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ROAD TRANSPORT INFRASTRUCTURE AND AGRICULTURAL COMPETITIVENESS FOR TOBACCO SMALL-HOLDER FARMERS IN THE NORTHERN REGION OF ZIMBABWE

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Abstract:
This study assessed the influence of road transportation infrastructure on tobacco smallholder competitiveness in the Northern Region of Zimbabwe. The study was guided by the agricultural marketing theory and a post positivist philosophy. A cross-sectional descriptive survey was utilized. Data was gathered from respondents using structured questionnaires. Reliability of data was checked using Cronbach's alpha (α). Five Hypotheses were tested using structural equation modelling having satisfied the validity and normality tests. SPSS® version 21 and AMOS® version 21 was used for data analysis. The research found a statistically significant correlation between transport cost, travel distance, and transport price. As the distance of the trip grows, the cost of transportation per ton-km lowers due to considerations like economies of distance. The poor quality of rural roads and limited vehicle utilisation were blamed for the extremely high transportation costs over small distances. Crop yields tend to be greater for farmers that have access to larger markets. The analysis also showed that the reductions in road user costs were nearly three times larger than the benefits to agriculture. In order to promote agricultural growth, the research suggested building and expanding road infrastructure in the Northern Region using local resources and technology.

Key words:
road transportation infrastructure, agricultural competitiveness, smallholder farmers

1 INTRODUCTION

Over 80 million tonnes of Australian agricultural (including horticultural) production must be transported annually between farms, storage facilities, processing facilities, and markets (Kwang, 2021). Long supply chains are a distinctive feature of Australian agriculture, with common distances between production, processing, and markets surpassing thousands of kilometers and seldom ever falling below hundreds. While most highways and major roads are sealed, much of the sparse rural road network is unsealed and in poor condition, particularly near production areas (Cullinane, & Cullinane, 2021, Bookbinder & Ülkü, 2021). Sub-Saharan African nations still have a poor degree of development in their transportation infrastructure. Research has shown that only an estimate of 30% of rural populations have access to all weather roads and the transportation prices are estimated to be twice as high as those of South and East Asia (Kandiero, 2009; Halaszovich, Tilo, & Kinra, 2020). The African Development Bank has acknowledged the significance of infrastructure investment in fostering economic growth, eradicating poverty, and reaching the Millennium Development Goals (MDGs). Examples of this infrastructure include transportation, electricity supplies, and telecommunications (Bayoumi, et al, 2021).

At a macro level, infrastructure investment allows for better private sector activities through lowering production cost, opening up new markets for goods and services and supporting trade. Bayoumi et al, (2021) proclaims that road transport infrastructure improvements reduces production costs through reduced transportation cost of goods and services. Smirnov and Vladimir (2021) postulates that market integration and intra-African commerce are hampered by inadequate transportation infrastructure, high transportation costs, and missing linkages in the transportation network. Distance and quality of road infrastructure matters as it reflects the cost of time and an increase in transport fare that reduces trade volume (World Trade Organization, 2004). Better access to an all-weather road contributes to more intensive use of labor, fertilizer, agro-chemicals and improved use of modern implements (Tanko, 2013; Melo, 2021). Rostow (1960) argues that expansion and improvement of the transport and the infrastructure is considered as a necessary pre-condition for capital formation and increase in the production and productivity. Thus road infrastructure influence the loading of goods and passengers, number of trips made by vehicles per day, travel cost and time as well as the type of vehicles that ply the road and these in turn influence agricultural production and productivity (Soe et al., 2020, Hendijani & Saeidi, 2020).

The vast majority of people reside in rural regions in the majority of developing nations. In terms of factors affecting the supply and demand of labor, this indicates that rural regions have a greater impact on the growth of the nation. In emerging nations, the rural areas' lack of development has resulted in extreme poverty. This explains why rural development planning has been preoccupied with the need to reverse the various inequalities in income, employment, resource access, ownership, control and use, as well as food utilization and access (United Nations Department of Economics and Social Affairs, 2014). In 2014 roughly 40% of the African population lived in rural areas (United Nations Department of Economics and Social Affairs, 2014) and more than 75% of the rural population earned a living through agriculture (FAO, 2014). This reality is evident in Zimbabwe. In Zimbabwe over 70% of its population lives in rural areas. The majority of the people directly or indirectly depend on agriculture and its associated activities (IFAD, 2001). It is estimated that 3.6 million Zimbabweans are food insecure and need relief (Zimbabwe Vulnerability Assessment Committee, 2011).

The Zimbabwean road transport infrastructure services appear to be underperforming in terms of adequacy quality, accessibility transport costs and on time delivery. In Zimbabwe's Northern Region, it is quite concerning because farmers are unable to participate in profitable marketplaces. Small-scale farmers are frequently at a disadvantage as a result of agriculture's increasing integration into markets, hence steps must be done to assist them profit from this integration. The renaissance of agricultural can be realized only if products actually get into lucrative markets but it is difficult for tobacco farmers in the Northern region of Zimbabwe to satisfy the market, achieve consistency, and remain sustainable. The apparently cost ineffective and inefficient road transport infrastructure is widely blamed for the exclusion of potential small holder farmers' accessibility. Rural infrastructure in Zimbabwe, particularly roads, continues to constrain farm incomes and adoption of technologies (Banjo et al., 2012; Kailthya, Subham & Kambhampati, 2022). Although there has been significant investment in roads and transportation over the years, the cost of agricultural production and the sale of commodities are negatively impacted by the high cost of transportation services. Conventional road management and appraisal tools through the District Development Funds (DDF) were fully put in place addressing the benefit of improved accessibility, especially in the rural areas. Most studies covering this area were most centered on infrastructural development and economic growth not paying much attention specifically to road transport infrastructure. For instance, most studies in Zimbabwe are related to road transport infrastructure and pricing whilst others deal with transport infrastructure and economic growth (Carricano, 2014; Ngarava, 2016; Mazodze, 2019; Mutami, 2020). None of them have exposed the relationship between road transport infrastructure and agricultural competitiveness. This becomes a yawning research gap. This study therefore seeks to address the impact of road transport infrastructure and agricultural competitiveness of small holder tobacco farmers in the Northern region of Zimbabwe. In return, the paper proposed towards improving the transport system for tobacco small holder farmers in the Northern Region of Zimbabwe.

2 LITERATURE REVIEW, HYPOTHESIS AND MODEL DEVELOPMENT

This section presents literature review, development of hypothesis and the research model.

2.1 Transport infrastructure

Yorganc, (2018) and Trimbath, (2011) agree that transportation infrastructure is the underlying structure that supports economic activities by moving people and goods, including the delivery of inputs to production places, goods and services to customers, and customers to marketplaces. According to Hensher and Puckett (2005), infrastructure planning, design, and construction in Zimbabwe have remained largely unchanged over the last century; therefore, attention must be focused on the research of new construction materials and processes in order to innovate the sector. The goal is to develop techniques and materials that respond to the need for reducing environmental impact and increasing sustainability while reducing timescales for the entire construction and maintenance process in order to increase the sector's competitiveness and the efficiency of transportation flow (Ngugi et al. 2007; Qaim 2012; Chelang'a et al, 2013; Fischer et al. 2016).Various constructs were used to measure road transport infrastructure which include road reliability, transportation costs and accessibility.

2.2 Competitiveness

For the purposes of this study, competitiveness is defined as a sector's, industry's, or firm's ability to compete by trading its products profitably in the global marketplace while earning at least the opportunity to meet the cost of returns on resources employed (Porter, 1998). Competitiveness is also defined as the set of policies, institutions, and factors that determine a country's level of productivity (Global Competitiveness Report, 2008/9), which positions an economy's sustainable level of prosperity. This means that more competitive economies can generate higher levels of income for their citizens. The level of productivity also determines the rates of return on investments in an economy (Lokesha & Mahesha 2016, Cold et al., 2019; Soe et al., 2020). Firm-level competitiveness refers to the competitiveness of businesses in numerous industries, such as agriculture and manufacturing. The purpose is to enhance productivity in an area through increasing a firm's productivity at a geographical level, such as a city, region, or nation. The European Union (2012) defines competitiveness as an economy's capacity to offer its population with high and growing standards of living, as well as high rates of long-term employment. In a supportive business environment, fierce competition is a key driver of productivity growth and competitiveness (Kiel et al., 2014; Tamene & Megento, 2017, Scoones et al., 2018; Mazwi et al., 2020).Agriculural competiveness was measured using productivity of farmers,financial output (profit), product quality, on time product delivery and product cost.

2.3 Development of hypothesis

According to Iyanova and Masarova (2013), who are supported by Usman (2014), there is a growing body of literature on the relationship between road network investment and economic development in developed countries such as the United States and the United Kingdom. In developing nations like Nigeria, however, few studies have looked into the likely link between transportation infrastructure investments and economic progress. Many researchers who have studied the relationships between transportation infrastructure investment and economic development have looked through broad lenses rather than focusing on capital (Prud'homme, 2005; Shafik; 2005; Lakshmanan, 2011; Bagchi & Pradhan, 2013). Akhmetzhanov and Lustoy (2013) demonstrated that there are clear links between transportation infrastructure and regional development. Kustepeli et al. (2020) investigated transportation infrastructure and goods movement and discovered a positive impact. Infrastructure-provided services are critical to economic activity. The vertical and horizontal alignment, road roughness, surface type, road width, and sight distance all contribute to the overall condition of the road (Thagesen, 1996; Bennett & Greenwood, 2001 Alnoor; Eneizan; & Makhamreh; 2019). Boopen (2006) argued that road quality a greater positive impact on productivity in developing countries than any other investment. Therefore it is hypothesized as:

H_1: road quality has a positive effect on agricultural competitiveness.

An efficient transportation system promotes economic growth by reducing travel time, lowering accident costs, and lowering transportation costs (Kiggell, Kilbourn, and Heyns 2021). Transportation expenditures may have indirect consequences such as lower commodity prices and higher productivity. Rural transportation networks and operations are critical for rural development and the agricultural sector since they give access to farm inputs (fertilizers, herbicides/pesticides, and improved seeds), as well as other socio-economic activities for the rural population. As a result of the enhanced accessibility, agricultural production may grow. For many African countries, agricultural development is a vital phase in the process of economic transformation and prosperity (Anderson & Kym; 2021, Seok & Hanpil; 2021). Therefore it is hypothesized as:

H_2: Road connectivity has a statistical significance on agricultural competitiveness

Road conditions, according to the literature, have a major impact on transportation costs. Transportation prices are influenced by a variety of factors, including transportation costs, transportation market competition and regulation, trip distance, and cargo volume. There is a well-established relationship between transportation costs and road conditions. The link between transportation cost, transportation pricing, and road conditions, on the other hand, is poorly understood (Dorward & Chirwa, 2011; Banjo et al., 2012). The transportation chain for agricultural products to urban/larger markets can be loosely divided into three transport segments: primary transport, middle transport, and last transport. The impact of road conditions on journey distance and transportation costs is direct. The study also discovered that when trip distance increases, so does the cost of transportation. Transport price is very high over short-distance rural trips which is generally less than 50 km in length and referred to as the 'first mile' (Njenga et al., 2014). Therefore it is hypothesized as:

H_3: Transport cost has a statistical significance on agricultural competitiveness

Figure1 presents the conceptual framework within which the impact of road transportation infrastructure on rural agricultural development is evaluated. Road transport infrastructure (RTI) is considered an important part of Agricultural Competitiveness (AC). The key independent variable of this study is road transport infrastructure. Road transport infrastructure is assessed in this thesis in the light of the following variables: road quality, road connectivity, transport costs and reliability. Furthermore, the framework adheres to the general principles of complexity theory, theory of constraints, strategic alignment theory, the trip distribution model, gravity model the accessibility model and agricultural marketing theory. The overall underlying conceptual framework model is depicted diagrammatically in Figure 1 where Agricultural Competitiveness (AC) represents the dependent variable.

The study identified four constructs namely road quality, road connectivity, transport costs and reliability. Lastly, Innovation (IN) factors moderate the indirect relationship between road transport infrastructure (RTI) and Agricultural Competitiveness (AC).

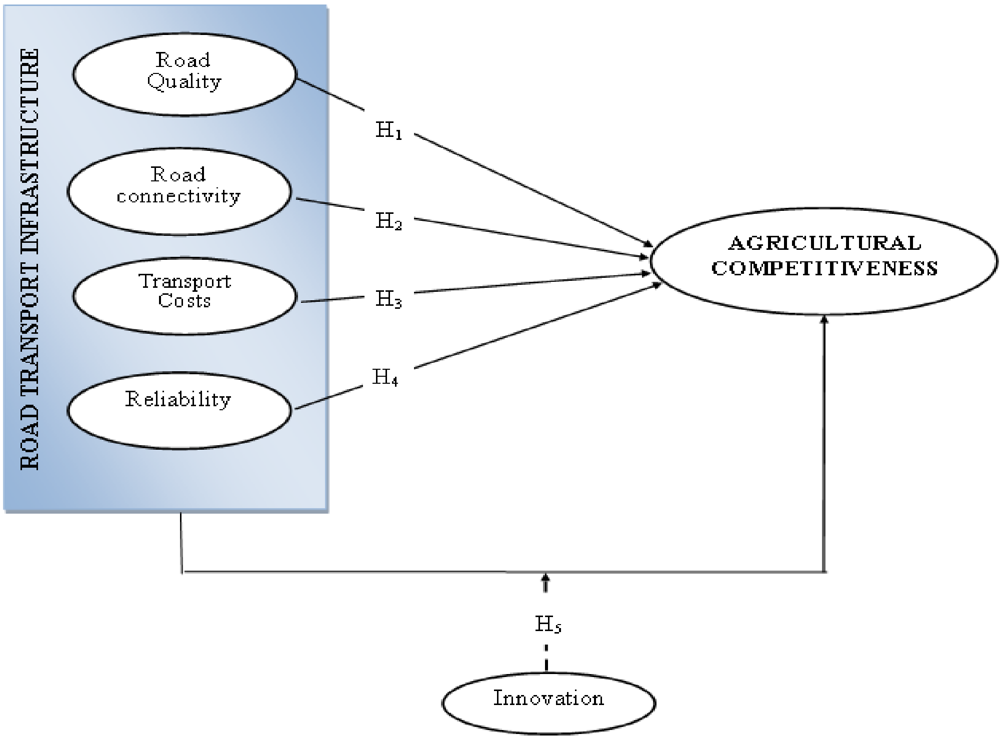

Fig. 1 *Relationship among Road Reliability (ARA), Road Connectivity (RCA), Transport Cost (TCA), Quality Of Roads (QRI), Innovation (IAC) and agricultural competitiveness (AC)*
Source: (Researchers., 2021)

3 METHODS AND METHODOLOGY

The study adopted a post-positivist philosophy as it posits that common sense thinking and scientific reasoning are quite similar. This indicates that a person's grasp of daily life is comparable to a scientist's comprehension. The main distinction is that a scientist would follow a process to get findings. Post-positivism rejects the positivist approach that a researcher can be an independent observer of the social world source. Post-positivists contend that a researcher's beliefs and even personal identity may have an impact on their observations and, in turn, their conclusions (Zikmund & Babin, 2016).By making an effort to acknowledge and take into account these biases in the theories and body of knowledge that theorists produce, post-positivism seeks objective solutions. This study used a quantitative methodology. It depends on the use of statistics to decision-making in order to bring forth reality and objectivity. The research used 30 rural villages for a deliberate sampling process. Using the stratified probability sample approach, structured questionnaires were employed to collect data from 387 households from the Northern Region of Zimbabwe. Secondary data was obtained through document reviews. Descriptive statistics technique percentages, standard deviations, frequencies, means and chi square were used to highlight the socio-economic characteristics of the farmers in the study area. Cronbach's alpha (α) was used to assess reliability. Before testing hypotheses, data were verified using exploratory factor analysis (EFA), convergent validity, and discriminant validity. Hypotheses were tested using structural equation modelling having satisfied the validity and normality tests and data was analyzed using SPSS® version 21 and AMOS® version 21.

4 RESULTS

Prior to doing exploratory factor analysis, the viability of the data for factor analysis was assessed using Bartlett's Test of Sphericity and the Kaiser Meyer Olkin Measure of Sampling Adequacy (KMO) in SPSS Version 20. To assess the sample's suitability, a KMO measure of sampling adequacy was applied. The KMO statistic has a range of 0 to 1, with 0 denoting that the sample is completely inadequate and 1 denoting that it is completely adequate. In order for the sample to be sufficient, Kaiser recommended that the measurement be at least 0.5. To check if the data could be used for factor analysis, the Bartlett's Test of Sphericity was employed. Field (2009) recommended that the Bartlett's test of Sphericity should be significant at $p < 0.05$ for factor analysis to be performed. Table 1 presents results obtained (KMO = .948, Approx. Chi-square = 20385.878, Degrees of freedom [DF] = 595; $p<0.001$) and indicated that the sample was suitable and allowed performing of exploratory factor analysis as recommended by Field (2009). In order to prevent results from being duplicated in subsequent studies, exploratory factor analysis was used to limit and condense the number of linked variables to a manageable and pertinent amount. To make factor findings easier to read, the factor rotation approach was applied. Analysis of factors was simplified using the Varimax method as it maximises the total sum of variables of the squared loadings that is squared correlations between variables and factors (Zikmund & Babin, 2016).

Tab. 1 *KMO and Bartlett's Test*

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.575
Bartlett's Test of Sphericity	Approx. Chi-Square	2750.815
	df	666
	Sig.	.000

Source: (Researchers., 2021)

Table 2 displays the factor loadings for each factor. Factors with loadings of less than 0.6 were suppressed, therefore they weren't given. Field (2005) recommended the consideration of loadings above 0.6 so as to make the understanding much easier. As a consequence, the results in Table 2 met the minimum cut off limit for factor loadings that Bagozzi and Yi (1988). Reliability is the degree to which results attained by a measurement procedure may be replicated and produce similar results on repetitive trials (Cooper & Schindler, 2011; Hair, et al., 2013; Wong et al., 2012). Using Cronbach's Alpha (α), constructions' internal consistency was evaluated. The study's constructs' reliabilities are depicted in Table 2. Table 2 shows that all constructs had a Cronbach's alpha (α) of more than 0.6 as recommended by Bagozzi, and Yi, (1988).

Tab. 2 *Construct, number of items and Cronbach's (α)*

Construct	**Number of Items**	**Cronbach's alpha (α)**
Road Reliability (ARA)	6	.839
Road Connectivity (RCA)	6	.727
Transport Cost (TCA)	6	.788
Quality Of Road (QRI)	5	.846
Innovation (IAC)	6	.716

Source: (Researchers., 2021)

To make sure that no construct correlated with other ideas, the researcher used convergent analysis. A measurement model was initially evaluated to make sure it was suitable for testing before convergent validity was determined. Maximum Likelihood Estimation (MLE) was used to estimate the measurement model so as to acquire better estimates Field, (2009). CMIN/DF ($\chi2$/Df), Goodness of Fit Index (GFI), Adjusted GFI (AGFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA) were considered in determining the measurement model fit indices. CMIN/DF = 4.619; GFI = 0.899; AGFI = 0.871; NFI = 0.939; TLI = 0.944; CFI = 0.952; and RMSEA = 0.071 were the proper model fit indices reported by the measurement model. A decent model, according to Hu and Bentler (1999), should have a $\chi2$/DF between the scales of 0 and 5, with smaller values suggesting a better match. Hu, and Bentler, (1999) suggested that values for GFI, AGFI, NFI, TLI and CFI specify a good fit when they are closer to 1, and RMSEA must be between 0.05 and 0.10 for it to be satisfactory.

Hypothesis Testing

The study tested the hypotheses in order to accept as true or reject as false the acclaimed statements or associations between variables Ragab, and Arisha, (2017). Road transport infrastructure was treated as a second order construct because it is multidimensional. Hypothesized relationships (H1, H2, H3, H4 and H5) were tested in AMOS version 21 using structural equation modelling (SEM) technique. Maximum Likelihood Estimation (MLE) was used to estimate the structural model Field, (2009). The structural model indicated satisfactory model fit indices (CMIN//DF = 1.89; GFI = 0.899; AGFI = 0.903; NFI = 0.910; TLI = 0.896; CFI = 0.919 and RMSEA = 0.147). Table 3 shows results of hypotheses tests.

Tab. 3 *Results of Hypotheses testing (H_1, H_2, H_3 and H_4)*

Hypotheses	Hypothesised Relationship	SRW	CR	Remark
H_1	Quality Of Roads → Agricultural Competitiveness	.829	19.056***	Supported
H_2	Road connectivity → Agricultural Competitiveness	.177	2.685***	Supported
H_3	Transport cost → Agricultural Competitiveness	.227	3.959***	Supported
H_4	Road reliability → Agricultural Competitiveness	.629	10.739***	Supported

Notes: SRW standardized regression weight, CR critical ratio, ** significant at $p < 0.05$, *** significant at $p < 0.001$,

Source: (Researchers., 2021)

The structural equation modelling approach was used in AMOS version 21 to investigate the hypothesized correlations (H1, H2, H3, H4, and H5). Infrastructure for road transportation was viewed as a second order construct. Maximum Likelihood Estimation (MLE) was used to estimate the structural model (Field, 2009). Structural equation modelling technique is ideal since it is able to determine relationships and also able to suggest a general fit between observed data and the research model (McQuitty & Wolf, 2013). The structural model indicated satisfactory model fit indices (CMIN//DF = 4.619; GFI = .899; AGFI = .871; NFI = .939; TLI = .944; CFI = .952 and RMSEA = .071). The research then tested the moderation effect of using well validated measurement models to identify innovation as a moderating role on the effect of road transport infrastructure on agricultural competitiveness.Moderated regression analysis was used to test H_5 and the results are summarised in Table 4

Tab. 4 *Coefficients of moderated regression results*

Variable	Beta	t-statistic	p value
Road Transport Infrastructure	.113	2.391	.000
Innovation	.035	2.115	.000
Road Transport Infrastructure × Innovation	.108	2.009	.000

Note: ***Significant at p<0.001

Source: Research data (2021)

Results show that coefficients for the interaction terms (road transport infrastructure × Innovation) were insignificant (p>0.000). This suggests that innovation moderates the effect of road transport infrastructure on agricultural competitiveness. Therefore, H5 was supported. The study established that there is a total of over 1000 kilometres of road network connecting communities in the area of which less than 70% was classified as bad roads. It was discovered that just 400 kilometers of the district region's road network need engineering. This indicated that there were no adequate roads linking communities in the area despite the road infrastructure which was perceived to be generally poor. Majority of the farmers in the region (about 85%) were connected to the nearest urban market by unpaved road. This was consistent to Gollin (2012), Kiprono & Matsumoto (2014) who made the point that roads in rural communities are poor and rural connectivity is very low. The investigation showed that the average farm distance from the major road or the closest market to the village was about 50 km.

The study also discovered that increased agricultural productivity results from lower transport costs. Crop yield will rise by 0.291 percent if transport costs are cut by 1%.This expected change concurs with the results of Hine & Ellis (2001), who suggest that a one percent reduction in transport cost, fully passed to farmers, will increase agricultural output by 0.3 percent. Limi et al. (2015) also found that a one percent reduction in transport price and waiting time cost could increase agricultural production by more than one percent. The agriculture industry would consequently gain from investments in road infrastructure that lower transportation costs and prices. Selling to markets that are further away is connected with both a higher crop price and a cheaper unit transport price expressed in ton-km. The lengthier routes benefit from distance savings; the roads are generally in good shape (because secondary highways going to the larger markets are in better condition); and they entail effective forms of transportation (since longer trips use cars as opposed to walking and cycling).

The study established that the cost of transportation was highly influenced by the nature of road used as revealed by a chi square value X2 (DF=2) of 58.817, and p=0.000 indicating a strong relationship between the two variables. It is therefore expected that, paving the road networks in the district will among other things reduce the travel cost from the various communities to the market. This finding was consistent with Easterling et al., (2008) who indicated that underdeveloped rural roads in Zimbabwe led to high market transportation costs for both farm supplies and agricultural goods. Prices of output and input are impacted by rising transportation costs.

The objective of the study was to test the moderating effect of innovation on the influence of road transport infrastructure on agricultural competitiveness. Thus, it was hypothesised that, there is need to invest highly in agriculture through adoption and introduction of new and modern technology, creating ready market, putting measures on pests and diseases control, encouraging people to do commercial farming for both the government and people involved in agriculture to benefit.

5 CONCLUSIONS AND IMPLICATIONS

The researcher came to the following conclusions and suggestions based on the study's findings. Roads are the lifeline that is the arteries of economic region. These crucial channels promote agricultural development and form an integral part of a metropolis and the area that serves it. For exploitation of the agricultural potential of an area particularly in the Northern Region of Zimbabwe, roads should be developed on a priority basis for a complete change in the agricultural landscape. Road network comprising of trunk roads line roads, approach roads and village roads will provide proper access to markets for all types of farmers. For the development of inherent agricultural potentials of the Northern Region of Zimbabwe, road accessibility is a desire need as road transportation plays an important role in marketing agricultural produce. As a matter of fact, this critical distance should vary in accordance with the nature of transportation and the total distance. The literature that is currently available has shown that road conditions have a big impact on transportation costs. The cost of transportation, market competition and regulation, journey distance and cargo volume are all elements that impact the cost of transportation. Road conditions and transportation costs have a well-established link. However, nothing is known about the connection between transportation costs, costs of transportation, and state of the roads.

Following a road repair, a decrease in transportation costs may result in higher farm-gate prices and lower agricultural input prices, which may encourage a rise in agricultural production. Only if farmers receive a decrease in transportation costs in the form of lower transportation tariffs for delivering agricultural goods to markets and transferring agricultural supplies to rural regions will the benefit be felt. However, in oligopolistic and monopolistic transport markets, there is frequently no correlation between the reduction in transportation costs and the drop in transportation rates, according to the research. However, the amount of agricultural growth and quantification of the crop output rise are not well established. The literature does present the idea on how increased road infrastructure and transportation service may contribute to an increase in agricultural productivity.

The government should invest highly in agriculture through adoption and introduction of new and modern technology, creating ready market, putting measures on pests and diseases control, encouraging people to do commercial farming for both the government and people involved in agriculture to benefit. The agricultural sector in Zimbabwe for the foreseeable future will remain the mainstay and engine as well as the stepping stone of growth of the economy. The researcher proposed the following policy recommendations based on the study's results to assist close the district's deficit. The findings of this study may be turned into a variety of indicators to help policy makers in the transportation and rural planning sectors. The Development and Expansion of Road Infrastructure in the Northern Region of Zimbabwe is a major recommendation that can be drawn from the recent debate over agriculture and infrastructure as seen from the literature review, and from the analysis presented in this study, is that rural road transport infrastructure development projects should be appraised in a more holistic way and should consider investments in hard infrastructure (Well Engineered Road Network) to address systemic inefficiencies that decrease the competitiveness of agricultural value chains in the district.

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