both organic and inorganic fertilizers to maintain soil health and fertility as well as establishment and promotion of soil testing services to help farmers understand their soil nutrient needs and apply the right type of fertilizers in the required proportions. This will optimize crop growth and reduce the overuse of fertilizers. The county should provide subsidies and financial incentives to make fertilizers more affordable for small-scale farmers. This will encourage the use of fertilizers and enhance agricultural productivity.

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