Profit Efficiency of Palm Oil Processing in Osun State, Nigeria

CO Idiaye
Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria

TO Owolabi
Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria

IB Oluwatayo
Department of Agricultural Economics and Agribusiness, University of Venda, South Africa

Abstract

This study estimated profit efficiency among palm oil processors in Osun state, Nigeria. It examined the costs and returns in processing and the factors contributing to profit inefficiency. Data was collected from 120 respondents. Descriptive statistics were used to profile the socioeconomic characteristics of the processors, budgetary analysis was used to determine the costs, returns and profitability, while the stochastic frontier profit function was used to estimate profit efficiency and its determinants.
The results revealed that palm oil processing was dominated by women (85.8%), majority of whom were between the ages of 31-60 years (73.3%). Moreover, most of the processors did not belong to any cooperative groups (82.5%), lacked credit access (91.7%) and operated small scale commercial enterprises (70%). The analysis of costs and returns showed that palm oil processing was profitable in the area with positive gross margin and net income. A profit efficiency of 0.622 was estimated showing that there remained a considerable scope of 37.8% to increase profitability. The regression analysis showed that increase in educational attainment of processors, credit access and storage access tended to decrease profit inefficiency.
It was concluded that the profitability of palm oil processing can be increased in the study area as well as in the country as a whole by proper policy to empower processors and proffer solutions to the challenges identified by them.

Keywords: Efficiency analysis, Nigeria, Palm oil processing, Profitability, Stochastic frontier.

1. Background to the Study

The principal product of the oil palm crop (Elaeis *guineensis*) is the palm fruit which is processed into three main commercial products which are palm oil, palm kernel oil (PKO) and palm kernel cake (PKC). However, the oil palm tree is highly versatile in its uses, ranging from domestic cooking to industrial manufacturing. For instance, the leaves are used for making brooms and roofing materials, while the thicker leaf stalks are used for walls of village huts. The bark of the palm frond, on the other hand, is peeled and woven into baskets, while the main tree trunk can be split like sawn timbers and used as supporting frames in buildings (Komolafe *et al.,* 1990). Moreover, palm oil can be converted to cooking oil, used as raw material for manufacturing soaps, creams, margarines and confectionaries or converted to fuel to drive automobiles as is the case in Malaysia (Eric and Ikheoha 2007). A sap tapped from the female flower is drunk as palm wine and is a rich source of yeast. Palm wine can be allowed to ferment and then distilled into a gin locally known as "*Akpetesin*" in Ghana and "*Ogogoro*" in Nigeria (Akinyosoye, 1976). Palm oil is obtained from FFBs while the residue from the processed fruit is used as fuel (*ogusho*) and fertilizer. Palm kernel oil is extracted from the nut inside the palm fruit, leaving the palm kernel cake (PKC) as residue. Palm kernel oil is used as vegetable oil for cooking as well as in soap making. PKC, on the other hand, is used for livestock feed. Palm kernel shells are also a useful energy source as well as industrial raw materials in making mosquito coils (Soyebo *et al.*, 2005).

The oil palm is monoecious in nature, having separate male and female flowers. They are primarily pollinated by various insects in Africa. Oil palm trees can grow up to 20 metres tall with an average life span of 25 years. The tree starts to bear fresh fruit bunches (FFBs) after its first three years of life with each individual piece of fruit on the bunch consisting about 50% oil. The two major natural fruit forms of oil palm are the Dura and the Pisifera. A third, hybrid, form has emerged through a controlled cross pollination of the Dura and Pisifera palms and it is known as the Tenera fruit. Dura is the common wild palm found all over Nigeria. The fruit has a thick shell and a large kernel. It gives a low amount of palm oil and begins fruiting after 6-7 years of planting. Tenera has a thin shell and a small kernel. It produces a high quality of palm oil and begins fruiting after 3-5 years of planting. The main distinguishing features of the three fruit forms, as highlighted by Matthew (2009), are shown in table 1.

Dura	Pisifera	Tenera
Thick-shell	Less shell	Thin shell
Thin mesocarp	Mainly mesocarp	Thick-mesocarp
Viable embryo	Unviable embryo, if present seeds are sterile	Viable embryo
Large kernel	Very small kernel, sometimes no kernel.	Good size kernel
Contains very small quality of oil	Fruit contains highest oil content	High oil content in the fruit
Unimproved	Unimproved	Improved

Table 1: **The Major and Hybrid Forms of the Oil Palm Fruit**
Source: Matthew (2009)

Palm oil processing begins as soon as the oil palm fruits begin to ripen after harvest since delay in processing at this stage can lead to rotting of the fruit, resulting in low output of palm oil. Necessary care is taken in handling the fruit to avoid excessive bruising which can result in poor quality palm oil output. Therefore, damage done to fruits in the processes of harvesting, transportation and handling of bunches are usually minimized to an extent by processing the fruits as early as possible after harvest, often within 48 hours. Adeniyi (2014) explained the stages involved in palm oil processing as itemized in table 2

Table 2: **Stages Involved in Palm Oil Processing**

Stage	Unit Operation	Purpose
1	Fruit fermentation	To loosen fruit base from the spikelet and to allow ripening process to abate.

2	Bunch chopping	To facilitate manual removal of fruit
3	Fruit sorting	To remove and sort fruits from spikelets
4	Fruit boiling	To sterilize and stop enzymatic spoilage, coagulate protein and expose microscopic oil cells
5	Fruit digestion	To rupture oil-bearing cells to allow oil flow during extraction while separating fiber from nuts
6	Mash pressing	To release fluid palm oil using applied pressure on ruptured cellular contents
7	Oil purification	To remove water-soluble gums and resins in the oil by boiling a mixture of oil and water; the decanted oil is rid of water by further heating
8	Fiber-nut separation	To separate de-oiled fiber from palm nuts
9	Second pressing	To recover residual oil for use as soap stock
10	Nut drying	To sundry nuts for later cracking

Source: Adeniyi, 2014

The foregoing steps in palm oil processing are carried out using traditional, modern or advanced techniques. The traditional method involves employing manual/human effort in the striping, sterilization, milling (digestion), separation and clarification processes. This method is laborious and yields a low percentage of palm oil relative to the other methods, thereby adversely affecting the income of processors. The traditional method is still used in many parts of Nigeria and it is estimated that about 25,000 tonnes of palm oil is lost annually due to the inefficiency of this method which is employed by majority of the small scale processors in the country who account for 70% of the palm oil produced (FAO, 2002). Switching from the traditional method to the use of simple processing equipment will reduce labour drudgery, increase marketable surplus and enhance profit efficiency (Adeniyi, 2014).

The modern method, on the other hand, is a semi-mechanized system characterized by two major innovations in processing equipment: the manual or mechanized screw press and the diesel powered digester, both of which are locally manufactured or assembled by artisans in the oil palm producing regions of Ghana, Cameroon, and Nigeria (FAO, 2002). Manual examples include the NIFORT and KIT hydraulic presses.

The advanced method, however, is a fully mechanized oil mill in which every stage of processing is done by a specialized machine, meaning that manual labour requirement is low. It is a capital intensive method and would only be economically viable in large scale palm oil production. An example of an advanced oil milling system is the integrated continuous and motorized digester screw press (DSP) developed by the National Institute for Oil-palm Research (NIFOR).

The oil palm is an important crop to global food security, especially in developing countries and has become an increasingly important driver of economic development and poverty reduction in the major producing countries of south-East Asia, Central and West Africa due to the fact that it is by far the most productive of all the vegetable oil crops, yielding more oil per hectare than any of the other major oilseed crops such as rapeseed, sunflower, soybeans, peanut, or cottonseed and it is cultivated in about

43 countries, all of which are developing countries in the humid topics (Cheng Hai Tech, 2010).

As an economic tree crop, oil palm provides employment to over 4 million people along the value chain in about 20 oil palm growing states in Nigeria and palm oil processing is a major source of income and employment to a large proportion of the resource poor rural population in Nigeria (Ahmed 2001; Aniedu *et al*., 2007). However, production has been on the decline in Nigeria, largely due to the inefficiency in the production system occasioned by high labour costs, rudimentary processing techniques, poor infrastructure (electricity and water supply), inadequate credit access, among others (Omoti, 2004). The industry is dominated by small scale processors whose total output cannot meet the domestic demand for palm oil products, thus making Nigeria a net importer of palm oil and related products (Asogwa *et al*., 2006; Olagunju, 2008).

At the level of the processors themselves, there are serious problems that reduce their ability to earn a decent profit from their enterprises. For instance, most of them source their FFBs from wild, unimproved groves which are low yielding, much unlike what obtains in countries like Indonesia and Malaysia where most palm oil producers have access to improved oil palm groves and, expectedly, these countries have better average outputs than Nigeria (Oghenemaro *et al;* 2006). Furthermore, huge profits are lost by processors due to wastage associated with the traditional methods of processing that most of them employ (Ukpabi, 2004). Add to the foregoing the problems of inadequate finance, labour shortage, unavailability of land, high maintenance costs (Emokaro and Ugbekile, 2004; Mgbakor, *et al*., 2013), inadequate storage, poor market information/access and exploitative middlemen, then it is easy to understand why palm oil processing has become less profitable for its main actors in Nigeria. This study, therefore sought to examine the profit efficiency of palm oil processing in Osun State, Nigeria as well as the factors that contribute to inefficiency.

2. Conceptual Framework

Figure 1 shows the production-related and external factors that can affect profit efficiency of palm oil processing. Market, information, credit and storage access, along with availability of labour and other inputs at reasonable costs, coupled with the use of improved groves and the educational endowment of the processor all contribute to improved returns in oil palm processing leading to higher profit efficiency, and the reverse is true. Lower input costs mean lower cost of production and consequently higher profits for processors; also, access to credit allows for large scale processing which is more efficient and thus more profitable than small scale activities (Olagunju, 2008). Storage access, on the other hand, permits processors to avoid low prices for their output during periods of glut while they can make higher profits during the off-season, thereby more efficiently converting output into revenue (Ezealaji, 2011). The use of improved varieties will ensure more yield (Mgbakor, *et al*., 2013) while formal education of a processor makes it easy for them to accept new innovations and adapt to new systems of processing which can increase yields and boost profit (Olagunju, 2008). Further, external factors, which influence the profitability of palm oil processing, such as government policies, seasonal variations in oil palm yields, price instability, the effects of climate change, pest infestation and handling of FFBs and finished products (by distributors) may be favourable or unfavourable to processors resulting in either increased or lowered returns.

3. Methodology

3.1 Sampling and Data Collection

The study was carried out in Ayedire Local Government Area of Osun State in south-western Nigeria. Ayedire Local Government was purposively selected because of its strategic importance in palm oil production in the state. Primary data was used for this study which was generated using a structured questionnaire and oral interviews. A total of 120 palm oil processors were selected for the study.

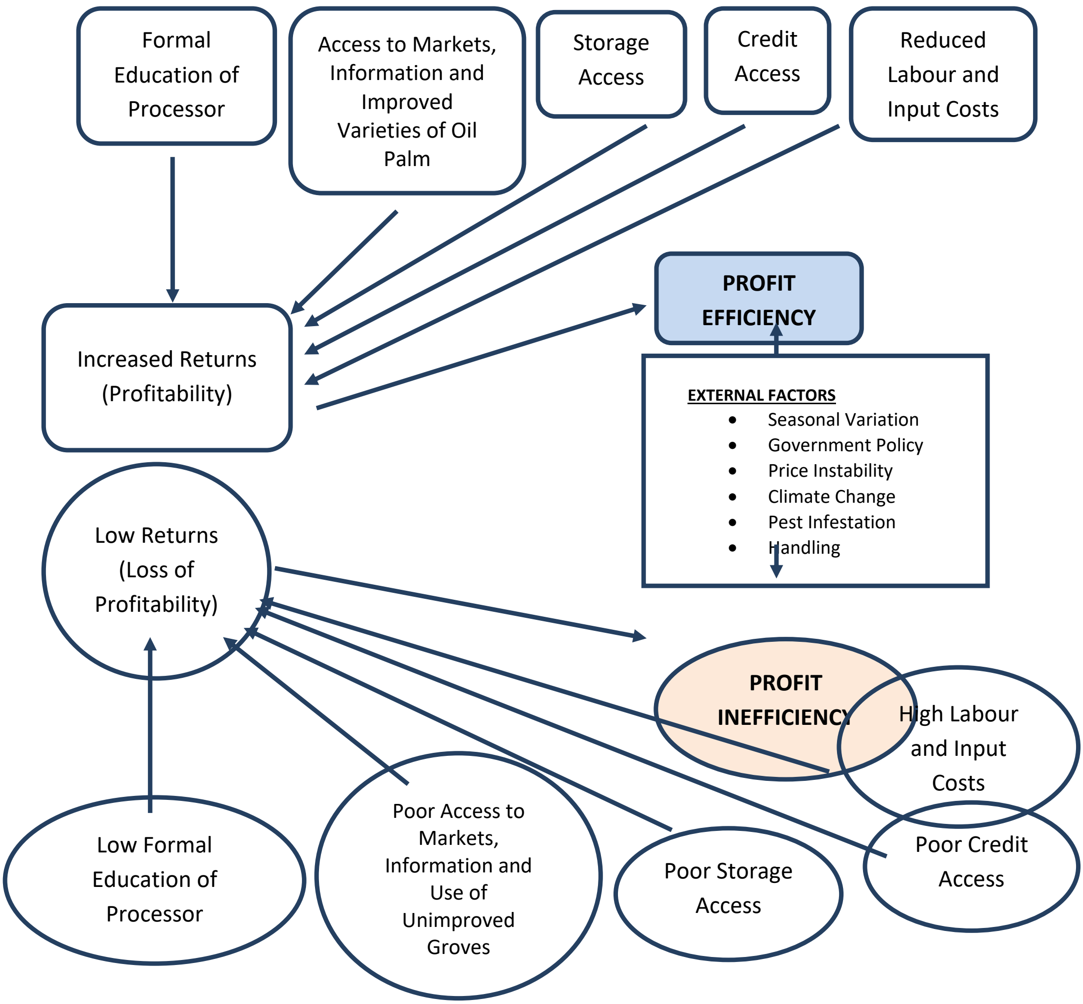

Figure 1: Determinants of Profit Efficiency of Palm Oil Processors in Osun State
Adapted from Ogunniyi (2008), Olasunkanmi *et al.* (2013) and Elijah *et al.* (2014)

3.2 Analytical Techniques

- *Descriptive statistics* were used to describe the socioeconomic characteristics of the processors and the factors militating against the profitability of palm oil processing in the study area.
- *Budgetary analysis* was used to examine the costs and returns in palm oil processing and estimated profit among the processors selected for study. The total revenue (TR) from the sales of palm oil, palm kernels, palm oil mill effluents (POME) and other minor products of processing and all costs incurred in production were itemized in an enterprise budget and the gross margin and net income determined. *Gross margin* (GM) was determined by subtracting the total cost of goods sold (total variable cost, TVC) from the total revenue earned following Fatoba *et al*., (2013). Net income (NI) was obtained by subtracting the total cost of fixed inputs (total fixed cost, TFC) from the GM. i.e.

$$GM = TR - TVC$$
$$NI = GM - TFC$$

TVC included the cost of FFBs, firewood, labour wages (per man-day), fuel (in liters) and transportation while TFC included the costs of machines, drums, shovels, cutlasses, and head pans.

- *The stochastic frontier profit function* was used to estimate profit efficiency among the palm oil processors. **Profit efficiency** is a concept used in assessing whether a farmer or processor is expending an optimal, balanced level of rent for the use of capital. According to Ali and Flin (1989) profit efficiency is defined as the ability of a farm to achieve the highest possible profit given the prices and levels of fixed factors in that farm while **profit inefficiency** is the loss of profit for not operating at that frontier. **A profit function** is an extension and formalization of the production decisions taken by a farmer. According to production theory, a farmer is assumed to choose a combination of variable inputs and output that maximizes his profit subject to the technology constraint (Sadoulet & De Janvry, 1995).

The implicit general form of the profit frontier is defined as follows:

$$\pi = f\left(p_1, p_2, p_3 ... p_i, z_i\right) \exp e_i$$

Where;

= normalized profit which is defined as the gross revenue (or TR) less the TVC, divided by price of output.

p_i = price of each variable input use in processing

z_i = level of fixed inputs used processing

e_i = error term, defined as $v_i - u_i$

v_i = the statistical dis- turbance term

u_i = processors' specific characteristics that are related to their profit efficiency

The explicit **Cobb-Douglas functional form** of the stochastic frontier profit function for the palm oil processors in the study area was specified as follows:

$$\ln \pi_i = \ln \beta_0 + \ln \beta_1 p_{1i} + \ln \beta_2 p_{2i} + \ln \beta_3 p_{3i} + \ln \beta_4 p_{4i} + v_i - u_i$$

Where;

p_1 = average price per bunch of FFB

p_2 = average price of firewood

p_3 = average price per man day of labour

p_4 = average price of other processing materials

β_0, β_1, β_2, β_3 and β_4 are the parameters to be estimated

π_i, v_i and u_i are as defined earlier

The profit inefficiency model was specified as follows:

$$u_i = \alpha_0 + \alpha_1 z_{1i} + \alpha_2 z_{2i} + \alpha_3 z_{3i} + \alpha_4 z_{4i} + \alpha_5 z_{5i} + \alpha_6 z_{6i} + \alpha_7 z_{7i}$$

Where;

z_1 = age of processors (number)

z_2 = number of years of formal education of processors (number)

z_3 = household size of processors (number)

z_4 = access to credit (Yes = 1, 0 otherwise)

z_5 = access to market information (Yes = 1, 0 otherwise)

z_6 = access to storage facilities (Yes = 1, 0 otherwise)

z_7 = years of experience in processing

α_1 . . . α_7 are the parameters to be estimated

4. Results and Discussion

4.1 Description of the Socioeconomic Characteristics of the Processors

Table 3 shows that more than half (57.5%) of the processors are 50 years of age or younger which implies that they are a predominantly economically active group. There is, however, also an indication of an ageing population of palm oil processors as a good proportion of them (42.5%) are aged 51 years or older; the fact that 19.2% of them are above the age of 60 while under 2% are 20 years or younger underscores this fact and might indicate that palm oil processing is not being readily adopted by the youth. Also, palm oil processing in Osun state is a female-dominated activity with nearly 86% of the processors being female. This result agrees with those obtained by Ayinde *et al.*, (2012) and Aniedu *et al.*, (2007) who observed that women are the major stakeholders in palm oil processing in Nigeria. Furthermore, most of the processors (84.2%) were married with a moderate average household size of 5 persons. While the relatively small household sizes might bode well for household welfare, they might also imply that there is less availability of family labour for processors in the study area to call upon, thus increasing their reliance on hired labour with the attendant increased cost of production since palm oil processing is highly labour intensive.

It can be inferred from Table 3 that educational attainment is low among the processors as secondary education is the highest form of education any of them had while 26.7% of them did not even have any formal education. As indicated by Asiabaka (2002) and Olagunju (2008) this could have negative implications for the adoption of new technologies that have the potential to improve profit efficiency in palm oil processing as well as the practice of sound and innovative business management. Processing experience was seen to be high among the respondents with an average of 20.5 years spent in the activity. However most (82.5%) of the processors did not belong to any socioeconomic groups (cooperatives, processors' associations, informal savings and religious groups) which are effective ways for members to access credit as well as government subsidies on inputs.

Table 3: **Socioeconomic Characteristics of Palm Oil Processors**

Characteristics	Percentage (n=120)	Characteristics	Percentage (n=120)
Age		**Household Size**	
<20	1.7	1 – 5	60.8
21 – 30	5.8	6 – 10	35.0
31 – 40	23.3	>10	4.2
41 – 50	26.7	Mean	5.4 (± 2.4)
51 – 60	23.3	Range	1 – 12

>60	19.2	**Processing Experience (Years)**	
Mean	49.8 (±14.0)	1 – 20	60.8
Range	17 – 80	21 – 40	29.2
Sex		41 – 60	8.3
Female	85.8	>60	1.7
Male	14.2	Mean	20.5 (± 15.05)
Marital Status		Range	1.5 – 65
Single	2.5	**Membership of Groups**	
Married	84.2	Yes	17.5
Widowed	12.5	No	82.5
Divorced	0.8	**Religion**	
Educational Attainment		Christianity	33.3
No Formal Education	26.7	Islam	66.7
Primary Education	45.0		
Secondary Education	28.3		

4.2 Description of the Processing Activities and Credit Access of Respondents

The scale of production of the processors was determined by the land area (in hectares), owned or rented, from which palm fruits were harvested for processing. Processors that owned or rented above five hectares were identified as large scale processors, those who had between two and five hectares were classified as medium scale, while those with less than two hectares were categorized as small scale processors. Majority of the processors in the study area (70%) were small scale commercial processors who mostly operated rented plantations (64.2%). Among those who rented plantations, most (58.3%) reported, during Focus Group Discussions (FGDs), that they entered into contracts with owners of plantations wherein they "owned" a plantation for a processing season with an agreement to pay a rent to the owner of the plantation after processing had been completed. The agreed rent was usually between 1 to 1.5 kegs of palm oil for every 20-40 oil palm trees present on the plantation. With regards to the method of processing, only the intermediate system was observed among the sample of processors who all had adopted the diesel powered digester but without the screw press; the pressing of the sludge resulting from the digestion process was done manually using the feet and hands to squeeze out the palm oil in a round plastered pit. The overwhelming majority of the processors (91.7%) had no access to credit facilities and most of them (79.2%) claimed to rely on personal savings to finance their processing activities. A summary of the processing activities of the respondents is presented in Table 4.

Table 4: **Processing Activities and Credit Access of Palm Oil Processors**

Description	Percentage (n=120)	Description	Percentage (n=120)
Scale of Production		**Market Information Access**	
Small Scale Commercial	70.0	No	7.5
Medium Scale Commercial	25.3	Yes	92.5
Large Scale Commercial	4.7	**Market Access**	
Method of Processing		No	3.3
Intermediate	100	Yes	96.7
Ownership of Plantation		**Perception of Market Access**	
Rented	64.2	Bad	0.0
Owned	35.8	Fair	33.3
Large Scale Storage Facilities for Palm Oil		Good	66.7
No	40.0	**Formal Credit Access**	
Plastic Kegs	47.5	No	91.7
Drums	12.5	Yes	8.3
Large Scale Storage Facilities for Palm Kernels		**Sources of Credit**	
No	85.0	Personal Savings	79.2
Sacks	15.0	Friends and Relatives	16.7
Contract Marketing of Palm Oil Output		Cooperatives	3.3
No	41.7		
Yes	58.3		

4.3 Cost and Returns in Palm Oil Processing

An analysis of the costs and returns in palm oil processing in the study area was done to ascertain the profitability of the activity. Table 5 contains a summary of the analysis. Overall, palm oil processing was found to be profitable with a combined GM and NI of ₦17,456,235 and ₦17,223,505 respectively.

Table 5: **Total Cost and Return of Processors**

Variable	Total Value (₦)	Mean Value (₦)
TR	39,199,880	326,665.67
TVC	21,743,645	181,197.04
GM	17,456,235	145,468.63
FC	232,730	1,939.42
NI	17,223,505	143,529.21

4.4 Profit Efficiency Analysis

Table 6 presents the parameter estimates of the stochastic frontier profit function. The estimates are interpreted as elasticities of the variables i.e. the effect of changes in the respective variables on the profit efficiency of palm oil processing. The efficiency model estimates showed that a unit increase in expenditure on FFB will increase the profit earned from palm oil processing by 11%, while a unit increase in labour cost will reduce profit by 19%. Further the mean profit efficiency was estimated at 0.62, indicating that palm oil processors in Osun State are still operating below the efficiency frontier.

Table 6: **Maximum Likelihood Estimates (MLE) of the Stochastic Frontier Profit Function**

Efficiency Model			
Variable	**Parameter**	**Coefficient**	**t-ratio**
Constant	β_0	0.53	42.50
FFB Cost	β_1	0.11	4.09***
Firewood Cost	β_2	-0.10	1.07
Labour Cost	β_3	-0.19	6.62***
Other Materials Cost	β_4	-0.01	4.58***
Inefficiency Model			
Variable	**Parameter**	**Coefficient**	**t-ratio**
Constant	α_0	0.12	9.79***
Age	α_1	0.35	2.88***
Education	α_2	-0.19	9.68***
Household Size	α_3	-0.65	1.05
Credit Access	α_4	-0.21	4.67***
Information Access	α_5	0.32	7.98***
Storage Access	α_6	-0.26	1.90*
Processing Experience	α_7	0.13	8.18***

Diagnostic Statistics	
Sigma Square	0.14
Gamma	0.50
Log Likelihood	-18.93
LR test	0.69
Average Efficiency	0.62

*Note: *** means significant at 1% level, * means significant at 10% level*

On the other hand, the inefficiency model showed that the age of processors, educational attainment, access to credit, storage access and experience in years all had significant effects on profit inefficiency. The negative and significant coefficient of educational attainment indicates that the more educated a processor was, the less inefficient he/she was likely to be. Furthermore, credit access and storage access were shown to be important factors that reduced the profit inefficiency of palm oil processing. However, the older a processor got, the more profit inefficient they became as indicated by the positive and significant coefficient of the variable.

4.4 Constraints in Palm Oil Processing

Table 7 presents the constraints identified by the processors which they experienced in their activities. They were required to rank the set of constraints as either "major", "minor" or "no" constraints to their processing. The result shows that seasonality of FFB (70.3%), high cost of labour (75.2%) and lack of start-up funds (67%) were the constraints overwhelmingly voted for as major constraints to palm oil processing in the study area. Given the inability of most processors to store FFB against the off-season, it is understandable that seasonality of the crop was seen as a major challenge to processing. Moreover, palm oil processing is a labour intensive activity, especially when employing the intermediate and traditional methods and due to lack of start-up funds, most processors engaged in contract marketing which indirectly transfers some of their profit to the market contractors. These constraints pose a drag on the profitability of the processors.

Table 7: Constraints Identified by Palm Oil Processors

Constraint	Major	Mild	No
High Cost of FFB	25.6	25.6	48.8
Seasonality of FFB	70.3	21.5	8.2
Inadequate Modern Technology	51.2	39.4	9.4
High Cost of Equipment	15.6	38.0	46.4
Lack of Funds to Purchase Processing Machine	38.9	27.2	33.9
High Cost of Labour	75.2	17.4	7.4
Poor Transportation	53.0	24.0	23.0
Poor Market Network	5.0	11.6	83.4

Lack of Storage Facilities	43.7	43.7	12.6
Unstable Supply of Materials	8.4	10.0	81.6
Lack of Portable Water	3.3	7.5	89.2
Lack of Start-up Funds	67.0	15.6	17.4

5. Conclusion and Recommendations

The mean profit efficiency of 0.62 obtained for the palm oil processors in Osun State is an indication that there remains a considerable scope (37.8%) for them to increase profitability in their enterprises (possibly by improving allocative and technical efficiencies). Further, it has been revealed by this study that cost of production (especially labour cost) greatly limits the profitability of palm oil processing in the study area. Conversely, educational attainment, credit and storage access reduce profit inefficiency.

Based on the findings of the study, it is recommended that:

1. Given the important role that palm oil plays as a major economic product in Nigeria as well as its potential for export and foreign exchange generation, policy focus should be placed on public-private initiatives that can be explored to provide input subsidies, credit and start-up capital for existing and potential processors. There is already growing interest (even among the youth) in the country in the marketing and distribution of agricultural produce (including palm oil) within and outside the country. Therefore injection of subsidies, coupled with the fast-growing markets, will mean increased earnings as well as job creation in the sector.
2. Labour cost was seen to be a greatly limiting factor in the profit efficiency of palm oil processing in Osun state. This can be linked to the fact that the intermediate method of processing (which is labour intensive) is the overwhelmingly adopted method in the study area. Therefore it is recommended that processors be given support to acquire modern processing tools which will reduce labour demand and increase output. Through the collaboration of the Federal Ministry of Agriculture (FMARD), the state governments and private sector players, this can be achieved.
3. There is a great need for adequate storage access to enable the processors store the FFBs whose seasonality threatens continuous production. Therefore it is recommended that storage facilities be provided through processor cooperatives and government intervention and the supply of required amenities (water and electricity) be prioritized for areas where palm oil is processed. These measures will greatly increase the profitability of these enterprises with attendant economic benefits to the country.

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