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Economics of Palm Oil Production Under Semi-Mechanized Processing Method in Afijo Local Government Area of Oyo State, Nigeria

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Abstract
The study analysed palm oil production under semi-mechanized processing method in Afijo Local Government Area of Oyo State. A multistage sampling procedure was used to randomly select 80 palm oil processors. Data was collected with the aid of structured questionnaire. Descriptive statistics, budgetary analysis and ordinary least square regression model were used for the data analysis. The results showed that majority of the palm oil processors were female. Their mean age was 44 years. The majority of the respondents had one form of formal education or the other. 36.3% of the oil processors had between 10-20 years' experience in oil palm processing. Total cost, revenue, and profit per annum were ₦1,243,357, ₦1,673,820 and ₦430,463.4 respectively with Farm Gross Ratio of 0.30 and Return On Investment of 1.35. The study showed that education had 5% significant effect on the net returns of the processors in the study area. Major constraints were high cost of modern processing facilities and difficulty at getting modern equipment by processors, poor access to good road, poor incentives to processors, insufficient fund for buying of processing machine, low capital, price fluctuations, inexperienced manpower, high cost of hired labor and lack of storage facilities. It was recommended that government should provide social amenities such as such as electricity, pipe borne water, good road network, storage facilities and access to credit facilities and subsidize equipment needed by the processors in order to reduce both running and overhead costs in areas where palm fruits are processed to palm oil production by the processors.

Keywords: Economics, oil palm, processing, gross margin

Introduction

The Oil palm (*Elaeis guineensis*) is recognized as the most important global oil crop (Murphy *et al*., 2021) and efficient oil producing cultivated plant (Bassey, 2016) supplying about 40% of all traded vegetable oil (Murphy *et al*., 2021). Oil palm whose fruits are processed into palm oil is a native of the tropical rainforest region of West Africa (Busari *et al*., 2022). Palm oil which is extracted from the fleshly mesocarp of palm fruit from oil palm (palm tree) has become a vital resource in the majority of Nigerians diet (Biodun *et al*., 2021). Generally, Nigeria local requirement for palm oil is about three million metric tonnes, but the country only produces about 1.02 metric tonnes of oil palm and spends about $500 million annually on oil palm importation in order to complement existing gaps in the sector (Okata, 2020). Processing of palm oil from palm fruit involves separation of fruits from fibrous attachment, followed by crushing of fruit, heating and extraction of oil using oil seed expeller, clarification in a filter press by sedimentation. Processing of palm fruits into palm oil is an economic activity even though this is still subsistence in nature in Nigeria.

Oil palm is a perennial crop which originated in the tropical rainforest of West Africa. The major product of oil palm is palm oil and it accounts for 63% of annual produce of vegetable oil exports in the world (Udoh and Essien, 2016). Its demand globally is growing constantly in step with per capita income and global population. Oil palm is cultivated in about 43 countries all of which are developing countries in the humid tropics (Chukwuma, 2010). In Nigeria, oil palm is grown in 24 states of Nigeria namely; Abia, Akwa Ibom, Cross River, Rivers, Bayelsa, Imo, Anambra, Ebonyi, Enugu, Delta, Edo, Ondo, Ogun, Osun, Oyo, Ekiti, Benue, Kwara, Kogi, Nasarawa, Plateau, Taraba, Adamawa and Kaduna (Ekenta *et al*., 2017). Delta, Edo, Akwa-Ibom, Cross River, Bayelsa, Rivers, Anambra, Enugu, Imo, Abia, Ogun, Ondo, Oyo and Ekiti are the

major palm oil producing states in Nigeria. Nigeria is the largest consumer of palm oil in Africa with a population of 197 million people (World Bank, 2018). The nation consumed approximately 3 million MT of fats and oils in 2018, with palm oil accounting for 44.7% or 1.34 million MT [Price Waterhouse Coopers (PWC), (2019)].

Palm oil is highly rich in carotene and is an essential cooking oil in Nigeria. Primary raw materials used for producing detergents, soap, margarine, confectionery, epoxy resins, bakery trade etc. come from palm oil. It also serves as addictive to animal feed. Palm wine obtained by tapping the tree is used as a very good alcoholic drink in many social gatherings in Nigeria. It also has medicinal value. The leaves, rachises and petioles of the oil palm are made into thatches for roofing buildings. The brooms for sweeping are made from the leaf midribs and the terminal shoot has some religious relevance in most churches**.** Palm oil also serves as a source of income for the majority of the individuals in developing countries (Bassey, 2016). Furthermore**,** oil palm is regarded as a stabilizing crop to global food security especially in developing countries and has become an increasingly important driver of economic growth and poverty reduction in the major producing countries [American Oil Chemists Society (AOCS), 2013]. This was due to the fact that oil palm was by far the most productive of all vegetable oil crops and yields more than any other major oilseed crops like soya beans, cotton seeds, rape seeds among others.

Nigeria exports of palm oil constituted about 21- 50% of total world exports between 1963 and 1965 and was placed as the leading producer and exporter of oil palm (FAO, 1966) with a share of 43% of the global market but, presently, the country is ranked 5th in the global production of palm oil with an annual production of 74.08 million metric tonnes. This represents less than 2% of the global output (Busari *et al*., 2022). This sordid situation is partly a reflection of the poor management of palm forest resources and also due to the crude oil boom witnessed by Nigeria in the 1970-79. Malaysia now holds the leading position as the world's largest producer of oil palm, closely followed by Indonesia, leaving Nigeria at the fifth position (Busari *et al*., 2022).

There are different techniques used in processing palm oil and these range from modern methods to traditional methods. However, the traditional or semi-mechanized 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). In Nigeria, 80% of palm oil production comes from dispersed smallholders who harvest semi-wild plants and use manual processing techniques (Adeyemi, 2019). According to Adeyemi (2019), among the small-scale producers, traditional, or semi-mechanized methods were used for oil extraction from the fresh fruit bunch. Extracting palm oil by processing fresh fruits palm bunches were labour-intensive and involved the following processes; threshing, picking, parboiling, digestion, extraction and separation and these result in a reduction of low- quality palm oil with very high free fatty acid (FFA) contents and a large quantity of dirt and water. Evidence has also revealed that the local techniques of oil palm processing have been proved to be stressful, time consuming and result in low yield due to the massive percentage of waste during processing (Basiron, 2002).

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 is a major source of income and employment to a large proportion of the resource-poor rural population in Nigeria but the high cost of modern processing equipment has discouraged intending processors from probably establishing and investing in a more technology and more capital-driven scales. Consequently, significant proportion of the processors resort to hiring of processing equipment and this has resulted to delay in processing of palm fruits (Nwalieji and Ojike, 2018). Several studies (Adesiji *et al*., 2016; Nwalieji and Ojike, 2018; Alabi *et al*., 2020) have focused on oil palm processing among farmers and processors using the traditional methods of production, however, only very few examined the returns on investment of oil palm under the semi-mechanized processing method. Therefore, this study aims to examine returns on investment of palm oil production in Afijo Local Government Area of Oyo State, Nigeria. The specific objectives are to: describe the socio-economic characteristics of palm oil processor in the study area; identify the existing oil palm processing methods used by processors; estimate the cost and returns of palm oil production; determine the factors affecting the net returns of the processors and identify major constraints to palm oil production in the study area. The knowledge of this research will help to formulate appropriate policies that will favour palm oil production.

Materials and Methods

Study Area

The study was carried out in Afijo Local Government Area of Oyo State. The population density of the Local Government is 222 persons per square Kilometre. It is bounded in the North by Oyo East Local Government Area, Akinyele Local Government Area in the South and Iseyin Local Government Area in the West. It also shares common boundary with Ejigbo and Iwo Local Government Areas in the East. The Yorubas' mainly dominate Afijo Local Government Area. The vegetation is rainforest. It has double maximum rainfall in June and September. Only the months of December and January are relatively dry. The climatic condition of this area supports the main occupation of the inhabitants, which is farming. The indigenes are mostly farmers who had

taken the advantage of vast agricultural land that favours the cultivation of food crops such as maize, guinea corn, yam, cassava, cowpea, soya beans, fruits, tomatoes and cash crops such as cocoa, oil-palm, coffee, orange and citrus.

Sampling size and sampling procedure

Multistage sampling procedure was adopted for this study. The first stage was the purposive selection of Afijo Local Government Area in Oyo State owing to the high level of production and processing of palm fruits to palm oil in Oyo State. The second stage was the selection of eight (8) villages that were predominant in processing of palm fruits to palm oil in Afijo Local Government Area of Oyo State. These villages were: Jobele, Iware, Akinmoorin, Kelebe, Abaesu, Ilora, Fiditi and Aba Lemomu. The third stage involved a random selection of 10 processors each from the purposively selected villages in the study area to give a total of 80 processors interviewed for the study.

Method of data collection

The study mainly used primary data. Data on processors socio-economic characteristics, cost of inputs used and output, were collected through a structured questionnaire.

Method of data analysis

Data were analysed using both descriptive (percentages, frequency distribution tables, mean standard deviation) and inferential statistics (ordinary least square regression and budgetary techniques). The budgetary analysis enables the estimation of the total costs as well as total revenue accrued to an enterprise, gross margin, farm net profit and profitability of an enterprise within a specific production period (Nandi *et al*., 2011).

The gross margin was calculated as follows:

$$GM = GR - TVC$$

Where GM = gross margin; GR = gross revenue or gross income and TVC = total variable cost.

$$TVC = TOC + TLC$$

Where TOC = total operating cost and TLC = total labour cost.

The total cost of production (TC) was defined as:

$$TC = TVC + TFC$$
$$TFC = TOC + TLC + TFC$$

Where TFC = total fixed cost and TVC, TOC and TLC are as previously defined.

The net farm income (NFI) and the return on investment (ROI) used as a measure of profit and profitability respectively was calculated as:

$$NFI = GM - TFC$$
$$ROI = GM/TC$$

Ordinary least square regression model

Ordinary least square regression was used to determine the factors affecting the net returns of the processors in the study area. This is an economic tool for predicting the value of dependent variable given the values of the independent variables. The coefficient of determination (R^2) shows the level of variation in dependent variable (Y), which is explained by variations in the independent variables (Xi). The model for this analysis was:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \text{----------} + \beta_{10} X_{10} + \varepsilon$$

Where:

Y= Net returns of palm oil processors (₦), (Net Returns = Total Revenue – Total Cost)

X_1=Education (years)

X_2= Processor years of experience (years)

X_3= Labour Cost (₦)

X_4= Cost of Palm Fruits (₦)

X_5= Water Cost (₦)

X_6=Processing (milling) Cost (₦)

X_7= Transportation cost (₦)

X_8= Cost of Firewood (₦)

X_9= Processing Period (days)

X_{10} = Depreciation on Tools (milling equipment, drum, bowl, basket and so on) (₦)

β_0 is the constant term and β_1, … β_{10} are the parameters estimated

ε is the error term or the disturbance term.

Results and Discussion

Socio-economic characteristics of the respondents

Results in Table 1 revealed that majority of the respondents (88.8%) who were into palm oil processing in the study area were female. This result agrees with those obtained by Ayinde *et al*., (2012) and Adeyemi, (2019) who observed that women are the major stakeholders in palm oil processing in Nigeria. Age distribution also showed that the mean age of the respondents in the study area was 44years. The palm oil processors with formal education were 77.5%, while 22.5 % of the respondents had no formal education. This result implies that education will enhance technology adoption and the ability of farmers to plan and take risks. About 65.3% had a household size of 1- 5, 41.3% had a household size of 6-10 persons, while only 2.6% had a household size of more than 10 persons within the household with a mean household size of approximately 6**.** Most (72.5%) of the respondents were married. The large proportion of married respondents may be as a result of the fact that early marriage is a common practice in the study area.The result further revealed that 36.3 % of the oil processors had between 10 – 20 years' experience in oil processing, while 16.3% of them had less than 10 years' experience in oil palm processing. The average experience of the oil palm processors was 23 years. This showed that the majority of the cassava farmers had considerable experience in oil palm processing which could help in effective management decisions with respect to input combination, labour use and resource allocation in the study area. This result corroborates the findings of Aminu and Umoh (2020).

Results showed that the mean annual income from palm oil was ₦102,662.50. Furthermore, the main occupation of the respondents in the study area was palm oil processing while only 18.8% were engaged in other occupation aside from oil palm processing.

Methods in palm oil processingFrom the data, as shown in Table 2, 5% adopted the local/traditional method of oil palm processing which involved the use of mortar and pestle to pound the boiled palm fruits instead of the digesters, while 95% adopted the semi-mechanized methods. About 35% processors perceived the semi- mechanized as effective in oil palm processing compared high cost of procuring modern facilities even though findings from the study revealed none of the processors in the study area uses the full mechanized method due to its high cost. On the type of labour used, 73.8% of the sampled processors employed the use of family labour, while the remaining (26.3%) was from co-operative (group).

Costs and return in processing of palm fruits to palm oil Table 3, showed that the total variable costs was ₦1,180,355; which represented 94.9% of the total cost of production. The variable cost item with the highest cost is the cost of fresh palm fruit which has an average cost of N511,700 and this account for (41.15%) of the total variable cost. Also, the total fixed cost was ₦63,001.62 which represented (5.1%) of the total cost of production. The total cost of processing was N1,243,357, while the total revenue amounted to N1, 673, 820 which gives a gross margin of N493,465 per annum and a net profit of N 430, 463.40. This implies that the oil palm processing enterprise is profitable with fairly good returns on investment of 1.35 in the study area (Adesiyan *et al,* 2007; Olagunju, 2008; Nwadu *et al*., 2021). Also, the return on investment was observed to be 1.35 which implies that for every one naira (₦1) invested in palm oil production, a gain of 35 kobo was realized. Since Fresh Fruit Bunches (FFBs) accounts for about 42% of the total variable cost, the high cost of purchasing FFB probably contributed to the low returns. To increase the quantities of FFBs purchased by the processors, and increase their returns on investments, there is need to assist oil palm producers by subsidizing input used which will subsequently leads to a reduction in coast of FFBs.

Constraints faced by palm fruits to palm oil processors Table 4 showed that high cost of procuring modern processing facilities, poor access to good road, poor incentives to processors, low capital, price fluctuations, poor price of palm oil, inexperienced manpower, poor quality of palm fruits, high cost of palm fruits, seasonality of palm fruits, high cost of hired labor and lack of storage facilities were identified as challenges of palm oil processing in the study area. A similar study conducted by Enwelu *et al.* (2014) and Nwandu *et al.* (2021) also identified similar constraints including tax policies and access to improved variety of palm fruits.

Factors affecting the net returns of the palm oil processors in the study area

Table 5 shows the factors affecting the net returns of the palm oil processors. The value of the coefficient of determination (R-square) of 0.4646 shows that 46.5% variations in net returns of oil palm processors is explained by specified factors (independent variables) in the regression model. Education has a positive coefficient and significant ($P \leq 0.01$) effect on the net returns of the oil palm processors. This may be due to the fact that educated processors possess ability to embrace innovation that will boost their production. Education enlightens and so the level of education could also contribute to effective oil palm fruits processing to produce more quantity of palm oil for sale and hence increase farmers' income. This finding is in line with that of Ini-mfon *et al*. (2013), Amusa *et al*. (2017), Aminu and Umoh (2020) who found that as the number of years of formal education of the palm oil producers increase, the net returns increases as well. Depreciation on tools has a negative coefficient and a significant effect ($P \leq 0.01$) on the net returns of the oil palm processors. As the cost of depreciation on tools increases, there is a substantial decrease in the net return of the palm oil processors in the study area. Increase in labour and equipment cost increase the overhead cost of production which eventually reduces the net returns. This finding is in agreement with that of Aminu and Umoh (2020) whose findings showed that as the cost expended in the purchase of equipment and hiring of labour used in processing of palm fruits to palm oil in Akwa Ibom State, Nigeria increases, the net returns decreases.

Conclusion

This study revealed that palm oil processing is a profitable venture in the study area. The budgetary analysis showed that oil palm processing was a profitable enterprise. The average Gross Margin was ₦493, 465 and a Net Profit of ₦430,463.40 per annum. The Returns on Investment was 1.35 which showed that the enterprise was profitable in the study area and worth venturing into to boost production of palm oil. Although high cost of processing facilities, difficulty in getting modern equipment, poor access to good road, poor incentives to processors, insufficient fund for buying of processing machine, low capital, price fluctuations, poor price of palm oil, inexperienced manpower, poor quality of palm fruits, high cost of palm fruits, seasonality of palm fruits, high cost of hired labor and lack of storage facilities were identified as constraints to palm oil processing in the study area. The processing technique adopted by majority of the oil palm processors in the study area was semi- mechanized method. Based on the findings of this study, the following recommendations are made. Since the enterprise is profitable, more people should be sensitized and encouraged to venture into processing of palm fruits. This can be done by extension agents. In addition, since the improved method of processing is highly effective, government can also assist by making modern equipment and machines available at

subsidized rate. Social amenities such as electricity, pipe borne water, good road network, storage facilities and access to credit facilities which can reduce the overhead cost and increase returns on investment should be regularly provided in areas where oil is processed to facilitate palm oil production by the processors.

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Table 1: Distribution of respondents by their socio-economic characteristics

Variable	Frequency	Percentage	Mean (Standard Deviation)
Gender			
Female	71	88.8	
Male	9	11.3	
Total	80	100.0	
Age			
Below 30	11	13.8	
31- 40	22	27.5	
41-50	27	33.8	
51-60	15	18.8	
Above 60	5	6.3	
Total	80	100.0	43.56 (11.0)
Educational level (yrs)			
No formal education	18	22.5	
Primary education	27	33.8	
Secondary education	28	35.0	
Tertiary education	5	6.3	
Vocational education	2	2.5	
Total	80	100.0	3.26 (1.64)
Household size			
1 – 5	45	65.3	
6 – 10	33	41.3	
Above 10	2	2.6	
Total	80	100.0	5.68 (2.65)
Marital status			
Single	5	6.3	
Married	58	72.5	
Divorced	3	3.8	
Widowed	14	17.5	
Total	80	100.0	
Processing Experience (years)			
Below 10	13	16.3	
10-20	29	36.3	
21-30	23	28.8	
31 -40	1	1.3	
Total	80	100.0	22.58 (10.21)
Annual Income			
10,000 – 100,000 51		63.8	
101,000 – 200,000	25	31.3	
201,000 – 300,000	3	3.8	
300,000 Above	1	1.3	
Total	80	100.0	₦102,662.50 (47,523.20)
Occupation			
Primary occupation	65	81.3	
Secondary occupation	15	18.8	
Total	80	100	

Source: Field Data, 2019

Table 2: Distribution of methods in palm oil processing

Variables	Frequency	Percentage (%)
Processing Methods		
Traditional method	4	5.0
Semi- mechanized method	76	95.0
Total	80	100.0
Effective Method		
Semi-mechanized method	28	35.0
Full mechanized method	52	65.0
Total	80	100.0
Mode of Processing		
Individual (family)	5	73.8
Co-operative (group)	21	26.3
Total	80	100.0
Extraction Method		
Pounding in mortar	3	3.8
Mashing kin pith	2	2.4
Milling in machine	75	93.8
Total	80	100.0

Source: Field Data, 2019

Table 3: Costs and returns in processing of palm fruits to palm oil under semi-mechanized method

Variables	Value	Percentage (%)
Variable Cost		
Labor	44,050	3.54
Fuel	5,655	0.45
Firewood	494,300	39.75
Water	27,000	2.17
Fresh Fruit Bunches(FFBs)	511,700	41.15
Transportation	16,750	1.34
Milling	80,900	6.5
Total Variable Cost (TVC)	1,180,355	94.9
Fixed Cost		
Milling Equipment	20,211.25	1.6
Drum	36,299.98	2.9
Shovel	7.5	0.0060
Sieve	1,171.53	0.09
Bowl	160.29	0.01
Cutlass	2,795.42	0.2
Jerry-can	1,504.27	0.12
Basket	851.39	0.06
Total Fixed Cost (TFC)	63,001.62	100
Total revenue (TR) from palm oil	1,673,820	
Total cost (TC)	1,243,357	
Gross margin (TR-TVC)	493,465	
Net returns (TR-TC)	430,463.4	
Farm Gross Ratio (GM/TR)	0.30	
Return On Investment (TR/TC)	1.35	

Source: Field Survey, 2019

Table 4: Challenges encountered in palm fruits processing in the study area

Problem Constraints	Strongly Agree(4)	Agree(3)	Strongly Disagree(2)	Disagree(1)	Total Score	Mean Score(x)	Rank
High cost of processing facilities	61	18	0	1	300	3.75	Constraint
Difficulty at getting modern equipment	60	18	2	0	298	3.73	Constraint
Poor access to good road	59	20	1	0	298	3.72	Constraint
Poor incentives to processors	56	22	1	1	293	3.66	Constraint
Insufficient fund for buying of processing machine	57	20	2	1	293	3.66	Constraint
Low capital	48	24	5	3	277	3.46	Constraint
Price fluctuations and poor price of palm oil	41	29	9	1	270	3.38	Constraint
Availability of water	40	28	7	5	263	3.29	Constraint
Inexperienced manpower	42	24	9	5	259	3.24	Constraint
Poor quality of palm fruits	30	33	1	16	252	3.15	Constraint
High cost of palm fruits	31	33	4	12	251	U3.14	Constraint
Seasonality of palm fruits	28	37	13	2	251	3.14	Constraint
High cost of hired labour	34	23	14	8	245	3.06	Constraint
Lack of storage facilities	32	17	17	14	227	2.84	Constraint

Source: Field Survey Data, 2019
Note: ≥ 2.50 = A Constraint, ≤ 2.5 = Not Constraint

Table 5: Factors affecting the net returns of the processors in the study area

Variable	Coefficient	Standard error	t	P>|t|
Education	2880.185***	1077.834	2.67	0.016
Processing experience	3242.457	5419.699	0.60	0.557
Labour cost	-8.281794	8.577328	-0.97	0.347
Cost of palm fruits	-.5704962	.6240179	-0.91	0.373
Water cost	-2.939591	12.34036	-0.24	0.814
Processing (milling) cost	1.723126	2.417581	0.71	0.479
Transport	1.513053	9.622434	0.16	0.877
Firewood	-.6208407	.9030255	-0.69	0.501
Processing days	-268.9098	452.6658	-0.59	0.560
Cost of tools (Depreciated)	-4.47958***	1.590042	-2.82	0.411
Constant	3734.392	7357.222	0.51	0.618

R-squared = 0.4646 = 46%,Adj R-squared = 0.1969, Prob > F = 0.1527
Source: Field Survey Data, 2019
Note: ***Significant at P ≤ 0.01