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Investigating the profit efficiency of garri processors at the post-harvest value chain in Rivers State, Nigeria

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ABSTRACT

The study focused on the profit efficiency of *garri* processors at the post-harvest value chain in Rivers State, Nigeria. A purposive sampling procedure and snowballing techniques were used to select 120 respondents for this study. The study utilized primary data collected with the aid of a structured questionnaire and analyzed using descriptive statistics and inferential statistics, such as the Stochastic (profit function) frontier model. The results revealed that more than 75% of the garri processors in Rivers State were female. The results revealed that garri processors were 37% profit-efficient, while the cost of cassava roots, the cost of grating/milling, the cost of hiring equipment, and the cost of transportation were negatively affecting the profit of garri processors. Years of experience in garri processing and education decrease the profit inefficiency of garri processors, while the cost of the cassava roots increases the profit inefficiency of the garri processors in Rivers State. The study suggested that adequate training should be conducted for garri processors in Rivers State by the extension agents and the Nigeria Stored Products Research Institute (NSPRI), and the government should provide incentives for such training. Also, garri processors in Rivers State should be encouraged to adopt the garri processing plant installed by the Rivers State government.

Keywords: efficiency, garri processors, profitability, Rivers State, stochastic frontier model

1. Introduction

Cassava (*Manihot esculenta*) is resistant to drought and is mostly grown in dry areas [1]. Cassava is widely cultivated in Nigeria, and contributes greatly to the nutrition and livelihood of the poor resource small holder farmers who predominated the sector [1]. Nigeria is among the largest producers of cassava and cassava products in Africa [2]-[4], and it is considered as a basic food calories consumed in Africa [4].Cassava roots is said to contains 30-40% dry matter and 25-30% starch, and contains nutrients such as potassium, calcium, iron, vitamin A, vitamin C, vitamin B-6, sodium, folic acid, and protein [5], [6]. Cassava has diverse uses and by-products. Traditionally, it is used as cassava flour, pounded cooked fermented cassava pastes known as fufu; granulated roasted cassava known as garri; starches; cooked fresh sliced roots known as abacha; granulated cooked cassava (attieke); and drinks with cassava components [7]. Cassava plays a major role in Nigeria's food security, in that more than 80% of poor Nigerians eat cassava and its by-products at least once a day [1]. Despite the roles played by cassava in food security, its potential has not been fully tapped due to its limitations.

One of the major limitations of cassava is the rapid deterioration of the root at post-harvest, which often begins after 48 hours of its harvest, and the presence of cyanogenic compounds in cassava [7]. Therefore, processing as a form of value addition appears to be the best method of preserving the cassava roots, which are highly perishable, and removing the cyanogenic compounds in them. Processing of cassava is usually done in order to increase the shelf life of the cassava and reduce post-harvest losses. One of the forms cassava is mostly processed into is garri in Rivers State, and other cassava-producing States in Nigeria [7], [8]. To process cassava into garri, the cassava roots must first be peeled, washed, grated into mash, dewatered, pulverized, sieved, and finally roasted to produce the garri. These activities take an average of five to seven days. The garri processing is mostly carried out by women, and with traditional technologies. However, processing cassava using traditional methods is considered as tasking, time-consuming, ineffective, and inefficient [7], [8]. Garri serves as food for man and livestock feeds [4], and it is the most popular food product from cassava. It is consumed as processed or reconstituted with hot water to give a dough-like paste called "Eba", and it can be taken as snacks with cold water, milk, sugar, and groundnut. Garri has become an essential food supply commodity in Nigeria and some parts of West Africa. This is evident in its high demand within Nigeria, coupled with its high price [4]. [9] reported that about 148 million people eat garri across the country, which made up of about 74% different tribes of people in Nigeria. Therefore, garri processing and marketing has a great potential of contributing immensely to economic empowerment and the development of the downstream component of the agribusiness sector in Nigeria [4]. Despite these potentials, [10] noted that about 8% of cassava is lost during on-farm processing of garri, while about 14.4% is lost during commercial processing of garri, which signifies some economic loss in the process and profit inefficiencies of the garri processors or farmers. These profit inefficiencies on the side of the processors or farmers have a way of reducing the economic returns of the farmers or processors if the price of the processed products is not high enough to offset the incurred costs due to seasonal variations in garri prices [11].

Recently, some technological advancement was made with the establishment of a 450 metric tons cassava processing plant at Afam in Oyigbo Local Government Area of Rivers State by the Rivers State Government, in order to improve the profit efficiency of the garri processors, but only a very few garri processors adopted the technology [11], [12]. The implication of the low adoption of this technological advancement is that it could result in profit inefficiency for the garri processors.

It is a known fact that cassava production and processing in Nigeria are mostly done in traditional methods by smallholder farmers and processors who dominate the area [3], [4]. This often results in inefficiency in the system, especially profit inefficiency due to economic losses encountered in using traditional methods in the processing sector [11]. There is a very low level of investment in cassava processing in Rivers State. It showcases itself by the predominance of women who are resource-poor in the cassava processing business. One noticeable problem is the lack of/ inadequate data on how the business works and who is involved in it. This limits the ability of the business to attract the necessary attention of the private entrepreneurs, non-governmental organizations (NGOs), and governmental organizations in the sector. These have negative consequences for the achievement of food security, the reduction of poverty, and employment generation in Rivers State. It is evident that a lot of socio-economic factors affect the performance of the cassava processing business and the efficiency of the system, especially profit efficiency. Even with this facts, most works that attempt to looked at the cassava processing ventures, concentrated on its value chain, post-harvest technological needs of garri processors, and the profitability of the business [13], [1], [6], [14], [15], [8], without given adequate attention to whether the garri processors are profit efficient or not. It is on these notes that this study is designed to assess the profit efficiency of the garri processors at the post-harvest value chain in Rivers State. The objective of the study is to describe the socio-economic profiles of garri processors in Rivers State, to determine the profit efficiency level of the garri processors, and to identify the factors that influence the profit efficiency of garri processors.

2. Methods

The study was carried out in Rivers State, Nigeria. The State was created on 27th May, 1967. The State lies between Latitude 4.7500^{0}N and Longitudes 6.8333^{0}E [8], with a total land area of about 50,000 square kilometers. The region has a total annual rainfall of over 4000mm, with minimum and maximum temperatures of 22.40 °C and 310 °C, respectively. Rivers State is made up of 23 local government areas [16], with only 7 Local Government Areas involved in agricultural production. The State is made up of 10 different ethnic groups, with the dominant ethnic groups as Ijaw, Ikwere, Khana, Kalahbari, and Ogoni. The total population

of the State is about 6.9 million people [17]. The major crops produced in Rivers State are Maize, cassava, plantain, banana, and leafy vegetables.

A purposive sampling procedure and snowballing sampling techniques were employed to select the required respondents for this study. Firstly, three (3) Local Government Areas (LGAs) were purposively selected from the seven (7) LGAs for agricultural production. The three selected LGAs are Abuoa/Odua, Eche, and Ikwere. The reason for their selection is the predominance of cassava production and garri processing in those areas. Secondly, two communities, each from the 3 Local Government Areas, were purposively selected, giving a total of 6 communities. Lastly, the snowball sampling technique was used to select 20 garri processors from each of the selected communities to give a total of 120 garri processors selected for the study. The study made use of primary sources of data collected with the aid of a structured questionnaire and interviews. The questionnaire was designed and administered to the respondents using trained personnel. The collected data were analyzed using descriptive statistics such as mean, frequency, and percentage, and inferential statistics such as the Stochastic Frontier (Profit function) Model and Gross Margin Model. These were chosen due to the type of data collected and the suitability of the instruments.

2.1. Model specification

2.1.1. Stochastic frontier (profit function) model

The stochastic frontier (Profit function) model was used to determine the profit efficiency level of the garri processors (objective two) and the factors that affect the profit efficiency of the garri processors (objective three). Cobb-Douglas function is fitted into the stochastic frontier model, and the empirical stochastic production model is expressed as;

$$\ln Pi = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + v_i + u_i \quad (1)$$

where: ln = natural logarithm; P_i = Profit realized by garri processors (naira); β_0 = Constant; β_1–β_7 = parameters to be estimated; X_1 = Cost of cassava roots (Naira); X_2 = Cost of peeling and washing of the cassava Naira); X_3 = Cost of grating /milling; X_3 = Cost of sieving and frying of the garri (Naira); X_4 = Cost of hiring the equipment used in garri processing (Naira); X_5 = Cost of firewood (Naira); X_6 = Cost of transportation of the garri to the market for sales (Naira);

The cost inefficiency effect is a non-negative with a half-normal distribution. It is assumed that it is truncated at zero, and thus it is specified as;

$$U_i = \theta_0 + \theta_1 \ln Z_{1i} + \theta_2 \ln Z_{2i} + \theta_3 \ln Z_{3i} + \theta_4 \ln Z_{4i} + \theta_5 \ln Z_{5i} + \theta_6 \ln Z_{6i} + \theta_7 \ln Z_{7i} \quad (2)$$

where: U_i = profit inefficiency; θ_0 = constant; θ_1–θ_6 = parameters to be estimated; Z_1 = age of the garri processors (years); Z_2 = Experience in garri processing (years); Z_3 = Education (years in formal education); Z_4 = Household size (number of people); Z_5 = quantity of cassava processed (kg); Z_6 = cost of the cassava roots (years); X_7 = Membership of organization (years)

2.1.2. Gross margin model

Gross margin model is expressed as follows:

$$GM = TR - TVC \quad (3)$$

where: GM = Gross margin; TR = Total revenue made by the garri processor; TVC = Total variable cost incurred by the garri processor.

3. Results and Discussion

3.1. Socio-economic characteristics of the garri processors in Rivers State

The results of the socio-economic characteristics of the garri processors in Rivers State are presented in Table 1. The variables in the analysis include the age of the garri processors, sex, educational level, household size, marital status, experience in garri processing, membership of an association, and extension contact. The results of the socio-economic variables in Table 1 revealed that 54.1% of the garri processors in Rivers State are within the age range of 41-60 years. While 3.3% falls within the age range of 71-80. The mean age of the garri processors in Rivers State was 45.5 years. This shows that the majority of the garri processors in Rivers State are within their productive age. This is in line with [6]. Furthermore, the results revealed that the majority

(78.3%) of the garri processors in Rivers State were female. While the minority (21.7%) were male. This implies that women are more into garri processing in Rivers State. This validates the statement made by [18]. Education influences the decision-making process and also helps in the adoption of innovative ideals. The results in Table 1 reveal that about 51.7%of the garri processors in Rivers State spent between 7-12 years in formal education, while 6.7% had no formal education. The average years spent in formal education by the garri processors in Rivers State were 9.9 years. This implies that the garri processors are literate enough to make a good decision. Household size is a vital socio-economic variable in any agricultural operation. It has the ability to reduce the cost of labour by supplementing with family labour.

Table 1 showed that 70.83% of the garri processors in Rivers State had a family size of between 1 and 5 persons, while 8.33% had a household size of between 11 and 15 persons. The average household size of the garri processors in Rivers State was eight persons. This implies that the garri processors in Rivers State have a good family labour for the processing operation. This is in line with [1]. The majority (70.8%) of the sampled garri processors are married, while only about 13.1% of them are single, and a minority (4.2%) of them are widowed. Results in Table 1 revealed that 84.2% of the garri processors had between 1 and 30 years of experience in the garri processing business, while 1.6% had garri processing experience of above 45 years. The mean years of experience in garri processing by the sampled garri processors was 19.8. This implies that the garri processors in Rivers State are well-experienced in the business. This validates the work of [7]. Results revealed that only about 38.3% of the garri processors belonged to an association, while about 61.7% were not members of any association. This has a serious negative implication in providing support to the garri processors and accessing loans from financial institutions. Also, extension is vital because, through extension, value chain actors are informed about new innovations. The results showed that about 13.3% of the garri processors had contact with the extension agents, while about 87.7% were never visited by the extension agents.

Table 1. Socio-economic factors of the sample garri processors

Variables	Frequency	Percentage	Mean (Std Dev.)
Age (Years)			
21-30	15	12.5	
31-40	33	27.5	
41-50	31	25.8	**45.5 (11.73)**
51-60	34	28.3	
61-70	3	2.5	
71 -80	4	3.3	
Sex			
Female	94	78.3	
Male	26	21.7	
Years of formal Education			
0 years			
1-6	8	6.7	
7-12	40	33.3	**9.9 (3.52)**
13-18	62	51.7	
	10	8.3	
Household Size			
1-5	85	70.83	**8 (3.06)**
6-10	25	20.83	
11-15	10	8.33	
Marital Status			
Single	16	13.3	
Married	85	70.8	**(0.50)**
Widowed	5	4.2	
Divorced	14	11.7	
Years of Experience			
1-15	53	44.2	**19.8 (5.32)**
16-30	48	40.0	
31-45	17	14.2	
46-60	2	1.6	

Table 1. Continued

Variables	Frequency	Percentage	Mean (Std Dev.)
Membership of association			
Yes	46	38.3	
No	74	61.7	**(0.49)**
Extension contact			
Yes	**16**	**13.3**	
No	**104**	**86.7**	**(0.06)**

Source: Field survey, 2023

3.2. Profitability of garri processing in Rivers State

Gross Margin and Return on Investment were used to analyze the profitability of garri processing in Rivers State. The results of the findings are presented in Table 2.

Table 2. Profitability of garri processors in Rivers State

Variables	Average quantity (kg)	Price (₦)	%TVC
Quantity of raw cassava processed in the study area	1338.84		
Cost of the cassava roots		24, 916.67	55.32
Cost of peeling and washing the cassava		4, 134.17	9.18
Cost of grating/milling		1600.41	3.55
Cost of sieving and frying of garri		5,169.30	11.48
Cost of hiring equipment used in garri processing.		1,535.42	3.41
Cost of firewood		5,000.10	11.10
Cost of transportation to the market for sales		2,687.08	5.97
Total Variable Cost (TVC)		**45,043.15**	**100**
Quantity of garri sold (Q)	128.37	433.16/kg	
Total Revenue (TR) = Q x Price		**55,604.75**	
Gross Margin (Total Revenue - Total variable cost)		**10,561.60**	

Source: Field survey, 2023

The results in Table 2 revealed that the average quantity of cassava roots processed into garri in the study area by the sampled garri processors was 1338.84 kg, and it costs about ₦24,916.67 on average to purchase this quantity of cassava roots, which accounted for 55.32% of the total variable cost. Likewise, the cost of sieving and frying of garri, as well as the cost of the firewood used in the frying, was ₦5,169.30 and N5,000.10, respectively, and accounted for 11.48% and 11.10% of the total variable cost, respectively. The least cost incurred was the cost of hiring equipment used in garri processing (₦1,535.42), and it accounted for 3.41% of the total variable cost. The analysis also revealed that the total cost of processing 1338.84kg of cassava into garri in the study area was ₦45,043.15, while the total quantity of garri gotten from the 1338.84kg of cassava roots was 128.37 kg, which was sold at ₦433.16/kg to realize a total revenue of ₦55,604.75. The results revealed that the Gross Margin in garri processing in Rivers State was ₦10,561. 60. This shows that garri processing is profitable in the study area. This is in agreement with [7].

3.3. Profit efficiency of the garri processors in Rivers State

The profit efficiency of the garri processors in Rivers State, and the factors influencing the profit efficiency, were analyzed using the Stochastic (profit function) frontier model and presented in Table 3.

The results in Table 3 revealed that the sigma-squared ($\sigma 2$) estimate of 0.56, which is significantly different from zero at 5% level, indicates a goodness of fit and correctness of the distribution form assumed for the composite error term. The gamma estimate of 99% was significantly different from zero at 1% level of

significant. This implies that 99% of the variation in profit obtained by the garri processors was as a result of profit inefficiencies of the garri processors. This also implies that 99% of discrepancies between observed profit and the frontier profit are due to profit inefficiency of the garri processors.

The result, as presented in Table 3, revealed that the cost of cassava roots, the cost of grating/milling of the cassava, the cost of hiring equipment used in garri processing, and the cost of transportation were negative and statistically significant at 10%, 1%, 1% and 10% levels of probability, respectively. This indicates that they negatively determine the total profit made by the garri processors in Rivers State. Thus, an increase in these variables will lead to a decrease in the total profit made by the garri processors in Rivers State. The results showed that the coefficient of cost of cassava roots was negative and statistically significant at 10%, which implies that 1% increase in the cost of cassava roots will decrease the total profit made by the garri processors by 0.94%. Also, the coefficient of the cost of grating/milling of the cassava was negative and statistically significant at 1% level of probability. This implies that 1% increase in the cost of grating/milling of the cassava will decrease the total profit by 1.92%. Likewise, the coefficient of the cost of the equipment used in garri processing was negative and statistically significant at 1% level of probability. This shows that a 1% increase in the cost of the equipment will decrease the total profit made by garri processors by 1.4%. In line with *a prior* expectation, the coefficient of transportation cost was negative and statistically significant at the 10% level of probability. This revealed that a unit increase in this variable will decrease the total profit made by the garri processors by 0.82 units. The possible explanation could be that all these charges were not put into consideration before setting the final market price by the garri processors. This finding is in line with the work of [19].

Table 3. MLE estimates of the stochastic frontier on the factors of profit efficiency of the garri processors

Variables	coefficients	Standard error	t-ratio
Cost of cassava roots	-0.9372	0.5140	-1.882*
Cost of peeling and washing of cassava	0.2710	0.3741	0.724
Cost of grating/milling	-1.9181	0.7135	-2.689***
Cost of sieving and frying of garri	0.2302	0.3746	0.615
Cost of hiring equipment	-1.4416	0.5474	-2.63***
Cost of firewood	-0.1505	0.3484	-0.432
Cost of transportation	-0.8238	0.4518	-1.823*
constant	0.8166	2.6504	0.308
Inefficiency variables			
age	0.8776	1.0652	0.824
Experience in garri processing	-0.5831	0.3387	-1.722*
Education	-0.8042	0.2037	-3.947***
Household size	0.2717	0.3956	0.687
Quantity of cassava	0.2906	1.0019	0.290
Cost of cassava roots	0.5110	0.2989	1.709*
Membership in the organization	1.5931	1.7654	0.902
Constant	6.5462	3.2233	2.0309**
sigma-squared	0.5601	0.2719	2.060**
gamma	0.9999	0.3768	2.654***
log likelihood function	-141.67		
LR test	45.91		

Source: Field survey, 2023; Note: ***, **, * is significant at 1%, 5% and 10% respectively

3.4. The stochastic frontier maximum likelihood (ML) estimate of the profit inefficiency model

The Maximum Likelihood (ML) estimate of the profit inefficiency model of the garri processors in Rivers State is presented in Table 3. Socio-economic variables were considered and estimated in the model as the likely factors influencing the profit inefficiency of the garri processors in Rivers State. The results, as presented in Table 3, revealed that the coefficient of years of experience of the garri processors in the profession was negative and statistically significant at a 10% level of probability. Thus implying that a one-year increase in the number of years of experience of the garri processors will increase the profit made by the garri processors by 0.58%, and decrease the profit inefficiency of the garri processors by 0.58 units. This could be because of the adequate knowledge of the modality, nature, and timing of the business due to long duration in the business. This finding is in line with the work of [20] on the profit efficiency of Broiler Production. Likewise, education was significant (1%) and negatively related to the profit inefficiency of the garri processors in Rivers State. This implies that the profit made by garri processors from the sales of their garri depended on the level of education acquired by the garri processors. The results showed that a one-year increase in the level of education will decrease profit inefficiency of the garri processors, and increase their total profit made from garri sales by 0.8%, and this is in line with the *a priori* expectation. This could be because the literate garri processors are expected to be more innovative because of their ability to get information more quickly and their ability to take more risks. This is in line with the work of [21] on the profit efficiency of sheep production.

Also, the result in Table 3 showed that the coefficient of the cost of the cassava roots purchased by the garri processors was positive and statistically significant at 10% level of probability. This implies that the profit made by the garri processors in Rivers State, is largely depended on the cost of the cassava roots purchased by them. Thus, a 1% increase in the cost of the cassava roots purchased, will decrease their profit and increase their profit inefficiency by 0.51%. This could be that the garri processors with low ability to bargain, usually buy the cassava roots more expensive than those with high bargaining power due to the flexibility of prices of the cassava root from the cassava farmers.

3.5. Profit efficiency of the garri processors in Rivers State

The frequency distribution of the profit efficiency of the garri processors in Rivers State, are presented in Table 4.

Table 4. Frequency distribution of the profit efficiency of the garri processors

Ranges	Frequency	Percentage
0-0.2	39	38.6
0.21-0.4	21	20.8
0.41-0.6	17	16.8
0.61-0.8	13	12.9
0.81-1.0	11	10.9
Total	101	100
Maximum	0.990	
Minimum	0.002	
Average	0.367	

Source: Field survey, 2023

The results in Table 4 revealed that the mean profit efficiency of the garri processors in Rivers State was 0.37, which suggested that, on average, the observed profit was 63% less than the optimum profit. This implies that an average garri processor was 0.37 profit efficient and 63% less than the maximum possible level due to their inefficiency. The results revealed that out of 120 sampled garri processors in Rivers State, only about 101 (84.17%) garri processors made some profit from the business. While about 19 (15.83%) garri processors in Rivers State encountered losses in their business, they were dropped in the profit efficiency analysis.

The profit efficiency indices indicate that the minimum and maximum profit efficiency scores ranged from 0.002 to 0.99, showing that there was a high variation between the least profit-efficient and the most profit-efficient garri processors in Rivers State, with an average of 0.37. Thus, if an average garri processor were to achieve the profit efficiency level of its most efficient counterpart, then 63.3% extra profit could be realized, i.e, (1-0.37/0.99 x 100).

4. Conclusion

Efficiency is said to be one of the major determinants of the performance of any business. This research work which dwells on the profit efficiency of garri processors at post-harvest value chain in Rivers State, established that the sampled garri processors were 37% profit efficient. Cost of cassava roots; cost of grating/milling of the cassava; cost of hiring equipment used in garri processing; and cost of transportation were the factors that negatively affected the total profit made by the garri processors in Rivers State. Also, the study established that years of experiences in garri processing and education decreases the level of profit inefficiency of garri processors, while cost of the cassava roots purchased increases the level of profit inefficiency of the garri processors in the study area. Thus, the study recommended that adequate training should be conducted for the garri processors in Rivers State by the extension agents and Nigeria Stored Products Research Institute (NSPRI), and government should provide incentives for such training. These will increase the profit efficiency of the garri processors, and encouraged more garri production. Also, the garri processors in Rivers State should be encouraged to adopt the garri processing plant installed by the Rivers State government.

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