Methods of Palm Oil Processing in Ogun state, Nigeria: A Resource Use Efficiency Assessment

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Abstract

Data for this study were obtained with the aid of structured questionnaire. A total of 70 questionnaires were administered to the palm oil farmers/ producers with the response rate of 95.71 %. The data were analysed by the use of descriptive statistics, multiple regression and costs and returns tools. The results obtained revealed that although mechanized palm oil processors were not fully economically efficient in the use of resources, mechanized palm oil processing was still more profitable relatively. Palm oil processors should therefore adopt good management strategies and practices in order to ensure efficient utilization of existing and available resources.

Keywords: Palm Oil, Resource use, Efficiency

Introduction

Palm produce accounted for about 82.1 % of the Nigeria's total domestic export between 1966 and 1973 (Usoro, 1974) and about 22 % of the foreign exchange earnings up to the beginning of the civil war (Modebe, 1978). As at 1986, the Nigeria's domestic palm oil production was estimated to be 760,000 metric tonnes while her imports then stood at 179,000 metric tonnes. Palm kernel, a by-product of palm oil is also consequently produced in large quantities in Nigeria during the same period. Palm kernel output however declined from 419,000 metric tonnes during the period 1960 – 1965 to 385,000 metric tonnes from 1985 – 1987 probably due to poor market outlet for the product.

The oil palm is one of the important economic crops in the tropics (Anyawu et al., 1982). It is the most important source of oil and produces more oil per hectare than any of the oil producing crops. The primary products of the oil palm are palm oil (from the mesocarp) and palm kernel oil obtained from the kernels (seeds). Palm oil contains carotene, a precursor of vitamin A, a high prized energy vitamin rich food used for cooking in oil producing countries of Africa. Palm oil and palm kernel oil provide raw materials in the manufacture of soaps and detergents, margarine, candle, confectionery, epoxy resins, bakery trade, lubricants, pomades and cosmetics. Other uses include palm kernel cake obtained from the crushing of palm kernel to extract oil. It serves as additives in livestock feed manufacture.

Palm wine which is obtained from the male inflorescence is very popular and of great socio-economic importance in some parts of Nigeria. The trade in palm wine competes favourably with that of palm oil. There is no part of oil palm that is not of economic value. The leaflets are used for making thatch for roofing houses while the leaf rachises are used for fencing, reinforcing buildings and basket making. The midribs of the leaflets are used for brooms. The palm cabbage, a soft tissue and the apical bud serves as a delicacy for eating.

The bunch refuse, which is left after the fruits have been removed from the palm bunch, is a rich source of potassium. Locally, it is used for making soap. The fibre residue left after the oil has been extracted from the fruit provides fuel while the shell from cracked palm nuts provides not only fuel, but also serves as an aggregate for flooring houses. The palm trunk is sawn into timber and used in construction of fences, roofing houses and reinforcing buildings.

The Food and Agriculture Organization (FAO, 2002) of the United Nations compiled a bulletin describing methods of palm oil processing. According to the bulletin, often small-scale facilities, which process two or less tonnes of fresh fruit bunch per hour, employ batch processes that utilize manual labour and have low operating costs. Large-scale facilities typically use continuous systems and require skilled labourers and greater management. Large-scale plants process more than ten and often up to sixty tonnes of fresh fruit bunches per hour (Kwaski, 2002).

Palm Oil Processing Methods

Manual/ Traditional Palm Oil Processing

Pounding (digestion) and oil extraction are the most tedious and essential operations in traditional palm fruit processing; therefore, early efforts concentrated on these tasks. In small-scale processing, digestion, that is, the breaking up of the oil-bearing cells of the palm fruits' mesocarp, is the most labour intensive activity (Kwasi, 2002). Two methods of fruit maceration are common in traditional processing: pounding cooked/soaked fruits in large wooden or concrete mortars with a wooden pestle and foot trampling the cooked but cold fruits in canoes or specially constructed wooden troughs. The general traditional method of oil extraction consists of steeping the pounded fruit mash in hot or cold water; removing fibre and nuts in small baskets and hand squeezing; filtering out residual fibre from the oil/water emulsion in perforated metal colanders or baskets; boiling and skimming palm oil from the oil/water mixture and drying the recovered oil (Poku, 1998).

The village traditional method of extracting palm oil involves washing pounded fruit mash in warm water and hand squeezing to separate fibre and nuts from the oil/water mixture. A colander, basket or a vessel with fine perforated holes in the bottom is used to filter out fibre and nuts. The wet mixture is then put on the fire and brought to a vigorous boil. After about one or two hours, depending on the volume of material being boiled, the firewood is taken out and the boiled mixture is allowed to cool. On cooling to about the body temperature (98.6^{o}F), a calabash or shallow bowl is used to skim off the palm oil. Large quantities of water is used in washing the pulp hence this procedure is called the 'wet' method (FAO, 2002).

Oil extraction processes from the palm-nut was a process that span approximately 21 days for the farm family, and it involves the cooperation of the man, his wife and children, and in some cases, members of the extended family. The first stage in palm collection was the climbing of the palm trees using ropes woven from raffia palms. The man uses a cutlass or an axe to cut down the nuts, usually bunched together in a big cob of about eighteen inches long. The wife's role was to haul to the trough the nuts collected in a single day, which amount to "a little over one puncheon (13 cwt) or 180 gallons of oil and fifty-six bushels of palm kernel" (Bradbury, 1957). In certain circumstances, such as when the tapper is a bachelor or the husband is sympathetic if the wife is very sick, the man could assist the woman in gathering the scattered nuts to his own trough.

At the end of the collecting period, the palm nut collector (*Oberokpa*in: Isoko- Urhobo) then slices the bunches into four or more smaller pieces each, covers them with palm branches after which they are left for a period of two to three days to ferment a little. This fermentation softens the nuts and facilitates further processing.

Water is then added to the pulp and shaken vigorously to float the oil that is left in the nuts and hairy integument. The oil is siphoned off from the top of the water into drums and boiled for about one hour. The oil obtained through the traditional method of processing is usually of poor quality; hence it may be further subjected to additional boiling to remove impurities after which it is poured into kegs of various litre sizes ready for consumption and sale. Meanwhile, the clean nuts and fibrous residues are thrown out of the trough to dry for about nine to ten days. These are shared by the women who participated in the palm oil processing. The women crack the nuts to recover the seeds for domestic use and for sale (Mba, 1982).

Mechanized/Modern Palm Oil Processing

The process of producing crude palm oil requires a large set of equipment, which can range from crude, manual mechanisms to advanced automated machinery. Regardless of the types of machines used to produce crude palm oil, there are still a set of basic steps needed to produce palm oil.

The first step in palm oil production is harvesting the palm fruit bunches. A harvester cuts the fresh fruit bunches from trees and allows them to fall to the ground. The fruits may be allowed to ferment, or fully ripen, in order to loosen the base of the fruit lets from the bunches and to make their removal easier.

The fruit lets are removed from the bunch during the threshing process. Threshing can either be done by hand or with a mechanical thresher, which rotates or vibrates to separate the fruits from the bunch.

The sterilization process uses heat to partially cook the fruit. This process also stops enzymatic reactions that lead to oxidation and disrupts the cells in the mesocarp, allowing for easier oil extraction (Kwaski, 2002). Wet processes use water to sterilize the fruit by either steaming or boiling the fruit, producing wastewater as a by-product, while dry processes sterilize the fruit by smoking or roasting it **(see plate 1**).

Plate 1: Sterilization using the dry process at New Life Project Plantation, Kanchanaburi

(Source: Duang Prateep Foundation, 2009)

When implementing a wet process, the fruit is sterilized before the threshing process. In a dry process, the fruit is sterilized using dry heat after the threshing process. The digestion process crushes the fruit before extraction and warms the pulp to maximize oil yield. Facilities that use the wet process remove the nut from the pulp before pressing to yield “grade A” oil.

The pulp is then pressed to burst out the oil-containing cells thus releasing the palm oil. There are several types of presses that may be used to press the fruit pulp; they include manual presses, hydraulic presses and screw presses. The screw press is the most commonly used press because it yields the most oil when pressing the mesocarp (Baryeh, 2001). Next, the oil is heated and filtered to remove impurities. In the wet process, additional steps must be taken to ensure that water moisture in the mixture is removed. This is usually done in a clarifying tank, which drives excess moisture out of the oil through heating to reduce the moisture content from 0.25% to 0.15% (Kwaski, 2002). Once the oil has been checked for appropriate moisture and fat content, it is ready to be stored and sold.

A mechanical improvement, based on the traditional wet method process, is achieved by using a vertical digester with perforated bottom plate (to discharge the aqueous phase) and a side chute for discharging the solid phase components. The arrangement combines digestion, pressing and hot water dilution into one mechanical unit operation.

The ‘dry’ method uses a digester to pound the boiled fruit, which is a considerable labour-saving device (Kwasi, 2002). The oil in the digested or pounded pulp is separated in a press that may be manual or mechanical. Motorised mechanical presses are preferred, whether hydraulic or screw type. **(See Plate 2).**

WET PROCESS	DRY PROCESS
Grade A oil	Grade B oil
Wastewater produced	No wastewater
Fibre burned to generate electricity	Fibre sold as animal feed
Nut sold or processed into kernel oil	Nut crushed during processing

Plate 2: Comparison of wet and dry processes

(Source: Duang Prateep Foundation, 2009)

Most medium-and large-scale processing operations adopt the 'dry' method of oil extraction. This is because the fibre and nut shells may immediately be used to fire the boiler to generate steam for sterilization and other operations, including electricity generation. If the huge volumes of fibre and shells are not used as boiler fuel, serious environmental pollution problems may result (Poku, 1998). Too much water in the fibre increases the amount and cost of steam required to dry the fibre. Hence the preference for the dry method in plants handling more than six tonnes fresh fruit bunches (FFB/h). Processing machinery manufacturers tend to make machines to fit individual processing operations.

Large-scale plants, featuring all stages required to produce palm oil to international standards, are generally handling from 3 to 60 tonnes of FFB/hr. The large installations have mechanical handling systems (bucket and screw conveyers, pumps and pipelines) and operate continuously, depending on the availability of FFB. Boilers, fuelled by fibre and shell, produce superheated steam, used to generate electricity through turbine generators. The lower pressure steam from the turbine is used for heating purposes throughout the factory. Most processing operations are automatically controlled and routine sampling and analysis by process control laboratories ensure smooth, efficient operation. Although such large installations are capital intensive, extraction rates of 23 - 24 percent palm oil per bunch can be achieved from good quality Tenera (Kwaski, 2002).

Materials and Methods

The data were collected by means of structured questionnaire administered with 70 respondents using a combination of purposive and simple random sampling techniques. Five towns were purposively selected namely; Igbogila, Abeokuta, Ikenne, Odogbolu and Elere-Adubi, based on the fact that they form among others, the major producers of palm oil in the state. Fourteen out of an average population of thirty palm oil processors registered with the state government were selected from each town using random sampling technique. The analytical tools used in this study were descriptive statistics and resource use efficiency indicators.

In order to evaluate the economic efficiency of palm oil processors as users of resources, the study adopted the method used by Oladeebo and Ezekiel (2006), where the marginal value productivities (MVPs) for each resource were computed and such computed MVPs were then compared with their respective acquisition cost (MFC).

The MVP of a particular resource was computed thus: MVP = MPPxi.PQ
Depending on the functional form selected as lead equation for regression, the MPP and the corresponding values of MVP were obtained as follows:

$$Linear\ MPP = \frac{dQ}{dx} = \mathcal{R};\ MVP = \mathcal{R}.PQ$$

$$Double\ log: MPP = \mathcal{R}.\frac{Q}{x_i};\ MVP = \mathcal{R}\frac{Q}{x_i}.PQ$$

$$Semilog: MPP = \frac{\mathcal{R}}{x_i};\ MVP = \frac{\mathcal{R}}{x_i}.PQ$$

$$Resource - use\ efficiency = \frac{MVP}{PQ}\ that\ is\ \frac{MVP}{MFC}$$

Where

$\mathcal{R}$= regression coefficient
Q = mean output of palm oil products
x_i = mean value of resource
$\frac{dQ}{dx}$ = derivative of Qi and Xi
Px_i = price of resource per unit
PQ = price of output per unit
MFC = marginal factor cost

When Resource-use efficiency (RUE) equals unity (1), resources are optimally utilized; when it is less than unity, resources are over utilized and when greater than unity, resources are underutilized.

Results and Discussion

Quality of Palm Oil Produced

Table 1 shows that 35.3 % of the manual processors, 36.1 % of the semi-mechanized processors and 85.7 % of the fully mechanized processors produce palm oil of Grade A quality respectively. However, fully mechanized method gives the best quality since most of the processors in the group produced oil with virtually no content of free fatty acid. As a result, palm oil produced using this method attracts higher price than the one from manual and semi-mechanized method in the industrial markets.

Table 1: Quality of Palm Oil Produced

TYPE	MANUAL METHOD		SEMI-MECHANIZED		FULLY MECHANIZED	
Quality	Frequency	Percentage(%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Grade A	6	35.3	13	36.1	12	85.7
Grade B	3	17.6	9	25.0	-	-
Hard oil	4	23.5	3	8.3	2	14.3
Soft oil	3	17.6	8	22.2	-	-
Special oil	1	5.9	3	8.3	-	-
Total	17	100	36	100	14	100

Source: Field Survey, 2012

Source of Labour Used

Table 2 shows that while semi and fully mechanized processors hire substantial amount of labour; manual processors mostly make use of family labour and in addition still hire some labour to supplement family labour at peak periods. However, manual processors prefer to use more of family labour to reduce their cost of production.

Table 2: Source of Labour

Source of Labour used	MANUAL METHOD		SEMI-MECHANIZED		FULLY MECHANIZED	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Family	9	52.9	3	8.3	-	-
Hired	8	47.1	33	91.7	14	100
Total	17	100	36	100	14	100

Source: Field Survey, 2012

Resource Use Efficiecy in Manual Palm Oil Processing

In order to determine the economic efficiency in the use of resources by the oil palm processors, the MVP of each resource was compared with its MFC. The estimates of the Cobb- Douglas production function which was log-linearized were used in the computation of MVPs of each of the resources. The results are presented in Table 3. The efficiency indicator reveals that labour cost and expenditure on farm implements were over-utilized. Manual palm oil processors were not only grossly inefficient but also characterized by over-utilization of resources such as farm size and expenditure on transport. Economic efficiency and productivity could be improved if the farmers use less of these resources.

Table 3: Resource Use Efficiency Indicators of Manual Palm Oil Processing

Input	MVP	MFC	MVP/MFC	Efficiency Index	Elasticity
Labour cost (X_1)	209.6	500	0.42	Overutilization	0.882
Farm size(X_2)	-1624	45	-36.0	Gross inefficiency and overutilization	-0.233
Expenditure on transport (X_3)	-199	45	-4.42	Gross inefficiency and overutilization	-0.0722
Expenditure on farm implements (X_4)	0.405	17	0.024	Overutilization	0.227

Source: computed for survey data 2012
MFC= Marginal Factor Cost
MVP= Marginal Value Product

Resource Use Efficiency in Semi-Mechanized Palm Oil Processing

Results of analysis on the efficiency of resources used in the semi-mechanized palm oil processing system as shown in Table 4 indicate that resources such as cost of labour and farm size were over-utilized. Economic efficiency and productivity could be improved if the farmers use less of these resources. For labour, the ratio of MVP to MFC was less than one, indicating over utilization of labour in production which also implies a non-optimum use of labour resources in the production process.

Table 4: Resource Use Efficiency Indicators of Semi-Mechanized Palm Oil Processing

Resources	MVP	MFC	MVP/MFC	Efficiency Index	Elasticity
Labour Cost (X_1)	27.260	200.00	0.13600	Overutilization	0.15100
Farm Size(X_2)	-199	45	-4.42	Gross inefficiency and overutilization	-0.0722
Expenditure on transport (X_3)	-1624	45	-36.0	Gross inefficiency and overutilization	-0.233
Expenditure on extraction (X_4)	206,936,230	600.00	344.89000	Underutilization	0.13200

Source: computed for survey data 2012
MFC= Marginal Factor Cost ; MVP= Marginal Value Product

Resource Use Efficiency in Fully Mechanized Palm Oil Processing

In Table 5, the MFC of each input was compared with their respective MVP to determine resource use efficiency. For labour, the ratio of MVP to MFC was less than one, indicating over utilization of labour in production.

Extraction cost and transport expenses had ratios of MVP to MFC greater than one, which is 344.89 and 61.9, respectively, showing that both were underutilized.

Table 5: Resource Use Efficiency Indicators of Fully Mechanized Palm Oil Processing

Resources	MVP	MFC	MVP/MFC	Efficiency Index	Elasticity
Bunches of palm fruits (X_1)	-3.551	810.00	-0.00438	Gross inefficiency and overutilization	-0.00246
Hired Labour(X_2)	27.260	200.00	0.13600	Overutilization	0.15100
Expenditure on transport (X_3)	123.890	2.00	61.90000	Underutilization	0.36000
Expenditure on extraction (X_4)	206,936,230	600.00	344.89000	Underutilization	0.13200

Source: Computed for survey data 2012
MFC= Marginal Factor Cost; MVP= Marginal Value Product

Conclusion and Recommendation

The socio-economic characteristics of the palm oil processors showed that 75% of the mechanized processors are below 46 years of age compared to 47% of the manual processors. This implies that majority of the mechanized palm oil processors are still young, active and agile and could be more enthusiastic to accept and implement new technologies on palm oil processing. The study also revealed that men are more into the venture of fully mechanized palm oil processing than women. This is not contrary to the widely held belief that manual palm oil processing is a business that is predominant among women. Since the fully mechanized processing business has been identified to have the potentials of being more profitable, easier and safer than the manual and semi-mechanized methods, women should be encouraged to take to the fully mechanized palm oil processing.

Findings from the study also showed that manual palm oil processors over-utilized labour cost and expenditure on transport. Semi-mechanized palm oil processors were characterized by over-utilization of resources such as cost of labour and farm size. It was also found that the fully mechanized palm oil processors over-utilized labour and underutilized transport expenses. From the aforementioned results, it is obvious that none of the methods of palm oil processing yielded an optimal use of resources. Thus, the indication to profitability of palm oil processing in the study area did not guarantee that the resources are efficiently used.

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