Employing The Ordinary Least Square (Ols) Technique To Assess The Effect Of Weather Parameters On Rice Cultivation In Sierra Leone

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Abstract: The importance of the effect of weather to rice cultivation in the emerging nations is of vital insofar as the agricultural sub sector is involved**.** Currently, the association between weather and rice cultivation continues to create further attention in Sierra Leone agricultural growth. The increase in population and revenue in emerging nations carters for additional food request, although, the supply aspect is not enough to equalise the demand side. This research work assessed the effects of weather inputs on rice cultivation regarding planting area deviations in Sierra Leone. The authors employed weather time series data comprising sunshine, rainfall, minimum and maximum temperatures, as well as data from 1985 to 2021. To test for stationarity properties in the data, the Augment Dickey-Fuller (ADF) technique was used. Furthermore, all the series showed to unveil a long run association by Johansen Cointegration method at first levels I with the likelihood of taking the linear combination. The regression results shown that an increase in unit rainfall besides the usual moisture needed decrease the mean rice cultivation by 14.3 %. Though by stepwise regression method, other metrological parameters including sunshine, means of minimum and maximum temperature had lesser significance on rice cultivation. Predominantly, an increase in unit in the area planted was discovered to increase rice cultivation by 54.37 %.

Key Words: Planting Area Deviation, Rice Cultivation, Weather Input.

1. Introduction

Sierra Leone depends on agricultural productions as main cradles of food crop to feed the rising population [1]. There are sufficient sign on, and from the detail that the whole population hinges on agriculture productivities including; rice, cassava , maize and sweet potatoes [2]. It is stated that about 75 % of the Sierra Leonean population live in the rural vicinities where their key economic undertakings is crop cultivation and animal keeping [3]. Besides, the agricultural division is controlled by small scale cultivators from the rural setting which contributes dual effects as cultivators, vendors and consumers simultaneously [4]. So far, agricultural sector adds to about 20 % of Sierra Leone's GDP and has for decades been referred to as one of the mainstay of national economic growth [5]. Also, agriculture in Sierra Leone offers more than 75 % of total employment particularly to the rural inhabitants which comprises of about 75 % of the sierra Leone total population [6]. Rice crop is cultivated in several areas within the country, nonetheless, it is dominated by the North-western and Southern upland areas including Rokupr and Tomabum, Conversely, Sierra Leone's agriculture is controlled by weather-related conditions as is a rain-fed cultivation structure [7] in which irrigations systematisation is practically not available [8]. Enduring dependence on rain-fed rice cultivation scheme [9], constantly becomes susceptible to any small change in weather. Incidentally, any abnormalities from the usual weather condition particularly sunshine, temperature and rainfall will lead to a substantial effects on rice cultivation in addition to food security. For the moment, rice cultivation needs optimum weather situations for growth from planting to harvest, though, any periodic disparity in weather from one season to another or time to time poses doubt to rice cultivation, and food security within the country. From this details, it is significant to have a vibrant thoughtful of potential effects of meteorological parameters on rice cultivation and significant of fluctuating the area planted. On the contrary, weather changeability as an ecological element deviate consumer preference, wants and demand [10]. Consumer's preferences and wants on rice characteristics such as the quality, aroma and security shifts through management alterations such as the use of weather acceptance seeds, biochemical and irrigation activities which increase the gap between cultivators and consumers. Similarly, owing to weather shock occurrences as showed in several areas makes cultivators react by choosing crops varieties, land area provisions owing to previous weather surprises [11]. Under-assessing the effects from shocks is a key factor to deprived cultivation [12], thus, it increases cultivators awareness to crop cultivation and hence shifting to additional economic ventures which are not prolific in the rural surroundings [13]. Numerous methods to increase rice productivity in Sierra Leone have been endorsed by the stakeholders, targeting rice cultivation, protection and hunger dominance. Nevertheless, the environmental method has certainly received less attention as a significant factor to be measured. Conversely, there are insufficient research

studies on the overall long term impact resulting from weather variation but with short weather, effects have not sufficiently enclosed. Hence, the present research work aimed at understanding on how weather disparity such as sunshine, rainfall, minimum and maximum temperatures influence rice cultivation in Sierra Leone and precisely in the study area. Furthermore, the study as well envisioned to examine how disparities in farm size under cultivation could mix with weather to impact rice cultivation and output. Also, aside from attaining specified aims, an awareness of the main association between weather parameters and planted area with rice cultivation could help the small scale rice growers on cultivations prediction as well as forecasting.

2. Materials and Research Methodology

2.1 Type of data and sources

Panel data relating to rice cultivation, weather parameters and area planted are all involved in this research study. The authors obtained rice cultivation data for the study area for the previous years (1985-2021) from the Sierra Leone government agencies such as: Ministry of Agriculture, Forestry and Food security (MAFFS), and Statistics Sierra Leone (SSL).The Climatological data which are average sunshine (hrs.), monthly rainfall (mm), average monthly minimum and maximum temperature (^{o}C) for the same period were obtained from the Sierra Leone Meteorological Agency.

2.2 Methodology

2.2.1 Profile of the study area

Kambia is one of the districts located in the North-western uplands of Sierra Leone. It is situated between latitude of 9^{0} 734. 2$^{"}$N and longitude of 12^{0}55$^{"}$3.55$^{"}$W. The district is one of the leading with regard to rice cultivation in the country [14]. Basically, the altitude and physiology immensely affect the climatological condition in Kambia district. Rice cultivation is among the key agricultural practices accepted in the district. Furthermore, other crops such as cassava, maize, millet, beans, and several others are similarly cultivated. Statistics show that in the North-western uplands, area under rice cultivation is approximately 12 % of the total arable land in Sierra Leone. Also, approximately 20 % of the national rice produce is from this region. Although experience dry as well as cold weather conditions between April and July, the district captures rainfall that varies between 2,500 mm and 3,000 mm, and this is due to its location on the tropics. The rainfall distribution, tropical climate and disparities in temperature favour rice cultivation, nonetheless, rice cultivation is accepted largely within Kambia district, the study area.

3. Data stationarity and Johansen Cointegration

The authors started by validating the time series data for stationarity [15] by employing Augmented Dickey fuller [15] (ADF) regression model. The protracted ADF is generally used to verify the unit root test by the help of the ordinary linear (OL) regression model. Fundamentally, the authors employed two stated hypotheses[16] during the test for a unit root in time series[16] as; $\mathbf{H_0 : \rho = 0}$ (Presence of unit root) and $\mathbf{H_1: \rho < 0}$ (absence of unit root). The authors as well showed by employing the ADF test for Unit roots[17]. ADF test uses designed statistic |t| value and relates it to that of the ADF critical values at different percentages such as 1%, 5% and 10% levels of significance (all as absolute values). If the OL regression statistics |t| is more than any of the critical values, then there are sufficient confidence to reject the null hypothesis ($\mathbf{H_0}$) and hence, accept the alternative hypothesis ($\mathbf{H_1}$). Furthermore, the long term association between data was recognised. Again, the Interaction of variables produces equilibrium as well as disequilibrium in the long run[18]. Similarly, Johansen cointegration was executed to test the association displayed by the variables in the long run[19]. More specifically, the cointegration is carried out at their levels of I (1) order series. Consequently, the authors hypothesized that the null hypothesis ($\mathbf{H_0}$): there is none cointegration association between variables and the alternative hypothesis ($\mathbf{H_1}$): $\mathbf{H_0}$ is untrue such that there are cointegration equations[20]. Accordingly, the test was executed at a 5 % significance level. The Johansen cointegration test showed that there are two cointegration equations that can be shown by the series thus rejected the null hypothesis[21]. The result therefore portrays the likelihoods of having long run mixture of variables in the model [22].

4. Panel data characteristics

The descriptive features of the panel data measured for this research study are displayed in Table 1 below. The average rice cultivated is 2022.8 (kg/ha/yr.).The minimum and maximum cultivated rice obtained was 187.0 and 6664.0 (kg/ha/yr.) respectively. The mean, minimum as well as maximum rainfall received in the planting to harvest season (April to July) per annum measured per month 126.9, 63.9, and 76.7 mm. The mean, minimum together with the maximum temperature was 28.0, 30.6, and 38.4 (^{o}C) respectively. Nevertheless, other significant weather factors are revealed in (Table 1) together with planted area (ha).

Table 1. Descriptive statistics for the included variables

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Area (ha)	35	45.8	22/1	14/0	76.7
Rice production (“000”kg/ha/yr.)	35	2022.8	1201.3	187.0	6664.0
Average Sunshine	32	8.2	0.7	5.9	9.1
Average Temperature minimum (^{o}C)	33	15.4	0.7	10/3	15.0
Average maximum Temperature (^{o}C)	33	28.0	0.7	30.6	38.4
Average rainfall (mm)	33	126.9	33.3	63.9	173.3

Source: Authors” calculation 2022

5. Model Assessment for weather factors that influence rice cultivation

Rice cultivation comprises interactions of several variables such as natural and non-natural factors. The natural factors include sunshine, rainfall, temperatures etc., while non-natural factors are labor, technology, capital etc. Again, the association between variables influences rice cultivation and productivity in a particular

situation. To assess the effects of weather on rice cultivation, an econometric model was specified using OLS regression equation [23]. The association between rice cultivation as dependent variable is recognised with sunshine, average rainfall, time, average minimum and maximum temperature, as well as size of the area planted. By means of a stepwise regression both the area planted and rainfall confirm to display positive effects on rice cultivation in the study area[24].

$$y_r = \alpha_0 + \alpha_1 \text{rain} + \alpha_2 \text{tmax} + \alpha_3 \text{tmin} + \alpha_4 \text{sun} + \alpha_5 \text{area} + \alpha_6 \text{time} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (1)$$

Where, y_r is the rice cultivated, α_0 is the constant term, α_1 is the coefficient for rainfall variable signified as rain, α_2 is the coefficient for maximum temperature variable signified as tmax, α_3 is the coefficient for minimum temperature signified as tmin, α_4 is the coefficient of sunshine signified as sun, α_5 is the coefficient of area planted signified as area, α_6 is the coefficient of time trend variable signified as time(per annum), and ε_t is the error term. From this, after performing the stepwise regression, equation (2) is obtained as stated below.

$$y_r = \alpha_0 + \alpha_1 \text{rain} + \alpha_2 \text{area} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Whereas, α_0 is the constant, α_1 is the coefficient for rainfall signified as rain, α_2 is the coefficient of area planted signified as area, and ε_t is the error term.

6. Stationarity assessment for area planted and rainfall parameters

To use the equation defined in model (2) above for the analysis, the authors first executed the stationarity test by employing the Dickey-Fuller technique. Here, the aim was to remove the unit root if present in the available time series data which might result to spurious equations. The specified hypotheses for this test are **H_0: ρ = 0** (presence of unit root), and **H_1 :ρ => 0** (absence of unit root). Thus, the true models are designated in succeeding equations.

$$y_{tk} = y_{tk-1} + \rho_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\

Cons	2840.560 2	989.991 1	2.8 7	0.02 2	347.73 13	4261.7 84

F=0.0042, R^2 = 0.2423, Adjusted R^2 = 0.2121 DW (3, 35) = 2.00213

The study as well established that rice cultivation needs an optimum quantity of rainfall during the growing stage, however, any abnormalities from the optimum plant requirements will cause poor harvests. Similar results were observed by Elwakeel, Ahmed [29] as they investigated the impact of rainfall on rice cultivation. Newton, Akar [30] also shown that increase rainfall above the required quantity might decrease rice harvest and rice in the Rokupr rice project. Among the two leading rice producing districts, Kambia district is reported to receive lesser rainfall than Port Loko district, yet, the former was better regarding rice cultivation owing to the presence of small irrigation structures [31]. Hence, the availability of irrigation equipment within the district might help cultivators to have a better water plan in line with plant necessity than rain-water which cannot be control by rice cultivators. Precisely, the result lures attention on the general influence of rainfall in the entire planting period, nevertheless, it might be stated otherwise once is to be considered[31] at diverse phases of plant development. Also, similar findings was stated by Mesfin, Gebremedhin [32] on the impact of rainfall on diverse development stages of rice in Liberia. For the moment, the result from (Table 4) illustrates that an increase in one unit of area planted will increases rice cultivation by 54.37% and was significant at the 0.05 % level. This findings show that rice cultivators might gain more rice harvests if increase in the area planted was their top priority. This suggests that there is higher necessity for rice cultivators to increase their planting area so as to achieve optimum rice output in Kambia district. A Parallel result was re-counted by Contreras-Soto, Rafael [33] as they noted that increase in inter cropping area still remains the foremost choice for small scale rice cultivators to increase their crop output in Africa. Furthermore, the rice cultivation model shows that despite the importance of the rainfall, and the deviations of the area planted, rice cultivation was as well enabled by other variables such as machinery , soil characteristics, higher seeds varieties, insecticides and herbicides, and farm management skills that could contribute to rice cultivation.

10. Conclusion and Recommendations

This research study used the OLS regression to assess the effect of weather parameters on rice cultivation in Kambia district, North-western, Sierra Leone. The results shown that rice cultivation is highly bothered by variations in the area planted and rainfall. Precisely, an increase in unit average rainfall above what the rice needs in the cultivating season decrease rice output by 14.3 %. Additionally, increases in area planted by one unit leads to an increase rice output by 54.4 %. Nevertheless, the results make an alert that an increases in rice cultivation will requires larger land area for agricultural activities, thus, there is a high likelihood of increasing land struggle in Kambia district, the study area. Therefore, it is recommended that further research studies be carried out particularly on land management with respect to crops cultivation. Moreover, the state should as well have control over the land tenure systems in the country and foster a good affiliation among land users particularly rice cultivators, since rice cultivators' best needs are to maximize rice output through increasing their planting area.

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