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Less oil but more money! Artisanal palm oil milling in Cameroon

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The present study was carried out in four of the seven oil palm production basins generated during the Fonader-sponsored smallholder development scheme in the late Seventies and Eighties. The four basins include: Eseka, Dibombari, Muyuka, and Lobe. The objective of our study was to understand why oil palm smallholders prefer to mill their fresh fruit bunches (FFB) despite the low extraction rates of the artisanal mills and the remarkable presence of industrial mills where they could sell bunches. Our study included the submission of 200 semi-structured questionnaires to different categories of palm oil processors from 131 artisanal mills. Categories included both millers (mill owners and mill managers) and users (smallholders and intermediaries). Our results showed that the processing of FFB in artisanal mills was able to generate a better income to all categories of processors especially during the low production season. Smallholders in Dibombari and Muyuka were found to get the highest additional profit reaching 65.2 and 74%, respectively at low season, when compared to income generated by the selling of FFB at 48,000 FCFA and 50,000 FCFA /ton to Socapalm and CDC mills, respectively. The artisanal milling activity also provided temporary employment opportunities to young men, with an impact on juvenile delinquency and rural exodus. The present study also revealed that the cost of FFB processing the extraction rates of the mills and the demand for red palm oil were amongst the factors which greatly affected the decision making of oil palm processors.

Key words: Artisanal milling, crude palm oil, *Elæis guineensis*, extraction, vegetable oil.

INTRODUCTION

Artisanal milling is quite common to the oil palm belt of West and Central Africa, which is the cradle of the oil palm (*Elæis guineensis* Jacq.). Fresh fruit bunches (FFB) from natural stands of oil palm (Dura variety) are known to be harvested for immemorial times for the production of red palm oil, which is used in the preparation of numerous traditional dishes. Ngando et al. (2011) estimated that artisanal mills in Cameroon contribute to 30% of the total palm oil produced in the country. Historically, the most common method of artisanal milling was the trampling method, for which boiled nuts were taken to the side of a nearby stream and placed on a concave rock, trampled by foot in order to extract the crude oil which was later skimmed-off to produce red palm oil. Another common method was the pounding of boiled nuts with the use of a mortar and pestle. These

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two forms of artisanal milling are nowadays replaced byimproved mechanical artisanal mills with better milling efficiency.

In Cameroon, the first industrial plantation (Ferme Suisse) was developed in 1907/1909. By 1928 Pamol Plantations was created followed by the Cameroon Development Corporation (CDC) in 1947/1948, then Safacam in 1959 and lastly Socapalm in 1968 (Carrère, 2010). Such agro-industrial plantations exploit their own palms whose bunches are supplied to industrial mills for processing. In the late 1970s the government of Cameroon began to develop the smallholders' oil palm sector with funding assistance from the World Bank under the control of FONADER (National Fund for Agriculture and Rural Development) (Bakoumé et al., 2002). This scheme was in charge of supplying the necessary funds to agro-industries which were in turn responsible for the supply of the necessary in-kind resources and technical expertise to the settlers who were eligible to join the nucleus estate and smallholder scheme (NESS). Smallholders involved in the scheme were supposed to supply all their harvested FFB to the company's mill in order to pay back their credit. The size of holdings ranged from 2 to 5 ha. By then, artisanal milling was virtually unknown in the surroundings of these companies. With the collapse of Fonader in the early 1990s, smallholders started facing problems for the supply of FFB to agro-industrial companies such as Pamol, CDC or Socapalm.

First, smallholders who supplied their FFB to the companies were not paid regularly. Sometimes, they had to wait for 3 months or more to get paid. In the case of CDC, the Smallholders' Department that used to exist as a separate entity was merged with Estate Management under the control of the Estate Manager and this became a major obstacle to the smooth functioning of the Smallholders' Department. The transportation of harvested FFB from the smallholder's farm to the company's mill also experienced delays as the priority was given to the company's fruits. Smallholders at times had to wait for 2 to 3 days or even a week to ship their palm fruits, which were then downgraded at the mill. Even when smallholders tried to transport their FFB by their own means, they often had to face high transportation cost due to the poor state of the roads especially during the rainy season. Smallholders also complained about low FFB prices and they based their argument on the fact that the companies made use not only of the CPO, but also of the other by-products like kernel, fiber, empty fruit bunches and kernel oil. Stringent quality control measures put in place for FFB delivered at the mill were at the origin of supplementary discounts. After the collapse of Fonader in the 1990s, the supply of inputs, technical advice, and quality planting material came to an end. Such services were considered as the bond between smallholders and agro-industrial companies. Smallholders became increasingly reticent to pay back their loans through the supply of their FFB to the Company. This situation often generated conflicts between company officials and smallholders. Some smallholders considered the Project as a governmental subsidy to the poor farmers' population, something which did not need to be reimbursed. Such conflicts strained the existing relationship between smallholders and the major companies.

The fall in the market prices for cocoa and coffee, the economic crisis of the late 1980s and early 1990s and the devaluation of the Franc CFA fueled the diversion of farmers from main cash crops to the cultivation of oil palm (Ngando et al., 2011). This situation also gave rise to the development of independent smallholders, especially the "elites", who were richer newcomers able to develop large areas of plantations (Levang and Nkongho, 2012). The liberalization policy followed by the Government of Cameroon also meant that in due time, public companies were supposed to be privatized and as such the subsidies they used to tap from the Government, which enabled them to cater for smallholders were drying out.

The new generation of small- and medium-holders which appeared in the 1990s and which was not always located in the vicinity of industrial mills had to look for means of processing their own FFB production. The first generation of dependent oil palm smallholders was also fed up with the management system put in place by the companies, so they decided to process their own FFB given that the demand of red palm oil in the local market was rapidly increasing. Within two decades, the number of artisanal palm oil mills grew tremendously and the supply of FFB to the major companies decreased accordingly.

Officials in the Ministry of Agriculture and Rural Development consider artisanal milling as a huge waste because of its low extraction efficiency compared to industrial mills. Agro-industrial companies must temporarily close down their mills during the low production season due to the absence of FFB from smallholders, which usually complement FFB from the estate. Last but not least, such companies consider that a large proportion of the FFB processed in artisanal mills is stolen from their estates. Thus, plantation companies regularly ask the Government to close down artisanal mills, at least those which are close to estates. This did not happen, as the number of artisanal mills is still on the rise.

The overall objective of the present study is to assess the profitability of the processing and marketing of red palm oil. Our specific objectives were basically:

i. To identify the different types of people involved in artisanal milling; the production efficiency of the various types of artisanal mills, the quality control measures put in place during processing of FFB;

Table 1. Distribution of respondents by type of service provider and users.

Type of service provider/users	Frequency of service providers/users in:				Total
	Eseka	Dibombari	Muyuka	Lobe	
Millers	33	41	23	34	131
Smallholders	11	05	19	13	48
Intermediaries	06	04	08	03	21
Total	50	50	50	50	200

* Note: 95% of millers also own oil palm plantations.

ii. To assess the return to labor, milling charges and contribution to income for each type of palm oil processor;
iii. To identify processors involved in the sale of red palm oil in the domestic markets; describe the market chains - artisanal or informal (wholesalers and retailers);
iv. To describe fluctuations in the price of red palm oil in the local market over the years;
v. To assess the financial contribution from the sale of red palm oil to household livelihood as well as problems hindering the smooth functioning of the sector.

The major underlying question was: Why do oil palm smallholders prefer to mill their FFB irrespective of the low extraction rates of these artisanal mills?

METHODOLOGY

A preliminary survey resulted in the selection of four oil palm production basins. This choice was based on the long-standing relationship between oil palm producers and agro-industrial Companies in basins such as Eseka, Dibombari, Muyuka and Lobe. Each basin is located close to an industrial mill belonging to one of the following companies: Eseka- Socapalm; Dibombari- Socapalm; Muyuka- CDC and Lobe- Pamol (Table 1).

As a first step, information about the distribution and abundance of the different types of artisanal palm oil mills was obtained from the Department of Agriculture at the local level, oil palm smallholders and employees of the nearby agro-industries. Then a randomized sample of the different types of artisanal mills in each zone was selected. A total of 131 artisanal mills were sampled with the submission of 200 semi-structured questionnaires during the peak season of oil palm production, which falls within the months of February to June.

Three types of service providers were identified in the course of the survey, namely: mill owners, mill managers and mill workers. Information concerning the functioning of the mill was obtained from either the mill owner who personally supervised the mill or the mill manager when the owner was absent. Out of the 131 sampled millers, 125 were processing FFB from either their own farms or through the purchase of FFB from other smallholders in addition to the utilization of their mill for commercial purpose.

The survey also identified two types of mill users, namely oil palm smallholders and middlemen. A total of 48 of the sampled users were oil palm smallholders who did not own artisanal mills but brought their FFB to the mill for processing. A total of 21 users were middlemen who did not own oil palm plantations but were buying FFB from smallholders for processing in an artisanal mill.

RESULTS

Type of service providers (millers) and users

The respondents under study were categorized into oil palm processors, namely mill owners and mill managers; and users, that is, smallholders and middlemen. Mill owners own and manage their own palm oil mill, while mill managers are employed by the proprietor of the mill to manage and supervise the various activities in the mill. Smallholder users are those who carry their own FFB to the mill, pay for milling and labor charges and return with the palm oil. Middlemen do not own oil palm plantations, they buy FFB from smallholders, organize transportation to the mill, pay for the milling and labor charges, and return with the palm oil.

Our survey revealed that 95% of mill owners and mill managers do own plantations. The primary reason for them to buy a mill was basically to mill the FFB from their plantation in order to get more income from the sale of red palm oil, before using the mill for commercial purpose. Smallholders who did not own artisanal mills harvested and processed FFB in a commercial artisanal mill. Women and young people constitute the major part of the middlemen: they buy FFB and process it in an artisanal mill. If compared to oil palm smallholders, middlemen were relatively scarce in the sampled mills because most smallholders preferred to mill their FFB because of added value.

We found that artisanal milling was a major source of income for the different service providers/processors. Other sources of income for the sampled respondents included farming of other cash crops/food crops, as well as off-farm activities.

Identification of service providers and mill users

The personal information for the service providers and users is shown in Table 2. With regards to gender repartition, more men were involved in artisanal milling than women and young people, probably because men have customary rights to land and are able to plant and harvest directly from their farms during peak and low season while women and young people must purchase

Table 2. Personal information from respondents in the four zones under study.

Personal information	Mill owner	Mill manager	Smallholder (user)	Intermediary (user)	Total
Household head	52	47	33	09	141
Non-household head	11	21	15	12	59
Gender					
Male	55	60	41	13	169
Female	08	08	07	08	31
Average age	47	41	39	34	40
Ethnic group					
Native	26	21	24	07	78
Non-native	37	47	24	14	122
Level of education					
Primary	25	25	18	09	77
Junior high school	25	20	17	05	67
High school	10	12	09	04	35
University	03	11	04	03	21
Marital status					
Married	52	47	34	11	144
Single	08	20	11	08	47
Widow(er)	02	01	02	02	07
Divorced	01	0	01	0	02

FFB. Mill owners are older on average, while middlemen are younger, thus revealing that more young people and young women are involved in the activity.

More non-natives were involved in the activity, thus indicating that they need to stabilize their income levels especially when they are still to get fully integrated in their new community. The survey also reveals that more mill managers as compared to the other categories were university graduates and they were able to use this activity to generate income to register for public examinations or to continue their studies. More married persons were involved in artisanal milling as compared to singles. While the husband was involved in the processing of FFB, the wife was involved in the marketing of the palm oil.

Types of artisanal palm oil mills in the sampled zones

The study identified six different types of artisanal palm oil mills in the selected zones. These are: i) manual vertical press; ii) digester with separate manual metallic cage press (hand-operated screw press); iii) motorized horizontal screw press; iv) digester with separate hydraulic press; v) combined motorized digester/hydraulic press system (digester screw press) and vi) semi-automated press.

The Manual press is locally called tournée tournée (manual vertical press): This press adopts the wet process during which the sterilized fruits are poured into the digester and the fruits are macerated by manually turning the vertical shaft to extract a mixture of oil and water which is collected at the base. The resulting mixture of water and oil is poured into larger drums. This mixture is then clarified to extract red palm oil.

Manual or hand press with a digester adapted to a car engine [digester with separate metallic cage press (hand operated screw press)]; this press follows the dry process. A vertical digester adapted to a car engine is used in the maceration process. A mixture of oil, moisture, fibers and nuts is collected at the base and this mixture is hand-pressed in a metallic cage to extract the oil.

Motorized press (motorized horizontal screw press); this press follows the wet process during which sterilized fruits are poured into the digester and the fruits are macerated. Hot water is continuously poured into the digester at a regular rate in order to wash off the released oil. The resultant mixture of water and oil is poured into larger drums. This mixture is then clarified to extract red palm oil.

Digester with separate hydraulic press; this press adopts the dry process technique where by sterilized fruits are poured into the digester and the fruits are macerated. A mixture of oil, moisture, fibers and nuts is collected at the base and this mixture is pressed using a hydraulic press to extract the oil.

Combined motorized digester/hydraulic press system

Table 3. Type of artisanal mills utilized by sampled respondent.

Type of processing equipment	Frequency of equipment used by respondents				Distribution of types of presses in the four study areas
	Eseka	Dibombari	Muyuka	Lobe	
Manual vertical press	26	20	3	0	49
Digester with separate manual cage press	0	2	0	26	28
Motorised horizontal screw press	7	16	15	0	38
Digester with separate hydraulic press	0	0	3	5	8
Combined motorised digester/ hydraulic press	0	1	0	4	5
Semi-automated press	0	1	1	1	3
Total	33	40	22	36	131

(digester screw press); this press also adopts the dry process technique. In this press, the digester is linked to the press through an operating table. Here digestion and pressing take place simultaneously powered with an engine. Semi-automated press; this press also adopts the dry press technique. Here little or no human labor is needed as most of the processing stages (boiling, digestion, and clarification) are mechanized. This system is the most efficient and the most expensive one which makes it unaffordable to the majority of small-scale millers.

Depending on the zone, it was common to find respondents who were linked to specific artisanal mills for reasons partly linked to availability and production efficiency. Table 3 shows the utilization of the different artisanal palm oil mills by sampled respondents in the four areas under study.

Motorized horizontal screw presses were preferred in all four zones, followed by manual vertical press while semi-automated palm oil press was rarely used. As opposed to the other artisanal palm oil presses, which were mostly used for commercial purpose, the manual vertical press was mostly bought for home use. The cost of a given type of artisanal mill depends on the complexity and extraction efficiency of the mill. Taking the exchange rate at 1 USD = 500 FCFA, the manual vertical mill was the cheapest one in terms of cost with an average of 150,000-250,000 FCFA (300 to 500 USD), the most expensive artisanal mill was the semi-automated with an average price of 15 to 20 million FCFA (30,000 to 40,000 USD), while the others ranged in price from 2 to 5 million FCFA (4000 to 10,000 USD). The durability of the palm oil press depends on whether it was purchased as new or second hand. The maximum intake capacity of the sampled mills was 1 ton FFB per hour in the semi-automated mills.

Various steps of FFB processing

Pickup cars are used to transport FFB from the plantation to the mill, while motorbikes equipped with special bags carry loose fruits, or even FFB where roads are not passable by cars. When bunches arrive at the artisanal mill, they are stored in separated piles for each farmer and are covered with jute bags or palm leaves and left to ferment for almost one week. Depending on the work plan of the mill manager, FFB could either be chopped/splitted into halves with a machete before being allowed to ferment. After 7 days, the fruits from fermented bunches can easily get detached from spikelets. The next operation is the stripping of whole or chopped bunches with the use of the blunt edge of a cutlass. The sieving of loose nuts separates the nuts from the dirt with the use of a locally fabricated wire mesh. As compared to the chopping/splitting, stripping operations which are considered as operations for men only, the selection of loose nuts is mostly done by women. The loose fruits are then poured into 200 L (or bigger) metallic drums for boiling. The required amount of water is put in the drum, and a fire is lighted underneath.

The mixture is allowed to boil for around 4 to 6 h. Boiling the loose nuts before digestion plays an important role to soften the nuts, inactivate lipase enzymes and coagulate proteins (Babatunde et al., 2003; Chow and Ma, 2007). When the boiled nuts are ready, digestion can start. Digestion is the process by which the boiled or sterilized fruits are macerated for easy separation of oil from fibers. This operation utilizes the palm oil press from the manual mill to the more sophisticated semi-automated press. Jannot (2000) distinguished between two types of digestion. Indeed, in the continuous type, oil mixed with water and sludge are collected at one outlet while the chaff comes out through another. In the discontinuous type, after digesting the boiled fruits, the mash can further be pressed using the same machine or a separate one in order to extract red palm oil. The last operation is clarification, which involves the boiling of a mixture of sludge and effluent with the addition of the required quantity of water for a period of 2 to 3 h. At the end of this operation, the red palm oil is left suspending

Table 4. Extraction efficiency of the different types of palm oil presses.

Efficiency parameter (in peak season)	Type of presses (ranked from least to most efficient)					
	Manual vertical press	Digester with manual metallic cage press	Motorised horizontal screw press	Digester with separate hydraulic press	Combined motorised digester/ hydraulic press	Semi-automated press
Average quantity (in L) of CPO/ton of FFB	148.86	156.94	163.55	166.22	167.77	200.00
Average quantity (in kg) per ton of FFB	133.98	141.25	147.2	149.6	151	180.00
Extraction efficiency (%)	13.3%	14.1%	14.7%	14.9%	15.1%	18.0%

on the top of a mixture of water and effluent. The red palm oil is then skimmed off and placed into gallons of various sizes and allowed to cool before being corked.

Estimation of extraction rates from the different types of palm oil presses

Extraction efficiency refers to the time it takes to press a given quantity of loose nuts, as well as the quantity of red palm oil produced at the end of the milling process. Based on the different types of palm oil mills identified during the present study, the semi-automated mill was ranked first with the highest extraction efficiency reaching an average 18%, while the manual vertical press had the lowest extraction efficiency with an average 13.3% during peak season as shown on Table 4. On average there was a 0.7% reduction in the quantity of palm oil produced at low season when compared to the peak one. Reasons for this reduction could be linked to poor fruit set during low season of oil palm production. The peak season falls within the months February to May. The low season falls within the months June to September, it is a period during which oil palm registers a drop in production. The mid-season falls within the months October to January, with a production in between the two former ones. These production seasons are directly linked to the extended periods of drought observed in the course of the year.

Type of labor utilized and comparative duration of milling operations for peak and low season

In Dibombari, Muyuka and Lobe, majority of the sampled respondents utilized hired labor to process FFB, while few respondents used both hired and family labor. Only in Eseka, the sampled respondents employed either family or hired labor, depending on the quantity of FFB to process and the availability of labor, or in most instances a combination of both family and hired labor. This can be due to the dominance of manual mills for household use in Eseka. Similarly to the case of smallholder oil palm plantations, labor in the artisanal mills is dominated by non-natives (migrant workers). The type of operations performed in the mills (from chopping/splitting, stripping, sieving/selection, boiling, to digestion and clarification) requires physical strength and is often provided by young men aged 18 to 45. It is rare to find women working in the artisanal mills, and even when they do so; their work is limited to the sieving/selection of loose nuts or to office work in larger mills.

The labor time and working days are stepped up during peak production season due to an increase in the number of bunches entering the mill as compared to during the low production season. The peak season for oil palm production in Cameroon falls within the months of February to May, the low season falls within the months of June to September, while the mid-season falls within the months of October to January. These seasonal differences in the production of oil palm also have an effect on the quantity of work available in these artisanal mills at each given season, and this is one of the reasons why artisanal mills tend to recruit temporary workers, with payment based on the quantity of FFB processed (Nchanji et al., 2013).

Profitability of FFB processing to millers and users

The processing of FFB into red palm oil provides

Table 5. Seasonal changes in average cost/net income (in FCFA) for processing one ton of FFB.

Variables	Eseka		Dibombari		Muyuka		Lobe	
	Peak	Low	Peak	Low	Peak	Low	Peak	Low
Cost of 1 ton FFB	40,000	45,000	42,000	50,000	41,310	47,405	36,875	40,800
Transportation	11,347	11,347	11,624	11,624	8,735	8,735	12,237	12,237
Labour charge	8,845	8,435	9,723	9,723	6,392	6,392	7,868	7,868
Milling charge	7,139	7,139	5,376	5,376	5,592	5,592	3,726	3,726
Total expenditure	67,331	70,923	68,723	76,723	62,029	68,124	60,706	64,631
Palm oil price FCFA/L	400.2	543.8	498.2	669.7	513.6	658.8	399.2	505.7
Red oil produced in L /ton FFB	145.3	140	172.8	158.3	186	163.6	165.9	153.6
Gross income	58,150	76,131	86,090	106,018	95,526	107,787	66,225	77,675
Net income	-9,181	+5,200	+17,367	+29,295	+33,497	+39,663	+5,519	+13,044

income to the mill owner through the payment of milling charge, and to the mill workers through the payment of labor charge. In all four zones under study, artisanal milling was a major source of income for the respondents especially during the peak season because of an upsurge in the number of bunches to process. During the peak season when the supply of FFB is high, it is easy for a middleman to buy bunches and process, as compared to during the mid-peak and low season when there is a drop in production. This drop in production is inversely proportional to an increase in the demand of red palm oil. Table 5 provides data on costs and benefits incurred in the processing of one ton of FFB according to the season.

The purchase and milling of FFB gives a net positive income to middlemen in all studied zones except for Eseka in which a negative balance can occur during peak season. In all other areas, even women and youths who do not own oil palm plantations can make a positive turn over when they buy and process FFB. One ton of FFB is able to produce slightly more palm oil after milling during the peak production season as compared to during the low production season. However, this increase in production is counterbalanced by the lower price of palm oil during peak production. The four factors which impact the financial output of artisanal palm oil milling are: i) the cost of production, ii) the price paid for one liter of red palm oil (depending on the season), iii) the cost of transportation to major markets and iv) the extraction efficiency of the artisanal mill.

Why do smallholders prefer to mill FFB by themselves?

Even though the milling efficiency of artisanal mills is lower, smallholders make more money through self-milling than selling FFB to the agro-industrial companies. Oil palm smallholders also say that they make good use on some of the by-products released in the course of processing. For example, kernels and fibers are utilized as fuel for the boiling of loose nuts and during clarification, as such very little is spent for the purchase of fuel wood.

The purchase price of a ton of FFB by the three agro-industrial companies in Cameroon: Socapalm, CDC and Pamol is 48,000 FCFA, 50,000 FCFA and 42,000 FCFA respectively and this price is constant during peak and low season. Any change in the price of crude palm oil in the global market has no incidence on the price paid to smallholders for FFB. From Table 6, it is clear that artisanal milling is most profitable to oil palm smallholders

in the Dibombari and Muyuka zones during both low and peak season. The situation is quite different for oil palm smallholders in the Eseka and Lobe zones where artisanal milling is only profitable during the low season. As compared to Dibombari and Muyuka areas which benefit from the presence of a large local market for the sale of red palm oil, Eseka and Lobe are more isolated and buyers have to travel for longer distances from the towns and cities. Poor state of roads has also a negative impact on the price of red palm oil especially during the peak season when supply outweighs demand. Results from Table 6 also show that artisanal milling is profitable to oil palm smallholders without mills in Eseka and Lobe only during the low season. When there is a fall in the

Table 6. Comparative net income of a smallholder from the sale of red palm oil or FFB.

For 1 ton of FFB	Eseka		Dibombari		Muyuka		Lobe	
	Peak	Low	Peak	Low	Peak	Low	Peak	Low
Sold to an intermediary	40,000	45,000	42,000	50,000	41,310	47,405	36,875	40,800
Sold to an agro-industry	48,000	48,000	48,000	48,000	50,000	50,000	42,000	42,000
Processed in an artisanal mill	30,819	50,200	59,367	79,295	74,807	87,068	42,394	53,844
Processed in own mill	37,958	57,339	64,743	84,671	80,399	92,660	46,120	57,570

Table 7. Average wholesale price of palm oil sold in artisanal mills in FCFA/Liter.

Zone	Size of container	2009		2010		2011		2012	
		Peak	Low	Peak	Low	Peak	Low	Peak	Low
Eseka	22 L	242	281	281	343	356	474	400	544
Dibombari	20 L	488	564	523	585	541	614	498	670
Muyuka	77.4 L	384	521	506	674	522	658	514	659
Lobe	118 L	295	338	329	372	369	420	399	506

price of red palm oil during peak production season, especially in zones where they cannot break even, it is advisable for oil palm smallholders to supply their FFB to the agro-industrial mills. When there is an increase in the price of red palm oil, it is advisable for oil palm smallholders to mill their FFB in artisanal mills.

Marketing of red palm oil

The wholesale and retailing of red palm oil is a major source of income especially to the female population. Red palm oil is sold right at the premises of the palm oil mill, where it is common to find men and women alike coming to buy this product. When palm oil is purchased at the doorstep of artisanal mills; it is then transported to the villages, nearby towns or city markets where it can either be wholesaled or retailed. Soap production and palm oil refining companies like AZUR and MAYOR, based in Douala have their agents in the field who buy palm oil directly from the artisanal mills in large quantities and transport it to factories using big tankers. Red palm oil is also purchased and transported to the northern part of Cameroon where oil palm is not cultivated due to unfavorable climatic conditions. It is also sold to neighboring countries like Nigeria, Equatorial Guinea, Gabon, Congo, Central African Rep. and Chad.

There has also been a steady increase in the wholesale and retail price for red palm oil over the years, and this can be attributed to both the increase in population and the increase in the utilization of palm oil especially by downstream industries as shown in Table 7.

Palm oil is sold in wholesale at artisanal mills while in villages, towns and city markets, it is sold either in wholesale or at retail prices. There are periods in the year (especially during low production season) when the price of a liter of red palm oil can reach 1,000 to 1,300 FCFA especially in large cities like Yaoundé and Douala. In towns like Buea, Limbe, and Kumba; the retail price for a liter of palm oil during low season can reach 800 to 900 FCFA. Meanwhile, during peak production season, the price for a liter of red palm oil can fall down to 400 to 500 FCFA.

DISCUSSION

The profitability of artisanal milling

Artisanal milling generates income to people from all social classes, age groups and it is not gender biased in the sense that even women who do not have customary rights to own land (with the exception of Eseka) can buy fresh fruit bunches, process them in the artisanal mills, sell the resulting red palm oil and make a meaningful profit (Ibeckwe, 2008; Olagunju, 2008). According to Soyebo et al. (2005) and Ezealaji (2011), women make more profit when they buy FFB, process and sell the resulting palm oil than if they just buy and sell red palm oil alone. Women are disadvantaged by the lack of necessary capital, limited access to extension services and lack of land ownership. Since most women fall in the category of middlemen, they often have to face the problem of the unavailability of FFB during the low season, since most smallholders will not want to sell their FFB because of price increase in the processing and sale of red palm oil.

Indeed, one of the ways to adapt to this situation is to process and store red palm oil during the peak season and wait for the low season, in order to sell it when the

Table 8. Additional profit for smallholders when FFB is processed in artisanal mills.

Fate of FFB	Eseka		Dibombari		Muyuka		Lobe	
	Peak	Low	Peak	Low	Peak	Low	Peak	Low
Processed in an artisanal mill	30,819	50,200	59,367	79,295	74,807	87,068	42,394	53,844
Sold to agro-industry	48,000	48,000	48,000	48,000	50,000	50,000	42,000	42,000
Additional profit from artisanal milling	-35.8%	4.6%	23.7%	65.2%	49.6%	74%	0.9%	28.2%

price is better. Some middlemen also rent mature oil palm plantations for the purpose of harvesting and processing FFB. The young men who work in these artisanal mills also benefit from the milling activity and this is an efficient way to reduce rural exodus and juvenile delinquency. Taiwo et al. (1999) and Ekine et al. (2006) also describe the involvement of men in high-energy demanding jobs, while more women accept less strenuous jobs, while Solomon and Okolo (2008) refer to the oil palm as a “male crop”. The smallholders are also able to make additional profit from the processing of FFB, compared to the sale of bunches directly to the agro-industrial mills, especially during the low season when the price of red palm oil is on the rise as shown in Table 8.

Artisanal milling was quite profitable in three of the four zones under study, for both peak and low season with the exception of Eseka which recorded a deficit at peak season. Dibombari and Muyuka zones recorded the highest profit from artisanal milling at low season. Such variation in profit between different zones could be linked to the cost of production, the existing market for palm oil, the extraction efficiency of the mill and the cost of transportation. When oil palm smallholders cannot make a profit from the processing of their FFB, it is advisable for them to supply their FFB to the agro-industry.

The mill owners are not left behind as they also benefit from milling charges paid by smallholders and middlemen alike who come to mill their FFB. All these advantages of artisanal milling are linked to the presence of a domestic and sub-regional market for red palm oil, despite the fluctuation in price depending on the season of production.

The shortcomings of artisanal milling

The quality of red palm oil processed in these artisanal mills has often raised a lot of questions. Previous studies reveal an increase in free fatty acid, moisture content and dirt on red palm oil when stringent quality control procedures are not put in place and this reduces the “shelf life” of red palm oil which can easily get rancid. Corley and Tinker l. (2003), Owolarafe et al. (2008) and Ngando et al. (2011) reported on the increase of free fatty acid concentration during the fermentation of fresh fruit bunches and Poku (2002) recommends the processing of FFB at 48 h after harvesting at the latest. The capacity and extraction rates of artisanal mills are much lower with an average of 14% (Cheyns and Rafflegeau, 2005) and thus they cannot compete with industrial mills, which are providing extraction rates of 23% and more and have higher milling capacity.

The dilapidated nature of some of the mills makes milling not sustainable because of frequent breakdowns, coupled with the recruitment of untrained personnel to manage the mills as reported by Akangbe et al. (2011) and Ibitoye et al. (2011). Okonkwo (2011) highlighted the need for mill personnel to receive training in order to ensure food safety and product quality. Another concern is the unhygienic conditions in which the milling operations are performed and the uncontrolled disposal of waste generated by such mills. Finally, from the marketers’ point of view, the red oil is subject to price fluctuation and high cost of transportation depending on the season of production (Ekine et al., 2006).

Different types of by-products are produced by the processing of fresh fruit bunches into red palm oil. These by-products are: empty fruit bunches, empty kernels, kernel cake, fibers and sludge. Such by-products are now increasingly recycled in industrial mills and they pose a threat to the environment when disposed of in an uncontrolled manner. For example, empty fruit bunches could be recycled to the field as a source of organic mulch or composted. Palm kernel can be used as a source of energy and the kernel cake could be a source of animal feed. Fibers are another important source of energy when used as fuel and palm oil mill effluent could also be an important source of organic manure, but when disposed of carelessly into nearby streams, it could be a source of pollution, a breeding ground for mosquitoes and unpleasant smell.

Agro-industrial companies want to get rid of artisanal mills

Plantation companies consider artisanal milling as detrimental to their business. Indeed, in many occasions they have asked the Government to forbid artisanal milling because they suspect the rampant theft of fresh fruit bunches in their plantations to be the result of artisanal milling. Companies consider that peripheral plantations are the most affected because of theft. The

theft of fresh fruit bunches from agro-industrial plantations occurs mostly at night and results not only in the loss of bunches from affected palm trees but also to unsustainable harvesting, as live fronds are often destroyed in order to easily cut the peduncle of the bunch with a machete.

The local population complains that the company does not provide jobs and that they were expelled from land belonging to their fore-fathers. Thus, stealing and processing from the company is merely considered as compensation. The price of red palm oil produced by artisanal mills is not submitted to any regulation by the government, while the price of crude palm oil produced by agro-industries is presently fixed at 450 FCFA/ Liter to avoid the closure of downstream industries. When asked to increase FFB buying prices, company managers respond that because of the fixed CPO price they would go bankrupt. As an adaptive response to the increase of theft of FFB in agro-industrial plantations, the companies have hired the services of security officials/guards to carry out regular patrols on their plantation with eminent court action on defaulters.

The transportation of palm oil in areas where these agro-industries are located is subject to strict control by security officials/guards in order to ascertain the source of the palm oil. In the worst cases, the company decides the replacement of oil palm with other crops like banana and rubber in peripheral plantations which face high levels of theft as noticed in CDC Mondoni palms and Socapalm Nkappa.

Which way forward?

One of the possible ways forward would be for oil palm smallholders/artisanal millers to group themselves into cooperatives in order to increase their bargaining power (Jelsma et al., 2009; Ibitoye et al., 2011). At present, smallholders process and sell the red palm oil individually without a common price at a particular season of production. They are not informed about improved sustainable processing methods, market strategies or market information systems. There is also a need to improve on the extraction rates and quality control procedures of artisanal mills (Badmus, 1991). Partnerships between smallholders and agro-industrial companies should be facilitated by the Government, especially with the recent interest shown by foreign oil palm companies to develop plantations in Cameroon (Levang and Nkongho, 2012; Hoyle and Levang, 2012; Nkongho et al., 2014).

The round table on sustainable palm oil (RSPO) emphasizes the need for the certification of independent oil palm smallholders under group certification and the certification of scheme oil palm smallholders through the agro-industries in which they are in partnership. Group certification of independent oil palm smallholders and their respective artisanal mills will involve the grouping of these smallholders/artisanal millers into cooperatives and the training of both smallholders and artisanal millers on the principles and criteria of RSPO. Smallholders would gain knowledge on the identification and delimitation of high conservation value forest (HCVF), primary forest and peat land, etc. Techniques that minimize soil erosion would be adopted where appropriate. These include practices such as ground cover management, biomass recycling, terracing, and natural regeneration or restoration; knowledge on best management practices such as integrated pest management (IPM) (incorporating cultural, biological, mechanical and physical methods to minimize the use of chemicals), the health and safety of plantation workers, updated and efficient fertilization, as well as farm record keeping.

At the level of artisanal mills, workers should receive training on safety and product quality, as well as ways of disposing solid and liquid waste with little effect on the soil and water ways, amongst others. A water management plan should be put in place and this should take account of the efficiency of use and renewability of sources, ensuring that the use and management of water during milling operations does not result in adverse impacts on other users within the catchment area. The treatment of palm oil mill effluent (POME) to required levels and regular monitoring of discharge quality especially biochemical oxygen demand (BOD), should be in compliance with national regulation. The adherence to RSPO certification and others would also open new doors for funding and market opportunities (RSPO, 2013).

Conclusion

Our study identified six different types of artisanal mills commonly used in the four study zones. In terms of milling efficiency semi-automated mills showed the best milling efficiency, with the poorest performance coming from manual presses. Different categories of millers and users were identified, namely mill owners, mill managers, oil palm smallholders, and middlemen. All categories were able to make a sizeable profit from their activity in the processing and marketing of red palm oil. Oil palm smallholders were found to mill part of their FFB and sell part of it to agro-industrial companies depending on the size of their farms and the season of production, while middlemen were able to mill and store red palm oil until the selling price became more profitable.

Nevertheless, artisanal milling has its own setbacks. These include low extraction efficiency, old, unsafe and dilapidated mills, the absence of quality control procedures, fluctuations in the price of red palm oil for those involved in marketing and the worrying increase in theft of bunches from agro-industrial plantations. Our study finally highlights a need for improvement in the

extraction efficiency and quality control measures in these mills, the need for millers and marketers to group themselves into cooperatives, and the need for developing partnerships between oil palm smallholders and agro-industries.

Conflict of Interests

The authors have not declared any conflict of interests.

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