AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 16, No 4 pp 122-131, 2024
Published by Faculty of Agriculture, Trakia University, Bulgaria
ISSN 1313-8820 (print)
ISSN 1314-412X (online)
http://www.agriscitech.eu
DOI: 10.15547/ast.2024.04.048

Agricultural Economics

Socio-economic analysis of different palm oil processing techniques in Olorunda Local Government Area, Osun State, Nigeria

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(Manuscript received 2 June 2024; accepted for publication 5 November 2024)

Abstract. *The study analyzed comparative returns on investment of oil palm processing under different techniques in Olorunda Local Government area, Osun State, Nigeria. Data were collected between March and May, 2022 from 120 processors and analyzed to describe the socio-economic characteristics of oil palm processors, the net return on production, the determinants of oil palm output and major constraints encountered in oil palm processing in the study area. Multi-stage sampling procedures were used to select processors for the study. Primary data were collected with the aid of semi-structured questionnaire and analyzed using both descriptive and inferential statistics such as frequency distribution, tables, stochastic frontier production function and budgetary analytical tools. It was found that oil palm processing enterprise is female dominated majorly operating traditional method. The majority (69.2%) had formal education, while (61.7%) do not belong to cooperative society. The result further revealed an average benefit cost ratio (BCR) of ₦1.42 implying that oil palm processing is profitable in the study area. However, the traditional method is less profitable accruing a net revenue of ₦35243.24 and a BCR of 1.25 compared to modern method returning higher ₦109872 and a BCR of 1.5. Furthermore, coefficients of level of education (P<0.05), membership of cooperative society (P<0.1) and method of processing (P<0.01) were positive and significant to the quantity of oil produced, while inadequate finance, high cost of processing equipment among others were the major challenges to oil palm processing. In conclusion, establishment of commercial palm fruit plantation, cooperative equipment leasing and provision of low interest loan are recommended for an enhanced economic well-being.*

Keywords: Oil palm processing, oil palm processors, stochastic production function, processing technique, cost and returns

Introduction

Originating in the tropical rainforest of West Africa, oil palm (*Elaeis guineensis*), whose fruits are processed into palm oil, is an ancient perennial crop (Busari et al., 2022). The seed thrives well in humid tropical climate, giving rise to a monoecious species that alternately produces unisexual male

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and female inflorescences (Barcelos et al., 2015; Okolo et al., 2019). Used in a range of food and non-food varieties, it is a food security grown crop (Potts et al., 2014; Vijay et al., 2016). In terms of production and trade value, the tree crop is an agricultural commodity, and demand for it is expected to rise significantly. According to the International Potash Institute (1957), the main product of oil palm is the palm fruit, which may be processed into three different commercial products: palm kernel oil, palm oil, and palm kernel cake. Numerous industrial sectors have very varied downstream applications for the two distinct forms of oil found in oil palm (Goggin and Murphy, 2018). In 2018, palm oil surpassed soybean oil as the most widely used vegetable oil in the world, accounting for 40% of global fats and 10% of polyunsaturated fat (Murphy, 2019).

Today, oil palm is vital to the economies of several nations, particularly Indonesia, Malaysia, and Nigeria, from which it exports significant amounts of oil, meal, and other byproducts (Murphy, 2019). In general, oil palm is currently grown in plantations in the Americas, Asia, and the wet tropics of Africa. Despite this, 85% of the world's oil palm is produced in the South East Asian nations of Malaysia and Indonesia, where the majority of oil palm is produced (Murphy, 2015; Goggin and Murphy, 2018). The oil palm sector employs 6 million people directly and an additional 11 million indirectly annually, with an estimated yearly value of US$ 60 billion (Kadandale et al., 2019). By 2050, according to estimates from a variety of industry sources, between 93 and 156 Mt of palm oil may be needed (Harris et al., 2013; Pirker et al., 2016).

Nigeria basically produces two species of oil palm: Dura and Tenera. Oil palm is currently found in three states: wild, semi-wild, and cultivated. The majority of oil palm and palm kernels come from wild palm groves that are frequently in a semi-cultivated state rather than from oil palms that are cultivated (International Potash Institute, 1957). Nigeria now produces 1.0 million tons of palm oil a year, ranking it as the world's fifth-largest producer (Statista, 2020). According to Foundation for Partnership Initiatives in the Niger Delta (PIND) (2019), Nigeria was the world's top producer of palm oil until the 1960s. Zaire then overtook Nigeria as the world leader in oil palm exports, a position it only momentarily reclaimed in 1964–1965 (Hartley, 1988). Due to Malaysia's dedication to oil palm plantation cultivation, Nigeria has since lost this position as the world's top producer of oil palm.

With 197 million population, Nigeria is the largest consumer of palm oil in Africa (Obayelu et al., 2022). The exorbitant price of processing equipment has deterred prospective processors from starting and funding palm oil businesses. As a result, a sizeable fraction of processors turn to renting processing machinery causing a delay in the palm fruit processing (Nwalieji and Ojike, 2018). There are different techniques used in processing palm oil and these range from traditional methods to modern methods (hand operated press and power operated mills). However, small-scale processors prevalently utilize traditional processing methods, and it is through these processors that the majority of palm oil processed in Nigeria is produced (Nwalieji and Ojike, 2018). The modern palm oil processing mills have higher extraction rate (13.00-18.00%) compared to manually operated traditional mills, resulting in lower (8.00-10.00%) oil extraction rate (NIFOR, 2019). Several studies (Murphy et al., 2021; Obayelu et al., 2022) have focused on oil palm processing among farmers and processors using the traditional methods of production, however, empirical evidence on the returns on investment of oil palm under (power operated mills and hand operated press) methods remains varied and patchy. Therefore, this study aims to examine returns on investment of palm oil production in Olorunda Local Government Area of Osun State, Nigeria. The specific objectives are to: describe the socioeconomic characteristics of palm oil processor in the study area; identify the existing oil palm processing methods used by processors; estimate the cost and returns on oil palm production; determine the factors affecting the net returns of the processors and identify major constraints to palm oil production in the study area.

Material and methods

Study area

This study was conducted in Olorunda Local Government Area, Osun State. Olorunda Local Government Area has its headquarters at igbona community on the outskirts of the state capital, Osogbo. Its land area covers 97 km^2 and a population of 131,761 in the 2006 census. The Local Government Area enjoys tropical climate and two seasonal rainfall from April to July and September to October. Average temperature is about 32^oC and humidity can be as high as 95%. There are about 25 to 15 peri-urban areas, 30 villages and hamlets in the LGA and people are predominantly Oyos who have their homesteads and farms in the area but mostly reside in Osogbo. The people of Olorunda LGA are predominantly small holder farmers. The major food crops of the area include yam, cassava, plantain, cocoyam, vegetables and maize, while cocoa and oil palm are the major cash crops. The people of the area also involve in craftsmanship, trading and artisan works.

Sampling procedure

Multi stage sampling procedure was used in selecting representatives for the study. The first stage involved purposive selection of Olorunda local government area (Olorunda LGA) because of accessibility of processors, then random selection of five communities was the second stage. The last stage involved random selection of 24 processors from 5 communities making a total of 120 processors.

Method and types of data collection

For this study, primary data were employed. Oil palm processors in the study area were administered semi-structured questionnaires to complete in order to collect relevant data. Socioeconomic characteristics, quantity of oil palm produced (measured in liters), cost of producing a ton of oil (measured in Naira), income from oil processing (measured in Naira), labor costs, marketing costs, transportation costs were collected.

Analytical techniques

Data collected were analysed using descriptive and inferential statistics. Descriptive statistics include frequency count, percentages, mean, ranking and standard deviation. Inferential statistics include Gross margin, Benefit Cost ratio and least square regression technique.

Gross margin analysis

The costs and returns of oil palm processors in the study area were calculated using gross margin analysis. Gross margin is the difference between total revenues and total variable costs. The mathematical form of budgetary analysis is represented as follows:

$$GM = P * Q - \sum_{i=1}^{n} V_i M_i \quad \cdots\cdots (1)$$

GM = Oil palm gross margin

P = Market price of output

Q = Quantity of output

V_i= Unit price of the variable input i

M_i= Quantity of variable input i

n = Number of variable input used.

Benefit cost ratio

Benefit cost ratio (BCR) analysis was used to evaluate the viability of oil palm processing techniques by comparing the benefit accrued in monetary term to associated costs. The mathematical form of BCR analysis is represented as follows:

BCR = Benefits / Costs.....……(2)

Where:

Benefits are the positive outcomes in monetary terms accrued from oil palm enterprise, while costs are expenses associated with running the enterprise.

Least Square Regression Technique

$Y= F(X_1,X_2,X_3,X_4,X_5,X_6,X_7,et)$

The explicit equation is:

$Y =b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4$…..+ et

……..……..(3)

Where

Q = quality of oil palm produced (measured in liters)

X_1 = age of the processor in years

X_2 = years spent in processing

X_3 = income from secondary (measured in Naira) occupation

X_4 = level of education (dummy variable)

X_5 = Gender of the processor (dummy variable)

X_6 = income from oil processing (measured in Naira)

X_7 = cost of producing a ton of oil (measured in Naira)

X_8 = membership of cooperative society (dummy variable)

X_9 = household size

β_0…….β_7 = parameters to be estimated

et = error term

Results and discussion

Socioeconomic characteristics of oil palm processors

Table 1 presents the socio-economic characteristics of the oil palm processors in the study area. From the Table, the mean age of the respondents in the study area is 42.33 years which indicates that most of the respondents are still in their active stage of productive age group 41-60 years. The results also show gender distribution as the majority (71%) were female. This is largely influenced by culture that favours women involvement in oil palm processing and marketing. The findings of Nwandu et al. (2021) and Sanusi et al. (2022) confirmed that oil processors are in their economic active age and female dominated, while Jimoh et al. (2021) reported female dominance in food crop processing and marketing. The majority (73%) are married with averagely large household size of 5 persons. Large family size translates to ready supply of family labour, hence reducing labour cost incurred through hiring (Jimoh et al., 2021). Making informed decisions and adopting modern technologies on processing practices might be hindered as the majority (67.5%) of the processors possess primary education only. It is evidently shown that the majority (60.8%), had no contact with extension agent. This clearly implies that processors hardly have consultations with experts to share their challenges and update their knowledge on processing know-how.

Table 1. Distribution of respondents by socio-economic characteristics

Characteristics	Frequency	Percentage (%)
Age		
< 21	4	3.3
21-40	29	24.2
41-60	66	55.0
>61	21	17.5
Mean ± SD = 42.33±10.335		
Gender		
Male	34	28.3
Female	86	71.7
Marital Status		
Single	18	15.0
Married	88	73.3
Divorced	4	3.3
Household Size		
1-5	20	16.7
6-10	66	55.0
11-15	27	22.5
16-20	9	5.8
Mean ± SD = 5.16±2.086		
Level of Education		
No formal	15	12.5
Primary	81	67.5
Secondary	19	15.8
Tertiary	5	4.2
Extension contact (Number of visit)		
None	73	60.8
Once	38	31.7
Twice	7	5.8
Thrice and above	2	1.7

Source: Field survey, 2022

Enterprise characteristics of oil palm processors

Table 2 clearly revealed that the majority (61.7%) of the respondents do not belong to

cooperative society indicating that most of them may not have access to loans to finance their businesses as reported by Nwandu et al. (2021). Additionally, the majority (68.5%) of the palm oil processors used hired labour while 31.7% used both hired and family labour. Also, the majority (68.3%) of processors got their processing palm fruit from wild grove farming, (25.0%) from cultivated land, while only (6.7%) got theirs from oil palm plantation. This clearly showed that oil palm farming is yet to be transformed to large scale mechanically driven that could guarantee easy and massive access to palm fruits for processing. Furthermore, about (73.3%) of the processors used traditional method, while (26.7%) used modern method of processing. This could be due to the traditional method being less costly, more so, inadequate funding and lack of technological know-how may hinder use of modern method. The average level of experience among processors is 20.25 years with 40.0% having between 11 and 20 years of experience. This indicates that they possess the needed experience that could help them improve their technical efficiency for greater productivity as indicated by (Sanusi et al., 2022). The majority (73.3%) of processors did not have capacity to acquire processing machine, only (10.0%) acquired by outright purchase, while few (16.7%) acquired through loans. This indicates the reason why most of the processors adopt traditional processing method due to high cost of modern processing machines. Also, the majority (87.5%) sell their product in the nearest major market and go through the mean distance of 19.66km, while few (25.5%) had their product sold on-site. This could help reduce activity of middle men who might be price speculators.

Table 2. Distribution of respondents by enterprise characteristics

Characteristics	Frequency	Percentage (%)
Membership of cooperative society		
Yes	46	38.3
No	74	61.7
Types of labor used		
Hired and family	38	31.7
Hired	82	68.3
Mode of acquiring palm fruits		
Grove	82	68.3
Cultivated	30	25.0
Plantation	8	6.7
Oil palm processing method		
Traditional	88	73.3
Modern	32	26.7
Processing experience		
1-10	28	23.3
11-20	48	40.0
21-30	32	26.7
>31	12	10.0
Mean ±SD = 20.25±10.05		
Mode of acquiring machine		
None	88	73.3
Outright purchase	12	10.0
Credit facility	20	16.7
Mode of sale		
Market	105	87.5
Processing site	15	12.5
Distance to main market		
<6	16	13.3
6-10	24	20.0
11-15	11	9.2
>16	69	57.5
Mean ± SD= 19.66±9.746		

Source: Field survey, 2022

Costs and returns on oil palm processing

The costs and returns of processing palm kernel oil include the difference between total revenue and total variable costs (TVC). The total revenue of processing palm oil includes return from oil, un-cracked kernel and cracked kernel. Whilst, the total costs consist of the total variable cost (fresh fruit, transport, storage, diesel, labor, harvesting, threshing, boiling/sterilizing, digesting/processing and fuel/electricity).

Under traditional method, Table 3 referred, revenue of ₦129657.10 is accrued from processed oil accounting for 97.92% of the total revenue. Un-cracked kernel accounts for 1.32% (₦1753.57) and cracked kernel accounts for just 0.76% (₦1000.00). Comparatively, 61.29% (₦161,680) of the total revenue is generated from processed oil under modern method, whilst 22.75% and 15.96% was accrued from uncracked and cracked kernel, respectively. However, processing the same tonne (1tonne) of fresh fruit bunch, modern processors still have revenue more than traditional processors in all revenue types.

In the same vein, Fresh fruit takes the highest proportion (64.90%) and (46.34%) of the traditional and modern method of total variable costs, respectively, amounting to ₦68828.57and ₦77100. The traditional processors have no need to buy diesel since they are not powering any machines and modern processors have no need for hiring labour (labour cost) since the machine will be doing almost all the works. We can say these costs are interchangeably connected, implying that need for diesel may be interpreted as no need for labour cost.

However, the above implication may not be explicit enough, because of the need for labour in all processing procedures. Notably, modern processors have cost for harvesting, threshing and boiling which the traditional processors do not. This may be because modern processors classified labour cost under each processing operations rather than in bulk. Observably, the cost for fuel/electricity was higher among traditional processors (₦6142.86) than modern processors (₦5840), this however, is not expected since modern processors use machines that need power and traditional processors do not. Total variable costs stands at ₦97167.43 and ₦153,908 for traditional and modern method of processing, respectively. This indicates that modern processors expend more cost in processing than their counterparts.

The gross margin for the traditional method is ₦35243.24 with a BCR of 1.25, which implies that every ₦1 invested would yield ₦0.25, while the modern method amounts to ₦109872 with a BCR of 1.59, implying that every ₦1 invested would yield ₦0.59. This indicates that oil palm processing is a profitable enterprise for both traditional and modern processors, but more profitable for the modern method. On average, BCR for both enterprises is 1.42. In the same vein, Olajide (2020) reported a mean BCR of 1.26 for both methods, and Sanusi et al. (2022) reported a BCR of 1.32, implying oil palm processing is profitable.

Constraints faced by palm fruits processors

Ranked in descending order as shown in Table 4, inadequate finance had the highest frequency (54.2%) followed by high cost of processing equipment 47.5% and 42.5% for Seasonality of oil palm fruits to make them the most severe constraints to palm oil processing and marketing in the study area. Conformably, Onaja and Ogali (2015), Nwandu et al. (2021) and Sanusi et al. (2022) stated that inadequate finance is one major constraint to oil palm processing. Other constraints include: Poor access to information (38.3%), high maintenance cost (35.8%), labour shortage (29.2%), scarcity of water (26.7%) and shortage of firewood (20.8%).

Table 3. Results of budgetary analysis of oil palm processing enterprises

Item	Traditional method (n=70)		Modern method (n=50)	
	Mean (₦)	% Budget share	Mean (₦)	% Budget share
Revenue				
Oil	129657.10	97.92	161680	61.29
Un-cracked kernel	1753.57	1.32	60000	22.75
Cracked kernel	1000.00	0. 76	42100	15.96
Gross revenue	132410.67	100	263780	100
Variable costs				
Fresh fruit	68828.57	64.90	77100	46.34
Transport	4107.14	3.87	5900	3.55
Storage	3000.00	2.83	3160	1.90
Diesel	-	-	7588	4.56
Labour	5317.43	5.01	-	-
Harvesting	-	-	27900	16.77
Threshing	-	-	15260	9.17
Boiling/sterilizing	-	-	5000	3.01
Digesting (processing)	9771.43	9.21	6160	3.70
Fuel/electricity	6142.86	5.79	5840	3.51
Total variable cost (TVC)	97167.43	91.63	153908	92.50
Gross margin	**35,243.24**		**109,872**	
BCR	**1.25**		**1.59**	

Source: Data analysis, 2022

Table 4. Distribution of the respondents according to constraints to processing of oil palm

Constraints	Frequency	Percentage
Inadequate finance	65	54.2
High cost of processing equipment	57	47.5
Seasonality of oil palm fruits	51	42.5
Poor access to information	46	38.3
High maintenance cost	43	35.8
Labor shortage	35	29.2
Scarcity of water	32	26.7
Shortage of firewood	25	20.8

***Multiple choices**

Source: Field survey, 2022

Factors influencing the quantity of palm oil produced in the study area

Table 5 shows results from the regression analysis. Out of the four functional forms (Linear, semi-log, exponential and double-log) estimated in the multiple regression analysis, the linear form was selected as the lead functional form. This was chosen based on the value of co-efficient of multiple determinations (R^2), the number of significant variables and the a priori expectations. All variables included in the model were tested for violation of assumptions before running them against the dependent variable.

The value of R^2 from the linear function of 0.949 showed the highest value of 94.9%, and the highest number of significant variables with the signs in line with our a priori expectations. This implies that about 95% of the variation in output of oil palm is explained by the variables included in the model with the remaining 5% unexplained. The unexplained variations are due to random error (U) in the variables.

The results showed that level of education, method of processing and membership in cooperative society were positive and significant to quantity of the oil produced.

Explicitly, level of education (β=0.737) was positive and significant at 5% to the dependent variable. This implies that a year increase in the processor's level of education will result in 0.737 unit increase in quantity of oil palm produced.

Observably, level of education is a resultant of quantity of output produced as education gives them enlightenment to embrace innovation that will boost their production as reported by Obayelu et al. (2022).

Membership (β=0.016) was positive and significant at 10% to the dependent variable implying that a unit increase in the membership status of processors in cooperative society will result in 0.016 unit increase in quantity of oil produced. Noting that this variable is a dummy, we can say processors that are membership in cooperative society have more quantity of oil produced than the non-members possibly as a result of credit or input accessed.

Lastly, processing method (β=0.323) was positive and significant at 1% to the dependent variable, this implies that the choice of modern method of processing will result in 0.323 unit increase in quantity of oil produced. In the same vein, with income from oil processing the level of income realized might be a resultant of processing method of choice. This indicates that modern method of processing will lead to higher quantity of oil produced translating to higher level of income.

Table 5. Multiple regression analysis on oil palm output

Variable	B	Standard	error	Sig
(Constant)	-7.789	1.267	-6.146	0.000
Age	0.003	0.013	0.244	0.808
Income from secondary occupation	-0.004	0.004	-1.149	0.255
Household size	0.010	0.007	1.397	0.167
Level of education	0.737	0.103	7.118	0.000**
Income from oil processing	0.005	0.010	0.438	0.663
Gender	-0.009	0.010	-0.962	0.340
Membership in cooperative society	0.016	0.008	1.998	0.050*
Processing method (modern)	0.323	0.014	23.399	0.000***
R_2	0.949			
Adjusted R_2	0.943			
F value	159.147**			

Source: Field Survey, 2022 Note: ***, ** and * indicate level of significance at 1%, 5% and 10%, respectively

Conclusion

The study shows that palm oil processing is a profitable venture in the study area. The major processing technique adopted was the traditional method. The comparative budgetary analysis shows that the modern method of processing is more profitable than the traditional method with gross margin of ₦109,872 and benefit cost ratio (BCR) of 1.59 compared to gross margin of ₦35,243.24 and BCR of 1.25, respectively. Inadequate finance, high cost of processing equipment and seasonality of oil palm fruits were the major constraints to oil palm processing in the study area. Major factors affecting the quantity of the palm oil produced in the study area were level of education (P<0.05), method of oil palm processing (P<0.01) and membership in cooperative society (P<0.1). It is recommended that government and development partners should educate oil palm processors on the need to use modern method of processing, which will help them improve their output and income. Noting that modern processing plant is capital intensive, there is need to provide low interest loan for processors to help them step up their plant and farmers should organize themselves in cooperative entities for equipment leasing and establish commercial palm fruit plantations for easy access to massive palm fruits for processing at affordable prices.

Acknowledgement

The research team hereby appreciate office of the Osun State Agricultural Development Programme and all those that contributed to the success of the study.

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