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Technical Efficiency in Value Addition to Cassava: A Case of Cassava-Garri Processing in Lagos State, Nigeria

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Abstract: The study examined the technical efficiency in garri processing in Lagos State, Nigeria. Data used for the study were obtained using structured questionnaire administered to 100 randomly selected cassava-garri processors in Epe Local Government Areas of the state. Data collected were analysed using descriptive statistics, Likert scale, gross margin analysis, stochastic frontier production function. Findings revealed that majority of the sampled processors were women with mean age of 38.7years. The benefit cost ratio of 1.31 implies that for every ₦1 invested in processing cassava to garri, a return of ₦1.31 and a profit of ₦0.31 were realised. The result of the stochastic frontier analysis revealed that costs of cassava tubers, labour and land had significant influence on garri output while age, gender, household size and membership of cooperative association were the socio-economic attributes determining the technical efficiency of the respondents in the study area. Given the profitability status of the cassava-garri processors in the study area, it can be concluded that cassava-garri processing enterprise is a profitable and viable enterprise which can drive high income generation for the people to earn a living vis-à-vis boast food production and employment opportunities in the study area as well as the state.

Keywords: cassava-garri, processing, stochastic frontier analysis, technical efficiency, value addition.

Introduction

Cassava *(Manihot esculenta* Crantz*)*, a starchy root crop, is a major source of food and industrial crop in Africa because of its ability to grow in low-quality soil, its resistance to drought and disease, and its flexible cultivation cycle (Sanni *et al.* 2009). Cassava is a very versatile commodity with numerous uses and by - products. Traditional uses of cassava fall into nine categories as identified by Ugwu and Ay (1992): Cooked fresh roots (that include pounded fresh cassava, locally known as fufu in Ghana; Cassava flours: fermented and unfermented; Granulated roasted cassava (gari); Granulated cooked cassava (attieke, kwosai); Fermented pastes (agbelima, fufu in Nigeria); Sedimented starches; Drinks (with cassava components); Leaves (cooked as vegetables); and Medicines. Cassava root is a good source of carbohydrates, and it is also a source for bio-fuel as well as animal feed (Adekanye *et al*. 2013). Cassava suddenly gained prominence in Nigeria in 2002, following the pronouncement of a presidential initiative on the crop. The initiative was aimed at using cassava production as the engine of growth in Nigeria. In recent times, government has encouraged the use of the crop to produce a wide range of industrial products such as ethanol, glue, glucose syrup and bread. Recently, the Nigerian government promulgated a law, making it compulsory for bakers to use composite flour of 10 per cent cassava and 90 per cent wheat for bread production. The new regulation which came into effect, January 2005, stipulated that the large flour mills that supply flour to bakeries and confectioneries must pre-mix cassava flour with flour.

Nigerian cassava production is by far the largest in the world; a third more than production in Brazil and almost double the production of Indonesia and Thailand. The crop is produced in 24 of the country's 36 states. In 1999, Nigeria produced 33 million tonnes. In 2004, the estimated cassava output from Nigeria was approximately 34 million tonnes while in 2009; it produced approximately 45 million tonnes, which is almost 19% of production in the world. The average yield per hectare is 10.6 tonnes (FAO, 2013). Major limitations of cassava are its rapid postharvest physiological deterioration, which often begins within 48 hours after harvest and the presence of cyanogenic compounds. This means that roots greater than 48 hours old have little market value and limits the range over which fresh roots can be marketed. Processing as a form of value addition appears to be the best method of preserving the highly perishable cassava roots and for removing 'cyanogenic glucosides' which impart toxicity to the roots. The most effective ways of reducing the total cyanide content of cassava products are to adopt the processing methods involving different combinations of soaking, grating, fermentation, boiling and drying/roasting of whole or fragmented roots (Dziedzoave *et al*. 2010; Adeniyi and Akande. 2015).

One of the major and most important products of cassava is Gari. Garri is a widely consumed Nigerian food; an estimated 4.2 million tons were produced in 2009 (NBS 2010). It is consumed principally as a main meal (eba) or taken as a snack when soaked in cold water, sweetened with sugar and consumed with roasted groundnut, coconut and sometimes dry fish. Gari features more frequently up to 2 or 3 times in the daily diet of most households in the producing areas (Komolafe and Arawande, 2010). Cassava's bulk is substantially reduced when processed into garri and thus more suitable for transport. Shelf life is also increased. The cassava roots must be peeled, washed, grated into mash, dewatered, pulverized, sieved, roasted and finally sieved. Peeling represents the most labor-intensive unit operation of the cassava value chain, non-mechanized and traditionally done by women and sometimes children. Moreover, peeling represents a critical stage in terms of food safety as the process removes the outer periderm of the root, where the highest concentrations of cyanogenic compounds lie. When farmers are able to efficiently and effectively chip, grind, and dry cassava, they are better able to trade with bulk purchasers in local markets. Farmer incomes will rise when they are able to guarantee processed cassava for products that are high-quality inputs and have a long shelf-life (Hillocks, 2002). For sustainable food security, strategies have to be developed to increase food production. One of the ways to achieve this is through efficient use of resources by farmers/processors which is one of the major agricultural problems in Nigeria. Other problems include how the various factors that explain production efficiency could be examined so as to improve the crop production in the country. One way of approaching the problem of increasing production therefore, is to examine how efficient the farmers are using their resources, if resources use is inefficient, production can be increased by making adjustment in the use of factors of production in optimal direction. This implies that for producers to achieve their goals in earning more profit the available resources used in production should be efficiently utilized. Inefficient use of these resources and technologies by producers will end in more cost-effective to increase output (Ike, 2008).

However, what is seen in Nigeria in recent time is government efforts at trying to increase agricultural productivity so as to achieve economic development for farmers and alleviate poverty through various schemes such as microcredit programmes, increase in agricultural loan, encouraging the use of technology but considerable research on the availability, affordability and efficiency of cassava-garri processors in the study area is observed to be very weak.

Cassava processing using traditional methods is tasking, ineffective, time-consuming and also inefficient. Such difficulties arise in the grating and draining of the starchy fluid from the cassava dough since the conventional methods available involve processes that require a lot of labour and man hours. The problem is worsened when the quantities to be produced are very large (Steven and Eric, 2009). Cassava farmers are often unable to process harvested roots and have to sell their crops at a very low price to middlemen who are willing and able to reach them (Nweke, 2004). As a result, there is need to reverse the foregoing scenario with a view to improving technical efficiency among cassava-garri processors through the investigation of the nature of productivity and efficiency in their production. Determining technical efficiency will provide practical tools for decision makers to apply production policies needed to improve garri production. The knowledge gain from the assessment of productivity, profitability and technical efficiency level of cassava-garri processors will also enable one to make policy recommendations for greater efficiency and productivity. The purpose of this study is therefore to estimate the technical efficiency in value addition to cassava in producing garri in the study area.

Objectives of the study

Specific objectives of the study were to:

- describe the socio-economic characteristics of garri producers in the study area;
- estimate the profitability of processing cassava to garri in the study area;
- determine the technical efficiency of cassava-garri processing in the study area;

Methodology

Study area: The study was conducted in Lagos state, Nigeria. The state was created on May 27, 1967 and located in the mangrove-swamp forest region of the south-western part of Nigeria. The State lies between latitudes $6^0$35N and 6.58^0N longitude 3^0 45'E and 3.75^0 E. The state has a population of 17 million according to 2006 population census and a land mass of 3,577 square kilometers with a marine shoreline of about 180 km extending inland to a maximum distance of about 32km. The state has a humid tropical climate characterized by distinct dry and wet seasons with moderate mean annual rainfall which varies between 1381.7 mm and 2733.4 mm. Lagos State is Nigeria's most industrialized State. It accounts for over 60% of the Federation's total industrial investment. Primary agricultural production typifies the rural economy of Lagos State with industrial activities. While the State is essentially a Yoruba-speaking environment, it is a socio-cultural melting pot attracting both Nigerians and foreigners alike.

Nature and Sources of Data: Primary data was used for this study. These were collected through the administration of structured questionnaires to randomly selected cassava-garri processors. The data collected included respondents' personal information, processing inputs, and cost of production, income and expenditure.

Sampling techniques: A Multi-stage sampling technique was used for this study. The first stage involved the purposive selection of Epe Local Government Areas for ease of data collection. The second stage involved the purposive selection of two local council development areas (LCDAs) from the three LCDAs in Epe LGA due to the presence of large cassava-garri processors; the third stage involved the random selection of ten communities from the selected LCDAs and the final stage involved the random selection of 10 garri processors from each community making a total of 100 respondents for the study. However, data from 70 interviewers were used in the analysis. The other 30 were excluded due to lack of information. The sampling frame is the list of cassava-garri processors in each of the chosen communities.

Analytical techniques:

Descriptive statistics such as frequencies, means and percentages were used in analysing the socio-economic characteristics of the respondents.

Gross margin analysis was used to determine the profitability of garri production in the study area. The gross margin was represented by:

GM = TR – TVC …………………………….. (1)

Rate of Returns on investment (RORI) analysis is used to determine the amount of profit made when one Naira is spent on cassava processing. It is the ratio of Net Return to the Total Cost of production. The bigger it is, the better the profit made on garri. It is expressed as:

$$ROI = \frac{N.R.}{T.C.} * 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where

G.M = Gross margin

TR = Total revenue

TVC = Total variable cost

T.C. = Total cost in Naira

The stochastic frontier production function model: The basic concept of a stochastic frontier production functions as proposed by Aigner *et al.* 1977 was applied in the analysis of data. The Cobb-Douglas production function was linearised in the form:

$$InYi = \beta 0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \beta_5 InX_5 + \ldots + Vi - Ui \ldots\ldots\ldots (3)$$

Where; InYi =Natural Logarithm of Y; Yi = Garri output (kg); X_1 = Cost of cassava tubers used (₦); X_2 = Cost of firewood (₦); X_3 = Value of depreciated assets (₦); X_4 = Labour (₦); X_5 = Transportation cost (₦); X_6 = Cost of land (₦)

Vi = represent random disturbances cost due to factors outside the scope of the farmers which is assumed to be identically and normally distributed with a mean of zero (iid) and constant variance of V~N (o, σ2v) and independent of U. Ui = non-negative random variable associated with technical efficiency in production, and is assumed to be independently identically and normally distributed. U~N (o, σ2u) where the conditional mean μ is assumed to be related to farm and farmers-related socioeconomic characteristics.

The inefficiency model is specified as:

$Ui = \delta 0 + \delta_1 D_1 + \delta_2 D_2 + \delta_3 D_3 + \delta_4 D_4 + \delta_5 D5 + \delta 6D6 + \delta 7D7$ … ………… (4)

Where; Ui = Inefficiency model; D_1 = Age (years); D_2 = Gender (1-male, 0- female); D_3 = Educational level (educated 1; 0 if otherwise); D_4 = Household size (Number of people); D_5 = Processors experience (years); D_6 = Cooperative membership (membership = 1, 0 if otherwise); D_7 = Ownership of cassava farm (1 if owned, 0 if otherwise δ= Parameters to be estimated.

Results and Discussion

Socio-economic characteristics of cassava-garri processors in the study area

Table 1 presents the result of the socio-economic characteristic of the garri processors. The table reveals that majority (61.4%) of the processors were female while 38.6% were male. The dominance of garri processors by female in the study area was because processing and marketing of garri were seen as the female job while the men were more involved in cassava farming. This result agreed with those of Adekanye *et al.* 2013; Inyanda, 2014; and Adeniyi and Akande, 2015.

Table 1: Socio-economic characteristics of the respondents *N = 70*

Variable	Frequency	Percentage	Mean
Gender			
Female	43	61.4	
Male	27	38.6	
Age			
20-30	15	21.4	
31-40	23	32.9	38.7
41-50	19	27.1	
>50	13	18.6	
Educational Level			
No Formal Education	17	24.3	
Primary	16	22.9	
Secondary	20	28.6	
Adult/vocational	14	20.0	
Tertiary	3	4.3	
Marital Status			
Single	5	7.1	
Married	51	72.9	
Divorced	4	5.7	
Widowed	10	14.3	
Household Size			
1-4	20	28.6	
5-8	43	61.4	6
9-12	7	10.0	
Processors Experience			
<5	3	4.3	
5-10	55	78.6	11.4
>10	12	17.1	
Religion			
Christianity	32	45.7	
Islam	27	38.6	
Traditional	11	15.7	
Other Occupation			
Garri Processing Only	20	28.6	
Self-Employed	15	21.4	
Paid Employment	7	10.0	
Farming	28	40	

Source: Field Survey Data, 2016

The age distribution of the respondents' shows that a larger percentage of the respondents (32.9%) were within the age range of 31-40 years. The mean age of 38.7 years implies that the respondents were within the economic active age group and are able to cope with the rigours associated with cassava-garri processing.

The result further reveals that 24.3% of the respondents had no formal education while most (28.6%) had secondary education and only 4.3% had tertiary education. This implies that the educational level of the respondents is low and could be responsible for their reliance on local technologies for their operations. This is in consonance with Adeniyi and Akande, 2015 who opined that Education is considered highly necessary in the adoption of new technology and the various technical operations involved in the use of mechanized systems. Majority (72.9%) of the sampled respondents were married with a mean household size of 6 people. This indicates that the sampled household heads are responsible bread winners who have a duty to provide for their household members. This result corroborated the finding of Omolehin *et al* (2007) who opined that in African traditional settings, married men are considered to be more responsive since it is assumed that a person having family would want to have the best results that would translate to more output and consequently income to meet family needs. Majority of the respondents (78.6%) had garri processing experience of between 10 and 15 years, 17.1% had more than 10years experience while 4.3% had less than 5years processing experience. The mean year of garri processing experience was 11.4years. This implies that the garri processors in the study area are well experienced in their trade. This is substantiated by the findings of Olaoye (2010) and Aminu *et al.* (2014) who observed that experience is important in determining the profit levels, the greater the experience, the more the processors understand the system, conditions, trends, terrains, prices etc. Nwaru (2000) supported the finding that experience reduces management risk and that the number of years a producer spent in garri production is an indication of the practical knowledge acquired.

Cassava-garri processors characteristics

Table 2 reveals that most (34.3%) of the respondents had no cassava farms while the remaining 65.7% had cassava farmlands with size ranging from 0.5ha-4ha. The means farm size of 1.49 implies that the farmers were operating on medium scale. This assertion is based

on Babatunde (2004) farm size classification. According to him, farm size classification of 0.01-1.0ha is classified as small scale, 1.1-2.0 ha is medium scale and above 2.0ha are large scale farms respectively. The study also reveals that most (36%) of the respondents finance their operations through Ajo/Esusu, 23% through cooperatives, 6% through loans/ gifts from friends and relatives while 5% finance with bank loans.

Table 2: Cassava-Garri Processing Characteristics *N = 70*

Variable	Frequency	Percentage	Mean
Cassava Farm Size (ha)			
Do not have a farm	24	34.3	
0.5 – 1	20	28.6	
1.1 – 1.5	5	7.1	1.49
1.6 – 2	10	14.3	
>2	11	15.7	
Sources of Finance			
Bank Loans	5	7.1	
Friends/Relatives	6	8.6	
Ajo/Esusu	36	51.4	
Cooperatives	23	32.9	
Assess to Bank Loans			
No	58	82.9	
Yes	12	17.1	
Cooperative Membership			
No	36	51.4	
Yes	34	48.6	
Type of Labour Employed			
Family	26	37.1	
Hired	26	37.1	
Both	18	25.7	
Labour Cost (₦)			
None	26	37.1	
1000-10000	27	38.6	
10100-20000	4	5.7	12952.86
20100-30000	6	8.6	
>30000	7	10.0	
Income (₦)			
<10000	1	1.4	
10000-30000	21	30	57570.29
30100-60000	30	42.9	
>60000	18	25.7	
Ownership of Processing Equipment			
No	47	67.1	
Yes	23	32.9	
Extension Contact			
No	49	79	
Yes	21	30	

Source: Field Survey Data, 2016

Majority (58%) had no assess to bank loans and only 48/6% belong to a cooperative society.

This could have a negative effect on credit mobilisation and expansion of the processing operations. The result also reveals equal usage of either family or hired labour (37.1%) in the study area while 25.1% employ both family and hired labour. The mean labour cost was ₦12,952.86 while the mean income from garri processing was ₦57,570.29. Furthermore, 67.1% of the sampled respondents did not own processing equipment and 70% had no contact with extension agents

Profitability of Processing Cassava into Garri in the Study Area

The results in Table 3 revealed that the cost of cassava tubers (77.48%) accounted for the largest proportion of the total cost of processing cassava to garri in the study area. This is followed by cost of land (21.73%). The cost of labour, grating and rent constituted 9.06%, 5.80% and 4.72% of the total cost respectively. The low cost of firewood (0.72%) may be due to the fact that most of the respondents got the firewood freely from their farms or near-by bushes. The low storage cost (0.64%) among the respondents may be due to the fact that most

of them sell their garri at the processing points, in open spaces, along the road where stalls are allocated to other foodstuff sellers or pay for a section of another person's shop when there are leftovers to be sold the following day/market.

Table 3: Average Costs and Return to Garri Production in ₦/Month

Items	Amount	%TC	%TR
Variable cost			
Cassava tubers	78, 273.57	54.78	41.73
Labour cost	12, 952.86	9.06	6.91
Cost of grating	8, 290	5.80	4.42
Transportation cost	2, 029.14	1.42	1.08
Firewood cost	1, 027.86	0.72	0.55
Storage cost	921.43	0.64	0.49
Rent	6, 745.71	4.72	3.40
Miscellaneous	512.09 0.36	0.27	
Total Variable Cost (TVC)	**110, 716.66**	**77.48**	**59.03**
Depreciation on equipment	1,120.100.78	0.60	
Cost of land	31,058	21.73	16.56
Total Fixed Cost (TFC)	**32, 178.1**	**22.52**	**17.16**
TC (TFC + TVC)	142,894.76		
Total Revenue (TR)	187,570.29		
Gross Margin (TR - TVC)	76,853.63		
Net Returns (GM - TFC)	44, 675.53		
ROR (NR/TC*100)	**31%**		
BCR (TR/TC)	**1.31**		

Source: Field Survey, 2016

The average total cost incurred by the processors per month was ₦142,894.76 while total revenue of ₦187,570.29 was realised thereby returning gross margin of ₦76,853.63 and net returns of ₦44,675.53. The Rate of Return on Investment (RRI) of 31% indicated that processors of cassava to garri earn 31% profit on every naira invested. The benefit cost ratio of 1.31 which implies that for every ₦1 invested in processing cassava to garri, a return of ₦1.31 and a profit of ₦0.31 were realised further confirmed that cassava-garri processing enterprise is a profitable and viable enterprise which can drive high income generation for the people to earn a living vis-à-vis boast food production and employment opportunities in the study area and the state.

Technical Efficiency of Garri Processors in the study area

Table 4 presents the maximum likelihood estimates (MLE) of the parameters in the stochastic frontier model. The estimate of the sigma-square is significantly different from zero at one percent level, attesting to the goodness of fit and correctness of the specified distribution assumption of the composite error term. The variance ratio (gamma) estimated to be 0.634 is statistically significant at 1% suggesting that the systematic influences that are unexplained by the production function are dominant sources of error. That is, the technical inefficiency effects are significant in the stochastic frontier model and that the traditional production function with no technical inefficiency effect is not an adequate procedure in this regard. In other words, the presence of technical inefficiency among the sample processors explains about 63percent variation in their output levels. The result of the production function reveals that, the coefficient of cost of cassava tubers ($P<0.05$) and cost of land ($P<0.05$) had a positive significant relationship with garri output while the coefficient of labour cost ($P<0.01$) had a negative significant relationship. This implies that, a 1% increase in costs of cassava tuber and land will increase garri output by 0.0306% and 0.274% respectively. However, a 1% increase in the cost of labour will decrease garri output by 0.251%.

The result of the inefficiency model on table 5 shows that the estimated coefficient of age was positive and significant at $p<0.05$. This implies that technical inefficiency increases with the age of the processors suggesting that the older farmers are less technical efficient than the younger farmers. This result agrees with Iheke and Oliver-Abali (2011); Chukwuji, *et al*. (2007) that older farmers are more risk averse and hence, adoption of innovation decreases with age. The result also revealed that technical efficiency is increased by gender of the respondents in the study area as it had a negative significant relationship with technical inefficiency at 5% level.

This implies that the female processors are technically efficient than their male counterparts in the study area. Household size of the processors was positive and significant ($P<0.05$). This implies that the smaller the number of people in the processing household that

Table 4: Stochastic Frontier Estimation of Production Function of Cassava-Garri Processors in the Study Area

Variables	Parameters	Coefficients	T-ratio
Production Model			
Constant	β_0	4.368	7.370
Cassava tubers (₦)	β_1	0.306	2.250**
Firewood cost (₦)	β_2	0.067	0.183
Depreciated assets (₦)	β_3	1.217	1.538
Labour cost (₦)	β_4	-0.251	-4.167***
Transportation cost (₦)	β_5	0.060	0.927
Cost of land (₦)	β_6	0.274	2.326**
Inefficiency Model			
Constant	δ_0	3.421	9.710
Age (years)	δ_1	0.625	2.211**
Gender (dummy)	δ_2	-0.335	-2.351**
Educational status (dummy)	δ_3	2.092	0.156
Household size (No of pple)	δ_4	0.001	2.143**
Processors experience (years)	δ_5	-0.593	-1.214
Cooperative membership	δ_6	-3.642	-2.055**
Ownership of cassava farms	δ_7	-0.360	-1.155
Sigma-squared	σ^2	0.496	7.629***
Gamma	Y	0.634	18.261***
Technical efficiency			
Mean TE		0.76	
Min. TE		0.55	
Max. TE		0.96	
RTS		**1.673**	

Source: Computed from Field Survey Data, 2016

Participates in garri processing activities, the higher their inefficiency level. This also suggests that some members of the processors household could be involved in other income generating activities to boost their incomes. The study further reveals that membership of cooperative association had a negative significant relationship with technical inefficiency of the respondents. This implies that respondents who are members of cooperative association are more technically efficient. This finding is in line with the observation of chukwuji and Inoni (2002), who noted that members of cooperative societies are able to adopt better techniques of production than non-members because of the greater awareness created and encouragement given to their members

Technical Efficiency and RTS Estimates of the respondents

The technical efficiency indices were derived from the maximum likelihood estimates (MLE) results of the stochastic production function using computer programme frontier 4.1. The indices summarized in table 4 shows that the technical efficiency of the sampled cassava-garri processors was less than one, implying that all the respondents were producing below the production frontier. The maximum technical efficiency was 0.96 while the minimum processor achieved 0.55. The mean technical efficiency was 0.76. This implies that on the average; cassava-garri processors in the study area were able to obtain about 77% of the potential garri output from a given mix of production inputs, indicating that the production level was about 24% below the frontier. This also means that a significant proportion of the output was lost due to technical inefficiency factors. The variation in the level of technical efficiency might be as a result of specific processing characteristics such as nature of inputs used, technology and the processors' management skills in attaining higher level of technical efficiency.

The Return to Scale (RTS) value for the function as shown on table 5 was found to be greater than unity, indicating increasing return to scale. Hence, the processors can be said to be operating in stage 1 (irrational stage) of production. This implies that garri processors in the study area are yet to operate at optimum scale of production.

Hence, there is need for improvement such as improve technologies and using more variable inputs to boost production. This result agrees with findings of Ehinmowo and Ojo (2014).

Conclusion

The study examined the technical efficiency in value addition to cassava-garri processing in Lagos State. The profitability analysis showed that cassava-garri processing enterprise is a profitable and viable enterprise in the study area. The result of the stochastic frontier analysis revealed that costs of cassava tubers, labour and land had significant influence on garri output while age, gender, household size and membership of cooperative association were the socio-economic attributes determining the technical efficiency of the respondents in the study area. The authors recommend that garri processors should be encouraged to form and join viable cooperative associations that can be used as a drive for acquiring loans for members at affordable interest rates. Such loans could be used to communally purchase land and some processing machines that are beyond individual processor such as grating machines, dewatering machines, peelers, dryers and fryers. These machines could be used by members for their gari processing at the payment of token amount cheaper than the cost of manual labour that are currently being used. This will also make garri processing faster and allow more processing cycle to be covered and consequently more employment opportunities created and more profit accruable to garri processors.

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