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Effect of Rural Feeder Roads on Income Levels among Pineapple Producers in Rwanda

Umutoni Solange[1], Patrick Mulyungi[2], Fredah Wanzala[2], Ntaganira Eric[3], Aimable Nsengiyumva[4]

Abstract: ***Feeder roads play an important role in agricultural development. This aims to evaluate the effects of rural feeder roads on income levels among pineapple producers in Gakenke district, Rwanda. A multi stage sampling techniques were employed. Primary data with help of questionnaire were collected from 178 small holder pineapple growers. Propensity score matching was used estimate the data. The key findings from the study revealed that in 2017B, results showed that the average farm income per season of the farmers was 150,985, 76,318.2 Frws/ha; 68,406Frws/ha and 54,012Frws/ha using NN, KM and RM. In the next season of 2017A, the average treatment on the treated was 107,139 Frws/ha and the mean difference as program impact ranged from 32,473Frws/ha; 24,560 Frws/ha and 10,167Frws/ha. As recommendations, the government of Rwanda, policy makers and legislators need to promote feeder roads to increase income levels.***

Keywords: Rural feeder roads, benefits, Propensity score matching, Gakenke district Rwanda.

I. BACKGROUND INFORMATION

Agriculture has a big part boosting the economies of developing countries where their economies are agriculture depending and is the main source of rural income (Tunde & Adeniyi, 2012).However agricultural development has various factor stimulators, among them the infrastructure is a motor by that the sustainable infrastructure contributes to the increase of output per capita and output per unit of land through the reduction of transaction cost in input, providing easy access of the products to the market and networking within the sub region (Gajigo & Lukoma, 2011). Approximately one billion people (40%) of the rural population served by the International Development Association (IDA), the World Bank's fund for the world's poorest countries, lack reliable access to the road network. As a result, rural road investment is a significant component of government and aid agency budgets.

The World Bank alone spends US$ 1 billion per year on rural roads; this excludes expenditure on main and secondary roads (Mu & Van de Walle, 2007).Roads lead the farmers to the input markets and products markets, the inadequacy of roads and transportation limit the margins of farmers by the high cost of input and the late access of product market (Gajigo & Lukoma, 2011).The high transportation cost may cause the price inequality of traded agricultural commodities from the shortages in some regions and surpluses in others within the same areas but separated by short distances(Gajigo & Lukoma, 2011).In Sub-Saharan Africa very strong impetus has recently been given to infrastructure investments. For the period 2008-2010, the Chinese EXIM bank committed around $20 billion in infrastructure for financing railway rehabilitation in Nigeria, Angola as well as building dams in Ethiopia for instance. The African Development Bank spent over $5 billion in the next three years, of which over 60% in infrastructure (mainly roads, energy and water). The World Bank committed in 2009 more than $7 bn in Sub-Saharan Africa (with almost $1.5 billion in roads). Despite the investments rural accessibility remains a major challenge in developing countries. It is widely recognized that improved rural roads have a positive impact on rural inhabitants. Such improvements are expected to enhance their ability to access social services, markets and jobs, and therefore contribute to improving their living standards (Khandker et al., 2009).

In Rwanda agriculture therefore remains at the center of strategies to reduce poverty and improve food security and nutrition, but, poor physical infrastructure – exacerbated by hilly and mountainous topography remains a major constraint for smallholder farmers to increasing their access to markets, enhancing their competitiveness and improving their incomes and livelihoods. As a result of isolation coupled with deficient all-season connectivity, high transport costs, farmers have difficulties in sourcing and transporting inputs such as seeds and fertilizers, and marketing their products. This has maintained and perpetuated the subsistence trait of the agricultural farming in Rwanda. In the fiscal year 2012 – 2013, the GoR in partnership with development partners (DPs) have committed to invest in feeder roads development programs with the aim to enhance farmers' access to markets, attracting competitive prices and increased incomes through improvements of rural infrastructure.

Despite that current feeder roads programs have made progress to ease access to markets and increase off-farm employment among others, challenges regarding to seizing market and businesses opportunities that are created by feeder roads for smallholder farmers, institutional organization of the sector, financial and human resources capacity to continue sustaining the construction, rehabilitation and maintenance the feeder roads remain present and alive. It is through this background that this study is initiated to investigate

social economic of feeder roads on agriculture production and will address the issues that surround the feeder roads subsector and provide guiding principles for GoR, DPs and the many stakeholders to create an enabling environment for great impact of the feeder roads (Rumonge, 2017).Lack of access to rural transport maintains the subsistence trait of the agricultural farming (Rumonge, 2017). Despite of the massive investments in rural feeder roads, studies indicate efforts in construction of feeder roads that did not provide the promised results still there is high price of agriculture products and market access is still problem (Beuran, Gachassin, & Raballand, 2015).The suggested ineluctability of the effects of feeder roads on income of pineaple producers thus has to be questioned and is investigated in this study using Rwandan example.

II. METHODOLOGY

A. Research Design

The study adopted a cross sectional and descriptive research design. Mixed methods approach in an attempt to in Rwanda was also be used. The mixed methods approach engrossed the use of both quantitative and qualitative methods for the purpose of achieving and increasing the reliability of the results.

B. Study Area

The study was done in the Northern Province of Rwanda in Gakenke district. The Northern Province is with the high altitude, the most populous and the least densely populated of Rwanda's five provinces. The district was preferred in this study because it is first district which has been introduced in, rural feeder roads.

C. Target Population

According to Igbeneghu and Popoola (2011),a population is the mass of units of analysis (e.g. respondents) about which, the researcher measured his or her variables. Population means all the elements in a well-defined set of values. To evaluate the effects of rural feeder roads on agricultural transaction costs of pineapple production in Rwanda out of 650 farmers only 178 farmers was selected.

D. Sampling Techniques

A sample is a group in a research study on which information is obtained. The sample is always smaller than the population; this is because the researcher can rarely have time to access all members of the population. Sampling therefore refers to the process of selecting individuals in the sample. Sampling is necessary because population interest is large, diverse and scattered over a large geographic area. Proportionate sampling was employed to sample respondents; the sample size of each stratum was proportionate to the population size of the stratum as the two cooperative differ in number of pineapple farmers. Cluster sampling was used to sample respondents as the respondents live in different sectors. Finally simple random sampling was used to select respondents. This means every member in the cooperative was picked randomly.

E. Research Instruments

The study used questionnaires as the main instrument for data collection. However, he also made use of direct interviews especially to the small holder farmers. The list of questions given to respondents to answer on their own.There area advantages associated with the use of questionnaires as tools of data collection. They are a quick method of collecting data, plenty of data can be collected, it is a cheaper method of collecting data and very economical in terms of time (Silvertown, 2009).The person was expected to respond to the question by not filling it. Moreover, the questionnaires are useful for literate people whereby some of them may be given to illiterate and some questions may not bean answered and gaps may be left.

F. Data Analysis

The data was exported to SPSS version 16 and STATA version 13, for analysis. The data analysis incorporated both descriptive and econometric analysis. Propensity score matching was used to estimate the social economic benefits of rural feeder roads.

G. Theoretical Model

Propensity Score Matching (PSM) Method was used to estimate the effects of rural feeder roads on agricultural transaction costs of pineapple production for those who easily access feeder roads against those who do not that is access is 1 and non-access is 0. According to Caliendo and Kopeinig (2008),estimation of the propensity scores, choosing a matching algorism, checking on common support condition and testing the matching quality are step in implementing PSM. Imposing a common support condition ensures that any combination of characteristics observed in the treatment group can also be observed among the control group

(Arpino & Mealli, 2011).The common support region is the area which contains the minimum and maximum propensity scores of treatment and control group households, respectively. For any terracing household, there should be control household with closest propensity score as the match. To accomplish the match, the nearest neighbor (equal weights version) will be tested.

The nearest neighbor method simply identifies for each household the closest twin in the opposite technology access status. Caliper matching which means that an individual from the comparison (non-participant) group was also be tested as a matching partner for a treated individual that lies within a given caliper (propensity score range) and is closest in terms of propensity score.

Kernel matching estimators was also be tested. This is matching method whereby all treated units are matched with a weighted average of all controls with weights which are inversely proportional to the distance between the propensity scores of treated and controls Becker and (Herryman, 2010).It then computes an estimate of the effect as the average difference in households‟ outcome variable between each pair of matched households. The effect of rural feeder roads for an individual *i*, noted δi, is defined as the difference between the potential outcome in case of rural feeder roads and the potential outcome in absence using PSM.

$$\delta i = Y1i - Y0i \quad (1)$$

In general, an evaluation seeks to estimate the mean effect of the rural feeder roads is averaging the impact across all the individuals in the population. This parameter is known as Average Treatment Effect or ATE:

$$ATE = E(\delta) = E(Y1 - Y0) \quad (2)$$

Where *E* represents the average (or expected value) and another quantity of interest is the Average Treatment Effect on the Treated or ATT, which measures the effect of the treatment on those individuals who access feeder roads:

$$ATT = E(Y1 - Y0 \mid D = 1) \quad (3)$$

Finally, the Average Treatment Effect on the Untreated (ATU) measures the effect that the treatment would have had on those who did not feeder roads:

$$ATU = E(Y1 - Y0 \mid D = 0) \quad (4)$$

The problem is that, not all of these parameters are observable, since they depend on counterfactual outcomes. For instance, using the fact that the average of a difference is the difference of the averages, the ATT can be rewritten as:

$$ATT = E(Y1 \mid D = 1) - E(Y0 \mid D = 1) \quad (6)$$

The second term, $E(Y0 \mid D = 1)$ is the average outcome that the treated individuals would have obtained in absence of treatment, which is not observed. However, we do observe the term $E(Y0 \mid D = 0)$ that is, the value of *Y0* for the untreated individuals and $ATT = E(Y1 \mid D = 1) - E(Y0 \mid D = 0)$.

III. RESULTS AND DISCUSSION

Table 1 showed income from pineapple production for small holder farmers in the study area by feeder roads accessibility project. The factors involved in pineapple production such production and price were holding constant; only the researcher emphasized on sales revenues from pineapple sales between two consecutive farming seasons of 2017A& B for both accessors and non accessors of feeder roads by comparing revenues as outcomes and the outcomes variables were compared from 2017A and 2017B.

Table 1 detailed the farm revenues from the investment on pineapple production project. In all two farming season of 2017B and 2017A, results showed that the average farm income per hectare of the farmers was 150,985Frws/ha and the mean difference as program impact was 76,318.2 Frws/ha; 68,405.9 Frws/ha and 54,012.4 Frws/ha using NN, KM and RM matching logarithms and all estimates were statistically significant by 3.31*; 3.11* and 2.55* at 5% percentage level of significance. In the next season of 2017A, the average treatment on the treated was 107,139 Frws/ha and the mean difference as program impact ranged from 32,473Frws/ha; 24,560 Frws/ha and 10,167Frws/ha respectively and all estimates were statistically significant by t- values of 2.66*; 2.34* and 2.29* respectively at 5% percentage of significant. The higher gross farm margin is a results of joint action of pineapple producers and key value chain actors and their collection centres which reduce local traders to buy their produce at unpredicted price and other subsidies to farmer groups and these findings conflict with the findings of (Kaguongo et al., 2008), that high cost of seeds, fertilizer and labor are the major challenges in pineapple production industry in most developing African countries.

These findings also are consistent with the findings of Baruwa (2013)who reported that 75% of pineapple farmers in Edo State attributed their main purpose of pineapple production to profit making. Moreover,Ofuoku, Olele, and Emah (2008)reported that pineapple production using crown and sucker production techniques were privately (N550,438/ha and N679,138/ha) and socially (N730,228/ha and N841,828/ha)profitable in Osun state with sucker production technique having a higher competitiveness withEffiong (2005) and Itam, Ajah, and Agbachom (2014)also reporting the profitability pineapple production with gross margin of N182,725.00 and net profits of N162,045.00 in Osun state, Nigeria.

Table 1: Income levels based on ATT propensity score matching

Matching Logarithms	Seasons	Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Effect of feeder roads access on total sales revenues								
NNM	2017B	Household Income levels	Unmatched	150,984.8	120,913.0	30,071.8	26,650.4	1.13
			ATT	150,984.8	74,666.7	76,318.2	23,065.2	3.31*
	2017A		Unmatched	107,139.4	100,913.0	6,226.4	16,919.2	0.37
			ATT	107,139.4	74,666.7	32,472.7	19,586.6	2.66*
KM	2017B		Unmatched	150,984.8	120,913.0	30,071.8	26,650.4	1.13
			ATT	150,984.8	82,579.0	68,405.9	21,962.3	3.11*
	2017A		Unmatched	107,139.4	100,913.0	6,226.4	16,919.2	0.37
			ATT	107,139.4	82,579.0	24,560.4	18,275.0	2.34*
RM	2017B		Unmatched	150,984.8	120,913.0	30,071.8	26,650.4	1.13
			ATT	150,984.8	96,972.5	54,012.4	21,210.0	2.55*
	2017A		Unmatched	107,139.4	100,913.0	6,226.4	16,919.2	0.37
			ATT	107,139.4	96,972.5	10,166.9	17,363.6	2.29*

A. Densities of the Estimated Propensity Score Over Treatment And Control

Figure 2, presents the results of the covariate balancing test to verify the hypothesis that both groups have the same distribution in covariates after matching. It presents the covariates' means, their t-test of differences in means as well as the percentage bias before and after matching, for all covariates, the matched sample means are not well distributed and are not similar for both the treatment and the control. This is an indication that there are untreated located at off support region of the region.

The graph shows that some untreated individuals are out off support the region indicating that all the treated in pineapple production spent more and this reduced by consequent the expected on farm income as expected. In addition to this there is no appropriate match among the acessors and non acessors with the feeder roads accessibility hence unbalanced of all the treated and the untreated individuals were found within the same region of common support indicating that also all treated individuals have not received the associated untreated individuals for all covariates estimates (cost investment, yield and revenues). This shows that the whole assumption of common support was not satisfied (Becker, Bentolila, Fernandes, & Ichino, 2010).

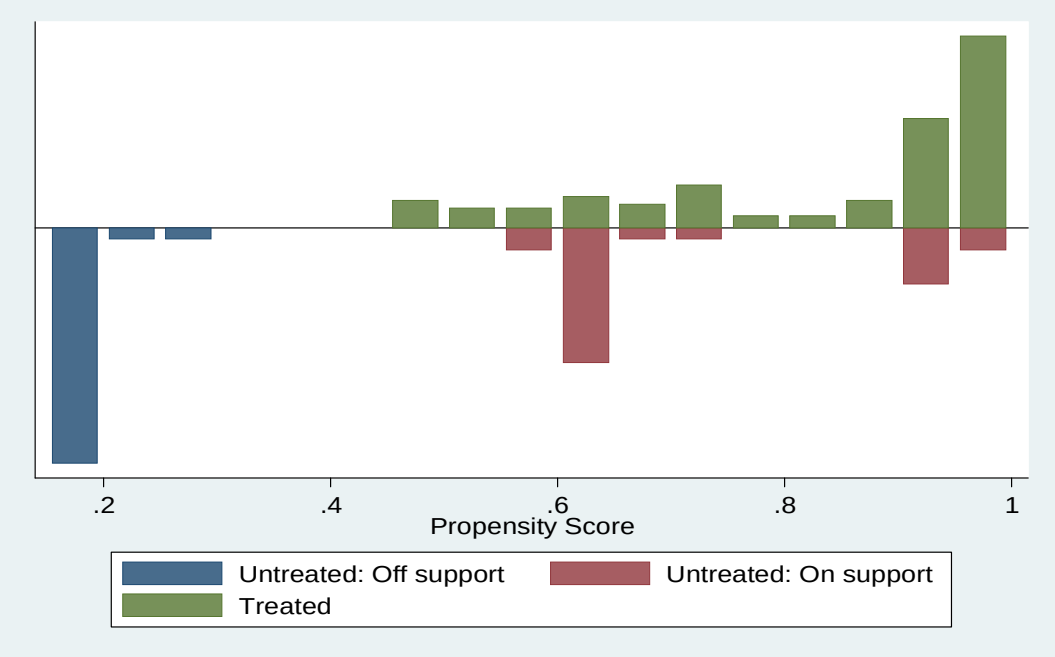

Figure 1: Propensity score of treated and control after matching

IV. RECOMMENDATIONS

The government of Rwanda through the Ministry of Agriculture and Animal Resources with other stakeholders like PASP project should invest in feeder roads construction and rehabilitation to reduce the associated transactional costs that may be increased due to uncouthness of rural roads and may it favorable to farmers for footpath between a village and the road by a bicycle, motorbike, and vehicle track

This study also recommends massively to the government to invest on road infrastructure. Access to roads has a decisive impact on the likelihood of poverty among rural households. In line with the empirical evidence we found, roads are imperative for poverty reduction and consumption growth in rural areas.

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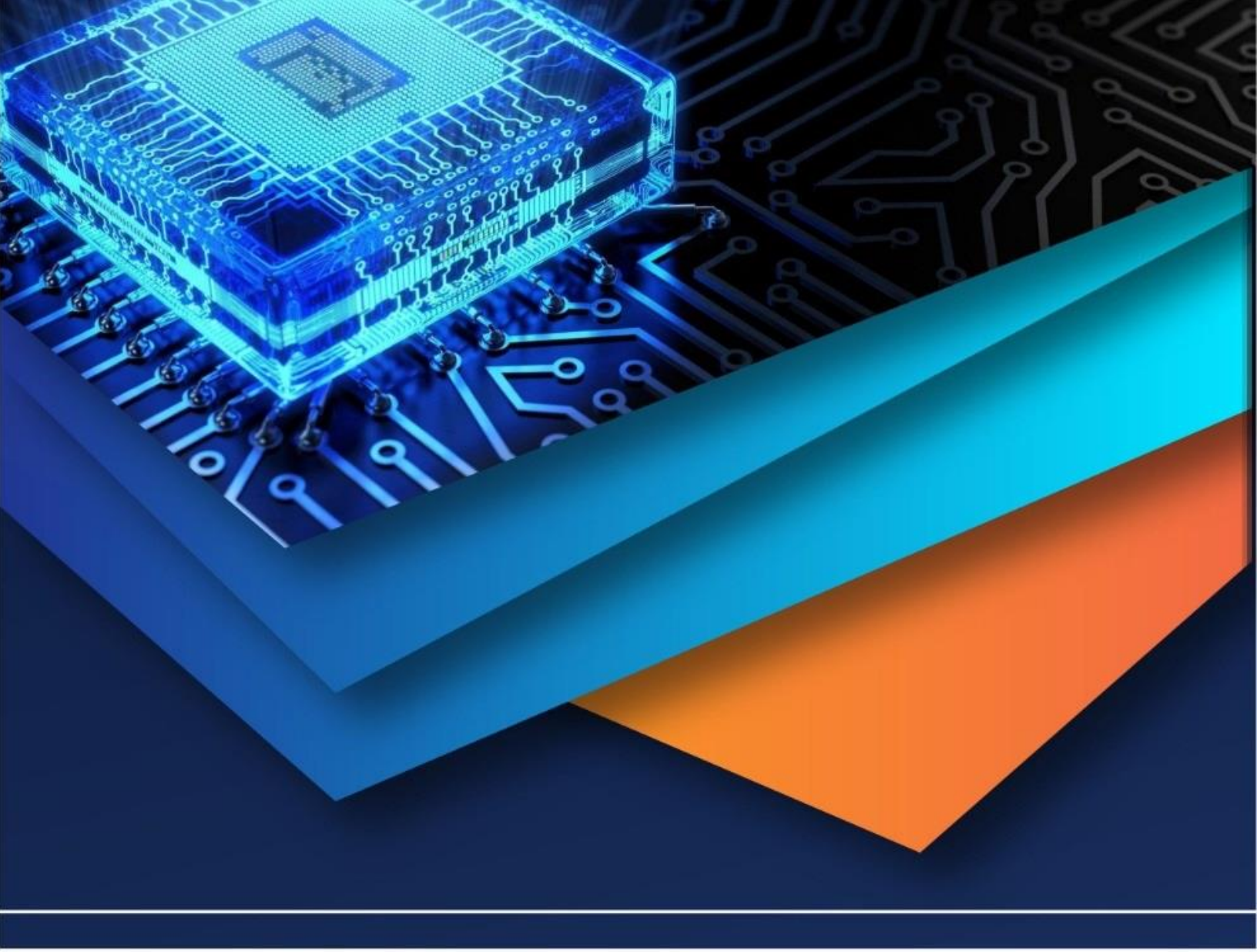
- ✓ Mutoni Solange[1] “First Author”, is a Postgraduate student finishing her MSc studies in Jomo Kenyatta University of Agriculture and Technology.
- ✓ Patrick Mulyungi[2] (PhD), is the Senior Lecturer at Jomo Kenyata University of Agriculture and Technology.
- ✓ Fredah Wanzala[2] (PhD), is the Senior Lecturer at JKUAT
- ✓ Ntaganira Eric[3], is MSc holder in Agriculture and Applied Economics from JKUAT, the former Assistant Lecturer at JKUAT, Ki-gali Cumpus, a consultat in Agricultue Sector.
- ✓ Aimable Nsengiyumva[4], is MSc holder in Agriculture and Applied Economics from JKUAT, the former Assistant Lecturer at JKUAT, Kigali Cumpus, He is now the Secretary to the Scientific Committee of Rwanda Agriculture Board.



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