

Analysis of the profitability of oil palm processing techniques in Kogi State, Nigeria

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Abstract

The processing of palm fruit is one of the most prominent agricultural processing activities carried out in Nigeria. This paper ascertained the extent of oil palm processing profitability across the different categories of processors in Kogi State, Nigeria. The study estimate cost and returns of the processing enterprises; determined the profitability of the processing enterprises; and examined the determinants of the returns from the processing activities in the study area. A multistage sampling technique was used to select 80 oil palm processors comprising of 15 manual processors, 55 semi-mechanized and 10 mechanized processors in Kogi State, Nigeria. Descriptive statistics, gross margin analysis, Ordinary least square regression model was used in the data analysis. The result of the study revealed that the gross marginal value of N80,093.70, N231,482.24 and N506,365.00 for manual, semi-mechanized and Mechanized processors with returns of N52,187.70, N142,078.61 and N365,965.00 per processor for manual, semi-mechanized and mechanized systems. The result revealed oil palm processing is a profitable enterprise irrespective of the processing technique, however, with the mechanized more profitable. The result of the regression estimates showed the F-ratio value statistically significant at ($p < 0.01$), indicating that the model is fit for use in the analysis. The estimate showed a coefficient of determination (R^2) value 68%. The regression output showed that the oil palm fruit cost, transportation cost and the cost of depreciation were statistically significant with inverse relationship with the processors net return. However, extraction cost and use of processing machines or technology were statistically significant with direct relationship with net returns from oil palm processing in the study area. The study concluded that oil palm processing is a profitable venture in the study area with great potential for poverty alleviation if the potential is harnessed. The study recommended that machines or technologies for processing should be subsidized to make it affordable to small-scale processors. Also, the capacity of the small-scale processors should be enhanced to enable use such machines.

Keywords: Oil palm fruits; Processors; Processing systems; Nigeria

1. Introduction

Oil palm (*Elaeis guineensis*) has been a major crop in the economy of some evolving industrial nations in the world and has assisted them to rise from economic doldrums to advanced economies (Iyaji et al., 2023). Furthermore, Nigeria was the world's largest producers of palm oil, before the crude oil boom era and now Malaysia has taken the leading position (Onwubuya, 2012). In Nigeria, 80% of palm oil production comes from dispersed smallholders who harvest semi-wild plants and use manual processing techniques (Olagunju, 2008). According to Olagunju (2008), among the small-scale producers, traditional, or semi mechanized methods were used for oil extraction from the fresh fruit bunch. Traditional palm oil processing is labor-intensive and involves the following activities; threshing, picking, parboiling, digestion, extraction and separation and these result in production of palm oil of low-quality palm oil with a high proportion of free fatty acid (FFA) contents and a large quantity of dirt and water (Nwandu et al., 2021). While the mechanized

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processing sector is more efficient, technology driven, operates at a larger economy of scale, higher productivity in terms of the volume of the oil palm fruits handled and also produces better quality of crude palm oil and further refined palm oil products.

Processing of oil palm fruit according to FAO (2005) is defined as a process by which palm fruit is transformed into palm oil and kernel through threshing or stripping, sterilization, milling and digesting, pressing and clarification. While Nnabuike (2013), stated that processing of palm oil involves the use of different techniques ranging from modern method to traditional method. However, small processors oil palm processing in this part of the world is dominated by the traditional method. Processing transforms the low value palm fruit to value added palm oil. Oil palm fruit processing in the study area involves traditional methods encompassing little use of improved technologies, and the fairly largely mechanized processing which involves greater use of improved local technologies. Many individuals embark on the traditional method of processing with little adoption of improved technologies, while the semi-mechanized processors make more use of improved local technologies. In carrying out these operations, there is the need for choice of both technique and scale of operation. One characteristic feature of the of the Nigerian palm oil industry, is that it depends on less use of sophisticated machines, labor-intensive and handles less volume of oil palm fruits.

There are different techniques used in processing palm oil and these range from modern methods to traditional methods. However, the traditional methods of processing are more prevalent among small-scale processors and these small-scale processors are responsible for the bulk of palm oil processed in Nigeria (Nwalieji and Ojike, 2018). Several of these resource poor lack capital for the purchase of processing machines and equipment. This is responsible for the dominance of traditional processors in rural areas. High cost of processing equipment has discouraged intending processors from establishing and investing in palm oil enterprise. This is responsible for why some of the processors have resorted to hiring of processing equipment as well as responsible for the delay in processing of palm fruits (Nwalieji and Ojike, 2018). However, an efficient processing technology will increase the quality and quantity of palm oil available for consumption and trade. An improvement on the production techniques used in palm oil processing will lead to higher productivity which will help bridge the gap between the supply and demand of palm oil hence a reduction in palm oil import. Palm oil processing provides income to numerous households and serve as a major source of employment to a large number of the resource-poor rural population in Nigeria especially in Kogi State, Nigeria.

Palm fruit processing provides both direct and indirect employment to numerous households involved in the processing and marketing of palm oil and oil palm products. Processing activity provides array of opportunities for the marketing of agricultural produce (Ahmed,2001). This study analyzed the comparative performance of the various oil palm processing technologies. Though there are studies on economic analysis of oil palm processing in Nigeria, studies that examined the economic analysis from the point of view of the different production techniques are however, very scanty or few particularly in Kogi State, Nigeria to the best of the researcher's knowledge as at the time of carrying out this research. This constitutes a gap in literature that this study seeks to fill. The general object of the study is to analyze the profitability of oil palm processing techniques in Kogi State, Nigeria. The specific objective of the study includes to;

- describe the socio-economic characteristics of oil palm processors in Kogi State, Nigeria;
- estimate the oil palm processors costs and benefits in the study area;
- determine the profitability of oil palm processing in the study area;
- determine the factors influencing the processors' net returns in the study area;

2. Research Methodology

The study area is Kogi State, Nigeria. The people are majorly Igala, Ebara and Yoruba (Okun) speaking Languages. The State consists of 21 Local Government Areas. The State is located between latitude 6°30'N and 8°5'N and longitude 5°51'E and 8°00'E. The people are active farmers. Major crops grown are Cocoyam, maze, yam, and Cassava. It is also common practice to find each farming family keeping one form of livestock or the other. The variety of palm trees grown mostly were the tall sky scraper trees which need the aid of climbing robes to harvest palm bunches. The following are different types of indigenous oil palm operations and technologies in which the men, women and Children are involved respectively. The Men are involved in producing Baskets, Wood carving among others. The women are involved in processing palm fruits into Palm oil, Kernel into palm kernel oil, making soap and cream and other products. Kogi State is made up of an agrarian population, where the economy and social life revolve round Agriculture. The study utilized primary data for the study. The data was collected through questionnaire administered to 80 oil palm processors, comprising of 15 manual, 55 semi-mechanized and 10 mechanized oil palm processors in Kogi State, Nigeria. Persons engaged in the processing of oil palm fruits were chosen by using a random sampling technique. The data utilized both descriptive and inferential statistics. The study employed the use of net income and profitability ratios in its analysis.

The formula used for the analysis is as follows;

$$\text{Gross margin (GM) of palm oil processors} = Q_y P_y - \sum X_i P_{xi}$$

Q_y = Palm oil processed (Litres)

P_y = Unit price of palm oil processed (N /litre)

$Q_y P_y$ = Total Revenue generated from processing palm fruit (N /litre)

X_i = Quantity of the i th variable input used in processing palm fruit (N)

P_{xi} = Price per litre of the i th variable input (N)

$GM = TR - TVC$

$TC = TFC + TVC$

$$\text{Net Returns (NR)} = GM - TFC$$

$$\text{Benefit-cost ratio (BCR)} = \frac{TR}{TC}$$

$$\text{Expense Structure ratio} = \frac{FC}{TC}$$

Where

TC = total cost

TR = total revenue

TC = total cost

TR = total revenue

TFC = total fixed cost

TVC = total variable cost,

GM = gross margin

NR = Net Returns

2.1. Model Specification

2.1.1. Ordinary Least Square Regression analysis

$$Y_i^* = x_i \beta + u_i$$

Y_i^* = the dependent variable is the returns from oil palm processing by the processors.

X_1 = Processing experience (years).

X_2 = Oil palm fruit cost (Naira)

X_3 = Extraction charges (Naira).

X_4 = Transportation cost (Naira)

X_5 = Water/Energy cost (Naira)

X_6 = Depreciation charges (Naira)

X_7 = Processing technologies/machines (if present, yes = 1, no = 0)

u_i = Error term

3. Results and discussion

Table 1 showed that most of the processors were still young and in their productive age. However, there appears to be more respondents involved in mechanized oil palm processing. The age distribution of the manual and semi-mechanized processors, revealed that most of them were young. The result revealed that both male and female processors utilize the manual, semi-mechanized and mechanized oil palm processing system, however, the result revealed that there were more male processors among the manual and mechanized oil palm processors. The result showed that there were more female processing using the semi-mechanized processing system.

The result further revealed that the respondents were mostly married. The result revealed the respondents comprised mostly of mature and responsible men and women. The result showed that a larger proportion of the different categories of processors had one form of formal education or the other. Only small proportion had no formal education and primary school education. The result revealed that the distribution by household sized showed that close to half of the respondents had household size distribution of 1-5 persons. While also a good proportion had household size of between 6-10 persons in the study area. Only a small proportion had household size of greater than 10 persons. The

distribution of the respondents by their primary occupation revealed that a larger proportion of the processors had farming as their primary occupation in the study area.

Table 1 Socio-economic characteristics of the respondents in the study area

Processors Variables	Manual method		Semi-mechanized		Mechanized method	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Age (years)						
≤ 30	4	26.67	-	-		
31-40	-	-	14	25.45	2	20.00
41-50	11	73.33	30	54.54	-	-
51-60	-	-	11	20.00	8	80.00
>60	-	-	-	-	-	-
Gender						
Male	9	60.00	13	23.64	8	80.00
Female	6	40.00	42	76.36	2	20.00
Marital Status						
Single	4	26.67	2	3.64		
Married	11	73	53	96.37	10	100.00
Education level						
No formal edu.		-	8	14.55	-	-
Primary Sch	2	13.33	5	9.09	2	20.00
Secondary sch	7	46.67	32	58.18	8	80.00
Tertiary	6	40.00	10	18.18	-	-
Household size						
1-5	6	40.00	31	-	-	-
6-10	9	60.00	16	29.09	5	50.00
>10	-	-	8	14.55	5	50.00
Primary occupation						
Farming	11	73.33	39	70.91	8	80.00
Non-farming	4	26.67	16	29.09	2	20.00
Sources of oil palm fruits						
Wild groves	-	-	16	29.09		-
Private farms	15	100.0	32	58.18	2	20.00
Rural markets	-	-	7	12.73	8	80.00
Membership of Association						
Member	3	20.00	19	34.55	10	100.00
Non-member	12	80.00	36	65.45	-	-
Average income (Naira)						
≤100,000	8	53.33	-	-	-	-
100,001-200,000	2	13.33	29	52.72	-	-
200,001-300,000	-	-	8	14.54	-	-
>300,000	5	33.33	18	32.72	10	100.00

Credit access						
Had access	-	-	15	27.27	2	20.00
Had no access	15	100.00	40	72.73	8	80.00
Source of labour						
Family	4	26.67	-	-	-	-
Hire	2	13.33	4	7.27	5	50.00
Both	9	60.00	51	92.73	5	50.00
Total	15	100.00	55	100.00	10	100.00

Source: Field survey, 2023

The result revealed that most of the processors source their oil palm fruits from private farms owned by individuals. Some of the semi-mechanized processors sour oil palm fruits from wild groves, only a small proportion comprising mainly of mechanized processors source oil palm fruits from rural markets. The result revealed that the mechanized processors had higher income than the other group of processors, while the semi-mechanized had more income than the manual processors in the study. The result revealed that a large proportion of the processors were non-members of any processing association while only a small proportion of the processors had access to credit. However, most of the mechanized processors had access to credit to fund their processing enterprises. The result of the distribution of the respondents according to their source of labour revealed that manual, semi-mechanized and mechanized processors depend largely on both family and hired labour.

Table 2 Estimate of the Manual oil palm processors costs and benefits per processor

Items	Value (₦)
Palm oil	113,614.70
Palm kernel (cracked)	27,846.67
Palm kernel (un-cracked)	20,133.33
Sludge	15,522.33
Gross Return	177,117.03
Variable costs	
Palm fruits bunches	57,333.33
Hired labour (processing activities)	10,000.00
Extraction charge	10,253.33
Water/Energy/others	10,563.33
Transportation cost	8,873.33
Total Variable cost	97,023.33
Fixed cost	
Interest on borrowed Capital	14,000
Depreciation on assets	5,533.00
Rent	8,373.30
Total Fixed Cost	27,906.00
Total Cost (TVC + TFC)	124,929.33
Return per farmer (TR-TC)	52,187.7

Source: Field Survey, 2023

The result of the cost of inputs and the value from the returns from the oil palm manual processors' use of the inputs is shown in Table 2. The result revealed an average total cost of N124,929.33 per small-scale manual processors in this

study. The average fixed cost was N27,906.00 and average variable cost of N97,023.33. The cost of oil palm fruits has the highest cost of N57,333.33. Whereas, total cost was N124,929.33 and net return was N52,187.7

Table 3 Profitability parameters in manual Palm oil processing

Indicators	Ratios
Return - Cost Ratio (TR/TC)	1.42
Gross Margin (GM=TR-TVC)	80,093.70
Rate of Return (NR/TC)	1.42
Net Margin (TR-TC)	52,187.70
Expense Structure ratio (FC/TC)	0.22

Source: Field Survey,2023

Table 3 shows the profitability of oil palm fruit enterprise. The Return Cost Ratio is high 1.42. The result of the study showed a gross margin result of N80,093.70 and net return of N52,187.70. Expense Structure Ratio (ESR=FC/TC) is 0.22 representing approximately 22% of the Total cost of production, which comprises of fixed cost components (i.e interest, depreciation of assets and Rent).

Table 4 Estimate of the Semi-mechanized oil palm processors costs and benefits

Items	Value (N)
Palm oil	408,781.80
Palm kernel (cracked)	12,063.63
Palm kernel (un-cracked)	13,090.00
Sludge	12,818.18
Gross Return	446,753.61
Variable costs	
Palm fruits bunches	109,045.50
Hired labour	20,000.00
Extraction charge	50,449.50
Water/Energy/others	27,103.64
Transportation cost	8,672.73
Total Variable cost	215,271.37
Fixed cost	
Interest on borrowed Capital	37,749.09
Depreciation on assets	33,327.27
Rent	18,327.27
Total Fixed Cost	89,403.63
Total Cost (TVC + TFC)	304,675.00
Return per farmer (TR-TC)	142,078.61

Source: Field Survey,2023

The result of the cost of inputs and the value from the returns from the semi-mechanized oil palm processors' use of the inputs is shown in Table 4. The result revealed an average total cost of N304,675.00 per semi-mechanized processors

in this study. The average fixed cost was N89,403.63 and average variable cost of N215,271.37. The cost of oil palm fruits has the highest cost of N109,045.50. Whereas, total cost was N304,675.00 and net return was N142,078.61.

Table 5 Profitability parameters in manual Palm oil processing

Indicators	Ratios
Benefit Cost Ratio (TR/TC)	1.47
Gross Margin (GM=TR-TVC)	231,482.24
Rate of Return (NR/TC)	1.47
Net Margin (TR-TC)	142,078.61
Expense Structure ratio (FC/TC)	0.29

Source: Field Survey,2023

Table 5 shows the profitability of semi-mechanized oil palm processing enterprise. The Return Cost Ratio is high 1.47. The result of the study showed a gross margin result of N231,482.24 and net return of N142,078.61. Expense Structure Ratio (ESR=FC/TC) is 0.29 representing approximately 29% of the Total cost of production, which comprises of fixed cost components (i.e interest, depreciation of assets and Rent).

Table 6 Estimate of the Mechanized oil palm processors costs and benefits

Items	Value (₦)	% total cost
Palm oil	938,000.00	
Palm kernel (cracked)	21,375.00	
Palm kernel (un-cracked)	56,900.00	
Sludge	40,000.00	
Gross Return	1,056,275.00	
Variable costs		
Palm fruits bunches	233,200.00	
Hired labour (processing activities)	126,550.00	
Extraction charge	145,000.00	
Water/Energy/others	32,160.00	
Transportation cost	13,000.00	
Total Variable cost	549,910.00	
Fixed cost		
Interest on borrowed Capital	13,400.00	
Depreciation on assets	121,000.00	
Rent	6,000.00	
Total Fixed Cost	140,400.00	
Total Cost (TVC + TFC)	690,310.00	
Return per farmer (TR-TC)	365,965.00	

Source: Field Survey,2023

The result of the cost of inputs and the value from the returns from the mechanized oil palm processors' use of the inputs is shown in Table 6. The result revealed an average total cost of N690,310.00 per mechanized processors in this

study. The average fixed cost was N140,400.00 and average variable cost of N549,910.00. The cost of oil palm fruits has the highest cost of 233,200.00. Whereas, total cost was N690,310.00 and net return was N365,965.00.

Table 7 Profitability parameters in manual Palm oil processing

Indicators	Ratios
Return cost ratio (TR/TC)	1.53
Gross Margin (GM=TR-TVC)	506,365.00
Rate of Return (NR/TC)	1.53
Net Margin (TR-TC)	365,965.00
Expense Structure ratio (FC/TC)	0.20

Source: Field Survey, 2023

Table 7 shows the profitability of mechanized oil palm processing enterprise. The Return Cost Ratio is high 1.53. The result of the study showed a gross margin result of N506,365.00 and net return of N365,965.00. Expense Structure Ratio (ESR=FC/TC) is 0.20 representing approximately 20% of the Total cost of production, which comprises of fixed cost components (i.e interest, depreciation of assets and Rent).

Table 8 Determinants of net returns from processing activities in the study area

Variables	Coeff	Std. Err	T-value	P>(t)
Processing experience	1350.756	5717.762	0.24	0.814
Oil Palm fruit cost	-10.42152	3.289296	-3.17	0.002
Extraction/Labour cost	3.981077	1.383614	2.88	0.005
Transportation cost	-17.51145	6.15035	-2.85	0.006
Water &energy cost	1.683869	1.361377	1.24	0.220
Depreciation cost	-5.13174	.8853274	-5.80	0.000
Processing tech.	347062.6	113931.9	3.05	0.003
_cons	409609.1	141476.6	2.90	0.005
No of obs.	80			
F(7, 72)	22.27			
Prob.>f	0.0000			
R-Square	0.6841			
Adj-R-square	0.6534			
Root MSE	4.0e+05			

Source: Field Survey, 2023

The results presented in Table 8 showed that several variables entered into the model were statistically significant. With an R2 of 0.6841, it showed that 68.41% of the changes in oil palm processing returns of palm oil were determined by the various variables included in the model. The remaining 31.59% were determined by intervening variables. Also, an F-ratio of 22.27 indicated that the overall regression equation was statistically significant at 1% level.

Cost of oil palm fruit with a coefficient -10.42152 and a t-value of -3.17 is statistically significant at 1% level and was also negative. The implication was that, the lower the cost of oil palm fruit, the more the returns from the processing enterprise by the processors. This is because oil palm fruit is a major resource used in oil palm processing. This also confirms the findings of Ogbonna and Ezedinma (2005), who opined that the cost of palm fruits was the highest cost factor in oil palm processing. This is inconsistent with the findings of Ozioma et al.,(2017), that reported that increase oil palm fruit reduces the volume of oil palm fruit processed. Transportation cost of oil palm processing with a coefficient

-17.51145 and a t-value of -2.85 is statistically significant at 1% level and was also negative. The result was consistent with a prior expectation that returns from oil palm processing should be inversely related to the cost of transportation. The implication of the result is that, the lower the transportation cost, the higher the returns from the processing enterprise from the mechanized processors. This agrees with the findings of Dimelu and Anyaiwe (2011) stated that good transportation facilities undermine the productivity of smallholder oil palm actors and directly affect the economic return to farmers.

Cost of depreciation of the fixed asset of the processing enterprise with a coefficient -5.13174 and a t-value of -5.80 is statistically significant at 1% level and was also negative. The implication was that, the lower the cost of depreciation, the higher the returns from the processing enterprise by the processors. Machines and equipment are expensive, cost much and at times beyond what many processors can afford, hence, they hire or rent. High cost of processing equipment is a serious problem faced by processors in Nigeria and according to Omoti (2004) this problem has discouraged intending processors from establishing their own mills. According to Ajibefun & Daramola (2004), they help in eliminating waste. This will lead to an increase in productivity and incomes. However, the cost of extraction and the type of processing technology were both statistically significant with positive coefficients each. The cost of extraction of the palm fruit with a coefficient 3.981077 and a t-value of 2.88 is statistically significant at 1% level and was positive. The result was inconsistent with a prior expectation that returns from oil palm processing should be inversely related to the cost of processing. The implication is that, the higher the processing cost, the higher the returns from the processing enterprise by the processors. Also, the type of technology or whether or not the processor deployed the use of machines in its processing activities had a coefficient of coefficient 347062.6 and a t-value of 3.05 is statistically significant at 1% level with a positive coefficient. The implication is that, the more the processor deployed the use of machines in its processing activities the higher the returns from the processing enterprise by the processors. The implication of this finding is that improvement in technology or deployment of machines in processing, would lead to increase in their output and returns. Olagunju (2008) noted that with increased capital, improved technology and skilled labour, the processors profit would increase substantially. This is inconsistent with the findings of Ozioma et al.,(2017), that reported that increase in the use of technology reduces the volume of oil palm fruit processed and the output processed by extension.

4. Conclusion and Recommendations

The processing of palm fruit is one of the most prominent processing activities carried out in Nigeria. This paper ascertained the extent of oil palm processing profitability across the different categories of processors in Kogi State, Nigeria. Nigeria was once a leading country in oil palm production in the past. The country presently imports palm oil - widely used by the Nigerian people for both food and non-food purposes. If Nigeria will again regain its past glory in oil palm production, attention should be paid not only to oil palm production as well as in the processing of oil palm. The results of the study revealed that though oil palm processing have a good return under the different processing techniques in the study area, the result showed that mechanized and the semi-mechanized processing systems have higher returns and profit relatively compared to the manual processing system. The result also, showed that cost of oil palm fruits, transportation cost, depreciation charges, extraction cost and the processing technique were the major determinants of the net returns from oil palm processing in the study area. The study concluded that oil palm processing is a profitable enterprise in the study area. The study recommended that the government should subsidize oil palm processing equipment and small cottage processing machines be developed to facilitate access of small-scale oil palm processors adoption and utilization of oil palm processing equipment. Also, the study recommends that the relevant inputs be also subsidized to enhance the processors welfare in the study area.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study,

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