

Evaluating the Effect of Domestic Price on Rice Cultivation in an African Setting: A Typical Evidence of the Sierra Leone Case

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Abstract—Rice, which is the staple food in Sierra Leone, is consumed on a daily basis. It is the most imperative food crop extensively grown by farmers across all ecologies in the country. Though much attention is now given to rice grain production through the Small Holder Commercialization Programme (SHCP), however, no attention has been given in investigating the limitations faced by rice producers. This paper will contribute to attempts to overcome the development challenges caused by food insecurity. The objective of this paper is thus, to analysis the relationship between rice production and the domestic retail price of rice. The study employed a log linear model in which, the quantity of rice produced is the dependent variable, quantity of rice imported, price of imported rice and price of domestic rice as explanatory variables. Findings showed that, locally produced rice is even more expensive than the imported rice per ton, and almost all the inhabitants in the capital city which hosts about 65% of the entire population of the country favor imported rice, as it is free from stones with other impurities. On the other hand, to control price and simultaneously increase rice production, the government should purchase the rice from the farmers and then sell to private retailers.

Keywords—Domestic price of rice, Econometric model, Rice production, Sierra Leone.

I. INTRODUCTION

FOR many years, rice grain has taken an excellent position as an intentional crop for food security and economic growth of many nations around the world. FAO (2000) classified the crop as the most important food depended upon by over 50 percent [1] with nearly 80 percent of the world's population [2] to meet their daily requirements for energy [3]. As a result of the importance of both food and nutritional security [4], with growing challenges of the attainment food necessity, it has been projected that annual rice production, needs to increase by 5.8 million metric tons in 2020 [5] to meet the anticipated global demand by 2030. The latest global trend in the rice industry explains that, there is an emergent import demand for the commodity in sub-Saharan Africa, as witness from pressure on the world supply with the steady increase in the boom in commodity price over about the last five years [6]. The African continent has become a key factor

in international rice business, accounting for 32% of global imports in 2006, at a record level of 9 million tones that year [7]. Africa's emergence as a full-scale rice importer is elucidated by the fact that during the previous decade rice has become the fastest-growing food source in Africa [8]. Certainly, as a result of population growth, rising incomes and shift in consumer preferences in favor of rice, especially in urban areas [9]. The relative growth in demand for rice is faster in this region than anywhere in the world [10]. This has been happening throughout the sub regions of Africa. Recently (2005–2011); rice production has been increasing at a rate of 8% annually, with 77% of the production increase because of expansion in acreage with only 35% being attributed to an increase in output. A large amount of the acreage expansion has been in the rainfed eco-zones, predominantly the two main eco-zones that make up 80% of rice acreage in West and Central Africa sub regions, the rainfed lowland and upland rice ecosystems [11], however, demand for rice grain in both Central and West African sub regions, has far surpassed the local production. Africa cultivated about 9 million hectares of rice in 2006 and production [12], which surpassed 20 million tons for the first time, is expected to increase by 7% per year in future [12]. Within the West Africa sub region, where the rice sub-sector is certainly the most imperative in sub-Saharan Africa, the circumstances is mostly grave. Regardless of the upward trends in international and local rice consumption is increasing at a rate of 9% annually, exceeding local rice production growth rates of 7% annually. The production-consumption gap in this sub region is being filled with by importations, valued at over US\$ 1.7 billion per year [13]. The share of imports in consumption rose from an average of 43% from 1991 to 2000, to an average 57% by 2002–2004 [13]. The FAO projected that present rice importations into the Central Africa and West sub-regions had grown to an amount greater than 6 million tons costing about \$ 1.2 billion in scarce foreign exchange yearly. The cost of importing rice thus, remains a serious burden on trade balances in the sub-region.

The crop rice has long been gathered, utilized, and cultivated by various populations around the world for more than 20,000 years ago, longer than most crops. The total area under rice cultivation is globally estimated to be 150,000,000 ha with annual production averaging 500,000,000 metric tons [14] and this represents about 31% of the total harvest of grain crops globally. Around 2005, more than half of the global population depended on rice grain as its main daily source of carbohydrates and protein, each consuming from 110 to 200kg

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of rice annually. Conversely, the Green Revolution of the mid 1960s, saved the world's population from a disaster of eminent food scarcity, it was the severe increase in rice productivity that solved the then distressed food demands of the world's populations. At present, around two billion people in Asia continent alone receive 82% of their calorie ingestion from rice. In accordance with the projected population expansion, the population that depends on rice globally is expected to reach 3.7 billion in 2030. The value of the crop in food security and socioeconomic solidity is thus obvious. The significance of rice grain in the national and international economies obliged the development of resolution 2000/2001 of the international Conference on FAO of the UN to proclaim 2004 as the International Year of rice grain.

Rice is the leading and main food crop that most Sierra Leoneans depend on, and constitutes a key part of their diet. Within the last three decades rice grain has seen steady increase in demand and its growing significance is obvious in the food security planning strategies of Sierra Leone. Though a small number of countries have achieved self-sufficiency in rice production, the demand for the crop exceeds production with large quantities of rice imported to meet the demand at a huge cost in Sierra Leone. Rice has been established in the agricultural sector and diets of Sierra Leoneans.

In Sierra Leone, rice crop is mostly produced in the upland eco-zones, which account for about 68% of total national rice acreage. The inland valley swamp is the second major eco-zones, which covers another 28%. A small portion, less than 8%, of the inland valley swamp rice acreage have been developed, and this allows partial water control. Local rice production has declined, and Sierra Leone currently meets only 66% of its total needs. As the nation recovers from civil conflict, a sustainable rice production will rely on better support for input supply with output marketing, as well as development of lowland rice productivity.

The Sierra Leone Government has prioritized agricultural sector as the most imperative division of the country's economy around which it has focuses its development efforts. However, this is not astonishing as agriculture contributes about 48% of the national GDP and employs more than 77% of the national labor force. Seventy-four percent of the land area of the country, covering 5.6 million hectares, is appropriate for cultivation. This area comprises 1.1 million hectares of lowland and 4.3 million of upland. About 88% of the lowland ecology is arable and suitable for rice cultivation, and these comprise the fertile inland valley swamps that are found in all the farming communities in the country, the deep flooding riverain grasslands in the southern province, the less fertile saucer shaped bolilands in the northern region and the tidal mangrove swamps of the North-western coastal belt. Rice in Sierra Leone is also grown on the upland regions, using the environmentally damaging, slashing and burning system of cultivation which is being discouraged by the agricultural authorities. About 95 of the Sierra Leonean farmers reside in the rural communities where they derive their livelihoods from agricultural activities. And yet, each year the country do imports about 39% of the staple food. Subsistence rice

farming is the leading agricultural activity that is practice by nearly 85% of the farming families. Though farmers do cultivate other crops such as sweet potatoes, cassava, and vegetables, rice is evidently the foremost crop cultivated by most farmers.

Sierra Leone requires about 530,000mt of milled rice [15] yearly to meet the consumption requirements of the population. The National paddy rice production was estimated at 525,000mt in 2006 and 639,000mt in 2007. The level of rice independence rose from 57.48 percent in 2002, to 69.50 percent in 2005 and followed by 72 percent in 2007. This implies the rest must be imported at an increasingly expensive price in the existing situation of high prices for foodstuffs including rice. The International nominal prices of most food commodities reached, in the first four months of 2008, their highest peak in almost 45 years, while prices in actual terms in nearly 35 years. The price of rice, the leading staple food in Sierra Leone has seen a steady increase by more than 55% generally in the whole country.

The rising of food prices including rice in Sierra Leone since January 2008 up till now is a very serious risk to the livelihoods of most Sierra Leoneans. Mostly affected by this latest food price inflation, are those with low-income in the urban areas and peri-urban families, who are mostly reliant on the market to access their daily food needs. Smallholder food deficit cultivators are also among the mostly affected by the persistent increase in prices of the leading food, causing among them, and extreme levels of food uncertainty. The development of local rice production is thus a key factor in the strategies for developing food security, motivate economic growth and hence increase rural income. Attempt to support rice production schemes is the only solution to drag the country beyond the worsening rice circumstances and reverse the present declining trend in food independence. Although rice is the staple food of most Sierra Leoneans, so far the annual per capita consumption of rice is regarded the highest amongst the sub Saharan Africa.

In Sierra Leone, The production of rice is mostly in the hands of the small-scale cultivators who produce barely sufficient for home use with little or nothing for the market. During the 2005/06 cropping period 58 percent of the households only cultivated less than 2 ha of farm land whereas only 46 percent cultivated 2ha and above. Rice acreages per household ranged from 0.5ha to 6.5ha with an average of 1.12 ha. Generally the small-scale cultivators in Sierra Leone are resource poor with only the hoe and cutlass as the main implements while extensive labor is largely supplied by members of the household thereby limiting their scale of production. Conversely, pervasive use of unimproved varieties, limited use of chemical fertilizer, in addition to unimproved cultural activities negatively affects rice production.

Since country's independence, the agricultural policy has been focused on the realization of rice self-reliance among other objectives. The major government interventions in the agricultural sector have incorporated both direct government participation (advanced rice farming) and indirect, through the

donor-funded incorporated agricultural projects. All the interventions targeted small-holder cultivators, who make up about 85% of the farming populace. However, the outcome of these interventions was generally unsatisfactory and throughout the last 25 years, the generally performance of the agricultural division has been unsatisfactory. There are some major challenges to conquer, if Sierra Leone has to eliminate extreme hunger, and these include:

- Food uncertainty remains a threat particularly in rural regions of Sierra Leone.
- Production technology is still at the subsistence-stage and requires a changeover to commercial agriculture.
- Majority of the population has inadequate information of nutrition, translating into poor dieting activities with the high incidence of malnourished as well as poor growth in children.
- The service delivery system for production (modern inputs and research) is feeble.
- The lack of an inclusive agricultural database system poses difficulty for predicting climatic situations, pest as well as disease threats.

A rice production survey was recently implemented in Sierra Leone and the results indicates that the final consumers of rice grain in the country could not notice the impact of domestic rice production due to their preference for imported rice varieties from abroad. Thus, This Study reveals a new opportunity for assessing the rice production in Sierra Leone, anchored in the data collected by the Statistics Sierra Leone (SSL). Better accuracy at the country level will offer the necessary foundations for enhancing rice production and thus, overcoming food uncertainty in the country.

The study then aims to answer the subsequent research question:

Does domestic price of rice affect rice production?

The objective of this study is to assess the constraints hindering rice production in Sierra Leone using econometric model and specifically:

To examine the association between rice production and the domestic retail price of rice.

II. MATERIALS AND METHODS

This section emphasizes the materials and methodology utilized in the study.

A. Econometric Model Specification

The major considerations in designing a model were to incorporate all essential demand-side, supply-side with policy variables and keep it straight and effectual in explaining the reasons of variation in rice output over the period 2001-2010. In this model, the quantity of domestic rice produce yearly is the dependent variable. The explanatory variables include price of imported rice, quantity of imported rice and the price of domestic rice. These variables are significant in understanding the variations in rice output in Sierra Leone.

From the theoretical and empirical discussions, the rice production function for this study can be specified in the form of a log as:

$$\begin{aligned} \ln(QDRP)_t = & \theta + \lambda_1 \ln(RPDR)_t + \\ & \lambda_2 \ln(QRI)_t + \lambda_3 \ln(RPIR)_t + \delta_t \end{aligned} \quad (1)$$

where: QDRP=quantity of domestic rice produced
RPDR= retail price of domestic rice in Leones (Le)
QRI=Quantity of rice imported into the country
RPIR= retail price of imported rice in Leones (Le)
 δ_t = white noise error term

B. A Prior Signs of the Variables

The retail price of domestic rice is projected to have a positive association with the quantity of rice produced, since the price serves as an incentive to producers for a higher demand and thus motivates producers to produce more rice thereby taken advantage of the higher price and hence earn higher earnings.

The sign on the coefficient of the quantity of rice imported (QRI) is projected to be negative since the two commodities are substitutes; which imply the more rice produced, the less imported rice and the reverse is also true.

The sign on the coefficient of the retail price of imported rice is projected to be positive as the higher the price of the imported rice, the lesser the quantity consumed and thus, the lesser the quantity imported, and the lower the quantity of imported rice, the higher the demand for domestically produce rice, and so the higher the quantity of domestic or local rice produced to catch up with the higher demand [16].

C. Stationarity and Non-Stationarity

The significance of the perception of stationarity arises from the reality that practically the whole concept of statistical estimation theory is anchored in asymptotic convergence theorems (and that is the weak law of large numbers), which presumes that all data series are stationary. In the real world, however, non-stationarity is very common in macroeconomic time series such as money supply, consumption, prices, and income and trade data. If the authors treat non-stationary series as stationary, then it will bias the method of Ordinary Least Squares (OLS), and hence, will bring about misleading economic analysis. For instance, the model will systematically go wrong in predicting results and can as well cause the problem of spurious regressions in a situation where R-squared is approximating unity; F and t statistics appear significant and valid. Fundamentally, the problem lies with the incidence of spurious regression that occurs where the regression model of non-stationary series, and which are unrelated, shows that the series are correlated. Therefore, there is usually a problem of inaccuracy concluding that a correlation exists between two unrelated non-stationary series. The problem usually increases with increase in sample size, and is not usually solved by integrating a deterministic time trend as an explanatory variables so as to induce stationarity. To evade the spurious regression difficulty, and its related non-stationary trend of the variables, the stationarity tests were executed on the variable. As long as stationarity or non-stationarity of the variable was ascertained, the non-stationary

variable can be differenced to take the non-stationary series to stationarity.

D. Unit Root Testing

After ascertain the vector of variables of interest, and then we can consider the order of integration (stationary) of each series by utilizing Augmented Dickey-Fuller (ADF) unit root test [17]. This is a 't' test that depends on rejecting the hypothesis that, the series follows a random walk [18] supportive of stationarity. The ADF test has higher predictive value, particularly, when the series follows an autoregressive (AR) procedure, which is reasonable for various less frequent data sets, for instance the annual series being employed in this study. The ADF can be represented as:

$$\Delta\rho_t = \lambda\rho_{t-1} + \beta t + \varepsilon_t \quad (2)$$

The ADF Test is;

H0. $\lambda = 0$; that is, ρ_t has units roots-not stationary

H1. $\lambda \neq 0$; that is, ρ_t has no units' roots-stationary

The unit root testing results obtained by using the ADF tests are treated as dependable for this study, and thus, it would appear rational to continue only with these results considering the data limitation faced during the study. The SPSS 19 statistical package was used to achieve the results.

III. RESULTS AND DISCUSSIONS

In this section the authors analyze the data and discuss the results of the log regression.

A. Descriptive Analysis

Rice is the cultural and staple food for most Sierra Leoneans, and by itself, its production is a foremost agricultural activity. Yet, rice is produced by mostly small-scale farmers working at a subsistence scale. In an effort to achieve food independence, the Sierra Leone government does offer assistance to farmers such as improve seeds, fertilizers as well as some farming implements to help the production process. Table I underneath presents a descriptive analysis of the variables that are included in this work.

Table I explains that the average rice production for the period 2001 to 2010 the 10-year period is 901,103.4 metric tons, whereas the maximum registered in 2010 is 1,334,122. Conversely, the average retail price per ton for domestic rice is Le 1, 917,111, whereas the average retail price of imported rice is Le1, 442,435.213. This explains that the domestic rice is even more expensive than the imported rice per ton; and this emphasizes the argument that rice importation is discouraging the efforts to promote local production as a feasible income generating activity. Though the quantity imported is comparatively small (166.1211 metric tons annually), it is competent of feeding the inhabitants in the urban area of Sierra Leone.

B. General Model Results

In this section, the authors run the model on the log of the data collected for each variable without scrutiny for time series properties of the variables under consideration and it is specified as:

$$\begin{aligned} \text{Ln}(\text{QDRP})_t = & \theta + \lambda_1 \text{Ln}(\text{PDR})_t + \lambda_2 \text{Ln}(\text{QRI})_t + \\ & \lambda_3 \text{Ln}(\text{PIR})_t + \delta_t \end{aligned} \quad (3)$$

The results in Table II show that R-squared has a value 0.9454, this means, about 94.5% of variations in the dependent variable (LnQDRt) are explained by the variations in the explanatory variables. Again, the Adjusted R-squared, that captures the relational effect of an added variable on the dependent variable, has high value of 93.2%. This explains that the model was a good fit. Additionally, the F-Statistic, tests the joint significance of the independent variables at the 1% level of significant. This implies that the explanatory or independent variables are jointly significant in establishing the variations in the dependent variable (QDRP); that the joint changes of the independent variables significantly affect the progress of the quantity of rice production in Sierra Leone.

Table II illustrates that only log of the quantity of rice imported is significant at 5% level; the other two explanatory variables are not significantly correlated with the dependent variable. Therefore, the authors suggest model specification problem, this could indicates that the model is suffering from multi-co linearity difficulty as suggested by the DW Statistic of 2.8 (Table II). The quantities and retail prices of both domestic and imported rice are shown in Fig. 1

TABLE I
DESCRIPTIVE STATISTICS OF VARIABLES OF INCLUSION

Statistics	Domestic Rice Production (QDRP)	Retail Price of domestic Rice(Le)	Rice Importe d (QRI)	Retail Price of Imported Rice (Le)
Mean	901,103.4	1,917,111	166.1211	1,442,435.213
Maximum	1,334,122	3,231,421	209.324	2,813,655.43
Minimum	321,710	922,004.4	101.2	771,402.25

TABLE II
LEVEL REGRESSION ANALYSIS RESULTS

Variable	Coefficient	Std. Error	T-Statistic	Prob.
LFERT	0.3001	0.1872	1.7232	0.1704
LnQDRP	0.1772	0.8110	0.2404	0.8661
LnQRI	0.5563	0.1712	3.6123	0.0157
LnPIR	0.9124	0.6356	1.2190	0.2543
C	-4.732	2.4678	-1.911	0.1458
R-squared				0.9454
Adjusted R-squared				0.9321
F-statistic				66.314
Prob(F-statistic)				0.0001
Durbin-Watson stat				2.8003

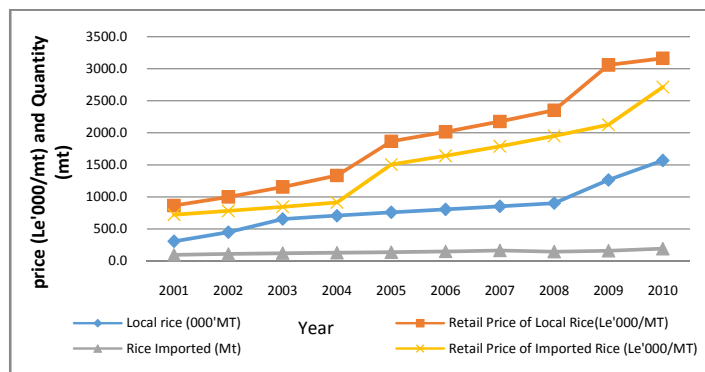


Fig. 1 The quantities as well as the retail prices of both domestic and imported Rice (2001-2010)

C. The Final Log Model

As already revealed, it became apparent that the model was experiencing multi-colinearity problems; thus, the retail price of imported rice was dropped from the model as it was established to have a high correlation with the retail price of the domestic rice. The new model is established to have improve significantly and this model is shown in [4]:

$$\begin{aligned} \ln(QDRP)_t = & \theta + \lambda_1 \ln(RPDR)_t + \\ & \lambda_2 \ln(QRI)_t + \delta_t \end{aligned} \quad (4)$$

The new model was projected in its level as stationarity tests reveal that log variables were however stationary in their level. In a circumstance of structural breaks with data gaps such as the one the authors are faced with as a country emerging from civil conflict, log models are usually suitable since they narrow down the data gaps and as well smoothens the series. Because of this, the log model is being estimated for the production of rice in Sierra Leone.

The results of the new model after dropping the retail price of imported rice are shown in Table III.

TABLE III
LEVEL REGRESSION ANALYSIS RESULTS AFTER DROPPING THE RETAIL PRICE OF IMPORTED RICE

Variable	Coefficient	Std.Error	T-Statistic	Prob
LnFERT	0.1204	0.1211	1.0049	0.3615
LnRPDR	1.2304	0.1411	8.5420	0.0013
LnQRI	0.7452	0.1652	4.7234	0.0381
C	-6.810	1.9298	-3.509	0.0251
R-squared			0.9743	
Adjusted R-squared			0.9834	
F-statistic			80.171	
Prob(F-statistic)			0.0000	
Durbin-Watson stat (D-W stat)			2.0454	

The results explain that R-squared has a value of 0.974 (Table III), which means about 97.4% of variations in rice production in Sierra Leone. F-statistic is significant at 1%

level, implying that, the explanatory or independent variables are jointly significant in establishing the variations in rice production in the country. This underscores that reality that the model is a very good-fit. The D-W statistic (2.05) reveals that the problem of multi-colinearity does not significantly alter the results of the model.

The retail price of domestic rice in the local market has the predicted positive sign, which is well significant at the 1% level. This shows that there is a positive as well as significant relationship between the quantity of rice produced and the domestic retail price of rice as sold in the market. This indicates that a 1% increase in the retail price of domestic rice will lead to 123 % (Table III) increase in rice production in the country. This result undoubtedly emphasizes the function of price as an incentive for increased rice production. Reference [19] in their paper stated that, previous research has established a strong positive relationship between productivity in rice production and price. Reference [20] also noted a positive and significant relationship between rice prices increases and increase in output. Like other producer prices, the price is a good indicator of the projected revenue; and since 2008 when the Sierra Leone government initiated the 'tractorization' scheme, there has been increase awareness among rice farmers regarding the need for to produce more and to sell their produce. The log of the quantity of imported rice (LnQRI) has the unexpected positive sign, which is significant at the 1% level. Though the authors expected domestic rice production to have an inverse relationship with imported rice, as the two commodities should basically be substitutes, however, the result proves what has been the dispute sometime now that domestic rice production goes mostly to feed the rural populace and not the urban populace. It is a reality in Sierra Leone that the majority urban dwellers hardly eat domestic rice. The reason is that, domestic rice is usually not processed and packaged in a form required by urban inhabitants; urban inhabitants require rice that is normally free from stones and easy to wash and cook. Though many attempts have been done in de-stoning domestically produced rice, it is only imported rice does meet the quality

required by the urban inhabitants. Thus, increase domestic rice production does not at all cause a decline in the quantity of rice imported into the country, as urban populations rely on imported rice for their daily consumption.

IV. CONCLUSION AND POLICY IMPLICATIONS

Rice is the most tradable commodity among the Mano River Union countries in which Sierra Leone is a member. There is an apparent flow of rice from Sierra Leone to neighboring states. Periodically, when rice prices are high mostly as a result of external forces, there is the propensity for State authorities to stop rice exportation. It is obvious that this measure has had little, and if any, only provisional effects on rice prices within the country. Thus, this study has proved the doubts of many analysts that importation of rice will continue regardless of the increase in local rice production as a result of the problem of smuggling as well as poor processing of the locally produced rice to meet the need of the residents in the urban areas.

Agricultural activity is the mainstay of the rural residents and the leading of the country's economic sectors. The crop sector actually dominates the agricultural sector while rice grain is the predominant in the crop sub-sector. The domestic retail price is established to be a good signal to producers for increase demand, which later motivates farmers to produce more rice. Practically, all Sierra Leonean farmers grow rice which is the leading staple food and regarded as a political and cultural crop within the country. Therefore, rice development does not only offer food for the common people, but it also provides employment for a sizeable number of farmers, saves foreign exchange and impacts on the generally economy of Sierra Leone.

It is obvious that Sierra Leone has a better comparative advantage in rice production for import substitution and that is to supply its domestic markets.

The agricultural sector is an imperative aspect of the economic life of most populace in Sub-Saharan Africa, since the economies are typically agrarian economies. In Sub-Saharan Africa, rice production forms an integral aspect of agricultural activities. In Sierra Leone, rice farming is seen as not only a means of food supply, but also a possible way of improving rural income as well as foreign exchange earnings. This is the reason for the recently implemented Small Holder Commercialization Programme (SHCP) in Sierra Leone. The price of rice being a good economic indicator would manipulate the decisions of most farmers to produce more. This study has revealed that the retail price of domestic rice is most times higher than the imported rice, which proposes the following:

That there is a possible market for locally produced rice.

That there could be possible supply of bottlenecks restricting the free movement of rice trade from production areas to milling centers, and from storage facilities to market centers.

The study will thus, be useful in helping agricultural researchers in investigating the rice supply bottlenecks and developing high-yielding varieties of rice to increase

production in the country. As domestic rice is established to be less competitive, rice researchers would require focusing on improving yield output and access to both local and international markets. As rice researchers require feedback from the rice sellers and consumers, this study will inform investigators on market demand situation of rice in Sierra Leone, which in turn should assist shape research proposals.

Hence, policy emphasis on achievement of self-sufficiency in rice production seems to be economically necessary. There is need for the government authorities to reinstate the produce marketing boards to help farmers to access inputs as well as to sell their output. Additionally, to control price and simultaneously increase rice production, the government should purchase rice from farmers and then sell to private retailers.

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