International Journal of Scientific Research in Science, Engineering and Technology (www.ijsrset.com)
© 2020 IJSRSET | Volume 7 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
DOI : https://doi.org/10.32628/IJSRSET2072128

Factors influencing the Production of Local Rice in Ghana : The Moderating Role of Open Innovation

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National social science foundation of China (14BGL024): Research on the open innovation mechanism and promotional policy of small and medium-sized enterprises from the perspective of Network Embeddedness founded this research.

ABSTRACT

Purpose – The study reports the factors influencing the production of local rice in Ghana with a moderating effect of open innovation to boost rice production.

Design/methodology/approach – This study employs a cross-sectional survey to gather the views of 250 rice farmers. A self-administered survey questionnaire was used to collect the data. The data was analyzed using SmartPLS software 3.2.8.

Findings – The study indicates that land tenure system, inadequate infrastructure and irrigation system are the factors influencing the production of local rice in Ghana. The findings suggest

that all four factors have a significant and positive effect on the production of rice. The study shows that there is a direct and positive relationship between open innovation and output of rice production in Ghana. Open innovation was found to moderate the positive relationship between infrastructure and rice output. Again, the relationship between land tenure system and rice production is moderated by open innovation. Furthermore, the relationship between irrigation and rice production is moderated by open innovation.

Practical implications – To improve rice production, the study therefore, recommend that, infrastructure is provided in the rice producing areas to enhance rice production by investing in the area of road networks, rice-milling equipment such as pre-cleaners, destoners that separate stones and heavy impurities from grains, hullers, polishers, paddy separators, aspirators and graders to ensure post-harvest product quality.

Originality/value – These findings offer a far-reaching approach to enhance the production of local rice in Ghana, in the quest to achieve food security. Old-fashioned agricultural methods are simply not sustainable enough to achieve food security for a rapidly growing population; hence, innovation is the way to go to achieved food security by investing in the agricultural sector.

Keywords : Land Tenure System, Infrastructure, Irrigation, Open Innovation, Output of Rice

I. INTRODUCTION

Rice is a significant staple agriculture food crop in the world and one of Ghana's primary food sources. Still, one in which there is food insecurity in the country, with demand exceeding domestic production and 66% of the rice consumed is imported. According to MoFA. (2016), rice consumption in Ghana has progressively risen in the last twenty years, joining cassava and yam as one of the three most-consumed crops in Ghana. The consumption of rice increased from 17.5 kg to 38 kg per capita between 1999 and 2008, and is projected to outrun 63 kg per capita by 2018 (Tian Hongyun, William Adomako Kankam, Isaac Gumah Akolgo, Thomas Bilaliib Udimal, & Florence Appiah-Twum, 2019a).

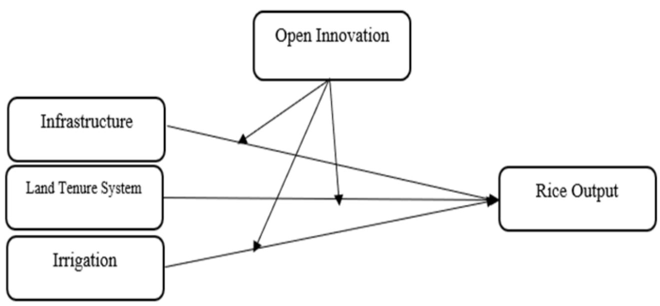
In the coming years, the market for rice is projected to increase further due to population growth, urbanization, and changing customer tastes. In 2016, Ghana's government revealed intentions to become a net rice exporter by 2020 (Oxford Business Group, 2017). In 2015, Ghana consumed 980,000 tons of rice, but produced just 330,000 tons, or around 34 percent, domestically, according to the US Department of Agriculture (USDA). Imported rice mainly from the USA, Vietnam, Thailand, Pakistan, and Togo, filled this significant void. In 2015, adverse weather conditions impeded cereal production across Sub-Saharan Africa, and drought conditions associated with El Niño are predicted to continue suppressing yields, according to the Food and Agriculture Organization.

So, it is about time Ghana pays attention to open innovation in the cultivation of local rice. As open innovation relates to the application of highly customized knowledge inflows and outflows for increasing internal innovation and growing opportunities for global use of innovation. However, prior research indicates that the state of innovation in the agricultural sector in Ghana, has not been fully harnessed, documented and improved upon and made available to farmers for adoption (Mabe, 2018). Open innovation is a framework that has the capacity to relate to the outcomes of open science to a swifter rendition and growth of its innovations. Thus, open science embodies greater efficiency and productivity, more transparency and better response to interdisciplinary research needs (Bogers, Chesbrough, & Moedas, 2018). Like open science, open innovation assumes broad and effective engagement and participation in the innovation process.

However, effective commercialization of new knowledge in open innovation also requires the discovery and development of a business model to help boost rice production (Bogers et al., 2018). Ghana's overall yield difference ranges from 14 to 73 percent for agricultural production (MoFA., 2016). Despite Ghana's comparatively substantial agricultural sector, which employs about 33.50% (International Labour Organization, 2019; Plecher, 2020); which contributes to more than 20% of GDP, Ghana is a net importer of many of its fundamental agricultural goods, including rice. This study seeks to find out the factors influencing the production of local rice in Ghana, the moderating effect of open innovation.

II. Theoretical Background and Hypotheses development

This paper is focusing on the factors influencing the production of local rice in Ghana with a moderating effect of open innovation to boost rice production.



2.1.1 Infrastructure and rice output

In this research, infrastructure encompasses storage and milling facilities, parboiling devices, drying patios, and warehouses to improve rice mill quality. The lack of adequate rice-processing plants in rice-producing communities in the country is jeopardizing efforts to increase local rice production to curb excess dependence on imports of goods for domestic consumption (Tian Hongyun, William Adomako Kankam, Isaac Gumah Akolgo, Thomas Bilaliib Udimal, & Florence Appiah-Twum, 2019b). Sadly, farmers in the three northern regions of Ghana have their harvest for farming seasons comprising of thousands of bags of rice-locked up in warehouses due to the unavailability of mills to process the commodity, phenomena that forced the growers to apply local methods of rice processing that do not meet market standards (Hongyun et al., 2019b).

Ghanaian consumers keep emphasizing, besides price, the presence of stones in domestically grown rice as a motivation behind the preference of imported brands (Hongyun et al., 2019b). Inadequate processing facilities in the communities producing rice hinder the rice production in the land, which accumulates in poor rice quality locally (Hongyun et al., 2019b). The small number of non-operative processing machines in the country has prompted the government to continue to inject massive amounts of money in order to import certain items, which are able to satisfy the population's requirements. This has a detrimental impact on smallholder farmers' income generation, and not only does it prevent most farmers from joining the rice sector only by debiting them (Mabe, 2018), since farmers have to rely more on locally made drums to thresh paddy and long travel distances into mill paddy rice to face lack of processing facility.
Antle (1984) invested how human capital and infrastructure constrain the choice of technology and hence productivity. The results show that farmers' education, extension schemes, transport and communication infrastructures, provision of irrigations, and use of wide yielding varieties and climate conditions are the function of productivity (Antle, 1984). In the study of poverty and income-distribution, Ut, Hossain, and Janaiah (2000) studied household data from 8 separate ecology and infrastructure growth villages in the north and southern Vietnam. The findings suggest that the adoption of irrigated conditions of modern rice varieties greatly improved the rice yield and reduced the production unit cost (Ut et al., 2000).

Edmonds (2002) explores the role of growth of the infrastructure and technological change in the mid-1990s in explaining growth in agricultural production and land-use changes in the Mekong Delta region of Vietnam. The study shows that the cost of transport involved in transferring agricultural input and output between farms and markets influences the use of agricultural land and production decisions significantly (Edmonds, 2002). The findings suggest that the quality of the local infrastructure is much more crucial in explaining the accelerated land-use intensity and performance level (Edmonds, 2002).
H1. Infrastructure is positively related to output of rice production.

2.1.2 Moderating Role of open innovation in the relationship between infrastructure and rice output

Open innovation will also boost rice quality for the target market. By open innovation, we are referring to the use of standard ways of harvesting and threshing facilities that has the potential to bring a change in the processing of paddy rice to global standard by investing in rice mill well equipped with pre-cleaners, destoners that separate stones and heavy impurities from grains, hullers, polishers, paddy separators, aspirators and graders.
The previous studies indicate that production depends on the schooling of the farmer, the extension services, the transport and communication networks, the quality of irrigation, the use of wide yield varieties

and climatic factors (Antle, 1984; Hongyun et al., 2019b; Liu, Shamdasani, & Taraz, 2020). In a similar fashion, Yu and Fan (2011) found that in order to increase agricultural production and productivity and raise farmers' revenue, the government needs to expand its investment policy to upgrade rural infrastructure, including irrigation, transportation, and electricity.

H2. The relationship between infrastructure and rice production is moderated by open innovation.

2.1.3 Land tenure system and rice output

Land tenure system is an infinite series of decrees, rules and duties that control the allocation/right and value to land (Kasanga, 1988; Kasanga & Kotey, 2001). The land tenure system has been used for the administration of properties over the years as a socio-juridical basis: these are the rights and privileges and how land can be established or transformed into society. Due to the farming system in Ghana, the land tenure practices are the foundation supporting agriculture, social and economic interactions among the citizenry. The scheme of land tenures is a significant transformation in the country's rice production due to its impact on acquisition and protection (Alarima, Adamu, Masunaga, & Wakatsuki, 2011; Naab, Dinye, & Kasanga, 2013).

In Nigeria, Alarima et al. (2011) have found negative links among rice production and land tenure systems. The system has the tradition, in particular in the low-lying rain-fed landscape, to limit the land size of possessions and reserves. As land use rights are restricted, land tenancy schemes for farming continue to shift away from out-of-date household and shareholder operations to a shorter cash loan payable in cash (Naab et al., 2013). According to Yaro (2012) the complex existence of customary land tenure structures created a state of uncertainty and strain because of the perception of custom administrators' titles and duties on property. Koirala, Mishra, and Mohanty (2014) examine the factors influencing rice production and the technological output of rice farmers in the Philippines. The finding indicates that land size, irrigation, and labor cost are major factors influencing rice production (Koirala et al., 2014).

In the same vein, Roland (2016) argues that land consolidation has significant effect on output. Blarel, Hazell, Place, and Quiggin (1992) investigated this effect empirically and concluded that fragmentation is so efficient that alleviating fragmentation may actually make farmers worse off.

H3. There is a positive relationship between land tenure system and rice production.

2.1.4 Open innovation and land

In recent years the growth of these high yielding species by modern breeding techniques, and the progress towards increasing yield capacity, have been important milestones in increasing rice production. The phenomenon of land tenure has continued to decrease farm size, and thus, the solution is to embrace open innovation in agricultural land use, the implementation of semi-compact, high yield varieties, in combination with enhanced rice production innovations such as the Green Revolution (Mohanty et al., 2017).

Kusrini (2018) examined the impacts on the status of sustainable rice production and the contributing factors of innovation and infrastructure support and argues that owing to restricted land and water supplies, regular changes in the environment, and the high land conversion, sustainable rice production needs the help of open innovation and infrastructure (Kusrini, 2018).

H4. The relationship between land tenure system and rice production is moderated by open innovation

2.1.5 Irrigation and rice output

Irrigation is a labor-intensive method for providing water for growing crops. Irrigation is a mechanism by which artificial means such as drains, ditches, and sprinklers can supply a regulated quantity of water

(Hongyun et al., 2019b). Thus, irrigation involves adding regulated volumes of water at appropriate intervals to plants. The key purposes of irrigation systems are to promote crop production, conservation of vegetation, overcome the impact of insufficient rainfall, etc. Irrigation helps to grow farm crops, sustain habitats, and restore degraded soil in dry areas and in less than normal rainfall times.

It is mainly useful to support the plants in the dry season and in dry areas (Boserup, 2017). The use of effective irrigation systems and controls are critical in the case of farming. There are usually two types of controllers suitable for irrigation control systems: open-loop system and closed control loop systems (Hongyun et al., 2019b). Open control loop structures refer to the use of set strokes, for instance, as seen in basic irrigation timers, while closed control loops are used to provide feedback from sensors, operate on the input, and make use of the output of these responses to the irrigation system (Schubert, 2018).

Mkanthama, Makombe, Kihoro, Ateka, and Kanjere (2018) assessed the success of irrigated and rainfed lowland rice cultivation employing technical efficiency and measured the technical efficiency of irrigated and rainfed lowland rice production in Tanzania. Data were collected from an irrigated site in the Morogoro District of Bagamoyo and Dakawa, a lowland rainforest site. The study result shows that irrigation farmers' average technological output is 96% compared to an average of 39% for a lowland rainfed system (Mkanthama et al., 2018). There are no farmers with less than 80 percent technological output for the irrigated system. This high technical efficiency indicates that in order to achieve the rice production targets aspired to, the opportunity for increasing production, therefore, lies in changing the production technology (Mkanthama et al., 2018).

Yu and Fan (2011) evaluated the rice production response using the 2004 and 2007 Cambodia Socioeconomic Surveys. The findings show that agricultural production is far below its capacity and that technological innovations and supplies, including fertilizers and irrigation, will greatly increase it (Yu & Fan, 2011). Dari, Sihi, Bal, and Kunwar (2017) estimate direct seed rice production in terms of yield and water quality, based on various irrigation systems and sowing dates. The research says the two key facets of "rice production" to create a "win-win" approach are the sowing periods and irrigation schemes (Dari et al., 2017). This could theoretically increase rice production in the scarce water areas in the strategic and judicial use of irrigation water with control of the time needed to sow (Dari et al., 2017). Koirala et al. (2014) found that investing in irrigation has a positive and statistically significant effect on rice production, at the 10% level of significance.

H5. There is a significant positive relationship between irrigation and rice production.

2.1.6 Moderating Role of open innovation in the relationship between Irrigation and Rice Output

The philosophy and strategies of the framework of agricultural innovation are primarily considered to be a prerequisite for the design and execution of effective and sustainable programs for agriculture development (Kamara, Dorward, Lalani, & Wauters, 2019). The agriculture innovation system has gained popularity in the agriculture innovation literature and has been embedded in policy documents of agriculture sector institutions in many countries (Kamara et al., 2019). Market demand has heightened the pressure on businesses to create innovative and effective systems that are perceived as reasonable (Tsinopoulos, Sousa, & Yan, 2018).

Potentially, it has been discovered that engaging in open innovation could very well boost productivity (Tsinopoulos et al., 2018). Open innovation programs strive to promote the use of multiple outlets of knowledge as an enterprise strives to develop its technologies and expertise (Chesbrough, 2017). Open innovation improves the operation and maintenance of scheme in the cultivation of rice by adopting water measuring devices for enhanced water usage under irrigation (Mango, Makate, Tamene, Mponela, & Ndengu, 2018; Mosha, Vedeld, Katani, Kajembe, & Tarimo, 2018). The adoption of open innovation requires that the skills of personnel or extension officers are enhanced to ensure that farmers adopt proper low cost rice production techniques (Ananth, Sahoo, Babu, Barik, & Sundaray, 2018). It is worth knowing that rice production in Ghana has not seen much improvement and lag behind demand and self-sufficiency in terms of productivity (Mabe, 2018).

Previous research has established the relationship between innovation and irrigation systems (van Rooyen, Ramshaw, Moyo, Stirzaker, & Bjornlund, 2017). Irrigation transformations, often based on the adoption of advanced technologies (drip irrigation or sprinkler) which allowed 'quick wins' mainly in large farms, with large-scale public programs, aimed at crop cultivation. This was indicative of a sequential cycle in which knowledge was moved from the inner world of research institutes and universities to the outer world of farmers and consumers (open innovation) (Chesbrough, 2017).

H6. The relationship between irrigation and rice production is moderated by open innovation.

2.1.7 Open innovation and Rice Production

In the past couple of years, open innovation has become a household name in the context of practical and valuable disciplines in the field of innovation study. (Frishammar, Richtnér, Brattström, Magnusson, & Björk, 2018). Open innovation relates to the application of highly customized knowledge inflows and outflows for increasing internal innovation and growing opportunities for global use of innovation.

Open innovation can boost the productivity of companies through technological progress and organizational learning (Gutierrez-Gutierrez, Barrales-Molina, & Kaynak, 2018). Companies have further possibilities to acquire, integrate, and employ knowledge by multi-cooperation with other innovation outlets. Open innovation offers businesses the privilege of discovering, acquiring, and expanding expertise in the current fields of technology (Chesbrough, 2017). Open innovation tools not only facilitate rapid economic implications of growth but also have a positive effect on the mid to long-term success metrics of businesses (Bogers, Chesbrough, & Strand, 2019).

Empirical evidence suggests that open innovation influences output of rice production (Hongyun et al., 2019b). Empirical evidence on open innovation shows positive and significant impact on productivity of firms (Fu, Mohnen, & Zanello, 2018). While there is a clear link between open innovation and performance/output, this study postulates that there is a positive relationship between open innovation and these variables and output- land tenure system, water control system, and inadequate infrastructure (Dodgson, 2018).

H7. Open innovation is positively related to rice production

III. Methodology

This study employs a cross-sectional survey to gather the views of 250 rice farmers. The aim is to determine the factors influencing the production of local rice in Ghana. Quantitative research technique was adopted to find the factor influencing the production of local rice in Ghana. A self-administered survey questionnaire was used to collect the data to empirically examine the hypotheses. Relying on the 2010 Ghana population and housing census, there are 2,118,252 people in the Volta Region (Ghana Statistical Service, 2013). Using a 95% confidence interval, a sample size of 250 was determined (Tweneboah-Koduah, 2018).

Convenience sampling technique was adopted to pick out the farmers for this research owing to the absence of a sampling frame for rice farmers in the Volta Region (Tweneboah-Koduah, 2018; Tweneboah-Koduah & Owusu-Frimpong, 2013). The study was conducted in the Volta Region. So far, Volta Region, the sole region in Ghana in which upland hill rice of Glaberrima origin can still be found. A 5-point Likert scale was adopted from (Tweneboah-Koduah, 2018) questionnaire was self-administered face to face to the respondents measuring the degree of agreement of 1 for strongly disagree to 5 for strongly agree and categorized into two sections. In all, 200 questionnaires representing 80% were used for analysis.

3.1 Variables and measures

The constructs of interest in this research were (open innovation, Infrastructure, Irrigation, land tenure system and output of rice). Regarding measures, the items for land tenure system were adapted from (Yaro, 2012), Items for infrastructure were adopted from (OECD, 2015), we relied on the items developed by (Yun, Park, Kim, & Yang, 2016) to measure openness, measuring scales were derived from previous literature by (Mango et al., 2018) to measure irrigation. Finally, we adapted the scale developed by Anning-Dorson (2018) to measure output.

IV. Analysis

In this analysis, the possible relationships between the constructs were tested/evaluated (open innovation, Infrastructure, Irrigation, land tenure system and output of rice). We employed partial least squares (PLS) with SmartPLS 3.2.8 in the analysis (Ringle, Wende, & Becker, 2015). The primary benefits of structural equation analysis far outweigh the old-fashioned multivariate analysis according to (Haenlein & Kaplan, 2004).

Falk and Miller (1992) submitted that PLS is versatile when it came to upholding minimum sample criteria, determining the scale elements and the distribution of measurable variables; indeed, PLS does not require data normality and is more acceptable concerning large and small samples. The PLS Path Modeling algorithm is a classic measurement method that first examines the measurement model, such as its internal consistency, converging validity and discriminating validity. The second step involves the calculation of the structural model and requires a measure of the collinearity of constructs and an assessment of the significance and the relationships.

4.1 Measurement (outer) Model

To measure all the constructs, the PLS bootstrapping method was used. The criterion suggested for the assessment of the significance of factor loadings by (Hair Jr, Sarstedt, Hopkins, & Kuppelwieser, 2014) has been observed. The composite reliability level is at a minimum agreed at 0.7 (Hulland, 1999) and at a minimum of 0.4 for the average variance extracted (Magner, Welker, & Campbell, 1996). The results for the item loadings are listed in Table 1.

Table 4.1: Measurement Model Analysis

Constructs	Items	Loadings
INF	INF1	0.816
	INF2	0.775
	INF3	0.886
	INF4	0.854
	INF5	0.903
	INF6	0.649
INF * OPNES	OI_INF_MOD	1.301
IRIG	IRIG1	0.767
	IRIG2	0.741
	IRIG3	0.850
	IRIG4	0.838
	IRIG5	0.790
	IRIG6	0.784
IRIG * OPNES	OI_IRIG_MOD	1.343
LAND	LAND1	0.870
	LAND2	0.872
	LAND3	0.848
	LAND4	0.824

	LAND5	0.873
LAND * OPNES	OI_LAND_MOD	1.315
OPNES	OPNES1	0.711
	OPNES2	0.877
	OPNES3	0.906
	OPNES4	0.889
	OPNES5	0.830
	OPNES6	0.802
OUTPUT	OUTPUT1	0.752
	OUTPUT2	0.772
	OUTPUT3	0.669
	OUTPUT4	0.707
	OUTPUT5	0.831
	OUTPUT6	0.852

Note: IRIG = Irrigation, OPNES=Openness, INF= Infrastructure

The findings on reliability and validity of the constructs employed for the analysis are presented below. The internal reliability shows how reliable the measurement components are in the estimation of the particular construct. The standard specifications for inclusion of all constructs is observed. The standard value of 0.70 is needed for Cronbach's Alpha but for our constructs all of them satisfy the requirements. To validate their inclusion, the composite reliability for constructs should be > 0.6. In this analysis, the composite reliability is > 0,6, indicating that all measurement items for their various constructs hold together well.

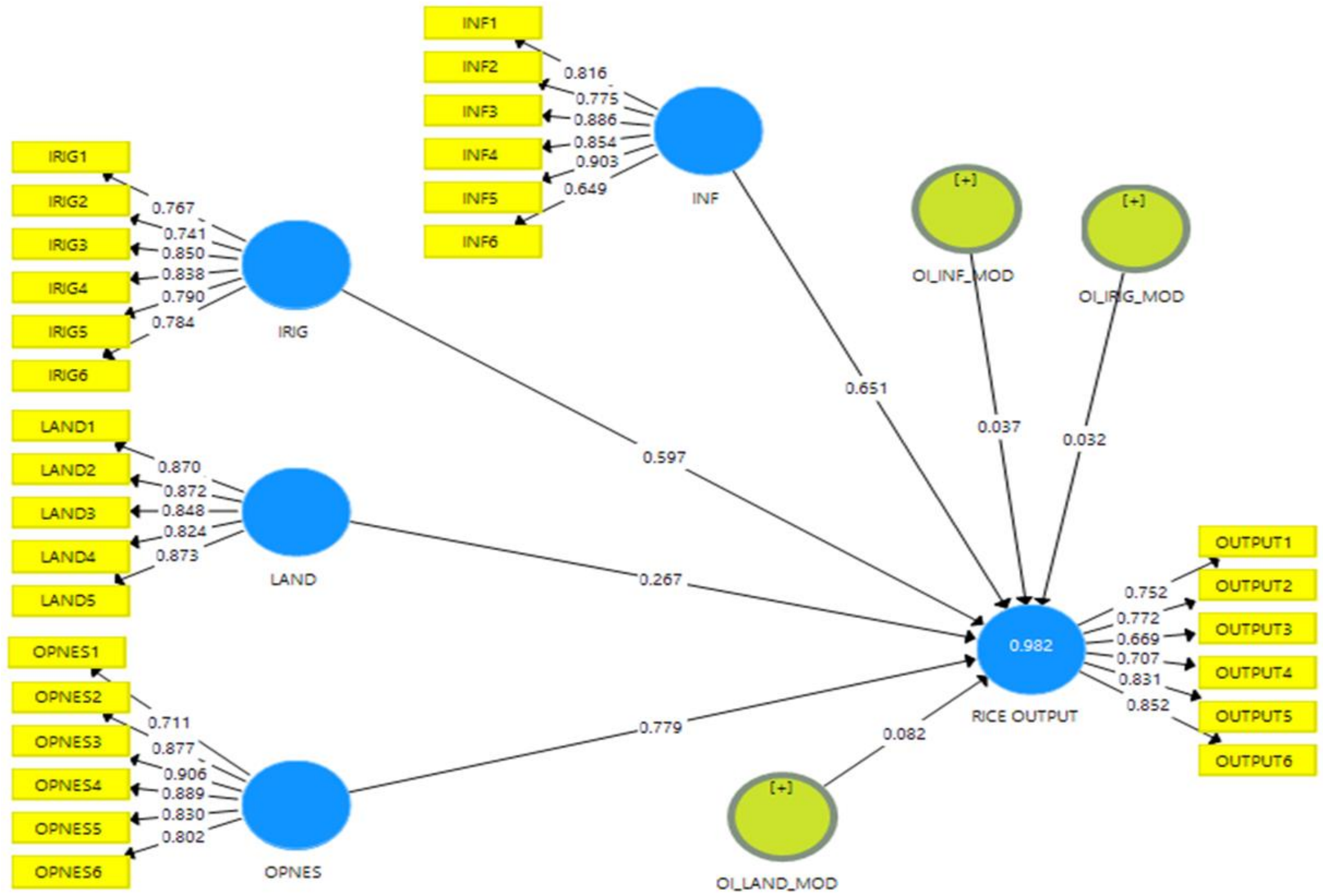


Figure 1. Measurement Model

Until their measurement items can be defined as keeping together it is necessary AVE of a construct to meet requirements of > 0.5. Again, the VIF values are clearly below the threshold of 5, which indicates that collinearity does not reach critical levels in any of the constructs (Hair, Ringle, & Sarstedt, 2011). The table 4.2 below presents the result on reliability and validity of the constructs used for the study.

Table 4.2 : Tests of Construct Reliability and Validity

Constructs	Cronbach alpha	Composite reliability	rho_A	AVE
INF	0.898	0.923	0.903	0.670
OI_INF_MOD	1.000	1.000	1.000	1.000
OI_IRIG_MOD	1.000	1.000	1.000	1.000
OI_LAND_MOD	1.000	1.000	1.000	1.000
IRIG	0.884	0.912	0.889	0.633
LAND	0.910	0.933	0.917	0.735
OPNES	0.914	0.934	0.922	0.703
OUTPUT	0.858	0.895	0.865	0.588

Note: IRIG= Irrigation, OPNES=Openness, INF= Infrastructure

The Table3 below presents the result on the discriminant analysis. Discriminant Validity indicates that the measurement model of the construct is clear of unnecessary elements. The redundant elements must be detected and deleted as the measuring model must be re-run. Free parameter estimates could be limited to redundant pairs. The relationship among exogenous constructs should not surpass 0.85. The magnitude of correlation above 0.85 means that the two exogenous constructs are redundant or have substantial multi-linearity issues.

The result shows that the square root of all AVE values is greater than their latent correlations. Thus, for satisfactory discrimination the diagonal values in the respective rows and columns should be much higher than the off-diagonal values. Table 3 shows that diagonal values (AVE square root) are greater than their respective off-diagonal values and are perfectly valid for discrimination. In other words, the root of the AVE metrics for each construct is considerably greater than the latent variable correlation, and this shows that the final updated test model for all the constructs have sufficient discriminating validity. All constructs achieve the discriminating basic requirements of validity

Table 4.3 : Discriminant Validity

	1	2	3	4	5	6	7	8
INF	**0.818**							
IRIG	0.386	**0.796**						
LAND	0.561	0.550	**0.858**					
OI_INF_MOD	-0.389	0.418	0.610	**1.000**				
OI_IRIG_MOD	-0.361	0.376	0.576	0.501	**1.000**			
OI_LAND_MOD	-0.371	-0.409	-0.380	0.363	0.321	**1.000**		
OPNES	0.662	0.518	0.317	0.544	0.501	0.401	**0.838**	
RICE OUTPUT	0.355	0.541	0.333	0.504	0.459	0.572	0.553	**0.767**

Note: IRIG= Irrigation, OPNES=Openness, INF= Infrastructure

The Table 4 below indicates the outcome of R^2 evaluating the structural model. The estimate for R^2 varies from 0 to 1 with a bigger estimate showing predictive accuracy (Hair Jr et al., 2014). The percentages 075, 0.50 and 0.25, therefore, define the accuracy level of the measurement to be substantial, moderate and low. The accuracy of the model is measured. The R^2 demonstrates the overall effect of the endogenous latent variables, and the magnitude of variances described by the exogenous variables associated with the endogenous latent variable (Hair Jr et al., 2014).

The blindfolding has been used to validate the validity/relevance of the model for each endogenous construct. Q^2 parameters extend from 0.420 to 1.000 in this analysis, suggesting small medium and large effect sizes.

Table 4.4 Result R2 and Q2

Constructs	R-SQUARE	R-SQUARE ADJUSTED	Q^2	EFFECT SIZE
INF			0.521	Large
IRIG			0.473	Large
LAND			0.570	Large
OI_INF_MOD			1.000	Large
OI_IRIG_MOD			1.000	Large
OI_LAND_MOD			1.000	Large
OPNES			0.561	Large
RICE OUTPUT	0.982	0.982	0.420	Large

Note: Small: 0.0 < Q^2 effect size < 0.15; Medium: 0.15 < Q^2 effect size < 0.35; Large: Q^2 effect size > 0.35

The Table 5 below shows f^2 effect size. It reports variations in R^2 when a given exogenous variable is removed from the model (Hair Jr et al., 2014). The research suggests that exogenous constructions have a medium to large impact on endogenous constructions.

Table 4.5. Results of f^2

Constructs	f^2	Effect Size
INF	4.751	Large
IRIG	1.052	Large
LAND	0.256	Medium
OI_INF_MOD	0.023	Small
OI_IRIG_MOD	0.007	Small
OI_LAND_MOD	0.042	Small
OPNES	7.501	Large

Note: small : 0.0 < f^2 effect size < 0.15; Medium: 0.15 < f^2 effect size < 0.35; Large: f^2 effect size> 0.35

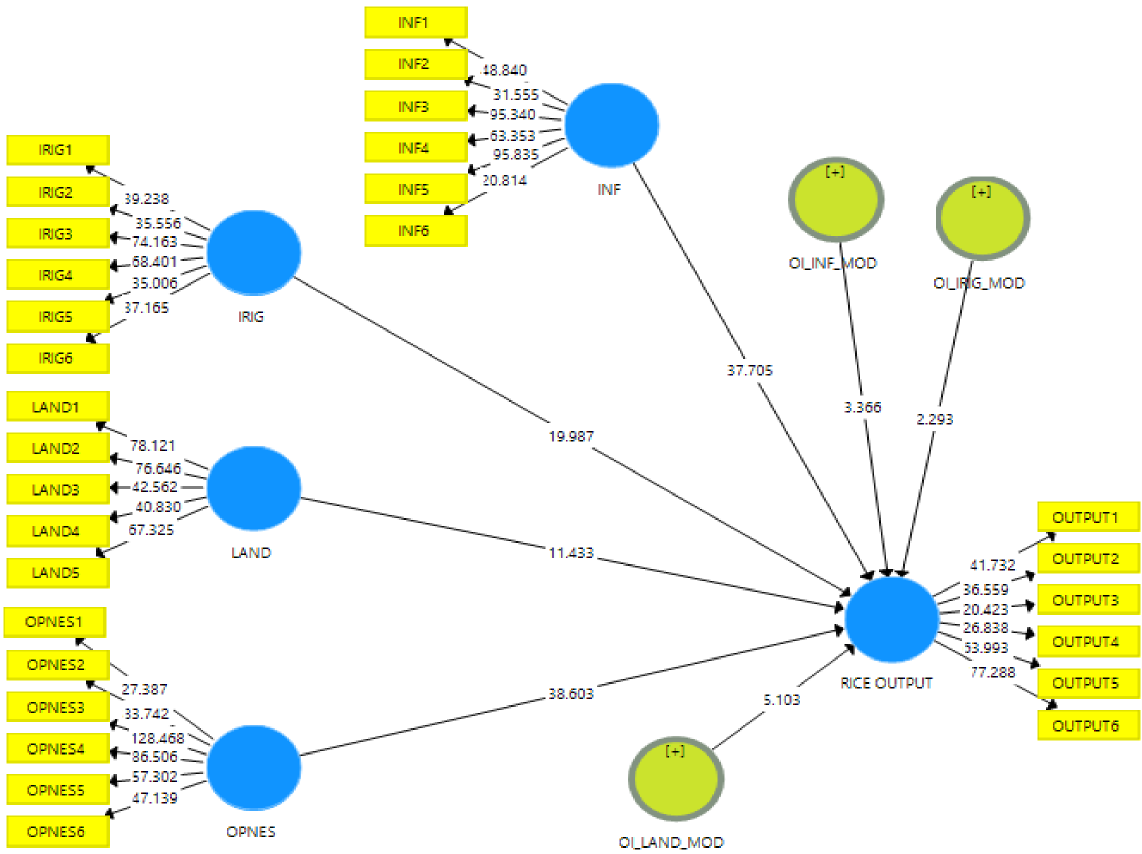


Figure 2. Measurement Model Results

4.2 Testing of hypothesis (Testing of Direct Effect)

The study sought to analyze the factors influencing local rice production in Ghana. The study also analyzed the moderating role of open innovation in the relationships among infrastructure, irrigation and land tenure system and rice output. As shown in Fig. II and Table IV, rice output was used as the dependent variable whereas the factors influencing local rice production were used as independent variables.

The results revealed that Infrastructure has a statistically significant relationship with production of rice (β = 0.651, t-value =37.705, $\rho < 0.000$). Irrigation is found to have influence on the production of rice (β = 0.597, t-value =19.987, $\rho < 0.000$). Moreover, Land tenure system was also found as a significant determinant of rice production (β = 0.267, t-value=11.433, $\rho < 0.000$). The results also revealed that there is a significant positive relationship between open innovation and production of rice (β = 0.779, t-value =38.603, $\rho < 0.000$).

Table 4.6 Structural Model Results

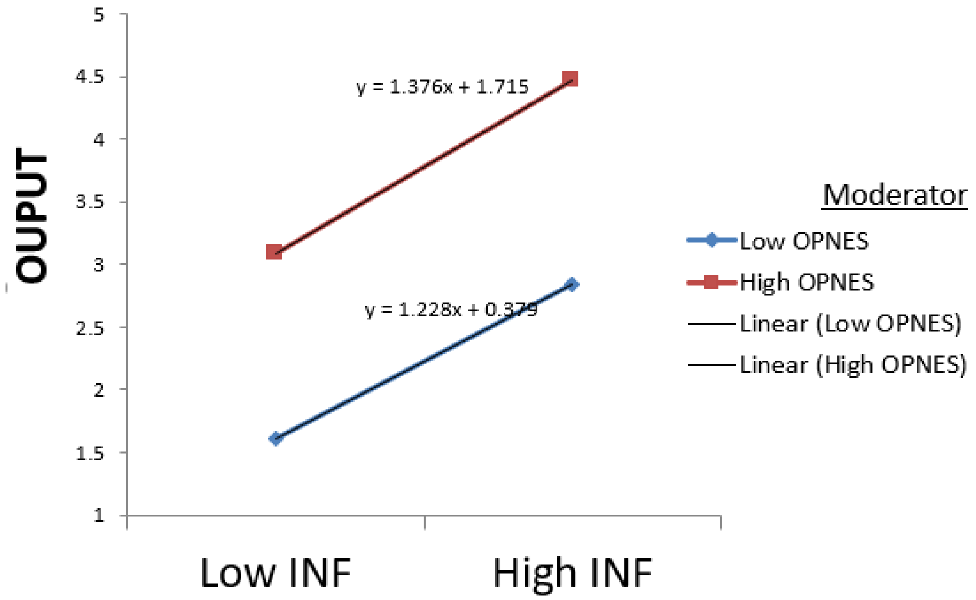
Hypotheses	Original Sample (O)	Sample Mean (M)	Standard Deviation	T-Statistics	P-Value
INF → RICE OUTPUT	0.651	0.650	0.017	37.705	0.000
IRIG → RICE OUTPUT	0.597	0.598	0.030	19.987	0.000
LAND->RICE OUTPUT	0.267	0.268	0.023	11.433	0.000
OI_INF_MOD → RICE OUTPUT	0.037	0.039	0.011	3.366	0.001
OI_IRIG_MOD→RICE OUTPUT	0.032	0.033	0.014	2.293	0.022
OI_LAND_MOD→RICE OUTPUT	0.082	0.084	0.016	5.103	0.000
OPNES→RICE OUTPUT	0.779	0.779	0.020	38.603	0.000

Notes. OI_INF_MOD=Moderating role of open innovation in the relationship between infrastructure and output, OI_IRIG_MOD→RICE OUTPUT =moderating role of open innovation in the relationship between irrigation and output, OI_LAND_MOD→RICE OUTPUT=moderating role of open innovation in the relationship between land tenure system and output.

4.3 Testing the moderating effect

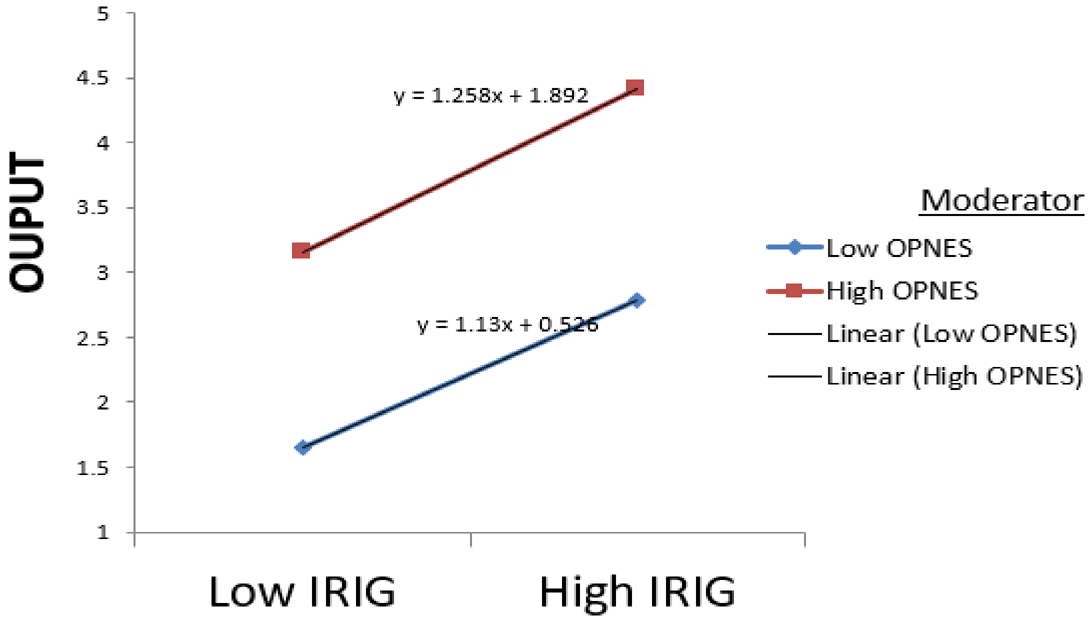
This research adopted the product-indicator technique to test for the moderating effect of open innovation in the relationship among infrastructure, irrigation and land tenure system on the production of rice. Hypothesis 2 states that open innovation moderates the positive relationship between infrastructure and rice output, such that this relationship will be stronger when open innovation is higher than when it is low. Hypothesis 4 states that the relationship between land tenure system and rice production is moderated by open innovation. Again, Hypothesis 6 states that the relationship between irrigation and rice production is moderated by open innovation. As shown in Table 4.6, the results indicate that open innovation positively moderates the relationship between infrastructure and rice output (β = 0.037, t-value =3.366, ρ < 0.001). Similarly, open innovation moderates the positive relationship between irrigation and rice output (β = 0.032, t-value =2.293, ρ < 0.002). Moreover, open innovation moderates the positive relationship between land tenure system and rice output (β = 0.082, t-value =5.103, ρ < 0.000).

The moderating role of open innovation in the relationship between infrastructure and rice output.



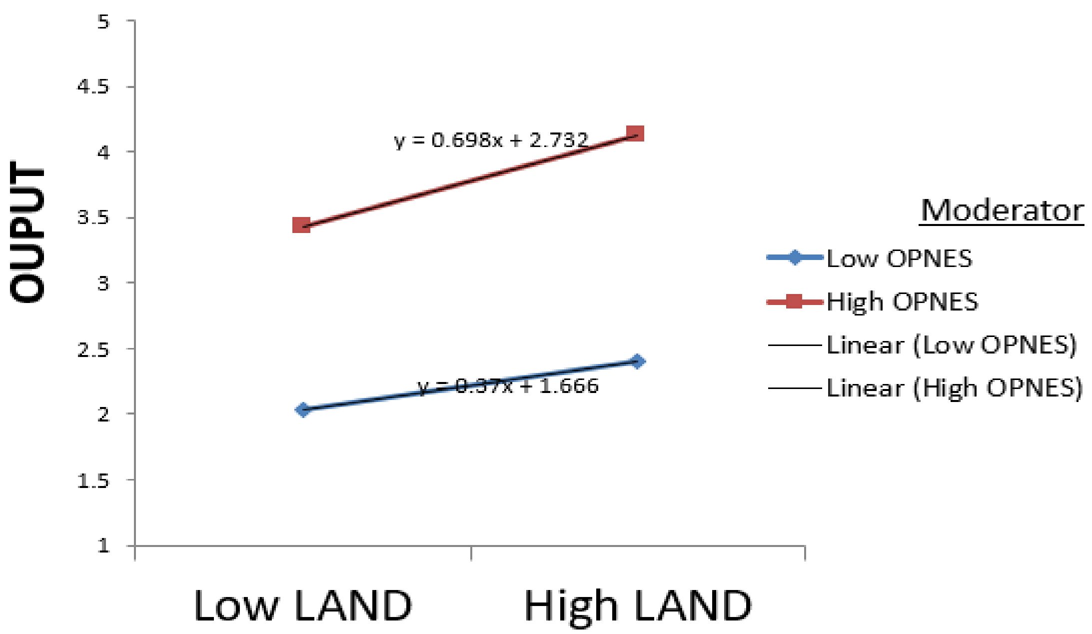
Open innovation strengthens the positive relationship between infrastructure and rice output.

Moderating role of open innovation in the relationship between irrigation and rice output.



Open innovation strengthens the positive relationship between irrigation and rice output

Moderating role of open innovation in the relationship between land tenure system and rice output.



Open innovation strengthens the positive relationship between land tenure system and rice output.

4.4 Discussion and Limitation

The overarching aim of this study is to determine the factors influencing the production of local rice in Ghana with a moderating effect of open innovation. The factors influencing the production of local rice in Ghana were identified through a detailed review of the literature and their impact on output of rice was investigated among rice farmers in the Volta Region of Ghana. The factors were land tenure system, irrigation and infrastructure and open innovation as a moderating variable. Evidence from the study indicates that land tenure system, infrastructure and irrigation are the factors influencing the production of local rice in Ghana.

The study found a positive relationship between land tenure system and output of rice. This is consistent with the previous research by Roland (2016) who argues that land consolidation has significant effect on output. Koirala et al. (2014) examine the factors influencing rice production and the technological output of rice farmers in the Philippines. The finding indicates that land size is a major factor influencing rice production (Koirala et al., 2014). Irrigation was found to be the major contributor to rice output. This finding collaborate with Koirala et al. (2014) who found that investing in irrigation has a positive and statistically significant effect on rice production, at the 10% level of significance. Literature has shown that infrastructure is a variable that influences rice output. This resonates with the findings of Antle (1984) who found that farmers' education, extension schemes, transport and communication infrastructures, provision of irrigations, and use of wide yielding varieties and climate conditions are the function of productivity.

The research found that open innovation is a major determining variable which is widely accepted by management scholars as a major factor influencing performance. This finding is consistent with Fu et al. (2018) who found open innovation to have positive and significant impact on productivity of firms. From the study open innovation was found to moderate the relationship between infrastructure and output of rice. This results collaborate with Yu and Fan (2011) who argue that in order to increase agricultural production and productivity and raise farmers' revenue, the government needs to expand its investment policy to upgrade rural infrastructure, including irrigation, transportation, and electricity. However, this study confirms that the relationship between irrigation and rice output is moderated by open innovation. Rass, Dumbach, Danzinger, Angelika C Bullinger, and Moeslein (2013) posit that, there is a direct relationship between open innovation and output of rice.

Furthermore, there is a moderated relationship between open innovation and other variables. This finding is in harmony with previous work by Fu et al. (2018) who found that firms that are active in innovation have higher productivity than less innovative ones. Moreover, the relationship between land tenure system and output of rice is moderated by open innovation. This is consistent with Kusrini (2018) who examined the impacts on the status of sustainable rice production and the contributing factors of innovation and infrastructure support and argues that owing to restricted land and water supplies, regular changes in the environment, and the high land conversion, sustainable rice production needs the help of open innovation and infrastructure (Kusrini, 2018).

4.5 Innovation and recommendation

The study for the first time applied open innovation as moderator in the production of local rice in Ghana. The study found a direct and positive relationship between open innovation and output of rice production in Ghana. The study recommends that infrastructure is provided in the rice producing areas to enhance rice production by investing in the area of road networks, rice-milling equipment such as pre-cleaners, destoners that separate stones and heavy impurities from grains, hullers, polishers, paddy separators, aspirators and graders, to ensure post-harvest product quality.

The study recommends that the government invests in irrigation infrastructure, irrigation systems be improved while new gravity-controlled schemes will be developed to improve rice production under irrigation and farmers be trained in the maintenance of schemes and the usage of water measuring devices for improved water usage under irrigation.

The study put forward the formulation of suitable land policies to ensuring secure tenancy of farmlands to those who want to go into rice farming. The study sought to find out the factors influencing the production of local rice in Ghana that include land tenure system, infrastructure and irrigation.

4.6 Future Research Direction

Like any other research, this research has limitations, which must be acknowledged. The study focused on only one region in assessing the factors influencing the production of local rice in Ghana. Future research should look at the other regions where local rice is cultivated and how open innovation should be applied to boost rice production in Ghana.

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Cite this article as :

Kankam William Adomako, Tian Hong Yun, Florence Appiah-Twum, Isaac Gumah Akolgo, Eric Owusu Asamoah, "Factors influencing the Production of Local Rice in Ghana : The Moderating Role of Open Innovation", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 7 Issue 2, pp. 679-695, March-April 2020. Available at doi : https://doi.org/10.32628/IJSRSET2072128

Journal URL : http://ijsrset.com/IJSRSET2072128