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Processing practices of small-scale palm oil producers in the Kwaebibirem District, Ghana: A diagnostic study

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ABSTRACT

Ghana produces about 2,000,000 metric tons of oil palm fruits annually, and small-scale processors contribute about 60% of crude palm oil production. The country is not self-sufficient in the fats and oils needed for industrial use and home consumption. A large percentage of the palm oil produced by small-scale processors cannot be utilized by the larger scale industries in Ghana or abroad because of its poor quality. There is an urgent need to explore the causes and to identify ways to address the situation. We carried out a diagnostic study in the Kwaebibirem District using key informant interviews, focus group discussions and surveys based on a semi-structured questionnaire to assess the processing practices of small-scale oil palm fruit processors, and to analyse the rationale behind these practices and their effects on the quality of palm oil produced. The processing practices identified included storage of loosened fruits for long periods before boiling, disposal of effluent into drains, use of spent tyres for boiling fruits and no clarification of the oil. About 54% of the processors store oil palm fruits for 1–3 weeks before processing, possibly allowing some fermentation, to increase extractability and reduce labour costs. This practice may reduce the quality of palm oil by increasing the levels of free fatty acids. The effects of the storage period on the quality and quantity of palm oil, the seasonal oil content of oil palm fruits, and the types of linkages and interactions amongst actors in the oil palm industry were identified together with stakeholders as issues for further research. Innovation in small-scale oil palm fruit processing is revealed as a multi-stakeholder, multiple-scale, and interdisciplinary process.

1. Introduction

Oil palm (*Elaeis guineensis* Jacq.) cultivation is a core part of Ghana's agriculture. It has been selected by the government as a key strategic pillar of agricultural and industry-led growth for poverty reduction because of its potential to provide income for many rural smallholders [1]. In 2009, Ghana produced about 2,103,600 metric tons (MT) of oil palm fruit bunches and 130,000 MT of palm oil [2]. Small-scale processors produce about 60% of the country's palm oil [3]. The crude palm oil (CPO) produced by these processors does not meet the quality standard for industrial utilization because of its high content of free fatty acids. In order to meet the country's fats and oil requirements, which are estimated at 252,432 MT, the country imports large quantities of palm oil annually. In 2007, for instance, about 150,000 MT of oils and fats were imported of which 94% was in the form of palm oil [3]. Projections of palm oil use for 2011 show that 255,700 MT will be needed for household and industrial consumption, but only 161,200 MT will be produced in the country, giving a shortfall of 94,500 MT [4]. This shortfall is envisaged to increase to 101,800 MT by 2012. So there is a potential for a huge internal market for small-scale palm oil processors in Ghana, provided they can deliver the required quality.

When supported through training and provision of efficient processing equipment the small-scale oil palm processors can produce good quality crude palm oil to meet the demand of the local industry. However, the government's policy has been to support smallholder outgrower schemes attached to large and medium scale processing mills. This has not been successful because the outgrowers divert the fruit bunches to their families who process them at the small-scale mills.

This study is part of a larger research and development programme called Convergence of Sciences-Strengthening Innovation Systems (CoS-SIS), which aims at improving rural livelihoods in Ghana, Benin, and Mali by integrating social and technical

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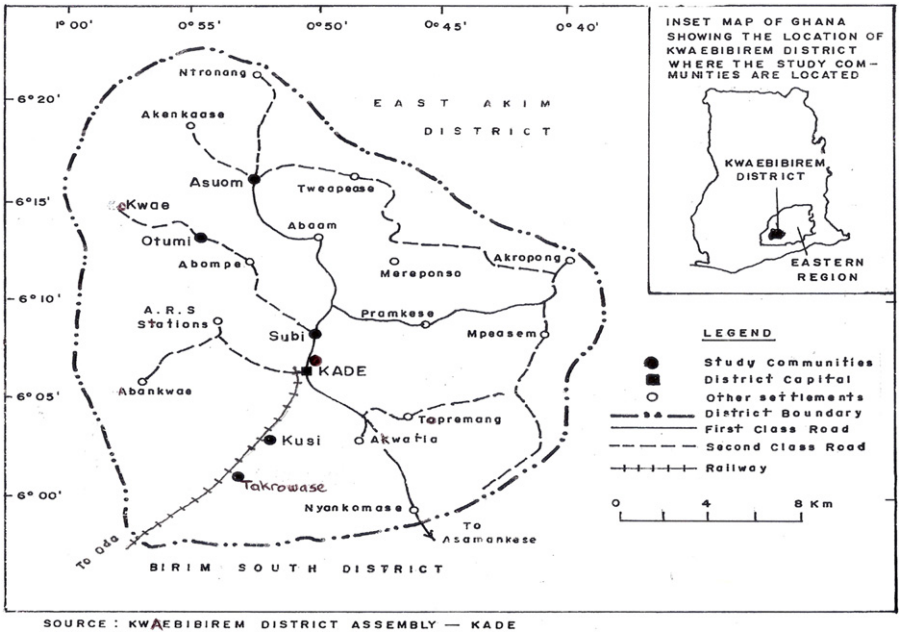

Fig. 1. Map of Kwaebibirem District showing the six study sites.

approaches to poverty reduction in West Africa (for further details, see the Introductory paper to this special issue). Although many agricultural research investments have been successful, it is increasingly recognized that conventional agricultural research is not sufficient to enable agricultural innovation [5]. In many cases there is a lack of an effective process for integrating practice-based knowledge and scientific knowledge, community learning and the empowerment of actors and institutional change. Sayer and Campbell [6] argue that sustained improvements to the livelihood of smallholders in agriculture require a different type of research: one based on understanding the rural people's practical knowledge and enhancing rural people's capability to adapt to changing conditions rather than delivering 'finished', but not necessarily fitting technologies. The CoS-SIS programme applies this alternative approach to agricultural research.

The oil palm sector was selected by CoS-SIS' national consultative group as one of the priority domains for research in Ghana. Unpublished exploratory and scoping studies by two of the authors of this paper (S. Adjei-Nsiah and C. Osei-Amponsah) were conducted in 2009 in order to explore opportunities and constraints in the oil palm industry, which were then examined in-depth in the diagnostic study reported here. They revealed that small-scale oil palm processors have access to the bulk of fresh fruit bunches (FFB) produced by farmers. However, oil palm processors are not able to access remunerative markets for their product. Because of the poor quality of their palm oil they are not able to sell to local industrial and international markets. The increasing domestic and international demand [7] for palm oil provides opportunities for small-scale processors to improve their incomes. The quality issue thus was selected as the entry point for the CoS-SIS research in the oil palm domain in Ghana. This study focuses on the contribution of the oil palm processors in quality management.

The paper first examines the importance of processing oil palm fruits among small-scale processors in the study area and identifies the different actors with which small-scale oil palm processors are engaged in the industry. It also outlines the constraints and opportunities of the palm oil industry using a problem tree analysis. The paper then explores processing practices, and shows why palm oil samples randomly collected from the study areas are of low quality, as well as the rationale for the practice of storing oil palm fruits for long periods. Drawing on the findings, the paper discusses the implications of the analysis of the problem tree and comments on the issues agreed with local stakeholders for further research. It also outlines institutional constraints beyond the level of the individual processor that could (within the CoS-SIS programme) be used for intervention by a national stakeholder platform known as the Ghana oil palm Concertation and Innovation Group (CIG).

2. Study context

Initial exploratory and scoping studies were conducted in one district of each of the Western, Eastern and Ashanti Regions of Ghana, where there is a high level of oil palm production and processing, to identify constraints and opportunities in the domain. The Kwaebibirem District of the Eastern Region was finally chosen as an appropriate case because of the presence of different production systems (conventional and organic) and scales (large, medium and small) of processing as well as the presence of the only research institute for oil palm, the Oil Palm Research Institute (OPRI) of the Council for Scientific and Industrial Research (CSIR).

The Kwaebibirem District is located in the south-western corner of the Eastern Region of Ghana (Fig. 1). Agriculture employs 77% of the economically active labour force [8]. The major cash crops are cocoa, oil palm and citrus and the major food crops are maize, plantain, cassava and cocoyam. Land for farming is acquired through lease holding, self-owned land, family lands, sharecropping, and stool lands. Stool lands are inherited through royal, matrilineal kinship in the Akyem realm of the Eastern Region. The main industrial activity of the local people is the operation of small-scale oil palm processing mills for the processing of oil palm fruits [8].

The study was conducted from March to October 2010 in six purposively selected towns: Otumi, Asuom, Kusi Takrowase, Subi and Kade (Fig. 1). The towns were grouped into three zones based on their location in the district. Otumi and Asuom are within the area of the Ghana Oil Palm Development Company (GOPDC) (a 60-MT capacity, multi-nationally owned agro-industrial processing and refinery plant) in Kwae, where there is very much competition for fresh fruit bunches (FFB). Kusi and Takrowase are within the Oil Palm Research Institute area, where competition for fruits is

minimal owing to the absence of a large mill. Subi and Kade (the district capital) are located at the centre of the district and competition for fruits is lower than in Otumi and Asuom.

3. Methodology

The broader CoS-SIS programme, within which this study was undertaken, uses five main steps: exploratory and scoping, diagnostic and baseline, joint technical experimentation, monitoring and evaluation, and institutional experimentation by CIG, a platform of actors to address institutional constraints beyond the small-scale processor level, facilitated by a research associate.

The entry point for the study was selected at an initial local stakeholder workshop held in Kwaebibirem District, Kade. The workshop involved representatives from the Ministry of Food and Agriculture, the Forest and Horticultural Crops Research Centre, the Oil Palm Research Institute, the Ghana Oil Palm Development Company, small-scale oil palm farmers, processors, mill owners, mill workers, the principal researcher, the CoS-SIS national co-ordinator and the research associate. Using results from a scoping study, the participants discussed and agreed that the study should be centred on poor processing practices. This entry point is linked to the poor quality of palm oil produced by small-scale processors. Poor oil quality is related, in addition to the seasonal high moisture and low oil content of the oil palm fruit's mesocarp, to environmental hazards of some processing practices, and inadequate access to local industrial and export markets. The diagnostic study thus sought to better understand these issues from an institutional, technical and social-economic perspective, with the aim of aligning further interdisciplinary studies to the needs and the context of the small-scale oil palm fruit processors. The people directly involved are private smallholder farmers, processors, mill owners, mill workers and buyers in the small-scale oil palm industry. In addition, a local stakeholders' platform was set up in the district to discuss and give input to the entire project at different stages of the research process.

The following questions were addressed:

- What is the importance of oil palm processing in the study areas?
- What are the processing practices and the operation units of small-scale processing?
- Who form the networks of small-scale processors?
- What are the constraints in the oil palm industry for small-scale processors?
- What are the quality levels (in terms of FFA) of crude palm oil in the district?
- What are the emerging issues from the diagnosis for further research?

4. Data collection

In each of the six towns introductory meetings were held by the principal researcher with small-scale processors, mill owners, mill workers, farmers, extension staff, chiefs and some informal leaders (old, young, males and females). Individuals were identified at these meetings to act as potential key informants. Subsequently, the key informants (two from each town) were interviewed to understand how the small-scale industry operates. Next, the information gathered was presented and discussed in groups of 8–10 people (farmers, mill owner, mill workers, processors, buyers) at each of the milling sites. Group pressure and mutual censorship can bias the discussion in such groups. We found that especially when the mill owner was in the group, the workers either refused to speak or just repeated the mill owner's views. To correct this bias, individual face-to-face interviews were held with the actors at home, mill or on their farms. Specific issues (processing practices or constraints in the industry) arising from the interviews were then discussed, in six focus groups.

Table 1
Numbers of mill owners, processors and farmers surveyed in each of the towns in Kwaebibirem District, 2010.

Town	Mill owners	Processors	Farmers
Asuom	3	7	20
Otumi	9	23	23
Subi	9	19	24
Kade	5	14	6
Kusi	6	20	27
Takrowase	3	9	10
Total	35	92	110

Based on the information gathered by these preparatory interactions, pre-tested semi-structured questionnaires were prepared and a survey was conducted with purposefully selected farmers (110), mill owners (35) and processors (92) (Table 1). The questionnaire sought information on the demographic and social-economic characteristics of the respondents' production and processing practices. In addition, milling site visits, visually aided dialogues, participant observation and discussion at local stakeholders' workshops were used to collect additional detailed information on actors' perceptions and practices.

A problem tree was then constructed, based on the stakeholders' assessment of the constraints identified in the community meetings, focus group discussions and personal interviews. The stakeholders – farmers, processors, mill owners, workers, extension officers, scientist, and a district assembly officer – validated and prioritized at a workshop the major constraints identified. In four groups (each group composed of a combination of all stakeholder categories), the constraints were prioritized through voting and listed so the constraint with the highest vote came first on the list. The lists from the four groups were combined in a plenary session and a final constraints list composed. The facilitator then asked the stakeholders to categorize the constraints into institutional or non-institutional constraints, further separated into above-processor or at-processor levels.

Useful qualitative and quantitative information on the oil palm industry in Ghana was collected also through a review of written information supplied by the Oil Palm Research Institute (OPRI) of the Council for Scientific and Industrial Research (CSIR), the Forest and Horticultural Crops Research Centre of the University of Ghana, the Kwaebibirem District Directorate of the Ministry of Food and Agriculture (MOFA) office and the district office of the elected Assembly. In addition, a further round of key informant interviews among national level officials was used to understand the regulatory and policy context. They included individuals in the Food and Drugs Board, Ghana Standards Board, Ghana Export Promotion Council, Ghana Regional Appropriate Technology Industrial Service, MOFA and OPRI of CSIR.

SPSS software version 16 was used to analyse both the qualitative and quantitative data in this study. Finally, in order to assess the FFA content of palm oil produced in the district, a total of 18 crude palm oil samples were collected from three processing units in each of the six towns and analysed in the laboratory of the Nutrition and Food Science Department of the University of Ghana. The FFA content was determined as an indicator of quality, using the American Oil Chemists' Society's official methods and recommended practice Ca 5a-40 [9].

At the end of the study, the results were presented at a workshop for validation to local stakeholders. They clarified the information presented to them and agreed it was a true reflection of what pertained in the industry at the time. The main results of the study were

Table 2
Distribution of sources of income of small-scale palm oil processors ($n = 92$).

Income source	Distribution frequency (%)
Processing oil palm	66.3
Oil palm farming	7.6
Buying and bulking of palm oil	4.3
Petty trading	3.3
Salaried work	2.2
Other sources (combination of sources)	16.3

then written on flip charts and further discussed in small groups to identify the type of research needed to address the issues and constraints identified. The suggestions from the groups were fine-tuned in plenary with the help of the facilitator; they have formed the basis of the further studies and CIG activities undertaken in the oil palm domain under the CoS-SIS programme.

5. Results

5.1. Importance of the oil palm domain

The three most important cash crops grown in Kwaebibirem District in order of increasing importance are cocoa, citrus and oil palm. The number of farmers growing oil palm in the district is estimated at 13,095. Total land area under oil palm is estimated at about 50,700 ha (K. Ametepe, 2010, personal communication), 72% of which is cultivated by smallholders. This has resulted in the establishment of many small-scale mills, scattered throughout the district, to process the harvested oil palm fruit bunches into palm oil. About 66% of the processors stated that they obtain their main income from oil palm processing (Table 2).

On average, a small-scale mill engages approximately 25 people who each carry out various operations. Several processors may use one mill, so the following numbers per processor are not necessarily equivalent to the production per mill.

During the peak fruit production season (February–June) a processor processes on average about 11 MT of fresh fruit bunches (FFB) per month whereas in the lean fruit production season (July–January) a processor processes an average of about 4 MT of FFB per month. Per processor an average of 772 l of crude palm oil (CPO) is produced per month in the lean season compared with 2192 l in the peak season. A metric ton of CPO sells between 720 GHC (480 US$) and 1000 GHC (667 US$), depending on the season. Most of the oil is sold to local traders for the regional West African market but palm oil is an important part of local people's diet, and it is also used as a raw material for small-scale domestic soap-making.

5.2. The small-scale oil palm fruit processor

About 80% of the processors in the district are females. The oil palm fruits are usually processed into crude palm oil using semi-mechanized processing equipment at a milling site. The mill is locally called 'Cramer' after a Belgian engineer who first set up a small-scale mill in the district in 1982 (Nana Yeboah, 2010, personal communication). The processor usually does not own the milling equipment but accesses such service from a mill owner for a fee. About 82% of the respondents had milled fresh fruit bunches at their current milling site for between 0.2 and 10 years, whereas 18% had used their current mill for over 10 years. About 39% of the processors preferred to mill fruits at a particular site because of proximity to their homes, and 25% liked to work at a specific mill because of the peace and relationships of familiarity and trust amongst all actors at that mill. Processors were found not to be a member of any formal association. However, a kind of informal association existed at particular mills that enabled them to collectively assist sick and bereaved members. Most processors (91%) had never had any type of formal training on good processing practices but a few had attended a training workshop on other topics. Knowledge and skills in processing the palm fruits into oil normally were acquired from friends or parents who had been engaged in the enterprise before them.

The buyers of crude palm oil were mainly local agents who purchased the oil on behalf of Nigerian buyers, and women traders who buy the oil for re-sale in Togo. Also, a few market women buy crude oil to sell it in the cities of Ghana. Most of the processors (52%) did not have access to any formal credit facility and those who did were largely pre-financed (34%) through a credit relationship with the local agents of Nigerian and Togolese buyers. The others (14%) accessed credit from two non-banking financial institutions (Opportunity savings and loans, and Sinapi Aba), or the Kwaebibirem Millers Association and the Kwaebibirem Rural bank.

5.3. Actors in the small-scale oil palm fruit processing industry

The processor can be seen as the node in the network of actors at a processing mill. A mapping exercise with the processors showed there are typically twelve actors (Togo market buyers of CPO, Nigerian agent buyers of CPO, various mill workers, oil palm private and outgrower farmers, formal and informal creditors, transporters, mill owners, palm oil processors, domestic soap makers, kernel oil processors, local market buyers and bulkers of CPO). Notably, research scientists, extension agents and policy makers were not visualized as actors in the network; they were not even mentioned by the processors as being involved. An effective co-ordinating body like a processors association also does not exist. A processor seems to be a self-reliant and autonomous 'patron' who prefers to work and trust her own network rather than collaborating with the other processors and their networks.

The local agents for the Nigerian and Togolese buyers move from one mill to another to purchase the palm oil. Other processors travel to sell their palm oil on market days in Togo. Some local people, mainly men, bulk up the oil by building metal tanks and placing them at specific mills where they purchase immediately the oil produced by the processors, and store it in the tanks until it is sold in the period November–February when palm fruits are relatively scarce and the price of CPO is highest. The buyers normally advance money to the processors just before the peak fruit production season for financing the palm oil production.

5.4. Constraints on the small-scale oil palm processing industry

The problem tree constructed was based on information gathered from the focus group discussions, on individual interviews with processors and prioritization of the issues by stakeholders (Fig. 2). All the constraints above the processors' level (ovals to the right of the figure) were seen as institutional constraints and as lying beyond the local stakeholders' control, i.e., as issues and constraints that should be tackled by the CIG. For example, the weak regulatory framework for the industry was seen as a policy issue that should be dealt with at the district and national levels through the facilitation of CIG activities. However, it is noteworthy that a number of issues and constraints were positioned at the level of the processors themselves. The numbering in Fig. 2 indicates the relative importance to stakeholders of each constraint. So the 'poor market incentive' (1) is identified as the most important and urgent issue to be addressed and 'the lack of a regulatory framework' (7) as the least important.

Analysis of the tree shows that socio-technical constraints may be found at the organizational–institutional level of the mill, and also in individual processor's lack of skills, technology, quality production/price incentives, and market access. Lack of access to

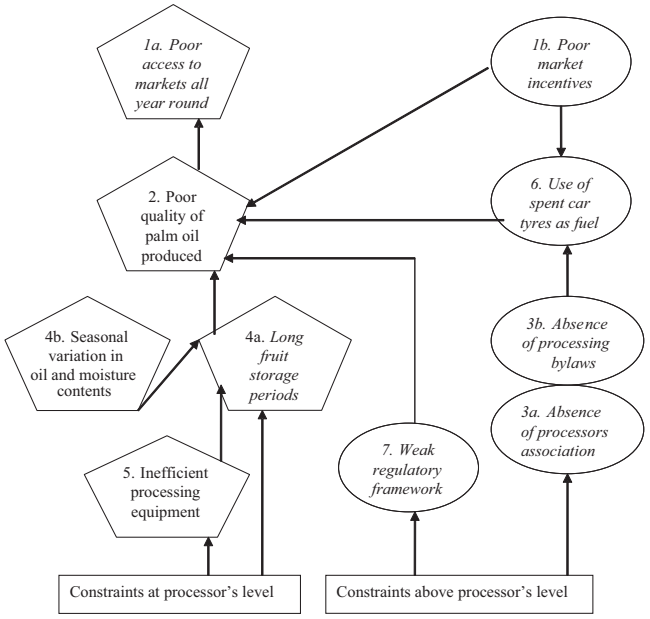

Fig. 2. Problem tree showing constraints of small-scale oil palm processing. Priority of the constraints as ranked by stakeholders from highest (1) to lowest (7). Constraints with the same number are linked, but a is ranked higher than b. Ovals and pentagons indicate respectively the constraints located above processor's level and at processor's level (i.e., at the mill). Italic font indicates institutional constraints; non-institutional constraints are in roman font. The arrows represent a causal linkage between constraints.

markets was positioned as an institutional – and a high priority – constraint embedded in practices, norms, and informal and formal rules in the small-scale oil palm industry. An examination of the diagram further indicates that the poor quality of palm oil produced by small-scale processors is rooted in two causal chains: (1) the long, pre-processing storage of the fruits, and (2) the absence of an appropriate regulatory framework. The problem tree analysis further indicates that the use of inappropriate fuel, as well as the lack of bylaws to regulate the sites where the processing activities take place, results in practices that not only affect the quality of the palm oil but also pollute the environment. The combined effects of the identified socio-technical and institutional constraints located at both the processor and above-processor levels impact the processors, and hence palm oil quality, and hinder their access to remunerative markets all year round.

5.5. Processing of oil palm fruits

The majority of the processing operations at the small-scale mills were done manually without any equipment. The only operations that were mechanized were the pounding of the fruits and the extraction of the oil. There were three main types of pressing equipment used: the digester screw press, the digester with separate spindle press, and the digester with separate hydraulic press. The digester screw press was used by 4%, the digester with separate hydraulic press by 8%, and the digester with separate hand spindle press by 88% of the processors.

The fresh fruit bunches together with the loose fruits are brought in trucks from the farm gate to the processing mill. The processors estimate the weight of the fresh bunches by counting the number of bunches (31%) or by visual assessment (50%). Only about 19% of the processors weighed the fruit bunches because in this case they bought the bunches from the research institutions (Oil Palm Research Institute and the Forest and Horticultural Crops Research Centre). The reason why weighing scales usually are not used is because the technique is mistrusted by both processor and farmers.

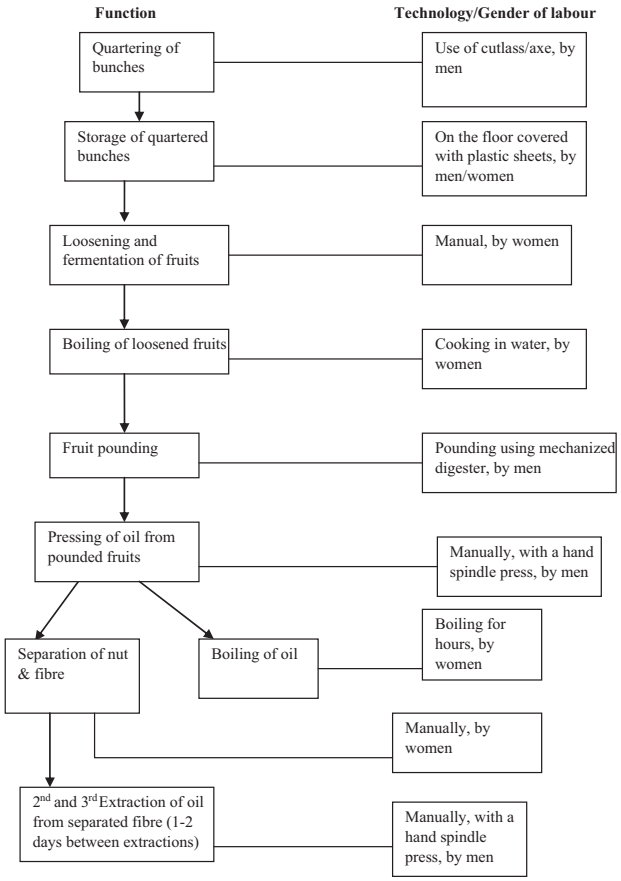

Fig. 3. Flow chart diagram showing operation units in the small-scale processing of oil palm fruits.

The bunches are first quartered into spikelets (this is mainly done by men), after which the spikelets are kept on the floor and covered with palm leaves, plastic sheets, or left uncovered for 3–5 days. This practice aids in the loosening of the fruits more easily since strippers are not available. The loosened fruits are then heaped and stored on the floor of a shed for a period ranging from 1 to 4 weeks (see Fig. 3 for the flow of processing activities).

Women carry the stored fruits from the shed to a cooking place. The stored fruits are cooked by boiling them in big metal containers called *loco* for 1–4 h, depending on the amount of fruits. Cooking is usually done overnight (on an open fire) using spent lorry tyres, empty fruit bunches and fibre as sources of fuel to ensure that the fire keeps burning during the night even when unattended. Some mills, however, use only empty bunches and fibre as a fuel source and the fruits are boiled during the day. Cooked fruits are collected and thrown into a mechanized digester for pounding. This is followed by the extraction of the palm oil by men, by pressing the hot, pounded fruits that are confined in a metal press cage.

Clarification is in principle the last stage of processing. It is usually omitted in order to reduce operational costs. Storing the fruit bunches for some weeks before processing helps to get rid of their water, making clarification unnecessary (see Section 5.7). If clarification is not carried out, the extracted palm oil is drawn off after allowing it to stand for about 2–3 h to allow the sludge to settle. The remaining sludge is boiled for about 15 min and the residual palm oil scooped from the top. The thickened sludge is drained onto the mill floor or into drains. At the few mills where clarification is done, the extracted palm oil is collected into big cooking pots and boiled for 1–2 h under low heat. During this process, the clean palm oil rises to the surface and floats over a mixture of water and solid

particles. The pressed, pounded fruits yield a fibre and nut cake. These are separated manually by the women after which the fibre is heaped tightly and stored for 1–2 days, and the oil is extracted a second time; the process is repeated with the stored cake and then pressed for a third time. The later extractions may be added to first pressing before selling the oil or is sold separately (by the workers), both at the prevailing price. The nuts are usually separated from the fibre and dried and then processed into palm kernel oil by the processors themselves during the oil palm fruit lean season or sold to other operators who specialize in processing these nuts.

5.6. Analysis of environmental and health challenges of some processing practices

The majority of the mills are located near water bodies (80%) on the outskirts of inhabited areas. Few of the mills are annexed to home yards and neighbouring houses. The study revealed that there are at least four practices that potentially may harm the environment and people's health. First, the fuel used by the processors for the boiling activity includes spent car tyres, empty fruit bunches, fibre cake and bamboo sticks. The fires are set in the open spaces at the mill for boiling the fruits. Smoke from the car tyres pollutes the air and might pose health hazards to the processors, mill workers and people living near the mills. Second, the processors dispose of the effluent directly onto the earthen floors of the mills, into nearby streams and farms (86%), thereby polluting surface water. Third, for packing the CPO the processors often use containers thrown away by heavy industries in town, which may contain toxic substances such as cyanide. Fourth, in order to obtain CPO with a bright red colour, which is attractive to customers, some processors adulterate the oil with Sudan dye; this food dye is banned in Ghana and in many other countries. The processing equipment is hardly ever cleaned (perhaps once or twice during the lean season when the machine is not frequently in use), leading to accumulation of dirt and oil in the equipment.

5.7. Fruit storage as a processing practice

Most processors store the fruits for a period ranging between 1 and 4 weeks prior to processing. The processors indicated that this practice is used in order to get rid of water from the fruits (18%), to enhance extraction (22%), or to make the pressing of the pounded fruits easier (33%). About 27% of the processors stored the fruits for a combination of these reasons. The long storage period minimizes the operational stages of processing so as to reduce labour cost. However, processors in Asuom, Otumi and Subi normally keep their fruits between 1 and 5 days and clarify the oil. This is because, traditionally, the processors in these towns like to make a special type of palm oil for cooking (*zoomi*). This oil has a relatively better quality and sells at a better price than ordinary CPO (1.5–2 times higher). They use the standard practices when making ordinary palm oil. Those in Kade and Kusi store their fruits for 1–2 weeks and processors in Takrowase keep fruits for about 2–4 weeks (Fig. 4). Clarification of the palm oil was not carried out at these three sites because the processors here assume that the CPO will eventually be used for soap making (they sell mainly to Nigerian and Togolese agents) so that it does not need cleaning. About 40% of processors perceive that storing fruits longer gives higher quantities of CPO but reduces the quality of the palm oil. The rest (60%) did not think that fruit storage affected either quality or quantity.

5.8. Palm oil quality: processors' perceptions of quality CPO

Quality was understood by processors, palm oil buyers and mill workers in relation to the use of the palm oil. They all agreed that some quality checks were required for palm oil destined for home consumption but not for soap making. A high content of free fatty acids (FFAs) was not a problem according to the small-scale processors, and they did not use this concept. This was because it was not common to assess quality in terms of FFA contents in the markets that the processors currently access. There is thus no incentive to produce good quality ordinary palm oil because buyers pay the same price for all grades of ordinary CPO.

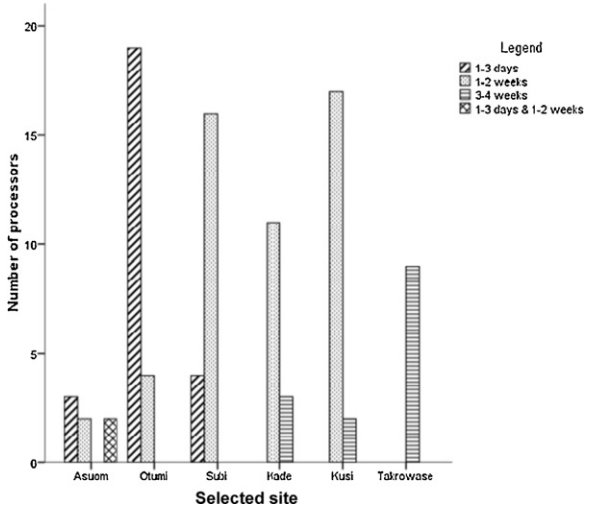

Fig. 4. The number of processors storing oil palm fruits, by length of storage period, at six selected sites in Kwaebibirem District, Ghana.

The buyers of palm oil used for home consumption assess quality on the basis of their experiential knowledge and by smelling and tasting the oil to check it for rancidity (a component of quality that is closely related to FFA content). Other buyers of this type of oil look at the colour and texture of the fibre produced from the processed oil palm fruits (if they are present during processing). A fresh reddish orange colour and soft fibre indicate good oil quality, brown and dry fibre means poor quality oil. Quality also is checked by the freshness of the loosened fruits and the colour of the palm oil produced.

Laboratory analysis showed that FFA values were significantly ($p < 0.05$) different between towns (Table 3). The FFA content ranged from 10.0 to 23.8% and was in all cases much higher than the maximum acceptable FFA content of 5% specified by industrial and export markets. The FFA contents indicate that it is probably the practice of storing the fruits before processing that leads to a high FFA build-up and thus to a lower quality of the palm oil produced. The processors also recognized that stored fruits produce rancid palm oil with a bad smell and dark colour, which is not good for home consumption.

6. Discussion

Traditionally, the processing of food in Ghana is done by women, which may explain why most oil palm fruit processors are females.

Table 3
Average free fatty acid (FFA) contents (with standard errors) of palm oil samples obtained from six towns in Kwaebibirem District ($n = 18$).

Towns	FFA content (%)
Asuom	11.4 ± 1.28a
Otumi	10.0 ± 0.69a
Subi	10.6 ± 1.04a
Kade	15.9 ± 1.04a
Kusi	21.6 ± 3.55b
Takrowase	23.8 ± 1.46b

Means followed by different lower case letters are statistically different ($p < 0.05$).

A similar gender division has been reported for Nigeria [10]. It is not surprising that the majority of processors rely on local knowledge, which has also been documented in Nigeria [11]. More surprising is the fact that they have not been offered any formal training in processing. The study further shows that some key stakeholders are presently not involved in the socio-technical arrangements. Particularly scientists, district assembly officials and extension agents who are needed to provide relevant advice and training, do not pay attention to the small-scale processing network. In Honduras, Fromm [12] also reported that scientists and extension agents were absent in the oil palm processing network.

On the basis of the key informant interviews it seems likely that there is a lack of interest and expertise in oil palm processing within the Ministry of Food and Agriculture and its extension agents, and a lack of interest also in the Ministry of Trade and Industries. Furthermore, the oil palm research institute has no food technologist to handle research in palm fruit processing. On the one hand, national agricultural policies are generally focused on crop production and not on processing, whereas on the other hand industry-related policies focus on the larger and medium scale industries. Agricultural scientists for their part seem to be primarily interested in breeding and producing high yielding oil palm seedlings for farmers. So far, research on fruit processing is not a priority for the Oil Palm Research Institute. The technical process and social dynamics at the small-scale mill thus have received very little attention in the district. In a similar study for Banten, Indonesia, Hardjono [13] also found that the lack of assistance from relevant institutions, insufficient human capability, and a poor extension service led to the failure of adoption of good processing practices. Clearly, there is a need for agriculture-related institutes and policy makers to consider full value chain analyses, rather than to halt their work at the field or farm gate stage of the chain.

A further consideration is that the staff at all levels in the oil palm producing institutions and industries are predominantly male, whereas the participants in the small-scale processing industry are mostly women. This cultural and gender aspect of small-scale oil production needs more attention. There is evidently a need for further studies to understand the activities of all the actors in the industry and how this might affect innovation among processors.

Using the analysis of the problem tree (Fig. 2) it is clear that processors produce poor quality oil due to poor market incentives. They keep fruits for long periods in the belief that this will produce more oil and because it helps in reducing operational costs as they can skip the clarification stage of processing (Fig. 3). The low oil quality (high FFA content) arises from the effect of the lipolytic enzyme lipase from the palm fruit, or from autocatalytic hydrolysis and/or microbial activity [14]. Various studies have shown that long storage of fruits leads to high FFA contents and poor quality palm oil [15–18]. In the case of Kwaebibirem District the stakeholders hold different views on fruit storage as a processing practice. While scientists look at it from the point of view of quality in terms of FFA content, the processors, mill owners and mill workers believe that stored fruits give higher CPO yields and lower operating costs, even if it reduces oil quality. Further research (joint learning) is needed to explore the optimum palm oil quality and quantity levels that would leave processors better off in relation to market prices and the cost of processing. The results would allow processors to consider revision of their practices, based on tested options for quality improvement, and to consider the development of new market opportunities. As shown in Fig. 2, the seasonal high moisture content of fruits is also linked to quality of CPO. As processors explained, this is because high contents of moisture in CPO may lead to a higher FFA build-up. An experiment may be needed to establish and quantify the seasonal trend and the underlying causes.

The problem tree analysis illustrates that processors assess their constraints as a mixture of the technical, social and institutional. These findings parallel those of a study in Nigeria by Nwawe [19], who, after ascertaining the factors militating against adoption of improved oil palm production technologies, explained that institutional factors such as lack of membership in co-operatives and absence of extension services influenced adoption more than technical factors. That is, the oil palm stakeholders understand that their constraints are multifaceted and operate or originate at different levels. In addition, we noted that it is the internal and external organization of the small-scale processing sector that appears to provide answers to questions of the social, economic, and cultural rationales of the processors for investing in informal network relations. The issues identified in Fig. 2 as lying beyond the processors' reach should be addressed through interventions by the CIG. The results of the current study provide important input to the work of the CIG, as well to options for joint experimentation with the processors to enhance their ability to design and select technologies fitting their goals and constraints.

The results of our study to understand the constraints of processors, as outlined in Fig. 2, were presented at a local stakeholder meeting for validation and to generate suggestions for further research. This led to the identification of research questions to address a number of the constraints:

1. To understand the small-scale processing industry as a whole, and at different levels, and the kinds of interaction amongst actors at each level:
   - An ethnographic study investigating the institutions and the interactions between processors, millers, mill workers, farmers, and buyers of CPO in a trans-boundary network, with special attention to the pivotal position of the processor in the internal and external organization of the mill, the social dynamics amongst actors in her network, and how her position affects innovation at the mill. This work will allow assessment of which institutional changes might enhance effectively the ability of individual processors, or possibly groups of processors, to have access to more remunerative markets.
2. To address the issue of low quality palm oil and the related lack of market access:
   - A joint experiment with processors, farmers, mill owners, mill workers, scientists and extension agents concerning the optimum fruit storage period, to reduce FFA levels and improve quantity and quality outcomes (constraints 2 and 4a in Fig. 2, with a view to matching market expectations of quality – constraint 1a).
   - A socio-economic analysis of oil palm processing in relation to operational costs (labour and fuel) and processing practices (period of fruit storage) employed at the mill, in order to understand efficiency at the level of the mill (constraints 4a and 1b in Fig. 2).
3. Laboratory and participatory experiments to establish seasonal variations in the oil and moisture content of fruit mesocarp (constraint 4b in Fig. 2).

7. Conclusions

This study is part of an action research programme to improve the processing practices of small-scale oil palm fruit processors in the Kwaebibirem District of Ghana. The diagnosis has assessed the processing practices of small-scale oil palm fruit processors in six purposively selected sites in the district. We conclude that the constraints faced by processors are multi-faceted and multiple-scale and therefore that a cross-disciplinary research approach is needed to effectively address these complex issues and search for integrative solutions that are well embedded in the current local processing practices. This will ensure that the processors can take

advantage of an opportunity to access a remunerative market, for improved livelihoods.

A problem tree analysis has shown the diverse socio-economic, institutional as well as technical nature of small-scale processors' constraints. An appropriate combination of social and technical research with an institutional policy package is needed to effectively address the constraints identified. However, any efforts to improve livelihoods through changes in processing practices should carefully consider which phases of processing could be mechanized, so as not to deprive the most vulnerable people in the district from obtaining incomes from the processing activities.

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