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# Economic Analysis of Palm Kernel Nut Processing: Evidence from Ogun State, Southwestern Nigeria

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## ABSTRACT

Prior to ramping up advocacy for palm kernel nut processing as a means to diversify livelihood source, it becomes germane to look into the economic analysis of palm kernel nut processing as a way of proffering empirical based evidence on the status of the enterprise. The study was conducted in Ipokia Local Government Area, Ogun State, Nigeria. To select 40 palm kernel processors for the study, a multistage sampling approach was used. The study employed both descriptive and inferential statistics. The findings showed that the majority of processors were engaged in the extraction of palm kernel cake and oil from palm kernel nuts. Profit realized from the extraction of oil and cracking of palm kernel nut per ton per week was ₦57, 378.66 (USD 145.26) and ₦24, 775.11 (USD 62.72) with a return on investment of 1.37 and 1.32 respectively. Thus, the enterprise is profitable. In addition, the regression analysis showed that household size ($p<0.05$), processing experience ($p<0.01$) and processing stage ($p<0.05$) significantly influenced the profit of the palm kernel nut processors. The study therefore recommends effort be made to attract investors to support the smallholders in order to improve their livelihood and export funding.

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## INTRODUCTION

The oil palm (Elaeis guineensis) is a legendary plant that was first cultivated in West Africa's tropical rain forest (Akinniran et al., 2013) with several economic uses (Sarku, 2015; Sanusi et al., 2022). It is a palm species that serve as the sole source of palm related oils to humans (Owutuamor et al., 2019). Through its revenue-generating endeavors and value addition in its supply chain, it has the potential to promote economic growth and food security (Verheye, 2002; Sarku, 2015; Owutuamor et al., 2019). Palm oil and palm kernel are basically the primary product of oil palm fruit processing with the latter particularly valuable because of the oil derived from it. Palm kernel represents only 4 to 6 percent of the fresh fruit palm bunch and its only 10 to 15 percent of the value of the primary product of oil palm fruit processing (Okoli, 2003).

A significant section of the rural population relies on palm oil as a key source of income and employment in Nigeria, where production has experienced significant fluctuations (Palm Oil Analytics, 2017; Owutuamor et al., 2019). It is interesting to note that more palm oil is needed for industrial production than there is available. On the other hand, a fall in agricultural output and export, particularly in the processing of oil palm, which involves adding value and might result in a higher GDP, is not good for the nation's economic development. However, palm kernel oil might be used to supplement the shortage since it is mostly produced by small-scale processors and has a low extraction capacity per unit of output (Ofusu-Budu and Sarpong, 2013).

The maximization of farmers' net farm income and wealth is generally acknowledged to be one of the main goals of value addition (Anderson and Hanselka, 2013; Shashi et al., 2017). Expanding the activities in value-adding processes is crucial if they are to take advantage of economies of scale and avoid producing merely to benefit participants in their supply chain's downstream. Furthermore, the lack of good roads in potential high-producing areas, high labor costs in oil palm processing, and a lack of the necessary infrastructure for credit facilities and the processing of oil palm have all seriously hampered value addition processes (Edem, 2012; Gourichon, 2013; Nwalieji and Ojike, 2018). It therefore becomes imperative to analyze the economics of palm kernel nut processing

with the view of examining the costs and returns accruing to its processing; identify the stages involved in the processing; determine the factors that influence the net income of processors and; identify the bottleneck faced by the palm kernel nut processors.

## MATERIAL and METHOD

### Study Area

The study was conducted in Ogun State. The state is found in Nigeria's southwest. It is located in the humid tropical lowland region between latitudes 7° and 8° 27' E. Benin Republic borders it on the west, Lagos State on the south, Ondo State on the east, and Oyo and Osun States on the north. The estimated population of the State is 3,728,098 (NPC, 2006). The land area of the state is around 16, 409.26 square kilometres (Soewu et al., 2012), however, the arable land stands at 1, 204,000 hectares with only about 350,000 hectares presently cultivated. The state is blessed with good climatic condition suitable for palm oil production. The soil condition favors the production of food and cash crops.

### Sampling Techniques

A multistage sampling procedure was used in selecting the palm kernel processors for the study. The first stage involved the purposive selection of Ipokia Local Government Area (LGA). This was based on the dominance of the LGA in palm kernel production activities. In the second stage, Koko village was purposively selected based on its fewer activities as regards to palm kernel processing when compared to other villages within the LGA. Due to their less involvement in the activity, snowballing technique was used in selecting 40 palm kernel processors.

### Source of Data and Data Collection

Primary data were collected through a semi-structured questionnaire administered to 40 palm kernel processors to elicit relevant information on their socioeconomic characteristics, costs and returns accruing to the enterprise, activities involved in the processing, factors influencing palm kernel processing, and records on the bottleneck faced by the processors.

### Data Analysis and Model Specification

The study employed both descriptive and inferential statistics. The socioeconomic characteristics of the processors, the activities involved in the processing, and the constraints faced by the processors were all described using descriptive statistics such as frequency counts, percentages, and mean values. The profitability of the processors was ascertained using the budgetary model, and the variables affecting palm kernel processing were investigated using the multiple regression technique.

### Budgetary Technique

Estimating the profitability of palm kernel nut processing in the study area involved costs and returns analysis. The cost function is written as follows, using modifications from Obalola et al. (2017):

$$\pi = TR - TC \quad (1)$$

π = Profit; TR = Total revenue from palm kernel nut processing; TC = Total cost of palm kernel nut processing

$$TR = P_y . Y \quad (2)$$

$P_y$ = Average price of palm kernel nut sold; Y = Numbers of palm kernel nut processed

$$TC = TVC+TFC \quad (3)$$

TC = Total cost of palm kernel nut processing; TVC = Total variable Cost of palm kernel nut processing; TFC = Total Fixed Cost of Palm kernel nut processing

$$TVC = \sum_{p=1}^{n} Pi\, Xi \quad (4)$$

$P_i$ = Price of variable input, $i$ ; $X_i$=Quantity of input $i$ used and;
TFC = Total fixed cost of palm kernel nut processing which is the depreciated value on fixed inputs represented as:

$$Dp = (F-S)/L \quad (5)$$

Dp = Depreciation value; F = Cost of purchasing fixed inputs; S = Salvage value, L = Useful life

### Multiple Regression Model

In order to identify the variables affecting the net income of palm kernel nut processing in the study area, multiple regression analysis was utilized. Obalola and Tanko (2016) state that the model is implicitly described as follows:

$$Y = f(X_1,X_2,X_3,X_4,X_5,X_6,X_7, X_{-8} + \mu) \quad (6)$$

Y = Net income to processor (naira)
$X_1$ = Sex (dummy)
$X_2$ = Age (years)
$X_3$ = Marital status (1 if married; 0, otherwise)
$X_4$ = Household size (number)
$X_5$ = Level of education (categorical)
$X_6$ = Processing experience (years)
$X_7$ = Distance to source of nut (km)
$X_8$ = Processing stage (dummy)
$\mu$ = Error term

Three functional forms was fitted to the data and the lead equation was chosen based on statistical and econometric criteria such as the coefficient off multiple determination $R^2$ value, the F value, significant variables and so on. Explicitly, the functional forms are expressed:

1. Linear function

$$Y = \delta_0 + \delta_1X_1 + \delta_2X_2 + \delta_3X_3 + \delta_4X_4 + \delta_5X_5 + \delta_6X_6 + \delta_7X_7 + \delta_8X_{-8} + \mu \quad (7)$$

2. Semi log form

$$Y = \delta_0 + \delta_1 \log X_1 + \delta_2 \log X_2 + \delta_3 \log X_3 + \delta_4 \log X_4 + \delta_5 \log X_5 + \delta_6 \log X_6 + \mu \quad (8)$$

3. Double log form

$$\text{Log } Y = \delta_0 + \delta_1 \log X_1 + \delta_2 \log X_2 + \delta_3 \log X_3 + \delta_4 \log X_4 + \delta_5 \log X_5 + \delta_6 \log X_6 + \mu \quad (9)$$

$\delta_0$ = Constant;
$\delta_1$ - $\delta_8$ = Parameter estimated;
Other variables are as previously defined.

## RESULTS and DISCUSSION

### Socioeconomic Characteristics of the Palm Kernel Nuts Processors

The result revealed that majority of the palm kernel nuts processors were male with less than a quarter of the processors being female (Table 1). This implies that the enterprise was dominated by male and this is attributed to the fact that palm kernel nut processing requires a lot of strength which most female may not be able to supply. This contradicts the findings of Yinusa (2015) and Sanusi et al. (2022) who reported that palm oil processing were predominant amongst the women. The majority of palm kernel nut processors were within the age bracket of 41-50 years amid the mean age of 48years implying that most of the processors were still within their productive age when compared to the human development report (2006) and this may have a positive influence on the amount of income generated. This supports the position of Ibitoye et al. (2011), Akinniran et al. (2013) and Sanusi et al. (2022). The majority (92.50 %) of palm kernel nut processors were non-members of association, as a result, may negatively influence their output as they were most likely not have access to credit facilities to increase their scale of operation. The result revealed that majority (95 %) of the palm kernel nut processors were married while 2.50 % of the processors were separated and widowed. This corroborates with the finding of Sanusi et al. (2022). Similarly, the mean size of the household was 5 persons which is fair to supply labour during the processing activities. Furthermore, the processors are educated having a minimum of primary education, though, the majority (55 %) of the palm kernel nut processors had secondary education and tertiary education (32.50 %). This signals a strong adsorption capacity on innovation.

Table 1. Socioeconomic characteristics of the palm kernel processors

| Variable | Frequency | Percentage | Mean | Standard deviation |
|---|---|---|---|---|
| **Sex** | | | | |
| Female | 9 | 22.50 | | |
| Male | 31 | 77.50 | | |
| Total | 40 | 100.00 | | |
| **Age** (years) | | | | |
| ≤40 | 4 | 10.00 | 48 | 7.35 |
| 41-50 | 25 | 62.50 | | |
| 51-60 | 9 | 22.50 | | |
| >60 | 2 | 5.00 | | |
| Total | 40 | 100.00 | | |
| **Membership of association** | | | | |
| Non-member | 37 | 92.50 | | |
| Member | 3 | 7.50 | | |
| Total | 40 | 100.00 | | |
| **Marital Status** | | | | |
| Married | 38 | 95.00 | | |
| Single | 2 | 5.00 | | |
| Total | 40 | 100.00 | | |
| **Household size** (persons) | | | | |
| 1-3 | 6 | 15.00 | 5 | 1.79 |
| 4-6 | 27 | 67.50 | | |
| 7-9 | 7 | 17.50 | | |
| Total | 40 | 100.00 | | |
| **Educational level** | | | | |
| Primary | 5 | 12.50 | | |
| Secondary | 22 | 55.00 | | |
| Post-secondary | 13 | 32.50 | | |
| Total | 40 | 100.00 | | |

### Stages of Palm Kernel Nut Processing

Majority (72.50 %) of the palm kernel nut processors were into extraction of palm kernel oil and cake from palm kernel nuts (Table 2). The cracking of un-cracked palm kernel nuts without extraction was reported by 25 % of the processors and 2.50 % were into extraction of palm kernel oil and cake from un-cracked palm kernel nuts. The result further revealed that about 37.50 % of the palm kernel nut processors obtained oil, cake and sludge from the cracked palm kernel nuts; 2.50 % obtained sludge only; 2.50 % obtained cake and sludge; 35 % obtained oil and cake; 17.50 % obtained cake only and 5 % obtained oil and sludge.

Table 2. Process stage involved in extraction of palm kernel

| Variable | Frequency | Percentage |
|---|---|---|
| **Process Stage Involved** | | |
| Cracking of nuts | 10 | 25.00 |
| Extraction of oil from un-cracked nuts | 1 | 2.50 |
| Extraction of oil from cracked nuts | 29 | 72.50 |
| Total | 40 | 100.00 |
| **Various Product Obtained** | | |
| Sludge | 1 | 2.50 |
| Cake and sludge | 1 | 2.50 |
| Oil and cake | 14 | 35.00 |
| Cake | 7 | 17.50 |
| Oil and sludge | 2 | 5.00 |
| Oil, cake and sludge | 15 | 37.50 |
| Total | 40 | 100.00 |

### Profitability Analysis on Cracking of Palm Kernel Nuts

The costs and returns structure for extracting cracked palm kernel nuts showed that ₦210, 886.05 (USD 533.88) in total revenue was obtained from extracting cracked palm kernel nuts (Table 3). The revenue from oil contributed most (64.40 %) to the total revenue. This was followed by revenue from cake contributing 25.62 % and sludge contributed 9.97 % to the total revenue. The total cost incurred by the processor was ₦153, 507.39 (USD 388.62). This comprised the total fixed cost of ₦43, 073.05 (USD 109.04) accounting for 28.06 % to the total cost of production; and the total variable cost of ₦110, 434.34 (USD 279.58) making the largest (71.94 %) component of the total production cost. The gross margin realized was ₦100, 451.71 (USD 254.30) and the profit realized was ₦57, 378.66 (USD 145.26). It was observed that for every ₦1 invested in the enterprise ₦1.37 will be return to the enterprise. This supports the work of Sanusi et al. (2022) who revealed that for eery ₦1.00 invested in palm oil processin enterprise, a net profit of one naira thirty-two koo (₦1.32) is realised. This makes the return on investment and shows that the enterprise is a profitable venture.

The palm kernel nut cost and return structure showed that the total profit made from palm kernel nut cracking was ₦ 102, 845.27 (USD 260.36). Cracked kernel and shell constitute the revenue component with former contributing the most (80.43 %) and the lather, contributed 19.57 % to the total revenue. The total cost incurred by the processor was ₦78, 070.16 (USD 197.64) with the total fixed and variable costs of ₦19, 026.00 (USD 48.16) and ₦59,044.16 (USD 149.47) constituting 24.37 % and 75.63 % to the total production costs respectively. The gross margin accruing from the processing was ₦43, 801.11 (USD 110.88) and the profit ₦24, 775.11 (USD 62.72) was realized. The return on investment was 1.32 indicating that the enterprise is profitable. That is, for every ₦1 invested in the enterprise ₦1.32 will be returned to the enterprise.

### Socioeconomic Factors Influencing Profit Level of the Palm Kernel Nut Processors

Multiple regression analysis was used to determine the effects of socioeconomic characteristics on the profit level of the palm kernel nut processors (Table 4). Linear, semi log and double log functions were estimated. The linear function was chosen as the lead functional form based on the standard econometric criteria. The result of the heteroscedasticity robust standard error of the multiple regression analysis of the determinants of profit level of the palm kernel nut processors revealed the R squared of 62.9 %. This implies that the variation in profit of the processors was jointly explained by the explanatory variables while the remaining 37.1 % was due to variable not included in the model. The variance inflation factor test of multicollinearity shows that there is absence of such as the value is lower than the critical value of 5, the F-statistics revealed the overall fitness of the model at ($p<0.01$) level of probability. The result revealed that household size ($p<0.05$), processing

experience ($p<0.01$) and processing stage ($p<0.05$) significantly influenced the profit of the palm kernel nut processors. Considering the relationship exhibited on the signs of the significant variables, the coefficient of household size revealed a decline in the profit gained by the processors by ₦9,832.5 with a unit increase in the size of the household. This can be attributed the responsibilities expected on a large household. This is not in tandem with the position of Sanusi et al. (2022) for there exits a positive relationship between household size and profit realisation. For processing experience, a year increase in the experience of the processors will increase their profit by ₦2, 061.58. This is not farfetched from what is derived from experience on how to cope with the risk and challenges faced in the enterprise, thus, enhancing their profit level. The coefficient of processing stage revealed that the profit of processors that are involved in cracking of palm kernel nut to extraction increases by ₦23, 746.11 (USD 60.11) compared to processors that are involved in cracking only. This implies that processors that engaged in cracking of un-cracked nut to extraction have higher rate of return on investment compared with their counterparts.

Table 3. Costs and returns analysis of palm kernel nuts processing

| **Processing stage** | **Extraction of Oil** | | **Cracking of Nut** | | |
|---|---|---|---|---|---|
| Variable | **Mean revenue and cost (₦)** | **%** | **Variable** | **Mean revenue and cost (₦)** | **%** |
| **Revenue** | | | **Revenue** | | |
| Oil | 135,817.72 | 64.40 | Shell | 20,131.64 | 19.57 |
| Sludge | 21,030.83 | 9.97 | Cracked kernel | 82,713.63 | 80.43 |
| Cake | 54,037.50 | 25.62 | - | - | - |
| **Total revenue** | **210,886.05** | **100.00** | **Total revenue** | **102,845.27** | **100.00** |
| **Fixed cost** | | | **Fixed cost** | | |
| Rent on land | 9,346.97 | 6.09 | Land | 7,089.07 | 9.08 |
| Knife | 568.69 | 0.37 | Knife | 456.25 | 0.58 |
| Scale | 1,840.81 | 1.20 | Scale | 3,829.17 | 4.90 |
| Expeller | 11,611.68 | 7.56 | Cracker | 7,651.52 | 9.80 |
| Dryer | 10,226.19 | 6.66 | Dryer | - | - |
| Filter | 2,293.27 | 1.49 | Filter | - | - |
| Storage | 2,666.67 | 1.74 | Storage | - | - |
| Drum | 1,266.47 | 0.83 | Drum | - | - |
| Kegs | 2,086.51 | 1.36 | Kegs | - | - |
| Bucket | 1,165.80 | 0.76 | Bucket | - | - |
| **Total fixed cost** | **43,073.05** | **28.06** | Total fixed cost | **19,026.00** | **24.37** |
| **Variable cost** | | | **Variable cost** | | |
| Hired labour | 27,868.75 | 18.15 | Hired labour | 14,836.37 | 19.00 |
| Cracked nut | 77,091.84 | 50.22 | Un-cracked nut | 41,131.72 | 52.69 |
| Transportation | 3,530.00 | 2.30 | Transportation | 1,076.07 | 1.38 |
| Electricity | 1,943.75 | 1.27 | Electricity | 2,000.00 | 2.56 |
| **Total variable cost** | **110,434.34** | **71.94** | **Total variable cost** | **59,044.16** | **75.63** |
| **Total cost** | **153,507.39** | **100.00** | **Total cost** | **78,070.16** | **100.00** |
| **Gross margin** | **100,451.71** | | **Gross margin** | **43,801.11** | |
| **Profit** | **57,378.66** | | **Profit** | **24,775.11** | |
| **ROI** | **1.37** | | **ROI** | **1.32** | |

1 USD = ₦395

## Constraints Facing Palm Kernel Nut Processing

The constraints faced by the palm kernel nut processors in decreasing order of magnitude are lack of credit facilities, importation of palm kernel oil and the problem of transportation (Table 5). The lack of credit facilities is anticipated as most of the processors reported they were non-members of association, perhaps limiting their access to credit facilities which can be used to scale up their operations. Production of palm kernel should be encouraged to tackle the issue

on importing more of the product at the detriment of the local processors. This can be achieved through thorough advocacy for palm production.

Table 4. Multiple regression estimates of the determinants of profit of the processors

| | Linear function | |
|---|---|---|
| Variable | Coefficient | P-value |
| Constant | 28957.89 | 0.363 |
| Sex | -13116.01 | 0.371 |
| Age | 313.26 | 0.580 |
| Marital status | -4094.05 | 0.522 |
| Household size | -9832.5*** | 0.000 |
| Level of education | -137.78 | 0.889 |
| Processing experience | 2061.58*** | 0.006 |
| Distance from source of nut | -144.80 | 0.481 |
| Processing stage | 23746.11** | 0.049 |
| R squared | 0.553 | |
| F(8, 31) | 4.79*** | |
| Prob> F | 0.0007*** | |
| Mean VIF | 2.09 | |
| Number of observations | 40 | |

***, ** and * means p<0.01, p<0.05 and p<0.1 probability levels respectively

## CONCLUSION

Extractions of palm kernel oil and cake from palm kernel nuts are the major activities by the palm kernel nut processors. These were disaggregated into those who obtained oil, cake and sludge from the cracked palm kernel nuts; sludge only; cake and sludge; oil and cake; oil and sludge and cake only. The profit accruing to the extraction of oil and cracking of palm kernel nut were ₦57, 378.66 and ₦24, 775.11 respectively. Household size, processing experience and processing stage significantly influenced the profit of the palm kernel nut processors. The study therefore recommends effort be made to attract investors to support the smallholders in order to improve their livelihood and export funding. Lack of credit facilities, importation of palm kernel oil and the problem of transportation were the registered constraints faced by the palm kernel nut processors. The study there recommends that processors be provided the avenue to access credit which can be used to scale up there operations. Also, a strong advocacy that is capable of attracting investors be implemented. This is expected to enhance production and help solve the demand and supply gap met via importation.

Table 5. Constraints faced by the palm kernel nuts processors

| Variable | Frequency | Percentage | Rank |
|---|---|---|---|
| Lack of credit facilities | 22 | 55.00 | 1st |
| Transportation problem | 5 | 12.50 | 3rd |
| Importation of palm kernel oil | 13 | 32.50 | 2nd |
| Total | 40 | 100.00 | |

### Conflicts of Interest

The authors have declared no conflict of interest.

### Authors' Contributions

The authors contributed to the conceptualization, methodology, analysis and writing of the manuscript.

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