Impact Of Improved Rural Roads On Agricultural Production In Rwanda'S Rural Maize Farming Cooperatives: Evidence From Three Maize Farming Cooperatives In Kirehe District.

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Abstract: The aim of the present study was to examine the impact of improved rural roads on agricultural production in Rwanda's rural maize farming cooperatives: evidence from three maize farming cooperatives in Kirehe district. The specific objectives of the study were: to examine the impact of improved rural roads on crop intensification in maize production; to evaluate the impact of improved rural roads on level of maize output and; and to assess the impact of improved rural roads on maize markets access and participation. The research design that was used in this study was Descriptive Research Design. The researcher attempted to describe and explain conditions of improved rural roads on agricultural production using questionnaires to fully describe the impact on agriculture inputs use, level of maize production and maize market access and participation. Simple Random Sampling technique was used to get 67 respondents randomly selected from three maize farming cooperatives located at various distance intervals from Kigali-Rusumo main road in Gatore sector (Cyunuzi center) rural wards to 35 kilometers far through Cyunuzi center to Remera village in Gahara Sector and to Musaza Sector. The researcher constructed time-distance variable to the inputs supplier and to the nearest big markets in Kirehe District (Kirehe market) as measurements of road accessibility. The data that were used covered the period of time in 2014 season A. The researcher used the multiple regression and correlation models to fully explain the relationship. The data collected from the field were coded then presented in forms of frequencies, tables and charts through the statistical package for social sciences (SPSS version 6.0) and MS-Excel. The findings from this analysis showed that the R^2 is 0.248 (24.8%) which showed that the variables contributes to the market access and participation at 24.8%, this means that the factor of markets access and participation count only 24.8 percent and the remaining depend on other factors. From the ANOVA table with F-test statistic of 6.880248 with p-value of 1.06E-05, since the p-value is less than 0.05 (p-value <0.05), the researcher could accept the null hypothesis hence there is no significance impact of improved roads on markets access and participations for maize farmers at 0.05 level of significance and 95% of confidence interval. In other words being adjacent to rural roads does not guarantee to market participation, the results are in relation to the determined points of disposing the maize produce mentioned above whereby farmers sell most of their maize produce mostly to cooperatives 41(61.19%), to the traders in local markets 15(22.39%) to mobile traders10 (14.93) and to neighbors 1 (1.49%), this make them not find the necessity of participating to the nearby big markets for selling maize produces.

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1. Introduction

Rwanda is dependent on its road transport system for the economical development of the country. All the major towns are connected by the road network. Rwanda is also well connected by the road transport system with the neighboring countries of Uganda, Tanzania, Burundi and the Democratic Republic of Congo. The road system plays a very important role in the import and export business of the country. Roads in Rwanda are classified into national, districts and gravels. Classified roads constitute about 34% of the entire road network in Rwanda. These can be summarized as: national road (2860 kilometers), district roads (1835 kilometers), and gravel roads (3.5 kilometers). The commitment of the government on roads in terms of budgetary provisions for financial year 2012/2013 on the road system was 132,746,924,294 Frw. The road transport in Rwanda has greatly improved through rehabilitation and upgrading of various roads which has resulted in faster economic development of the country. Rwanda has a total road network of 14,008 kilometers broken down as follows: Paved Roads 2,662 kilometers, Unpaved 11,346 kilometers (Fortune of Africa, 2015).

2. Statement of Problem

Rwanda has adopted a number of strategies that have to do with infrastructural development in rural communities as well as in urban areas. The

government targets rural communities in providing functional rural roads in order to improve the socioeconomic conditions of rural communities. The prime objective of the government is to contribute to economic growth and to the government's poverty-reduction strategy through improving and maintenance of road infrastructure.

Many rural areas in the country are becoming increasingly accessible to feeder roads hence it is expected that farm inputs usage, level of agriculture outputs and produces market participation are bound to increase with respect to increased rural feeder roads. Hitherto few if any research has been done in Rwanda to show the impact of these improving rural roads on targeted farmers' livelihoods. It is for this reason the study on the impact of improved rural roads on agricultural production in Rwanda's rural maize farming cooperatives: evidence from three maize farming cooperatives in Kirehe District.

3. Objectives of the Study

The global objective of the present study was to examine the impact of improved rural roads on agricultural production in Rwanda's rural maize farming cooperatives: evidence from three maize farming cooperatives in Kirehe District.

3.1 Specific objectives of the Study

i. To examine the impact of improved rural roads on crop intensification in maize production;

ii. To evaluate the impact of improved rural roads on levels of maize output and;

iii. To assess the impact of improved rural roads on maize markets access and participation.

3.2 Hypothesis

Ho: There is no significant difference in crop intensification, maize output and markets access and participation between maize farmers of most accessible and those of remote areas of Kirehe District.

H_1: There is a significant difference in crop intensification, maize output and markets access and participation between maize farmers of most accessible and remote areas of Kirehe District.

4 Research methodology

4.1 Research Design

In this study, the researcher surveyed 67 maize farmers from three cooperatives COAIGA, COOPAGA and COACIMU. A multi-stage questionnaire was used to collect primary data either qualitative or quantitative data on these aspects of livelihoods of the farming communities of Kirehe District. Secondary data were obtained from the internet search, published books and journals, articles and records from Ministry of Agriculture and Animal Resources (MINAGRI) as well as from the report of KWAMP, and cooperatives authorities.

4.2 Target population

This study targeted three maize farming cooperatives of Kirehe district in the eastern province of Rwanda particularly COOPAGA, COAIGA and COACMU maize farming cooperatives because all of them pertained to same area of our interest.

4.3 Sampling size and technique

The sample size was determined by using the following formula .

$$n = \frac{z^2 \times p \times q \times N}{d^2 (N - 1) + z^2 \times p \times q}$$

Sample size for study is 67

The research used Stratified sampling techniques to determine the sample size in each of three cooperatives found along Cyunuzi-Musaza-Gahara feeder road.

5 Data Collection Instruments

Data was collected using different instruments. Hence the use of:-

a) Primary source.

Primary data were collected from respondents through issuing of questionnaires. Respondents were guided by the researcher to understand the questions whereby they delivered the required information.

b) Secondary source

During the process of documentary analysis, the researcher reviewed some documents relevant to the study topic. The researcher red documents such as reports, journals, newspapers and other publications to get secondary data related to improved roads on community livelihoods worldwide as well as for Rwanda where the current study is taking place. Libraries and internet sources were visited also to get huge information.

5.1 Data Management and Analysis

Statistical package for social science (SPSS 16.0) and MS-Excel were used to analyze the relationship between improved rural roads on agricultural inputs use (fertilizers and improved seeds), level of maize outputs and maize markets access and participation. Descriptive statistical and quantitative methods were used to discuss the data analysed. The descriptive statistics used were frequency distribution, mean, figures and tables. The quantitative methods employed were the regression analysis, analysis of variance (ANOVA) and Pearson correlation. The F-test was used to test for the statistical significance of the variables. The multiple linear regression models were applied to do the analysis and findings were presented for R Square, ANOVA and coefficients.

6. Results And Interpretation

6.1. Assessment of inputs use in maize production in the study area

6.1.1 Assessment of fertilizer application in maize production in the study area

Table 1: Fertilizers usage by maize farmers in the study area

Inputs usage	Frequency	Percent
Organic fertilizer only	6	9
Organic and inorganic fertilizers	50	74.6
Non user of fertilizers	11	16.4
Total	67	100

Source: Field data, 2015

The results from the field study revealed that the farmers who applied the organic and inorganic/chemical fertilizers are represented by 50(74.6%) of all sampled maize farmers and the remaining applied organic fertilizers only as reported by 6(9%) of all sampled farmers. No any farmer who applied only the inorganic fertilizers. Lastly 11 (16.4%) respondents did not apply any fertilizer.

6.1.2 Assessment for improved seeds usage in the study area

Respondents were also asked whether they use improved seeds in their maize farming. The quantities of seeds used also were provided by the respondents. The results from the field study are shown by the following table:

Table 2: Distribution of maize farmers who used improved seeds and the quantities utilized

Used improved seeds	Frequency	Percent
Yes	50	74.6
No	17	25.4
Total	67	100

Source: Field data, 2015

As illustrated on the above table, it is evident that the maize farmers who used the improved seeds (the hybrid seeds) are 50(74.6%) and those who did not use the improved seeds due to various circumstances and used local seeds are represented by 17(25.4%) of all respondents.

6.1.3. Summary for the inputs usage in the study area

The following table pertained to inputs use in sampled maize farming cooperatives and the findings are discussed according to the mean value for each type.

Table 3: Descriptive statistics of the general situation of quantities of inputs use in the study area

Variables	Unit of measurement	Mean	Max	Min
Farm inputs for maize farming				
Inorganic fertilizers	Tons/ ha	0.0870	0.7500	0.0000
organic fertilizers	Tons/ ha	5.7224	50.0000	0.0000
improved seeds	Tons/ ha	0.0146	0.1250	0.0000
Labor	Man-days	7.1950	48.5156	0.5822
Land	Ha	0.6625	5.0000	0.0600

Source: Field data, 2015

When looking on the quantities on inputs used in maize farming in the area of the study, the mean value of inorganic fertilizer used were 0.0870 Tons per hectare (87Kg/ha); quantity of organic fertilizer were 5.7224 tons per hectare (5722.4Kg/ ha), the quantity of improved seeds used were 0.0146 tons per hectare (14.6 Kg/ ha). In this case also, the mean value of labors used in maize farming for each household was 7.1950 man-days and then the mean value of land cultivated by household was 0.6625 hectare of land.

6.2. Assessment of the impact of the improved rural road

6.2.1. Impact of improved rural roads on fertilizers intensification

To investigate the impact of being adjacent to improved roads and residents in remote areas against fertilizers usage, the researcher used the data collected from different localities from most accessible area to the remote areas. In this study, the researcher used Multiple Linear Regression Model in which (Y_i, X_1) come from a random sample. The observations (Y_i, X_1) regression equation now can be explained in the following form:

$$Y = f(Chemical\ fertilizer, organic\ fertilizer\ and\ Seeds)$$

The developed regression model, according to the author of this research, could be written as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

Where:

Y= Distance from the main road

β_0 = A constant

$\beta_1, \beta_2, \beta_3$ are coefficients

X1=Quantity of inorganic

X2=Quantity of organic

X3=Quantity of seeds

In this study the fertilizer usage are expected to decrease with distance from main road taking other factors constant (Ceteris Paribas). The findings from analysis of multiple linear regression model are summarized in the following tables:

Table 4: Test statistics of impact of improved road on fertilizer intensification in the study area

SNo	1	2	3	4
Test statistics	Multiple R	R Square	Adjusted R Squared	Standard Error
Results	0.245816	0.060426	0.015684	5.939667
Observation	67			

Source: Field data, 2015

Table 5: Analysis of variance on the impact of improved rural road on inputs use

ANOVA					
	Df	***SS***	***MS***	***F***	***Significance F***
Regression	3	142.2902	47.64673	1.350545	0.266095
Residual	63	2222.617	35.27964		
Total	66	2365.558			

Source: Field data, 2015

Table 6: Regression analysis on the impact of improved rod on inputs use

	Coefficients	***Standard Error***	***t Stat***	***P-value***
Intercept	27.71812	0.954659	29.03459	3.51E-38
X (Chemical)	5.605622	24.01638	0.233408	0.816201
X (Organic)	-0.81173	0.405161	-2.00348	0.049431
X (Seeds)	270.109	194.5265	1.388546	0.169861

Source: field data, 2015.

According to the research hypothesis,

Ho: There is no significant difference between the inputs use, level of maize output and markets access and participation between maize farmers of most accessible areas and those of remote areas of Kirehe District.

H_1: There is a significant difference in inputs use, level of maize output and markets access and participation between maize farmers of most accessible areas and those of remote areas of Kirehe District.

To prove these, the researcher set up the level of significance α=5%(0.05) and confidence interval of 95% for all variables as the condition for test to be applied which is the multiple linear regression model and some formula used for test statistics For the F-statistic of 1.350545, significance F-value of 0.26>0.05 of level of significance, the researcher could not reject null hypothesis and emphasize that, there is no significant difference in agriculture inputs usage between improved rural roads area and the remote area of the area of study. The regression model developed by the researcher can be expended as:

$$Y = 27.71812 + 5.605622X_1 - 0.81173X_2 + 270.109X_3$$

(3.51E-38) (0.816201) (0.049431) (0.169861)

This means the Y-intercept is positive (approaching zero) and the relationship between improved road to chemical fertilizer and seeds is positive while the relationship for improved road and organic manure is negative. As road quality drops, organic manure goes up, but road quality goes up with chemical fertilizer and seeds. The impact of improved road on organic manure is significant (0.04<0.05), for other inputs (chemical and seeds) are not significant (0.81> 0.05 and 0.16 >0.05). The t-statistics values for each βi in the developed regression model is large enough in magnitude to reject the null hypothesis that each βi = 0.

6.2.2 Assessment for the impact of mean distance to the inputs supplier

When mean distance to the inputs suppliers was computed to the quantities of inputs the results were as follows.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

Where:

Y= Mean distance to the inputs supplier

β_0 = A constant

$\beta_1, \beta_2, \beta_3$ are coefficients

X1=Quantity of inorganic

X2=Quantity of organic

X3=Quantity of seeds

Table 7: Test statistic for the mean distance to input supplier and usage

SNo	1	2	3	4
Test statistics	Multiple R	R Square	Adjusted R Squared	Standard Error
Results	0.384022	0.147473	0.106876	1.561957
Observation	67			

Source: Field data, 2015

Table 8: Analysis of variance on the mean distance to the input supplier and usage

ANOVA					
	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	26.5878	8.862601	3.632645	0.017494
Residual	63	153.7017	2.43971		
Total	66	180.2896			

Source: Field data, 2015

Table 9: Regression statistics for mean distance to the inputs supplier and usage

Regression Statistics				
	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	2.26416	0.251047	9.018866	6.01E-13
X1 (Chemical fertilizer)	-16.5823	6.315601	-2.62562	0.010843
X2 (Organic fertilizer)	0.069439	0.106545	0.651732	0.516945
X3(Improved seeds)	50.62389	51.15474	0.989623	0.326144

Y= Mean distance to the inputs supplier
X1=Quantity of chemical fertilizer
X2=Quantity of organic fertilizer
X3=Quantity of improved seeds

From the above findings, when the mean distance was computed to quantities of inputs used, the findings show that the R Square now increased to 14.75% implying that the impact of lowering the distance to the inputs supplier contributed on inputs usage at only 14.75%, other factors were responsible for the remaining portion. However when we look the F-statistic, it increased from 1.350545 to 3.632645, and now the significance F-value shifted from 0.26>0.05 of level of significance to 0.017<0.05 implying that the Null hypothesis is now rejected and we adopt the Alternative one though the distance is contributing very little to the inputs usage. The hypotheses confirm that, there is a significant difference in agriculture inputs usage between distant and accessible maize farmers of the area of study. The regression model developed by the researcher can be expended as:

$$Y = 2.26416 - 16.5823X_1 + 0.069439X_2 + 50.62389X_3$$

(6.01E-13) (0.010843) (0.516945) (0.326144)

This means the Y-intercept is positive and the relationship between mean distance to chemical fertilizer is negative and significant (0.01<0.05) it means as mean distance drops the usage of chemical fertilizer goes up. For organic fertilizer and seeds the relationship is positive but not significant (0.5>0.05, 0.3>0.05 respectively) when the mean distance goes up the usage of seeds and manure goes up as well. Basing of these findings the researcher can highlight the intervention of other factors in promoting fertilizer intensification other than improving road quality like the existence of the inputs supplier in the villages due to cooperatives policy of the government.

6.2.3 Impact of improved rural roads on cost of agricultural inputs in the study area

To evaluate the impact of improved rural roads on cost of inputs used in maize farming in the study area, the researcher also served the simple linear regression model as discussed in the previous paragraph, and it can be written as:

$$Y = \rho_0 + \rho_1 X_1 + \rho_2 X_2 + \rho_3 X_3 + \rho_4 X_4$$

Where:
Y = distance variation,
ρ0= a constant,
$\rho_1, \rho_2, \rho_3, \rho_4 \ldots \rho_n$ are the slopes of the functions,
X_1, X_2, X_3, X_4 are variables involved in the regression model
X_1 = Cost of inorganic fertilizers,
X_2 = Cost of organic manure,
X_3 = Cost of improved seeds,
X_4 = Cost of labor.

Table 10: Test statistics of impact of roads on cost of inputs use

SNo	**1**	**2**	**3**	**4**
Test statistics	Multiple R	R Square	Adjusted R Squared	Standard Error
Results	0.1740	0.0303	-0.0323	6.0827
Observation	67			

Source: Field data, 2015

Table 11: Analysis of variance on the impact of improved roads on cost of inputs

ANOVA					
	Df	***SS***	***MS***	***F***	***Significance F***
Regression	4	71.6007	17.9002	0.4838	0.7475
Residual	62	2293.9570	36.9993		
Total	66	2365.5576			

Source: Field data, 2015

Table 12: Regression equation on the impact of improved roads on cost of input use

	Coefficients	***Standard Error***	***t Stat***	***P-value***
Intercept	28.9253	1.5082	19.1781	0.0000
X1:Cost of Inorganic	-0.0001	0.0001	-0.9588	0.3414
X2: Cost of Organic	0.0000	0.0000	0.7149	0.4774
X 3: Cost Seeds	0.0000	0.0000	1.0790	0.2848
X 4: Cost of Labors	-0.0001	0.0002	-0.6293	0.5314

Source: field data, 2015

The null hypothesis stated that there is no significance difference in inputs use, maize output and markets participation between maize farmers of most accessible areas and remote areas of Kirehe District. In this theme the researcher is focused on the statistical evidence on the impact of improved rural roads on cost of input use. The researcher used test statistic to see if the data observed are in agreement with the model. To prove the null hypothesis, the researcher used the level of significance α: equal to 5% or 0.05 and the confidence interval of 95%. The findings from the analysis could be widely explained by the following model:

$$Y = 28.9253 - 0.0001X_1 + 0.0000X_2 + 0.0000X_3 - 0.0001X_4$$

(0.0000) (0.3414) (0.4774) (0.2848) (0.5314)

The R^2 (R square) for the developed equation is 0.0303 or 3.03%, this mean that the impact of improved roads on cost of inputs use within the area of study is explained by only 3.03 % other part is explained by other factors. From the ANOVA table the F-test statistic is 0.4838 with p-value of 0.7475. Since the p-value is greater than 0.05, the researcher nullify the hypothesis that the regression parameters are zero at significance level 0.05. Thus the impact of improved roads on cost of inputs use in maize farming in the area of study is not significant.

6.2.4 Assessment of impact of roads using mean distance to the inputs supplier and cost of inputs

To test the impact of improving accessibility to inputs supply the researcher was interested in the mean distance to the inputs supplier; the researcher developed the model to explain the relationship to be as follows: $Y = \rho_0 + \rho_1 X_1 + \rho_2 X_2 + \rho_3 X_3$

Where:

Y = Mean distance to inputs supplier variation,

ρ0= a constant,

ρ_1, ρ_2, ρ_3, ρ_4..... ρ_n are the slopes of the functions,

X_1, X_2, X_3, are variables involved in the regression model

X_1 = Cost of inorganic fertilizers,

X_2 = Cost of organic manure,

X_3 = Cost of improved seeds,

The findings are represented in tables 4.24, 4.25, and 4.25 below.

Table 13: Test statistics of impact of roads on cost of inputs use basing on mean distance to the inputs supplier

SNo	**1**	**2**	**3**	**4**
Test statistics	Multiple R	R Square	Adjusted R Squared	Standard Error
Results	0.642015	0.412183	0.384191	1.296989
Observation	67			

Source: Field data, 2015

Table 14: Analysis of variance on the impact of improved roads on cost of inputs for the mean distance of inputs supplier

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	74.31223	24.77074	14.72539	2.26E-07
Residual	63	105.9773	1.68218		
Total	66	180.2896			

Source: Field data, 2015

Table 15: Regression equation on the impact of improved roads on cost of input use for mean distance to inputs supplier

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	3.303284	0.265814	12.42707	1.34E-18
X (Chemical fertilizer)	-2.7E-05	9.11E-06	-2.97779	0.004117
X (Organic fertilizer	-9.2E-06	4.82E-06	-1.90039	0.061959
X (Seeds)	4.62E-05	8.3E-06	5.566184	5.72E-07

Source: Field data, 2015

The findings above are showing that improving accessibility to inputs through reducing distance to the farm inputs supplier has resulted in a different figure of relationship where by the R Square is increased to 0.412183, it means now the mean distance to inputs supplier explains the cost of fertilizers and improved seeds at 41.21%.This means that reducing the mean distance to the fertilizers and seeds supplier is somehow a good explainer of the cost of inputs. The Significance level of 2.26E-07 (Significance F <0.05) show that there is significance difference in cost of inputs to maize farmers in accessible areas and those in inaccessible areas.

$$Y = 3.303 - (2.7\text{E}-05)X_1 - (9.2\text{E}-06)X_2 + (4.62\text{E}-05)X_3$$

1.34E-18 0.004117 0.061959 5.72E-07

The difference is significant for the cost of chemical fertilizer and improved seeds but not significant for the organic fertilizer.

6.3 Assessment of level of maize production in the study area

6.3.1 Assessment of the maize production during the year of 2014 in study area

Best yields of maize can be obtained with an application of both inorganic and organic fertilizers in Rwanda. The information below pertained to level of maize output when distances were related to the levels of maize output; the results from the field survey are given on the table below:

As illustrated within the table, there is a small number of farmers who harvest less than 1 ton of maize according to the area cultivated and inputs used as reported by 7(10.4%) of all farmers. Those who harvest between 1-3 tons represent 19(28.3%) and those that are getting above 5 tons per hectare represent 18 (26.9%). The big number of maize farmers harvest between 3-5 tons of maize per hectare 23 (34.3%).

Table 16: Distribution of maize production during the season 2014/2015

Maize production	Frequency	Percent
Less than 1 ton	7	10.4
1-3 tons	19	28.4
3-5 Tons	23	34.3
Above 5 Tons	18	26.9
Total	67	100.0

Source: Field data, 2015

6.4. Impact of improved rural road on level of maize output in the study area

Maize output was indirectly expected to be affected by change in distance. The theory behind this objective is based on the fact that as far as remote area is concerned, maize framer are bound to show poor performance in usage of inputs and therefore not able to get good yield taking other factors constant. Thus our model of maize output is a production function.

$$Y = f(fertilizers, labor, land\ \&\ Seeds)$$

The developed regression model, according to the author of this research, could be written as:

$$Y = \rho_0 + \rho_1 X_1 + \rho_2 X_2 + \rho_3 X_3 + \rho_4 X_4$$

Y = Level of maize output

$X_{1,2,3,4}$ = Variables involved in the model

X_1= Quantity of fertilizers in tons

X_2= Labor in mandays

X_3= Size of the land in hectares

X_4= Quantity of seeds in tons

The findings from the analysis are now shown on the following tables.

Table 17: Descriptive statistics of improved rural roads on level of maize output by improving inputs usage

SNO	**1.0000**	**2.0000**	**3.0000**	**4.0000**
Test statistics	Multiple R	R Square	Adjusted R Squared	Standard Error
Results	0.949	0.901	0.893	1.041
Observation	67.0000			

Source: Field data, 2015

a. Predictors: (Constant), Quantity of improved seeds(Tons), Quantity of labor (Mandays), Quantity of Organic and Chemical fertilizer(Tons), Size of the land (Ha).

b. Dependent Variable: Level of maize output (Tons).

Table 18: ANOVA table of improved roads on level of maize output due to inputs usage

ANOVA					
Source	**Df**	**SS**	**MS**	**F**	**Significance F**
Regression	5.000	601.601	120.320	110.947	0.000
Residual	61.000	66.153	1.084		
Total	66.000	667.754			

Source: Field data, 2015

a. Predictors: (Constant), the quantity of improved seeds used (Tons), Quantity of workers used (Mandays), Quantity of Organic and Inorganic fertilizers (Tons), Size of the land (Ha) of maize in 2014.

b. Dependent Variable: Quantity of maize harvested in 2014/2015(Tons).

Table 19: Regression model on the impact of improved roads on level of maize output by improvement of inputs usage

	Coefficients	**Standard Error**	**t Stat**	**P-value**
Intercept	-0.074	0.205	-0.362	0.719
X 1(Inorganic)	3.287	4.228	0.778	0.440
X 2(Organic)	0.309	0.079	3.906	0.000
X 3 (Seeds)	11.706	44.374	0.264	0.793
X 4 (Labors)	0.043	0.043	1.007	0.318
X 5 (Land)	0.212	1.345	0.158	0.875

Source: Field data, 2015

The results from this analysis showed that the R^2 is 0.901(90.1%) which indicated that there is high correlation between data. The inputs usage explains level of maize output at 90.1%. From the ANOVA table with F-test statistic of 110.947 with p-value of 0.000, since the p-value is less than 0.05 (p-value <0.05), the researcher could reject the null hypothesis and accept the alternate hypothesis, hence the maize output depends with high significance on inputs use such as fertilizers (Inorganic/organic), improved seeds, labor and land size at 0.05 level of significance and 95% of confidence interval. The developed equation can be written as:

D= Distance

$$Y = -0.074 + 3.287X_1 + 0.309X_2 + 11.706X_3 + 0.043X_4 + 0.212X_5$$

This means that as farmers apply more fertilizers, on the big land size, more yield of maize will be obtained.

However the correlation for the level of maize output to distance from the Kigali road towards inaccessible areas was explained using the following model, the findings were obtained as follows:

Maize output = f (Distance from main road)

$Y=\alpha_0+ \alpha_1 D$

Where:

Y=Level of maize output

Table 20: Descriptive statistics of improved rural road on level of maize output

SNO	1.0000	2.0000	3.0000	4.0000
Test statistics	Multiple R	R Square	Adjusted R Squared	Standard Error
Results	0.186082	0.034627	0.019775	3.149193
Observation	67.0000			

a. Predictors: (Constant), Distance from Kigali road in (Km)

b. Dependent Variable: level of maize output (Kg)

Table 21: ANOVA table of improved roads on level of maize output

ANOVA					
	df	**SS**	**MS**	**F**	**Significance F**
Regression	1	23.122	23.122	2.331454	0.131635
Residual	65	644.632	9.917416		
Total	66	667.754			

a. Predictors: (Constant), Distance from Kigali road in (Km)

b. Dependent Variable: level of maize output (Kg)

Table 22: Regression model on the impact of improved roads on level of maize output

	Coefficients	**Standard Error**	**t Stat**	**P-value**
Intercept	5.324069	1.821308	2.923211	0.004763
X Variable 1	-0.09887	0.064749	-1.52691	0.131635

Dependent Variable: Level of maize output

The distance explained level of maize output at only 3.46% and there is no significance difference in maize production for the areas that are accessible and those that are inaccessible in the area of study (R Square = 0.0346, F Significance 0.131635>0.05) hence we can nullify the hypothesis and reject the Alternative one saying that there is no significance difference in maize production between areas more accessible and those remote in our area of the study. Further the model can be explained as follows:

Y=5.324069 - 0.09887D. This means that the distance is explaining weakly the maize output in the area of the study.

6.5. Assessment of maize market access and participation

6.5.1. The assessment of the impact of improved roads on markets access and participation.

This theme is primarily focused on the market access and participation behavior of small-scale maize farmers in the study area. It attempts to determine the factors influencing the decision of the farmers / farming households to participate in the market.

6.5.2 Respondents access and participation in the markets during the season 2014/15

Findings in the following table indicate sample statistical descriptive on markets access and participation and it summarizes that, controlling for differences in market access and the underlying determinants of market participation, households nearby the main roads (Kigali- Rusumo) with higher productivity are expected to have greater participation in agricultural markets. Combining distance, number of trips and time taken to the nearby big market from the maize farmers surveyed in this way offers a promising approach to testing the hypotheses across the study area.

This hypothesis can be proved by regression model below.

$$Y = f(Distance\ to\ the\ market, Cost\ of\ transportation, Time\ to\ the\ market)\ .$$

$Y = \rho_0 + \rho_1 X_1 + \rho_2 X_2 + \rho_3 X_3$

$X_1 = Distance\ to\ the\ market$

$X_2 = Cost\ of\ transportation$

$X_3 = Time\ to\ the\ market$

$Y = Trips\ to\ the\ martket$

Table 23: Regression statistics of markets access and participation in area of study

SNO	1.0000	2.0000	3.0000	4.0000
Test statistics	Multiple R	R Square	Adjusted R Squared	Standard Error
Results	0.496768	0.246779	0.210911	1.054381
Observation	67.0000			

Source: Field data, 2015

a. Predictors: (Constant), cost of transporting maize to the nearby big market (Rwf/kg), Distance to the nearby big market, Time to the nearby big market (Hours).

b. Dependent Variable: Trips per month to the nearby big market.

Table 24: Analysis of Variance of market access and participation

ANOVA					
	df	SS	MS	F	Significance F
Regression	3	22.94672	7.648908	6.880248	0.000442
Residual	63	70.03835	1.11172		
Total	66	92.98507			

Source: Field data, 2015

a. Predictors: Constant, cost of transporting maize to the nearby big market (Rwf/Kg), Distance to the nearby big market (Km), Time to the nearby big market (Hours)

b. Dependent Variable: Trips per month

Table 25: Analysis of regression of markets access and participation

	Coefficients	Standard Error	t Stat	P-value
Intercept	3.495781	0.730114	4.787991	1.06E-05
X Variable 1	0.239059	0.201917	1.183949	0.240881
X Variable 2	-0.12798	0.035887	-3.56612	0.000698
X Variable 3	0.008951	0.026634	0.336064	0.73794

Source: Field data, 2015

The findings from this analysis showed that the R^2 is 0.248(24.8%) which showed that the variables contributes to the market access and participation at 24.8%, this means that the factor of markets access and participation count only 24.8 percent and the remaining depend on other factors. From the ANOVA table with F-test statistic of 6.880248 with p-value of 1.06E-05, since the p-value is less than 0.05 (p-value <0.05), the researcher could accept the null hypothesis hence there is no significance impact of improved roads on markets access and participations for maize farmers at 0.05 level of significance and 95% of confidence interval

6.5.3. Level of markets access and participation for maize farmers in the study area

The table below illustrates the degree of association at which maize farmers participate in the markets. These results were achieved through Pearson correlations by combining the distance the nearby big market and number of participant to the main markets which is Kirehe modern markets.

6.6 Assessment of challenges in maize production in the study area

6.6.1 Main reasons for not using some types of fertilizers in the study area

A large proportion of farmers applied fertilizer in their maize farming in season A of 2014, however, few farmers failed to apply inorganic fertilizers others also could not apply both inorganic and organic manure. Although farmers applied fertilizers they also showed the problems which hinder fertilizer application in the study area. The following information table pertained to main reasons expressed by farmers as factors that limit fertilizers application in their maize farming activities and the summary from field survey is given here below.

Table 26: Main reasons for not using fertilizers in the study area.

	Frequency	Percent	Valid Percent	Cumulative Percent
Long distance to the supplier of fertilizers	17	25.4	25.4	25.4
Fertilizers are expensive	50	74.6	74.6	100.0
Total	67	100.0	100.0	

Source: Field data, 2015

The results from the field survey indicates that the main reasons for not using fertilizers include long distance to the fertilizer suppliers as reported by 17(25.4%) respondents and the fertilizers are expensive as reported by 50 (74.6%) respondents. These results are in line with other information whereby, the percentage of agricultural households incurring expenditure on chemical fertiliser in Kirehe district is 52.4%. The national average is around 29%, with Gakenke District incurring the highest percentage (63%) and Nyarugenge District the lowest (2.2%) of all districts (NISR, 2012). Another report is as per the Ministry of Agriculture and Animal Resources, which highlighted that the government of Rwanda considers that, the rural farmers need the usable roads networks for timely and efficient transportation of their inputs to the farm as well as the transference of their farm produce out of the farm. Also, farmers need a nearby and accessible marketing of their farm produces. It continues that, since most of the inputs have to be imported, the cost of transportation to remote areas combined with the inherent poor demand for inputs keep the prices of the inputs high (MINAGRI, 2012).

Table 27: Major problems associated with use of improved seeds in the study area

	Frequency	Percent (%)
Long distance to the seeds suppliers	17	25.4
Improved seeds are expensive	50	74.6
Total	67	100.0

Source: Field data, 2015

As showed in the table 4.10 above, it is evident that the most problems associated with planting the improved seeds in the area of study is due to the high cost of improved seeds in the area as reported by 50 (74.6%) of all interviewees and the problem of long distance to the improved seeds supplier was reported by 17(25.4%).

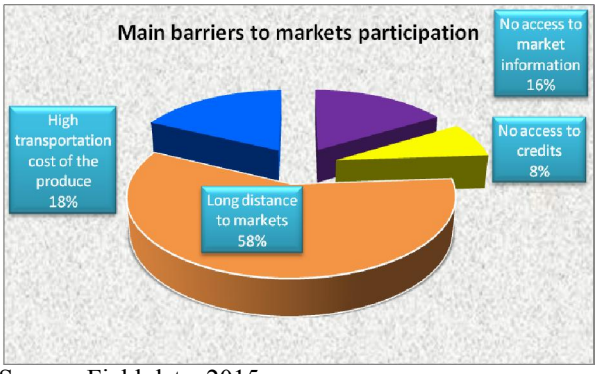
6.6.2 Major problems faced by farmers with regard to cost of inputs

When asked to state the main constraints with regards to cost of inputs, the farmers mentioned insufficient funds to buy inputs and for hiring labor. Majority of farmers reported the cost of labor to be 700frw-800frw per man-day.

6.6.3. Main barriers faced by maize growers in markets access and participation in the study area

Markets access and participation by farmers can be affected by some barriers. The results from the field study on the main barriers that are hampering the markets access and participation are now summarized by the Figure 1.

The results from the field study revealed that most of maize farmers do not participate in the markets due to long distance as reported by 58% of them; other important factor is high transportation cost of the maize produce as represented by 18% of respondents, these farmers reported that, they normally contribute to the transportation of farm produce and are paid after all the deductions including transportation cost especially when they sell to the cooperative. There are other limitations factors of markets participation like no access to credits and lack of access to markets information as said by 8% and 16% of all sampled maize farmers in the area of the study.



Source: Field data, 2015

Figure 1: Distribution of main barriers to markets participation

7. Conclusion And Key Findings

The main objective of the study was to assess the impact of improved rural roads on the agriculture production: a case of three maize farming cooperatives of Kirehe District. The present research report was guided by the following specific objectives: First, to examine the impact of improved rural roads on inputs use in maize production; Secondly, to evaluate the impact of improved rural roads on levels of maize output and; and Finally, to assess the impact of improved rural roads on maize markets participation.

Key findings

The key findings from the field survey reveal that, when looking on the quantities on inputs used in maize farming in the area of the study, the mean value of inorganic fertilizer used were 0.086955 Tons per hectare (86.955Kg/ha); quantity of organic fertilizer were 5.7224 tons per hectare (5722.4Kg/ ha), the quantity of improved seeds used were 0.0146 tons per hectare (14.6 Kg/ ha). In this case also, the mean value of labors used in maize farming for each household was 7.1950 man-days and then the mean value of land cultivated by household was 0.6625 hectare of land

When looking at mean of distances; the researcher found that to inorganic fertilizer supplier is 2.466 km, while the mean distance to organic supplier is found to be 0.782 km, the mean distance to improved seeds supplier was 2.6 km. When the maize farmer wanted to sell the maize produce, he ought to travel at least the distance of 27.49 km to big market located at Kirehe town- Nyakarambi center. When the researcher further applied the econometrical tests for the impact of improved rural roads on agricultural inputs use, the researcher found that, the R square was found to be 0.0604≈6.04%, indicating that the impact of improved rural roads in inputs use is still low, and the relationship between distance variation and inputs use for maize farming is explained by only 6.04. F-value of 0.26>0.05 of level of significance, the researcher emphasize that, there is no significant difference in agriculture inputs usage between improved rural roads area and the remote area of the area of study.

With respect of impact of improved rural roads on the level of maize output, the researcher found the findings from this analysis showed that the R^2 is 0.901(90.1%) which indicated that there is high correlation between data. The inputs usage explains level of maize output at 90.1%. From the ANOVA table with F-test statistic of 110.947 with p-value of 0.000, since the p-value is less than 0.05 (p-value <0.05), hence the maize output depends with high significance on inputs use such as fertilizers (Inorganic/organic), improved seeds, labor and land size at 0.05 level of significance and 95% of confidence interval.

However, the application of fertilizers did not depend on adjacency to improved roads because when the improved road was compared to the level of maize output the findings shows that: The distance explained level of maize output at only 3.46% and there is no significance difference in maize production for the areas that are accessible and those that are inaccessible in the area of study (R Square = 0.0346, F Significance 0.131635>0.05) hence we can nullify the hypothesis and reject the Alternative one saying that there is no significance difference in maize production between areas more accessible and those remote in our area of the study.

The findings for the impact of improved rural roads on maize market access and participation showed The findings from this analysis showed that the R^2 is 0.248(24.8%) which showed that the variables contributes to the market access and participation at 24.8%, this means that the factor of markets access and participation count only 24.8 percent and the remaining depend on other factors. From the ANOVA table with F-test statistic of 6.880248 with p-value of 1.06E-05, since the p-value is less than 0.05 (p-value <0.05), the researcher could accept the null hypothesis hence there is no significance impact of improved roads on markets access and participations for maize farmers at 0.05 level of significance and 95% of confidence interval. In other words being adjacent to rural roads does not guarantee to market participation, the results are in relation to the determined points of disposing the maize produce mentioned above whereby farmers sell most of their maize produce mostly to cooperatives 41 (61.19%), to the traders in local markets 15 (22.39%) to mobile traders 10 (14.93) and to neighbors 1 (1.49%), this make them not find the necessity of participating to the nearby big markets for selling maize produces.

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