Improving the quality of crude palm oil

Charity Osei-Amponsah

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Transdisciplinary research on artisanal processing in Kwaebibirem District, Ghana

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Thesis

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Chapter 1

General Introduction

1.1 History and development of oil palm processing

Oil palm is indigenous to West Africa, and rural communities in the forest belts of Ghana are familiar with its cultivation and use (Gyasi, 1992). The crop is useful for the production of edible oil, and also oil which is an input for the industrial sector of local, regional and global economies. Two main kinds of oil are processed from oil palm fruits, namely crude palm oil and palm kernel oil. The focus of this study is on artisanal crude palm oil processing and the processors involved in this enterprise.

Oil palm processing started in Ghana around the 16th century and the palm oil produced was first traded to England at about 1590 (Henderson and Osborne, 2000). Interest in its trading however increased only in the early 1800s during the industrial revolution. At this time, palm oil was produced by households (Lynn, 1991) using mortar and pestle for pounding the boiled fruits. Oil palm production was then mainly from natural groves managed by peasant farmers. Later plantations were established by the Dutch (Dickson, 1969). Ghana's first international commercial trade in palm oil was in 1820 (MOFA, 2011). By 1884, 20,000 tonnes of palm oil (mainly from peasant palm fruit production) was exported and accounted for about 75% of export revenue (Gyasi, 1992). In the late 19th and early 20th century, more plantations were established by the British and other Europeans. Then through an oil palm ordinance in 1913, rights were given by the government to mill operators to extract palm oil by mechanical means within the vicinity of the plantations. However, this plantation system failed partly due to internal political insecurity and rivalry among the European powers seeking territorial hegemony. Also, the British colonial administration did not favour plantations because it believed the indigenous peasant farming system was more resilient economically (La-Anyane, 1961; 1963). Around the same time, cocoa production surpassed oil palm production because it was less labour intensive (La-Anyane, 1966), this contributed to a decline in peasant oil palm production. Some farmers, however, continued with the small-scale cultivation of oil palm, and sold the harvested fruit bunches or processed them into palm oil (Gyasi, 1992).

Then, after Ghana's independence in 1957, there was a policy change which put more emphasis on plantation systems (Ministry of Agriculture, 1990). This led to the creation of state farms, but the attempts at engaging in state-owned farms did not

prove economically viable (Miracle and Seidman, 1968). During this second half of the 20th century initiatives were made to modernize oil palm processing but again with little success. For example, the establishment by the Ministry of Agriculture of communal processing factories developed in high oil palm density areas did not work out, due to lack of enthusiasm from the local people. The factories could not also offer a price which would be above what the farmers could make from processing the fruit bunches themselves, because of the factories' high start-up costs (Kaniki, 1980). Then from 1977, the government sought to promote plantations through private corporations, foreign assisted government ventures, and joint public-private projects. As a result, three large plantations with processing plants were built in the Eastern (Kwaebibirem district), Central and Western Regions, but artisanal processing continued alongside the large-scale processing. In the latter part of the 20th century, medium-scale processing mills started operating in these regions, especially in the Kwaebibirem district. Together with the large-scale processing mill, they dominate the local industrial market, supermarkets and export markets because they produce quality palm oil which meets the standards of these markets.

Artisanal oil palm processing in the Kwaebibirem district is part of the way of life for most people. In the past, palm oil was produced at home from fruits harvested from wild groves. The oil was produced in small quantities for cooking and the excess sold in the local markets. With the establishment of the Oil Palm Research Institute in the district by 1964, farmers were introduced to high-yielding hybrid (*Tenera*) oil palm seedling varieties. The production of fresh fruit bunches increased and it was almost impossible to continue using the old home method of pounding with a mortar and pestle to process several tonnes of fruit bunches. An artisanal oil palm processing mill using semi-mechanised equipment was first developed and used by a Dutch engineer to process fruits from his farm. Later different designs of the technology spread in many parts of the district. This type of artisanal processing enterprise started developing gradually in the district and palm oil production increased, exceeding household cooking needs. Some traders who were already familiar with buying and selling in neighbouring Togo started purchasing palm oil to sell in the Togolese market. Since 2005, a Nigerian market has also evolved which buys a large proportion of the palm oil.

The artisanal processors are perceived to produce poor quality palm oil and therefore have no access to these in principle more remunerative markets. This thesis intends to investigate why the quality is poor, and explore ways artisanal processors can improve on the quality of their palm oil.

1.2 Main actors of the oil palm industry

1.2.1 Small-scale production, processing and marketing

The small-scale independent farmers cultivate 87% of the roughly 306,000 hectares (ha) of land under oil palm cultivation and produce about 80% of the fresh fruit bunches in Ghana (MoFA, 2011). Their farm sizes range from 2-10 ha with an average fresh fruit bunch productivity of 4-8 tonnes/ha. These farmers are generally free to decide how to use their land, which variety of seedlings to plant, how to manage their farms and which processor to sell the bunches to. Land for cultivation is acquired from chiefs as stool lands (lands attached to the chieftaincy administration), family heritage lands, owned property or rented land for sharecropping. Some farmers use certified seedlings and seed nuts from the Oil Palm Research Institute but the majority especially those living farther away from the Eastern Region where the institute is located, tends to cultivate 'volunteer' or uncertified seedlings (Adjei-Nsiah *et al.*, 2012a).

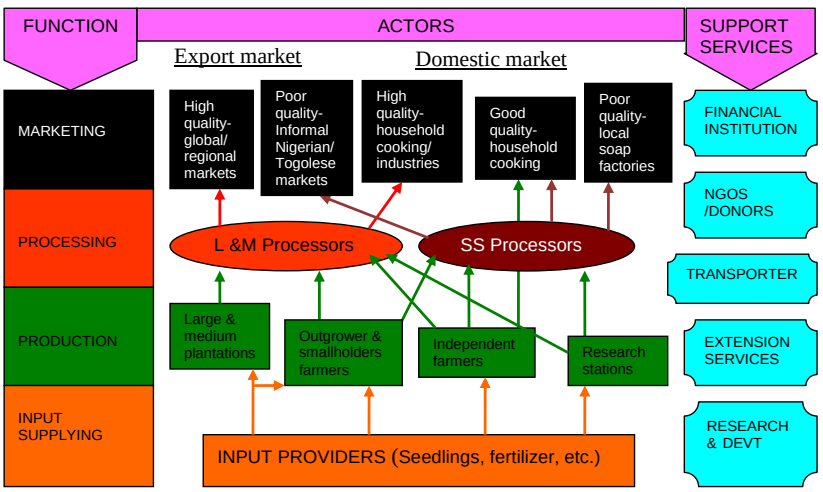

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Figure 1.1 Overview of the oil palm industry in Ghana, L is large scale, M is medium scale and SS is small-scale or artisanal processors.

The small-scale processing enterprise made of artisanal mills is predominant in most oil palm producing areas of Ghana. Processing is semi-mechanised with palm oil extraction done mainly through the use of a separate digester and hand spindle press. Processing capacity is from 3 to 8 tonnes fresh fruit bunches/day with an extraction

rate of 9-15% (GoG, 2010). The (predominantly female) processors go to particular mills to access processing facilities, extract the palm oil and sell it at the same place. Few processors produce good quality palm oil for home consumption while the majority make poor quality ordinary crude palm oil which is sold to the local soap making enterprise (Figure 1.1) or to Togolese and Nigerian informal markets. The price of the commodity is determined by these markets and the fruit bunch production seasons. This thesis focuses on the majority of artisanal processors currently producing poor quality crude palm oil and the options for accessing different markets.

1.2.2 Medium and large scale production, processing and marketing

The larger plantations are mostly owned by private foreign investors and the government of Ghana, and they have access to credit from international financial institutions such as the World Bank's International Financial Corporation (World Bank, 2011). The main large-scale players in the industry are Ghana Oil Palm Development Corporation, Twifo Oil Palm Plantation and Benso Oil Palm Plantation. The medium-scale plantations are usually private with or without assistance from financial institutions. Examples are Juaben Oil mills, Golden Star, Ameen Sangari and Obuoma mills. Both scales of production are characterised by commercial production of fresh fruit bunches with farm sizes ranging from 200 to 500 ha for medium-scale and above 500 ha for large-scale production. The companies generally maintain a nucleus estate which consists of their own plantation, then a smallholder farmers' scheme on the plantation's land, and outgrower production schemes based on individual's owned or leased land. Smallholder farmers are bound by contract, credit agreement and other economic arrangements to the plantations.

The medium and large-scale producers together with their smallholders and outgrowers cultivate 13% of the total area under oil palm production in Ghana. Fresh fruit bunch productivity is about 9-14 tons/ha/year (GoG, 2010). Germinated nuts or seedlings of high yielding varieties are sourced from the Oil Palm Research Institute in Ghana; the Centre de Coopération International en Recherche Agronomique pour le Développement (CIRAD) in France; Pobé in Benin; Binga in Congo Democratic Republic, and LaMé in Côte d'Ivoire.

The plantations are also linked to 15-60 tonnes/hour capacity processing and refinery facilities with palm oil extraction rates of 18-21.5% (GoG, 2010). Processing activity starts with the arrival of the fresh fruit bunches at the processing site and ends with the packaging of palm oil for delivery to various buyers. Processing of fresh fruit bunches is highly mechanised. The crude palm oil is of high industrial quality and it is refined into other products, exported and/or sold to domestic manufacturing companies, while smaller quantities are sold at supermarkets as edible vegetable oil.

The price of palm oil sold by the medium and large scale plantation is quoted based on the prevailing world market price and the quality level of the oil.

1.3 Palm oil quality standards

Quality of crude palm oil can be assessed both by looking at physical properties (smoking point, colour, viscosity) and chemical characteristics like iodine, free fatty acids, peroxide, dirt, moisture contents and bleachability index (PORAM, 2011). Palm oil is composed of fatty acids esterified with glycerol, and its quality is affected by reactions which cause the breakdown of the esterified fatty acids and formation of free fatty acids. The relevant standards for quality crude palm oil are: free fatty acid (≤5%); dirt (≤0.01 %); moisture (≤0.1 %); and (>3) for bleachability (PORAM, 2011).

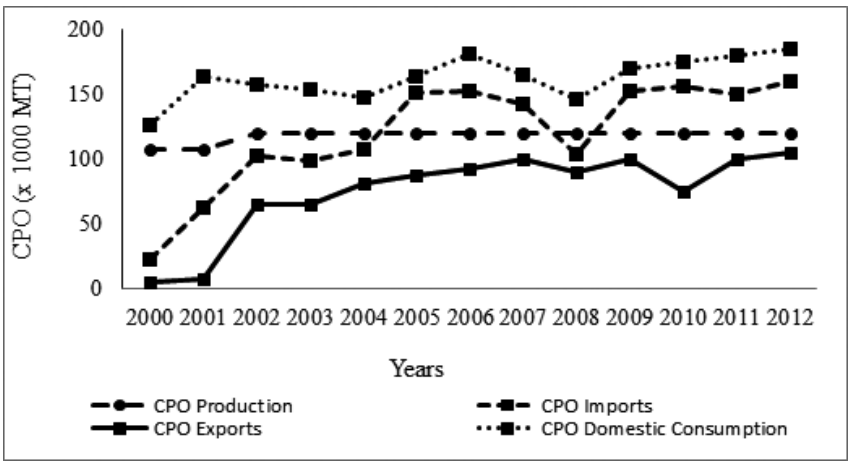
The free fatty acid (FFA) level of palm oil is the most essential indicator of quality for selling palm oil in especially export and domestic industrial markets (Kardash and Tur'yan, 2005). A high level of FFA implies the palm oil is very rancid and of poor quality. On the other hand, palm oil of low FFA value (≤5%) is classified as high quality and also attracts a higher price. Quality assessment of palm oil for household consumption is basically organoleptic, in that buyers taste, smell and assess colour of palm oil to determine its quality. Palm oil of good taste, smell and deep red colour is generally perceived as the best for household consumption. For the purposes of this research, I use FFA levels as an indicator for palm oil quality. The quality of palm oil is then categorised based on its FFA level as high quality (1-5%), good quality (5-10%) and poor quality (above 10%).

The vast majority of artisanal processors produce poor quality oil and this type of palm oil is not acceptable to local industrial and exports markets because it affects the efficiency and cost of refining processes (Gibson *et al*., 2007). Such palm oil also gives a rancid taste which does not meet the preference of households for cooking purposes. The only market option for this type of quality is the local soap manufacturers and informal markets in Nigeria and Togo, which buys any quality of the palm oil but at a lower price. If palm oil is to enhance rural development, then exploring alternative markets by artisanal processors for higher prices is important. Potential access to remunerative markets thus necessitates the assessment of palm oil quality level and the need for improvement in the artisanal processing enterprise.

1.4 Government interventions and policies for the oil palm industry

Ghana's industrial quality crude palm oil (CPO) production amounted to 120,000 metric tonnes (MT) in 2012 (Index Mundi, 2013), while 185,000MT of CPO was imported. Crude palm oil production trends over 12 years show stagnation (Figure 1.2) while Ghana's domestic consumption continues to increase with a growth rate of 2.8% in 2012. Ghana is a net importer of CPO, but re-packs a portion of what is produced

and imported for export to other African countries. Most West African countries are net importers also, and neighbouring countries like Nigeria and Benin imported 470,000 and 450,000 MT respectively in 2012. Most of these imports are from Malaysia and Indonesia, the world's biggest (together 89%) producers of palm oil.



Source: data compiled from Index Mundi (2013)

Figure 1.2 Crude palm oil (CPO) production, imports, exports and domestic consumption (×1000 MT) in Ghana, between 2000 and 2012.

Ghana's projections for high 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. On the other hand, domestic consumption of the commodity will increase drastically within the period (GoG, 2010). Ghana currently imports high quality palm oil in the order of 50,000 MT per year and this will increase to over 125,000 MT by 2025. There is a growing demand for such crude palm oil not only in Ghana but globally. In West Africa alone, there is a market which demands close to 1 million MT a year. China and India have rapidly growing economies which needs a lot of crude palm oil (imports show an annual growth rate of 100% since 2009) to feed its giant factories. Ghana thus has the opportunity to explore this demand by developing its oil palm industry further to meet the growing market interest in palm oil both domestically and internationally.

At the start of the new millennium, the Ghanaian government identified the oil palm industry as having great potential to create jobs and reduce poverty. Already over 636,000 households, mainly in rural communities, are engaged in oil palm cultivation generating about 8.75 million Ghana Cedis to the agriculture sector (GLSS, 2000). To

offset the gap between demand and supply of the commodity, 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 (GoG, 2003). The intervention was to serve as a precursor to agro-industrial development and economic development in particularly rural areas. Taking into consideration that land tenure system in the country remains a barrier for large-scale production, the initiative sought instead to help small-scale farmers to cultivate 100,000 ha of oil palm in the first five years and an extra 350,000 ha in the long run. The small-scale farmers were to be affiliated to processing mills to supply the raw material (fresh fruit bunches). The objective was to encourage farmer ownership in new processing mills to be managed under Corporation Village Enterprise called the COVE concept (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). This pro-poor initiative however did not survive and came to a halt by 2008 (Asante, 2012).

The current development plan document 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 (GoG, 2010). The plan focuses on access to credit, certification, land use and tenure policy, technology transfer, infrastructure development from the farm to the port, as well as pricing mechanisms and marketing issues. It recommends the establishment of a plantation and processing mill complex through the acquisition of 30,000 ha of land by the government, of which 50% will be used for a nucleus estate and the other 50% for smallholder development schemes. Artisanal processing was found to have a relatively lower efficiency level and questionable sustainability (GoG, 2010). It was thus not part of the best model recommended for addressing the shortfall in palm oil production in Ghana; yet history (Miracle and Seidman, 1968; Kaniki, 1980) shows that past policies and interventions tried to organise and fix developmental changes in the industry through similar interventions but with little success.

At the macroeconomic level, it may seem logical to kick out the 'inefficient' artisanal processors and channel all fruit bunches to the medium and large scale processors with high extraction rates. On the other hand, there is a high degree of embeddedness of palm oil production in rural societies and the artisanal enterprise provides livelihoods for several people in such areas. So, to enhance growth of the industry, the inefficiencies should rather be identified and addressed. However, the caution here is that, just coming up with technological fixes only to address problems

may not to be effective because actors in the artisanal processing industry have their own 'science' and practices which need to be understood alongside the introduction of new technology (Barrow, 1992). Research institutes and government organisations tend to overlook artisanal processors as key actors in the oil palm industry. I do not take a stance that I know what is best for artisanal processors, but I try to investigate how they can use their capabilities to develop knowledge and skills for addressing their own constraints in this thesis.

1.5 Research problem and objective

In 2008, when the Convergence of Science-Strengthening Innovation System (CoS-SIS) programme started, oil palm was selected by a national consultative committee as one of the priority domains to be part of the programme. Then, an in-depth exploratory study (Adjei-Nsiah *et al*., 2012a) of the oil palm industry assessed that there is a potential for developing the small-scale oil palm enterprise. This enterprise forms the bulk of fruit bunch production and also produces about 80% of crude palm oil in the oil palm industry. It therefore has a possible key to promoting growth and bridging the gap between supply and demand for CPO (MOFA, 2011). The exploratory study mentioned above found a myriad of constraints, key among them being the inability of artisanal processors to access profitable or remunerative markets all year round due to the perceived poor quality of the commodity. This constraint involves a complex knot of social, technical and institutional issues, which need different disciplines to untie, and also improve on the situation.

Research in agro-processing is usually discipline-oriented, either as social or technical science to address a specific aspect of a constraint. However, applying science-based methods and techniques separately may not necessarily be adequate as a research approach. Since the constraints of the artisanal oil palm processing enterprise are multifaceted and complex, being at the same time socio-technical and institutional, a research approach is needed that can address the constraints in an integrated manner. Yet, there is no universal model to choose for this kind of research that addresses such complexity. This is because the usual linear or even participatory technology development approaches may still leave out the understanding of the social fabric of the palm oil processing activities and its underpinning institutions.

There is an emerging debate that alternative ways of decision-making and agricultural research are needed (Hounkonnou *et al*., 2012). One key aspect of the debate is that scientific knowledge alone cannot provide solutions effectively; hence the involvement of stakeholders in the research process is needed to create solution options and ownership (Lang *et al*., 2012; Leeuwis, 2004). Diop (1992) and Richards (1985) offer examples of how local people's knowledge and technical science have

interacted productively. Also, according to Thompson (1991), if local knowledge and stakeholder's capabilities are blended with scientific knowledge and approaches, an effective and lasting result will be achieved. In such research, it is important to take account of and learn from what stakeholders already know and can do.

The CoS-SIS programme suggests a transdisciplinary approach in agricultural research. This enables the researcher to look into a wider context of the domain to be studied as an integrated whole. It also takes into account the complexity of the problems at stake, and its diverse perspectives. This implies that a technological improvement package alone in addressing constraints may not be successful, because it will only render the technical part of rural development (Li, 2007). On the other hand, a rich description of the everyday life of actors at an artisanal mill alone cannot address the technical issues. Therefore, the search for an effective solution to the problem is better served if one discipline informs the other and vice versa in knowledge interfaces (Jiggins, 1986).

Although oil palm stakeholders did not explicitly mention social relations within a mill as a constraint, a diagnostic study suggested that such relationships may influence CPO quality. For instance, there are issues of trust/mistrust in the flow of fruit bunches, money and CPO which may serve as opportunity or constraint to processors. Also credit delivery, pricing, and social and human capitals are cornerstones of a well-established trans-national trade network that keeps transactional costs low, but also influences quality of CPO produced. On the other hand, accessing new markets with a higher quality CPO obtained through change in practices will also affect processors' existing networks, while time will be needed to build new ones. The dynamics of these issues cannot be understood with the collection of information through a one-time survey. In addition, data and observations on technical aspects of production, like the type of extraction equipment or quality of fruit used, have equal scientific value (Sillitoe, 1998) as the keeping up of good relationships and efficient resource flows between the processor, caretaker, and workers at the mill or the practical knowledge of the actors involved.

The objective of this study is to investigate how artisanal oil palm processing can be improved by an increased quality of crude palm oil in order to enable artisanal processors to access remunerative markets, by addressing the interface of socio-technical and institutional constraints of artisanal processing. To achieve this objective, I specifically address the following questions:

- What are the socio-technical and institutional constraints of the artisanal oil palm processing enterprise in Kwaebibirem district of Ghana?

- Who are the actors, what are the networks and flows of resources at artisanal processing mills and how do they relate to the technical and institutional constraints?
- What knowledge can an action research provide and how can it help processors to improve on their processing practices?
- Why and how do the action research and other interactions influence institutional changes in the artisanal processing enterprise?

It is envisaged that artisanal palm oil processors are constantly involved in experimentation in their everyday processing activities. Therefore, I assume that a researcher and stakeholders, including the processors, can co-learn in a framework of specific experiments and interactions to construct together the necessary knowledge for improving the quality of crude palm oil.

1.6 Research methodology

1.6.1 The Convergence of Science-Strengthening Innovation Systems programme

The research is situated within the CoS-SIS programme. The philosophy of the programme is centred on creating appropriate institutional space for sustainable productivity and improved livelihoods for agriculture smallholders (Hounkonnou *et al*., 2012). It primarily consists of PhD research projects and institutional experimentations using innovation system thinking. The programme also suggests an alternative approach to agricultural research by emphasizing the active role of multiple stakeholders in the research process at different institutional levels. Five main stages are outlined for the CoS-SIS research as: exploratory and scoping studies; diagnostic and baseline study; participatory action research; facilitation of a concertation and innovation group (CIG) by a Research Associate (RA); monitoring and evaluation of the change process.

Following the programme's approach, close collaboration was established between the PhD researcher and the RA who already holds a PhD. First, an exploratory study (Adjei-Nsiah *et al*., 2012a) was done by the RA to identify constraints and opportunities of the oil palm industry in Ghana. This was followed by a scoping study carried out by the PhD candidate to validate findings from the exploratory study. All the constraints identified from the studies were categorised and prioritised by various stakeholders of the oil palm industry as social, technical and institutional issues that needed further research and a development intervention. The major issue prioritised by the stakeholders for further research was poor access to remunerative palm oil markets linked to the quality of the CPO commodity. This was

then chosen as the entry point for a diagnostic study (Chapter 2) and the lead problem to be solved through the study. The findings of the diagnosis which was validated by stakeholders defined the research activities and also the chapters of this thesis.

1.6.2 The transdisciplinary research process

Transdisciplinarity implies that the knowledge of the actors at the mill needs to be related to and compared with scientific knowledge (Long and Long, 1992) of the oil production process. Usually, transdisciplinary research involves several researchers who each bring in their own disciplinary expertise to collectively design and carry out a research (Visser, 2004) by engaging stakeholders (Leeuwis, 2004). It is less common that one single person carries out the research, integrating her/his knowledge of the different disciplinary fields in which she/he was educated. In this research, I draw on my training or 'knowing to' in laboratory testing, crop science, agricultural economics, rural sociology, and my academic exposure to communication and innovation systems and food science. I have tested and compared my knowledge of assessing quality palm oil against the practical 'know-how' or local knowledge of the processors. I did so by participating at the day-to-day interactions at several artisanal mills (Chapter 3); actively involving them in an experiment (Chapter 4); and facilitating the discussion at stakeholders' platform workshops (Chapter 5). I experienced how my involvement in such transdisciplinary research can help to better address the mutual interdependence of the social, technical and institutional constraints of artisanal processors. My attention here is not to coerce all processors to access new markets, but to be able to find by learning together, alternative markets which they can choose from, based on their options to decide which quality of palm oil to produce, and trading networks to develop.

The overall conceptual framework is adapted and modified from the transdisciplinary research model of Scholz *et al.*, (2006) and Wiek (2007) which also resembles the 'hedgehog' metaphor (Leeuwis, 2004). The metaphor talks about the existence of a complex societal problem (body of hedgehog), which needs to be studied from different disciplines (spines of hedgehog) and co-operation between disciplines makes solving the problem possible. According to these authors, transdisciplinary research follows two pathways. It initiates from a societal real-life problem that implies and triggers relevant socio-technical research questions; then it relies on mutual and joint learning processes between science and society (Siebenhüner, 2004). This research however goes beyond their framework to look at institutional constraints that may impede the success of addressing the problem. Thus the modified framework can be seen as an iterative sequence of three phases:

- Collaboratively framing and validating the real-life constraints
- Co-producing solution-oriented and transferable knowledge through joint participatory experimentation and local stakeholders' platform activities
- Applying the produced knowledge in both science and societal practice (Scholz *et al.*, 2006; Wiek, 2007; Leeuwis, 2004).

In my case, a local stakeholder's platform was formed to help various stakeholders to put their perspectives, knowledge, skills together to address the issue of poor quality crude palm oil. Thus institutional stakeholders of different levels, like the District Director of the District Agriculture Development Unit, extension officers and researchers from two research stations and most importantly, the processors, farmers and mill workers were selected. The platform offered the opportunity for stakeholders to assess their own situation, diagnose, prioritize problems and plan what research should be done, how, when, where it should be done (Lang *et al*., 2012) then shared and validated the research findings.

The local knowledge of processors was observed and learned effectively through ethnographic methods (Hammersley, 1998; Clifford, 1988; Chambers, 1997). Thus to understand the details of processing practices, actors' interfaces and engagements in social networks, I observed and interviewed the various actors. This is because, I intend to bring out the different actors' positions and decision making strategies through their own account of the everyday practices, networks and resource flows. The technical testing of palm oil quality together with social insights from actors provided a sound basis for a participatory joint experimentation exercise.

The different disciplinary methods generated both quantitative and qualitative data which were analysed with statistical tools or conceptually depending on the issues being addressed. The specific methods used, the data gathered and their analysis are elaborated in the empirical chapters.

1.7 Structure of thesis

In this introductory chapter, the history of the oil palm industry in Ghana has been described in a way as to position small-scale (artisanal) palm oil production along the modern context of medium and large-scale industrial enterprises that govern high quality market access. The research problem, objectives and research questions of the study are made explicit, together with the explanation of the transdisciplinary research approach used for the thesis.

As indicated in Figure 2.2, in Chapter 2 the entry point identified through an exploratory study is investigated to have a broader understanding of processing practices of artisanal palm oil production. The formulation of a problem tree led to socio-technical and institutional constraints as specific issues for research. The study area and selected sites for specific research activities are also described.

Chapter 3 narrates the everyday practice of artisanal oil palm processing in the case of a selection of three artisanal mills. The position of the female processor as the key actor, her networks, and the flows of resources between them are described. The agency of actors, power relations, trust/mistrust, contestation and force-fields are also explored. This chapter concludes on a recommendation of relevant actors for an effective joint experimentation. In this regard, the local knowledge of actors, the understanding of their processing practices and agency forms the basis of the study reported in Chapter 4.

For Chapter 4, a participatory action research approach is used to design a joint experimentation with relevant stakeholders, in addition to a researcher-based experiment. The assumptions or hypotheses underlying the experiments emanated from findings on local knowledge of artisanal processing in selected communities. It describes the learning process of palm oil producers in selected sites as they make changes in processing practices to improve on the quality of palm oil. The chapter also investigates whether it is profitable for processors to improve the quality or continue with the former processing practice and produce poorer quality palm oil.

In Chapter 5, I explore how the learning from Chapter 4 and the interactions among various stakeholders in the enterprise have impacted on the quality of palm oil. This is done by comparing ex-ante and ex-post information. The focus is mainly on how institutional constraints identified at the start of the research are addressed at the end. The intervention of the research associate (RA) and the facilitation of a concertation and innovation group established by the project in linking artisanal processors to a remunerative market is briefly mentioned.

Chapter 6 is the concluding chapter. It gives a summary of the key findings of the research. The reflections on doing a transdisciplinary research within the CoS-SIS context and the challenges faced are shared. The chapter also highlights the outcomes of the study and provides suggestions on how to design effective research for development in artisanal agro-processing settings.

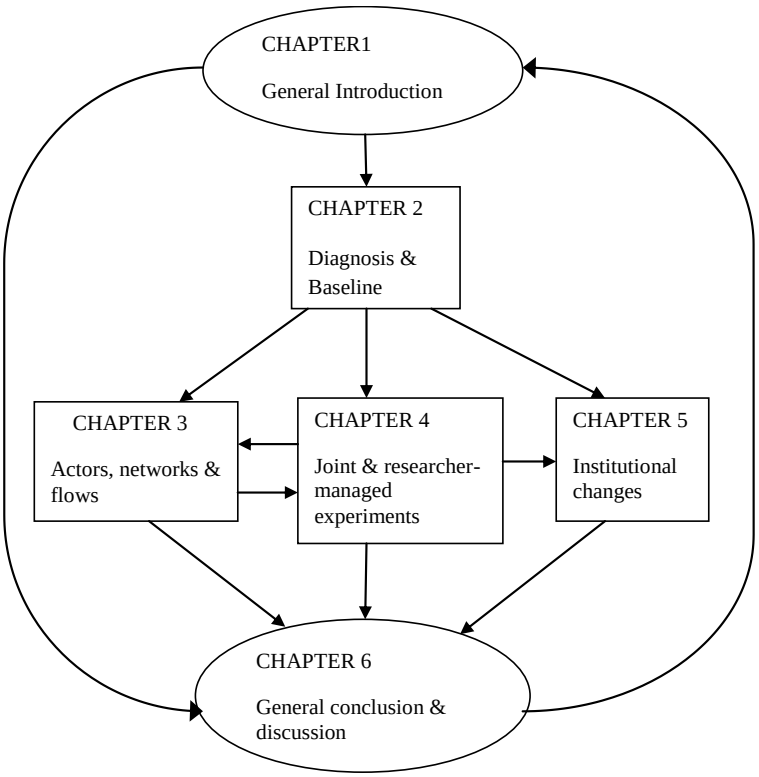


Figure 1.3 Linkages between the chapters of the thesis.

Chapter 2

Processing practices of small-scale palm oil producers in the Kwaebibirem District, Ghana: a diagnostic study[1]

Abstract

Ghana produces about 2,000,000 tonnes of oil palm fruits annually, and artisanal processors contribute about 60-80% 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 palm oil produced by artisanal processors cannot be utilized by either the larger scale industries in Ghana or abroad and also for cooking, 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, personal interviews, focus group discussions and surveys based on a semi-structured questionnaire to assess the processing practices of artisanal oil palm fruit processors, and to analyse the rationale behind these practices. The processing practices identified included storage of loosened fruits for long periods before boiling, disposal of effluent into drains, use of spent tires for boiling fruits and no clarification of the oil. About 54% of the processors stored oil palm fruits for 1 to 3 weeks after they have been loosened, 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 storage period on the quality and quantity of palm oil, and the types of linkages and interactions among actors in the oil palm industry were identified together with stakeholders as issues for further research. Innovation in artisanal oil palm fruit processing is revealed as a multi-stakeholder, multiple-scale, and interdisciplinary process.

[1] This is a slightly modified version of an article published as: Osei-Amponsah C., Visser L., Adjei-Nsiah S., Struik P.C., Sakyi-Dawson O.,Stomph T.J. (2012) Processing practices of small-scale palm oil producers in the Kwaebibirem District, Ghana: a diagnostic study . NJAS-Wageningen journal of life sciences 60-63: 49-56

2.1 Introduction

2.1.1 Background

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 (GoG, 2003). In 2009, Ghana produced about 2,103,600 metric tonnes (MT) of oil palm fruit bunches and 130,000 MT of palm oil (FAOSTATS, 2009). Artisanal processors produce about 60-80% of the country's palm oil (Opoku and Asante, 2008). The crude palm oil (CPO) produced by most processors does not meet the quality standard for industrial utilisation because of its high concentration of free fatty acids (FFA). In order to meet the country's fats and oil requirements, which are estimated at 252,432 MT, the country imports large quantities of high quality palm oil annually. In 2007, for instance, about 150,000 MT of oils and fats were imported of which 94 per cent was in the form of palm oil (ibid). 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 (MPOC, 2009). This shortfall is envisaged to increase to 101,800 MT by 2012. Thus there is a potential for a huge internal market for artisanal palm oil processors in Ghana, provided they can deliver the required quality.

When supported through training and provision of efficient processing equipment the artisanal oil palm processors can produce good quality crude palm oil to meet the demand of the local industry and household consumption. 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 out growers divert the fruit bunches to their families who process at the artisanal mills.

Although many agricultural research investments have been successful, it is increasingly recognized that conventional agriculture research is not sufficient to enable agriculture innovation (World Bank, 2006). In many cases there is a lack of an effective process for integrating practice-based knowledge and scientific knowledge, community learning, the empowerment of actors and institutional change. Sayer and Campbell (2001) argue that sustained improvements to the livelihood of small-scale producers 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 Convergence of Science-Strengthening

Innovation Systems (CoS-SIS) programme applies this alternative approach to agricultural research.

An exploratory study (Adjei-Nsiah *et al*., 2012a) and unpublished scoping study 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. The studies revealed that artisanal 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. Possibly, 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 (Anon, 2010) for palm oil for various uses provides opportunity for artisanal processors to improve their incomes. The issue of processing practices and poor quality of palm oil was thus selected as the entry point for the CoS-SIS research in the oil palm domain in Ghana. This chapter focuses on understanding the details of the entry point and exploring what can be done to contribute to quality management of palm oil in the artisanal processing enterprise.

The chapter first examines the importance of processing oil palm fruits among artisanal processors in the study area and identifies the different actors with which they are engaged in the enterprise. It also outlines the constraints and opportunities of the palm oil enterprise using a problem tree analysis. The chapter then explores processing practices, and shows the quality status of palm oil samples randomly collected from the study areas, as well as the rationale for the practice of storing oil palm fruits for long periods. Drawing on the findings, the chapter discusses the implications of the analysis of a 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 district and national stakeholder platform known as the Ghana oil palm Concertation and Innovation Group (CIG).

2.1.2 Study context

Initial exploratory and scoping studies were conducted in one district 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 study because of the existence 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 (Figure 2.1). Agriculture employs 77% of the economically active labour force (Addo, 2000). 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 artisanal oil palm processing mills for the processing of oil palm fruits (ibid).

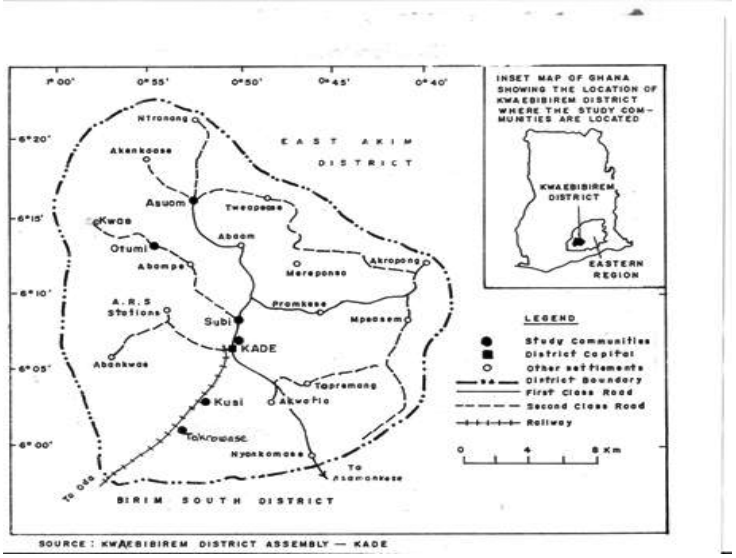


Figure 2.1 Map of Kwaebibirem District showing the six study sites

The diagnostic study was conducted from March to October 2010 in six purposively selected towns, namely Otumi, Asuom, Kusi Takrowase, Subi and Kade (Figure 2.1). 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 high 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.

2.1.3 Methodology and research questions

The entry point for the study was selected at an initial local stakeholders' workshop held in Kwaebibirem District, Kade. This workshop involved representatives from the District Agriculture Development Unit of the Ministry of Food and Agriculture, the Forest and Horticultural Crops Research Centre, Oil Palm Research Institute, Ghana Oil Palm Development Company, artisanal oil palm farmers, processors, mill owners, mill workers, the researcher, the CoS-SIS national coordinator and the research associate. Using findings from exploratory and scoping studies, the participants discussed and agreed that the study should be centred on processing practices and poor quality of palm oil. Poor quality of palm oil may be related to environmental hazards of some processing practices; also inadequate access to household consumption, 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 transdisciplinary study to the needs and to the context of the artisanal oil palm fruit processors. The people directly involved in the study were independent small-scale farmers, artisanal processors, mill owners, mill workers and buyers in the artisanal oil palm enterprise. In addition, a local stakeholders' platform was set up in the district to discuss and give input to the entire PhD research project at different stages of the process.

The following questions are addressed:

- What is the importance of oil palm processing in the study areas?
- What are the processing practices and the operation units of artisanal processing?
- Who are in the networks of artisanal processors?
- What are the constraints in the oil palm industry for artisanal 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?

2.2 Methods of data collection

Introductory meetings were conducted in each of the six towns by the researcher with artisanal 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. The key informants (two each from the six towns) subsequently were interviewed to understand how the artisanal enterprise operates. The information gathered was then presented and discussed in groups of eight to ten 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 enterprise) arising from the interviews were then discussed in turn, in six different focus groups.

Based on the information gathered by these preparatory interactions, pre-tested semi-structured questionnaires were prepared and a survey conducted with purposively selected farmers, mill owners and processors (Table 2.1). The questionnaire sought information on the demographic and social-economic characteristics of the respondents' production and processing practices. In addition to this, milling site visits, visually-aided dialogues, participant observation and discussion at local stakeholders' platform workshops were used to collect additional detailed information on actors' perceptions and practices.

Table 2.1 Numbers of mill owners, processors and farmers surveyed in each of the towns in Kwaebibirem district, 2010

Town	Number of mill owners	Number of processors	Number of 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

Useful qualitative and quantitative information on the oil palm industry in Ghana was collected also through a review of literature supplied by the Oil Palm Research Institute (OPRI) of the Council for Scientific and Industrial Research (CSIR), Forest and Horticultural Crops Research Centre of the University of Ghana, the Kwaebibirem District Directorate of the Agriculture Development Unit of the Ministry of Food and Agriculture (DADU-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, DADU of MOFA and OPRI of CSIR.

SPSS software version 16 was used to analyse the data in this study. Finally, in order to assess the FFA concentration (as an indicator of quality) of palm oil produced in the district, a total of 18 crude palm oil samples were collected from three processing sites in each of the six towns and analysed in the laboratory of the Nutrition and Food Science Department of University of Ghana. The concentration of free fatty acids was determined, using the American Oil Chemists' Society's official methods and recommended practice Ca 5a-40 (AOCS, 1990).

At the end of the study, the findings were presented for validation to local stakeholders at a workshop. They clarified the information presented to them and agreed it was a true reflection of what pertained in the enterprise at the time. A problem tree was then constructed, based on the stakeholders' assessment of the constraints identified in the town meetings, focus group discussions and personal interviews. The stakeholders- farmers, processors, mill owners, workers, extension officers, scientists, and district assembly officer validated and prioritized at the 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 pulled together in a plenary session and a final constraints list composed. The stakeholders then were asked by the facilitator to categorize the constraints into social-economic, technical and institutional constraints, and this was later separated into above-processor or at-processor levels.

The main findings of the study were 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.

2.3 Findings

2.3.1 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 cultivating oil palm in the district is estimated at 13,095. Total land area under oil palm is estimated to be about 50,700 ha (K. Ametepe, 2010, personal communication)

72% of which is cultivated by small-scale independent farmers. This has resulted in the establishment of many artisanal 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 2.2).

Table 2.2 Distribution of sources of income for artisanal processors (N=92)

Income source	Distribution frequency (%)
Processing of 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

On average, an artisanal 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 while 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 litres of crude palm oil (CPO) is produced per month in the lean season compared to 2192 litres in the peak season. A metric tonne (1000 litres) of CPO sold between 720 GHC (USD 480) and 1,000 GHC (USD 667), depending on the season, at Kwaebibirem district in 2010. Most of the oil is sold to local traders for the regional West African market, and it is also used as a raw material for artisanal domestic soap-making.

2.3.2 The artisanal 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-mechanised processing equipment at a milling site. The mill is locally called ‘Kramer’ after a Dutch engineer who first set up an artisanal mill in the district (Nana Yeboah, 2010, personnel 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 to 10 years, while 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 among 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 and/or parents who had been engaged in the enterprise before them.

The buyers of palm oil were mainly local agents who purchased the CPO on behalf of Nigerian buyers, and women traders who buy the oil for re-sale in Togo. Also, a few market women buy oil to sell it in the cities of Ghana (but this was Zoomi type of palm oil, which is not the focus of this study). 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.

2.3.3 Actors in the artisanal oil palm fruit processing enterprise in Kwaebibirem district

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 independent and outgrower farmers, formal and informal creditors, transporters, mill owners, palm oil processors, domestic local soap makers, kernel oil processors, local market buyers and bulkers of CPO). Notably, research scientists, extension agents and policy makers were not visualised as actors in the network. They were not even mentioned by the processors as being involved. An effective coordinating 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 directly 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 from November to 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.

2.3.4 Constraints of the artisanal oil palm processing industry

The problem tree was constructed (based on the information gathered from the focus group discussions, individual interviews with processors and prioritization of the issues by stakeholders) (Figure 2.2). 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, that is, as issues and constraints that should be tackled by the CIG. For example, the weak regulatory framework for the enterprise was seen as a policy issue which should be dealt with at the district and national levels through the facilitation of CIG activities. However, it is noteworthy that a number of the issues and constraints were positioned at the level of the processors themselves. The numbering indicated on Figure 2.2 indicates the relative importance to stakeholders of each constraint. Thus the poor market incentive (1) is identified as the most important and urgent issue to be addressed and the lack of a regulatory framework as the least important (7).

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 markets was positioned as an institutional - and a high priority - constraint embedded in practices, norms, and informal and formal rules in the artisanal oil palm enterprise. An examination of the diagram further indicates that the poor quality of palm oil produced by the artisanal processors is rooted in two causal chains: the long, pre-processing storage of the fruits, and 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 bye-laws 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. It is the combined effects of the identified socio-technical and institutional constraints located at both the processor and above-processor levels, that may impact the processors, and hence palm oil quality, and hinder their access to remunerative markets all year round. A study was conducted to understand the seasonal variation constraint identified from the problem tree but result attained was not empirically enough to report in the thesis.

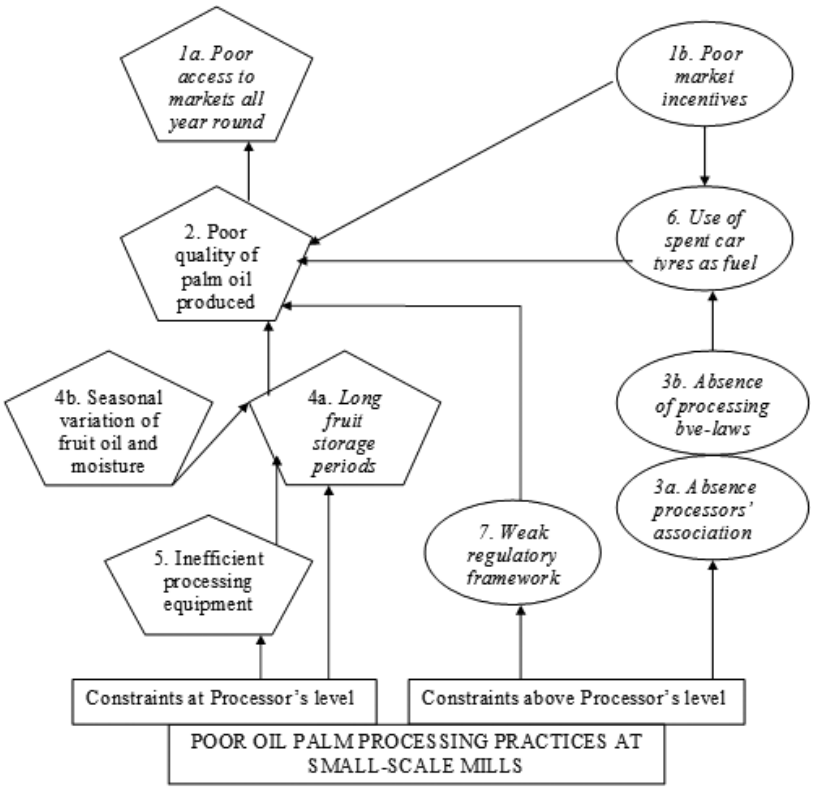


Figure 2.2 Problem tree showing constraints of artisanal oil palm processing

Priority of the constraints as decided among stakeholders is given from highest (1) to lowest (7). Constraints with the same number mean the constraints are linked but (a) is prioritized over (b). Oval and pentagon shapes indicate respectively the constraints located above-processor level and at processor level (i.e. at the mill). Italic font indicates institutional constraints; non-institutional constraints are in normal font. The arrows represent a causal linkage between constraints.

2.3.5 Processing of oil palm fruit

The majority of the operations at the artisanal mills are done manually without any equipment. The only operation that is mechanized was the pounding of the fruits. 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 four per cent of the processors; the digester with separate hydraulic press by eight per cent; the digester with separate hand spindle press was the most frequently used (88%).

The fresh fruit bunches together with the loose fruits are brought in trucks from the farm gate to a processing mill. The tonnage of fresh bunches is assessed by processors by counting the number of bunches (31%) or by visual assessment (50%). Only about 19% of the processors had their fruit bunches weighed because in this case the processors bought 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 the processor and the farmer.

In the mill operation, 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 fronds, sheets of plastic, or left uncovered for 3 to 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 between 1 to 4 weeks (see Figure 2.3 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 to 4 hours, depending on the volume of fruits. Cooking is done usually overnight (on an open fire) using waste lorry tires and empty fruit bunches and fibre as sources of fuel to ensure that the fire burns continuously even when unattended during the night. 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 palm oil by men, by pressing tightly on 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 by most processors in order to reduce operational costs. This is another reason why fruits are stored for a long period: to get rid of the water from the fruits in order to avoid the need for clarification. If clarification is not carried out, the extracted palm oil is drawn off after allowing it to stand for about 2 to 3 hours to allow the slurry to settle. The remaining slurry is then boiled for about 15 minutes and the residual palm oil scooped from the top. The thickened slurry is then drained onto the mill floor or into drains.

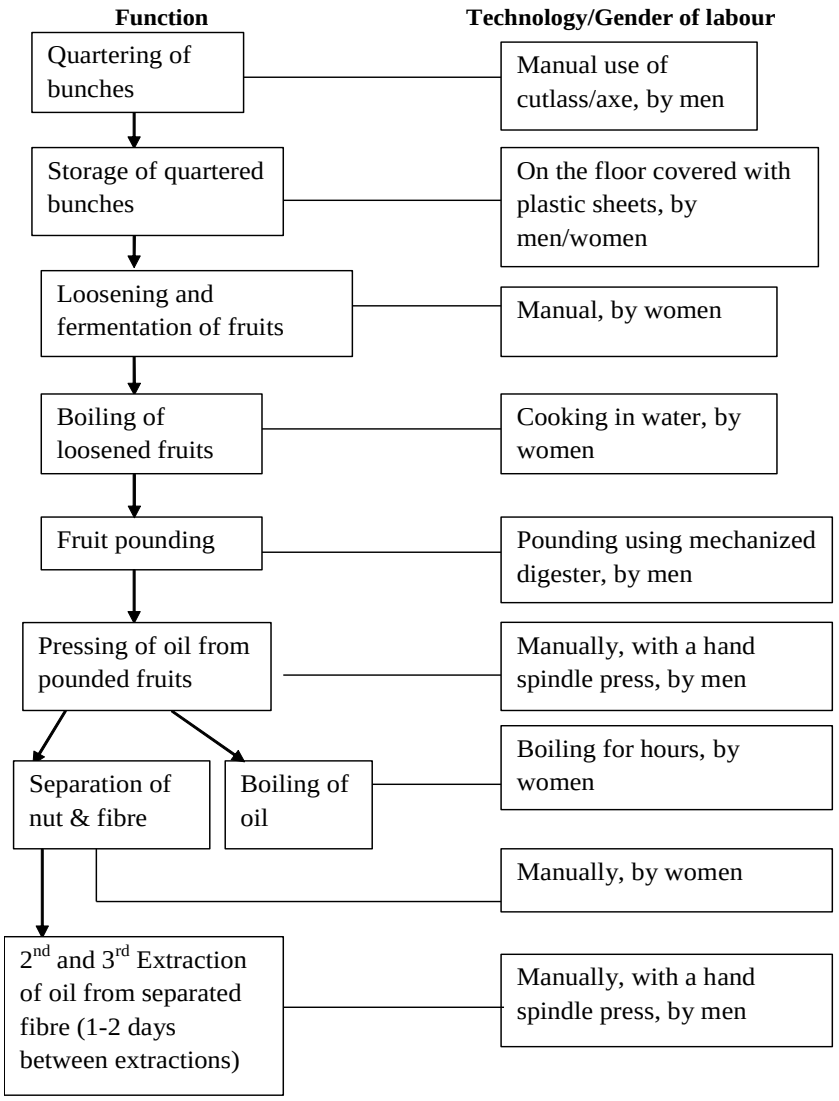


Figure 2.3 Flow chart diagram of operation units in artisanal processing

At the few mills where clarification is done, the extracted palm oil is collected into big cooking pots and boiled for 1 to 2 hours 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 produce a fibre and nut cake. These are separated manually by women (usually old) after which the fibre is heaped tightly and stored for 1 to 2 days and the oil is extracted a second time; the process is repeated with the stored cake and then pressed again for a third time. The later extractions may be added to that of the first pressing before sale or sold separately (by the workers), at a relatively low price. The nuts are usually separated from the fibre and dried and thereafter processed into palm kernel oil by the processors themselves during the oil palm fruit lean production season or sold to other operators who specialize in processing these nuts.

2.3.6 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 old car tires, 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 tires pollutes the air and might pose health hazards to the processors, mill workers and people living near the mills. Secondly, the processors disposed of the effluent directly onto the earthen floors of the mills, into nearby streams and farms (86%), thereby possibly polluting surface water. Thirdly, the processors often used the containers thrown away by heavy industries in cities for packaging the CPO, and these containers may contain toxic substances such as cyanide, which may make the palm oil harmful when used. Fourthly, in order to obtain a bright red colour for the CPO, that is attractive to customers, some processors adulterate the oil with Sudan dyes; this is a banned dye in Ghana and in many other countries in the world. The processing equipment is also 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.

2.3.7 Fruit storage as a processing practice

Most processors stored the fruits for a period ranging between 1 to 4 weeks. 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 the above reasons. The long storage period minimizes the operational stages of processing

so as to reduce the labour cost. However, processors in Asuom, Otumi and Subi normally keep their fruits between 1 to 7 days and also clarify the oil. This is because, traditionally, the processors in these towns like to make a special type (Zoomi) of palm oil for cooking. It has a relatively better quality and sells at a higher price than ordinary CPO by (1.5 to 2 times). They use the standard practices when making ordinary palm oil, but extend the storage period slightly. Those in Kade and Kusi store their fruits for 1 to 2 weeks and processors in Takrowase keep fruits for about 2 to 4 weeks (Figure 2.4). Clarification of the palm oil was not carried out at these three sites (Kade, Kusi and Takrowase) because the processors here assume the CPO eventually will be used for soap making (they sell mainly to Nigerian and Togolese agents) and, therefore, that it does not need cleaning. About 40% of processors perceive that storing fruits longer gives higher quantities of CPO. The rest (60%) were not sure if fruit storage affected either the quality and/or quantity.

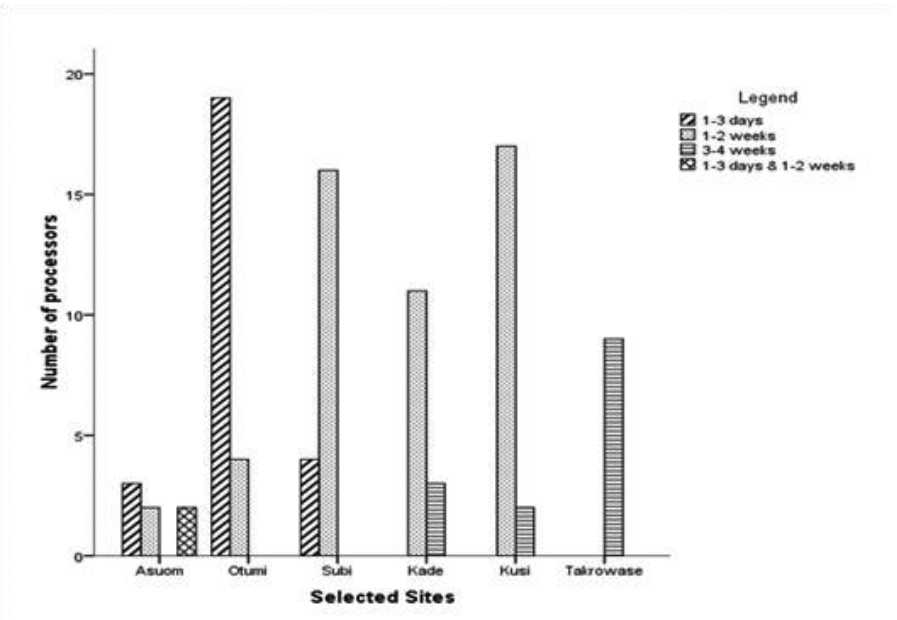


Figure 2.4 The number of processors storing fruits, by length of storage in six selected sites in Kwaebibirem District

2.3.8 Palm oil quality

Processors' perceptions of quality CPO

Quality was understood by the processors, palm oil buyers and mill workers in terms of the use of the palm oil. They agreed that some quality checks were required for palm oil destined for home consumption but not for soap-making (which they usually produce). A high concentration of free fatty acid (FFA) was not a problem according to the artisanal processors, and they did not use this concept. This is because it was not common to assess quality in terms of FFA concentrations 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. However, the buyers of palm oil for home consumption are known to assess quality on the basis of their experiential knowledge and by smelling and tasting the oil to check for rancidity (a component of quality that potentially relates to FFA concentration). 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 of CPO quality

Laboratory analysis showed that FFA values were significantly ($P<0.05$) different between towns (Table 2.3).

Table 2.3 Average concentrations and standard errors of free fatty acids (FFA in %) of palm oil samples obtained from six towns in Kwaebibirem District. (N=18)

Towns	FFA concentrations (%)
Asuom	$11.4\pm 1.28^{a[1]}$
Otumi	10.0 ± 0.69^{a}
Subi	10.6 ± 1.04^{a}
Kade	15.9 ± 1.04^{a}
Kusi	21.6 ± 3.55^{b}
Takrowase	23.8 ± 1.46^{b}

[1] Means followed by different superscripts are significantly ($P<0.05$) different.

The FFA level ranged from 10.0 to 23.8% and was in all cases much higher than the maximum acceptable FFA level of 5% specified for the industrial and export markets. The FFA levels indicate that it is probably the practice of storing the fruits before processing that leads to a high free fatty acid build-up and thus to a lower quality of the palm oil produced. The processors also recognised that stored fruits produce rancid palm oil with a bad smell and dark colour that is not good for home consumption.

2.4 Discussion

Traditionally, the processing of food is done by women; this may explain why most oil palm fruit processors are females. A similar gender division has been reported for Nigeria (Taiwo, 2000). Nor is it surprising that the majority of processors rely on local knowledge; this has been documented also in Nigeria (Owolarafe, 2002). It is more surprising 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 artisanal processing network. In Honduras, Fromm (2007) also reported that scientists and extension agents were absent in the oil palm processing network.

On the basis of the national level 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. Further, the CSIR-OPRI had 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 processing, while 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 into the fruit processing is not a priority for the Oil Palm Research Institute. The technical process and social dynamics at the artisanal mill thus have received very little attention in the district. In a similar study for Banten in Indonesia, Hardjono *et al*. (2003) 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 and transdisciplinary studies, rather than to halt their work at the field or farm gate stage of the chain.

A further consideration is that staff at all levels in oil palm producing institutions and industries are predominantly male, while the participants in the artisanal processing industry are mostly women. This cultural and gender aspect of artisanal 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 (Figure 2.2), it is clear that due to poor market incentives processors produce poor quality oil. They keep fruits for long periods in the belief that it will produce more oil and because it helps in reducing operational costs as they can skip the clarification stage of processing (Figure 2.3). The low quality (high FFA) arises from either the action of lipolytic enzyme lipase from the palm fruit, autocatalytic hydrolysis and/or microbial action (Corley and Tinker, 2003). Various studies have found that long storage of fruits may lead to high concentrations of FFA build-up and poor quality palm oil (Owolarafe *et al*., 2008; Olie and Tjeng, 1998; Tan *et al*., 2009; Onwuka and Akaerue, 2006). In the case of Kwaebibirem district, the stakeholders have 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, some processors, mill owners and mill workers believe that stored fruits give higher CPO yields and lower operating costs, even if it reduces the oil quality. Further research (co-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 the processors to consider revision of their practices, based on tested options for quality improvement, and to consider the development of new market opportunities.

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 and Edokpayi (2005), who, after ascertaining the factors militating against adoption of improved oil palm production technologies, explained that institutional factors such as lack of membership in cooperatives 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 organisation of the artisanal 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 Figure 2.2 as lying beyond the processors' reach should be addressed through interventions by the CIG. The results of the current diagnosis provide important input to the work of the CIG, as well as to options for joint experimentation with the processors to enhance their ability to design and select interventions fitting their goals and constraints.

The results of the study to understand the constraints of processors, as outlined in Figure 2.2, were presented at a local stakeholders' 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, as follows.

- To understand the artisanal processing enterprise as a whole, and at different levels, and the kinds of interaction among actors at each level:

An ethnographic study is needed to investigate the interactions and institutions that exist between processors, millers, mill workers, farmers, and buyers of CPO in a trans-boundary network. Special attention will be given to the position of the processor in the internal and external organisation of the mill, the social dynamics among actors in her network, and how her position may affect innovation at a 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.

- To address the issue of low quality of palm oil and the related lack of market access:

A joint experiment with relevant stakeholders concerning the optimum fruit storage period, to reduce FFA levels and improve quantity and quality outcomes (in Figure 2.2, constraints 2 and 4a, 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 a mill, in order to understand efficiency of producing different qualities of palm oil at the level of the mill (constraint 4a and 1b in Fig. 2.2) .

2.5 Conclusions

The diagnosis has assessed the processing practices of artisanal 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 a transdisciplinary 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 the artisanal 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.

Chapter 3

Understanding interactions of artisanal palm oil production from an actor perspective

It is early morning (06:00 GMT) at Kusi and already I see men and women performing activities with each other at an artisanal oil palm processing mill. Two women at the centre of the mill chat heartily while they fan off the debris from loosened oil palm fruits with the help of the blowing wind. At a corner two men and a woman eat *ampesi* and *nkontomire* stew[1] from one bowl; at the same time a young lady negotiates the price of palm oil with someone on her mobile phone. Other men and women are busily engaged in various processing activities of quartering, carrying boiled fruits to a digester and operating a press to extract palm oil from digested or pounded fruits. Standing outside this 'field' observing these material elements may not give an insightful outsider view of the *Kramer*. Many people may see a *Kramer* as just a physical structure with human, equipment, oil palm fruits and palm oil, but what may not be obvious from the outside, are the patterns of human and non-material interactions embedded in the *Kramer*. This chapter is therefore about the everyday life of actors in their enactment of the artisanal production of palm oil, seen from the perspective of the *Kramer* as a social field (Bourdieu, 1990; Long, 2001; Nuijten, 2003). I sought to describe the more inclusive network of humans, the material and non-material flows between them, rather than to only limit the analysis to the physical structure of the mill. I found that it is only by becoming a participant at the *Kramer* that one learns to understand the multiple interactions and the flows of resources that support the local, regional, and even transnational networks on which artisanal palm oil production thrives.

[1]Local food-made of boiled unripe plantain and spinach sauce.

3.1 Introduction

3.1.1 Motivation for the chapter

A search of the literature on artisanal palm oil production indicates that most of the studies are usually of one science discipline. They look at the economics of the enterprise (Olagungu, 2008; Adjei-Nsiah *et al*., 2012b); quality of palm oil (Dessassis, 1957; Tagoe *et al*., 2012; Zu *et al*., 2012) and equipment performance of the mill (Owolarafe *et al*., 2002). The studies which are basically 'people-less' neither provide ideas for intervention nor enhance sustainable development in the palm oil enterprise. Being involved in transdisciplinarity with an action research component, it became necessary for me to do an intervention in the PhD study. My initial idea of an intervention process was that it is socially constructed and negotiated by the actors. Therefore I thought of doing my own research with a target group, and later disseminate results to a larger group of palm oil producers.

I did not want to start the action research based on an assumption of a cause and effect analysis involving the input and output activities of the mill, but to first understand the social dynamics of artisanal palm oil production. So I needed to ask questions about the enterprise from the people involved. During my first visit to an artisanal mill in the Kwaebibirem District, I was told by the people I initially met that I had to speak to the person who owns the mill because he/she is the 'boss' and knew everything about activities at the mill. Then, I met informally with some of the mill owners but they did not seem to have the answers to most of my questions and they kept referring me back to the other people at the mill. It thus became evident that I could not do any effective intervention without knowing who the actors at the mill are, what they do, with whom they interact, and to what effect. I realised that understanding the interactions of actors in my study would possibly bring out crucial and relevant issues that would remain hidden in a stakeholders', an organisational or a SWOT analysis of the enterprise. Recognising these practical and methodological shortcomings motivated me to use an actor perspective in this chapter, which allowed me to experience at first hand the human agency (Long, 2001) in everyday *Kramer* life.

3.1.2 Research problem

Agricultural research and development interventions in rural small-scale enterprises in the past often focused on socio-economic and demographic analyses based on data from broad surveys (Scoones and Thompson, 2009; Faure *et al*., 2013). Although such

data may provide knowledge about the institutional context of the artisanal enterprise, they fail to provide an understanding of the place and spatial dynamics of how the actors' involvement in multi-scale networks influences their interactions. Formal capacity building in artisanal palm oil production enterprise in the Kwaebibirem district is low (Ametepe, Director of District Agricultural Development Unit of the Ministry of Food and Agriculture, personal communication, 2011). However, in this paper I question whether a top-down, public sector ministry approach would even be effective anyway because of the widespread lack of understanding and knowledge of institutional actors about the real-life practices at the artisanal mill.

One of the issues arising from Chapter 2 indicated that, in order to successfully intervene to improve the quality of palm oil, there is a need to understand the processing practices and the kind of material and non-material flows of resources among actors. The diagnostic study also suggested that the artisanal enterprise thrives on multi-scalar personal networks and much less on formal institutions, such as the nearby Oil Palm Research Institute and the district agricultural development unit. However, these informal networks are understudied, though they appear to be vital for the survival of the enterprise. A type of study which brings out the everyday interactions of the actors at a *Kramer* as a social field, not just as a physical place is needed to provide better insight into their activities.

3.1.3 Objective

The objective of this study is to understand the social dynamics among actors at artisanal oil palm processing mills and their interactions through wider networks. To achieve this, I look at who are the actors and their networks at the *Kramer* in the Kwaebibirem District; the flow of resources between them and how the dynamics of these flows create power relations in the *Kramer* as a social field.

3.1.4 Structure of the chapter

Section 2 describes the conceptual framework. Section 3 outlines the methodology; followed in section 4 by an analysis of case studies of lived-in experiences of actors and their networks in a *Kramer*. Section 5 provides the descriptions of the resource flows and the power relations at play in the *Kramer* networks. I conclude in section 6 by drawing lessons on the relevance of an actor perspective in the designing of an action research for Chapter 4.

3.2 Conceptual approach

This section looks at the actor-oriented approach developed in Wageningen by Norman Long (Long, 1989; 2001; Long and Long, 1992) as a way of understanding the differences and the dynamics of actors' roles and practices at a *Kramer*. I also elaborate on the notion of social field, interface and force-field as main concepts for analysing the actors and their networks (Bourdieu, 1990; Long, 2001; Nuijten, 2003).

3.2.1 Actor perspective and actors

I use an actor perspective or actor-oriented approach because I believe that planned intervention does not have an impact on the social lives of actors without its logic being actively re-constructed and transformed by the actors to suit their own situation. Actors in *Kramer* networks are not passive recipients of interventions but they use their agency to actively participate in adapting external interventions to derive maximum benefit for their condition. The people working at the mill do not act as a homogeneous unit. They all have their specific functions and positions in the production process. Their gender, power hierarchy, knowledge, and personal motivations to perform as they do explains the heterogeneity of actors' positions and responses generated in several case studies of *Kramer* networks. In my study I came across these actors: processors, mill owners, mill caretakers, various mill workers, farmers, buyer's agents and buyers. They were all involved in networks as a 'set of direct and indirect relationships and exchanges' (Long, 2001:60) at the *Kramer* site or beyond.

The actor perspective allows me to understand the multiple realities and differences in social roles and practices of various actors, making them the central focus in assessing everyday life experiences (Long and Long, 1992). The concept of actor here does not refer to collectivities and social categories that have no discernible ways of formulating or carrying out decisions. It refers to individual or institutional actors who possess agency to actively engage with new knowledge within the limits of information, uncertainty and other constraints they face (Long, 2001). The approach focuses on the actor's knowledgeability and capability (agency) to interpret and change practices rather than assuming these practices, rules and norms to be fixed, like in structural or institutional analyses. Since agency is embodied in social relations and can only be effective through them, my analysis of the social life of actors at the *Kramer* begins with the simple idea that different social forms develop under the same structural circumstances (Long, 2001). I therefore try to understand the differential responses of actors as they perform their roles in the enterprise. These differential

responses are inferred from ethnographic narratives of situated social practices of the actors by paying attention to the meaning and construction of values in the different cases.

3.2.2 Social field and interface

The concept of social field (Long, 2001) conjures a picture of open spaces: an irregular landscape with ill-defined limits composed of distributions of different elements such as resources, information, technological capacities, fragments of discourse, institutional components, individuals, groups and physical structure. The notion of a social field is thus broader than just the economic, political and institutional structures designed for achieving an objective. It actually includes 'relationships and values that may be utilised for the same purposes' (Long, 1968:9).

My notion of the *Kramer* as a social field should therefore not be looked at only as a physical structure with equipment and human linkages but also as configurations of material and non-material elements and relationships, as well as the dynamic interface of interests, negotiations, struggles and contestations. Importantly, this analysis of the *Kramer* does not only entail actors who are physically present but also those who, while absent, are yet actively interacting to make re-construction and ordering processes happen. Moreover, the concept of social field also covers the flow of resources in the networks and how they deal with issues of contestation in force fields.

Social interface is a way of exploring and understanding issues of social heterogeneity, cultural diversity and the conflicts inherent in processes in a social field (Long, 2001). The interface is the point of intersection between different life-worlds and it is here that social friction occurs. The interface interactions assume there is some degree of common interest between actors, but also that, there is likelihood for conflicts due to contradictory interests or objectives and unequal power relations existing in the social fields. Thus, there is a face-to-face encounter between actors represented by different interests and backed by their resources (see Section 4). I explore the interface by analysing points of interest, negotiations, confrontations and social differences through the narratives, experiences and practices of the actors.

3.2.3 Force fields

Bourdieu analyses a social field as the locus of relations of forces. The field is attributed to the interplay of relations between actors where the construction of meaning takes place, and where agents and institutions constantly struggle, according to the regularities and the rules of the space (Bourdieu and Wacquant, 1992:94-115). Every field thus has its own logic, rules and regularities. This notion applies to the

Kramer as a social field where actors must conform to different rules of engagements in order to be part of that space. Those who resist these logics and rules are in constant struggle with other actors in the field. For example, in the case of mill workers who fail to abide by rules set by a mill owner or a caretaker who is seen as over-exercising his/her authority in the network and therefore faces opposition from other actors (see below). Bourdieu's field is useful to me as a central organising concept for the analysis of power and status in the *Kramer* network, and for establishing the distribution of material, social and symbolic forms of capital (Long, 2001:58).

Nuijten's force field (Nuijten, 2003) resembles Bourdieu's notion of social field, but is less structurally determined. Force fields refer to wider fields of power without determining beforehand the main actors and central elements structuring the relations within the field. In the force field, forms of dominance, contention and resistance develop, as well as certain regularities and forms of ordering (ibid). Patterning arises from forces within the field; like in my case, as resources flow between actors in a *Kramer* network. Bourdieu (2001, 1997) establishes a direct link between one form of capital and one type of field, but Nuijten (2003) does not define one type of capital around which a force field develops. I follow Nuijten's approach by distinguishing the fields of force around the flow of certain resources within the social field. It helps me analyse the different actors with their specific roles, access to resources and the possession of different rights. My concern here is to study the organising practices around the flow of different resources, in addition to the struggles, competitions and conflicts that arise in the field and how actors manage the power relations.

I make use of another aspect of Nuijten's force fields which also draws on Wolf's differentiation of forms of power (Wolf, 1990). Wolf (ibid.), makes a connection between organising practices and power, and argues that organisation should not be viewed as a product and outcome but as a process. In this regard, I look at the 'flow of action' at the *Kramer* site to ask questions on what is going on, why it is going on, who engages in it, with whom, when, how often, and for what (Wolf, 1990:591). This I do to understand the issues of power in the social field by reflecting on patterns of organising practices and what they tell me about power relationships at the interface. Following Nuijten, I do not assume beforehand the existence of certain power relations in the social field. Instead, I analyse the forces and effects of the power relations that drive the organising processes. I engage in this task by paying attention to the ideas and representations of actors as they interact in the flows of resources like oil palm fruits, knowledge, palm oil and credit.

3.3 Methodology

3.3.1 Ethnographic approach

The term ethnography is used to refer to empirical accounts of particular forms of social organization, and to a set of research procedures or methods (Ellen, 1984: 7). Ethnography 'involves the researcher participating, overtly or covertly, in people's daily lives for an extended period of time, watching what happens, listening to what is said, and/or asking questions through informal and formal interviews....'(Hammersley and Atkinson, 2007:3). The method aims at obtaining and understanding detailed information on how the everyday practices of social interaction in networks are created and negotiated by different actors in a dynamic interface of artisanal oil palm processing in the Kwaebibirem District of Ghana. In this line, I often sat at the different *Kramers*, while observing and interviewing to gather first-hand data from principal actors like processors, mill owners, caretakers, buyers, various workers, farmers and buyer's agents.

Observation and interviews may bring to light how artisanal oil palm processing enterprises are embedded in dynamic local and transnational networks stretching from Kwaebibirem district way into Togo and Nigeria. They involve material and non-material flow of resources in the form of market economics, financial support, relations of trust, gossip, and other non-economic services between the various actors (Bourdieu, 1990; Hagedoorn, 2006). Thus, by following the actors in an ethnographic approach I seek to first know about the actors in order to contribute to understanding how the actors themselves serve as a starting point for learning and change (as indicated in chapters 4 and 5). This approach is opposed to a ready-made, generalist interventionist instrument (Appendini, 2001) which may not be accepted by the actors and not used at all because it fails to understand how they could make sense of it in their everyday practices of palm oil production and marketing.

In this chapter therefore, my aim is to apply an in-depth field-based approach that provides first-hand data from the actors' perspective of what happens at the *Kramer*. I used this method not as 'an experimental science in search of law but as an interpretative research in search of meaning' (Geertz, 1973: 5).

3.3.2 Selection of the study site

The Kwaebibirim district is the location for the study. There are about 200 of such *Kramers* in the district which serve as a place for the processing of fresh fruit bunches,

involving women, men, young people and very old women (all together about 2,500-3,000), some as processors and others in various operational stages.

The Kwaebibirem district (occupied mainly by people of Akyem ethnic group) was chosen as an appropriate site for this study because of the existence of different oil palm production systems and most importantly the large numbers of artisanal processors. The study was conducted from March 2010 to December 2012 in three purposively selected towns. The towns (Otumi, Kade and Kusi) were grouped into three zones based on their location in the district (see Chapter 2, Fig. 2.1). The land for setting up a *Kramer* is usually acquired from the chief of a town by paying an amount of money and donating drinks.

3.3.3 Selection of case studies

I used a case study approach to describe networks of different key actors and what flows between them in the artisanal palm oil production enterprise. The case study approach is used here as an empirical inquiry that investigates networks in their real-life context (Yin, 1984: 23; 2003). The unit of analysis is the artisanal oil palm processing enterprise, *Kramer*. Three different *Kramers*, each treated as a single case, were used to gather in-depth information. For the case studies, one *Kramer* each was purposively chosen from the three selected towns based on type of digestion and extraction equipment used, size of *Kramer*, gender and educational level of *Kramer* owner. I refer to the selected sites as *Kramer* A, B and C.

Kramer A in Otumi is owned by a 56 year-old female oil palm farmer and processor who has elementary school education. It is a medium sized artisanal mill, operating on a digester with a separate hand spindle press. The mill was started in 1993 by the 31st December Women's Movement, an NGO of the then First Lady (President's wife), for women in the Otumi branch of the Movement to assist them in processing their oil palm fruits. Later, when the political party for the Movement was no longer in power, some of the processors who were members left the mill to do other jobs for fear of being harassed by the political party then in power. The current owner paid off all the loans, and took complete ownership of the mill.

Kramer B in Kade is owned by a 72 year-old male, retired technical officer of the Ministry of Food and Agriculture with a secondary school education background. This mill is small and operates on a digester screw press equipment. He bought the equipment together with the land from a former mill owner.

Kramer C in Kusi is owned by 80 year-old male, farmer, processor and *Krontihene* (Defence Chief) of Kusi, with no formal education. The mill is large and operates on a digester with a separate hydraulic press. He was a commercial passenger lorry driver, but decided to stop and cultivate the improved *Tenera* oil palm variety

when the Oil Palm Research Institute was set up to provide high yielding seedlings to farmers. After some years, he started harvesting the fruit bunches from his farm but there was no one to buy them. As a result he started processing at home using tedious traditional methods of pounding and extraction. Later, he bought a digester and hydraulic press and set up a mill.

3.3.4 Data collection

My entry into the study towns started with introductions to some actors with the assistance of a Research Associate (RA) of the CoS-SIS programme who knew some of the people because he works in the district and also through an earlier exploratory study (Adjei-Nsiah *et al*., 2012a). Later, he helped me to organise *Kramer* meetings in the different towns, at which I explained the type of research I planned to be doing. Most of these early encounters with the people happened during the diagnostic phase of the PhD research (reported in Chapter 2). Subsequently, I visited the selected *Kramers* to have general conversations with actors and to acquaint myself with their activities. When I felt more accepted in the *Kramer* setting, I moved into detailed discussion and interviews with several actors. I first did key informant interviews with processors and mill owners of the selected sites. I then pre-planned interviews with main guiding questions as a checklist for different actors based on information gathered from the key informants. However, I quickly realised that the interviews had to be done in a flexible manner to capture the actor's own flow of thoughts and what they felt was important to share at a particular time. So sometimes I did not follow religiously the checklist but allowed the conversation to flow naturally during an interview.

Interviews were conducted several times with several processors, mill owners and caretakers, various mill workers, palm oil buyers and farmers at *Kramer* sites, on farms, at home and during workshops. I also engaged in focus group discussions. I collected useful information through my learning of all stages of oil palm processing and thus enhanced my ability to participate and understand actor's activities. As part of the research, I became a processor for one year. Being part of the network myself also helped enormously in my interaction with the actors; consequently, later on I could interact freely with some actors when we met at the lorry stations, at the market or even through mobile phone. The *Akyems* are Akan speaking people like me, so it was easier for me to conduct the interviews in Akan. The interviews and discussion outcomes were documented in English, in field notebooks or sometimes recorded. The information was later ordered by my reflection and teasing out of keywords which helped explain the issues and also as a way of identifying gaps which needed further interviewing for expanding the details of the analysis.

3.4 Description of actors and their network in the social field

This section describes the actors and their networks in the artisanal oil palm enterprise in the Kwaebibirem district. Like in other small-scale enterprises, palm oil production enterprises are dependent on their networks (Kaufmann and Tödtling, 2003).

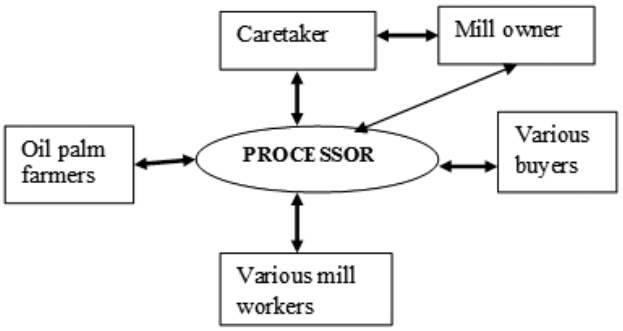


Figure 3.1 A simple diagram of actors and their interactions in the social field. Thick lines imply strong and frequent interaction, while a thin line implies less frequent interaction

3.4.1 The processor

The processor is usually a woman who does not own the *Kramer*, but owns a shed or has a space at the mill where she brings fresh fruit bunches (FFB) to access different services to produce palm oil. The processor interacts with several actors and is seen as the central or nodal point in the network, around whom most interactions in the social field evolve (Figure 3.1). There are several processors (an average of 10) working at a single *Kramer* and they interact with each other frequently. The processor makes all decisions concerning the ordering of her oil palm FFB, the procedures to be used for making her palm oil and how or when to sell the palm oil. She also makes decision (whether absent or present) about which workers to engage in the processing of her fruits. I found that the processors have not been formally trained in palm oil production but have learned the skills from their mothers or other processors. They also used their agency by applying the practical experiences (Long, 2001) they acquired through observation of innovations at other mills. An indication that processors are capable of sharing and learning from others to improve their processing practices.

Processors may be involved in some stages (less tedious ones like loosening of fruits from spikelets) of the processing activities with the support of family labour. Others allow mill workers to do all the aspects of processing fruits into palm oil, because they are busily engaged in another activity outside or too old to work at the

Kramer. In this case they supervise the workers through a caretaker using mobile phone calls to give instructions on what is to be done. I see that *Kramer* work involves a lot of trust building for the smooth flow of resources and effective production of the palm oil. In the *Kramer* network the processor relies on a lot of trust in dealing with other actors involved, and vice versa. Though not physically present at all times, the processor likes to work at a *Kramer* where she trusts the mill owner will always be in business or find alternatives for her processing activities all the time. A processor from *Kramer* C has been present at the mill for 26 years. She said to me: "*I trust the owner here, because he makes sure the equipment function all the time, so I can stay in business*" (Abena Asoo, 15/3/2011, Kusi). Processors do not like to move from one *Kramer* to another once trust is established at one mill.

The processor have friendship bonds with mill workers and also builds on lots of symbolic capital by bringing in little gifts of food for them, visiting them at home and paying promptly for services rendered to her for digestion and extraction. Actors in the social field attend funerals of each other's relatives and child naming ceremonies, as a form of mutual support. Although there is no formal association of *Kramer* workers or processors, they rely on an informal self-organisation to contribute small amounts of money for social support of members who lost dear ones, got married or staged a name-giving ceremony for a new-born child.

Figure 3.2 Processor sharing her food with mill workers

The processors have strong links with some specific workers who work on their fruits most times, even though they relate with all the other workers. In this case the processor and workers are mutually dependent on each other. While the processor needs the workers to process her fruit bunches in a way she desires and produce the palm oil at the right time, the workers also need their timely payment from the

processor (whether in cash or in the form of fruit fibre) to survive. An interesting example is seen at *Kramer* C, where the processor has frequent interaction with particular self-organised sets of machine workers and these workers are given some amount of pounded oil palm fruits (an incentive) as a form of payment for the service rendered. The self-organised workers are a team comprising 4 to 6 young men (aged 18-35 years) who work together.

3.4.2 The mill owner

The mill owner has ownership rights over all equipment, cooking pots (*loco*) and land for the mill. They are usually men, who set up a mill to provide processing services for interested processors at a fee. There is a strong and mutually dependent interaction between the owner and a caretaker. The mill owners I interacted with have less frequent links with processors and their interactions are usually centred on discussing social issues happening in the town. For all three cases studies, mill owners are often absent from managing the activities of the mill. In the case of *Kramer* B, the owner is present most parts of the day working in a small farm nearby or tending to his chickens, but not engaging in the operations of the mill. Owner of *Kramer* A on the other hand comes around to process her own fruits or sell palm oil to customers because she is a processor too, just as in the case of *Kramer* C. All these owners have some interactions with the other actors, but entrust the operations and on the spot decision making of running the *Kramer* to a caretaker. The owner-processor may come to the *Kramer* to supervise the processing of his/her fruits or delegate the caretaker to do that when not present.

3.4.3 The caretaker

The caretaker is like a *Kramer* manager. He is usually a male worker at the mill who is hardworking, trustworthy, and has basic numeracy and/or literacy skills, and is accountable to the mill owner. There is usually a lot of personal bonding between the caretaker and owner. In the example of *Kramer* B, the caretaker is seen by the owner as an important person for the success of the enterprise. He oversees the functioning of the equipment and all permanent and casual workers. Indeed, the owner always emphasises that the caretaker:

> "*Is the owner of the Kramer and ensures the smooth running of it……When he started working for me, I wanted to know his commitment level; I will intentionally ask him to work and account for the money later. I will then secretly check on the quantities of fruits to be processed that day. Surprisingly*

> *he always brought the exact amount I was expecting. He is really trust worthy"* (Agya Kwabena, 24/1/2011, Kade).

The owner gives the caretaker fowls and foodstuffs from his farm, while the caretaker takes care of the owner especially when he is sick, since in this case the owner is divorced. These exchanges may also be seen as calculated gift-giving which he (caretaker) is expected to reciprocate with loyalty (Wolf and Hansen, 1967) by taking good care of the enterprise. To reinforce the bonds of obligation, (Bourdieu, 1990) the caretaker in turn has honoured the owner by naming his daughter after him, a prestige reserved for only fathers, mothers and uncles in the *Akyem* tradition. This reciprocal exchange among the actors preserves the social and symbolic capital as acts of honour (De Nooy, 1999).

The caretaker needs a lot of trust to be able to work effectively with all actors and especially on behalf of the processor for whom he is seen to perform a lot of duties. This is evident at *Kramer* B, where processors do not worry about their inability to come to the *Kramer* often because the caretaker is able to oversee all the processing activities. One processor explained that:

> *"I am old, and feel tired most times so I do not like to come to the Kramer. Besides, I trust caretaker's judgement; he even sells better than I can do. I only have to call him on the phone to instruct him to sell or not"* (Maame Fosua, 14/03/2012, Kade).

I should also mention that the caretaker's ability to communicate in some little amount of English with new agents for Nigerian and Togolese trade networks, who cannot understand the local *Akan* language, 'provides the means for a non-economic form of domination and hierarchy' (Gaventa, 2003:6) which he uses for his own benefit. Here I see an actor using his agency to become skilled in managing an ambivalent position in the social field. Such agency is employed for the personal advantage of the actor. Several times in the field, I saw the caretaker effectively acting as a broker between processors and farmers or their buyers, and of course he builds social capital and also gets some financial rewards or gifts from his efforts as well. He tells me during one of my visits to *Kramer* B:

> "*I know a palm oil buyer from Togo who will just transfer money to my bank account and then call to instruct me on quantities needed, I buy them, manage everything and it is delivered to him through his transporter here, and he rewards me*" (Alex, 10/11/2011, Kade)

I find a clear contrast at *Kramer* C, where the caretaker is seen by some processors to connive with workers to 'steal' the processors' pounded fruits. I was told: "*When he is at the equipment and the workers hide some of the pounded fruits, he does not say anything and looks on, because he gets his share from it*" (Abena Asoo, 8/2/2012, Kusi).

I observed that processors here are most times present or will delegate trusted colleagues or family members to be present during pounding and extraction activities. At *Kramer* A, the situation is interesting; the caretaker is seen as trustworthy by the mill owner and a few processors. Like in the case of the caretaker at *Kramer* B, there is a strong friendship bond, mutual exchange of gifts between her and the mill owner. She does household chores for the mill owner, and she get foodstuffs and clothing as gifts. She has the mandate from the owner to supervise the daily operation of the equipment and its workers but she faces a lot of opposition. This is because the workers here have been working for some time without any supervision, long before she came around.

3.4.4 The mill workers

Apart from processors and caretakers, there are also various workers involved in the different stages of the processing activity (Chapter 2, Figure 2.3). They can be permanently or occasionally employed, like the casual workers who come to the mill during the bumper season of fruit bunch production. They interact directly with the processor who engages their services or the caretaker, who acts on behalf of the processor. The workers at a mill frequently interact with each other and depend on their team member's efficiency for survival. For example in the case of *Kramer* C where there are many self-organised sets of workers, they work hand-in-hand to extract the palm oil. They also bulk the fibre oil which they extract from their payment of pounded fruits or heap of fibre from processors, sell it at the end of each week for themselves, and share the money equally. The workers thus depend on each other to contribute massively to the collection of this so-called fibre oil. I observed them providing support for each other by fetching water for colleagues to drink while on the job, or getting them their snacks. These exchanges are done in a way that, as Bourdieu puts it, the 'giver's undeclared calculation has to reckon with the receiver's undeclared calculation, and hence satisfy his expectation without appearing to know what they are' (Bourdieu, 1990:112). This is vital for the continuous existence of the set because it enhances the formation of a strong bond.

3.4.5 The Farmer and the Buyer

The farmers and various palm oil buyers, like agents for a Nigerian buyer (Nigerian agents), people who go to Togo to sell palm oil (Togolese palm oil traders), and traditional soap manufacturers are another group of actors in the field. They operate mostly with the processor or through the caretaker on behalf of the processor.

The farmers are generally small-scale independent oil palm bunch producers who are not attached to large scale plantations. The fruit bunches are harvested every 2 weeks or 3-4 weeks in the bumper and lean seasons respectively.

Few processors sell directly to the Nigerian buyer and processors hardly physically come into contact with this buyer. Most processors have to deal with a subagent who is contracted by an agent, who in turn acts on behalf of the main palm oil contractor, who is responsible for buying palm oil, bulking and transporting to the actual buyer in Nigeria. The contractor and his agents are Ghanaians, usually migrants from the Northern part of the country but living in the Zongo (Muslim) communities of the district. The contractor and most of his agents were kola nuts producers who traded with Nigerians in the past. With the drastic decline in the production of the commodity due to more farmers now cultivating oil palm, the kola nut producers started trading in palm oil. The main contractor receives money from his clients, (palm oil retailers in Nigerian), he then distributes the money to his agents mostly men to buy palm oil from various towns. These agents also have subagents at various *Kramers* who buy and bulk the palm oil for them (agents). The subagents are mostly indigenes of Kwaebibirem and could be an influential processor or the caretaker at a *Kramer*.

The Togolese trader in this study refers to either a processor or individuals who buy palm oil from processors and travel to sell to clients during market days in selected Togolese towns. The palm oil sold to these buyers is said to be of poor quality and thought to be used by soap manufacturing factories. The traditional soap manufacturer from the district also comes to the *Kramer* to buy palm oil in smaller quantities for making local bar soap at home.

I observed several times the cordial manner in which processors interacted with their buyers through the way they chatted and welcomed them to their shed at the mill. The farmers and most buyers are usually not directly present at the physical structure of the mill but are actively involved in the interactions of the social field.

3.5 Flows of resource in the social field

Generally, actors engage in their production activities by using types of capital (DFID, 2000; Ellis, 2000). The capital is categorised into natural, physical, social, financial and human. Bourdieu (1990; 2001) also describes four capitals (economic, social,

symbolic and cultural) in his analysis of practice and field. To describe the flow of resources in the social field, I modify and make use of some of the aforementioned capitals (i.e. physical, financial, human, social and symbolic). I however prefer to call them resources to distinguish them from the economic connotation only of using the word 'capital' in the analysis (Arce, 2003). These resources are to me not separate entities to be categorised and analysed differently but rather, they are used and analysed together. For instance, the resource flows between actors could be both material (physical and financial) and non-material (friendship, trust/mistrust, practices, gifts). The non-material determines the ability to influence the quantity and quality of the other resources and their distribution in the networks (Hafner-Burton *et al*., 2009). I therefore need the non-material, social and symbolic capital assets to complement my analysis of the dynamics of the physical and financial flows. In this section I analyse the physical resource flows in the *Kramer* network of oil palm fruits and palm oil, the financial flow of cash money and credit, and the human resource flow of knowledge, each with its underlying non-material resources, like trust/mistrust and gift giving.

3.5.1 Flow of physical resources

This flow represents the technical production unit of the *Kramer* with flows of oil palm fresh fruit bunches (FFB) as input and crude palm oil (CPO) as output. It involves a collaborative network of mainly farmers, processors and then buyers. There are basically two types of processors, the one who is also an oil palm farmer and one who does not have a farm. The farmer-processor uses all the fruits from her farm for making palm oil. Depending on the quantity needed, she may buy more fruits from other farmers to top up her stock. The processor without a farm buys fruits from specific farmers to ensure constant supply, but may also buy from different farmers during the lean season. The processor's interest in this flow is to get enough FFB all year around, but this does not happen automatically and at the interface there are struggles and negotiations on prices and quantity needed by the processor to ensure her interests are met.

There are also conflicts between the farmer and processor due to the inability on the part of the farmer to constantly deliver FFB to the processor. The situation arises because some farmer's family members (especially sons) secretly harvest and sell fruit bunches intended for their father's customers to others. Some farmers also collect money from several processors and then make up a story that the fruits have been stolen from the farm. As a processor, I also had a conflict with my farmer because he delivered a lesser quantity of FFB than what I had paid for in advance. The farmer explained that thieves stole the FFB from his farm before the actual schedule for harvesting. These struggles and conflicts at the interface made me change my

everyday practice of upfront payments to him. I started paying him for the quantity of FFB at the point of delivery at the farm gate, which settled the conflict. Thus, social interface can be changed by everyday practices and, at the same time, allows everyday life to alter the encounters at the interface (Arce and Long, 1992).

Fresh fruit bunches are bought from the farm gate and it is the responsibility of the processor to cart them to her shed at the *Kramer*. I observed that none of the processors from the three *Kramers* had weighing scales to assess the true weight of bunches bought compared to what happens in the case of large scale industrial processors. For instance, the tonnage of fruits is assessed by the artisanal processors by counting of bunches to get one tonne (80-90 large or 100-120 small bunches) or just by visual assessment. Some farmer-processors like to also buy loosened fruits to add to bunches from their farms because, they are said to produce more oil during extraction. Jute sacs and 34 cm^3 sized metal buckets are used for measuring these loosened fruits. During the lean season of 2011 one jute sack of loosened fruits cost the processor 15 GH¢, and one bucket (*bokite*) was 3 GH¢.

Power is relational and linked to the possession of resources; in this case fresh fruit bunches. Thus, the more resource flows one has access to, the more powerful one is in the network. I find the farmer to be powerful in terms of having the prerogative to decide on which processor to sell fruits to, especially during the lean fruit production season. The situation is, however, different in the bumper season when the processor has enough fruits all the time so can choose on what quantity to buy from a farmer and even which farmer to buy from. A force field (Nuijten, 2003) thus develops around fruit supply which creates certain organising practices that determine the demand and supply process. A processor during a focus group discussion said this:

> *"The number of processors has increased in the district, these days; there is high competition for fruit bunches especially in the lean season. Farmers realising this even reduce the number of bunches they count as one tonne. What can we do, since fruits are needed to keep us in business we accept whatever is given us? The point there is, if one processor does not buy, another will buy. So the farmer dictates the tonnage estimation and the price. Processors are just struggling for fruit bunches everywhere in the district"* (FGD with processors, 2/06/2010, Kade).

A farmer in a later interview on the issue explained to me that:

> "*Initially famers were being paid with cheques from the medium scale plantations and they could only cash the money two weeks after delivery of*

> *fruits to them. Now when it is lean season the big company pays physical cash and it is much higher than what processors from* Kramers *pay us, it is profitable to sell to company. Fruits are just in high competition and processors have to compete for it*" (Enoch, 15/07/2010, Kade).

Interestingly, this transaction also hinges on trust as a social resource, because I found that some farmers continuously kept supplying FFB to their processors amidst the high competition. Their processors use gift-giving and friendship with the farmers to ensure that even in the lean season they can get enough fruits. They buy and pay farmers on time throughout the year, and there is mutual trust. As a processor, I also maintained a cordial relation with my farmer by giving him bread, every time I returned from the city.

Marketing of palm oil was mostly done at the processing sites. For the ordinary palm oil, I encountered basically three categories of palm oil buyers: the Nigerian agent, Togolese traders and traditional soap manufacturers. The buyers may not necessarily be present physically but are still active members of the force field. At *Kramer* A and B, the buyer normally comes to buy on Tuesdays and Thursdays, but at C, it is on Wednesdays and Fridays. Negotiation on the quantities of palm oil needed and the prices are usually done in advance over the mobile phone between the processor (or the caretaker on behalf of processors) and the buyer. This type of transaction happens mostly with the Nigerians agents and Togolese traders who require large quantities of palm oil. After production, palm oil was packaged into 22.5 (Figure 3.3), 62.5 and/or 250 litres containers for sale. The Nigerian agents like to buy in 22.5 litres yellow gallons from their Ghanaian subagents with 1 GH Cedis commission on each gallon bought. All the gallons of palm oil were loaded in big trucks with the supervision of the main agent near the Kade mosque and transported to the Togo border where it is said to be off loaded. Trucks from Benin come to load the consignment from the Ghana-Togo border to Benin and then onward to Nigeria.

Figure 3.3 A subagent with 22.5 litres gallons of palm oil for a Nigerian agent.

At all the *Kramers*, the local market vendors and traditional soap manufacturers come anytime without any prior notice, but this does not work out well in the lean season because the processor will have to preserve palm oil for her trusted buyers on request. The soap manufacturers usually buy fibre oil of very low quality from mill workers but also buy from processors if they have it. A processor explained to me who her buyers were:

> "*The women who trek to Togo to sell palm oil and Nigerian agents. There is a big man at Kade Zongo who collects a contract from the main buyers. He distributes the money and gallons to individual agents who intend to subcontract or go around the mills themselves to buy the palm oil from processors. When their gallons are filled from the* Kramers*, a big truck comes along to collect them back to Kade Zongo for proper packing and sending to Nigeria. Before I was selling mostly to the Togolese traders but that market was getting bad because the traders were always complaining of lack of sales at the Togo end, thus were buying from us at lower prices or even on credit. Then the Nigerian agents started coming around to buy and now there is competition which gets very tough in the lean season*" (Adwoa Hawa, 7/07/2010, Kusi).

On the other hand, I gathered from most processors at *Kramer* C that they sell to Togolese traders or travel to Togolese markets to sell themselves. This is because they like to keep their old market networks, as one processor mentioned:

> *"I started processing palm oil a long time ago (about 20 years) and I was dealing mostly with Togolese traders, because the Nigerian agents were not*

> *there (they started about 6 years ago). Some processors like to stick to their old customers. But it also depends on the prices being offered by a particular buyer. I like to sell to the one offering a higher price but some processors still sell to their old buyers all the time no matter the price differences*" (Yaa Kyere, 6/02/2012, Kusi).

Indeed I interacted with some processors like Mercy who keeps palm oil for her trusted buyer until he comes to buy even in the lean season. She explained: "*I have been in the business with the buyer for so long and most importantly he buys from me a lot during the bumper season, so it is fair to also sell to him when oil is scarce*" (Auntie Mercy, 20/5/2011, Otumi).

The buyers for Nigerian and Togolese markets also rely on trust with their agents, who also deal with subagents and/or processors to deliver the right quantity of CPO and at the specific time it is needed. The agent deals directly with a subagent at the *Kramer*, as a form of security, the agent goes with the subagent to know her house. I realised that even though subagents are usually trustworthy and accountable to their agents, the same cannot be said about some of the processors they have to buy from on behalf of the agent. It is unfortunate that the subagent sometimes overestimates the trustworthiness of processors she buys from and therefore ends up getting bad fibre oil mixed with water or late delivery of the CPO. The contestation in this force field becomes a dilemma for the subagent as she tries to remain in the 'right shoes' of the agent and keep the relationship going. In fact, one subagent said: *"It is confusing for me now, I do not know who to buy from, there are many of them, I get bad oil sometimes and I cannot stand by them when they are filling the gallons all the time"* (Grace, 20/3/2012, Otumi).

In their backstage performances, I often saw processors mix up fibre oil with freshly extracted CPO and deliver it to subagents to be sold to their agents. One day, on a sunny afternoon I met an agent for the Nigerian buyer by the roadside, who normally does not like to speak to me when he comes to the *Kramer*. I started a conversation with him about how business was going and he expressed his frustration, saying:

> "*I like to get my palm oil from some subagents because they are committed and take the pain to observe the filling of the gallons, so I do not get adulterated oil; others do not do that and they bring to me a mixture of water and oil which I also unknowingly send to my boss…This act started not long ago and now I have to use different coloured plastic bags to cover lids of gallons for palm oil*

> *from particular subagents as an indication of where palm oil was bought, so that if there is any problem I can trace it easily. But the whole process is tedious and time wasting*" (Abotsi, 17/3/2012, Kade).

The force field which revolves around the flow of physical resources creates regularities in consistent supply of FFB and CPO by trusted actors but there are also conflicts with late delivery of fruits and/or adulterated supply of oil. This is a recurring practice with which the actors involved in this network must always contend.

3.5.2 Flow of financial resources

In the interaction between *Kramer* actors, financial resources are needed for smooth transactions. Cash money moves from processors to farmers, mill owners (or their caretakers), and workers; and also from buyers to processors. Usually, the money paid as processing fee to mill owner and that for workers service does not raise much tension; however, this is not the same for all the studied cases. For instance I came across issues of contestation at *Kramer* A between some processors and the caretaker. This is because the (female) caretaker supervises and checks the tonnage of the fruits processed to be able to collect the exact amount for the mill owner, but the processors who like to cheat are not in favour of such a strong sense of accountability. The struggles between the actors at the interface also create tensions and quarrels between some processors and their workers on one side, and the caretaker, on the other side. This enactment of power by the caretaker 'creates friction, disgruntlement, foot-dragging, escapism, sabotage, protest or outright resistance' (Wolf, 1990:590; Scott, 1985). Indeed there is a lot of sabotage on her efforts; some processors complain and protest against her presence by gossiping, while others avoid her and do not speak to her at all, but in all these, the caretaker tells me:

> *"I have full support from the* Kramer *owner to continue my function and that is all I need to survive. Besides, it is the processors who are fighting me, who want to get me out of the place so they can cheat on the equipment service charges, but others like what I am doing"* (Hannah, 5/6/2011, Otumi).

Her case shows that: 'it takes clout to set up, maintain and defend' power relations but also 'wielding that the clout becomes a target for competition or alliance building, resistance or accommodation' (Wolf, 1990: 587). This is not a favourable condition for rural development especially when contested actors are put in charge of projects. As a researcher, I had to locate myself carefully in this power field because I was initially accused of being on the side of this particular caretaker as I happened to speak to her

first when I visit. Therefore, some processors did not want to be interviewed or be part of the discussions initially because of my interaction with her. I was seen as their 'enemy'.

The processor makes advance payments for the fruit bunches to the farmers even before they are harvested, especially in the lean season. This is money that has been collected from a buyer, who also pays for palm oil upfront to secure the quantity needed. There are conflicts concerning the non-delivery of fruits or palm oil or the right quantities at the right time between the processors and the buyers. These conflicts create tension and contentions in the social field and stales the relationship between the actors involved. For instance, during the study, I encountered times when verbal attacks happened between a processor and her buyer because though money had been collected in the previous two weeks, they could not deliver the palm oil. Either because the processor could not get the fruits from the farmer or made the palm oil but sold it to another buyer. One processor had this to say about the situation at Kramer C:

> "*The buyer can advance us some money for buying the fruits and I try to deliver the palm oil to him after processing. I can tell you the truth that sometimes when I am really pressed for money then I sell the palm oil quickly to another buyer here for the Togolese market. Later I look elsewhere for money and then buy fruits and process them for the buyer whose money I received before. Well, other processors do not care, they keep running away from the buyer until the case becomes very serious and the elders have to sit on it and find a solution*" (Yaa Kyere, 8/02/2011, Kusi).

Buyers, especially for Nigeria and Togolese markets, pre-finance processing activities by paying in advance for palm oil to be produced, they give such money to a subagent at the mill. The money (Figure 3.4) comprises the cost of buying the CPO and the commission to the subagent per quantity required. This is done with no formal contract signed, just by verbal communication and sometimes the mill owner or caretaker acting as a witness. This transaction is possible due to the accumulation of the capitals of honour and prestige (Bourdieu, 1990) between the Nigerian agent and their subagents and processors, and it becomes 'credit' which is used to marshal maximum money for buying palm oil. The subagents at the various *Kramers* use the money to buy many quantities of palm oil and keep them safe until they are ready for collection to ensure a constant supply to their agents.

Figure 3.4 A subagent for Nigerian agent giving credit to processors for palm oil production

The subagents at the *Kramer* who are able to collect a lot of money from the Nigerian agent are seen to be in a very powerful position (Figure 3.4). They determine which processor to buy from especially during the peak production periods. These power relations are inherently rooted in the social network, and create differentiation among interacting actors. One has to have a good relationship with such subagents to ensure that their palm oil is bought in the bumper season, and one highly valued way of creating a strong link with the subagent is to attend the funeral of their relatives and other social activities. Attendance to such activities is culturally important to the Akyem because they believe that the one who loves you attends the funeral of your relative. The processors who have other market channels for the palm oil than the Nigerian market do not succumb to this power from the force field. This example also shows that the *Kramer* as a social field involves cultural and social obligations, as much as financial and market demands.

3.5.3 Flow of knowledge as a human resource

Knowledge is a human resource that is constituted by the ways in which people categorise, code, process and impute meaning to their experience (Long, 2001:189). Processors acquire their knowledge about palm oil enterprise through practical experience from observing other actors. The flow of formal or scientific knowledge from the Research Institute and/or Ministry of Food and Agriculture was non-existent, as one processor mentioned, when I asked her about the interrelationship between processors and oil palm scientists in the district: "*For over the 15 years I have been processing oil palm no scientist has ever organised a workshop or processors' meeting to teach us proper ways of processing practices. The Research Institute is a shrine, something that is just there to be adored and worshipped*" (Linda, 16/7/2010, Kusi).

The actors of the social field have knowledge and agency which is embodied in their relationships with each other. This knowledge is the actors' cognitive and social construction that results from and is constantly shaped by their experiences, encounters and discontinuities that emerge at the points of intersection (Long, 2001) as they engage in the production and selling activities. The knowledge exchange occurs through face-to-face interactions but also often through mobile phone communications. Processors from one mill to another or even at a particular *Kramer* use slightly different practices in their processing activities, for instance, they have different periods of storing fruits. Peer-to peer interactions exist in the social field, between processors and also between the caretaker and processor through which practices are observed and discussed. This shows that the joint learning exercise to be done in Chapter 4 can hinge partly on this capacity of interactions to enhance their knowledge on how to improve quality.

I observed that processors learned from each other ways of processing fruits. For example, a processor heard from the next *Kramer* that it is better to use a small amount of water for boiling the fruits because it cooks faster. After discussing it with others, at one time I saw her trying it out with her workers. Later she told me: "*It is true, small water makes the boiling faster, I only have to check if the jute sac covering the fruits in the pot is wet, then it means the fruits are cooked*" (Agyeiwaa, 1/6/2010, Kade).

The flow of information between actors was also on prices of fruits and palm oil in the district. It involved the availability and location of fresh fruit bunches that could be accessed particularly in the lean season. In the field, knowledge on palm oil prices as it flows from one *Kramer* to another ensured that processors resist the dominance of some buyers. In one instance Abena Asoo who was about to sell palm oil to a buyer heard from a friend that another buyer was offering a higher price. She quickly negotiated with the friend on phone and arranged for that buyer to pick up the palm oil. As a processor, I also inquired about prices of palm oil often, so I could distance myself from the power play of buyers during the bumper season. Like other processors, I learned from other actor's experiences of the production enterprise and then used my own agency to plan when and to whom to sell my palm oil. It is evident that force fields exist with the flow of physical and financial resources in the social field, creating power relations, dominance, struggles and conflicts. Processors however use friendship, trust, gift-giving and knowledge as complementary, non-material forms of resources to resist and manage the power plays to continually survive in the field.

3.6 Conclusion

Let me now return to my motivation for writing this chapter. I want to design an intervention for improving the quality of palm oil from artisanal production. But to do

it effectively I first needed to understand the actors in the artisanal enterprise. So, in this chapter I sought to understand the social dynamics through the interactions of the actors in their networks at artisanal oil palm processing mills. The actor perspective was used to uncover the particulars of actors' lived-in worlds (Long, 2001).

I found that actors, especially processors rely much more on personalised and informal local and transnational networks than on formal organisational support from district agencies or research institutes. This they do to be able to effectively organise all activities at a *Kramer* through mutual support and interdependency of the actors.

Studying the *Kramer* as a social field brings to bear the agency of actors in creating innovations in artisanal palm oil production. Thus the learning about palm oil quality improvement should take place on the basis of their ability to learn and interact with other processors about their processing practices. Taking the various actors at the *Kramer* seriously provides new knowledge or insight that helps me to design the experiment in Chapter 4 differently. I found that:

- It is the processors who are the spider in the web and not the mill owners as I originally thought
- Different flows of resources exist at the *Kramer* which interact and shape a force field of varying power positions of the actors
- There is complementarity of the material and non-material flows of resources, and this should be taken into account in any developmental intervention
- Studying the everyday practices of artisanal palm oil production, including these 'invisible' flows and shifting power positions through seasons can be possible through an ethnographic method

Also I established that the artisanal enterprise is a force field with issues of power relations and conflicts based on actors' resources and social capital. For instance, actors who feel dominated in the network may not want to be part of projects strengthening the power of the dominant. This observation is highly relevant, because formalising these *Kramer* networks through project interventions would mean fixating their powerful dynamics which may not necessarily improve the effectiveness of the enterprise.

I have shown the crucial role and position of the processor. Since she makes all decisions concerning the processing of her fruits, it is important to involve these women in any learning intervention to improve processing practices. So also is the caretaker who has oversight responsibility of the mill environment and the equipment and, most importantly, often implements the decisions of the processor. Workers at *Kramer* who are engaged in all the processing stages should be involved in such

intervention, so that they can gain better understanding on how to improve their knowledge and build more capacity to improve their skills. Extension agents who are currently not involved in the *Kramer* network need to learn about processing practices to enhance their extension delivery services. Meanwhile they themselves will also gain from this intervention. This is the same for research scientists from the nearby Research Institute.

The organising practices of the flows of resources clearly show two main patterns. There is the consistent flow of fruits and palm oil which is based on trust between the actors involved, and the lack or delays in flows due to actors playing on their powerful positions in the field. The second patterning in the force field creates mistrust, struggles and contestation between actors. These patterns do not directly affect the anticipated intervention. However, if there is a possibility of linking the processors to more remunerative markets, then the project should be mindful of the power relations, contestation and mistrust associated with flows of fresh fruit bunches and palm oil that may impact on the sustainability of the new market.

I have come to understand that processors can reflect on their experiences and make decisions to continue or change their practices. This implies that any innovation of the *Kramer* will also evolve from the processor's own agency. Any intervention should therefore understand the dynamics of the *Kramer* as a social field, and take this social perspective as a bottom-up starting point for implementing projects. For it is only when we understand the logic and working of existing networks that we can propose ways of learning together for improving processing practices at the *Kramer* to enhance profitability of the enterprise.

Chapter 4

Improving palm oil quality- a search for profitable market options

Abstract

In Ghana, artisanal processors produce 60-80% of crude palm oil (CPO), but have limited access to remunerative markets because of the low quality of their oil. A diagnostic study of the situation in Kwaebibirem District of the Eastern Region suggested that this low CPO quality could be due to the long periods (up to 3 weeks after bunch harvest) of storing oil palm fruits before processing. The aim of this study was to investigate how quality of CPO can be improved through learning from joint experimentation and to assess profitability options of producing quality palm oil in the artisanal enterprise. Methods used in the study include firstly a joint experimentation carried out at a processing mill, secondly a parallel researcher-managed replicated experiment done with three different oil extraction machines in three different mills. Thirdly, CPO quality test through an organoleptic assessment of rancidity and laboratory analysis of free fatty acids levels. The experiments studied the variation of four different fruit storage periods (3, 7, 14 and 21 days) on yield, organoleptic appreciation and free fatty acid levels of CPO produced. The profitability for producing one metric tonne of CPO from the various fruit storage periods was also analysed. Scenarios of producing different qualities of CPO for the current markets (soap manufacturing and household consumption) and an external local industrial or export markets were investigated. It was found that producing good quality CPO is profitable for the household consumption but not for soap production in the current market. Selling in the household consumption market was found to be more profitable than the export or local industrial market. The study further describes how learning to improve quality of CPO occurred during and after the experimentation and concludes with options of remunerative markets for artisanal palm oil producers to explore.

4.1 Introduction

In developing countries, small-scale agro-processing enterprises are an important source of employment and income generation (Kroma, 2003). Appropriate interventions in small-scale agro-processing are particularly suited to contribute to poverty reduction as it builds on the skills and human resources, especially of poor women (Achoja and Eyaefe, 2010). In Ghana, processing of oil palm is a major source of income and employment to many women in the rural areas of the forest agro-ecological zone, especially in Kwaebibirem District of the Eastern Region (Opoku and Asante, 2008). Palm oil is an important product which has extensive domestic (preparing food, making local soaps) and industrial uses like cosmetics and pharmaceuticals (Berger and Martin, 2000). Different palm oil uses have different quality requirements. Given the susceptibility of the oil to quality deterioration along the processing chain means appropriate interventions need to be put in place to minimise quality loss. Improved quality of crude palm oil may enable artisanal processors to differentiate between their trade networks based on the different uses and also to increase their chance of participating in more remunerative markets.

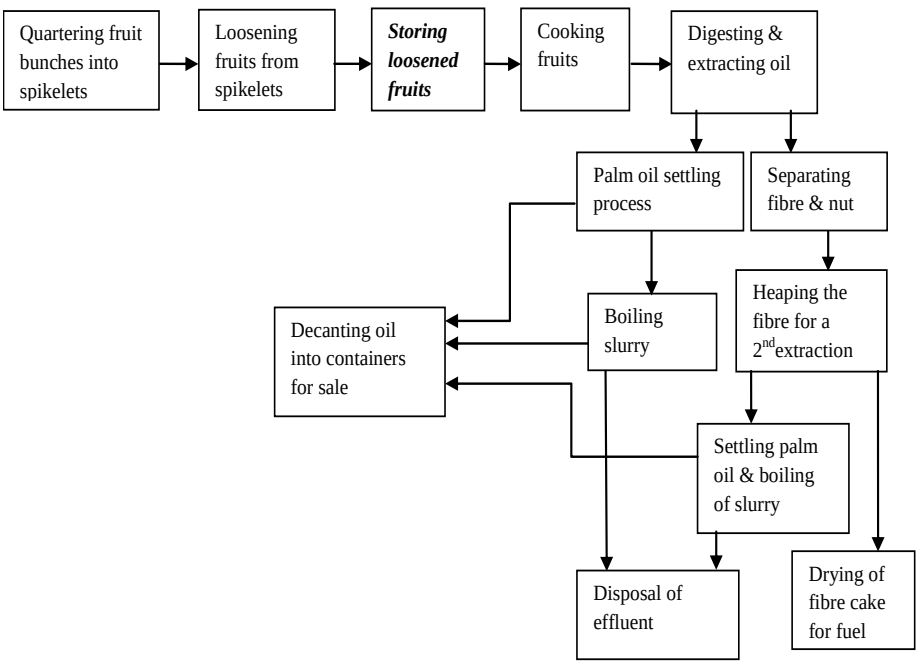


Figure 4.1 A flow diagram of stages of artisanal oil palm processing

Artisanal oil palm processing involves bunch quartering (cutting), fruit loosening, storing fruits for several days, boiling, digestion, extraction, allowing the palm oil to stand for 2-3 hours for water and dirt particles to settle, skimming and then decanting into containers ready for sale (Figure 4.1). Generally, all the processing stages are done manually except the digestion of cooked fruits which is done by diesel engine powered digester equipment. In contrast, industrial processing involves 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, all in a continuous highly mechanised process taking place within an hour.

The quality of crude palm oil (CPO) is indicated by various factors, and different end markets have different quality requirements. For household consumption, colour, smell and taste (mainly rancidity) are important, and affect price. However, rancidity does not relate to price in the West African regional markets such as the Nigerian and Togolese informal CPO market for soap manufacturing. On the other hand, price on the local industrial and international markets is dictated by free fatty acid (FFA) level, the lower the FFA, the higher the price. The FFA level is therefore an important quality parameter (Kardash and Tur'yan, 2005) in the selling of the product in these markets, with a maximum acceptable value of 5%. Free fatty acid level is not known or used as an indicator of quality in the existing markets artisanal producers accessed. It is therefore necessary to find out how processors can relate the quality parameters they know in their market (mainly rancidity) to FFA level from the other 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 (Dessassis, 1957; Henderson and Osborne, 1991). The longer a bruised fruit stays unsterilized the longer the hydrolysis activity continues and thus the higher the FFA level (Dessassis, 1957; Ngando *et al*., 2011; Tagoe *et al*., 2012). Fresh fruit bunches (FFB) must therefore be processed rapidly after harvesting to avoid the oil degradation and further FFA formation. The initial sterilisation process at large scale mills inactivates the lipase activity in the fruit. On the other hand, at the artisanal mills, FFB and spikelets are not sterilized within few days after harvesting. They are rather stored prior to the start of the processing activity to enable fruits to detach more easily from them. After this, loosened fruits may again be stored for several days before cooking. Zu *et al*. (2012) identified that, the processing practice which mostly affects CPO quality is duration of oil palm fruit storage before processing. A diagnostic study showed that loosened fruits are stored for a period of 7-21 days (Osei-Amponsah *et al*., 2012). Storage periods of 12-26 days were estimated

in about 10 communities of the same district (Tagoe *et al*., 2012), while Kyei-Baffour and Manu (undated) observed 14 days (excluding the number of days bunches were kept at the farm) in the Ashanti Region.

A high level of FFA in CPO is undesirable as it leads to rancid taste, lower price, and increases the cost of refining (Gibon *et al*., 2007). The artisanal processors value palm oil for its organoleptic properties (taste, smell and colour) and not for its FFA level. There is therefore the need to explore whether and how artisanal enterprise's assessment and perception of palm oil quality can be linked to that of FFA level. There is a demand for high quality crude palm oil in domestic industrial and export markets (GoG, 2010). To explore these markets, it is necessary for processors to innovate their processing practices in a way that allows them to meet higher quality criteria.

In artisanal palm oil production, processors make use of their knowledge and capabilities (Chapter 3). Whilst some of their practical know-how may be valid, other aspects may need further testing and validation. For instance, processors think that storing loosened oil palm fruits for longer periods before processing leads to more yield of CPO. 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 (Okyere-Boateng, 2011, personal communication; Sambanthamurthi *et al*., 1998). Assuming both are pertinent observations, the possible explanation could be that while no additional oil may be formed, the artisanal 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. It is therefore necessary to understand what processors and their mill workers think 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 innovation.

'Innovation arises from on-going circles of exchange, where information is not just accumulated or stored, but created' (Wheatley, 1992:113). Multi-stakeholder learning is thus crucial for innovation to occur (Woodhill, 2010). For agricultural development to occur, processes are required that enable small-scale producers to analyse and reflect on their practices and thus be empowered to make their own decisions. In agricultural research various attempts have been made (Scoones and Thompson, 2009; Asenso-Okyere and Davis, 2009) to take into account the perspectives, knowledge and experiences of those actors who are actively involved in production or processing. These create opportunities to help them improve their performance and also take ownership of the results of the research. In my case, it was

suggested during a local stakeholders' validation and research planning workshop that a joint experimentation be conducted using the processors' hypothesis as the basis. This local stakeholders' platform would then also serve as a learning platform for processors to improve upon their processing practices in a bid to produce good quality palm oil. In this way, new knowledge could be generated that was not there before. It is believed that such learning together 'brings a rich and varied set of life experiences to the learning environment' (Cranton, 1994:7).

Although there are studies on FFA and 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 quality in Ghana (Zu *et al*., 2012; Tagoe *et al*., 2012) were done by researchers alone without any learning agenda for the artisanal processors to improve on their practices. In this study, I made the processors' learning a focus and tried to find out how processors learn to improve their capacity to produce better quality palm oil. This study focuses on joint experimentation as a learning activity to enhance processors' knowledge on the effects of variation of fruit storage period on palm oil yield and quality. In addition there was a researcher-managed experiment on the same issue to complement and verify repeatability of the results of the joint experimentation.

4.1.1 Objective and research questions

The main objective is to investigate how to improve quality of palm oil through a joint experimentation process. To achieve this, I specifically asked:

- How stakeholders can jointly assess the effect of variation of fruit storage period on palm oil yield and quality in the artisanal palm oil enterprise?
- How does learning from a joint experimentation process occur?
- What attributes of quality assessment from artisanal processing could be correlated with FFA levels of palm oil?
- What are the profitability options for the production of palm oil?

4.2 Materials and methods

Fresh fruit bunches from ten-year old oil palm trees of the *Tenera* type were bought and carted to an artisanal mill on the day of harvest.

4.2.1 The joint experimentation process

The joint experiment was conducted at *Enye mahooden* oil palm artisanal mill at Takrowase from 21st March to 8th April 2011. Based on findings from Chapter 3 about the relevant actors to be included in an intervention, further discussion at a

stakeholders' platform workshop, and the willingness of actors to participate, the following individuals were selected to be part of the experimentation: three processors, a mill owner, a caretaker, two mill workers, a scientist and a technician from the Oil Palm Research Institute, the extension officer in-charge of Takrowase, and myself as a researcher.

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 the 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 mill as shown in Figure 4.1. The day after bunch harvest, each of the 500 kg FFB was quartered by skilled labour. The fruits were loosened for the heap labelled 1 (3 days storage period) by different labourers with supervision from the mill workers in the experimentation (labourers were not considered part of the experimentation group). On the third day, label 1 fruits 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. Volume and weight of palm oil produced were recorded. Fibre and nuts were separated and the fibre stored for a day after which oil was extracted again from the fibre, and recorded as volume of fibre oil.

Samples of the CPO were collected in a closed container by the researcher for FFA analysis after extraction and another set of the samples was kept at the Research Institute's laboratory at room temperature for a later sensory evaluation exercise. Loosening of fruits from all the other heaps was completed by the 6^{th} day after harvest, and the fruits were then placed back for further storage under the shed with the remaining labels. The manual loosening of some fruits from the spikelets on the second and third day after harvesting appeared a very difficult task for workers. The technician introduced a method of using a knife to cut loose the fruits (as was being done in the fruit and bunch analysis laboratory of the research institute for removing 30 fruit samples). The workers found the method tedious and time consuming, so the researcher and technician had to do it themselves to get all the fruits from label 1. Joint cost calculations were recorded of processing fees (based on the standard charge for 1 tonne of bunches or 15 cages of boiled fruits) for different processing activities and equipment use for each storage period, as well as the prevailing market prices paid at the mill of FFB and palm oil at the time of the experiment.

The main activities of the group were the weighing of the fruits to be boiled and the measuring of the volume and weight of palm oil extracted for each storage period. In addition, roles were assigned to processors for the supervision of mill workers engaged in the digestion and extraction steps of processing. The scientist, extension

officer and technician were mostly involved in the weighing of fruits and checking on time of fruit boiling. The processors initially observed how to check readings from the weighing scale and subsequently got involved with the weighing procedures.

3 days 7days 14 days 21 days

Figure 4.2 Fruit conditions at the end of the respective storage periods during

4.2.2 The researcher-managed experiment

The same experiment was repeated during the period as a researcher-managed trial to ensure replicability and to complement the results from the joint experiment. It was done in each of three mills: Nana Yeboah in Kusi with a hydraulic press, Kwarteng and Agya Owusu in Kade with respectively a hand spindle press and a digester screw. For these experiments 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 a different mill. The fruit bunches were divided into four equal sets of 100 kg each and its loosened fruits stored for 3, 7, 14 and 21 days. At the mills the bunches were quartered and fruits loosened according to the day for processing as in the case of the joint experimentation. For each storage period at the different mills the loosened fruits were processed in two batches and palm oil extracted using the equipment available at the different mills. Thus, a 3 x 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's extraction was calculated as [(palm oil weight/fruit weight) 100]. Three CPO samples each were collected from the oil extracted after each of the four storage period experiments, from the different mills for quality (FFA) analyses in a laboratory.

4.2.3 Laboratory analysis

The FFA levels of samples from both the joint experimentation and the researcher-managed experiment were determined at the laboratory of the Nutrition and Food

Science Department of University of Ghana. The concentration of free fatty acids was determined using the titrimetric approach following the American Oil Chemists' Society's official methods and recommended practice Ca 5a-40 (AOCS, 1990).

4.2.4 Organoleptic assessment of crude palm oil quality

In sensory evaluation methods, rancidity and other deviations in quality are used to assign preference ranks by a panel that differentiates 'excellent' from 'repulsive' samples (AOCS, 1993). Processors and buyers in the artisanal trade network have their own ways of checking quality (Chapter 2) which is different from laboratory testing. A descriptive test was conducted for sensory analysis with 40 untrained panellists drawn from the stakeholders' platform (largely processors, farmers, mill workers, mill owners, also few extension and research staff). Four different samples of CPO produced from the fruits stored for various periods were assessed by the panellists. Each panellist was given the opportunity to assess each sample for every storage period. With the aid of a questionnaire, panellists were asked to score each sample based on a three-point scale. The attributes used for scoring having been gathered during the diagnostic study as what processors used to assess quality for palm oil for home consumption. Thus the scoring was based on attributes of rancidity (taste), smell and colour, ranging from 1 (best) to 3 (worst) for each attribute. For example, rancidity could be scored as 1=not rancid, 2=rancid or 3=very rancid. They also assessed the overall best sample in relation to all the sensory attributes combined.

4.2.5 Analysis of data

The mean of FFA and percentage palm oil yields was calculated with SPSS. The comparison of the mean differences between the yields for the three extraction equipment and different storage periods was made with a one-way ANOVA using SPSS (ver. 16). The frequencies and means for the sensory evaluation were also established and analysed with SPSS and scatter graphs created. A correlation between organoleptic attributes and FFA was established and the Pearson co-efficient between the quality attributes was then calculated to test for significance.

4.2.6 Measuring profitability of CPO for different fruit storage periods

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:

$$NR_i = TR_i - TC_i \qquad (1)$$

with

$TR_i = P_i Q_i$ (2)

$TC_i = \sum_{k=1}^{k=n} Px_k X_{ki}$ (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 artisanal processors, scenarios for the three different markets which they can access are assessed. In this case, the current market they operate in can be seen as separated into two different scenarios.

Scenario 1: The processors produce CPO at any of the four fruit storage periods (3, 7, 14 and 21 days) and continue to sell to the current Nigerian and/or Togolese traders for soap making who are not particular about CPO quality; they pay the same price for any quality.

Scenario 2: Processors remain in the current market but differentiate quality by producing at 7 days fruit storage period to access the national household consumption market, as palm oil for cooking. Here there is an incentive of receiving a higher price for good quality.

Scenario 3: Processors move out of the current market by producing at a 3 days fruit storage period for high quality CPO to meet the standard for the local industrial and/or export markets. In this case quality is also expressed through higher prices.

In addition, I looked at a hypothetical situation for Scenarios 2 and 3, whereby processors produce at 5 days storage period and can either remain in the existing market for home consumption; or move out to sell to the local industrial or export market. This additional analysis is made with respect to the observation from the experiment that loosening of fruits at 3 days after harvesting is very difficult with regard to the existing manual loosening at the mill. Assuming that loosening is much easier at 5 days than at 3 days and also gives a better quality CPO than at 7 days, then processors can produce after 5 days of harvest for the two markets. For this analysis, estimates are made based on interpolation between the 3 and the 7 days fruit storage periods. It is assumed that 5 days fruit storage period would give an intermediate oil yield of 10.6% and a FFA level of 3.9% (both estimated by linear interpolation).

4.2.7 Analysing the learning process of the joint experimentation

To understand the learning process of the joint experimentation group, an experiential learning approach was used. Experiential learning is defined as 'the process whereby knowledge is created through the transformation of the experience of the learner who is at the centre of the learning process' (Kolb, 1984:38). In this analysis I focused on the processor as the learner but also drew lessons from the other members of the experimentation. Kolb (1984) proposed that experiential learning follows a continuously repeated cyclical process. Generally, knowledge creation occurs from experience, reflection, conceptualisation and then to application, which in turn leads to new experiences from where the cycle is repeating itself. Another concept which the learning situation in the artisanal palm oil enterprise follows is a review of the work of major experiential learning theorists by Malinen (2000), which concludes that experiential learning involves first and second-order experiences, reflection and dialogue. According to this view, first-order experiences are tacit, may seem true to the learner but inadequate for experiential learning to occur. The second-order involves 'disorientation' (Mezirow, 1991), or 'recognition of ignorance' (Revans, 1998) which challenges the first-order experience, and then leads to 'reconsideration and modification' (Malinen, 2000:75) of that experience. The stage of reflection ensures thinking and action taking. Dialogue is also a key factor in experiential learning and entails sharing, testing, justifying and believing (Malinen, 2000). This study adopts Malinen's approach to experiential learning to understand and describe how learning occurred through the activities of the joint experimentation and further sharing of

results at stakeholders' workshops. The narratives of stakeholders involved are used for the analysis.

4.3 Results and Discussion

4.3.1 Variation of palm oil yield and quality with fruit storage period

This section combines findings from the researcher-managed experiment with that of the joint experimentation. 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. 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 (Figure 4.3). 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% s.e.d. 1.17). There was no significant ($P>0.05$) oil yield difference between 7 (16.4%) and 14 (17.9%) days but yield declined significantly ($P<0.05$) thereafter to (12.3%) 21 days.

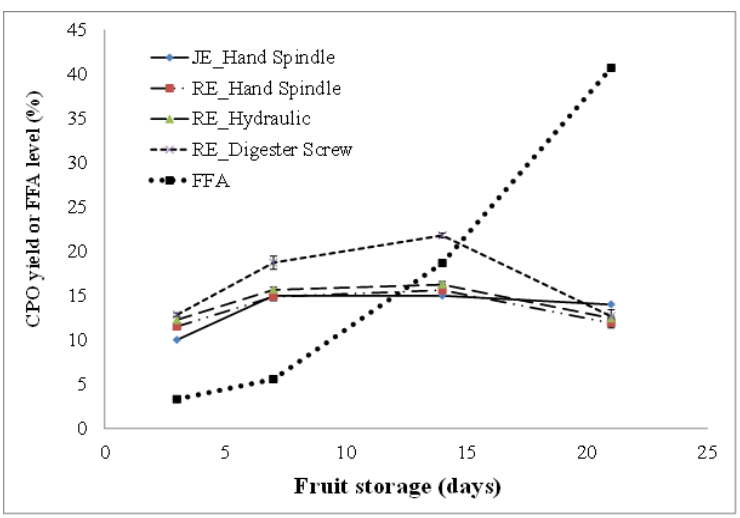


Figure 4.3 Variation of CPO yield (%) and FFA levels (%) with fruit storage period. Error bars represent the standard errors of the % mean CPO yields. JE= joint experiment; RE=researcher-managed experiment

The fruits processed at 3 days of storage, in all cases had the lowest oil yield. However, at 3 days of storage high quality oil with an FFA level of 3.3% was obtained, well below the maximum acceptable level of 5%. According to processors from the joint experimentation, the lowest oil yield for 3 days could be due to the

lower efficiency of the hand spindle press in extracting oil from boiled fresh fruits. They explained that this is because the pounded mesocarp at that period becomes like a thick mash, filling the holes of the press cage and thus hindering effective extraction of the palm oil (see Figure 4.6). The digester screw press was found to be more efficient than the other two extraction equipment.

The FFA level of oil processed after 7 days of fruit storage was already above the maximum acceptable 5% (Hartley, 1988; PORAM, 2011). Another study from a research station in Kusi (Tagoe *et al*., 2012) found an FFA level of 6.02% for a 6 days storage period, data that support this study. After 14 and 21 days of storage the FFA levels were very high (Figure 4.3). Zu *et al*. (2012) found an FFA level of 19.9% after 15 days of storage which is comparable to the 18.7% found in this study after a storage period of 14 days.

While FFA levels continuously increased with the period of fruit storage, CPO yield followed a quadratic function. Thus, optimisation of FFA level would imply shortening the fruit storage period to 3 days, at the expense of CPO yield. Optimisation of CPO yield, on the other hand, would imply stretching the storage period to 7 - 14 days, at the expense of oil quality. Poor quality oil cannot be sold for home consumption or at export markets. This poses a dilemma, and some processors discussed that it is better to have access to diverse markets to have different prices for the different quality grades.

4.3.2 Sensory evaluation-comparing organoleptic attributes and FFA levels

The purpose of this analysis was to find out if there is a correlation between attributes of palm oil quality (which stakeholders in the artisanal enterprise already know) 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 (Figure 4.4).

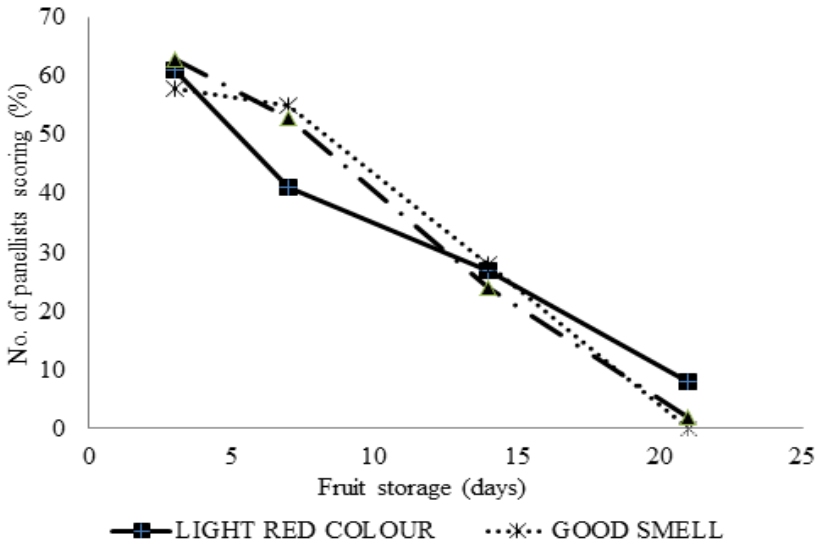


Figure 4.4 Percentage of number of panellists scoring CPO samples for different storage periods based on frequency scores for light red colour, good smell and non-rancidity (n=40)

The older the fruits became, the fewer the number of panellists who appreciated the smell and taste of CPO produced from it.

The panellists' preference for colour scoring shows that most of them preferred the CPO sample from 3 days storage period as light red, while as the fruit storage period increased to 21 days fewer people saw the CPO sample as light red. The scoring rather increased for dark red colour.

Figure 4.5 shows that as the FFA levels of the samples increased with fruit storage, the number of panellists who scored the sample as very rancid and of poor smell also increased. Correlation analysis showed that generally, FFA level had a strong positive correlation with what was considered by the population of panellists as a poor smell ($r=0.994$, $P<0.01$) and high level of rancidity ($r=0.998$, $P<0.01$). Narasimhan *et al*. (2001) also found that FFA positively correlated with harsh odour and rancidity.

It is interesting to note that, it was not every individual on the panel who could easily differentiate rancidity between samples from 3 and 7 days of fruit storage. Thus, the rancidity and bad smell rating as known to the processors can be used only as a potential proxy for high FFA level in palm oil, in practice to differentiate the quality for different markets. However, further learning is required to help standardise this type of assessment at the mill. This implies that either smell or taste can be used at the artisanal mill by processors to have a rough idea of the quality of CPO produced in relation to the storage periods of fruits used, especially between the extreme periods (3 or 7 and 14 or 21 days). In this case, they can relate longer storage periods to rancidity,

therefore, high FFA levels which mean poor quality and lower market price. This type of assessment is usually used by household consumers, but these organoleptic tools may be important for use not only for that market but also together with standard chemical testing for the export market. Such trained processors would potentially be able to also differentiate production for food consumption and soap markets, and to negotiate for better prices if the attributes can be standardised for different CPO quality levels.

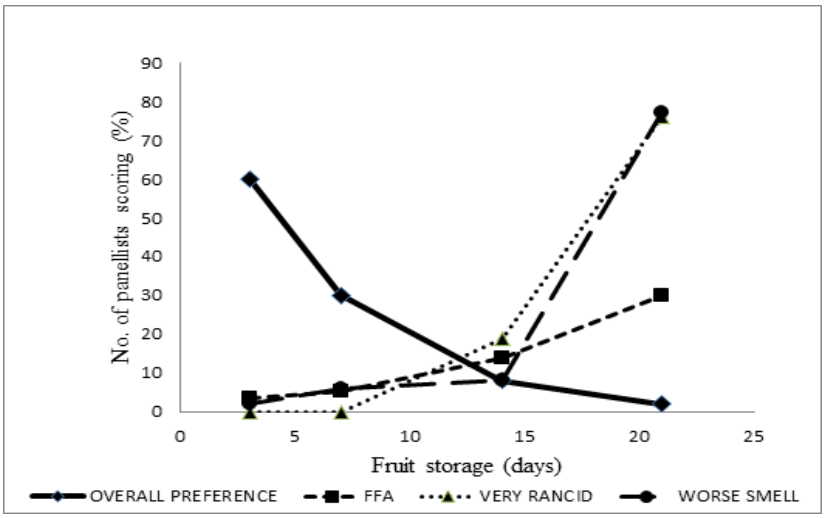


Figure 4.5 Variation of FFA level with percentage number of panellists scoring CPO samples for different storage period based on scores for very rancid, worse smell and overall preference (n=40)

Figure 4.5 shows that in terms of smell, taste, and FFA level the overall score for the sample processed from 3 days after harvesting was preferred by 60% of the panellists, while the sample from 21 days was preferred by only 2% on all attributes. The overall preference declined from 3 days of storage to 21 days while FFA levels increased. Thirty per cent of panellists scored the 3 days CPO sample as better than the 7 days sample. Overall scoring had a significant ($P<0.05$) negative Pearson correlation ($r=-0.984$) with storage period. As storage period increased preference for the CPO samples decreased. Therefore if processors want to sell palm oil for household consumption or cooking, they will have to process fruits within 3 to 7 days after harvest. Crude palm oil which is made between 14 and 21 days after harvesting the fruit bunches is ranked as very rancid and of poor smell. Such palm oil can be sold to local soap making manufacturers, and in the informal West African markets, but at lower prices.

4.3.3 Profitability analysis of palm oil production

The financial analysis of the processing activity for each of the four storage periods (3, 7, 14 and 21 days) was based on the average processing fees and fruit bunch price during the research period. The CPO derived from 8 tonnes of fresh fruit bunches for each fruit storage period was estimated at 920 kg (3 days), 1190 kg (7 days), 1250 kg (14 days) and 950 kg (21 days), based on their different yields.

For Scenario 1, the average price paid for 1 tonne of CPO was 1000 GH¢. For Scenario 2, the average price per tonne of CPO was 1800 GH¢ calculated based on 5-year national average wholesale price. For Scenario 3, the average freight-on-board price for 1 tonne of CPO was 1170 US$ = 1906 GH¢, as the average world market price received by a medium scale palm oil processing company in Kwaebibirem District, (1 US$=1.63 GH¢).

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.

Table 4.1 Analysis of profitability of CPO produced from 8 tonne of fresh fruit bunches (FFB) at different fruit storage periods for the three scenarios of marketing. Scenario 1 (Sc.1) is the existing market; Sc. 2 is the national household consumption market; Sc.3 is the local industrial or export market (for further details on scenarios see materials and methods).

Variables	**Experimental fruit storage period (fsp*)**							**Hypothetical fsp***	
	3			7		14	21	5	
	Sc. 1	Sc. 2	Sc. 3	Sc. 1	Sc.2	Sc. 1	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 (%)	-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

In Scenario 1, the current market consists mainly of Nigerian agents and Togolese traders who purchase palm oil to sell to clients in both countries for soap manufacturing. 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. This implies that the cost of production is over and above the total revenue, with benefit-cost ratios below 1 (Table 4.1 columns 2, 4, 6 and 7). The lowest net loss is attained with processing at 14 days of storage.

In all cases, the largest cost for the artisanal processors was the cost of fresh fruit bunches. FFB was the most important item of total costs, at about 80%. In Nigeria, Olagunju (2008) recorded FFB cost to be 56%. Ekine and Onu in (2008) also found that FFB cost was between 62-65% of total cost in small-scale production. In the case of Adjei-Nsiah *et al*. (2012b), it was 88% for both peak and lean fruit bunch production seasons.

In relation to processing after 3 days of fruit storage, narratives and observations from the field indicated that processors use various coping strategies to remain in business. These include the use of family labour for some processing activities and the use of fruit bunches from palms owned by processors themselves, which are not included as part of total cost of production. Processors also have inaccurate estimates (they usually overestimate) of the tonnage of fruit bunches because weighing is not done, but assessed through visual inspection when bunches are bought from farmers.

In Scenario 1, the production of CPO for 3 and 21 storage days gave the highest losses of 36.4% and 34.7% respectively. Adjei-Nsiah *et al*. (2012b) found a comparable result of 38%, in their analysis of the artisanal palm oil enterprise, during the peak bunch production season. Looking at the practice where processors like to store fruits after harvesting for several days before processing, it means they incur huge losses in this season, when CPO prices are very low. According to processors, they may obtain more profit if they are able to store the CPO they produced in the peak fruit production season until the lean production season when the price increases. It has been found that with the existing processing practice and market, a net return of 326 GH¢ per tonne, and a profit margin of 20% can be made by processors in the lean season from September to December (ibid).

Following Scenario 2, the option to sell the oil processed after 3 to 7 days storage for national household consumption, was the most profitable. The highest positive net return and benefit-cost ratio is reached from production after 7 days of fruit storage (Table 4.1). This option is by far the most profitable one across the scenarios and fruit storage periods. From Scenario 3, production of CPO after 3 days storage is profitable (Table 4.1, Column 3) if processors can access a local industrial or export market which offers a higher price for high quality. Producing CPO at 3 days storage gave a positive net return and therefore also a benefit-cost ratio above 1.

For Scenario 2, 7 days fruit storage had the highest net return (Table 4.1). For the processors, it is much easier and slightly cheaper to produce CPO at 7 days than at

3 days. This is because fruits can be loosened more easily and extraction with the hand spindle press is not tiresome (requiring fewer times of pressing per quantity of pounded fruits). Also, at this storage period the fruit mass after pounding does not fill the hole of the hand spindle press cage (Figure 4.6).

3 days storage 7 days storage

Figure 4.6 Palm oil extraction from hand spindle press cage for fruits of 3 and 7 days storage

From the sensory evaluation, the 7 days fruit storage palm oil sample was preferred by 55% of panellists for its good smell and 53% as not having a rancid taste (Figure 4.5). 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 Kumasi, Accra, Koforidua and Tema. This existing market looks more feasible to access than the export market, with regard to ease of extraction and the analysis shows processors can do much better in terms of more profits per unit of CPO sold.
The positive balance for Scenario 3 potentially implies a good opportunity. During the experimentation, it was however observed that the processes of loosening fruits and extracting oil are more tedious given the skills and facilities currently available at the mill. Discussion with actors indicated that the income from 3 days processing may not necessarily outweigh that of 7 days due to the challenges of getting the fruits ready for oil extraction already on the third day after harvesting.

It is also important to note that accessing this local industrial or export market looks cumbersome. This is because it involves more than technically improving quality, but also entails changes in division of work, relationship with farmers and buyers. The processors may also lose their current networks and its unique flow of social and symbolic capitals as described in Chapter 3. Such social conditions of production will be difficult to realise in the short term, and the outcome in terms of which actors loses or gains cannot be predicted easily. It was discussed by stakeholders that processors should also explore possibilities of new technologies which are available from Ghana Regional Appropriate Technology Industrial Service (GRATIS) if they want to process within 3 days after harvesting. This technology from GRATIS includes fruit strippers for loosening fruits and steam boilers. On the other

hand, GRATIS should engage in joint experimentation with the processors to assess whether the technology is indeed appropriate for artisanal processing and, if not, what adaptation could lead to its adoption. This is something the Concertation and Innovation Group (CIG) was exploring further to see how best to link processors to such technology. In addition, Chapter 3 shows that there are some social and cultural benefits processors derive from the existing trade network which may be lost if they move out entirely in order to access the industrial market. Processors will certainly balance financial against the non-financial, material costs and benefits in deciding to intervene and alter the flows of resources in order to differentiate between the different market options so as to improve on their livelihoods.

The overall profitability analysis showed that processors can only make profit by selling palm oil from 3 and 7 days storage period in either export or household consumption market. Since processing at 3 days is difficult and relatively expensive, 5 days fruit storage which is between the two periods (3 and 7 days) and probably gives an intermediate quality palm oil could be explored. The FFA level after 5 days storage period is estimated by linear interpolation to be around 3.9%. This would potentially make the oil meet the requirements of the local industrial, export and household consumption markets alike. For the hypothetical storage period of 5 days processors were calculated to make profit in both Scenarios 2 (export market) and 3 (household consumption market) as Table 4.1 (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. A reality check is of course still needed to find out whether this could provide an additional option for accessing the remunerative markets, next to 7 days of storage. This could become relevant if the price in the national household market would drop after more processors start to provide this market with oil processed after 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 the Research Institute and CIG to harness their innovation capacities.

4.3.4 Learning from joint experimentation and local platform building

The experiential learning of the processors

On the basis of Malinen's review of experiential learning theories (2000) the learning process that occurred during and after the joint experimentation can be analysed, drawing on the three aspects of experiential learning: second order experience, reflection and dialogue (Malinen, 2000). These three aspects areas relevant for adult

learning as in the case of the learning about palm oil quality by processors and other stakeholders in artisanal palm oil production.

Before the experimentation process, processors generally stored fruits for several weeks (up to 21 days) after harvesting before boiling for palm oil extraction because they believed this practice gave highest yields of CPO. They were in their first order experience, which is local or practical knowledge based on lived experience from the past. This knowledge is tacit, and because it seemed true at the time, it did not cause or induce learning in the enterprise. Therefore another type of experience was needed, which came through the joint experimentation and its outcome. The stakeholders together planned and explored options and decided on what to do throughout the experimentation. The results of this learning during the experimentation showed that storing fruits longer than 14 days after harvesting before processing actually reduced CPO yields. This is a second order experience for the processors which challenged their first order experience and it is expected to lead to reconsideration and adjustment or modification (Revans, 1998) of their initial knowledge.

In this case, the outcome of the experimentation indeed challenged the initial knowledge of the processors and 'modified earlier constructions' (Malinen, 2000: 75) as the processors began to reflect on their long fruit storage period practice. Reflection is said to be important in experiential learning where thinking and acting occurs (Van Manen, 1977). It was observed that reflection already started during the experimentation and continued even after the process. Processors and other stakeholders (mill workers and caretakers) involved in the experimentation critically reviewed the activities of each storage period experiment, and this led them to try out some new ideas by themselves in setting up additional experiments in the processing activities at the mills as a way of confirming the results of the experiment and to test at intermediate storage times between the earlier tested ones. This approach of the processors using repeated experimentation and testing, shows replication, as used a lot in technical sciences and one of the very reasons for the researcher-managed experiment. It is quite different from what technical scientists increasingly do through the use of mathematical models and stimulation.

Experiential learning also involves dialogue (Malinen, 2000), and this requires goodwill and collaboration from all stakeholders. The technician taught the mill workers and processors how to use the weighing scale and they in turn explained to him the processing activities at the mill. Sharing the outcome of the experiment by all involved was done not only at the mill level, but also with other processors, mill owners and workers, farmers, extension staff, and scientists at a local stakeholders' platform workshop. This platform created by the researcher appeared very useful in expanding the scope of dialogue between all stakeholders (Box 4.1). Scientists,

processors and farmers alike exchanged ideas, and discussed issues at these workshops that continued to run for two years. In the process, processors also learned from the outcome of correlating their organoleptic assessment and FFA level for palm oil quality and this could be a potential tool for differentiating between palm oil of low and high FFA levels. I realised that collaboration and understanding of each person's role in the experimentation led to outcomes being acceptable to the stakeholders (most importantly, the processors) and they were willing to learn from each other.

In this study, the process of experiential learning moved from reflection to action, as evidenced by the fact that processors started to experiment in their own way at the different mills, to further the learning by testing what worked best in their own situation. They tried to find out which storage period gave them the highest yield of CPO (for their current market) by applying the new knowledge and skills from their second order experience. Interestingly, repeats under controlled conditions are needed for scientists to dare to learn and make inferences from an experiment. It was also observed that the processors acted 'scientifically' by repeating the experiment themselves to ensure it was what really happened in the joint experimentation as they saw or heard from peers. This ensured the second order experience was there to boost learning that provided outcomes in the agenda to improve quality of CPO (reported in Chapter 5).

The learning process of the researcher

As a researcher I also went through experiential learning phases. Initially from hearing stories about the processing of oil palm I assumed I knew much about the effect of fruit storage period, thinking that fruit storage would not affect yields at all. However, through the results of the experiments, I had new information, to help me understand the issue better. Again, being part of the joint experimentation with other stakeholders, I had my own reflection points in the course of the process. I felt tempted at times to take over an activity and 'display' my scientific skills of measuring liquids for example, but processors also had their skills of measuring at the mill and it worked better when the skills of 'knowing what to do' and 'knowing how to do it' were used hand-in-hand. Thus, I learnt not to monopolise knowledge or impose my skills arrogantly, but to respect and take the practitioner stakeholders seriously as co-researchers. In that way, I was also seen as a stakeholder by the others; in that, we all are helping in the agenda of improving artisanal palm oil quality for better access to remunerative markets. Not as a researcher who had come to do research on them and just write a book about their activities only.

Box 1: Snapshots of stakeholders' reflections from discussion at platform workshop

'the workshops are good for creating a learning environment. I can tell you I had heard a lot and learned from the discussion. The discussion on long fruit storage is sinking down very well. Now I know I can also produce good quality palm oil for a different market'.

'the quality of palm oil is affected by the storage period of fruits. Fruits will produce good quality if they are not kept for a long period after loosening. Between 3 to 7 days storage period before processing is good for the best quality of palm oil'.

'the cost of processing the fruits relatively earlier is expensive but the palm oil generated attracts a higher price, it is better to sell quality palm oil at a good price than a lower quality palm oil which is cheaper. Besides the Nigeria buyer will take advantage and quote any price they want'.

'from my own experiment, I have observed that when you make oil with fruits stored for 7-10 days, the oil stores better and remains with good quality for a long time'.

'the 3 and 7 days storage periods palm oil have lower FFA levels are appropriate for attracting better prices. It is better for processors to produce palm oil within these days, especially just before the 7 days. The 7 and 14 days give similar yields but the 7 days has a better quality, processors should opt for the latter. This is achievable, but also depends on the type of market one wants to access. For example, the Nigerian buyers are not interested in quality but quantity however, there are remunerative markets which want high quality palm oil'.

'we should have different grades of the palm oil, that is good quality and poor quality palm oil for soap, so that we can sell at different prices'.

'processors should keep the fruits neat because when left on the ground for too long, it picks bacteria, worms and others which aids the rotten process and affect the quality at the end'.

4.4 Conclusions

This study sought to investigate how quality of palm oil can be improved through a joint experimentation process by processors and other stakeholders, including the researcher. It looked at the effects of variation in fruit storage periods on quality in terms of CPO and FFA level. Through an organoleptic assessment, rancidity and smell attributes were identified as a potential proxy for the FFA level which can help artisanal processors to differentiate between quality of palm oil for different trade networks and markets, hence for different prices, showing the more profitable market options processors can access.

The free fatty acids level of the palm oil was found to rapidly increase with prolonged fruit storage period, thus reducing the quality of palm oil with days of fruit storage after harvest. The production of palm oil at all storage periods was found to be non-profitable for the current informal Nigerian and Togolese markets. However, production of palm oil at a 7 days storage period for the national household consumption market was the most profitable. If produced at 3 days, palm oil could be sold with profit to the local industrial or export market, but more efforts are needed to make production at this period efficient. It is suggested that key stakeholders like the District Agriculture Development Unit, the millers' association and the Concertation Innovation Group explore food consumer markets (schools, hotels and restaurant, and individual consumers), and assist the interested processors to access them. There is a need for understanding the possible deterioration of quality of palm oil for household consumption, if stored for long periods. In addition to this, the millers' association in collaboration with CIG should explore the options available for the use of GRATIS technologies to further generate innovations for processing fruits earlier, towards production of higher quality CPO.

The joint experimentation created space for interaction and learning about processing practices, as well as for improvement of CPO quality to processors and other stakeholders like scientists from the research institute and extension agents. Two main things happened during the learning process. Firstly, processors 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 practice they knew well. Secondly, 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. The joint experimentation activity kept the learners (especially processors) active in the learning

process over a period of two years, which created outcomes reported in chapter 5. The learning experiment developed from the event of the joint experimentation into a continuous process which became an integral part of their daily work.

It is concluded that it is profitable for processors to improve on palm oil quality by reducing fruit storage periods. This will allow them to diversify their livelihoods by differentiating their prices in accessing the national market of home consumption and the export market for good quality palm oil. However, it is unlikely that they will all and fully move out of the less remunerative local and regional soap markets in the short run.

Chapter 5

Institutional change and the quality of palm oil: an analysis of the artisanal processing sector in Ghana[1]

Abstract

In Ghana, most oil palm fruits are produced by smallholders and processed by female artisanal processors. However, the ensuing crude palm oil (CPO) is high in free fatty acids (FFA) and therefore cannot be sold in remunerative local or export markets. An earlier diagnostic study indicated that the low quality is due to the artisanal processing practice of leaving loosened fruits unprocessed for periods of up to 21 days. Also, the use of old lorry tires as fuel for cooking fruits renders the oil unfit for international and domestic industries and affects the health of people working and living around the processing facilities. This study describes the effect of learning with processors and of creating a stakeholders' platform that was able to take action to address the constraints. Chiefs, the district assembly and a Concertion Innovation Group as a new stakeholder collaborated and linked up to support the local struggle to stop the use of tires for fuel. The emerging institutional changes are assessed against baseline information. The quality of CPO was found to have improved compared to what existed at baseline.

[1] This is a slightly modified version of an article submitted for publication as: Osei-Amponsah C., Stomph T.J., Visser L., Sakyi-Dawson O., Adjei-Nsiah S., Struik P.C. (2012) Institutional change and the quality of palm oil: an analysis of the artisanal processing sector in Ghana. IJAS-International journal of agricultural sustainability.

5.1 Introduction

The economy of Ghana revolves around smallholder agriculture production and processing (Chamberlin, 2008). Artisanal oil palm processing for instance is a major source of employment and income for many of the resource poor in rural Ghana, especially women who due to gender roles are attracted to food processing activities. However, these artisanal processors are faced with a myriad of problems that affect their productivity.

A diagnostic study (Chapter 2) found that processors do not have access to remunerative markets due to poor quality of the product. Furthermore, a problem tree analysis linked the lack of market access to socio-technical (Chapter 4) and institutional constraints. This chapter focuses on the institutional constraints.

Institutions are crucial for agricultural productivity and economic development (OECD, 2006), because they may create disincentives and unduly restrict opportunities for growth. We understand institutions as the rules, norms, practices and the roles played by stakeholders to shape interactions (Hounkonnou *et al*., 2012), Such institutions may constrain and even block the use of research outcomes, and therefore must be changed to make the development agenda complete and successful. This needed change, however, cannot be achieved by smallholders alone, because they have 'little' power to change rules, norms and practices, and for example, to withstand the complexities of linking into new markets. Also just experimenting with smallholders in this case artisanal processors as is done in research involving participatory approaches is not sufficient for agricultural development (Röling, 2010). This is because the smallholders suffer from low productivity not only because they are without skills, but most importantly because they do not have available incentives or windows of opportunity to raise their productivity (IFAD, 2003).

Institutional constraints are relevant and need to be investigated alongside other problems. However, such constraints are often only partly considered in research and development projects. Little attention has been given to institutions and impacts of institutional changes in artisanal agro-processing, and for that matter palm oil production in Ghana. For the artisanal palm oil enterprise in Kwaebibirem, a research which focuses on institutional changes is important for formulating policies that are embedded not only in the socio-technical but also in the institutional context of the enterprise.

This chapter takes the stand that in the artisanal palm oil production enterprise, there are fundamental institutional constraints that reduce its productivity and, in the long run, may hamper sustainability.

The remainder of the chapter is organized as follows: section 2 introduces the conceptual framework and research questions, section 3 looks at the research design and instruments, while section 4 specifies the institutional constraints. Initiatives to

institutional changes and their discussion are presented in section 5. Section 6 finally draws some conclusions.

5.2 Conceptual framework

Following the Convergence of Science-Strengthening Innovation System (CoS-SIS) programme points of departure (Hounkonnou *et al*., 2012) the oil palm domain project seeks to enhance artisanal processing sustainability through change in constraining institutions. In this regard, the institutional change is central to innovation (Jiggins *et al*., 1996; Byerlee and Alex, 2003; Barrett *et al*., 2009; Hounkonnou *et al*., 2012) in the artisanal processing enterprise. Such innovation may involve the interaction of individuals and organizations possessing different types of knowledge and authority (World Bank, 2006). This chapter looks at institutional change as innovations from the viewpoints of firstly, the level and extent of interactions between various stakeholders in the artisanal processing enterprise. Secondly, as the ability of relevant stakeholders to engage in joint experimentation and learn together. Thirdly, through the creation of a Concertion Innovation Group (CIG) and its activities.

There are many different meanings and also inconsistencies in the terminology 'institutions', this makes comparing theories in this area difficult (Kingston, 2007). What we do here is to draw on relevant concepts from sociological institutional change theories to discuss the institutional situation of the artisanal palm oil enterprise in Kwaebibirem. The concept of institutional entrepreneurship (Di Maggio, 1988; Hardy and Maguire, 2008) which analyses activities of change agents (entrepreneurs) is used to understand stakeholders' involvement in institutional change processes at different levels. Here entrepreneurs initiate change that breaks the institutional status quo and possibly contributes to transforming existing institutions or creating new ones. These entrepreneurs could be individuals or groups of individuals (Maguire *et al*., 2004) and can be likened to innovation champions (Klerkx and Aarts, 2013), in that they all contribute to innovation. However, in this study I use the concept of institutional entrepreneurs because my interest is in how institutional changes which combine with technological improvements may cause innovations to occur through this change agents. The entrepreneurs try to cause a change mainly because of the anticipated benefits to be derived, unlike innovation champions who mainly fulfil a coordinating role (Markham *et al*., 2010). We thus investigate institutional changes in the artisanal enterprise by focusing on the key roles of some stakeholders as institutional entrepreneurs and how they interact with each other to shape institutional outcomes (Fligstein and Mc Adam, 2011).

The chapter deals with institutions that also have an organisational basis. Institutions thus may be seen as a complex of norms and behaviours that are likely to persist over time especially in cases where historical, cultural, or practical patterns of interaction involved serving collectively valued purposes (Uphoff, 1986: 8-9).

Consequently, institutional change may take a long time, and is often difficult to enforce within a shorter time frame by external actors. What is often mistaken for institutions in the normative sense, are organisational practices (Nuijten, 2003). This study thus first draws on a conceptualisation of institution in its organisational aspects of changing practices through an action research (joint experimentation) and platform workshops. Secondly, we draw on the cultural aspect of institution of the Akyem chiefs' authority to demand change because they are able to exercise their power which is embedded in historically, locally rooted norms and practices of social organisation (Maiga, 2011).

To understand how innovation can occur in the artisanal enterprise, and the effect of the institutional change on quality of palm oil, we also utilized a comparative case study design (Kumar, 2005) involving an ex-*ante* and ex-*post* analysis. On the other hand, we understand that institutional changes take a long time to occur. Thus, this two-year study can only assess institutional changes that emerge. We focus on the organisational practices (Nuijten, 2003), processes and innovations that were observed in selected artisanal processing mills (*Kramer)*. We do this by looking at the analysis from three angles: the constraints identified in the enterprise, the entrepreneurs and instruments used for addressing the constraints, and the initiatives to institutional change identified during the study period.

This chapter sought to address the following:

- Which entrepreneurs and instruments were used to address the identified institutional constraints?
- Which institutional constraints existed, in the artisanal oil palm processing enterprise in the Kwaebibirem District?
- Which institutional changes were initiated?
- What were the intermediate outcomes generated by the change processes?

5.3 Research design and instruments

The research design involved diagnosing, collecting baseline information, planning the research agenda, taking action through joint experimentation by stakeholders, analysing and discussing findings at workshops, learning and assessing outcomes of the process.

5.3.1 The exploratory, diagnostic and baseline studies

The research started with an exploratory study (Adjei-Nsiah *et al*., 2012a) from 2008 to 2009 in the Kwaebibirem and Ahanta West districts of the Eastern and Western

Regions of Ghana respectively by the CoS-SIS research associate (RA). A scoping study was then done for three months in the Kwaebibirem and New Juaben (Ashanti Region) districts to compare contrast and also confirm the findings from the exploratory study. This was followed by a diagnostic and baseline study as reported in Chapter 2. After validation of results, stakeholders' selected artisanal mills from Kade, Kusi and Takrowase as an experimental group to be involved in the research and those of Subi, Otumi and Asuom as a control group. Both groups were included in the *ex-ante* stage of data collection. An *ex-ante* laboratory analysis of crude palm oil (CPO) quality (assessing FFA concentration levels of 18 palm oil samples) from selected mills in the experimental and the control groups was done to have a general idea of the quality level of CPO in the district at baseline.

5.3.2 Setting up the stakeholders' platform

A stakeholders' analysis provided a list of representatives from the experimental towns who were invited for a first stakeholders' workshop. The workshop sought to introduce the research to the district and discuss the findings of the scoping study. Stakeholders from the control group towns were not invited. A local stakeholders' platform was formed from among those who attended this workshop, based on their willingness to be part of the process. The roughly 30 initial participants comprised of representatives of oil palm farmers; artisanal processors; mill owners; caretakers and mill workers (about 65% of them directly involved with processing).

There were also four research scientists (a breeder, an agronomist, a socio-economist, an entomologist) of the Oil Palm Research Institute of the Council for Scientific and Industrial Research (CSIR-OPRI); an agronomist from the Forest and Horticultural Crops Research Centre (FOHREC) of University of Ghana, Kade; staff of the District Agriculture Development Unit of the Ministry of Food and Agriculture (DADU-MOFA), comprising the Director, a Women in Agriculture Development (WIAD) officer, and four extension agents from the study towns; a representative from the District Assembly; the CoS-SIS RA and the researcher (author of this thesis). Later, participation grew to over 60 stakeholders when farmers, processors and mill owners who were not initially invited heard about the platform and decided to join. A total of six workshops were organised between March 2010 and November 2012. All were held at the DADU-MOFA office or the District Assembly hall. The workshops were organised (sending invitations, arranging snacks etc.) by the CoS-SIS RA and facilitated by the researcher.

5.3.3 Analysis at workshops

During the first workshop, the CoS-SIS research approach was explained to the participants. The findings of earlier exploratory and scoping studies were also

presented. These issues were discussed at length, and it was decided that the research would focus on the socio-technical (reported in different studies) and institutional constraints in artisanal oil palm to help improve on the poor quality of CPO being produced. The second stakeholders' workshop focused mainly on the validation of the findings from a diagnostic study. In this regard, the researchers presented key information gathered in charts, graphs and tables on flip charts. It was decided by the stakeholders that an experiment on the effect of long fruit storage on palm yield and quality, one pertinent issue from the findings should be done.

The third, fourth and fifth workshops discussed the experimentation process and its findings. The final workshop was used as the exit strategy workshop which discussed all the outcomes of the research and the way forward for the enterprise in the district.

5.3.4 CIG and its activities

An innovation platform, called the Concertation Innovation Group which draws its membership from the national and district level was also established through the CoS-SIS programme to address institutional constraints higher than the smallholders' level. This is a ten-member group which meets every quarter usually at the University of Ghana, Legon in Accra. This platform is different (in terms of membership and functions) from the stakeholders' platform which operated at the local level in the Kwaebibirem district.

The CIG is made of representatives of oil palm farmers, processors, mill owners, district assembly, Ministry of Food and Agriculture (from the district), Ghana Export Promotion Authority, Environmental Protection Agency and Ghana Regional Appropriate Technology Industrial Service (at the national level), the researcher and facilitated by the CoS-SIS research associate. The main activity of CIG which is still on-going, is to provide processors with options for remunerative markets and help them link up to such markets. In addition, the CIG created awareness on harmful effects of bad processing practices through sensitisation workshops, and organised training workshops on good processing practices in the study towns.

5.3.5 The joint experimentation

We used an action research or learning-by-doing methodology through the creation of a joint experimentation group and then a local stakeholders' platform to facilitate knowledge sharing (tacit and codified) for the purpose of experiential and peer learning (see Chapter 4). The findings were presented by the leader of the joint experimentation group and representatives of the group led the discussion at the stakeholders' platform workshop.

5.3.6 Ex-post data collection

At the *ex-post* stage, it was found that the control group had at least partially been exposed to the intervention because some processors and owners from the mills in these towns (Kade, Kusi and Takrowase) attended some of the platform workshops. Some of them also attended the sensitisation activities of the CIG. Another control group of mills in Akyem Wenchi, Pramkese and Abaam who had not participated in any of the activities of the project were selected. The comparisons used in the study are thus based on the experimental and this final control group.

To understand the new roles of stakeholders, their attitudes, practices, levels of interaction and the learning that had occurred, reflective interviews were conducted with the experimentation groups, some platform members and officials of the governmental institutions involved in the oil palm enterprise. Reports of these interviews were analysed to understand and track changes in the interactions between the stakeholders with reference to the baseline information.

Interviews with purposively identified key informants, processors, mill owners and mill workers were used to understand palm oil production activities two years earlier at processing mills in the control towns. A survey was also done (July-August 2012) at the selected mills in six towns (experimental and control group) through semi-structured questionnaires. About 128 processors were involved in this survey, basically to assess changes in their processing practices.

At the end of the study period, 27 palm oil samples (from three different mills in each of the nine towns) were collected as experimental, exposed (same processors as in baseline) and control groups to assess the FFA levels. The American Oil Chemists' Society's official method and recommended practice Ca 5a-40 (AOCS, 1990) was used to analyse FFA levels of all samples.

5.4 Institutional constraints in artisanal palm oil production enterprise

The chapter reports four main institutional constraints. These are: practice of pre-processing long fruit storage; limited knowledge sharing and interaction among key actors; lack of a regulatory framework leading to the use of tires as fuel source for boiling fruits; poor access to remunerative palm oil markets, as a lack of incentives.

At *ex-ante*, 91% of processors from the six study towns had never received technical training and/or attended a workshop on improving processing practices. Most processors (73%) stored fruits between 14 to 28 days at the mills.

Following the mapping of stakeholders, we found that the artisanal processing enterprise involves a variety of actors at different institutional scales (Figure 5.1). We used the processor as the central actor and point of reference for the interactions among stakeholders. At *ex-ante* it was found that strong interactions existed among the processors and their mill workers, farmers, mill owners, local buyers, Togolese palm

oil buyers and Nigerian agents at the physical or geographical and organisational site of the mill. The strong interactions ensured an effective flow of information on prices of fruits, palm oil, processing practices and immaterial resources (e.g. attending and supporting activities at the funerals of bereaved families).

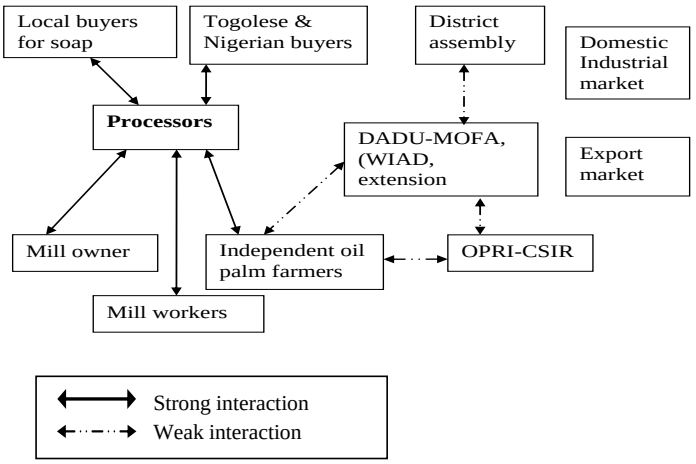


Figure 5.1 Stakeholders and intensity of interaction at the *ex-ante* analysis and as relevant to the processors. DADU-MOFA is District Agriculture Development Unit of Ministry of Food and Agriculture; WIAD-Women in Agriculture Development; CSIR-OPRI- the Oil Palm Research Institute of the council for scientific and industrial research. Frequent interactions are referred to as strong while less frequent interactions are considered weak.

Apart from the interaction among stakeholders as indicated by the solid lines and arrows in Figure 5.1, there was also information embodied in actors who were not integrated into the network and among whom the exchange of information was weaker, and occurred less frequently (dotted lines in Figure 5.1). Biggs (1990) found that agricultural innovation occurs through the collaboration of multiple sources such as farmers, civil society organisations, the private sector, development agencies and research staff. In contrary, we found that at the beginning of the project, the DADU-MOFA, which is responsible for agricultural development in the district, and especially its WIAD officer, responsible for collaboration and dissemination of information on good processing did not have the resources to link up with processors. The CSIR-OPRI was mostly engaged in providing high yielding oil palm planting material for sale to farmers; it was not mandated to provide technical advice to processors for producing high quality oil. The District Assembly responsible for the enactment of bye-laws on undesirable processing practices and environmental pollution had no links with the processors although they were collecting property taxes from mill owners.

At baseline, 86% of processors in the study towns used tires for boiling their oil palm fruits. This may cause environmental and health hazards, also affect the quality of the palm oil produced and thus access to remunerative markets. Domestic industrial or export and household consumption markets were inaccessible to the processors because of the poor quality of the palm oil and its reputation among the buyers from such markets. Quality and regulatory standards services were absent from the artisanal, often informal markets in which processors and local soap makers and regional CPO buyers usually operate.

This was the status quo in the enterprise at *ex-ante*, which called for institutional entrepreneur to make divergent changes and also actively participate in efforts that breaks this institutional template (Battilana, 2006). These change efforts must be triggered by enabling conditions and incentives. In our case, the options of accessing new markets for example, implied the need to change some processing practices and use environmentally sustainable ways of production. This knowledge disturbs the existing institutional arrangements and leads to the introduction of new ideas and type of interactions.

5.5 On the road to institutional change

In this section we describe leads or initiatives to institutional change for innovations in artisanal palm oil production that were observed within the study period in Kwaebibirem District of Ghana. Activities of two main groups of institutional entrepreneurs as change agents are also discussed.

5.5.1 Emerging interactions among key stakeholders

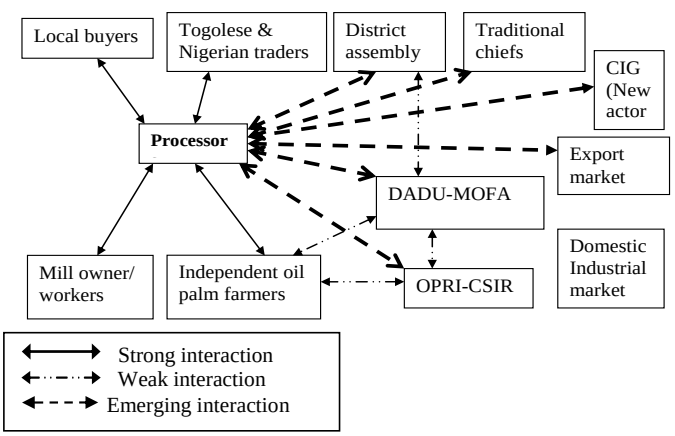


Figure 5.2 Stakeholders and their interactions at *ex-post* analysis.

A second mapping exercise held at the end of the study showed emerging interactions between the processors on the one hand, and the district assembly, traditional chiefs, the DADU-MOFA and CSIR-OPRI, on the other (Figure 5.2). Also, CIG as a newly created stakeholder is now linked with processors in trying to help them access markets and stop tyre usage. The most effective learning takes place through doing things based on trusted relationships (Vernooy *et al*., 2007). Thus, these linkages are crucial for collaboration among stakeholders involved in artisanal processing in Kwaebibirem District. It is clear that innovation occurs not only from academicians, but also from interactions between many different stakeholders in addressing a particular problem (Röling and Jiggins, 2001). However, there was still no linkage with the domestic industrial market. That link has not been explored yet due to the feeling on the part of both the CIG and processors that this market is not yet interested in artisanally processed palm oil.

5.5.2 Attitudes and interests for innovation

There is a general lack of investment in artisanal agro-processing research and development because this type of processing is considered to be ineffective (GoG, 2010) by policymakers, scientists and industrialists. Artisanal production systems like the *Kramer* (processing mill enterprise) are constructed on the basis of strong internal relationships of trust and reciprocity among farmers, processors and mill workers but they have weak external ties with researchers and policymakers. These mill stakeholders saw scientists from the research institute as being mainly interested in their research activities and not in incorporating the needs of processors into their work. Indeed processors referred to CSIR-OPRI as a 'white elephant', not useful for solving their dilemmas. During the course of the study, CSIR-OPRI used some aspects of the CoS-SIS programme's approach and carried out a needs-based assessment of major stakeholders in the artisanal enterprise to be able to incorporate such needs in its research agenda. The DADU-MOFA was initially interested in food crop and livestock production and palm oil processing was not part of extension service delivery. The DADU-MOFA was provided with information from joint experiments to take responsibility of collaborative learning with processors to improve on processing activities in the district.

Research was initially usually structured top-down. However, all stakeholders at the platform agreed that it was more effective to shift to a demand-driven research and development approach if sustainability of the artisanal enterprise was to be achieved. Many policies and much credit assistance have been directed towards facilitating and supporting large and medium scale plantations and their out-grower and processing plants (IFC, 2011) but not towards independent farmers and artisanal processors. The previous Presidential Special Initiative (PSI) on oil palm also had no plan to improve on activities of the artisanal processing enterprise. However an

enabling environment is a key component for innovation capacity. The platform created a space for governmental and research stakeholders to engage with each other and to set up a more inclusive agenda for improving the sector. This was achieved through mutual respect and the opportunity for every stakeholder to share their experiences and be listened to.

We found that collaboration and understanding of each person's role in the experimentation led to outcomes being acceptable to the stakeholders most importantly, the processors. For an innovation to occur there should be a reciprocal flow of information among all sources of knowledge. Peer learning and sharing of information occurred both at the mills and during stakeholders' platform workshops. Some processors and owners from mills in other towns, where no participatory experiments had been carried out, thus learned from their peers at the workshops. The *ex-post* survey showed that about 75% of processors in the experimental group now stored fruits for shorter periods (1-2 weeks) compared to the control group which had 36% of processors storing fruits for the same period.

5.5.3 Processors as institutional entrepreneurs at artisanal mill level

New information may trigger new self-definition, communication, practice and technological changes (Röling, 2010). Armed with new knowledge from a joint experimentation, processors acted as institutional entrepreneurs and responded to 'incentives embodied in the institutional framework' (North, 1990: 83). It was evident from the action research or joint experimentation that increasing the fruit storage period increased yields up to 14 days, then after yields decrease with longer storage. Quality measured through FFA concentration levels, on the other hand, increased sharply with increasing storage periods. After the experiment, some processors tried their own experiments at the mills to confirm the results of what was done jointly. They first diagnosed their fruit storage practices, then followed by their own experiment of reducing the storage period from what they had used before in order to find out which period gave them highest CPO yield for the same quantity of fruits they normally process (as reported in Chapter 4).

In this regard, there was first learning and then doing to assess their options to innovate. Their focus shifted from the original joint experimentation aim of learning to reduce FFA levels to high CPO yields. Thus innovation did not only concern changing processing practices to produce quality CPO, but essentially it also involved the processors' ability to design their own experiment in a way relevant to them at a particular time. Once they were convinced by the results, they started processing within 7-14 days. Thus in this case processors acted as change agents and also implemented the change themselves. Through experiential learning, they also found that the maximum palm oil yield point occurred at 10 days. Interestingly, a technical

analysis using surface response techniques for data analysis on the same issue found a maximum yield at 10 days (Agbotse, 2012). While our experimentation started off as 'seeking for high quality' that of the processors set off to 'seek for high quantity'. This means that institutional constraints such as lack of access to remunerative markets may serve as a disincentive for innovation in the palm oil enterprise. Indeed, in their window of opportunity, that is given their existing market outlets, the processors saw that enhancing the quantity of oil, even if it was of inferior quality was their best option at the time. This is because there was no opportunity to tap into the high quality market immediately.

Reflective interviews and follow-up visits to processors, and a survey after the experiments indicated that no processor from the experimental group was processing fruits at 3 days after fruit bunch harvest so as to produce the highest quality palm oil. They explained that this was due to the additional operational costs incurred when fruits are processed within that short period. Moreover, given that they had no immediate market that offered higher prices for such high quality CPO. They therefore preferred to process fruits stored for 10 days period, which provided more oil and thus more benefit, given the lack of incentive for offering anything but customary quality oil in the current market. This shows that change can be triggered if economic gain is expected, in this case leading the processors as entrepreneurs to innovate towards storage periods that optimize yield.

At a stakeholders' platform workshop however, processors indicated that if they were linked to a remunerative market, they would be able to produce the required higher quality CPO using the skills and information they had acquired from the action research and platform. Also their current knowledge would allow them to negotiate the price differences needed, given the yield loss and additional labour costs they would have to be compensated for.

5.5.4 CIG, District assembly and traditional chiefs' collaboration-as institutional entrepreneur

This section deals with a combination of existing culturally embedded and formal institutions. The platform workshops and some CIG activities helped to sensitize mill workers, processors and mill owners about harmful effects of burning old tires as fuel. They now are more aware of how tires can affect their health and the quality of the palm oil by increasing the sulphur content and contamination by carcinogenic poly-nuclear aromatic hydrocarbons (pers. com. Prof. E.A. Afoakwa, UoG).

According to Feeny, 'the basic source of the demand for change in institutional arrangements is the recognition that existing situation leaves potential gains uncaptured' (Feeny, 1988: 176). Thus, the chiefs, District Assembly and CIG understanding the harmful effect of tire as fuel source played an active collaborative role to cause change through the use of various resources. For instance, the CIG made

pictorial PowerPoint presentations of harmful effects of tire usage in food processing to members of the District Assembly. The Assembly men then partnered with the CIG and the presentation was made to people in the oil palm processing enterprise in the study towns. The CIG also engaged some traditional chiefs in the district who were known to be passionate about environmental sustainability, in the discussion. These chiefs took the matter seriously, and authorized their messengers, who used loud speakers to announce the ban of tire usage for oil palm processing in the towns. The chiefs also instituted fines for anyone caught burning tires at a mill in the towns.

Here we see the power of the cultural institution of chieftaincy being used as a resource by the institutional entrepreneur to address a constraint. On top of the experiential learning about the long fruit storage period, the directive force of the chiefs with support from the sensitisation activity of the CIG and District Assembly was needed to initiate change in the enterprise. It appears that even in the control towns, tire usage is no longer common among the processors. This may be explained by the commitment of the chiefs and the Assembly members (who were present at a CIG presentation on the issue) in the towns to abolish the use of car tire in palm oil processing enterprise.

We also found that change occurs when benefits to stakeholders within the enterprise are high, and the alternative options do not threaten their interest. Mill workers and the processors analysed the issue based on the harmful effect on their health and the economic gains to be made. A medium sized tire costs 2 GH¢ which could be saved bearing in mind that there are many easily available and free fuel sources (fibre cake, empty bunches, kernel shells, empty spikelets) at the mill which can be used for boiling. The only practical implication here is that, these types of fuel source burn faster than the tires and a worker is needed to frequently attend to the fire and add more fuel material.

Visits and subsequent meetings with stakeholders indicated that processors now use fibre cakes, kernel shells and empty spikelets, which are readily available at the mills at no cost. The survey results show that 72% of all respondents now use fibre cake and kernel shells together as fuel source. Car tires were no longer used at all, except for 2% of respondents in the control group.

5.6 Intermediate outcomes of the emerging institutional change

5.6.1 Improving the quality of crude palm oil

Laboratory analysis showed that within the experimental group FFA levels were significantly ($P<0.05$) different before and after intervention except in Kade (where there was only a slight reduction from 15.9 to 14.3%). The FFA levels ranged from 9.0-14.3% at *ex-post*, and was in all cases much higher than the maximum acceptable standard of 5% normally specified for the industrial and export markets (PORAM

standard specification for processed palm oil, 2011). Kusi and Takrowase showed much improvement from initial levels of 21.6% and 23.8% to 9.0% and 10.8% respectively. For the control group, FFA concentration levels were generally high, ranging from 14.2% to 22.8% comparable to what was observed in the experimental group before the learning process. This corresponds to their processing practice of storing loosened fruits for longer periods of 14 to 21 days.

Table 5.1 Mean concentrations and standard errors of free fatty acids (FFA in %) of CPO samples obtained from overall experimental (*ex-ante* and *ex-post*) and control groups in Kwaebibirem District. (n=9, for each group)

Groups	Overall mean and standard errors of FFA concentrations (%)
Experimental *ex-ante*	$20.4 \pm 1.64^{a[1]}$
Experimental *ex-post*	11.4 ± 0.85^{b}
Control	19.6 ± 1.56^{a}

[1] Means followed by different superscripts are significantly ($P<0.05$) different.

Overall, the quality of CPO in terms of FFA levels from the experimental group showed much improvement from 20.4% *at ex-ante* to 11.4% (Table 5.1) compared to 19.6% for the control group at *ex-post*. Kyei-Baffour and Manu (undated) assisted artisanal processors in the Ashanti region through training in processing practices, which led to a change in storing of fruits from over 14 to 6 days and a change in quality of CPO from FFA level of 10.6% at the *ex-ante* stage to 6.4% after their intervention. They suggested that training of processors is needed for minimising fruit storage periods and improving quality of CPO, but in our case it is not a sufficient condition.

The participants at the platform as well as the authors believe that, firstly, the co-learning by all stakeholders was important for a sustainable implementation of the new knowledge. Secondly, that there is a need to link artisanal processors to a wider market through the final interconnected set of technical and institutional changes that enables them to produce high quality crude palm oil. However, the choice for these market options rests with the processors because they make such decisions based on their knowledge and capability in relation to their specific social context. The question we therefore ask is should agricultural projects provide technological fixes for smallholders? Or smallholders should be given the opportunity to 'learn their way out' of the constraints and assisted through institutional changes to make choices from available options?

5.6.2 Market access through institutional change initiatives

Processors have not started selling to local industrial or export markets, but they now have acquired the skills and capabilities to produce high quality CPO to meet these markets' requirement. Along the facilitation activities of the CIG to help processors link up with new buyers, at the time of the survey, three processors from the experimental group on their own have been approached by exporters of CPO, and/or contacted palm oil retailers for household consumption in Ghanaian cities. Few others mentioned that they process some of their fruits into relatively higher quality palm which they able to sell to some specific buyers at higher prices. This shows the success for implementing change in this case production of quality palm oil for remunerative markets also depends on the capability of processors to take up windows of opportunities available. At the time of writing this chapter, some processors had produced palm oil, samples of which were taken for quality analysis by buyers from Italy and had met the required standards. The CIG, the processors and these buyers were negotiating the price of this quality of palm oil.

The platform brought together mill-based stakeholders, extension service providers, policy makers and scientists and allowed the kind of multi-stakeholder learning that created space for a potential change. In this case, after two years of research, a new network had been forged that, through the CIG, could assist processors to link to all year-round remunerative markets. However, a continued involvement and contact will be needed to make this into a true innovation rather than a brief attempt at an innovation. In addition, an incentive, in this case access to remunerative markets, is key to further innovation in artisanal palm oil processing, but the new market comes with new networks, bureaucracy and complexities. These are challenges the CIG must be mindful of and help processors cope with, as they learn to negotiate a space in this new arena.

5.7 Conclusions

Our study shows that the artisanal palm oil processing enterprise is able to innovate if relevant stakeholders learn to overcome constraints and create opportunities, and also change institutions, which affect them negatively. The stakeholders further up the chain learned to revise their view of what these processors could deliver in terms of quality.

Artisanal palm oil processing in Kwaebibirem district of Ghana was characterised by the use of undesirable practices, such as a long fruit storage period and the use of car tires as source of fuel. There was also lack of interaction among important stakeholders in the enterprise, and lack of access to remunerative year-round markets. An action research study was used as a form of intervention that attempted to address some aspects of the institutional constraints.

In this study, we looked at two different levels of institutional change. Firstly, the joint experimentation and formation of a local stakeholders' platform led to the creation of new knowledge and enhanced interactions among the stakeholders. Secondly, the setting up of a CIG which, through the cultural authority of the chiefs, was able to stop the use of tires as fuel source for boiling oil palm fruits. We found that different models of information sharing and joint learning are necessary and complement each other to address different institutional constraints. The burning of tires was effectively stopped through the advocacy of power holders like the chiefs and the District Assembly, and not just by peer learning only. The interaction-based learning from the joint experimentation and the stakeholders' platform also encouraged technological innovation in processing practices, thus, creating an opportunity for improving the quality of the palm oil produced. The simultaneous organisation of a stakeholders' platform for exchange of ideas and the enabling environment created by the CIG were central to initiating institutional changes. This may eventually lead to better market access for artisanal producers and higher incomes for them as well as for the small-scale independent farmers who produce the oil palm fruits bunches. The stakeholders' platform and the CIG as an institutional facilitator of innovation ensured ownership by the stakeholders. We found that institutional change emerged from the interactions; both from the stakeholders' platform and the CIG with the chiefs and the district assembly. The institutional entrepreneurs are thus important change agents for innovation in the artisanal processing enterprise.

We conclude that joint learning through action research is an effective approach to agriculture research and development in the case of Kwaebibirem District artisanal oil palm processors. Mainly because this kind of research which starts with a real-life constraint is bottom-up, and creates ownership of and commitment to the process of change with the stakeholders. However, this alone is not sufficient for institutional change; there should be incentives that trigger institutional entrepreneurs to cause the relevant change, and also artisanal processors should be willing to take up the opened opportunities and act on them.

Chapter 6

Main Research Findings and General Discussion

6.1 Introduction

Artisanal agro-processors are confronted with multi-faceted constraints, as the body of a hedgehog (Leeuwis, 2004). This calls for a research and development approach that differs from the linear disciplinary paradigm and governmental extension delivery services that do not usually take the real-life complexities into account (Faure *et al*., 2013). Such linear approaches are top-down, bureaucratic and less able to cope with dynamic and complex challenges (Rivera and Zijpp, 2002). For artisanal processors to effectively address their constraints, there is the need to promote interactions between farmers, processors, researchers and extension agents to create useful knowledge (Scoones and Thompson, 2009; Sanginga *et al*., 2009).

The CoS-SIS programme suggests an alternative approach to agriculture research and rural development which involves a transdisciplinary methodology that crosses the borders of technical and social science disciplines and engages multiple stakeholders. The programme's philosophy adopted in this research project is that smallholders in agriculture face complex constraints which mutually influence each other, and therefore need to be addressed in their entirety through grounded methodology. The main idea is to converge scientific knowledge from the technical and the social sciences, and the local or practical knowledge of those actively involved in production, and to integrate these in action research involving the interaction of direct and indirect stakeholders.

This thesis is one of the nine studies of the CoS-SIS programme. It is the result of a transdisciplinary research on artisanal oil palm processing in the Kwaebibirem District of Ghana. The thesis seeks to understand the interactions between socio-technical and institutional constraints and to investigate how research can create new knowledge to help address the identified constraints. The research started with a diagnostic and baseline study, findings of which were used in the formulation of research questions for Chapters 3, 4 and 5. To answer the questions, I cut across mainly food science and rural development sociology disciplines by integrating concepts and methods. In addition to integrating scientific and practical knowledge of

stakeholders, I also engaged relevant stakeholders in an action research or joint experimentation process. Knowledge generated from these interaction processes was disseminated at stakeholders' platform workshops, to create space for further learning by a larger group of stakeholders. The details of the different studies undertaken in the research have been discussed in the empirical Chapters 2, 3, 4 and 5 of this thesis.

In this concluding chapter I synthesise the main lessons from the different chapters by presenting their relevance and the mutual interdependency of the insights derived from the research process. These are then discussed within the wider context of the added value of transdisciplinary research and its role in making science relevant to enhancing rural livelihoods by improving the quality of palm oil as a condition for accessing more remunerative markets. I then look beyond the case study at the broader implications of doing this type of research at the interface between technical and social sciences to addressing development and change related constraints, and discuss the challenge of transdisciplinarity and the implications for future research in artisanal agro-processing.

6.2 Summary of the main findings

An exploratory study (Adjei-Nsiah *et al*., 2012a) found many constraints which gave pre-analytic conditions that demanded making choices. The constraints included: land tenure problems, use of 'volunteer' seedlings, diversion of fruits by outgrowers, lack of extension delivery services, inadequate financing, low oil extraction rate for small-scale processors, poor quality of palm oil produced, and lack of access to remunerative markets. These were prioritised by stakeholders at the first platform workshop, and the poor quality of palm oil produced by artisanal processors was selected as the entry point for the overall research. The objective of this study was to investigate how artisanal oil palm processing practices can be improved by researching the socio-technical and institutional constraints and their interplay through a transdisciplinary approach to improve rural livelihoods. To achieve the objective I addressed the following research questions:

- What are the socio-technical and institutional constraints of the artisanal oil palm processing enterprise in Kwaebibirem district of Ghana?
- Who are the actors, what are the networks and flows of resources at artisanal processing mills and how do they relate to the technical and institutional constraints?
- What knowledge can an action research provide and why can it help artisanal processors to improve on their processing practices?
- Why and how do action research and interactions in a local stakeholders' platform influence institutional changes in the artisanal processing enterprise?

Each empirical chapter answered one of the above questions, and the key findings are summarised below.

After the exploratory study, this research started off with a diagnosis and baseline phase to understand the operations of the artisanal processing enterprise and why the quality of the produced palm oil is poor. The diagnostic study (Chapter 2) identified the need to understand the different levels and kinds of interactions among actors at a mill. The study found that the storing of loosened oil palm fruits for longer periods was a key processing practice that could impact on the quality of the palm oil produced. However, the relation between storage period and quality was not known, and there was no independent information available on the effect of storage period on extraction rates. Therefore, suggesting an action research for processors to learn to address the issue of poor quality of palm oil. In addition, the labour costs involved in processing after different storage periods were not known, so there was the need for clarifying the quality-extraction rate optimisation by and for processors. This led to investigation into the profitability of scenarios for potential production of quality palm oil for different markets.

The study also identified that it was necessary to explore institutional changes which might enhance learning and innovation in processing practices for improved quality of palm oil and access to remunerative markets. However, the challenge was which monodisciplinary research could address this myriad of issues identified through the diagnosis. For instance, how would extension, or sociology, agricultural economics, food science, agronomy or innovation/communication alone effectively tackle the issues? Then also which stakeholders would take ownership of the process and its outcomes? Reflecting on these questions, stakeholders realised that no specific discipline could engage with the constraints identified, as such real-life complexity exceeds the boundaries of a single discipline.

The diagnostic study suggested that innovation in the artisanal oil palm processing enterprise could benefit from a multi-stakeholder, multiple-scale, and interdisciplinary process. Stakeholders collectively in a workshop decided that an alternative research in line with the CoS-SIS approach was therefore needed to address the social, technical and institutional constraints. This categorisation of the constraints served as an input to my agenda and planning for the rest of the research process. This bottom-up priority setting ensured that the research reflected the stakeholders' prioritised constraints, and made them partners in the process.

Chapter 3 describes the actors, their networks and flows of resources at the artisanal processing mill to understand the everyday experiences of *Kramer* life. I found that actors, especially processors rely much more on personalised and informal networks for accessing knowledge on processing practices than on formal

organisational support from district agencies or research institutes. There appears to be strong mutual support and interdependency among the actors for effectively maintaining networks and resource flows at a *Kramer*. Different flows of material and non-material resources were found to interact and shape a force field of varying power positions of the actors which they had to always contend with. Whereas agricultural projects for developing countries have often failed because no attention was paid to social dynamics (Li, 2007), this research is keen to explore the nodal position of the predominantly female palm oil producers in Kwaebibirem District in Ghana.

In Chapter 3, I referred to the people as actors and not as stakeholders like in the other chapters because I reported on their real-life issues as enacted at the mill rather than as a social category in the context of a project intervention. The main difference between the two concepts is that actors themselves are believed to have agency in the sense of knowledgeability and capability of the processing activity. Decision-making agency is imposed on stakeholders by external interventions (Long, 2001: 19) as the indirect or assumed knowledge of for example mill owners, scientists, extension officers and other sector agents, who are often not themselves involved in the everyday practice of the mill.

When we encounter processors (or smallholders in a broader sense) as actors, we discover their role and position in power fields. We also find how they reflect on their experiences and take decisions to continue or change their practices in view of their social-economic networks and the flows of resources. This implies that change or innovation in the artisanal enterprise will to some extent depend on the processors' own knowledge and capability, and their interdependency in processing and trade networks. Thus an intervention seeking to help in the improvement of the quality of palm oil should in my view understand the dynamics occurring at the processing mills and take that social perspective as a starting point for implementation. The ethnographic method provided a rich description of the processors' networks, the flows of financial, economic and human resources which are guided by relations of trust or mistrust, power struggles, friendship and contestation at the mill. These data were necessary to understand the participation of the processors in the experimentation. Therefore, the practical knowledge of processors that 'a long period of fruit storage leads to high palm oil yield' was used as one of the hypothesis for the joint experimentation of Chapter 4.

The action research or joint experimentation (Chapter 4) sought to assess the effects of variation of fruit storage period on the quality and yield of the palm oil produced. The quality of the palm oil in terms of its free fatty acid level was found to rapidly decrease as fruit storage period increased. The production of palm oil at all storage periods was non-profitable for the current informal Nigerian and Togolese

markets, while calculated losses differed between storage periods. However, palm oil produced at 7 days of storage appeared to be the most profitable, if sold to the national household consumption market. Producing at a 3 days storage period and selling to the export market was also found to be potentially profitable, but more effort by relevant stakeholders is needed to make production at this short storage period efficient. The experimentation between processors, farmers, mill workers, extension officers and scientists created space for interaction and learning about processing practices and options to improve palm oil quality.

The action research was innovative to the people involved in two ways. Firstly, processors learnt about the effect of fruit storage period on yield and quality of CPO produced; also that the quality attributes they knew in terms of bad taste and smell can be a potential proxy to directly relate to the free fatty acid level they did not know about. They learnt from the experience of doing a scientific experiment to understand and reflect upon their own experiential learning which provided them with a framework to continue the learning process in their activities. The stakeholders' platform activities which went on during the two years of the research, kept them actively involved in the learning process. Secondly, the researchers and extension agents collaborated with the processors and mill workers to learn from their practical knowledge and experiences.

The content of Chapter 4 is quite different from the other empirical chapters in terms of the methods and concepts of data collection used. This chapter relied mostly on the measuring of palm oil yields, the laboratory analysis and organoleptic assessment of free fatty acid levels, compared to the ethnographic method used in Chapter 3. Interestingly, Chapter 4 applied methods from food science and agricultural economics together with the outcomes of the ethnographic study (Chapter 3) in addition to the local or practical knowledge of the processors. The chapter reports on how processors used scientific ways of quantifying fruits and oil during an experimentation process with other stakeholders to produce new knowledge.

Although Chapter 3 uses an ethnographic method which conceptually has no links with the laboratory testing of free fatty acids levels of palm oil in Chapter 4, it is evident that without this information, the learning intervention would have been designed and implemented differently. This is because of an ungrounded assumption of which stakeholder should be involved and for what reason. This may also have led to ineffective sharing of knowledge. For instance, engaging only the mill owner (as I thought should be the case before the ethnography) in the experimentation would have helped him to learn from the process. However, a mill owner (as a stakeholder) is usually less effective in sharing the new knowledge with others because most mill owners are absent from the daily life-worlds of the *Kramers*. Thus, it was important to

include the processors who are the ones to take the decision about how long their fruits are stored before processing. Involving them in the learning process ensured that processors were now able to draw their own conclusions from the experiment, and apply them directly in the field. They continued experimenting by themselves at the mills to confirm the results from the joint experimentation, and told their peers about their discovery. This may not have been observed without the ethnography and discussion at the stakeholders' platform. It would also have been difficult to assess the institutional impact of the learning (Chapter 5) if I did not know beforehand from Chapters 2 and 3, who the actors in the research and their practices were, and what institutional constraints they faced.

The institutional constraints in the artisanal palm oil processing enterprise of Kwaebibirem district were identified from the problem tree in Chapter 2 as: 1) undesirable practices such as a long fruit storage period and the use of car tyres as source of fuel; 2) the lack of interaction among important stakeholders in the enterprise; and 3) the lack of remunerative year-round market incentives. The subject of Chapter 5 was to investigate how the action research intervention of Chapter 4, in addition to activities of a local stakeholders' platform and concertation innovation group combined to address the institutional constraints.

The quality of palm oil from a sample of processors who had been involved in the research was found to have improved. In addition, institutional changes occurred due to the joint experimentation and the formation of a local stakeholders' platform that enhanced interactions among the stakeholders of the research institute, government extension service and *Kramer* practitioners, especially processors. This interaction-based learning from the joint experimentation and the stakeholders' platform also encouraged technological innovation in processing practices, creating an opportunity for improving the quality of the palm oil. Learning through action research was therefore an effective approach to agriculture research and rural development in the case of Kwaebibirem District artisanal oil palm processors. However, it also shows that this effectiveness could mainly be achieved by first doing an actor-oriented ethnographic study to unpack the constraints, to find options actors have for change. This should then be followed up with a bottom-up learning approach, which creates ownership of and commitment to the process of change with the relevant stakeholders.

Institutional entrepreneurs such as processors (at the local level) and a Concertation Innovation Group, district assembly officers and traditional chiefs (at the district and national level) created different institutional changes. I found that different models of information sharing and interventions are necessary and complement each other to address different levels of institutional constraints. The multi-scale stakeholder approach used in the research ensured the flow of knowledge at different

organisational levels, (for instance between *Kramer* practitioners, within scientific or extension community and also between practitioners, scientists and extension service). Chapter 5 shows that the artisanal palm oil processing enterprise is able to innovate if relevant stakeholders learn to overcome constraints and create opportunities, and also change institutions which negatively affect the enterprise.

6.3 General Discussion

What does transdisciplinarity bring to agricultural research and development?

Due to the complex nature of the constraints identified from the problem tree of Chapter 2 (Fig. 2.2), a transdisciplinary approach that targets the use of different sciences and a shared learning by stakeholders is needed. Transdisciplinarity involves communication that is the exchange of information between divergent bodies of knowledge. Thus, the transdisciplinary research conducted in this thesis can be seen as an effort to integrate knowledge in four different ways: between technical and social sciences; between science and local or practical knowledge; between the world of science and lay people or *Kramer* practitioners' research (through action research); and between scientists, local decision makers and lay people (the establishment of a stakeholders' platform).

6.3.1 The integration of technical and social sciences

This research made use of methods from food science (technical science), agriculture economics, rural development sociology, innovation/communication, and anthropology (social science) to investigate a complex entry point, so as to address it in an integrated manner. This approach is not often used in agricultural studies, where a particular technical science concept is used to address constraints or an aspect of social science alone is used to understand a given context. The question I have asked myself is whether the use of one science alone is effective in making research relevant for agriculture development? And, which of the sciences is important in ensuring that relevance? These are issues that of course need discussion in the wider academic arena, but the position I take in this thesis is that an effective way of integrating different sciences to make maximum use of their advantages is necessary to address the constraints prioritized in the diagnostic study (Chapter 2). Because the way of doing research in technical and social disciplines is completely different, however learning to use one to inform the other helps to pull all the strings together in a coherent manner.

Social science data are often used as 'contextualisation' of technical solutions, using stakeholders as a technical tool (Li, 2007). However, my research shows that the

ethnography that provides the social data is necessary as an integral part of the research with the stakeholders to co-shape the outcomes. In this case, one science was not seen as more important over the other, but rather methods from both scientific domains were considered for their potential role in addressing the issues at stake, and therefore used together to answer the research questions of this thesis.

The food science method had the advantage of looking at the constraints in a cause-effect approach. This technical method was used in order to find how quality of palm oil varied with fruit storage period. The data variables were pre-conceived, in the sense that I knew beforehand what variables (weight of fruits, yields of palm oil, free fatty acid levels) were to be measured in both the joint and the researcher-managed experiments. My ethnographic approach, on the other hand, did not search for causal explanations but searched to explain the organising practices in everyday occurrences as lived by the actors. This information was collected through interviews and participant observation in a few pre-selected mills. These selected examples offered a rich insight into the artisanal processing practices. In this regard, the narratives gathered from the field through the ethnographic approach allowed for a description of the different categories of *Kramer* actors, their networks and the different flows of resources and how these could be impacted by innovation.

During the research process, I realised that there were several things I needed to understand from the actors first. Thus I was careful not to start with looking for an alternative palm oil market so as to fix the actors to it. I first had to know about issues of trust and mistrust, contestation and power struggles in the mills as a force field (Chapter 3). For the project to support the processors in entering into a new market there was a need to understand their organising practices, and know how they might impact on the success of accessing such markets. For example, there is a strong friendship and gift-giving relationship between processors and buyers that the actors involved would not easily give up. However, serious issues of mistrust in non-delivery or adulteration of palm oil also exist in the flow of resources at the *Kramer*. The question is what checks and balances should be put in place to manage the mistrust and cheating in order to ensure prompt delivery of quality palm oil at all times for efficiently accessing a new market. Entering into new markets comes with the loss of old networks and the creation of new ones, so how will the processors cope in that new environment? Will the new buyers pre-finance their processing activities, attend their funerals, bring gifts to them and gossip with them at the mills. The issue here is that *Kramer* actors would have to get used to new institutions (rules of the game), and usually people are reluctant to change if they do not see immediate benefits.

The analysis in Chapters 4 and 5 shows that the new markets (household consumption and export) are profitable, but there is no guarantee that all processors

will like to produce for those market based only on financial profitability. Some will prefer to maintain ties with the buyers for the existing Togolese and Nigerian markets because of the social capital built up over the years. There is thus the likelihood that processors will opt for diversification and risk spreading by accessing different markets, keeping up networks and going with new brokers. Depending on the market situation and experiences of trust or mistrust they encounter, the market options may change. These are choices processors will make each for themselves. Therefore, it is important to learn with them the way to produce good quality palm oil and to help them apply the new knowledge to select best options of more remunerative markets, but not to impose such markets on processors.

6.3.2 Integrating science and local or practical knowledge

Although there is a clear divide in the methodology between science and everyday practical knowledge, the two types of knowledge had to be integrated to provide a comprehensive resource for learning to improve quality of palm oil. The constraints of artisanal processors are complex, cross-cutting the knowledge of particular scientific disciplines. So I had to inquire about the nature of their problems to find what processors know, and how their views could be integrated into the research process to effectively address the constraints identified. For example, this study combined the knowledge of processors' assessment of CPO quality based on organoleptic properties with the scientific laboratory method of assessing free fatty acid (FFA) level as an indicator of current and future quality. In this case processors learned that what they knew as very rancid palm oil can be used as a proxy of high free fatty acid. However, the very rancid assessment by processors is limited. Whereas the laboratory FFA test had been realised through many trials and degrees of repeatability, the organoleptic testing in several populations of processors had not yet been done, and needs further study. Also the training of individuals to become better at it could be considered.

6.3.3 Systematic involvement of lay people or practitioners in experimentation

Artisanal processors are interested in finding ways of addressing their problems. The assumption in Chapter 4 was that processors are daily 'experimenting' in their activities. Therefore, it would be more effective if they would work together in a joint experimentation with other stakeholders and learn from each other. Action research in which the researcher engages lay people in a more systematic approach to learning about their practices is an important component of transdisciplinarity. But incorporating the experiential, non-scientific expertise of these practitioners into the whole research process is not very common (Hessels and van Lente, 2008). Their knowledge is usually not seen as equally valid as scientific knowledge (Sillitoe, 1998;

Holm, 2003). I found that artisanal oil palm processors produce knowledge through their practices which they share with others at the mills (Chapter 3), but this fact remains hidden from outsiders as long as they, including the nearby Research Institute, extensionists, and other stakeholders do not engage with the processors.

In the action research, the processors were given ownership of the quality improvement process because they were part of it from the beginning, and their practical knowledge was taken as a starting point. Their participation was not through mere dissemination of results to them after the researcher had done the experiments. Indeed the mill owner and processors, as lay people, presented the results from the joint experimentation to a local stakeholders' workshop. They interacted on equal footing with their peers and the other stakeholders, including scientists from the Research Institute and extensionists, by discussing the findings from an experiment they did themselves and therefore believed in.

6.3.4 Integrating scientists and lay people on a stakeholders' platform

An effective transdisciplinary research needs the 'establishment of partnerships' (Sillitoe, 1998:231). The local stakeholders' platform I created was relevant in ensuring exchanges of knowledge. This knowledge was mainly generated from joint experimentation, laboratory analysis, processors' own experiments, policy initiatives from the District Agriculture Development Unit, and research from the national Research Institute. The platform served as a common place where all the stakeholders involved in the oil palm enterprise at the local level could meet, plan and see to the implementation of the research process. Having experienced the insightful information from other stakeholders, scientists from the Research Institute who had not interacted with them before the platform was created saw the need to engage with processors and farmers to co-learn to improve the quality of crude palm oil. Indeed one scientist said to me, "*The platform workshops are useful, that is one thing I like about this research. I learnt a lot from the interactions as a scientist and also a farmer. The platform has improved the relationship between scientists from the Research Institute and the locals [processors, farmers, etc.]. Since your research is ending soon, we need to find ways of sustaining the platform*". At the stakeholders' platform neither scientists nor the other stakeholders felt threatened, everyone felt useful and free to contribute meaningfully to the discussions. Thus the platform created a space for the exchange of information, knowledge and skills, which processors and scientists alike benefitted from. The research thus led to an emergence of a new relationship between scientists and other stakeholders (Chapter 5) which can be developed further to enhance productivity of the Research Institute and the artisanal enterprise.

The stakeholders were also informed of the activities and outcomes of the Concerted Innovation Group (CIG) of the CoS-SIS programme (Chapter 5). This brought forth information on opportunities which processors in the enterprise can access. This flow and exchange of knowledge would not have been the case if processors had not been involved and taken seriously in experimentation and platform discussion. The knowledge sharing also ensured the agenda at the local level was impacted by the CIG's activities and vice versa, though the local platform and CIG operated at different organisational/decision making levels. This suggests that in the CoS-SIS approach to research and development, learning-based activities are necessarily multi-scale, such that various stakeholders operate at the national and district level, or are grafted on local level activities. The CIG and the local research agenda should necessarily evolve from the same entry point. The CIG may not be successful if it implements intervention at the national level without a direct linkage to practitioners 'constraints, and a feedback from the local level where impact of change is expected.

6.3.5 Challenges of doing transdisciplinary research

The main argument in this thesis is that a transdisciplinary approach to research is useful for making science relevant to the artisanal oil palm processing enterprise and through this to rural development. Despite its usefulness, the approach has challenges which have to be addressed to encourage individual researchers or project teams to explore further its use. In this section I elaborate on some of the challenges.

Transdisciplinary research is done for a specific purpose, by engaging specific bodies of knowledge and stakeholders to solve particular problems identified in a particular material, economic, social, and cultural context, in order to validate the results for that context. Therefore findings cannot be easily generalised for a whole palm oil producing population or the whole of Ghana or West Africa. What can be up-scaled to other research contexts are the methodological processes followed, and the experiences gained through the transdisciplinary approach.

Crossing borders of disciplines is a difficult task because of the differences in theoretical perspectives of the technical and social sciences, and even between the methodologically different approaches within each scientific domain. Since the way of knowing cannot be easily translated from one science to the other, merging the divergent perspectives, concepts and methods made this research very challenging.

Engaging many diverse stakeholders in a research, and to keep them involved over a period of two years takes quite an effort from both the researcher and the stakeholders. It is also a gradual integration process which is not fixed at the beginning but evolves from one stage of the research to another. This requires a lot of research time and patience to ensure all relevant stakeholders are on board to be able to

incorporate their ideas into each phase of the research. Another challenge in doing this research is how to integrate the language, terminologies and ways of creating knowledge used in the different disciplines, and also between the disciplines and the practical knowledge. For example, at the stakeholders' platform workshops it was at times difficult to communicate some scientific terms in the local 'Akan' language which was the main language of communication. This is because while trying to explain or discuss an important issue, an incomplete interpretation by some stakeholders made it lose the key essence of the message. The situation can lead to misunderstanding of the issues discussed at the platform, and stakeholders are likely to describe, according to their perspectives different outcomes of an experiment to their peers. This could potentially affect effective learning for innovation. Someone is therefore needed to do a proper rubbing of the different languages used by stakeholders to translate (Tsing, 2004) them into a message which is easily understood by everybody. For instance, the joint experimentation with some stakeholders revealed that a concept like free fatty acids has a similar meaning with the local experiential concept of 'palm oil that solidifies in the mouth' or rancidity used at the *Kramer*; but the language used and the way of knowing its severity is different among the stakeholders. What I did to minimise such misunderstandings was to listen and watch attentively as a facilitator of the platform, then translate the key messages I hear and repeat a summary back to the stakeholders to ascertain if we were all at the same level of understanding. In transdisciplinary research, it is therefore important to develop a third ear and eye or to be attentive and mindful of the differences in language, perspective, knowledge levels and even ways of human interaction for effective communication.

Usually the border-crossing of disciplines and interaction with different stakeholders is done by different researchers of different expertise in a team. In this case, the challenge of combining disciplinary approaches was the multi-tasking of a single researcher. At one point I was an ethnographer asking questions and describing the networks and flows of resources. At another stage I was the artisanal processor making palm oil at a *Kramer*, at yet another instance I was the facilitator at stakeholders' platform workshops. Next time I was a food scientist in the laboratory assessing the quality of palm oil, and I was also the researcher doing experiments with stakeholders. Performing each role effectively, while at the same time stepping out as a neutral, distant person to be able to better reflect so as not to impose my ideas and disciplinary bias on the process was difficult. I had to constantly struggle to come to terms with this problem especially during the experimentation phase and at platform workshops to be able to get good and genuine discussion from most stakeholders.

6.3.6 Implications for future transdisciplinary research

The research was part of a broader CoS-SIS programme and I present some reflections here to enhance the effectiveness of the programme in future endeavours. In addition, the trends in policy intervention (Chapter 1) show that growth and development of the oil palm industry have had very little success in Ghana. It is therefore evident that future research must use an approach that can boost the much needed growth in the industry. This calls for transdisciplinarity to enhance interactions among the sciences, bodies of knowledge, and different stakeholders to address specific, relevant constraints.

The CoS-SIS programme started off with the recruitment of research associates (RAs) and the selection of PhD students and their supervisors, all of whom had specific expertise from a particular social or technical discipline. The selection process was done long before the exploratory and diagnostic studies were carried out. This means the priority constraints identified during the diagnostic study and the expertise and disciplines needed to address these were not known at the moment of selection; yet students had been assigned four supervisors already by the programme. As I reflect on the process, I wonder whether this is the best way of organising such an academic and development programmes dealing with complex multi-faceted constraints of smallholders. Future research in this programme or any transdisciplinary programme for that matter demands a different selection process.

An alternative would be to have a team first conducting the exploratory and diagnostic studies to then decide on the skills and disciplines needed for research and development in the different domains. Such information would then become part of the criteria for selecting both the students and supervisory teams. Or the selected PhD student could be allowed to complete the diagnostic study and decide on the entry point with stakeholders before substantive supervisors are assigned. This would create a ‘solid’ matching of academicians to the practitioner stakeholders in the various study areas. It will also give the recruited research associate the right information to form the CIG and link its agenda to that of the student’s research. Thus avoiding the situation where the CIG tries to solve problems completely different from what the student is studying with stakeholders in the field because of differences in the entry point identified. These issues need to be debated not only by the CoS-SIS programme but also at the universities where students are engaged to work on projects in similar funded programmes for their PhDs. What determines the supervisors they work with and at what phase of the programme do they start their research?

Doing a transdisciplinary research implies changes are needed in the way both social and technical scientists look at issues. Instead of clearly demarcated and

protected boundaries, the sciences should be viewed as a continuum. For a particular project, all disciplines along the continuum that appear to be relevant can be used for addressing the constraints at different stages of the project. This is something scientists from both social and technical disciplines embarking on a transdisciplinarity journey must be mindful of, and learn to create space for each science to function. This is important as a means of enriching the scientific methodology tool kit and debate for smallholder agriculture research and development.

To be able to effectively engage in transdisciplinary research implies that one science, knowledge or stakeholder should not be considered to have priority over or be more important than the other. Moreover, science should not take precedence over practical knowledge, but such lay knowledge should rather be taken as an integral part of the scientific process, to help scientists understand the context in which their study takes place and to formulate the right research questions.

A conducive environment should thus be created to give space to the different components to enable transdisciplinarity to function to its maximum. Exploring this research means that the local stakeholders involved must understand the process from the beginning and be willing to commit to it. Allowing them to be part of the decision making and implementation of the research agenda provides them with an ownership position; this would make it more plausible that the process is continued even after the researcher pulls out. In this regard, I question whether a researcher should always take the lead and step directly into doing 'their' research? I see the exploratory and diagnostic studies as very relevant in shaping specific issues before and even during the actual research (experimentation) process. Engaging in this approach implies that the lead researcher or any other stakeholder should (learn to) be a good facilitator of the research process to ensure that all the disciplines are well coordinated and also, that the voices of all stakeholders are heard. The researcher should also know how to manage sensitive information observed or heard from interviewees in order not to compromise on ethical issues.

There is also the dilemma of what issues should be addressed within a given time because the targeted stakeholders need answers to their problems within a short time. On the other hand, a PhD researcher must be mindful that all the identified constraints and research questions cannot be answered within the designed time frame of the two years of fieldwork. This problem can be reduced by asking the stakeholders to prioritise their constraints so that the key problems become the entry point for the study, as was done in this case through an exploratory study. Even with such initiative I found that, for example, collecting data on the effects of the variation of weather conditions with oil and moisture contents in the oil palm fruit mesocarp to address another constraint would need more than two years to be able to generate insightful

trends. Consequently, this part of the research, despite the long-time effort of stakeholder involvement in the experimentation, had to be left out of the thesis because the data generated at the end of the period simply could not be translated into any practically or scientifically relevant insights. So, how long should a study take to be defendable as a PhD thesis, and at what cost to the society looking for findings? This is a question that transdisciplinarity throws at academic researchers, and it is necessary to make clear decisions on them and also make stakeholders understand that their expectations of the research may not always be met in the short run.

The scientific requirement of being relevant as an innovative research outcome does not necessarily mean that the outcome provides a solution to the practical problem. this is because, some complex problems like the variation of weather conditions with moisture content in fruit mesocarp needs much more than the two years for stakeholders' involvement and a lot more technical analysis. However, I could not have known this before, so how can researchers manage the expectations and deal with such disappointments in a transdisciplinary research? I think this situation may require relaying it to technical science alone at one stage, to see if an understanding could be created, and thereafter stakeholders can be brought in. Interestingly, lay people think that if their problem is relevant enough to warrant a study then they must and will have the solution to the problem soon. However, science is not able to resolve all issues in a short term, and in such a situation, the researcher should make the other stakeholders understand the challenge, and discuss the way forward to addressing it.

In my PhD trajectory I have come to the realisation that I had to focus more on being trained as a scientist in the broad sense first, and then with the skills acquired I could better reach out to society to understand the complex interrelationships between technical, social and institutional constraints. That is the way I can make my scientific contribution relevant to the needs of society and acknowledge its importance in formulating further scientific research questions. I found that integrating disciplines and different knowledge was necessary for processors to be able to change practices and improve the quality of palm oil, but not sufficient to link them to remunerative markets. That is, science can help the artisanal processors but for innovation to occur, they will need to make relevant decisions. What is crucial here, are the institutional changes in the enterprise that is, the re-configuration of actors, and the activities of the CIG to help processors link up with any of the new market options they would like to access. Yet most importantly, the 'action' lies in the hands of processors in changing aspects of their own institutions as organising practices to be able to take up these opportunities. Such institutions can be changed by processors' willingness to move out of old networks (for example Nigerian trade network of poor-quality palm oil) into

new networks for good-quality palm oil (household consumption and export markets) to shape innovation. A demand for further technological innovation, for example the use of strippers, would be created for processing oil palm fruit bunches at earlier storage periods. Thus technological innovations need social and institutional changes simultaneously, and these three aspects of artisanal processing constraints should be tackled together.

6.4 Recommendations

The transdisciplinary research undertaken in this thesis has been useful in enhancing stakeholder interactions to address constraints in the production of good quality oil palm in the artisanal processing enterprise in Kwaebibirem District. This section provides some recommendations to sustain the emerging innovation in the enterprise.

- Transdisciplinarity should be used as the more appropriate approach to research aimed at agro-processing and rural development projects to create space for multi-stakeholder interactions as a co-learning hub for innovation. Scientists from the oil palm research institute in the Kwaebibirem District now have the opportunity to interact closely with farmers and processors and have started incorporating some aspects of the CoS-SIS methodology in their research activities. It is recommended that the scientists who have followed this research and were part of the stakeholders' platform throughout the process should set up a small unit to train other scientists who want to do transdisciplinary research, and to sustain their interactions with the processors and mill owners.

- The national secretariat of CoS-SIS has started an institutionalisation process to support the Research Institute to gradually include transdisciplinarity into its mainstream research agenda. This laudable initiative warrants to be introduced in other agricultural research centres, primarily in Ghana and possibly also in the other CoS-SIS programme implementing countries, Benin and Mali.

- Policy interventions by governments of Ghana, through the Ministry of Food and Agriculture should also be based on findings from a multi-stakeholder engagement, in order to create a comprehensive strategy for the oil palm industry that addresses technical, social as much as institutional constraints in an integrated manner.

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Summary

This thesis argues that transdisciplinary research is useful for making science relevant to address challenges of artisanal oil palm processing and enhancing rural development.

The thesis is the outcome of one of the nine PhD studies of the Convergence of Sciences-Strengthening Innovation Systems (CoS-SIS) programme which was carried out in collaboration with universities and research institutes in Benin, Ghana Mali and The Netherlands (KIT and Wageningen University) from 2009 to 2013, and funded by the Netherlands Ministry of Development Cooperation. This PhD research is part of the oil palm domain of the programme in Ghana, and was motivated by a quest to understand and address the multi-faceted constraints of artisanal palm oil producers within their limited 'windows of opportunity' for development.

Oil palm is one of the leading cash crops in the rural economies of the forest belt of Ghana. Artisanal oil palm processing enterprises are able to produce about 80% of Ghana's palm oil, from the bulk of fruits produced. However, the palm oil produced is of poor quality and thus Ghana continues to be a net importer of high quality palm oil. Artisanal processors face complex socio-technical and institutional challenges that frustrate their access to more remunerative markets, as the high free fatty acid level of their product is unacceptable for national and global industrial markets. Understanding the interrelationships between technical, social, and institutional constraints required an integrated agriculture research-and-development approach involving various disciplines and facilitation of stakeholders' engagements.

I have used a transdisciplinary research approach by applying knowledge from different disciplines and a shared learning by stakeholders to understand and help address the constraints given priority in the artisanal oil palm processing enterprise. The research thus integrated knowledge in four different ways: between technical and social sciences; between science and local or practical knowledge; between the world of science research and lay people (through action research); and between scientists, local decision makers and lay people (the establishment of a stakeholders' platform). The field research was conducted in six towns: Asuom, Otumi, Subi, Kade, Kusi, and Takrowase in the Kwaebibirem district of Ghana. I focused on the artisanal processor as the key actor around whom most of the activities of the enterprise revolved.

The PhD research was preceded with an exploratory study by a Research Associate of the CoS-SIS programme to identify constraints and opportunities for the whole oil palm industry in Ghana. This study found the artisanal processing enterprise

as a potential for promoting growth in the oil palm industry. The findings from that study were further analysed and discussed at a local stakeholders' platform workshop which arrived at 'improving quality of palm oil' as a researchable theme. Thereafter, I started my PhD research with a diagnostic and baseline study (Chapter 2) to collect detailed information on this theme through interviews with key informants, focus group discussions, a survey based on a semi-structured questionnaire, and laboratory-based palm oil quality analysis. An analysis of a problem tree showed that socio-technical constraints might be found in the institutional organization of the mill, and also in individual processor's lack of skills, technology, quality production/price incentives, and market access.

The main objective of this thesis was to investigate how artisanal oil palm processing practices could be improved by researching the socio-technical and institutional constraints and their interplay through a transdisciplinary approach. To achieve this objective I addressed the socio-technical and institutional issues recommended from the diagnostic study. Thus Chapters 3 and 4 of the thesis delved into the socio-technical constraints while Chapter 5 reported on the institutional constraints.

Chapter 3 described the real-life of the artisanal processing actors, using an ethnographic approach. It identified the actors, their networks and the flows of material and non-material resources at the artisanal processing mill to understand the everyday experiences of *Kramer* (mill site) life. The study identified actors such as processors, mill owners, caretakers, mill workers, farmers and various palm oil buyers. The flows of resources usually consisted of oil palm fruits, palm oil, financial exchanges, and knowledge each intertwined with flows of non-material resources through local and transnational networks, such as trust/mistrust, power, contestations and friendship. I found that actors, especially processors rely much more on personalised and informal networks for accessing knowledge on good processing practices than on formal organisational support from district agencies or research institutes. It was evident that processors act rationally in the sense that they reflect on their experiences and take decisions to continue or change their practices in view of their social-economic networks and the flows of resources. This implies that change or innovation in the artisanal enterprise will to a large extent depend on the processors' own knowledge and capability, and their interdependency in processing and trade networks. Thus an intervention seeking to help improve the quality of palm oil should understand the social dynamics occurring at the processing mills, and take that understanding as a starting point for project implementation. In this case, I used the practical knowledge of processors that a long period of fruit storage leads to high palm oil yield as one of the hypothesis for the joint experimentation of Chapter 4.

Chapter 4 was the subject of an action research or joint experimentation which assessed the effects of variation of fruit storage period on the quality and yield of the

palm oil produced. The quality of the palm oil in terms of its free fatty acid level was found to rapidly decrease as fruit storage period increased. The production of palm oil at all storage periods was non-profitable for the current informal Nigerian and Togolese markets, while calculated losses differed between periods. However, palm oil produced at 7 days of storage appeared to be the most profitable, if sold to the national household consumption market. Producing at a 3 days storage period and selling to the export market was also found to be potentially profitable, but more effort by relevant stakeholders is needed to make production at this short storage period efficient. The action research was innovative to the people involved in two ways. Firstly, processors learnt about the effect of fruit storage period on yield and quality of CPO produced; also that the quality attributes they knew in terms of bad taste and smell can be seen as a potential proxy to directly relate to the free fatty acid levels they did not know about. They learnt from their experience of doing a scientific experiment to understand and reflect upon their own experiential learning which provided them with a framework to continue the learning process in their own activities. The stakeholders' platform activities which went on during the two years of the research, kept them actively involved in the learning process. Secondly, the researchers and extension agents collaborated with the processors and mill workers to learn from their practical knowledge and experiences.

Chapter 5 investigated the institutional constraints and how the action research conducted in Chapter 4 impacted on addressing them in the artisanal palm oil processing enterprise of Kwaebibirem district. The constraints were identified as: 1) undesirable practices such as a long fruit storage period and the use of car tyres as source of fuel; 2) the lack of interaction among important stakeholders in the enterprise; and 3) the lack of remunerative year-round market incentives. Using a case study approach of the ex-ante and ex-post situation of the enterprise, I found that the quality of palm oil from a sample of processors who had been involved in the research had improved. In addition, institutional changes occurred due to the joint experimentation and the formation of a local stakeholders' platform that enhanced interactions among the stakeholders of the research institute, government extension service and *Kramer* practitioners, especially processors, something which did not exist before. This interaction-based learning from the joint experimentation and the stakeholders' platform also encouraged technological innovation in processing practices. Thus, creating an opportunity for improving the quality of the palm oil produced. Also, institutional entrepreneurs such as processors, at the local level, and the Concertation Innovation Group (CIG) which operates at the district/national level, district assembly officers and traditional chiefs collaborated to stop processors from using car tires as fuel source for cooking oil palm fruits. I found that different models of information sharing and interventions are necessary and complement each other to address different levels of institutional constraints. The multi-scale stakeholder

approach used in the research ensured the flow of knowledge at different organisational levels, for instance between *Kramer* practitioners, within scientific or extension community and also between practitioners, scientists and extension service. This implies that the artisanal palm oil processing enterprise is able to innovate if all relevant stakeholders (are willing to) learn to overcome constraints and create opportunities, and also change institutions which negatively affect the enterprise.

In its totality, the PhD research taught me that to be able to effectively engage in transdisciplinary research implies that one science, knowledge or stakeholder should not be considered to have priority over or be more important than the other. Moreover, science should not take precedence over practical knowledge, but such lay knowledge should rather be taken as an integral part of the scientific process, to help scientists formulate the right research questions and fully understand the context in which their study takes place.

I also found that integrating disciplines and different knowledge was necessary for processors to be able to change practices and improve the quality of palm oil above what existed before, but this was not sufficient to link them to remunerative markets. Institutional changes in the enterprise are crucial, that is the re-configuration of actors, and the activities of the CIG to help processors link up with any of the new market options they would like to access. Yet most importantly, the action lies in the hands of processors in changing aspects of their own institutions as organising practices to be able to take up these opportunities. Innovation can therefore be shaped by processors' capacity to move out of old networks, for example the Nigerian trade network into new networks for good quality palm oil of the household consumption and export markets. For now, the processors have discovered new knowledge through participating in this research on how to produce quality palm oil, new options for markets and possibilities of diversifying palm oil production based on quality requirements of a particular market. They have also acquired a better understanding of the link between the market quality in terms of free fatty acid and their quality, in relation to rancidity through taste. The artisanal processors are therefore in a position to make better informed decisions about their production activities and become the owners of their livelihood improvement processes or projects.

SAMENVATTING

Deze dissertatie betoogt dat transdisciplinair onderzoek nuttig en relevant is om de uitdagingen aan te gaan die de artisanale verwerking van palmolie en rurale ontwikkeling in Ghana kenmerken.

De dissertatie is een van de negen promotie onderzoeken die werden uitgevoerd in het kader van het door DGIS gefinancierde *Convergence of Sciences – Strenghtening Innovation Systems* (CoS-SIS) programma in samenwerking tussen Wageningen Universiteit en universiteiten en instellingen in Benin, Ghana en Mali (2009-2013).

Een van de programma onderdelen was palmolie in Ghana en dit onderzoek wilde de veelsoortige belemmeringen leren begrijpen en bestuderen van de artisanale palmolie producenten binnen hun beperkte ontwikkelingsmogelijkheden.

Oliepalm is een van de voornaamste handelsgewassen in de rurale economie van de bosgebieden in Ghana. Kleinschalige, artisanale olieperserijen produceren zo'n 80% van alle palmolie. Helaas is de kwaliteit ervan laag en blijft Ghana netto importeur van palmolie van hoge kwaliteit. De artisanale producenten worden echter in hun toegang tot betere en meer remuneratieve markten belemmerd door tal van technische, sociale en institutionele omstandigheden. Vooral het hoge gehalte aan ongebonden vetten in hun product wordt niet aanvaard in de industriële Ghanese en wereldmarkten. Om de verbanden te begrijpen tussen de technische, sociale en institutionele belemmeringen was een holistische landbouwkundige onderzoek-plus-ontwikkelingsbenadering nodig van verscheidene disciplines en met een directe betrokkenheid van stakeholders.

Ik heb een transdisciplinaire aanpak van het onderzoek gekozen door kennis van verschillende disciplines en een gezamenlijk leerproces met stakeholders te gebruiken om de problemen aan te pakken die prioriteit kregen in de verwerking van palmolie. Het onderzoek heeft kennis geïntegreerd op vier verschillende manieren: tussen technische en sociale wetenschappen; tussen wetenschappelijke kennis en lokale of praktijkkennis; tussen de wereld van de wetenschap en 'leken' (in het actie onderzoek); en tussen wetenschappers en leken (in het opzetten van een stakeholders platform). Het veldonderzoek werd uitgevoerd in zes stedelijke gebieden in het Kwaebibirem district in Ghana: Asuom, Otumi, Subi, Kade, Kusi en Takrowase. Mijn accent lag bij de (vrouwelijke) artisanale verwerker (*processor*) als de kernfiguur om wie de meeste aktiviteiten van de palmolie perserij draaiden.

Aan het promotie onderzoek ging een explorerend onderzoek van een Onderzoeksassistent vooraf om de mogelijkheden en belemmeringen te identificeren

van de gehele palmolie industrie in Ghana. Deze studie wees de artisanale verwerking aan als potentiële onderneming om de groei van de oliepalm industrie te vergroten. De uitkomsten van dit vooronderzoek werden voorgelegd en besproken in een workshop van lokale stakeholders, waaruit het startpunt voor dit promotieonderzoek naar voren kwam: de verbetering van de kwaliteit van de palmolie. Daarna startte ik mijn promotieonderzoek met een diagnostische en een baseline studie (Hoofdstuk 2) om gedetailleerde informatie te verzamelen over de kwaliteit van de olie door middel van interviews met sleutelinformanten, individuele interviews en focus groep discussies, een enquête gebaseerd op een vragenlijst met half-gestructureerde vragen, en een in het laboratorium uitgevoerde kwaliteitsanalyse van de palmolie afkomstig van artisanale perserijen. Verdere analyse toonde aan dat er mogelijk sociaal-technische problemen waren in de institutionele organisatie van de perserijen, maar ook, dat een gebrek aan technisch kunnen van bepaalde verwerkers, technologie, de verhouding tussen kwaliteitsproductie en prijs, alsmede toegang tot de markt belemmeringen vormden. Het gebrek aan toegang tot betere markten werd gezien als een institutionele beperking van hoge prioriteit die lag verankerd in praktijken, normen, en in formele en informele regels in de artisanale olieperserij. Dit houdt in dat de geringe kwaliteit van palmolie die wordt geproduceerd door de verwerkers haar oorsprong vindt in twee oorzakelijke ketens: de lange opslagperiode van de vruchten voorafgaand aan de verwerking ervan en het ontbreken van markt prikkels en van een behoorlijk regelgevend kader.

Het voornaamste doel van deze dissertatie was derhalve om te onderzoeken hoe artisanale praktijken van olieverwerking konden worden verbeterd, door de sociaal-technische en institutionele beperkingen en hun interactie te bestuderen door middel van een transdisciplinaire benadering. Om dit doel te bereiken koos ik drie problemen die werden aangewezen in de diagnostische studie. Hoofdstukken 3 en 4 behandelen de sociaal-technische beperkingen, terwijl Hoofdstuk 5 verslag doet van de institutionele belemmeringen.

Hoofdstuk 3 beschrijft de reële zaken in de praktijk van alledag van de actoren in de perserijen door middel van etnografisch onderzoek. Ik identificeerde de actoren, hun netwerken van relaties met anderen en de stroom van materiele en niet-materiele goederen in de perserijen om het leven van alledag en de gang van zaken in de z.g. *Kramer* of artisanale perserij te begrijpen. Als actoren onderscheid ik verwerkers, eigenaren van de perserijen, zetbazen, vaste en losse werkers, boeren en opkopers van de palmolie. De stroom van goederen bestond vooral uit vruchttrossen van de oliepalm, palmolie, financiële middelen en kennis, elk verweven met niet-materiële stromen van ‘goederen’ als vertrouwen/wantrouwen, macht, twist en vriendschap. Verandering of innovatie in een artisanale onderneming blijkt sterk af te hangen van

de kennis en bekwaamheid van de verwerker en haar afhankelijke positie in verwerkende en handels ketens. Daarom zal een externe ontwikkelingsinterventie die ten doel heeft de kwaliteit van de palmolie te verbeteren, allereerst de dynamiek van de perserijen moeten begrijpen en dat inzicht gebruiken als startpunt voor interventie. In mijn eigen onderzoek nam ik de praktische kennis van de verwerkers als startpunt en gebruikte ik hun idee dat een lange opslagperiode van de vruchten leidt tot een hoge opbrengst van palmolie als hypothese voor het gezamenlijke experiment beschreven in Hoofdstuk 4.

Hoofdstuk 4 gaat over een stuk actie onderzoek of een gezamenlijk experiment dat de effecten bepaalde van een verschillende duur van opslagperiode op de kwaliteit en kwantiteit van de geproduceerde palmolie. Wij vonden dat de kwaliteit van de olie snel verminderde wanneer de opslagperiode toenam in termen van een stijgende concentratie ongebonden vetten. Ook bleek de productie van palmolie, ongeacht de duur van de opslag, geen economisch voordeel te bieden voor de bestaande Nigeriaanse en Togolese markten, hoewel er duidelijke verschillen in de berekende geldelijke verliezen bestonden tussen de verschillende opslagperioden. Palmolie die was geproduceerd na een opslag van 7 dagen bleek het meest winstgevend te zijn, indien de olie werd verhandeld op de nationale (Ghanese) markt voor huishoudelijke consumptie van palmolie. Olie geperst na 3 dagen opslag van de vruchten en verkocht op de exportmarkt zou ook profijtelijk kunnen zijn, maar dan moeten de relevante stakeholders meer moeite doen om de productie na zo'n korte opslagperiode efficiënter te maken.

Het actieonderzoek was innovatief voor de betrokkenen op twee manieren. Ten eerste verkregen de verwerkers inzicht in het effect van de duur van de opslagperiode op de kwantiteit en kwaliteit van de ruwe palmolie die werd geproduceerd; ook leerden zij dat hun eigen kwaliteitskenmerken als slechte smaak en geur van de olie zich laten vertalen in verschillende concentraties van ongebonden vetzuren – iets waar zij niet van wisten. Door mee te doen in een wetenschappelijk experiment leerden o.a. de verwerkers om hun eigen onderzoek-in-de-praktijk te begrijpen en erover door te denken, wat hen hielp om hun leerervaring in hun eigen aktiviteiten in de perserij voort te zetten. De stakeholders bleven gedurende de volle twee jaren van het onderzoek betrokken in de experimenten, waardoor zij die hele tijd in een leerproces bleven delen. Ten tweede was dit actieonderzoek innovatief, omdat voor het eerst lokale onderzoekers en voorlichters met de verwerkers en hun arbeiders in de olieperserijen samenwerkten en de laatsten hun praktijkkennis en ervaring direct konden overdragen.

Hoofdstuk 5 behelst het onderzoek naar de institutionele belemmeringen en de invloed die het actieonderzoek uit Hoofdstuk 4 heeft in de aanpak van die problemen

in de artisanale verwerkingsindustrie in Kwaebibirem district. De geïdentificeerde problemen waren: 1) ongewenste praktijken, zoals een te lange opslagperiode en het gebruik van autobanden als brandstof; 2) gebrek aan interactie tussen belangrijke spelers in de onderneming; 3) het ontbreken van marktprikkels gedurende het gehele jaar. Door een *ex ante* en *ex post case study* te maken van de situatie in de perserijen, ontdekte ik dat de kwaliteit van de olie van een selectie van verwerkers die in het experiment betrokken waren geweest, daadwerkelijk was verbeterd. Bovendien waren er door het onderzoek institutionele veranderingen in gang gezet vanwege het gezamenlijk experiment en was er een platform van lokale stakeholders gevormd dat een interactie teweeg bracht tussen het onderzoeksinstituut, de gouvernementele voorlichtingsdienst en mensen uit de verwerkingspraktijk van de *Kramers*, met name de verwerkers, die voordien niet bestonden. Dit leerproces door interactie in het gezamenlijke experiment en het stakeholder platform leidde ook tot technologische verbeteringen in de verwerking. Zo werd een mogelijkheid geschapen om de kwaliteit van de productie van artisanale palmolie te verbeteren.

Institutionele actoren, zoals de verwerkers op lokaal niveau, maar ook de Overleg en Innovatie Groep (CIG,) op district en nationaal niveau, de leden van het districtsbestuur en de traditionele leiders, zijn gezamenlijk opgetreden om het verbranden van autobanden te stoppen. Ik bemerkte dat er verschillende, complementaire manieren van informatieuitwisseling en interventie nodig zijn om de verschillende institutionele belemmeringen aan te pakken. De multi-stakeholder benadering die ik mijn onderzoek heb gebruikt heeft voor een stroom van kennis op en tussen de diverse organisatorische niveaus gezorgd, zoals bijvoorbeeld tussen *Kramer* praktijk mensen, binnen de wetenschappelijke~ en voorlichtingsgemeenschappen, maar ook tussen mensen uit de praktijk, wetenschap en voorlichting. Dit betekent dat de artisanale olieverwerkende ondernemingen in staat zijn zich te vernieuwen indien alle relevante stakeholders bereid zijn om te leren om belemmeringen uit de weg te ruimen en mogelijkheden te creëren, en zelfs om instituties te veranderen die een negatieve invloed hebben op de artisanale palmolie perserij.

Als geheel heeft dit promotie onderzoek me geleerd dat, wil men effectief in transdisciplinair onderzoek deelnemen, er niet één wetenschap, kennis of stakeholder prioriteit kan hebben over of belangrijker worden geacht dan een ander. Bovendien zou wetenschap niet per se voorrang moeten hebben boven praktische kennis, zodat lekenkennis integraal deel kan worden van het wetenschappelijke onderzoeksproces om zodoende wetenschappers te helpen om de context te begrijpen waarin hun onderzoek plaatsvindt en de juiste onderzoeksvragen te kunnen formuleren.

Ik heb ook ondervonden dat het nodig was voor de verwerkers om verschillende disciplines en soorten kennis te integreren om hun werkwijze te kunnen veranderen en de kwaliteit van de palmolie te verbeteren vergeleken met daarvoor, maar dat dit op zich nog onvoldoende was om hen toegang te verschaffen tot betere markten. Institutionele veranderingen binnen de onderneming zijn cruciaal, dat wil zeggen de reconfiguratie van actoren en de hulp van de CIG om de verwerkers met nieuwe markten in contact te brengen die zij interessant vinden. Maar het allerbelangrijkste is dat het initiatief in handen ligt van de verwerkers om aspecten van hun eigen instituties als organisatiepraktijken te veranderen teneinde die mogelijkheden op te pakken. Het concept institutie dient daarom te worden uitgebreid om de grotendeels onzichtbare, trans-nationale netwerken van de verwerker in te sluiten. Innovatie krijgt dan vorm door het vermogen van de verwerker om uit oude netwerken te stappen, zoals bijvoorbeeld het netwerk met de Nigeriaanse handelaren, en tot nieuwe netwerken toe te treden ten behoeve van de productie van goede kwaliteit palmolie voor huishoudelijk gebruik in Ghana als ook voor de export. Voor het moment hebben de verwerkers nieuwe kennis opgedaan door deel te nemen in dit promotie onderzoek naar verbetering van de kwaliteit van geproduceerde artisanale palmolie en het zoeken naar nieuwe markten door diversificatie van de productie conform de kwaliteitseisen van een bepaalde markt. Zo zijn artisanale verwerkers in de positie gekomen dat zij beter onderbouwde besluiten kunnen nemen over hun palmolie productie en hebben zij projecten of het proces van verbetering van hun *livelihood* in eigen hand.

What is CoS-SIS?

Definition and Purpose

Convergence of Sciences-Strengthening Innovation Systems is an action research programme in Benin, Ghana and Mali. It carries out scoping and diagnostic studies, agrarian system analyses and participatory field experiments with innovation platforms at the local, district and national levels. Its purpose is to identify pathways for creating opportunity for smallholder farmers in West Africa. Focusing on the enabling conditions at levels higher than the field and farm, the Programme supports sustainable intensification of smallholder farming for food security.

Partners and Funding

CoS-SIS is a partnership among the *Université d'Abomey-Calavi* at Cotonou, Benin; the *University of Ghana* at Legon, Ghana, and the *Instut Polytechnique Rural de Formation et Recherche Appliquée*, at Katibougou, Mali; and *Wageningen University*, and the *Royal Tropical Institute* in the Netherlands. It is funded to a total of € 4.5 million for six years (end 2008-mid 2014) by Dutch International Cooperation.

History and future

CoS-SIS is the second phase of CoS. CoS1 (2001-2006) focused on participatory technology development (PTD) in Benin and Ghana. It showed that smallholders can capture only limited benefits from even the best-adapted and appropriate technologies because of their constrained opportunities. Hence CoS1 researchers started to experiment with institutional change (in addition to their agronomic work). Their early results inspired CoS-SIS in that they convincingly demonstrated that institutional change is both important and feasible. CoS-SIS is currently supporting CORAF in implementing its IAR4D strategy with its West African partners.

Personnel

CoS-SIS employs eight post-doc Research Associates (RAs), recruited part-time from national research organisations and universities, and nine African Ph.D. researchers. Some of the RAs are graduates of the COS1 programme. The RAs facilitate Concerted action and Innovation Groups (CIGs) (multi-stakeholder platforms composed of key actors in an agricultural domain) at the district and national levels to experiment with institutional change. The Ph.D. researchers work at community level with groups of local people to analyse constraints and experimentally develop livelihood opportunities. The doctoral research feeds into the deliberations of the CIGs. The work is overseen by National, Regional and International Programme Coordinators, who together form the Programme Management Committee (PMC). Responsibility for

each country programme rests with a Programme Management Team (PMT) composed of senior representatives of universities, ministries, R&D organisations, the private sector, NGOs and FBOs. The PMTs and coordinators are proving to be high-level networkers and important advocates of the institutional change initiated by the CIGs and PhDs.

Domains reflect national priorities

- *Benin*: cotton, oil palm (inter-cropping oil palm and annual crops, and the oil palm seed system) and integrated water management (agro-pastoral dams in the North, and rice production in valley bottoms in the South);
- *Ghana*: palm oil and cocoa (work in the domain of small ruminants ended when the RA was promoted to another location by his home organisation);
- *Mali*: integrated water management, integration of crop and livestock production (both in the Office de Niger), and shea butter (*karité*).

Key activities

- Identifying key constraints that specific categories of smallholder farmers and processors experience when trying to improve their livelihoods and incomes through productive or value adding activities.
- Identifying and researching the institutional reasons for the constraints at the local and higher system levels.
- Identifying key actors, networks and mechanisms that maintain the constraints, as well as entry points for action to by-pass, or transform the institutional context to overcome them.
- Assembling multi-stakeholder platforms of key actors who can be expected to engage in institutional change in their respective domains.
- Enabling platform actors to experiment with institutional arrangements.
- Institutionalising achievements in university curricula, the programmes of research institutes, government policies, the structure of agricultural industries, and arrangements among enterprises and services and in value chains.
- Researching the processes of change and the work of the CIGs by means of real-time monitoring and a form of modified causal process tracing, based on two declared theories of change (intervention theory focused on internal and external activities and relationships of the CIGs; and power theory, focused on networks that have power to change or maintain institutional contexts linked to each domain).
- Ensuring that the outcomes of the action research are published and disseminated through international scientific media, and shared with local, national, and regional government agencies and political decision makers.

Appendix

PHD PROJECT – CHARITY OSEI-AMPONSAH (MRS)

QUESTIONNAIRE FOR PROCESSORS

The objective of this survey is to collect baseline information and also gather data for better understanding of the small scale oil palm processing industry in the Kwaebibirim District of the Eastern Region, Ghana.

A. GENERAL INFORMATION

NAME OF PROCESSOR ……..

1. Location of processor 1-Asuom 2-Otumi 3- Subi 4- Kade 5- Kusi 6- Takrowase
2. Sex of the processor 1- Male 2- Female
3. Is processor a migrant or indigene of the Kwaebibirim District 1- Migrant 2- Indigene (from which region, specify)……..
4. What is the age of the processor in years …….
5. What is processor's level of education or formal skills 1- No education 2- JHS/MSLC 3- SHS/Vocational 4- Post-Sec
6. Number all the persons who normally live and eat together in processor's household including the household head …….
7. Who is the household head 1- Male 2- Female
8. What is the number of household members engaged in processing activity? ……
9. What type of processing activity are they engaged in? 1- cutting of bunch into spikelets 2- loosening of fruits 3- carrying of fruits to boiler 4- fetching of water 5- collecting boiled fruits to digester 6- separation of fibre and nuts 7- others ……
10. What is the number of household members under 15 years? ……
11. What is the marital status of processor? 1- married 2- informal/loose union 3- divorced/separated 4- never married 5- widowed

B. PROCESSING AND MARKETING INFORMATION

12. What is the source (s) of livelihood/income for processor? 1- citrus farming 2- oil palm cultivation 3- processing of oil palm 4- bulking and sale of palm oil 5- petty trading 6- vocation 7- salaried work 8- remittances 9- others, please specify …….

13. Which of these income sources provide the highest income for processor? 1- oil palm cultivation 2- processing of oil palm 3- bulking and sale of palm oil 4- petty trading 5- vocation 6- salaried work 7- citrus farming 8- remittances 9- others, please specify ……..
14. What other income generating activities are engaged in during lean season/off farming season?.....
15. What is the source of the fresh fruit bunches for processing? 1- own farm 2- OPRI 3- GOPDC 4- from private farmer 5- others, please specify ……...
16. How many tonnes of oil palm bunches do you process per month in (a) lean season? …… (b) bumper season? …….....
17. How much palm oil (in drums/ frytol gallons) do you sell per month in (a) lean season? …… (b) bumper season? …….....
18. What type of palm oil do you process? 1- Zoomi palm oil 2- ordinary palm oil, and why ……..……...…… ……
19. Where does the processor process his/her fruit bunches (name and location of Krammer) …….
20. How long have you been milling oil palm fruit bunches (in years)? ……..
21. How long have you been milling fruit bunches at the present Krammer you are attached to (in years)? ……
22. Why does processor prefer that Krammer to others in the community? …… …… …… ……
23. Has processor received any technical assistance and training from any institution? 1 – No 2- Yes, please state the institute (s) ……

24. Who are the buyers of the processor's palm oil 1- agents for Nigerian buyers 2- other processors 3- mill owner 4- local bulker 5- Togo buyers 6- customers from the major local markets in Ghana 7- others, please specify ……
25. Where do you access information on prices of palm oil and fresh fruit bunches 1- processors at Krammer 2 – processors from other krammers 3- Nigerian agents 4- other customers 5- GOPDC 6 – others, please specify……..
26. Where do you access credit for the processing of palm oil 1 – pre-finance by customers 2 – Ghana Commercial Bank 3 – Sinapi Aba 4- District Assembly 5 – processors' co-operative 6 – Opportunity Loans and Saving 7 – none (do not take credit) 8 – others, please specify ……...
27. Income generation activity last season

Activity	Food Crop Farming	Oil Palm Cultivation	Cocoa & citrus Farming	Oil Palm Processing	Salaried Work	Remittance	Others, please specify
Income from activity/last season (GH ¢)							

C. PROCESSING PRACTICES & QUALITY

28. How long do you keep fruits before processing? 1- 3 days 2- 1 to 2 weeks 3- 3 to 4 weeks 4- other, please specify……
29. Why do you keep fruits before processing? ……
    ……..
    ……
    ……
30. What does quality palm oil mean to you?
    ……
    …….
31. Who determines quality of palm oil produced? 1- processor 2- miller 3- buyer 4- others, specify……
32. What practices do they employ to produce quality oil?……
    ……

……
……

33. What is the source of fuel? 1- fibre cake 2- bamboo 3- car tyres 4- firewood kernel shell 5- others, please specify……
……..

34. What is the source of water for processing? 1- dug-out well 2- stream 3- river 4- harvested rainwater 5- tap water 6- others, please specify……

35. What containers do you use to store palm oil? 1- yellow frytol 2- blue drums 3- metal drums 4- metal reservoirs 5- polytank reservoir 6- others, please specify
……

36. How do you sterilize fruits? 1- boiling 2- steaming

37. How do you dispose of waste (effluent) from processing activity?
……..

38. How much tax do you pay yearly to a) District Assembly…….. b) Internal Revenue Service…….

39. How much do you currently pay for digesting and pressing of fruits……..

40. Do you belong to any Processors' Association(s)? 1- no 2- yes

If (1), What are the reasons for **not** being a member?……....
……
……
…….

If (2), What are the reasons for being a member?……...
……
……

Charity Osei-Amponsah
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Name of the course	Department/ Institute	Year	ECTS (=28 hrs)
Project related competences			
CoS-SIS Introduction and Methodology Courses	CoS-SIS	2009	9.5
Innovation Management and Cross-disciplinary Design (COM 21306)	WUR	2009	4
General research related competences			
Research Design and Methods	CoS-SIS	2009	1.5
Proposal Writing and Policy development in Agricultural research course	IFS	2009	2
Sociological Theories of Rural Transformations (RDS 30306)	WUR	2009	4
Advanced Social Theory (RSO 32806)	WUR	2010	6
Career related competences			
Competences for Integrated Research	WGS	2009	1
Supervision of MPhil student	UoG/ CoS-SIS	2011-2012	1
"Opportunities through institutional Innovation: improving the Quaity of artisanal Palm Oil Processing in Ghana"	CoS-SIS	2009-2012	1
"Improving small-scale palm fruit processing practices in the Kwaebibirem, Ghana"	CoS-SIS	2009-2012	1
"Processing practices of small-scale oil palm fruit processors in the Kwaebibirem, a diagnostic study"	CoS-SIS	2009-2012	1
"Oil Palm in Ghana"	CoS-SIS	2009-2012	1
"Understanding the entry point and CoS-SIS programme action theory: oil palm domain, Ghana"	CoS-SIS	2009-2012	1
"Small-scale oil palm processing methods in Kwaebibirem District, Ghana"	CoS-SIS	2009-2012	1
"Crossing disciplines in agricultural research: experience from artisanal oil palm processing in Ghana"	XIII WCRS, Lisbon	2012	1
Än analysis of innovation processes in artisanal palm oil enterprise in Ghana"	CTA, Wageningen	2013	1
TOTAL			37

About the author

Charity Osei-Amponsah, born in 1972 is a native of Kwahu, Mpraeso in the Eastern region of Ghana. She attained her undergraduate and Master of Philosophy degrees in agricultural economics from the University of Ghana. Her Master's dissertation focused on the determinants of poverty among fishmongers in the Tema and Accra metropolis of Ghana.

From 2004, Charity worked as an integrated science teacher at the senior high school level. In the latter part of 2006, she joined the Institute of Economic Affairs, a policy think tank as a research officer. In 2009, she started a PhD study at the Wageningen University and Research Centre and conducted a transdisciplinary research on improving the quality of palm oil from artisanal processing enterprises in Ghana.

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