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FACTORS MILITATING AGAINST THE PRODUCTION OF LOCAL RICE IN GHANA: THE MEDIATING ROLE OF OPEN INNOVATION

Tian Hongyung, Kankam William Adomako, Isaac Gumah Akolgo, Thomas Bilaliib Udimal and Florence Appiah-Twum

School of Management, Jiangsu University, 301 Xuefu Road, Zhenjiang 212013, Jiangsu, P.R. China.

ABSTRACT: *The study reports the factors militating against the production of local rice in Ghana with a mediating effect of open innovation to boost rice production. 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 AMOS 20.0 software package. Findings from the study indicate that land tenure system, inadequate infrastructure and water control system are the factors militating against the production of local rice in Ghana. Moreover, the study found a negative relationship between land tenure system and output of rice. However, the study shows that there is a direct and positive relationship between open innovation and output of rice production in Ghana. The study, therefore, 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.*

KEYWORDS: land tenure system, infrastructure, water control system, open innovation, Ghana

INTRODUCTION

Open innovation has generated high interest among academics and practitioners in recent years, as both small and large firms are adopting open innovation in a grand style(Chesbrough, 2006). Chesbrough (2006) explains "Open innovation as the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology." According to Mabe (2018), the current 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. Open innovation is a framework that has the capacity to relate to the outcomes of open science to a more swift 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).

Rice is a significant staple agriculture food crop in the world, for instance over 30% of Asians, see rice as their life(Mabe, 2018; Talhelm & Oishi, 2018). This suggests that developed and developing economies are shaped by the rice consumption. In fact, rice has shaped the cultures, diets, and economies of both developed and developing countries alike (Ajala & Gana, 2015). The United Nations celebrated the year 2004 as an International year of rice for the immense contribution to the survival of human race. The greater part of the 20th century saw an average surge of rice production to a region of 5.6% per year (Talhelm & Oishi, 2018). Rice is actually a major source of income for most developed and developing economies. Rice has been labeled as the most important food on the world stage. It is widely cultivated in the world only second to wheat. According to Liyanaarachchi, Mahanama, Somasiri, and Punyasiri (2018), rice gives 20% of energy and 13% of protein. Ajala and Gana (2015) argue that rice has been able to meet the world's current population demand consumption per capita of 100kg to 240kg per annum.

West Africa can boast of over 20 million rice farmers. However, more than 50% of rice is imported every year into the sub-region (Klutse, Bationo, & Mando, 2018). The story is not different in Ghana. There has been an upsurge in the quantity of local rice consumption in the country, the demand is still on the lower side (MoFA, 2013). Rice is fast becoming the second staple food crop in Ghana after maize due to the upsurge in demand in the cities (MoFA, 2013). MoFA (2013) report indicated that, rice accounts for 58% of all cereal products imported into the country and 11% of all agricultural products between 2005 and 2009. There is a constant increase in the consumption of rice since the 1980s from about 12.4kg in 1984 to 63 kg in 2015. Currently, the consumption rate of rice in Ghana is expected to reach 63 kg per capita by 2018 (Kwofie & Ngadi, 2017). The city dwellers consume about 76% of total rice in Ghana, with 80% been imported and 20% are locally produced (MoFA, 2013).

In recent years, various governments have been urging consumers to utilize localize products such as local rice (MoFA, 2013). The aim is to deliver economic and social independence to the local economy. Ghana has enjoyed a steady growth in the production of local rice from 300,000 tons in 2005 to about 600,000 tons in 2010(MoFA, 2013). Out of this, 70% of the locally produced rice are consumed in the rural areas, 10% to feed animals and only 20% is consumed in the cities (MoFA, 2013). However, the country spends huge sums of money in importing rice from the USA, Thailand, and China(CARD, 2010). It has been estimated that Ghana spends over US$ 500 million on rice importation every year (Sedem Ehiakpor, Apumbora, Danso-Abbeam, & Adzawla, 2017).

Efforts put in place to boost the production of local rice to curb over-dependence of rice importation are faced with major challenges. Lack of adequate infrastructure for rice processing, land tenure system, lack of water control systems which leads to high-risk and non-intensive cropping practices, low yields and low profitability have been found to be major issues confronting the production and consumption of local rice in Ghana (MoFA, 2013). MoFA (2013), reports

further indicated that only 20% of locally produced rice is consumed in the cities and reduction of soil nutrients affect the production capacity of rice in Ghana. For example, the 2014/2015 farming season, farmers in the three northern regions had thousands of bags of rice locked up in warehouses due to the unavailability of mills to process the commodity, a situation that compelled the farmers to use manual means of rice processing which did not meet market standards (Sedem Ehiakpor et al., 2017). Rice production is faced with major limitation or challenges in Ghana. Rice pests and diseases inflict major losses of rice production and marketing in Ghana(Sedem Ehiakpor et al., 2017). Currently, lack of taste for locally produced rice has become a major social issue in Ghana and most countries on the African continent(Danso-Abbeam & Baiyegunhi, 2017). Due to low quality and poor packaging, most consumers prefer imported rice to the locally produced rice (Danso-Abbeam & Baiyegunhi, 2017; Klutse et al., 2018). Ghanaian consumers often cite the presence of stones and paddy rice in locally produced rice, and high price, as the reason they opt for imported brands(Abdulai, Zakariah, & Donkoh, 2018). This study seeks to determine the factors militating against the production of local rice in Ghana, the mediating effect of open innovation.

LITERATURE REVIEW

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

Rice Production

Rice has become a dominant staple food crop in Ghana. The consumption rate reached 620,000 tons in 2011/2012, with the urban dwellers consuming about 76% out of the 28kg per capita(CARD, 2010). The restaurants, hotels and fast food chain in the cities are the major reasons behind the huge consumption of the commodity. Due to rural-urban migration, which has cumulated to a shift in consumption pattern among city dwellers the demand for rice surged to about 35% in 2006 as indicated in the food and agriculture organization report. Though, Ghana has enjoyed a steady growth in the production of local rice from 300,000 tons in 2005 to about 600,000 tons in 2010, 70% of the locally produced rice is consumed in the rural areas, 10% to feed animals, and only 20% is consumed in the cities due to penchant desire for so-called perfumed rice by urban population(MoFA, 2013).

The Oryza sativa and Oryza Glaberrima are the notable species commonly cultivated among Ghanaian farmers(MoFA, 2013). Rice crop growing can be categorized into six main ecological units; upland, lowland, Deepwater, rain-fed, irrigated and tidal wetlands (MoFA, 2013). Rice accounts for about 19% of the production land of all cereal cultivation in Ghana. There was a surge from 0.09 to 0.16 million hectares in terms of land size between the year 2000 and 2010. Rice production has seen an upward surge over the years. The production pattern went up from 185,000 tons to 491,000 tons between 2007 and 2010 which saw a 15% increase during the same period. This development could be because of improvement in rainfall pattern and fertilizer subsidy program implemented by the government in 2008. Mostly, rice production is rigorously done in the Volta and three Northern regions, with their output totaling up to 80% in 2010. The three regions up north exceeded the national average of 2.71% per hectare but lagged behind an average

yield per hectare in the Greater Accra, which is 5.48 tons per hectare to 2.96 tons per hectare(Sedem Ehiakpor et al., 2017). In 2009, the three regions in the north produced 45,000 tons and 60,000 tons on average (MoFA, 2013).

Open Innovation

Bogers et al. (2018), defined open innovation as dispersed novelty practices grounded on a purposively achieved knowledge flows through administrative boundaries, with the adoption of financial and non-financial procedures to improve innovation. Open innovation takes the form of university research actions, mediators in the innovation process, consumer involvement, business associates, public and other stakeholders in different innovation activities (Fredberg, Elmquist, Ollila, & Yström, 2011). According to Chesbrough (2006)open innovation paradigm thrives on the concept that innovations are often not always motivated and developed entirely within a single firm. Open innovation involves "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively"(Chesbrough, 2006). In principle, open innovation model recommends that the span of innovative outputs be promoted by more openness towards external sources of knowledge. This openness inspires the flexibility of knowledge and information flows between firms. In the same fashion, openness leads to improve efficiency and effectiveness in product and service innovation (Huang & Rice, 2012). As a matter of fact, openness can generate promising solutions to grand challenges of systemic nature(Gryszkiewicz, Toivonen, & Lykourentzou, 2016). Above all, openness can lead the way for radical innovation in an unusual fashion(Gryszkiewicz et al., 2016). To Salter, Ter Wal, Criscuolo, and Alexy (2015)openness delivers value such as awareness and diversity of ideas from partners. The multiplicity of partners in innovation openness leads to a stronger performance in SMEs than larger firms(Ahn, Minshall, & Mortara, 2017). Thus, external knowledge account for 40 per cent of innovative sales in small firms as against 25 per cent in larger firms(Ahn et al., 2017). According to Leiponen and Helfat (2010)argue that firm with more extensive networks of linkages or more different types of linkages is likely to increase the probability of useful knowledge from outside of the firm. Specifically, extant literature shows that knowledge gained from external sources tends to augment firms' internal knowledge in shaping innovation performance(Roper, Du, & Love, 2008). Again, openness really inspires creativity, reduces risk in the process of innovation and accelerates the quality of innovation(Powell, 1998). Wherefore, an external innovation partner increases/enhances firms' access to technological development(Niosi, 1999). Openness has the power to harness the collaborative intelligence of external partners(Archer-Brown & Kietzmann, 2018). According to Roper and Love (2018)openness breeds positive externalities by allowing enhanced knowledge diffusion. Thus, openness is positively related to a firm's innovation performance. According to Julius (2014) open innovation cannot only be applied in the pharmaceutical and high-tech industries but also in the agrarian sector. It is a well-known fact that traditional methods of food production are not sustainable to achieve food security for the fast growing population in the world. Hence, the appropriateness of agric-tech which is the application of technology in agriculture to improve productivity, efficiency and profitability(Fields, 2017). Open innovation is reshaping the agricultural landscape and there is the need to play technological catch-up(Byrum, 2016).AIC (2018) opines that agricultural innovation is the driving force of economic and productivity growth in the agrarian sector, facilitating superior competitiveness as well as opportunities to meet food

security and sustainability goals in most economies around the world. In a similar fashion, agric-tech is a growing industry; with new technology, that has the potential to expand food production whilst reducing the impact on the environment(Fields, 2017). Embracing technological innovations in food production has gained substantial interest among policy makers and academics(Pivoto et al., 2018) due to the fact that agriculture is dominant occupation and lots of people in Ghana derive their livelihood from agriculture. Innovation in new technology offers the opening to increase the production of agriculture productivity substantially(Abdulai et al., 2018). The major constraints to the adoption of open innovation process comprise of the lack of financial support, information asymmetry, inappropriate transportation infrastructure and inadequate farm size. Furthermore, the open innovation is characterized by the degree of openness measured across two dimensions, which are collaboration breadth and collaboration depth. Empirical evidence suggests that, a greater degree openness leads to enhance innovation performance(Medeiros, Binotto, Caleman, & Florindo, 2016). This presupposes adoption of open innovation has the potential to improve rice production. Moreover, the success of open innovation hinges on the type of partnerships as it enables the product development process to better capture customer expectations(Dries, Pascucci, Török, & Tóth, 2014).

Inadequate Infrastructure and Open Innovation

Inadequate infrastructure in this study denotes storage and milling facilities, parboiling equipment, drying patios and warehouse to enhance the standard of rice mill. The Food and Agriculture Minister, Alhaji Mohammed Limuna argues that efforts at increasing local rice production to curb over-reliance on importation of the commodity are being challenged by inadequate infrastructure-precisely rice processing mills-in rice-producing areas in Ghana(Mabe, 2018). For the 2014/2015 farming period, farmers in the three northern regions had thousands of bags of rice locked up in silos because of inadequate mill to process the locally produced rice, a phenomena that forced the growers to apply local methods of rice processing which do not meet market standards. Ghanaian consumers repeatedly mention the presence of stones and paddy rice in domestically cultivated rice, apart from price, as the motivation behind the preference of imported brands. It can be said that inadequate processing milling facilities in the rice producing communities is hampering the production of rice in the country cumulating into the poor quality of rice produce locally . The limited number of processing machines in the region is non-operational -a situation that has forced government to continue pumping in huge sums of money to import similar goods to meet demands of the population. This is causing ripple effects on income generation of the smallholder farmers, aside discouraging most of the farmers from venturing into the rice sector only to incur debt(Mabe, 2018), as farmers are mostly confronted with lack of processing facilities by relying on locally made drums for threshing of paddy and travel long distances to mill paddy rice. However, the adoption of open innovation can improve the quality of rice for the target audiences. 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.

H1a: There is a direct relationship between infrastructure and rice production
H1b: The relationship between infrastructure and rice production is mediated by open innovation.

Land Tenure system and Open Innovation

Land tenure system to be innumerable decrees, precepts and responsibilities prevailing the allotment/or right and interest to own a land(Kasanga, 1988; Kasanga & Kotey, 2001). Over the years, the land tenure system has been used as a socio-legal basis in the administration of lands: that is rights and interest and how to develop or transfer land in the 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 land tenure system is a major setback in the production of rice in the country due to its ripple effects on both acquisition and security (Alarima, Adamu, Masunaga, & Wakatsuki, 2011; Naab, Dinye, & Kasanga, 2013). Alarima et al. (2011)found negative relationship between land tenure system and rice production in Nigeria. The process has a habit of limiting the size of possessions and reserves towards land development, particularly in the low-lying rain fed ecology. As right to use land becomes constrained, land tenure systems for farming are inclining to shift away from out-of-date household and sharecropping activities towards a more cash shorter-term rents paid in cash(Naab et al., 2013). According to Yaro (2012) the dynamic nature of the customary land tenure systems has created a state of insecurity and pressure as the title and duties of owners depend on the interpretation by those who administer custom. In recent years, key milestone has been achieved in increasing rice production through the development of these high-yielding varieties through conventional breeding techniques and the way forward for increasing yield potential. As the issue of land tenure system keeps reducing farm size, the solution lies in the adoption of open innovation in the use of farm land, adoption of semi dwarf, high-yielding varieties coupled with improved production technologies coming into the production of rice such as the Green Revolution (Mohanty et al., 2017).

H2a: There is a negative relationship between land tenure system and rice production.
H2b: The relationship between land tenure system and rice production is mediated by open innovation.

Water Control systems/Irrigation

Irrigation is the labor-intensive mechanism for supplying water for growing crops. In the cultivation of crops it is mostly useful in the dry season and dry areas to protect crops(Boserup, 2017). In the case of farming purposes, use of appropriate schemes of irrigation and its control is crucial. Typically, there are two kinds of controllers appropriate for controlling irrigation schemes: Open control loop systems and closed control loop systems. Open control loop systems relate to the usage of a fixed stroke, for example as it is seen with simple irrigation timers. Closed control loops take delivery of response from devices, act on the information and make use of the output of these results to the irrigation system(Schubert, 2018). To increase rice cultivation under irrigation, current systems will have to be transformed while new gravity-controlled projects will have to be constructed. In the rain fed lowlands, groups will be mobilized to partake in the construction or building of simple and low cost water control systems for enhanced rice production. Farmers will be educated to enhance their knowledge in the usage and repairing of systems. Water evaluating machines for superior water usage under irrigation will be provided. It is envisioned to build the technical know-how of operators to organize farmers to partake in the expansion of water control systems and to draw the general public's readiness to preserve these

structures. 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).

H3a: There is a significant positive relationship between water control system and rice production.
H3b: The relationship between water control system and rice production is mediated by open innovation.

Open innovation and Output of rice

In recent years, open innovation has become a household name in the area of practical and vital themes in innovation research arena(Frishammar, Richtnér, Brattström, Magnusson, & Björk, 2018). Open innovation refers to the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation. Open innovation has the capacity to enhance the performance of firms through promoting organizational learning(Gutierrez-Gutierrez, Barrales-Molina, & Kaynak, 2018). Firms have more advantages in knowledge acquisition, absorption and utilization by the means of multi-cooperation with external technology sources. Open innovation has value for firms to explore and absorb new knowledge, and to enhance knowledge capability in the existing technology areas. Open innovation instruments not only foster immediate innovation outcomes, but also positively affect mid- to long-term firm performance measures. Empirical evidence suggests that open innovation influences output of rice production. We sought to postulate that though there is direct relationship between open innovation and output, there is a mediated relationship between open innovation and these variables and output- land tenure system, water control system, and inadequate infrastructure(Dodgson, 2018). Empirical evidence on open innovation shows positive and significant impact on productivity of firms (Fu, Mohnen, & Zanello, 2018).

H4: There is positive relationship between open innovation and output of rice.

METHODOLOGY

This study employs a cross-sectional survey to gather the views of 250 rice farmers. The aim is to determine the factors militating against the production of local rice in Ghana. Quantitative research technique was adopted to find the factor militating against 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. Section A was made up of questions on the factors militating against local rice production and Section B was used to solicit the demographic information of rice farmers. In all, 200 questionnaires representing 80% were used for analysis.

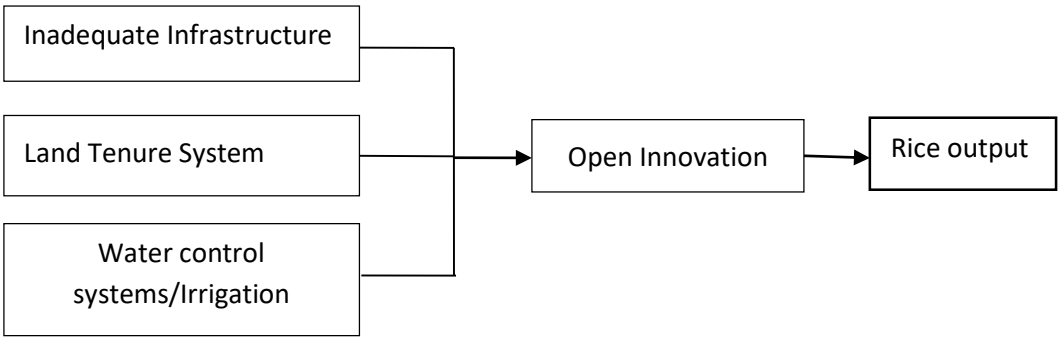

Fig 1 Conceptual framework

The data was analyzed using AMOS 20.0 software package. In order to adhere to modifications made in the indicators, the study through Amos 20.0 conducted confirmatory factor analysis. To ensure that the data is representative of its intended purpose, reliability, validity and factor loadings for the variables were assessed. An examination of the indicator loadings indicated that all factor loadings were significant. The Cronbach alpha for the constructs ranges from 0.882 to 0.939, which are well above the 0.70 indicating a good internal reliability of the constructs indicators. The data achieved validity test as all the values of AVE exceed the 0.50 threshold as well as the model achieved all the fitness indexes.

The analysis indicates that all the measurement models and constructs used fit the data well thus Absolute fit index, Incremental fit index and Parsimonious fit index were all within the acceptable ranges (RMSEA= 0.06, CFI = 0.947, GFI = 0.943). This is shown in table 1. This means that the data is a true measure of the model.

Name of Category	Name of Index
Absolute Fit	RMSEA = 0.060
	GFI = 0.943
Incremental Fit	AGFI = 0.904
	CFI = 0.947
	TLI = 0.956
	NFI = 0.962
Parsimonious Fit	Chisq/df = 1.713

Items	Estimate	P-value	Result
Open Innovation<--- Inadequate Infrastructure	1.263	0.008	Significant
Open Innovation <--- Water Control System	1.151	0.007	Significant
Open Innovation <--- Land Tenure System	Constraint		
Output <---Land Tenur System	-0.112	0.005	Significant
Output <--- Open Innovation	0.066	0.003	Significant
Output <--- Water Control System	0.154	0.686	Not Significant
Output <---Inadequate Infrastructure	Constraint		

Testing of hypothesis

The results confirmed and supported hypothesis H1 (β =1.263, P < 0.008), H2 (β = -0.112, P < 0.005), H4 (β = 1.151, P< 0.007) and H5 (β = 0.066, P < 0.003) showing positive and significant levels whilst hypothesis H2 shows negative relationship with output statistically significant.

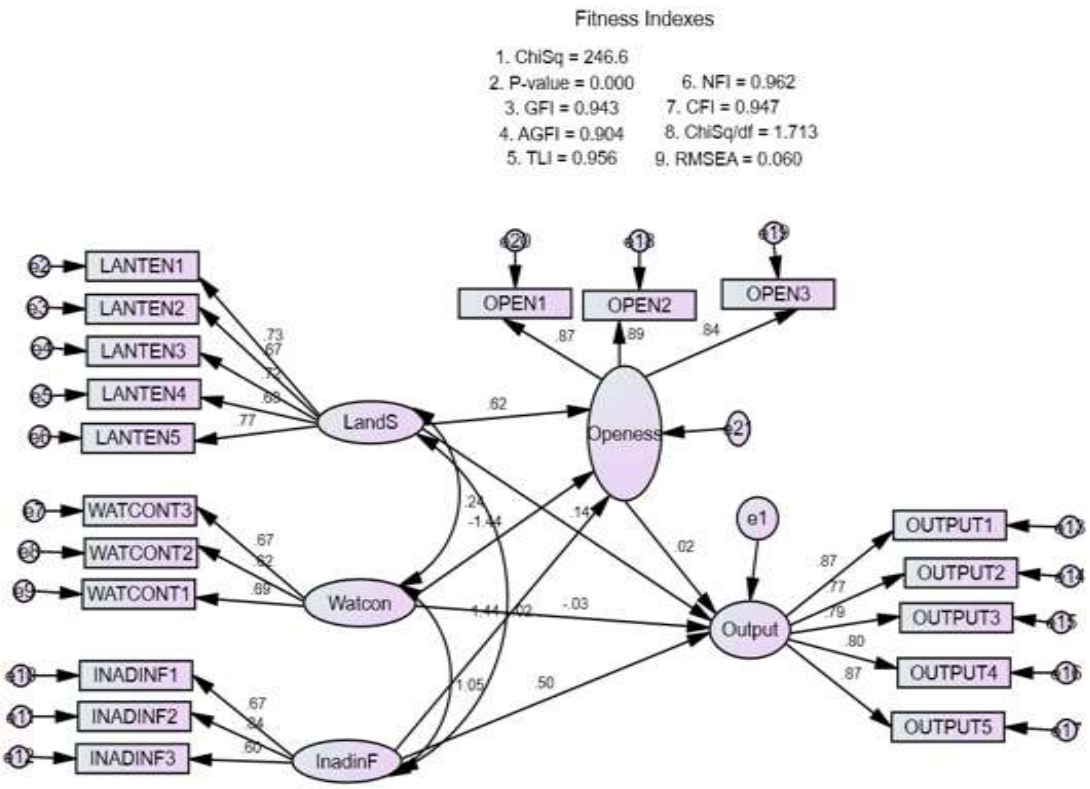

Figure 2

DISCUSSION AND LIMITATION

The overarching aim of this study is to determine the factors militating against the production of local rice in Ghana with a mediating effect of open innovation. The factors were land tenure system, water control system/irrigation and inadequate infrastructure and open innovation as a mediating variable. Evidence from the study indicates that land tenure system, inadequate infrastructure and water control system are the factors militating against the production of local rice in Ghana. The hypothesis H2 posited that, there is a negative relationship between land tenure system and output of rice in Ghana. The study found a negative relationship between land tenure system and output of rice. This is consistent with the previous research by (Alarima et al., 2011)who found negative relationship between land tenure system and rice production in Nigeria. Again, Naab et al. (2013) concluded that land tenure system is a major setback in the production of rice in Ghana due to its ripple effects on both acquisition and security.

Open innovation was used as a mediator in the study mediating between the inadequate infrastructure and output of rice. This results collaborate with(Fu et al., 2018; Rass, Dumbach, Danzinger, Angelika C Bullinger, & Moeslein, 2013) who found open innovation to have a mediation between inadequate infrastructure and output of rice. Moreover, the study found water

control system to have no significant relationship with output of rice. The possible explanation to this finding possibly comes from the fact that all the various dams built to support food production are not in used thereby having effect on rice production in Ghana. However, this study confirms that the relationship between water control system and rice output is mediated by open innovation. (Rass et al., 2013) posit that, even though there is a direct relationship between open innovation and output of rice, there is a mediated relationship between open innovation and other variables confirming hypothesis H4. 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. The most striking result of the study shows that there is a direct and positive relationship between open innovation and output of rice production in Ghana. That is, confirming hypothesis H5, this finding is in tandem with the works of Fu et al. (2018)and Rass et al. (2013)who found that open innovation influences performance.

Innovation and recommendation

The study for the first time applied open innovation 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 militating against the production of local rice in Ghana that include land tenure system, infrastructure and water control system/irrigation. Future research could expand the scope by including the variables militating against the production of local rice in Ghana. Future studies should examine the significance of open innovation in the production of local rice.

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 militating against 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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Constructs and their measures

		1	2	3	4	5
	Land Tenure System					
1.	There is lack of access to financial credit to rent land.					
2	Renting land is too costly					
3	There is traditional land tenure system					
4	Land shortage militate against rice production					
5	Size and quality of cultivatable land positively influenced the adoption of rice.					
	Inadequate Infrastructure					
6	There is lack of appropriate farming implements, post-harvest handling and processing equipment especially rice mills and threshers					
7	Lack storage facilities and rice mills					
8	Poor irrigation systems/facilities					
	Water control system/Irrigation					
9	There is unreliable water source/rainfall and prolonged drought					
10	Inadequate skills in water harvesting andirrigation					
11	Farm irrigation systems have been designed and operated to supply the individual requirements of each field on the farm					
	Output of Rice Production					
12	Government assistance in the provision of herbicides					
13	Improved seeds from the government will enhance the production of rice					
14	Increased contact with extension services					
15	Introduce irrigation systems would improve rice production					
16	There is inadequacy of researchers, technicians and extension staff for effective research to generate technologies for dissemination to stakeholders along the value chain to boost rice production.					
	Open Innovation					
17	Farmers believe that it is good to use external sources (e.g. research groups, universities, suppliers, customers, competitors, etc.) to Complement and improve production of rice					
18	Farmers believe bringing in externally developed knowledge and technology to use in conjunction with our own R&D.					
19	Farmers are opened to other government research organizations to improve rice production					