Role of small-scale enterprises in agricultural development agendas: Insights from oil palm processing enterprises in the Kwaebibirem District of Ghana

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ABSTRACT

Small-scale oil palm processing enterprises are important avenues of rural employment and livelihoods, but often receive little attention at the policy level. These enterprises are usually characterized as having 'poorly maintained structures', 'very inefficient operations', 'outside the formal economy' and production of 'low quality palm oil'. This article investigates the innovation capacity of small-scale oil palm processing enterprises and their relevance for the development of the oil palm industry in Ghana. The article uses a bottom-up innovation approach through a joint experimentation and profitability analysis, together with a researcher-managed experiment, to help processors learn how to produce quality palm oil and analyse different market options. Findings indicate that, the small-scale processors are capable of experimenting to acquire the knowledge and innovation needed to support agricultural development. The way to go, therefore, is not to 'exclude' these enterprises from the development blueprint, but to assist them build capacity through a bottom-up innovation approach, which integrates science and practice, as well as multi-stakeholders.

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Introduction

Agricultural policies on what scales of production to invest in for development tends to be top-down (Ellis & Biggs, 2001). Small-scale enterprises at the grassroots are usually not featured as components of the agenda (Lisa, 1999), and they are often overlooked in development policies (Arnold *et al.,* 1987; Lanjouw & Lanjouw, 2001).

The small-scale processing of oil palm fruits is a major livelihood activity and source of economic value for many women and young men in rural areas (Carrère, 2010; Khatib & Sisak, 2014; Opoku & Asante, 2008). The palm oil produced is sold as edible oil and provides non-farm incomes to women, who use it to make local soaps for sale (Angelucci, 2013). In Ghana, the oil palm industry has been targeted as a key sector for enhancing agricultural growth and rural development (GoG, 2003; MOFA, 2011). Initiatives geared towards achieving the growth agenda have given little attention to the small-scale enterprises (Angelucci, 2013; Ofosu-Budu & Sarpong, 2013). For instance, the oil palm development master plan (MASDAR, 2010), a blueprint, which outlines the strategies of the oil palm industry for 2010-2025 emphasises 'international best practices and promotion of large-scale mills to meet the increasing demand for higher quality palm oil'. The plan sees the small-scale enterprises as 'ramshackle', 'poorly maintained structures', 'very inefficient operations' and production of 'low quality palm oil' (MASDAR, 2010). But are small-scale oil palm processing enterprises incapable of innovating?; Are they of no relevance at all to the oil palm value chain?; And should they be overlooked in the current development agenda? The article provides insights on these questions, from a case study on small-scale palm oil production in the Kwaebibirem District of Ghana.

Literature review:*Ghana's oil palm industry*

Palm oil production in Ghana

Although oil palm (*Elaesis guineensis*) is native to West Africa, most producer nations (except Ivory Coast) are net importers of palm oil. The whole of Africa's total production of crude palm oil (CPO) is estimated to be 4–6 percent of world production (GoG/MoFA, 2010). While Ghana's share of total Africa's production, is only about 6 percent (approximately 0.4 percent of the world's production). In 2014, Ghana produced 495,000 metric tonnes MT, consumed 760,000 MT, imported 300,000 MT, and exported 35,000 MT, which represents an annual growth rate of 27.08 percent (Index Mundi, 2014). The projections for industrial quality palm oil production (2010 – 2025) suggest there will be only a modest increase in production if the current trend continues without any sustainable intervention in the industry. In addition to this, domestic consumption will increase drastically within the same period (MASDAR, 2010). There is, thus, an opportunity to explore this demand by developing the oil palm industry. An increase in the production of high quality palm oil (particularly from the small-scale mills) could be a solution to reduce the huge importation and also provide opportunity for economic growth in rural areas, through job creation.

There are three main scales for the production of palm oil. These are the small- (traditional and artisanal), medium and large scale. Women constitute 80 percent of small-scale oil palm processors. These women usually access the services of semi-automated artisanal (*Kramer*) mills largely operated by men. These processors buy fresh fruit oil palm bunches from small-scale farmers who cultivate 87 percent of land and produce 80 percent of the bunches in the industry (MOFA, 2011). Small-scale processing capacity is from 3 to 8 tonnes fresh fruit bunches/day with an extraction rate of 9−11 percent (MoFA, 2011). The small-scale operations produce 80 percent of Ghana's crude palm oil (CPO), but this is of poor quality mainly due to presence of high free fatty acids (FFA) (Angelucci, 2013). Few processors produce slightly better quality palm (locally called *Zoomi*) for home consumption, while the majority make ordinary crude palm oil, which is sold to the 'local' soap processors, Togolese and Nigerian informal markets (Osei-Amponsah & Visser, 2016). This article focuses on the production of ordinary crude palm oil at the small-scale level.

The medium and large-scale producers together with their smallholder and outgrower schemes cultivate 13 percent of the total area under oil palm production. The large-scale plantations are mostly owned by private foreign investors and the government of Ghana (World Bank, 2011). The large and medium-scale plantations are linked to 15−60 tonnes/hour capacity processing and refinery facilities with palm oil extraction rates of 18−21.5 percent (MoFA, 2011). Processing of fresh fruit bunches is highly mechanised, and the crude palm oil is of high industrial quality (low free fatty acid levels). It is refined into other products, exported and/or sold to domestic manufacturing companies.

Previous policy interventions and their effects in the oil palm industry

Oil palm processing started in Ghana around the 16th century (Henderson & Osborne, 2000), largely by households (Lynn, 1991). By the 19th and early 20^{th} century, plantations were established by the Dutch (Dickson, 1969), then British and other Europeans. Through an oil palm ordinance in 1913, rights were given to mill operators by the government to extract palm oil within the vicinity of the plantations. However, this plantation system failed, due to lack of a sustainable supply of oil palm fruits (La-Anyane, 1961; 1963). Then after independence there was another policy putting more emphasis on plantation systems (Ministry of Agriculture, 1990), which led to the creation of state farms. Again this failed, because engaging in state-owned farms did not prove economically viable at the time (Miracle & Seidman, 1968). During the second half of the 20th century there was an attempt to modernize processing activities but with little success (Kaniki, 1980). Then from 1977, government sought to promote medium to large plantations and processing plants through private corporations, foreign assisted government ventures, and joint public-private projects. Largely, the policy incentives of the 20th century centred on government for the acquisition of land for large and medium-scale oil palm plantation and processing mills. The policy interventions did not explicitly promote the production of palm oil by small-scale processors, and there were no specific gender-based strategies to address the needs of the large number of women involved in the industry at the village level.

At the start of the new millennium, the oil palm industry was identified by the government as having great potential to create jobs and reduce poverty. To offset the gap in demand and supply of palm oil, the President's Special Initiative (PSI) on oil palm managed by an inter-ministerial facilitation team was announced in 2002. This was an initiative to make the oil palm industry a key sector for sustained economic growth and development, particularly in rural areas (GoG, 2003; GoG, 2004). It was expected that the development of the new oil palm farms and efficient processing facilities would lead to employment creation (about 1.2 million farm operatives alone), foreign exchange generation (net inflow of about US$1.6 billion from CPO alone) and foreign direct investment flows (over US$4.0 billion). Again, this initiative did not have policy interventions for the already existing small-scale oil palm processing enterprise. The PSI did not survive and came to a halt by 2008 (Asante, 2012).

The current development policy is from the master plan study of the oil palm industry, launched by the Ministry of Food and Agriculture in 2012. It is expected to enhance Ghana's competitiveness in the palm oil export market and also to meet its domestic demand for manufacturing and household consumption (MASDAR, 2010). It recommends the establishment of a large plantation and processing mill with attached smallholder farmer schemes.

It is clear that past policies and interventions tried to enhance growth of the industry through large scale production (Asante, 2012; Miracle & Seidman, 1968), and 'fixing of development' (Li, 2007) for the small-scale enterprises (Kaniki, 1980), but with little success. The previous policy interventions, thus, created constraints of poor processing practices, low quality of product and lack of remunerative markets for the small-scale oil palm producers. The situation lead to a clear distinction between the large and small-scale producers, in terms of the quality and price of product, as well as types of market they access.

At the macroeconomic level of policy formulation, it may seem logical to kick out the 'inefficient' small-scale enterprises and channel all fruit bunches to the large scale mills with high quality palm oil and extraction rates. But, there is a high degree of embeddedness of palm oil production activities in rural areas that provide livelihoods for several actors in the value chain (Basiron, 2007; Ibitoye, Akinsorotan *et al.*, 2011; Ofosu-Budu & Sarpong, 2013; Osei-Amponsah & Visser, 2016; Rist *et al.*, 2010; Sargeant, 2001). Therefore, there is urgent need to address the 'inefficiencies' of the small-scale enterprises to make them viable to support livelihoods of many poor households. However, just coming up with technological fixes from only a top-down approach to address their challenges may not be effective. This is because the actors in this enterprise have their own 'science' and practices, which need to be understood alongside the introduction of new knowledge and technology (Barrow, 1992). Most importantly, as actors they are capable of applying their experiences and respond to change (Long, 2001; Osei-Amponsah & Visser, 2016).

Processing practices of small-scale palm oil enterprise

Small-scale oil palm fruit processing involves bunch quartering (cutting), fruit loosening and storing fruits before digestion. Generally, all the processing stages are done manually except the digestion or pounding of cooked fruits which is done by a diesel engine or electricity powered digester equipment (Fig. 1). In few cases oil extraction is also mechanized using a screw press. In contrast, large-scale processing is highly mechanized, involving steam sterilisation of fruit bunches within 48 h of arrival at the plant, followed by stripping of fruits, digestion and extraction, then clarification and drying of the palm oil. The time and way the fruits are processed after bunch harvest impacts on the quality of the palm oil produced (Hyman, 1990; Owolarafe *et al.,* 2008; Tan *et al.*, 2009).

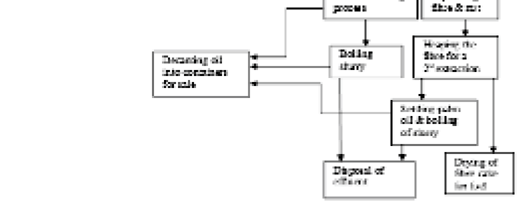

Fig. 1. A flow diagram of stages of small-scale oil palm processing
Source: Authors' own illustration

The quality of crude palm oil (CPO) is indicated by various attributes, and different end markets have different quality requirements. For household consumption, colour, smell and taste (mainly rancidity in scientific terms) are important, and affect price. Generally, household consumers buy *Zoomi* type of palm oil, which is less rancid. Rancidity is not a major determinant of price in the West African regional markets such as the Ghanaian, Nigerian and Togolese informal CPO market and that for 'local' soap manufacturing. On the other hand, price on the industrial and international markets is dictated by several quality parameters, but importantly, the free fatty acid (FFA) level. The lower the FFA, the better the quality and, thus, the higher the price. These unwanted free fatty acids are the same components that cause rancidity (Badmus, 1991). The FFA level is, therefore, an important quality parameter (Kardash & Tur'yan, 2005) in the selling of palm oil, with a maximum acceptable value of 5 percent (industrial and international) and low rancidity (household consumption) markets.

The FFA presence in CPO is primarily attributed to lipase activity in the oil palm fruit mesocarp. The lipase is activated through bruising in the course of harvesting, transporting and processing, and this leads to hydrolysis of triacylglycerol producing free fatty acids (Henderson & Osborne, 1991). The longer a bruised fruit stays unsterilized the longer the hydrolysis activity continues and, thus, the higher the FFA level (Ngando *et al.*, 2011; Tagoe *et al.*, 2012). Fresh fruit bunches (FFB) must, therefore, be processed rapidly after harvesting to avoid oil degradation through FFA formation. The initial sterilisation process at medium-and large-scale mills inactivates the lipase activity in the fruit. But, at the small-scale mills, FFB and spikelets are not sterilized until several days after harvesting when boiling is done. They are kept on the floor prior to loosening of fruits to enable fruits to detach more easily. Thereafter, the loosened fruits are still kept again for some time up to 21 days before they are cooked (Osei-Amponsah *et al.,* 2012). Zu *et al*., (2012) identified that the processing practice, which mostly affects CPO quality is duration of oil palm fruit storage.

It is necessary for small-scale processors to innovate their processing practices in a way that allows them to meet higher quality criteria of alternative markets. This article applies a bottom-up innovation approach as a way of jointly experimenting with key actors in the small-scale enterprise to generate knowledge they can identify with and use to improve on their practices.

Materials and methods

Bottom-up innovation approach

A bottom-up innovation approach is linked to the concept of user-led innovation and relates to the 'locus' of innovation generated by actors in a specific context (Von Hippel, 1988). Under this approach, the conceptualisation, implementation and interpretation of the research requires the integration of different levels of: scientific and local knowledge, social and natural sciences, and scientists and practitioners, through an iterative and adaptive process (Jiggins & Röling, 2000). This article adapts the approach by jointly planning the research, experimenting the cause-effect issues and analysing the information gathered with actors involved in small-scale oil palm enterprises.

In small-scale palm oil production, processors make use of their knowledge and capabilities (Osei-Amponsah *et al*., 2014). Whilst some of their practical know-how may be valid, other aspects may need challenging and improvement through testing and validation. For instance, processors think that storing loosened oil palm fruits for longer periods before processing leads to more yield of CPO (Nchanji *et al*., 2013; Osei-Amponsah *et al*., 2012). This seems to be at par with scientific knowledge about fruit formation and ripening which suggests that oil accumulation in the bunch is complete at the first sign of fruit abscission. This implies that once the ripening is completed, no more oil is formed in the fruits (Sambanthamurthi *et al*., 1998). Assuming both are pertinent observations, possible explanations could be that while no additional oil may be formed, the small-scale extraction process is made easier during post-harvest storage for the processor, or that the observation by the processors is not based on systematic testing. To enable processors innovate, it is necessary to understand what they and their mill workers know about fruit storage as a practice and to jointly test its effects through on-mill experimenting. This would allow blending of processors' practices, knowledge and experiences with scientific knowledge to help assess options for improving the quality of CPO.

Although there are studies on FFA in relation to CPO quality, most of them are centred on how quality varies with type of equipment and method of processing, and especially on quality deterioration with palm oil storage. The few studies that deal with fruit storage period and palm oil quality (Tagoe *et al.,* 2012; Zu *et al*., 2012) were done by researchers alone without any learning agenda for the small-scale processors to improve on their practices. This article makes the processors' learning central, and focuses on joint experimentation and researcher-managed experiment as learning activities. A researcher-managed trial is included to see if the outcome of the test with processors is replicated across equipment, and its results were discussed with the processors. To understand possible drivers of market choices made by processors and formal efficiencies of the enterprise, also assessed was the profitability of the production of palm oil through processing at different fruit storage periods.

The joint experimentation process

The joint experiment was conducted at a small-scale oil palm mill at Takrowase (Kwaebibirem District, Ghana) from 21st March to 8th

April 2011, as part of a 2-year research. Three processors, a mill owner, a caretaker, two mill workers, a scientist and a technician (both from the Oil Palm Research Institute), the extension officer in-charge of Takrowase, and the researcher participated in the experiment. Fresh fruit bunches (FFB) from 10-year old oil palm trees of the *Tenera* type were carted to the mill on the day of harvest. Two tonnes of bunches were weighed and divided into four sets of 500 kg each (around 45-50 bunches). Each of the 500 kg heaps was kept under a shed, separated with wooden bars and labelled 1, 2, 3, or 4 corresponding to four storage periods (3, 7, 14 and 21 days, respectively). The fruit storage period refers to the number of days between bunch harvest and processing of fruits. The experiment followed all the processing practices of the small-scale mills (Fig. 1).

A day after bunch harvest, each of the 500 kg FFB was quartered by skilled labour. The same day the fruits of the first heap (3 days storage period) were loosened. On the third day, fruits from this first heap were weighed and boiled for 2 h. The cooked fruits were then pounded and oil extracted using a separate digester and hand spindle press, respectively. Loosening of fruits for all the other bunches was completed on the 5th day and stored under their respective sheds. These fruits from the sheds (for periods of 7, 14 and 21 days) were processed in the same way as described above.

Volume and weight of extracted palm oil were recorded. Samples of the CPO were sent to the laboratory for FFA analysis and another set kept at room temperature for a sensory evaluation exercise. Joint cost calculations were recorded of transportation costs, processing fees, the prevailing market prices for FFB at the farm gate, palm oil at the mill, household CPO at national and industrial CPO at medium scale levels.

The researcher-managed experiment

A comparable but researcher-managed experiment was run parallel in three different mills, one each with a hydraulic press, a hand spindle press and a digester screw. For this experiment a total of 1,200 kg of oil palm fruit bunches was acquired from the 10-year old *Tenera* type trees and divided into three batches of 400 kg, and each sent to the different mills. The fruit bunches were divided into four equal sets of 100 kg each and its loosened fruits stored for either 3, 7, 14 or 21 days. Thus, a 3 × 4 factorial experiment was conducted with the main factors being three different types of oil extraction equipment (the hand spindle, hydraulic and digester screw presses) and four fruit storage periods (3, 7, 14 and 21 days after bunch harvest). The percentage of palm oil yield for each storage period was calculated as [100 × (palm oil weight/fruit weight)]. Three CPO samples each were collected from the oil extracted after each of the four storage period experiments, from the different mills for laboratory analyses.

Laboratory analysis

The FFA levels were determined using the titrimetric approach following the American Oil Chemists' Society's official methods and recommended practice Ca 5a-40 (AOCS, 1990), at the laboratory of the Nutrition and Food Science Department of University of Ghana, Legon.

Organoleptic assessment of crude palm oil quality

A sensory analysis descriptive test was conducted with 40 untrained panellists drawn from an oil palm actors' platform. Four different samples of CPO produced (during joint experimentation), each for a specific fruit storage period were assessed with the aid of a questionnaire. Panellists scored each sample based on a three-point scale of taste, smell and other attributes. This follows standard sensory evaluation methods, where deviations in quality are used to assign preference ranks by a panel that differentiates 'excellent' from 'repulsive' samples (AOCS, 1993). The scoring ranked taste (as rancidity) and smell, each ranging from 1 to 3.

Taste (1-not rancid; 2-rancid; 3-very rancid) and for smell (1-best; 2-good; 3-bad). In addition panellists assessed the overall best sample in relation to the sensory attributes combined.

Analysis of data

The comparison of the differences between the yields for the three extraction equipment and different storage periods was made with a two-way ANOVA. The frequencies and correlation between organoleptic attributes and FFA for the sensory evaluation were also established and analysed using SPSS (ver. 16).

Measuring profitability of CPO for different fruit storage periods

In order to understand the profitability of producing CPO for each of the storage periods, a combination of net income, profit margins and benefit-cost analysis were used. The net returns (NR), (Ross *et al*., 2001) was formulated as:

$$NR_i = TR_i - TC_i \quad [1]$$

with

$$TR_i = P_i Q_i \quad [2]$$

$$TC_i = \sum_{k=1}^{k=n} Px_k X_{ki} \quad [3]$$

where

NR_i- is the net return for storage period i

TR_i is the total revenue from sale of CPO produced, nuts and fibre oil from storage period i

TC_i is the total cost of processing CPO for storage period i

P_i is the price per tonne of CPO produced for storage period i

Q_i is the quantity in tonnes of CPO for storage period i

Px_k is the price per unit of the k^{th} input for CPO production,

X_{ki} is the amount of k^{th} input for CPO production in storage period i,

n is the total number of inputs used.

For each storage period i, the profit margin, a measure of the efficiency of the processing activity was calculated as NR_i/TR_i and the benefit-cost ratio (BCR) as TR_i/TC_i, where BCR>1 implies the activity is profitable. To analyse the profitability of producing good quality palm oil by small-scale processors, scenarios for the below defined three different markets are assessed:

Scenario 1: A processor produces CPO at any of the four fruit storage periods (3, 7, 14 and 21 days) and continues to sell to the current Ghanaian, Nigerian and/or Togolese traders for local soap making who are not particular about CPO quality; they pay a single price for any quality.

Scenario 2: A processor opts for the national household consumption market, producing palm oil for cooking by producing at 7 days fruit storage period to improve quality. Here there is an incentive of receiving a higher price for food quality oil.

Scenario 3: A processor opts for processing at 3 days fruit storage period to produce high quality CPO that meets the standard for the local industrial and/or export markets. In this case quality is also remunerated through higher prices.

Based on the outcomes an intermediate storage period of 5 days was assessed that allows a processor to both serve the market for home consumption or to move to the local industrial or export market. This additional interpolated storage period is made based on the observation from the experiments that manual loosening of fruits at 3 days after harvesting is very difficult. It is assumed that loosening is much easier at 5 days than at 3 days while processing gives a high enough quality CPO for both the home consumption and the industrial markets.

Results and discussion

Variation of palm oil yield and quality with fruit storage period

There were no significant differences ($P > 0.05$) in percentages of oil yield between the joint experiment with hand spindle press (JE_HSP) and the researcher-managed experiment with hand spindle press (RE_HSP), using the storage period as replication (Fig. 2). In the comparison of the instruments in the researcher-managed experiments, yields were significantly ($P < 0.05$) higher for the digester screw press (RE_DSP) than for the other presses, which were not different from each other (Fig. 2). Averaging across all equipment in the researcher-managed experiment, the percentage oil yield significantly ($P < 0.05$) increased between 3 and 7 days of fruit storage (12.2 to 16.4 percent s.e.d. 1.17). There was no significant ($P > 0.05$) oil yield difference between 7 (16.4 percent) and 14 (17.9 percent) days but yield declined significantly ($P < 0.05$) thereafter to (12.3 percent) 21 days.

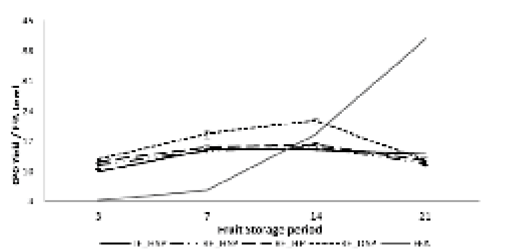

Fig. 2. Variation of CPO yield (percent) and FFA levels (percent) with fruit storage period. JE= joint experiment; RE=researcher-managed experiment
Source: Authors' own elaboration

The fruits processed at 3 days of storage gave the lowest oil yield, but the best quality oil with 3.3 percent FFA, well below the maximum acceptable level of 5 percent (Hartley, 1988; PORAM, 2011). Overall, the FFA level of oil processed after 7 days of bunch harvest (5.3 percent) was already above the 5 percent. After 14 and 21 days of storage the FFA levels were very high. Zu *et al*., (2012) found an FFA level of 19.9 percent after 15 days of fruit storage, comparable to the 18.7 percent for a storage period of 14 days found in this study. While FFA levels increased with the period of fruit storage, CPO yield increased to a point and then declined. Thus, maximisation of FFA level would imply shortening the fruit storage period towards 3 days, at the expense of CPO yield. Maximisation of CPO yield, on the other hand, would imply stretching the storage period to between 7 – 14 days, at the expense of oil quality. Using a response surface plot the optimum level for CPO yield was attained at 10 days, while maximum acceptable FFA level of 5 percent was realised for 5 days storage period.

The manual loosening of the fruit within 3 days after harvest turned out to be very difficult. Loosening after 5 days was assumed feasible and the data were used to estimate oil yield as 10.6 percent and the FFA level as 3.9 percent both based on linear interpolation. Given the nature of the curves of oil yield and FFA with time of storage both values could be assumed conservative estimates. Non-linear interpolation would lead to a slightly higher yield and lower FFA estimate. Without further experimentation linear interpolation seems safe (Blu *et al*., 2004).

Sensory evaluation-comparing organoleptic attributes and FFA levels

The percentage of the panellists who scored the different CPO samples for good smell followed a similar trend to non-rancid taste. The older the fruits became, the fewer the number of panellists who appreciated the smell and taste of the CPO. The FFA levels of the samples increased with fruit storage, and this was directly related to rancid and smell attributes. For example, a highest number of panellists scored the 21 days storage period CPO sample as very rancid (76 percent) and as of bad smell (77 percent). The analysis showed that, generally FFA level has a strong positive correlation with what was considered by the number of panellists as a bad smell and high level of rancidity (Table 1). Narasimhan *et al*., (2001) also found that FFA level positively correlated with harsh odour and rancidity.

TABLE 1

Pearson correlations for FFA levels of CPO with some organoleptic attributes

	Bad smell	*Very rancid*
FFA Levels	0.994**	0.998**
	(0.006)	(0.002)

**Correlation significant at 0.01 percent level
Source: Authors' own elaboration

It is, however, interesting to note that rancidity for CPO samples from 3 and 7 days (FFA levels of 3.5 percent and 5.3 percent respectively) of fruit storage could not easily be differentiated. As 63 percent of panellists scored CPO from 3 days as not rancid, about 53 percent felt CPO of 7 days was also not rancid. Thus, identifying the critical level of 5 percent is not easy within the reach of taste buds of people. In practice therefore, the rancidity attribute of CPO as known to the small-scale processors can be used only as a proxy for indicating high FFA level to be able to distinguish quality for different markets.

Deducing from Table 1, smell or taste can be used by these processors to rather relate longer storage period and higher FFA levels to poor quality and lower market price. This implies that, to venture into the high quality markets, processors must accept and have a formal chemical tool for testing quality. For now, what is important is to learn about the maximum period for keeping fruits after harvesting in order to produce palm oil of a certain quality range. Then also which storage period is feasible within the current technology and market options available. For instance, if processors want to sell palm oil for household consumption, they will have to process fruits within 3 to 7 days after harvest. Crude palm oil which is made beyond 14 days after harvesting is very rancid and of bad smell (Table 1). This however, can still be sold to 'local' soap makers at the village level and also in the informal West African markets, but at lower prices.

Profitability analysis of small-scale palm oil production

The financial analysis of the processing activity for each of the four storage periods (3, 7, 14 and 21 days) and then the interpolated 5 days was based on the average processing fees and fruit bunch price. Based on quantity of CPO derived from 8000 kg (8 tonnes) of fresh fruit bunches, CPO for each fruit storage period was estimated in relation to their different yields at 920 kg (3 days), 1190 kg (7 days), 1250 kg (14 days), and 950 kg (21 days). For Scenario 1, the daily average price paid for 1 tonne of CPO was GH¢1000 (at the small-scale mill during study period). For Scenario 2, the average price per tonne of CPO was GH¢1800 calculated based on 5-year-on-year national average price (SRID, 2011). For Scenario 3, the average price during study period for 1 tonne of CPO of 5 percent FFA was GH¢1906 (US$1170), from medium scale palm oil processing company in Kwaebibirem District, (using an exchange price of US$1= GH¢1.63).

The cost of operation which entails transportation, payments for various processing activities and fees for use of pounding and extraction equipment was found to be highest for the 3 days storage period. The difference in cost of production between the processing periods was purely due to the differences in payment for loosening fruits from spikelets. Independent of scenarios, the largest cost for the small-scale processors was the purchase of fresh fruit bunches (about 80 percent). In Nigeria, Olagunju (2008) recorded FFB cost to be 56 percent of total costs. Ekine & Onu, (2008) also found that FFB cost was between 62-65 percent of total cost in small-scale production. In the case of Adjei-Nsiah *et al.*, (2012), it was 88 percent for both peak and lean fruit bunch production seasons.

The current market (Scenario 1) consists mainly of Nigerian agents and Togolese traders who purchase palm oil to sell to clients in both countries for 'local' soap making. In this informal market all quality grades of palm oil are bought at the same price as set by the buyers. The analysis shows that processors have negative net returns for producing at all the storage periods in the current market when all labour is accounted for in monetary terms. This implies that the cost of production is over and above the total revenue, with benefit-cost ratios below 1 (Table 2: columns 2, 4, 6 and 7). The lowest net loss is attained with processing at 14 days of storage. The processors use various coping strategies, such as, family labour and processing of own fruit bunches all of which is not included in their calculation of cost of production. In Scenario 1, the production of CPO at 3 and 21 storage days gave the highest losses of 36.4 percent and 35.0 percent respectively.

TABLE 2

Analysis of profitability of CPO produced at different fruit storage periods for three scenarios of marketing. Scenario 1 (Sc.1) is the regional market of oil for local soap making; Sc. 2 is the national household consumption market; Sc.3 is the local industrial or export market

	Experimental fruit storage period (fsp)*							*Interpolated fsp*	
	3			*7*		*14*	*21*	*5*	
Variables	Sc. 1	Sc. 2	Sc. 3	Sc. 1	Sc.2	Sc. 3	Sc. 1	Sc. 2	Sc. 3
Costs (GH¢)									
FFB	1200	1200	1200	1200	1200	1200	1200	1200	1200
Operations	306	306	306	290	290	274	274	290	290
Total	1506	1506	1506	1490	1490	1474	1474	1490	1490
Revenues (GH¢)									
Nuts & fibre oil	184	184	184	164	164	144	144	174	174
CPO	920	1656	1754	1190	2142	1250	950	1512	1601
Total	1104	1840	1938	1354	2306	1394	1094	1686	1775
Net return (GH¢)	-402	334	432	-136	816	-80	-380	196	285
Profit (percent)	-36.4	18.2	22.0	-10.0	35.0	-6.0	-35.0	12.0	16.0
Benefit-cost ratio	0.73	1.10	1.29	0.91	1.55	0.95	0.74	1.13	1.19

*fsp is fruit storage period in days
Source: Authors' own elaboration

The calculation indicates that Scenario 2, the option to sell the CPO processed after 3 and 7 days storage for national household consumption, was the most profitable. The highest positive net return and benefit-cost ratio is reached from production at 7 days of fruit storage (Table 2, column 6). The production of CPO after 3 days storage can be made more profitable if sold on the national or international industrial market (Scenario 3, Table 2: column 3). However, producing CPO after 3 days storage gave a lower net return and, therefore, also lower benefit-cost ratio than sale for national home consumption after 7 days storage.

When selling for national home consumption (Scenario 2), producing at 7 days fruit storage is much easier and cheaper than at 3 days. This is because fruits can be loosened more easily and extraction with the hand spindle press required fewer times of pressing per quantity of pounded fruits. Also, at this storage period the fruit mass after pounding does not clog the holes of the hand spindle press cage and more oil is recovered. Processors can produce palm oil at 7 days after bunch harvesting and explore the household consumption market by acting as wholesalers for various palm oil retailers from major Ghanaian cities like Kumasi, Accra, Koforidua and Tema. This market looks more feasible (based on current practices and technology) to access than the export market. The analysis showed processors might do much better in terms of more profits per unit of CPO sold than they are currently doing. The question is why are they not accessing this market? This is partly because of the practice of longer fruit storage which leads to poor quality CPO but also mainly due to lack of networking with relevant actors to help them learn their way out of this practice.

For the interpolated storage period of 5 days processors were calculated to make profit in both Scenarios 2 (export market) and 3 (household consumption market) as Table 2 (Columns 8 and 9) shows. Looking at the difficulty in processing fruits at 3 days of bunch harvest, and the relative ease in processing fruits at 5 days, it seems more realistic for processors to try the latter option. However, a reality check is still needed to find out whether this could provide an additional option for accessing other markets, next to 7 days of storage. This could become relevant if for example the price in the national household consumption market would drop after more processors start to provide this market with palm oil processed at 7 days of storage. Again, the relatively higher FFA level of the 7 days storage period is likely to enhance degradation of the oil quality during long storage at home for the household consumption market (Ngando *et al*., 2011). This may lead to a gradual shift to a higher quality, thus possibly increasing the price for 5 days storage CPO. These dynamics should be explored further by processors in collaboration with researchers of the Oil Palm Research Institute to harness their innovation capacities.

Conclusions

Despite the large quantity (80 percent) of crude palm oil produced by small-scale enterprises, they are not a priority in the current development plan. This is mainly because the enterprise produces low quality palm oil, which is largely due to the use of outdated processing techniques. This article is an example of how the small-scale enterprise could be assisted to improve on these processing techniques or practices. The article used a bottom-up innovation approach through a joint experimentation and profitability analysis, together with a researcher-managed trial. It looked with actors at the variation in fruit storage periods with CPO quality (FFA level), and the profitability implications.

The joint experimentation created space for interaction and learning about processing practices, as well as for opening up opportunity for improvement of CPO quality and market choices. The processors in this study learnt about the effect of fruit storage period on yield and quality of CPO produced. Then they learned to see the correlation between their assessment of quality of taste and smell and the FFA level. They, thus, learned to relate to a technical concept through a direct link to a quality assessment they knew well. Again, they learnt from the experience of doing joint experiment, which provided them with a framework for trying out different storage periods themselves, and fine tuning their processing practices. It is profitable for processors to improve on palm oil quality by reducing fruit storage periods. This will allow them to diversify production for different markets and also contribute to the national quest for palm oil self-sufficiency for home consumption.

It is suggested that the industry's development intervention should target the small-scale enterprise for the production of CPO for household consumption. The enterprise should, thus, be supported through knowledge sharing activities to help them improve on their processing practices. The article concludes that, actors in the small-scale oil palm fruit processing enterprise are capable of experimenting to acquire the needed knowledge if taken serious by other actors in the industry. The way to go is not to 'exclude' these enterprises from the development blueprint, but to assist them build capacity through a bottom-up innovation approach.

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