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EFFECT OF PHYSICAL AND INSTITUTIONAL INFRASTRUCTURES ON EFFICIENCY OF RICE FARMERS

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ABSTRACT

The aim of this paper is to identify the effect of physical and institutional infrastructure on rice productivity, the causes of the differences in rice productivity among the rice farmers, and the level of productivity of the rice farmers. A total sample of 90 rice farmers randomly selected from 9 clusters by selecting ten from each cluster. The stochastic frontier model used to analyse the data. The demography results show that male farmers 82.2% dominate rice farming and 65.6% of the respondents are within the economically active group (30 – 49) years. Further, 81.1% are married, 30% obtained tertiary education, while 51.2% have low-level education (primary and secondary education). 83.3% have more than six years of experience in rice farming, 76.7% have access to fertiliser, 48.9% have access to improved seed, and 37.8 have access to extension visit. The stochastic frontier results show that road networks, farm size, electricity, and education have a significant adverse effect on rice productivity, while improved seeds and climate change awareness have a significant positive effect on rice productivity. Also, the technical efficiency of an average rice farmer is 89.11%, the most inefficient rice farmer produces at 77.20% level while the most efficient rice farmer produces at 93.84% level. Furthermore, the inefficiency results show that qualification and marital status are positively significant, while access to improved seed is negatively significant. The study recommends further study to expand the sample to identify the specific problem of each rice cluster in the state.

Keywords: Physical infrastructure, institutional infrastructure, improved seed, climate change awareness.

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1. INTRODUCTION

One of the objectives of any country is achieving food security and self-sufficiency in food production. Rice (Oryzasativa) is one of the most consumed staple food worldwide (Antle et al., 2018). In West Africa, rice is the 3rd most consumed crop after maize and sorghum, and the consumption is growing at a faster rate than the production rate due to population explosion (Macauley, 2015). Thus, every country attempts to increase the production of rice for a steady food supply. Maraseni et al., (2018) reported that the growth rate of world rice production is less than the growth rate of the world population. In Nigeria, the supply of rice has never met the quantity demanded from 1980 to 2018 due to population growth. Furthermore, studies have shown some elements of technical inefficiency in the productivity of rice, though the level of inefficiency differs among nations. Thus, the need for a study in Nigeria is to identify the productivity level and the inefficiency in rice productivity to increase rice production in the country.

Maji et al., (2015) reported an average increase of 10% on the annual consumption of rice in Nigeria. Tanaka et al. (2017) and Uduma et al., (2016) noted that population growth, changes in job structure, tastes and dietary, suburbanisation, and rise in income following crude oil discovery in Nigeria induced the increase of rice consumption. There are 1,425,805 rain-fed and 410,209 irrigated rice farmers in Nigeria (Kano state Agricultural and Rural Development Authority [KNARDA], 2017). Further, the rice sector provides employments opportunity, poverty alleviation, and contributes to the economic development of Nigeria yet; local rice production has not met the demand. The inadequate supply of locally produced rice in Nigeria relates to the low level of inputs, low yields, and limited areas under rice cultivation.

The inputs are physical and institutional infrastructures as conceptualised by Tanko et al., (2019). They conceptualised physical infrastructures as road networks, farm size, irrigation, communication, and electricity; and the institutional infrastructures as fertiliser, market, storage, extension, education, and credit.

1.1. Physical Infrastructures

The rural road networks are convenience connecting farmers with their farmland, inputs and output markets. Gibbons et a., (2019) report a significant increase in output due to linked roads. Besides, high-speed rails expand access to markets (Lin, 2017). Thus, the need for a multifunctional policy on rural road networks (Demenge et al., 2015). Though, Baum-Snow, Henderson, Turner, Zhang, and Brandt (2018) reported an adverse effect of improving access to local markets by road networks on local economic activities. Also, Stenico et a., (2019) reported that truck fleets cause climate change which negatively affects crop yield.

Efficiency increases with plot size (Adamie et al., 2019). Thus, the size of the farm significantly affects rice output (Akudugu, 2016), and Ragasa and Chapoto (2017) affirm that rice productivity increase with farm size. Besides, Chang et al., (2017) reports higher profit efficiency by large farms compared to smaller ones. While Wang et al., (2015) reported a decline in rice yield due to land fragmentation. Also, Bhattacharyya and Mandal (2016) report a decrease in technical efficiency of rice farming due to land fragmentation.

Irrigation is most required during rainfall shortfall to supplement farm watering. Thus, Ahmed, Xu et al., (2017) and Chun et al. (2016) noted that providing irrigation facilities increases rice production. Fereres and García-vila (2018) reported that out of the 17% of land used for crop production, 40% of the output comes from irrigation. Besides, irrigated rice consumes 80% of the total fresh irrigated water compared to other irrigated crops (Tuong et a., 2005). This led to the adoption of water-saving management practices to attain self-sufficiency and security in food production and for export (Zhang et al., 2018). The water-saving management saves irrigation water usage and reduces fertiliser usage without losing rice yield (Pan et al., 2017). In Kano State, Nigeria, Tanko et al. (2019b) noted that failure to explore the available irrigation facilities lead to low rice productivity.

Rural electricity supply reduced the costs of maintenance and backups, thus, enhancing the productive activities of the rural dwellers (Narula & Bhattacharyya, 2017). They further noted that inadequate electricity supply distorts the productive activities of the rural populace. Also, Barnes and Binswanger (1986) report that private rural electricity supply significantly affects agriculture. Further, Binswanger et al., (1993) report an increase in investments and output due to the electrification of pumps in rural areas while Bhattacharyya and Ganguly(2017) noted that removing subsidy on electricity led to food inflation.

The services of mobile-enabled information nowadays reduced the irregularities and bridged the gap between access and conveyance of agricultural inputs and outputs. Thus, increasing mobile phone coverage facilitates technology adoption by ICT agricultural extension programs. For instance, Kirui et al. (2013) report an annual increase in commercial agriculture due to MMT services. Hence, modern communication edifies farmers to adjust to market signals.

1.2. Institutional Infrastructures

The usage of fertiliser on rice farmland significantly affects rice output (Tashikalma et al., 2014). Also, Osanyinlusi and Adenegan(2016) reported that fertiliser usage and the quantity used significantly increase crop productivity. Further, a comparative study shows that fertiliser usage increases rice output in China and Nigeria (Ahmed et al., 2017). Though, Guo et al. (2017) noted the need to regulate the usage of nitrogen fertiliser to increase the efficiency of rice production and maximise utilisation of resources. The level and direction of the impact of fertiliser usage on farmland depend on factors affecting its adoption. For instance, Abebaw and Haile(2013) report that the age of the farmer determines the adoption of fertiliser.

Storage is the handling and processing of a commodity from the production to the consumption stage. Modern technology offers facilities storing, processing, and handling of farm outputs. For instance, Kaminski and Christiaensen (2014) report lower post-harvest losses by farmers using an improved storage facility. Literature shows that storage facility maintains the quality of crops (Behsnilian & Mayer-Miebach, 2017; Du et al., 2017), maintain the colour parameters (Milkovska-Stamenova & Hoffmann, 2017). Also, storage maintains nutritional quality (Pandino et al., 2017), and improves storage performance (Licciardello et al., 2017; Sheng et al., 2017). Hence, inadequate storage facilities risk farmers output to pests and deteriorating climate (Gajigo & Lukoma, 2011).

Credit facilities improve the productivity of farmers (Nonvide, Sarpong, Kwadzo, Anim-Somuah, & Gero, 2017). Also, Akudugu (2016) reported that formal and informal credit significantly increases crop productivity. Further, Binswanger et al.(1993) reported that access to credit led to an increase in investments, demand for fertiliser, and tractors. Insufficient credit is a barrier to improving the productivity of farmers (Ojochenemi et al., 2017). Unfortunately, most banks shine away from rural banking owing to high risks involved (Ijaiya et al., 2017). Banks prefer urban banking, where the provision of infrastructure is concentrated (Binswanger et al., 1993). Further, the lack of financial data and administrative skills reduced access to credit by farmers (Nyaga & Nzulwa, 2017). Though, the informal sector provides loans to most female farmers due to absence of collateral security (Tran et al., 2016).

Crop productivity increases with easing access to market (Koppmair et al., 2016), and post-harvest losses decrease with market facilities (Kaminski & Christiaensen, 2014). Hence, Uduma et al. (2016) noted the need for conducive markets to rural dwellers thus, the need for government intervention in prospering markets (Czyzewski & Majchrzak, 2017; Goto & Douangngeune, 2017). Though, Akudugu(2016) report that access to market does not significantly affect crop productivity.

Education is vital for development, especially in Nigeria, where farming is the primary occupation in the country. Sasso and Ritzen (2019) reports that the knowledge and skills acquired by an individual contribute to reaching many societal goals such as taming patience or reduce rates of crime; thereby increasing the productivity of the workplace. Also, Adamie et al .(2019) report that efficiency increases with the level of education. Thus, quality education is vital for increasing agricultural productivity (Ibrahim, 2015). The absence of educational facilities and in-capabilities of rural dwellers restrains higher education attainment (Aslam & Rao, 2018). The need for a long term expenditure on public education to lessens the costs of education in rural areas (Zhang, 2019).

Extension services are the advice-giving to farmers by an expert on increasing crop productivity (Antle et al., 2018). Literature shows a significant increase in crop return due to extensions offered (Binam et al., 2004). Also, Owens et al., (2003) report 1 to 2 extension visits increase crop yield. Further, Maffioli et al., (2013) reported that the extensions offered increases the adoption of modern farming. Berhanu and Poulton(2014) noted that investing in extension services is the most effective means of increasing farmers' productivity because investment returns on extension services are high (Jin & Huffman, 2016).

The availability and efficient utilisation of an input (improved rice seeds) significantly increase rice productivity. For instance, Ahmed et al. (2017) reported that enhanced rice variety substantially increase rice productivity. Also, Zhou et al. (2017) noted that super rice has a stronger ability to cope with soil water deficit, holds greater promising to increase both rice yield and water use efficiency. The productivity of rice depends on genotype (Xue et al., 2017). The result of the study by Thirtle, Beyers et al., (2003) shows that farmers who adopt improved seeds are more efficient than non-adopters. As adoption of highbred seeds upsurge crop yield and reduces poverty (Moyo et al., 2007). Kim et al., (2017) noted that insufficient supply of improved rice seed stalled rice productivity.

Precipitation, rate of rainfall and its duration, humidity, level of temperature, drought, flood, and extreme temperature is part of the environmental issues that affect rice output and are caused by climate change (Kim et al., 2017; Xue et al., 2017). Also, Li, Wang, and Chun (2017) noted that climate change would significantly reduce rice output by 2050 unless steps are taken to tackle the problem. Kim et al.(2017) reported that climate change perception and adaptation measures are positively related. For instance, Huong et al., (2017) indicate that farmers who are aware of climate change have adopted a tackling measure. Factors affecting adaptation measures to climate are education, access to credit, extensions, experience, data on climate change, and belief (Khanal et al., 2018), socio-economic, geographical, ecological, and institutional factors (Joshi et al., 2017).

2. MATERIALS AND METHOD

The study was conducted in 9 rice clusters purposefully selected from the 17 rice clusters of Kano State, Nigeria. The questionnaires distributed are 90 to a random sample of 10 rice farmers in each of the 9 rice clusters. The Cobb-Douglas stochastic frontier model was used to analyse the data presented by Coelli and Battese(1996) as:

$$Y = \beta_0 + \beta_1 X + V - U \quad (1)$$

Where; Y is the quantity of rice produced by a farmer, β is the vector of parameters. X is the vector of the inputs; physical infrastructures (rural roads, irrigation, communication, electricity, and farm size), institutional infrastructures (fertiliser, storage, extension, education, market, and credit), an input (improved rice seed) and a proxy (climate change awareness) all measured in 5-Likert scale. V is the random error (noise) assumed independently and identically distributed N (0, σ2), U is the asymmetric error signifying the technical inefficiency of farmer in production assumed independently and identically distributed as half-normal { ~ | N (0, σ2) |} The density of the function U restrict the mode of the distribution to occur at = 0; so, the function of the half-normal random variable is:

$$f(\upsilon) = \frac{2}{\sqrt{2\pi\sigma_u}} exp\left(-\frac{\upsilon^2}{2\sigma_u{}^2}\right) \qquad u \geq 0 \quad (2)$$

In the absence of inefficiency, the functional model is equivalent to the OLS regression. Thus, the need to test the suitability of the frontier model as a good representation of the data collected. The generalised likelihood ratio test would be used to estimate β and γ where γ = σ2ʋ ÷ σ2s and σ2s = σ2v + σ2ʋ. Further, σ2ʋ is the error term variance (technical inefficiency) asymmetric, which shows how far away is the observed output from the maximum output that should have been produced by an efficient farmer. σ2v is the variance of the error term symmetric. σ2s is the sum of variation in the output produced due to random shocks σ2v and the technical inefficiency σ2ʋ. while γ is the gap that deviates from the maximum likelihood due to technical inefficiencies of the farmer. The parameter γ lies between 0 and 1; if γ = 0 shows the absence of ʋ therefore, all deviations from the frontier is caused by noise. However, when γ = 1 shows all shortfalls from the frontier are due to technical inefficiency.

Coelli and Battese (1996) developed the functional model of the technical inefficiency effect in a stochastic frontier production is a function of other explanatory variables. Thus functional model presented as;

$$\upsilon = \delta_0 + \delta_1 X_1 + e \quad (3)$$

Where; ʋ is the technical inefficiency. Xi is the socio-economic characteristics of the rice farmer; sex (1 if male and 0 if female), age (in years), marital status (1 if married and 0 if single), qualification (level of education), experience (years spent in rice farming), access to fertiliser (1 if access and 0 no access), access to improved seeds (1 if access and 0 no access), and access to extension visit (1 if access and 0 no access) and e is the error term. Furthermore, hypotheses were tested by the generalised likelihood ratio (GLR) test for the frontier and inefficiency model. The functional for the GLR is;

$$LR = -2\{\ln[L(H_0)] - \ln[L(H_1)]\} \quad (4)$$

Where: $L(H_0)$ is the value of log-likelihood function under null hypothesis, $L(H_1)$ is the value of log-likelihood under alternative hypothesis.

The estimated LR compared with the table of Kodde and Palm(1986). If the value is higher than the critical value at 5% level, the null hypothesis is rejected and accepts the alternative hypothesis.

3. RESULTS AND DISCUSSION

Table 1 presents the socio-economic characteristics of the respondents. The results show that there are more male rice farmers (82.2%) than the female as reported by Olarinre and

Omonona(2018) that there are more male rice farmers than female. Most of rice farmers are married (81.1%) than single. Further, more respondents are within the economically productive age group (30 - 49) 65.6% with an average literacy level (secondary and tertiary education) 55.6%. There are more experience rice farmers than inexperience with at least six years of experience (83.3%). Similarly, a higher number of rice farmers have access to fertiliser (76.7%) and access to improved rice (48.9%), but most could not access extension services (62.2%).

Table 1 Socio-economic characteristics of the respondents

	Frequency	**Percentage**
Sex		
Male	74	82.2
Female	16	17.8
Age (years)		
Below 20	7	7.8
20 – 29	17	18.9
30 – 39	26	28.9
40 – 49	33	36.7
50 and above	7	7.8
Marital status		
Married	73	81.1
Single	17	18.9
Qualification		
No formal education	17	18.9
Primary education	23	25.6
Secondary education	23	25.6
Tertiary education	27	30.0
Experience		
0 – 5 years	15	16.7
6 – 10 years	28	31.1
11 and above years	47	52.2
Access to fertiliser		
Yes	69	76.7
No	21	23.3
Access to improved seed		
Yes	44	48.9
No	46	51.1
Access to extension visit		
Yes	34	37.8
No	56	62.2

Table 2 presents the result of the MLE for the parameters of the Cobb-Douglas stochastic frontier production function for the rice farmers in Kano State. The results show that the coefficient of physical infrastructures road networks, farm size, and electricity are significant, and only education institutional infrastructure is significant. While the coefficient of input (improved rice seed) and a proxy (climate change awareness) is significant.

The coefficient of road networks is negatively significant at 10% level. The result is contrary to prior expectation and the findings of Llanto(2012). The negative elasticity implies that a 1% increase in road networks in the rural areas would reduce rice output by 0.09%. It follows that rice inputs such as pesticides, insecticides, rice variety, and fertiliser are expensive in areas with sparse road networks due to the high costs of purchasing and conveyance. Also, the absence of road networks in the rural areas bar farmers to accesses extension services and credit facilities. Further, sparse road networks discourage banks from establishing branches in rural areas as well as efficient delivery of extension services.

The coefficient of farm size is negatively significant at 10% level. The result is contrary to prior expectation and in line with Yan, Chen, and Hu(2019), who reports a negative and significant relation between farm size and rice productivity. The inverse elasticity implies that a 1% increase in the size of a farm would reduce rice output by 0.23%. The possible reason could be due to land fragmentation leading to small farm holdings. It could be due to non-utilisation of technology and land management system which determines the optimal suitable farm size. Thus, farmland fragmentation lessens the efficiency of rice farmers (Bhattacharyya & Mandal, 2016). Though, Ricciardi, Ramankutty, Mehrabi, Jarvis, and Chookolingo(2018) reported that larger farms are vulnerable to post-harvest loss and Sheng and Chancellor(2019) reports that the productivity of larger farm diminishes.

The coefficient of electricity is negatively significant at 10% level. The result is contrary to prior expectation and follows the findings of Ogundele and Okoruwa(2006). They report that an inadequate supply of electricity stalled rice processing. The negative elasticity implies that a 1% increase in electricity supply would raise rice output by 0.09%.

The coefficient of education is negatively significant at 1% level. The result is contrary to prior anticipation and the findings of Ahmadu and Erhabor(2012). They report that a farmer with higher years of formal education is technically efficient compared to a farmer with fewer years of study. The inverse elasticity signifies that an additional year of study would cut rice output by 0.54%. The possible reason could be that the quality of education of the farmers is low leading to inadequate awareness of modern rice farming systems. Further, the low level of rice farmer’s education leads to poor adoption of modern technologies in rice farming. Thus, Huy and Nguyen (2019)suggest facilitating rural education to improve the technical efficiency of farmers.

Table 2 Robust result of maximum likelihood

Variable	Coefficient	Std. Dev.
Constant	3.970***(4.04)	0.982
Road networks	-0.086*(-1.76)	0.049
Farm size	-0.226*(-1.72)	0.131
Irrigation facilities	0.023(0.61)	0.038
Electricity supply	-0.091*(-1.82)	0.050
Communication networks	0.026(0.33)	0.081
Fertiliser	-0.091(-0.14)	0.088
Improved rice seed	0.153*(1.79)	0.085
Storage facility	0.007(0.12)	0.065
Nearness to market	-0.077(-0.76)	0.101
Credit facility	0.068(1.26)	0.054
Education	-0.535***(-3.28)	0.163
Extension services	0.023(0.40)	0.058
Climate change awareness	0.261**(2.25)	0.116
Inefficiency model		
Constant	-4.795***(-2.64)	1.820
Sex	-0.387(-0.54)	0.720
Age	-0.286(-0.88)	0.327
Qualification	0.862**(2.42)	0.356
Marital status	2.675*(1.83)	1.463
Experience	0.286(0.62)	0.459
Access to fertiliser	0.379(0.52)	0.732
Access to improved seed	-2.885***(-3.01)	0.959
Access to extension visit	-2.747***(-2.86)	0.961

Note: Robust standard errors in parentheses, ***, **, * are P-values at 1%, 5%, and 10% respectively.

The coefficient of an input (improved seeds) is positively significant at 10% level. The result conforms to a priori expectation and in line with the finding of Chirwa (2007) who report a significant positive effect of hybrid seeds on productivity. The positive elasticity signifies that 1% increase access and usage of rice variety by a rice farmer would increase rice output by 0.15%. The coefficient of proxy (climate change awareness) is positively significant at 5% level. The result conforms to a priori expectation and follows the findings of Okonya et al., (2013) who report a positive impact of climate change awareness on crop production. The positive relation signifies that 1% increase awareness of climate change would increase adoption measure to reduce the negative effect; which would lead to a rise in rice yield by 0.26%. Because Huong et al. (2017) reported that awareness of climate change permit farmers to adopt a measure in tackling the problem.

The results of the inefficiency model in Table 2 showed that the coefficient of qualification is positively significant at 5% level. The result signifies that a 1% increase in farmer's level of education would increase the technical inefficiency of the rice farmer; thereby, reducing rice productivity by 0.86%. Some of the reasons include that most farmers have no formal education or received an inadequate education. Also, employing untrained and insufficient teachers to deliver the training would lead to half-baked graduates. Hence, the low literacy level of rice farmers hinders their ability to adopt modern rice farming tools. The coefficient of marital status is positively significant at 10% level. The result shows a cut in rice productivity by 2.65% due to a 1% increase in married rice farmers. The possible reason is that growth in family size means more expenditures and less left for the purchase of modern rice inputs.

Positive relation in the inefficiency model signifies that technical inefficiency increases with a unit rise in the variable, while a negative relationship in the inefficiency model signifies that technical inefficiency is reducing. The coefficient of access to improved rice seed is negatively significant at 1% level. The result implies that the technical inefficiency of rice farmers would decrease by 2.88% with an increase of 1% access to high yield rice. The result conforms to a prior expectation and in line with Abro et al., (2019), who reported that farmers using improved seeds are more efficient than those using local seeds.

The coefficient of access to extension visit is negatively significant at 1% level. It follows that a 1% increase access to extension visit by rice farmers would decrease the technical inefficiency of the rice farmers by 2.74%; thereby, increasing rice productivity. The result conforms to a prior expectation and in line with Ahmed, Tazeze, Mezgebo, and Andualem(2018). The quality of extension services rendered affects the productivity of rice farmers. Also, the inability of rice farmers to access extension services deters effective utilisation of modern rice inputs. Hence, extension workers are a vital means of disseminating modern farming techniques that improve the productivity of rice farmers. The coefficient of sex and age are negative while experience and access to fertiliser are positive though all were insignificant in explaining the technical inefficiency of rice farmers in the study area.

The choice of the empirical stochastic production frontier model used in analysing the data collected was made based on the generalised likelihood ratio test. Further, other tests of hypothesis involving the parameters of the frontier, stochastic, and inefficiency models are conducted using the GLR test and the results presented in Table 3.

Table 3 GLR tests of hypotheses for the parameters of the frontier, stochastic, and inefficiency model for rice productivity in the study area.

Null hypothesis	LR	X2 Critical value	Decision
1. The Cobb-Douglas production function is the correct representation of the data. H_0: $\beta_{kj} = 0$	11.28	14.853	Accept H_0

Null hypothesis	LR	X2 Critical value	Decision
2. There is no inefficiency effect in the model. H_0: $\gamma = 0$	16.32	10.371	Reject H_0
3. The inefficiency effect is non stochastic H_0: $\gamma = 0$	27.60	21.742	Reject H_0
4. The coefficients of the frontier model is zero. H_0: $\beta_1 = \beta_2 = \ldots = \beta_{13} = 0$	25.11	20.410	Reject H_0
5. The coefficients of the inefficiency model is zero H_0 : $\delta_1 = \delta_2 = \delta_8 = 0$	15.49	13.401	Reject H_0

The first null hypothesis indicates that the Cobb-Douglas production function is the appropriate representation of the data collected. The LR test affirms the assertion; thus, accept the null hypothesis. The second hull hypothesis tests the absence of inefficiency in the frontier model. The LR test confirms the existence of technical inefficiency in the model; thus, reject the null hypothesis. The third hypothesis states that though the model is inefficient, it is non-stochastic. The LR test proved that the technical inefficiency in the model is stochastic; thus, reject the null hypothesis. The fourth hypothesis test is that all the coefficients of the frontier model are zero. The LR test shows that at least one coefficient is not zero; thus, reject the null hypothesis. The firth hypothesis test is that all the coefficients of the technical inefficiency model are zero. The LR test shows that at least one coefficient of the technical inefficiency model is not zero; thus, reject the null hypothesis.

Table 4 Technical efficiency

TE Ranges	Percentage
Minimum	0.7720418
Mean	0.8911148
Maximum	0.9384101
Standard Dev.	0.0352406
Bags produced	Percentage
1 – 50	13.33
51 – 100	23.33
101 – 150	58.89
151 – 200	2.22
201- -250	2.22
251 and above	0

Technical efficiency: Table 4 presents the result of the productivity of rice farmers in the study area. From the results, the productivity of an average rice farmer is 89.11%, the productivity of the most efficient rice farmer is 93.84%, while the productivity of the most inefficient rice farmer is 77.20% in the study area. In other words, the worst rice farmer can improve rice productivity by 22.80%, an average rice farmer can improve rice productivity by 10.89%, while the most productive rice farmer can increase rice productivity by 6.16% in the study area. Moreover, 13.33% of the rice farmers produce 1 to 50 bags, 23.23% produces 51 to 100 bags, 58.89% produces 101 to 150 bags, 2.22% produces 151 t0 200 and 201 to 250, while 0% produces above 250 bags. Thus, the result shows that most of the rice farmers are relatively small scale because 82.12% produces 51 to 150 bags.

4. CONCLUSION

The result of the study reaffirms the poor state of infrastructures in the study area. From the results, all the significant physical and institutional infrastructures are negative. Thus, the coefficient of road networks, farm size, electricity, and education are negatively significant. The coefficient of input (improved rice) and the proxy (climate change awareness) is positively significant. Hence, the need for the government and private sector to invest in the provision of such infrastructures in the rural areas of the study and a further study that increases the sample size to cover more rice farmers in the study area.

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