Using Multinomial Logistic Regression Model (MLRM) to assess the Factors influencing the selection of Farming Business by Cassava and Rice Farmers in Bombali District, Sierra Leone.

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ABSTRACT: This research assessed the factors influencing the selection of a business by cassava and rice farmers in Bombali district, Sierra Leone. The primary data were obtained by using a multi-stage sampling procedure. Well-structured questionnaire was administered to 150 randomly selected cassava and rice farmers to prompt pertinent facts from respondents in the selected study area. A Multinomial Logistic Regression Model (MLRM) was employed to assess the factors influencing the selection of business by cassava and rice farmers in the study area. The findings shown that majority (70.00%) of the farmers' selected only rice farming business while as 20.00 % and 10.00 % of the farmers' selected only cassava farming business and rice and cassava as mixed farming business respectively. Additionally, the study shown a yearly mean of 1.97 tons of combined rice and cassava output, as well as a farm size of 1.21 ha for each farmer, a clue that the research covered subsistence family owned farm sites. The respondents were youths, with elementary formal education. The Logistic regression model presented that farm size, output and revenue from the selected business positively and significantly influence a farmer's preferred business. This suggests that the likelihood of selecting cassava or rice business increased with revenue netted from the business, output and farm size from selected business. The partial elasticities of output and revenue for rice and joint business were elastic, though other related factors along the sets equally classified were inelastic. This research work consequently, recommended that extension officials ought to intensify the awareness on various kinds, procedures and practices obtainable for cassava and rice farming to additionally advance their acceptance. Similarly, farm training programs on better management practices to increase cassava and rice output ought to be known to the cassava and rice cultivators.

KEYWORDS: Multinomial Logistic Regression,Business Selection, Bombali District

1. INTRODUCTION

Cassava and rice crops are classed as carbohydrates rich foods that fundamentally give energy in the human system. Cassava and rice were considered as foods largely for the deprived, and have shown a minor part in global trade [1]. This fallacy has remained for decades owing to the absence of gratitude of many people who hinge on these important crops [2], and the lives that these crops have saved during scarcity [3]. Cassava and rice are frequently the main staple food for most low-income consumers in Sierra Leone [4]. These crops are mostly grown by farmers for sustainability, and are grown on small plots of land stretching from one to ten hectares [5]. In Sierra Leone, cassava and rice are generally survival crops planted largely as food[6]. Thus, the farmer saves enough to feed his household members and vends only the extra. Nevertheless, there is currently a rising money making market for these crops. Cassava is processed into gari, a staple food in few areas of Sierra Leone. According to Conteh et al [7], Sierra Leone is one of the leading producer of cassava tuber in the Mano River Countries. Its production is presently put to a minimum of 2 million metric ton annually. The total area planted of the crop in 2019 was 200, 000 hectares with an average harvest of 7.11 metric ton per hectare[8].

Cassava and rice are vital crops and are considered by Sierra Leonean[9] as staple food crops and even major sources of revenue for rural families[9]. The importance of these crops in certain industries as animal feeds is highly known and they have be coming protuberant in the industrial division of most nation's economy[10]. As nutrition sustenance, cassava and rice have certain inherent features that make them good-looking, particularly to the ordinary cultivators in Sierra Leone[10]. Mainly, they are very rich in carbohydrates particularly starch and thus have a diversity of end consumers. In addition, they are accessible throughout the year making it desirable to other seasonal food crops such as mangoes, oranges and cacao.

Though, agricultural activity involves many threats and small scale famers ought to adjust their agricultural practices with the purpose of avoiding damages as poor control of risks may cause crop failures and hence low yield and low revenue. To manage this situation, cultivation of supplementary food crops and livestock by

small scale farmers has been accepted to certify steady revenue. Also, intercropping can also certify food security and revenue stability. Diversification influences the selection made by small scale farmers regarding business blend on their farms[11]. Diverse farm holders might have diverse behaviours to the business selected. Occasionally, farm holders who have upright behaviours as well might not cultivate particular food crops because of certain influences that upset their choices. Farm holders who cultivate cassava and rice do so as single or sometimes as mixed crops. From the above, this study seeks to examine the factors influencing the selection of business by cassava and rice farmers in Bombali district, Sierra Leone.

2. METHODOLOGY

2.1. Study Area

The study was conducted in Bombali district of Sierra Leone. Bombali district is located between latitudes 9.2476° N and longitude 12.1633° W. The district has an estimated land area of 7,985 km^2 and encompasses 13 chiefdoms. According to Statistics Sierra Leone (SSL, 2022), the population of Bombali district in 2015 was 606,183 people. Bombali and its environs is full of agricultural activities, and owing to its favourable climatic conditions, its land area is suitable for the cultivation of arable food crops such as rice, potato, cassava etc. The average rainfall is 2511 mm with average yearly temperature of 37^0 C (SLARI, 2022). The flora involves mostly of small grasses, short trees and tiny bushes.

2.2.Sampling Method and Sample Size

Multi-stage sampling procedure was used[12]. The first stage necessitated the randomly selection of 3 section areas [13] within the Bombali district (Rokontha, Binkolor and Malal). The next stage entailed the random selection [12] of 5 farming communities from each of the chosen section areas[12]. The last stage entailed random selection of 10 cassava and rice farmers in each community separately[12], which compromises of 150 sampled farmers.

2.3.Data Collection

The cost effective method was employed in collecting the data. Primary data were sourced and collected with the aid of a well-structured questionnaire that matched with the stated objectives. The data collected comprise of the total quantity of output produced annually in tones The farming inputs were, the quantity of seeds planted (kg), prices of cassava and rice in Leone, yearly production cost , average cost of farm tools , farm size in hectare, cost per kg of seedlings, fertilizer used (kg); amount of herbicides used in litres, total labor in man-days (hired labor and family participation), average pay rate per days of labor, average cost of agrochemicals, average cost of fertilizer, household size, farmer's age, years of schooling, availability to credit and number of contact with extension officials.

2.4.Analytical Procedures

The Multinomial Logistic Regression Model (MLRM) was employed subsequent Spencer at al [12-16] to prompt the likelihood of a farmer belonging to a precise class. Depending on the business selected, farmers were classed into three. The businesses comprised cassava, rice, and both businesses (mixture of cassava and rice business). A broad-spectrum form of the Multinomial Logistic Regression Model (MLRM) is given as:

$$\Pr(Q_i = j) = \exp(\alpha_i\beta_j) \Big/ 1 + \sum_{j=1}^{J} \exp(\alpha_i\beta_j) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Additionally, to confirm identification,

$$\Pr(Q_i = 0) = 1 \Big/ 1 + \sum_{j=1}^{J} \exp(\alpha_i\beta_j) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Where for the i^{th} individual, Q_i is the observed outcome and α_i is a vector of explanatory variables[17] while β_j is unknown parameters[17]. We can now abridged the functional model for this study along these lines[18] :

$$P_{ij} = \exp(X_i\emptyset_j) \Big/ 1 + \sum_{j=1}^{3} \exp(X_i\emptyset_j) \ , \quad \text{For } j = 1, 2, 3 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

P_{ij} Becomes the likelihood of belonging to each of the classes 1 and 2.

$$P_{io} = 1 \Big/ 1 + \sum_{j=1}^{3} \exp(X_i\emptyset_j) \ , \quad j = 0 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

P_{io} Becomes the likelihood of belonging to the original class (class 0)

Hypothetically, since the likelihoods for all the selections must condense to one, all coefficients of the original or reference class are normalized to point zero when estimating the functional model [7, 19], Therefore, for 3 selections only (3-1) separate collections of parameters in the model can be recognized and estimated. Correspondingly, the natural logs of the odd proportion of equations (1) and (2) offer the estimating equation as given below:

$$Ln = X_i\,(P_{ij})/(P_{i0}) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (5)$$

This represents the comparative likelihood of each of the classes 1 and 2 to the likelihood of the original class. All estimated quantities for each selection thus replicate the impact of X_i 's on the probability of the farmers selecting that alternative with respect to the original class. Nevertheless, subsequent Conteh et al [20], the coefficients of the original class might be recuperated through the utilisation of the following model

$$\emptyset_3 = -(\emptyset_1 + \emptyset_2) \dots\dots (6)$$

In equation (6), for every explanatory variable[21], the negative sign of the sum of the other two parameters (classes 1 and 2) is the parameter for the original class.

The model of the functions is stated in the manner given below:

$$P_{ij} = \beta_0 + \beta_1 AG + \beta_2 RV + \beta_3 SC + \beta_4 SF + \beta_5 CH + \beta_6 TS + \beta_7 XP \dots\dots (7)$$

Where, X = Farmer, AG =Age (in years), RV = Revenue (in Leones), SC = Education (years spent in formal school), SF = Size of the farm assigned to the selected business(s) in hectare, CH= Crop harvested (tonnes), TS =Training in a selected business (s) (1 if farmer is trained; 0 if not trained) , XP =Years of experience in the selected business.

2.5. Partial Derivatives (Marginal Effects)

The partial derivatives $(P_{ij})/(P_i)$ also known as marginal effects are found through the differentiation of both equations (3) and (4) with respect to the specific explanatory variable. The derivation methods indirectly specify that neither the magnitude nor the sign of the marginal effects required bear any association to the sign of the estimated coefficients employed in obtaining them [21].

2.6.Pseudo Elasticities

The E-views version 10.0 software automatically generates the partial derivatives and are later transformed to pseudo elasticities through $\pi Zi = X_i\left((P_j)/(X_i)\right)$, where X_i is the average value of Xi.

This pseudo-elasticity signifies the % point change[12] in P_j upon a 1 % surge in X_i. All the elasticities are superior to the estimated coefficients[12] as well as the partial derivatives through their prosperity of interpretation. Conversely, they may change sign and value when assessed at diverse stages.

3.0.RESULTS AND DISCUSSION

A synopsis of the distribution of all respondents as stated by the selection of a business is detailed in Table 1.

Table 1: Distribution of the respondents as stated by the selection of a business in Bombali District

Selected Farming Business	Frequency	Percentage
Rice	105	70.00
Cassava	30	20.00
Both rice and cassava	15	10.00
Total	150	100.00

Source: Authors" survey 2022

Results in Table 1 reveals that most (70. 00%) of the farmers select single rice farming business in the study area. This infers that single rice farming business is the most predominant cropping system in the study area. This endorses the report of the Sierra Leone Agricultural Research Institute (SLARI, 2018) which noted that Bombali was one of the highest rice producing district in Sierra Leone.

A synopsis statistics (sample mean and the standard deviation) of all the included variables for the multinomial logistic regression analysis for cassava and rice production in Bombali district is stated in Table 2.

Table 2: Synopsis of descriptive statistics of included variables used in the model in Bombali district

Variables	Mean	Standard deviation	Minimum	Maximum
Total output (tons)	1.97	2.91	0.08	28.05
Age (years)	40.06	7.89	22.07	58.29
Revenue (Le)	4,800,000	214044	265	745114
Schooling (years)	11.01	6.34	0.21	21.14
Total farm size (ha)	1.21	1.06	0.23	8.21
Experience (years)	18.42	14.08	0.12	58.73

Source: Authors" data analysis 2022

Results from Table 2 clarify that a mean of 1.97 tons of outputs each year was attained with an average standard deviation of 2.91 in the district.

Additionally, results from Table 2 discovered an average farm size of 1.21 ha per farmer, a clue that the study actually covered small scale family owned farm sites. The average years spent in school, experience in farming and age of the farmers were 11.01, 18.42 and 40.06 respectively, indicating that the farmers were comparatively younger with just primary or no formal schooling

3.1.Factors Influencing Selection of Farming Business by Cassava and Rice farmers in the Bombali District

The results of the logistic regression analysis displayed the factors influencing the selection of the farming business approved by cassava and rice in Bombali are detailed in Table 3. The impacts of the coefficients were estimated regarding the combined cassava and rice business (class 3), as the original or reference class[17]. Thus, the

implication from the estimated coefficients for every selected group was made in relation to group 3. Table 3 illustrates that the probability ratio (χ^2) was 90.01 and is significant at the 1% level. The test endorses that the entire slope coefficients are significantly dissimilar from nil. The would-be R^2 value of 0.3453 as well confirmed that the sum of the entire slope coefficients are not zero. Also, the explanatory variables are jointly significant in explaining the farming business selection by cassava and rice farmers in the Bombali district. In the some research works, Adong et al [22] obtained quasi R^2 value of 0.3300 while Calvin et al [23] stated quasi R^2 value of 0.3321 as signifying a fairly good-fit for a logistic regression model. Therefore, the quasi R^2 value of 0.3453 in this research work is suggestive of good fit as well as the correctness of the estimated multinomial logistic regression model[23].

Table 3: Results of estimated logistic regression model for the factors influencing the selection of business by cassava and rice farmers Bombali district

Variables	Cassava Business (Group 1)	Rice Business (Group 2)	Cassava & Rice Businesses (Reference group 1)
Total Output (tons)	1.2310	0.0732	-3.1231
	(5.31)***	(3.11)***	
Age (years)	0.0577	0.0578	-0.1542
	(1.65)	(0.95)	
Revenue(Le)	0.0031	0.0025	-0.0017
	(3.77)***	(2.14)***	
Schooling (years)	-0.0550	0.0375	0.0651
	(-1.94)	(0.41)	
Farm Size (ha)	0.1640	1.2242	-1.6006
	(2.31)**	(2.56)**	
Farming Experience(years)	0.0063	0.0322	-0.0621
	(0.08)	(0.63)	
Training on the selected Farming business	0.5045	1.5002	-2.4032
	(1.86)	(1.70)	
Constant	1.1641	-8.0002	7.0311
	(0.61)	(-1.54)	
No of Observations	30	105	15

Source: Authors data analysis, 2022

Number of observation = 150. Figures in parenthesis are Z-values, Log likelihood = - 69.213 LR Chi-square = 90.01***, Pro > Chi-square = 0.0002, Quasi R^2 = 0.3453, *** = Significant at 1% level, ** = Significant at 5% level,***

Results of all estimated equations were deliberated regarding the signs and significance on the parameters[23]. Thus, confirmation from the model as detailed in Table 3 states that the set of all significant explanatory variables differs across the groups regarding the levels of significance as well as the signs. Conversely, output, farm size and revenue with estimated parameters of 0.0031 and 0.0025 respectively from the selected farm businesses are positive and significantly linked with the categorisation of the two groups with respect to the reference group [24]. The positive sign infers that the probability of selected cassava or rice farming business inclines to increase with the revenue, output and farm size from the selected farming business in Bombali district.

Table 4: Partial Derivatives (Marginal Effects) together with the pseudo – elasticities estimated

Variables	Cassava Business (Group 1)	Rice Business (Group 2)	Cassava & Rice Businesses (Reference group 1)
Total Output (tons)	-0.3441	0.0090	0.1901
	(-2.321)	(0.2562)	(1.4673)
Farm Size (ha)	-0.0011	-0.0722	0.05123
	(-0.06891)	(-4.0072)	(0.4987)
Revenue(Le)	0.0087	0.0012	0.0019
	(0.5543)	(1.6432)	(1.0070)

Source: Authors data analysis 2022. *Above figures are marginal effects while as the partial elasticities are in the brackets.

Table 4 comprises the values of all the estimated marginal effects[24] as well as the pseudo – elasticities computed for the significant variables[25]. Besides the partial elasticities of output and revenue for cassava in addition to reference groups correspondingly that were elastic, the other factors within the groups as categorised were inelastic [25]. With respect to the variables that were elastic, 1 % variation in these explanatory variables will results in more than a proportionate change[26] in the likelihood of other categorised groups in relation to the reference group [26]. Also, variables that were inelastic[20], the possibility of categorising the farmers into any precise group is not largely affected by the marginal changes in these variables[9] as a 1 % change in these variables will cause a less than a proportionate change [20] in the likelihood of categorisation.[20]

4.0.CONCLUSION AND RECOMMENDATIONS

The study examined the factors influencing the selection of a farming business by cassava and rice farmers in Bombali district, Sierra Leone. Results of the multinomial logistic regression model revealed that the probability of selecting cassava or rice farming business increased with increase in revenue obtained from farming business, output and farm size from selected business.

This research work consequently, recommended that extension officials ought to intensify the awareness on various kinds, procedures and practices obtainable for cassava and rice farming to additionally advance their acceptance. Similarly, farm training programs on better management practices to increase cassava and rice output ought to be known to the cassava and rice cultivators.

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