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PROFITABILITY AND TECHNICAL EFFICIENCY ANALYSES OF SMALL SCALE PALM OIL PROCESSING IN THE ASSIN NORTH AND SOUTH DISTRICTS OF GHANA

BY

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THIS THESIS IS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ECONOMICS, AGRIBUSINESS AND EXTENSION, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

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DECLARATION

I Zigah, David Esela hereby declare that this thesis is my own work towards my MPhil degree and that, to the best of my knowledge, it contains no material published by another person or material which has been accepted in any other University for any degree except where due acknowledgement has been made in the text.

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DEDICATION

I dedicate this work to my parents and siblings for the care, support and love they have given me throughout my education. God richly bless them.

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ABSTRACT

This study analyses profitability and technical efficiency of small scale palm oil processors in Assin North Municipality (ANM) and Assin South District (ASD) of Ghana. The study used primary data collected during the 2011/ 20012 production season for analysis. The data was collected through the use of structured questionnaires administered on one hundred and fifty (150) small scale palm oil processors who were selected through a simple random sampling technique. Descriptive statistics were used to examine the socio-economic characteristics of the respondents. Gross Margin (GM) and Benefit/Cost Ratio (BCR) were the main financial tools used to assess financial viability of small scale palm oil processing. Maximum Likelihood Estimation of the Stochastic Production Frontier was employed to examine Technical Efficiency (TE) levels among the processors. The values obtained from GM and BCR analyses showed that small scale palm oil processing is financially profitable in both major (peak) and minor (lean) seasons. Results of the TE analysis indicated that the level of TE varies across processors and ranges from 54.2% - 99.4% with a mean of 92.4% suggesting that on the average crude palm oil output falls 7.6% short of the maximum possible level. The TE level is positively correlated with the level of education, experience and membership of association, but unexpectedly negatively correlated with access to credit.

Kendall's Coefficient of Concordance analysis of constraints militating against the industry showed that access to credit is the most constraining factor followed closely by transportation cost, labour cost and bad state of rural road network. The study recommended that policies that would improve, formation of active processing based associations, functional literacy and capacity building programmes for processors and rural road network should be pursued by central and local government structures in the study areas to further improve the profitability and TE in the industry in the study area.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAD	Average Annual Depreciation
ANM	Assin North Municipality
ANMA	Assin North Municipal Assembly
ASD	Assin South District
ASDA	Assin South District Assembly
BCR	Benefit/Cost Ratio
BOPP	Benso Oil Palm Plantation
CCFB	Chyuan Chya Food and Beverages
CPKO	Crude Palm Kernel Oil
CPO	Crude Palm Oil
CSIR	Council for Scientific and Industrial Research
DEA	Data Envelopment Analysis
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agricultural Organization Statistical Databases
FASDEP II	Food and Agriculture Sector Development Policy II
FC	Fixed Cost
FFB	Fresh Fruit Bunches
GLSS	Ghana Living Standard Survey
GM	Gross Margin
GOPDC	Ghana Oil Palm Development Corporation
IPPA	Initiative for Public Policy Analysis
MLE	Maximum Likelihood Estimation
MLGRD	Ministry of Local Government and Rural Development
MoFA	Ministry of Food and Agriculture
MPOC	Malaysia Palm Oil Council
OPRI	Oil Palm Research Institute
PSI	President's Special Initiative
RBD	Refined, Bleached and Deodorized

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SFA	Stochastic Frontier Analysis
SPF	Stochastic Production Function
SRID	Statistics, Research and Information Directorate
TC	Total Cost
TE	Technical Efficiency
TOPP	Twifo Oil Palm Plantation
TR	Total Revenue
TVC	Total Variable Cost
UNU	United Nations University
USDA	United States Department of Agriculture
VC	Variable Cost

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CHAPTER ONE

INTRODUCTION

1.1 Background of study

Palm oil, a kind of edible vegetable oil, which is derived from the pulp of the fresh palm fruit in its various forms, has become the leading vegetable oil produced globally, accounting for one quarter of global consumption and nearly 60% of international trade in vegetable oils (World Bank, 2010). The increase in consumption is due to its multiple uses in both food industry and non-food sectors. It also has many competitive advantages over other competing oils, such as having low cost of production, high yield, and being free from trans-fatty acids (Oil World, 2008). Oil palm commercially cultivated on about 12 million hectares of land in the humid tropics. Major producers are Malaysia and Indonesia (85% of global output). Other smaller but significant producers include Nigeria, Colombia, Costa Rica, Ecuador, Honduras, Cote d'Ivoire, Ghana, Cameroon, Papua New Guinea, and Thailand (World Bank, 2010).

According to Ayodele (2010), the palm oil industry in Ghana since independence has been geared towards meeting domestic demand and thus reducing import bills, (i.e. it has largely been an import substitution industry). The growth in oil palm cultivation from the 1970s was in response to the increase in domestic demand as a result of growth in population, urbanization and industrialization. The structure of the palm oil industry in Ghana has been shaped by the presence of two different markets: home consumption and industrial use in domestic manufacturing (Fold & Whitfield, 2012). As a result, Ghana's industry has two sub-sectors which are largely separated. The industrial use sub-sector consists of medium and large scale oil palm plantations and mills. Processing mills under large scale sub-sector process more than 10 tonnes fresh fruit bunches (FFB) per hour while installations that process between three and eight tonnes FFB per hour are termed

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medium scale (Poku, 2002). Large sub-sector is characterized by more efficient technology, economies of scale, higher productivity on farms (in terms of yields of oil palm bunches) and in mills (in terms of quantity of oil extracted). It also produces better quality of crude palm oil and further refined palm oil products, which are sold to companies for use in manufacturing. The small scale sub-sector, however, consists of household processors (who process manually and private smallholder oil palm cultivators, who largely sell their fruit bunches to small scale mechanized mills (Processing units handling up to 2 tonnes of fresh fruit bunches (FFB) per hour) (Poku, 2002). The small scale sub-sector is characterized by low-yielding oil palm variety, low productivity of farm and mill, and low quality crude palm oil which is sold in the village or at small town markets (Fold & Whitfield, 2012).

The palm oil industry in Ghana is expanding in recent times, as current total area under oil palm production is put at 360,000Ha up from 289,170Ha in 2003 (MoFA, 2011). The expansion in oil palm plantation is significantly accompanied by processing of palm fruits into edible oil, especially among women in many rural communities in Ghana where palm plantations are common. Statistics of crude palm oil (CPO) production in Ghana from 2002-2010 indicates that the small scale palm oil processing industry, mostly dominated by women, produced the greater portion (MoFA, 2011). For instance, out of the total of 402,473.00mt of crude palm oil produced in 2010, the small scale and the private holdings contributed 80% (MASDAR, 2011). Government has identified the palm oil sector as holding tremendous potential to create jobs and reduce poverty among the rural poor especially women and the development of the economy. Recent trends in world price suggest that crude palm oil when properly nurtured could easily become a major foreign exchange earner for the country. As result, Ghana has recently signed an agreement worth $21.6 million with Chyuan Chya Food and Beverages Limited (CCFB), and the China-Africa Economic Trade Limited. Under the agreement, Ghana will export 36,000 metric tonnes of palm oil to China every year (Essabra-Mensah, 2010). Although the deal would create over 100,000 jobs, the palm oil to be exported will be mainly sourced through small and medium scale palm oil producers in Ghana. That is however, dependent on the ability and efficiency of small and medium scale producers to increase production. To be able to raise the productivity of small scale palm oil producers to ensure the realization of this deal, there should be proper management and efficient utilization of resources in the sector.

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Processing of palm fruits into edible oil as primary economic activity of women in many communities in Ghana where palm plantations are common is no exception in the Assin North Municipality (ANM) and Assin South District (ASD) of Ghana. Efforts to improve the livelihoods of women in such communities could be targeted at such cottage industries as their efficient operation holds the key to poverty reduction among venerable households. According to Ekine & Onu (2008), determinants such as cost of palm fruits, cost of hiring equipment, transportation of the palm bunches, availability of labour, price of palm oil among others are crucial in the industry because the survival of the enterprise is highly dependent on these important variables since they influence the level of Gross Margin (GM) obtained by the processors.

Efficient allocation of resources is also important to ensure sustainability of small scale palm oil processing sector in Ghana because one way of reducing the cost of production is to increase output by increasing technical efficiency. In this regard, it is necessary to quantify current levels of technical efficiency so as to estimate losses in production that could be attributed to inefficiencies due to differences in socio-economic characteristics and management practices. It is against this background that this study was initiated to conduct profitability and technical efficiency analyses of small scale palm oil processing in the Assin North Municipality (ANM) and Assin South District (ASD) in Ghana.

1.2 Problem Statement

Palm oil, in its various forms, has become the leading vegetable oil produced globally accounting for one quarter of global consumption and nearly 60% of international trade in vegetable oils (World Bank, 2010). In 2007/2008, the world consumption of palm oil reached almost 40 million tonnes and in 2050, it is forecast to reach 93.256 million tonnes, depending on the edible oil substitute demand (Oil World, 2008). In recent decades, the domestic consumption of palm oil in West Africa has also increased more rapidly than its production. After centuries as the leading producing and exporting region, West Africa has now become a net importer of palm oil (Olagunju, 2008). Ghana has a long history of palm oil production. It was its primary export in late part of the 19th century and the early part of the 20th century (Ayodele, 2010). Like other countries in the region, Ghana has failed to take palm oil production beyond mere potential. This is due to the use of traditional methods of production coupled with the low quality of palm oil produced which could not make Ghana to meet up with the rising global and domestic demand. Its current annual production is put at 120,000MT down from 128,000 in 2008 (FAOSTAT, 2010).The domestic consumption level is estimated to be around 230,000MT per annum. The shortfall is being filled by import at great cost to the country.

In a bid to address the demand-supply gap governments at various times have come up with policies and programmes to support the oil palm sector. Most of these policies have consistently focused on committing more land to production and yield improvement programmes. For instance, the medium term objectives for industrial crop development spelt out in FASDEP II were to increase the availability of improved planting material, improve adoption of improved agronomic practices and expand average farm size per holder. In spite of the consistency in policy, the country is not able to secure self-sufficiency in domestic supply and to take advantage of the booming world market to earn a substantial foreign exchange from export of the product. The consistency in policy towards increasing productivity in crop yield which has not yielded the needed result of bridging the demand-supply gap has raised a number of pertinent questions both in policy circles and among researchers. For example, what are the factors explaining why Ghana is not self-sufficient in domestic palm oil production despite huge land under oil palm cultivation? Attempts by various governments to address this question have been focused on breeding high-yielding varieties and expansion of farm sizes in the country to the neglect of the processing sub-sector. World Bank (2010) pointed out that there is a significant yield gap between producers with yield ranging from seven tonnes palm oil/ ha/yr to less than half a tonne/ha/yr. For example, in 2010, MoFA estimated average yield of palm oil to be as low as 1.10tonnes/ Ha in Ghana. The study targeted the small scale processing industry because it controls greater portion of Ghana's total palm oil output and can be a major source of employment, especially for rural women, and can be used to address poverty in these areas.

In Assin North Municipality (ANM) and Assin South District (ASD) for instance, the small scale palm oil processors have no records of how profitable the business is and how efficient resources are being used. The critical questions for researchers in Ghana to resolve through empirical research are:

1. Is small scale palm oil processing profitable in the study area?
2. What is the average quantity of crude palm oil produced by small scale processors per production cycle?

3. Are small scale processors efficient in the use of production factors in palm oil processing?
4. What are the factors that drive efficiency in small scale palm oil processing?
5. What constraints do small scale processors face?

There is little, if any, empirical evidence in Ghana to answer the questions above. This study is therefore, aimed at bridging this research gap by conducting profitability and technical efficiency analyses of small scale palm oil processing in Ghana.

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1.3 Objective of the Study

The broad objective of the study was to examine the profitability and technical efficiency levels of small scale palm oil processors in the Assin North Municipality (ANM) and Assin South District (ASD) of Ghana.

The specific objectives of the study include:

1. To examine the cost structure and the returns associated with small scale palm oil processing in the study area;
2. To estimate the average quantity of crude palm oil produced by small scale processors per production cycle in the study area;
3. To determine the gross margin of small scale palm oil processing in the study area;
4. To evaluate the technical efficiency of small scale palm oil processors and identify the key factors that drive efficiency in the industry; and
5. To identify the critical constraints faced by small scale palm oil processors in the study area.

1.4 Hypotheses

The following hypotheses were tested in the study:

No.	HYPOTHESES	SOURCE
1	Small scale palm oil processing is financially profitable in the lean season of production.	Adjei-Nsiah *et al.*, (2012)
2	Small scale palm oil processors are technically inefficient in the use of production factors.	Kadurumba *et al.*, (2009)
3	Technical efficiency in small scale palm oil production is positively influenced by institutional factors such as access to credit and extension contact.	Ojo (2005)

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1.5 Justification for the Study

The crucial role of efficiency in increasing agricultural output has been widely recognized by researchers and policy makers alike. Thiam *et al.* (2001) highlighted the importance of efficiency as a means of fostering production which has led to proliferation of studies in agriculture on technical efficiency around the globe. Analysis of technical efficiency in agriculture has received particular attention in developing countries because of the importance of productivity growth in agriculture for overall economic development. An improvement in technical efficiency constitutes a major component of total factor productivity growth, and is identified in literature as particularly important in developing countries (Brümmer *et al.*, 2006).

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Increasing productivity and efficiency which eventually lead to optimum profit require a good knowledge of the current inherent efficiency or inefficiency and related factors. The efficient allocation of resources for development purposes and the factors of production need to be effectively mobilized to reduce the gap between actual and potential national outputs in order to reap the far reaching benefits (Amos, 2007). The use of empirical measurement provides clearer evidence (Coelli, 1996b) of the impact of some factors on the performance level rather than the use of theory. Also, the formulations of policy measures have possibly been hindered by the lack of relevant empirical studies at critical areas, considering the diversity in results of factors of the same kind at many sites of study.

Many studies have been conducted into palm oil processing systems and economic benefits of palm oil industry, which is increasing worldwide especially in Asia and West Africa because of high demand of the product globally. However, little or no research is known to have been undertaken on the profitability and technical efficiency assessment of palm oil production in Ghana especially in the case of small scale palm oil processing sector. In an economy where resources are scarce and opportunities for new technology are lacking, profitability and efficiency studies can show the possibility of raising productivity in the small scale processing sector by improving efficiency without expanding the resource base.

According to Ajibefun & Daramola (2004), resources must be used much more efficiently, with more attention paid to eliminating waste. This will lead to an increase in productivity and incomes. This study will therefore, provides literature to supplement previous works and serve as reference material for researchers and students in future studies into the sector.

It will also provide much insight into policies that could be pursued by governmental and non-governmental organizations as well as other major stakeholders to either to aid small scale palm oil processors to improve profit and technical efficiency levels. Understanding the levels of inefficiency/efficiency in the small scale palm oil processing can help address productivity gains if there are opportunities to improve management practices in the sector. Knowledge about profitability and technical efficiency in the sector will also serve as guide to investors when taking investment decision in the sector. The study also helps to identify the critical constraints facing small scale palm oil processors in the country. It would therefore serve as a useful input when stakeholders are taking steps to address these constraints.

1.6 Organization of the thesis

The thesis is organized into five chapters. Chapter one presents introduction, problem statement, research question, objectives of the study, hypotheses and concluded with the justification of the study. It is followed by Chapter two, which constitutes extensive review of relevant literature on the palm oil industry in Ghana, palm oil processing, related studies on palm oil production, profitability, constraints and technical efficiency and its determinants. Research methodology involving study area, data type and sources, sampling technique, conceptual framework, empirical model specification and method of data analysis are described in Chapter three. Chapter four presents and discusses the results of the study while summary, conclusions, recommendations and suggestions for further research are provided in Chapter five.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the literature relevant to the study. Overview of the oil palm industry in Ghana (colonial era and post-colonial era), the production trends of actual crude palm production in Ghana, Palm oil processing, Palm oil characteristics and usage, Returns from palm oil production, Economic importance of palm oil processing, and a review of related studies on palm oil production, and Technical efficiency in small scale palm oil processing have been provided

2.2 The Oil Palm Evolution in Ghana

2.2.1 Oil Palm Industry in Ghana during Colonial Era.

Oil palm plantations were not very much considered by the dominant British colonial administration in Ghana. The Dutch were the first to introduce the plantation system in Ghana about the beginning of the eighteenth century. Dickson (1969) reports the establishment or attempted establishment of several Dutch plantations near the coast during the eighteenth and nineteenth centuries. Other plantations included those established by German, British, and other European interests about the end of the nineteenth century and in the early decades of the twentieth century, particularly after the passing of the Oil Palm Ordinance of 1913, when "Numerous oil palm plantations including those at Butre, Sese, and Winneba were made" (Carrere, 2010). The Ordinance empowered the government to grant a mill operator the exclusive right to extract oil, by mechanical means, from the pericarp of palm fruits produced within 16 km of the mill. According to Fold (2008), the plantation system failed to gain a significant hold, partly because of the internal political insecurity engendered by inter-tribal warfare and by rivalry among the European powers seeking territorial hegemony. In addition, the negative attitude towards the system by the British Crown, which, from about 1850 onwards, gained the upper hand in the European struggle to colonize Ghana, also contributed to the failure of the plantation system in pre-colonial era (Dickson, 1969 & Howard 1978).

2.2.2 Oil palm industry in Ghana after independence

Things changed after 1957, during the post-independence period, when there was a policy change involving greater emphasis on the plantation system centered on oil palm and rubber. The policy change, up to the time of the 1966 military coup d'etat, encouraged state-owned and state-operated plantations. However, mainly because of capital constraints, political interference, poor planning, mismanagement, and the rigidity of the centralized state control system; these state-owned farms did not prove economically viable (Carrere, 2010). They succeeded only in worsening rural living conditions by dispossessing the peasants of their most fundamental natural resource, the land, with little or no compensation and by the deforestation and other forms of ecological and economic disturbance associated with the removal of natural vegetation to make room for monoculture plantations. Subsequently, some of the state plantations were sold. Others were abandoned, sometimes after felling of the palms, a practice that invariably left behind derived savanna or even grass in place of the original forest cover. Attempts were made to reorganize the remaining plantations into viable economic units under decentralized state control (Carrere, 2010).

After the 1981 coup d'etat and the subsequent liberalization of the economic system, a new policy sought to promote plantations through private enterprise, foreign aided government ventures, and joint government-private projects. The resultant plantations include the three major ones established by the government-owned but foreign-assisted, Ghana Oil Palm Development Co. (GOPDC) located around Kwae in the Eastern Region; the government/privately owned Twifo Oil Palm Plantations Ltd. (TOPP) located around Twifo Praso/Ntafrewaso in the Central Region; and the government/privately owned Benso Oil Palm Plantations Ltd. (BOPP) located around Benso/Adum Banso. They were to grow oil palms for producing oil from the fruit of the palm, "probably the heaviest producer of vegetable fats". This agro-industrial crop, which has a wide variety of uses, was a leading foreign exchange earner for Ghana, mainly based on small-scale peasant production in an oil-palm belt near the littoral, from about the mid-nineteenth century to the beginnings of the twentieth century (Gyasi, 1992).

According to Carrere (2010), the three major new palm plantations (GOPDC, TOPP, and BOPP); were established on land compulsorily acquired from peasant farmers by the government in the humid tropical environment of the interior. In addition to developing the acquired areas into palm plantations, the companies involved were to encourage palm fruit production among the peasants in the plantation hinterland through the nucleus estate system to help sustain their huge palm-oil-processing mills located inside the plantations (Carrere, 2010).

Since 1977, when they started, the three plantations have developed rapidly and contributed significantly towards the expansion of Ghana’s oil-palm hectares from 18,000 to 103,000 between 1970 and 1990. This growth of 24 percent per annum has resulted in the re-emergence of the oil palm as a major commercial crop and has served as a basis for the fast-developing palm oil and other agro-industrial processing industries; and rendered the country more than self-sufficient in palm-oil production (Fold, 2008). Table2.1shows major stakeholders in the oil palm industry in Ghana.

Table 2.1: Major Stakeholders in the Oil Palm Industry in Ghana

Company	Location
Benso Oil Palm Plantation (BOPP) Ltd.	Benso, Western Region
Twifo Oil Palm Plantation (TOPP) Ltd.	TwifoPraso, Central Region
Ghana Oil Palm Development Corporation Ltd. (GOPDC).	Kwae Via Kade, Eastern Region
National Oil Palm Plantation (Juaben Oil Mills Ltd).	New Juaben, Ashanti Region
Norpalm Ghana Ltd. (Prestea Oil Palm Plantation)	Prestea, Western Region
National Oil Palm Plantation. (Ayiem Oil Mills Ltd).	Ayiem, Western Region.
Golden Star Oil Palm Ltd	Bogoso, Western Region
Small Scale and Private holders	Scattered in the country

Source: Gyasi, 2008 & MoFA, 2011

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2.2.3 President Special Initiative on Palm oil

As part of the Government's strategy to revamp the oil palm industry in the country, a Presidential Special Initiative (PSI) on Palm Oil Plantation and Exports was launched around 2004. About US$3.4 million was invested in the initiative. Under the programme, about 100,000 ha of oil palm plantations were planned to be cultivated over a 5-year period in six regions in the country, together with the establishment of 12 nurseries to raise about 1.2 million high-yielding seedlings for supply to farmers. The Oil Palm Research Institute (OPRI) of the CSIR (Council for Scientific and Industrial Research) was given the task to produce two million high-yielding seedlings annually (Gyasi, 2008).

By 2008 only about 30,000 hectares had been put under cultivation due to insufficient funding (Government of Ghana, 2009). The already established farms are not properly maintained and consequent attacks by pests leading to low yields. This scenario was the norm across all the regions where the plantation took place. The nurseries established to produce seedlings for farmers are no more functioning due to lack of funding and lack of political will to continue the project after change of Government in 2008 (Asante, 2012).

2.3 Oil Palm Production in Ghana

2.3.1 Land under Oil Palm cultivation

According to Poku (2002), oil palm plantations in Ghana covered 304,000 hectares in 2002. In 2004, around 285,000 hectares of oil palm were cultivated (Carrere, 2010). Smallholders cultivated nearly 88% of the total area under production but produced only 72% of the oil palm fresh fruit bunch (FFB). The remaining 28% was produced by the private estates cultivating less than 12% of the total area. The existing plantations operate based on a nucleus estate with associated smallholder schemes and independent out-growers. The out-growers own and cultivate oil palm on their land, receive planting material and other inputs and technical advice from the companies (usually on credit) to which they are contractually obliged to sell their production (Fold, 2008). Total land under oil palm as given by the Statistics, Research and Information Directorate (SRID) of the Ministry of Food and Agriculture in 2010 is 360,000 hectares (MoFA, 2011).

2.3.2 The production trend of actual crude palm oil production in Ghana

According to Fold (2008), the total volume of palm oil production in Ghana is unknown due to a significant amount of household-based production for self-consumption or petty trade. He stressed that the greater quantity of total production for industrial use however, is produced in four large-scale plantations managed and controlled by three foreign companies (BOPP, TOPP, GOPDC, and Norpalm). MoFA categorized palm oil processing industry in Ghana into three main sectors, namely large scale, medium scale and small scale. Based on the production figures of MoFA, the actual quantity and projections of CPO produced by these sectors from 2002-2010is presented in table 2.2.

Table 2.2: Actual Crude Palm Oil Production (MT) in Ghana from 2002-2010

Year	Large scale	percentage	Medium scale	Percentage	Small scale	percentage	Total output
2002	67,188.90	27.50%	5,729.00	2.30%	171,366.00	70.20%	244,283.90
2003	69,749.90	26.37%	6,301.00	2.38%	188,503.00	71.25%	264,553.90
2004	75,346.40	26.00%	6,932.00	2.40%	207,353.00	71.60%	289,631.40
2005	78,595.80	25.00%	7,625.00	2.43%	228,089.00	72.57%	314,309.80
2006	82,400.10	24.12%	8,387.00	2.45%	250,888.00	73.43%	341,675.10
2007	66,451.30	18.90%	9,225.70	2.62%	275,976.80	78.48%	351,653.80
2008	66,668.32	17.53%	10,148.07	2.67%	303,572.32	79.80%	380,388.71
2009	75,415.00	18.74%	10,836.00	2.69%	316,222.00	78.57%	402,473.00
2010	70,444.00	17.72%	10,836.00	2.73%	316,222.00	79.55%	397,502.00

Source: (MoFA, 2011)

Statistics of crude palm oil (CPO) production in Ghana from 2002-2010 in Table2.2 indicates that the small scale palm oil processing industry produced the greater portion of the total output. For instance, out of the total of 402,473.00mt and 397,502.00mt crude palm oil produced 2009 and 2010 the small scale and the private holdings contributed 78.57% and 79.55% respectively and the situation is not different from the rest of the years. The contribution of the small scale palm oil processing sector is significant to the palm oil processing industry and the economy of Ghana at large. Women also dominate the small scale sector with few men giving technical assistance (MoFA, 2011).

2.4 Palm Oil Processing

The fruits of the oil palm are small (weighs about 6 to 20 g) and occur in bunches of about 10 to 40 kg. Naturally a bunch holds about 200 fruits; however, some cultivars of oil palm can have bunches with up to 4000 fruits (Rehm & Espig, 1991). The fruit is orange-red in colour (due to a high content of carotene) and it comprises a kernel enclosed in a shell (endocarp) surrounded by pulp (mesocarp). Two types of oil can be obtained from the oil palm fruit: palm oil from the fibrous mesocarp (only two mesocarp oils are available commercially, the other is olive oil) and palm kernel oil from the kernel. The ratio of produced palm oil and palm kernel oil is about ten to one (MPOC, 2011). The composition of oil palm fruit meesocarp is shown in Figure 2.1

Figure 2.1: Composition of Oil Palm Fruit Mesocarp

Source: Bockisk, 1998

Palm oil production can be divided into three stages, namely plantation, transportation to the mill and milling (Yusoff & Hansen, 2007). Hence, the production involves three sectors: agriculture (plantation stage), transport and industry (milling stage).

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When establishing an oil palm plantation the land needs to be cleared. In Ghana, this is commonly done by burning. Before planting, the land is prepared by ploughing and weeding (Clay, 2004). About four or five years after planting the oil palm is mature enough to produce fruit (Rehm & Espig, 1991). After this, the fruit bunches are cut down by hand. At larger plantations, harvesting is done with the help of mechanical lifts; otherwise, knives are attached to long bamboo-sticks. Oil palms grow tall and after about 25-30 years, harvesting becomes very difficult and the plantation is renewed (Rehm & Espig, 1991). Transportation of the fruit bunches to the mill needs to be done as fast as possible. Within 24 hours after detachment the fresh fruit bunches have to be processed if high quality and value is to be obtained (Rehm & Espig, 1991).This partly explains why, palm oil mills are normally located close to the plantations.

The procedure for extracting oil from the oil palm fruit is complex and can be summarized as follows: It involves the reception of fresh fruit bunches from the plantations, sterilizing and threshing of the bunch to free the palm fruit, digestion (mashing the fruit) and pressing out the crude palm oil. The crude oil is further clarified to purify and dry it for storage and export (Poku, 2002). At a refinery, the CPO is further treated (deodorized, freed from pigments, free fatty acids and phospholipids) to produce refined, bleached, and deodorized (RBD) palm oil. The palm cake obtained from pressing is sent to a kernel-crushing plant where the fibre is removed from the nut, the nut is cracked and the endocarp separated from the kernel. The kernel is further processed (e.g. pressed) to obtain crude palm kernel oil (CPKO) (Subramaniam *et al.*, 2010).

2.4.1 Processing Activities and Practices of Small Scale Palm Oil Processors

The major operating activities carry out at the processing centres include removal of spikelets from the bunch, storage of the fruit containing spikelets, fruit removal from spikelet and storage, boiling/steaming of fruits, digestion and pressing of fruits clarification of the CPO and separation of nuts from the fibre. Digestion and pressing of fruits are fully mechanized while removal of fruits from the spikelet and separation of nuts from fibre are partly mechanized in some of the centres.

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2.4.2 Removal of Spikelets from Bunches.

This process involves cutting of the fruit containing spikelets from the fruit bunch using either a cutlass or an axe. This is usually done by men due to its strenuous nature. Cutting of the spikelets from the bunch is done on the bare floor in most the processing centres while few of them perform it on a raised cemented platform. This activity usually results in fruit bruises which lead to reaction within the oil cells thereby increasing the free fatty acid content of the oil (Owolarafe *et al* ., 2008; Ngando *et al* ., 2011).

2.4.3 Storage of Spikelet Containing nuts, Removal and Storage of Fruits from Spikelet

Storage of spikelet containing nuts is done with the view of facilitating easy loosening or removal of nuts from the spikelets (Adjei-Nsiah *et al.*, 2012). Spikelets are usually heaped and covered with plastic sheets for a period ranging from 3-5 days. Heaping the spikelets cause the tissue attaching the fruit to the bunch or spikelet to wilt with time thereby causing the fruit to detach from the spikelet or the bunch. Removal of fruits from the spikelets is usually done manually by women and children. This activity employs a large number of the unemployed women in the rural communities. Majority of the processing facilities visited use this method to remove nuts from the spikelets. This method of fruit picking from spikelets usually delays fruit processing and promote fermentation of fruits resulting in high FFA and oil of low quality (Adjei-Nsiah *et al.,* 2012). This activity is partly mechanized in some of the centres by using equipment called Fruit thresher. Sometimes, after picking the fruits from the bunch or spikelets, processors further heap the fruits for a period ranging from 1-2 weeks causing the fruits to ferment or grow mouldy. About 41% of the processors store their fruits beyond one week before processing. However, to produce palm oil with low free fatty acids (FFA) content, Poku (2002) recommended that palm fruits should be processed within 48 hours after harvesting. This is to arrest lypolytic enzymes and stop the production of free fatty acids as poor and lengthy storage of fruits lead to a considerable increase in free fatty acids that will affect the quality of palm oil produced from these fruits (Owolarafe *et al* ., 2008; Ngando *et al* ., 2011). Processors outline three major reasons for which they store fruits before processing into oil. These reasons include difficulty in removing fruits from the bunch immediately after harvest before boiling, expectation of higher oil yield and reduced effluent resulting from processing. According to the processors, storing the fruits reduce the moisture content of the fruits which consequently leads to high quantity of palm oil. Some processors also erroneously believe that storing the fruits leads to increase in the oil content. They also argue that storing the fruits cause the mesocarp to become soft and easy to press for the release of oil. This practice also leads to low quality of oil as FFA level increases with fermentation (Tan *et al.,* 2009). However, the number of days fruits are stored before processing depends on whether the processor is processing for food and non-food uses. Fruits processed food uses are usually stored for a duration not exceeding one week while fruits processed for non-food uses are stored beyond one week.

2.4.4 Sterilization/Boiling of Fruits

One of the major operations in the processing of palm fruits is fruits boiling or sterilization. The objectives of fruit boiling are: inactivation of enzymes, softening of fruit, conditioning of nuts and coagulation of proteins (Babatunde *et al.,* 2003). During fruit boiling, the heat inactivates lipase, an active hydrolytic enzyme present in the mesocarp of the fruits. The most popular method for fruit boiling among small scale processors is the use of metal drum, fruit boiler or big cooking pots over an open fire. Fruits are boiled in metal containers ranging from 200-1000 litres in volume. The fruits are then covered with a jute sack. The metal container is placed on metallic tripod stove or tripod made from big stones/blocks with a lot of firewood placed under it. Bamboo is the source of firewood for almost all the centres visited. They supplement the bamboo with the dried fibre especially in the dry season. Most of the heat generated is lost to the environment thus requiring a lot of firewood. Heating may last for 1-3 hours depending on the volume of the fruits and the burning efficiency of the fuel. Recently, steam fruits boilers have been designed by the Ghana Regional Appropriate Technology Industrial Services (GRATIS) foundation which uses steam to sterilize the fruits and use less firewood and water (Adjei-Nsiah *et al* ., 2012). This equipment is used by few community processing centres supported by NGOs.

2.4.5 Digestion and Pressing of Fruits

Digestion is the process of releasing the palm oil in the fruit through the rupture or breaking down of the oil-bearing cells. This operation is highly mechanized in all the processing centres visited. After the fruits are digested, the digested material is pressed to release the oil. This involves separating the crude oil from the mash. This process is done by male operators managing the processing facilities.

2.4.6 Nut and Fibre Separation

Nut and fibre separation is another activity carry out in the processing centres. A process where the nut is picked manually from the fibre after the oil is squeezed out from the fibre and the nut. The fibre separated from the nuts is re-pressed with hand screw press to squeeze out any oil left in the mixture as result of the presence of nuts in the mixture. The nuts obtain is dried for 1-2 weeks and sold for processing. This activity is done manually by women. It is also mechanized in a few of the processing centres visited with a machine propel by diesel-powered engine.

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2.4.7 Clarification

The main purpose of clarification is to separate the oil from its entrained impurities (Poku, 2002). The fluid coming out of the press is a mixture of palm oil, water, cell debris, fibrous material and 'non-oily solids'. The clarifying process is not mechanized in any of the mills visited. After pressing, the oil is poured into a metal container and placed on a fire and heated for a period ranging from 1 to 2 hours till there is no water in the boiling oil at the top layer. The oil is then removed gradually into metal bucket or pan till there is only a thin layer of oil on the water. CPO aimed at soap making and other non-food purposes is not clarified. Such oil may contain high moisture levels which will increase FFA content of the oil during storage as a result of autocatalytic hydrolysis (Ngando *et al.*, 2011) making such oil unhealthy for human consumption.

2.5 Characteristics and uses of Palm Oil

Both palm oil and palm kernel oil are used in a variety of products (Figure 2.3). The two oils are however chemically and nutritionally unrelated. According to Teoh (2002), there are equal proportions of saturated and unsaturated fatty acids palm oil, while palm kernel oil contains mostly saturated fatty acids. Palm oil has a good resistance to oxidation due to its high natural content of the antioxidants carotenoids and vitamin E (MPOC 2011 & Edem, 2002). Both CPO and CPKO can be fractionated into liquid (palm/palm kernel *olein*) and solid (palm/palm kernel *stearin*) components used for different purposes (MPOC, 2011).

Palm oil and palm kernel oil have a wide range of applications; about 80% are used for food applications while the rest is feedstock for a number of non-food applications (Salmiah, 2000).

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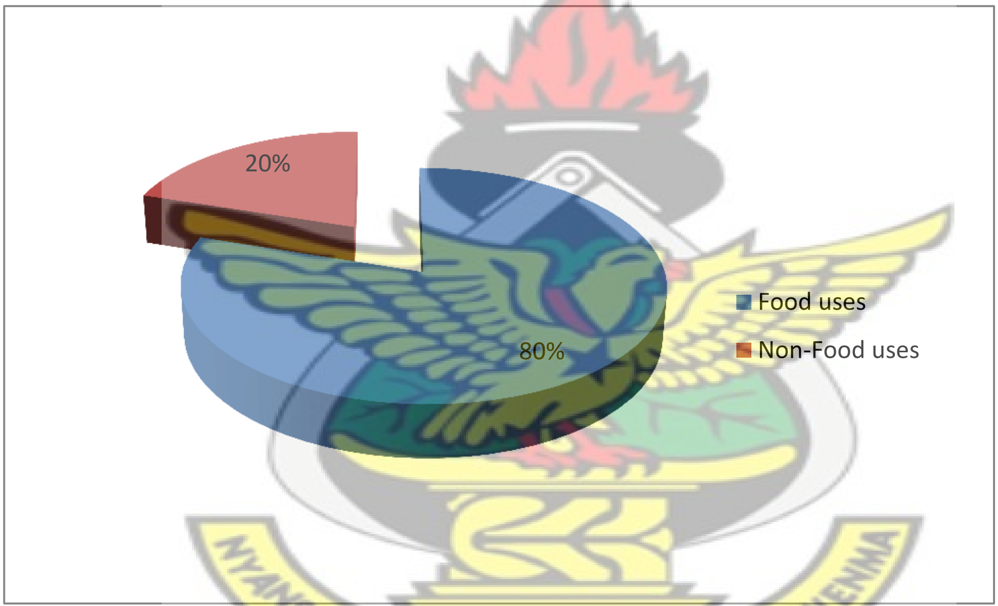
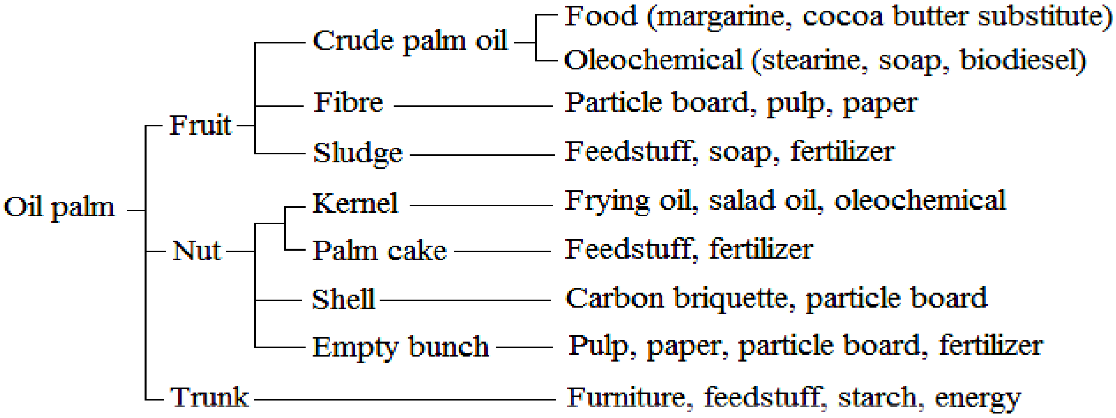
Figure 2.2 Food and Non-Food Uses of Palm Oil



Source: Salmiah, 2000

Figure 2.3 Uses of Palm Oil



Source: Adapted from Fairhurst & Mutert, 1999

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Palm oil for food purposes

The oil palm provides one of the leading vegetable oils produced globally, accounting for one-quarter of global consumption and approximately 60 per cent of international trade in vegetable oils (World Bank 2010). An estimated 74 per cent of global palm oil usage is for food products and 24 per cent is for industrial purposes (USDA, 2010).Palm oil has been criticized for being unhealthy (Lam *et al.*, 2009), but according to the Malaysian Palm Oil Council (MPOC), palm oil is highly suitable as edible oil because of its many nutrients and vitamins (MPOC, 2011). Basiron & Weng (2004) argued that palm oil is healthy edible oil and about 80% of the world's produced palm oil is used for food purposes. Since palm oil is resistant to oxidative deterioration it is good as frying oil. Potato chips, fries and doughnuts are often fried in palm oil (Sumathi*et al.*, 2008). Palm oil is also a major component of shortenings and margarines, and is commonly used in products such as reduced fat spread, ice cream, coffee whiteners, whipping cream, filled milk, mayonnaise and salad dressings, palm-based cheese and coconut milk powder (Basiron & Weng 2004). Natural palm oil is trans-fat free and hence often blended with other oils producing transfatty acid formulations (Gee, 2007).

Palm oil in non-food products

Oil palm is among the most productive and profitable of tropical crops for biofuel production. High-yielding oil palm varieties developed by breeding programmes can produce over 20 tonnes of fresh fruit bunches/ha/year under ideal management, which is equivalent to 5 tonnes oil/ha/year (excluding the palm kernel oil) (Poku, 2002).Basiron & Weng (2004) stressed that the non-food application of palm oil and palm kernel oil is only about 20 % but adds a high economic value. The oils form 10 per cent of the total dry biomass produced by the palm, but the 90 per cent left might be a source of fibre and cellulosic material for second-generation biofuel production (Basiron 2005). AS indicated in Fig 2.3 Palm oil can be used in soap and other personal care products such as many cosmetics and toiletries; and is also used in lubricants and greasers, printing ink, drilling mud and as an inert ingredient in pesticide formulations (Mekhilef *et al.*, 2011). Basiron (2005) furthermore stressed that palm oil is used as biofuel. Refined palm oil can either be converted into methyl ester and then be directly used as biodiesel, or be blended with petroleum diesel obtaining diesel fuel (Mekhilef *et al.*, 2011).

Other products from the oil palm

As shown in Figure2.3, several products can be obtained from other parts of the oil palm. For every kilogram of obtained palm oil, approximately 4 kg of dry biomass is also produced (Sulaiman, 2010). A third of this biomass is found in the fresh fruit bunches (FFB) and the other two thirds constitute trunk and frond material (Sulaiman, 2010). When replanting, about 75 tonnes of dry matter per hectare is produced (Basiron & Weng, 2004). Normally the empty fruit bunches are burned to produce energy, or used in mulching as a fertilizer (Subranamian *et al.*, 2010a). The pressed palm cake and the sludge that is left after clarifying CPO are used as fertilizer or as animal feedstuff

Figure.2.3. According to Fairhurst & Mutert (1999) about 25 % of the palm biomass can be returned to the field as nutrient rich mulch.

2.6 Returns from Palm Oil Production

According to Oil World (2008), palm oil uses less land than crop-based oilseeds. Only 0.26 hectares of land is required to produce one tonne of oil from palm oil, while soybean, sunflower and rapeseed require 2.2, 2 and 1.5 hectares, respectively, to produce one tonne. Palm oil generates nearly 10 times the energy it consumes, compared to a ratio of 2.5 for soybeans and 3 for ripe oilseed. Oil World (2008), highlighted that Production of palm oil is more sustainable than crop based vegetable oils such as soybean and rapeseed. It consumes considerably less energy in production, uses less land and generates more oil per hectare. Modern high-yielding varieties of palm, under ideal climate conditions and good management are able to yield 5 tonnes of palm oil per hectare, annually. Oil palm has the highest yield of any oil seed crop, averaging 3–4 tonnes of mesocarp oil per ha per year in the major palm oil producing countries (Wahid, 2005). Through the analysis of rattan, rubber, and palm oil in East Kalimantan, Indonesia, Belcher, *et al* (2004) computed the net present value and other financial viability indicators of each commodity. The study was conducted to look at the changing use and management of forest product in East Kalimantan because the traditional land-use was under pressure by a range of factors, including government policy. The results showed that palm oil gives the best of the land use options, when considering the profitability per unit of land compared to rattan and rubber. Goenadi (2008) suggests that, because of the growing climate in Indonesia, palm oil yields may potentially be as high as 6-7 tonnes per hectare. However, in 2008, Indonesia was averaging between 3-4 tonnes of palm oil per hectare. Increasing the yield of palm oil production gives Indonesia the potential to increase the production without requiring additional land conversion. Land-use returns from oil palm are significant as compared with many other forms of land-use. In 2007, a report prepared for the Stern Review estimated the return from palm oil land-use as ranging from $US960/ha to $US3340/ha. This was in comparison with smallholder rubber, rice fallow, cassava, and one-off timber harvesting which yielded $US72/ha, $US28/ha, $ US19/ha and $US1099/ha, respectively (Goenadi, 2008).Compared to other major oil crops, palm oil has lower production costs and produces more oil from less land (Yusoff & Hansen, 2007).They argued that returns on land, capital and labour produce substantial revenues both for individual producers and the country as a whole. Thoenes (2006), also held the same assertion that palm oil production has the lowest production costs per unit, when compared to other oils, for example soybean oil, which, although cheap, has 20 % higher production cost (the labour costs taken into account) per unit than palm oil.

2.7 Economic Importance of Palm Oil Processing

The economic importance of oil palm crops in developing countries is enormous. Generally palm oil industry is considered to be labour intensive and therefore, able to provide jobs for local inhabitants and improve employment levels (Casson, 1999). Jobs are provided for thousands of villagers in Ghana who otherwise may not have employment prospect (MASDAR, 2011). Palm oil provides developing countries and the poor a path out of poverty. Expanding efficient and sustainable agriculture such as Palm Oil Plantations provides small and large plantation owners and their workers with a means to improve their standard of living (World Growth, 2011). The World Bank (2010), with its mission to reduce poverty, sees this commodity as one which can play an important role in furthering economic development in these countries as well as securing a rising standard of living for the rural poor when the full range of environmental, social, economic and governance risks are addressed, and contributing to global food security.

According to the World Bank (2010), the sector directly employs up to 3 million people in Indonesia and up to 6 million worldwide. The economic contribution of palm oil and other plantation commodities provided the assurance of a remunerative source of income and unlimited employment opportunities throughout the year for the people of Malaysia (Basiron, 2011). Basiron (2011) noted that a day's work of harvesting oil palm fruits can provide a person with an income of more than US $30. In a country where two meals per day would cost only US $4, such an income is rather remunerative. Nobody should be deprived of a better life or even resort to begging as long as he or she is willing to put in a few hours of work in a day in our oil palm or rubber plantations (Sulaiman, 2010). Malaysia enjoys almost full employment, which also means that labour shortages exist especially in the plantation (MPOC, 2011). Generally, women in the villages are responsible for the processing and sale of farm produce. Small scale agro-processing seems to hold the key to rural poverty reduction and the prolific oil palm tree provides the best raw material for starting rural industries (Poku, 2002). According to him, palm oil processing provides sustainable employment and means of livelihood for women in rural communities of Africa. In Indonesia, 1.7–2 million people work in the oil palm sector (Wakker, 2006; Zen *et al.*, 2006). Looking at wider benefits, it is estimated by the industry players that the oil palm sector benefits around 6 million people, many of whom have been rescued from poverty (Goenadi, 2008).

2.8 Related Studies on Small Scale Palm Oil Production

According to Poku (2002), small scale does not necessarily mean a significant decrease in efficiency. It does, however, mean a reduction in working capital and operating costs. The small mills can be placed at the heart of local communities, minimizing reliance on vehicular transport that is normally unavailable in rural communities, given the poor

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condition of road networks and other infrastructure (Poku, 2002). The small scale sector is a means of helping farmers to get easy access to mills to avoid post-harvest losses. The development of small scale or even portable mills would allow communities and companies to plant and process oil palm fruit in remote areas (Jekayinfa & Bamgboye, 2007). However, they shared a different view in terms of efficiency of these mills as compared to the large mills. They highlighted that the large mills process at least 30 tonnes of fruit per hour, more profitable and require less energy per unit of oil produced than the current generation of small mills.

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Omoti (2004) noted that obsolete equipment is mostly used in small scale palm oil processing activities. He indicated that among small scale producers, palm oil is principally processed by traditional or semi- mechanized methods whose system is highly inefficient. Omoti's study revealed that methods used by the small scale processors are laborious, time consuming and inefficient. It also yields very low oil, often of poor quality and more often about 25 -75% of potential palm oil is lost during processing. High cost of processing equipment is a serious problem faced by processors in Nigeria and according to Omoti (2004) this problem has discouraged intending processors from establishing their own mills. Therefore, majority of the processors resort to hiring of processing equipment and this has resulted in delay in processing of the palm fruits.

Ekine & Onu (2008) examined the economics of small scale palm oil processing and noted that the quantity and amount of revenue realized by the processors are usually under estimated mainly due to inadequate recording and improper accounting procedures. They also indicated that the level of gross margin of small scale palm oil processors is negatively influenced by several factors, which include cost of palm fruits, cost of hiring equipment, transportation of the FFB, availability of labour, and price of palm oil among others.

2.9 Profitability Analysis in Small sale Palm Oil Processing

Ibekwe (2008) analyzes the role of women in oil palm fruit processing and marketing. The cost and return analysis showed that palm oil processing is profitable since BCR was 2.13. Ibekwe (2008) pointed out that the larger cost components of the industry were cost of palm fruit, labour, extraction and transportation. Olagunju (2008) also conducted a study on economies of palm oil processing in south western Nigeria and reported BCR of 1.29. The study also revealed the rate of return computed as Gross Ratio and Expenses Structure Ratio to be 0.29, 0.77 and 0.423 respectively. These financial indicators show that the enterprise is profitable. Olagunju (2008) noted that with increased capital, improved technology, improved road network and skilled labour, the processors profit would increase substantially.

In their study of technological and financial assessment of small scale palm oil Production in Kwaebibrem District of Ghana, Adjei-Nsiah *et al.* (2012) reported that in the peak fruit production period of April-May, processors make a loss of 38% of every cedi invested in the palm oil processing business and that the production of palm oil can be a profitable venture only during the lean fruit production season (from September – December) when oil is relatively scarce. According to Adjei-Nsiah *et al.* (2012) processors obtained BCR value of 1.26 in the lean season which quite similar to the BCR value (1.29) obtained by value obtained by (Olagunju, 2008).

Alufohai & Ahmadu**,** 2012) studied economics of processing fresh fruit bunches (FFB) into palm oil and reported that palm oil processing was a profitable business venture. This is evidenced by the gross margin and net profit per 20-litre of palm oil of N2, 080.51 and N1, 613.11 respectively. The Return on Investment (ROI) of 66% and the Benefit-Cost Ratio of 1.66 showed that the business was viable (Alufohai & Ahmadu**,** 2012). The value-added computation showed that it is more advantageous to process the Fresh Fruit Bunches before selling since the value of the product could be increased significantly (Alufohai & Ahmadu, 2012).

2.10 Analytical Framework

The premise on which technical efficiency analysis is based is the frontier production function. The latter describes the maximum feasible output of a firm for different input mix with a given production technology. As such, the production frontier of the i^{th} firm producing a single output with multiple inputs following the best practice techniques can be defined as,

$$Y^* = f\left(x_{i1},.....,x_{jm}\right)|\,T \qquad 2.1$$

Where Y_i^* and x_i s are the frontier output and inputs, respectively, of the i^{th} firm, and T is the given technology. For this exposition, we assume that the i^{th} firm is producing less than the feasible amount due to some organisational factors. The production function can then be written in a modified neo-classical framework as follows:

$$Y^* = f\left(x_{i1},.....,x_{jm}\right)\exp(u_i) \qquad 2.2$$

Where U_i represents the combined effects of various non-price and organizational factors that constraint the firm obtaining it's maximum possible output Y_i^*. The term, $\exp(u_i)$, is therefore, firm-specific, and it reflects the i^{th} firm's ability to produce at its present level. This level represents the firm's technical efficiency.

The parameter, u, depends on the various constraints that face the firm. When there are no constraints, U assumes a value of zero or a value of less than zero when there are constraints. A measure of the technical efficiency of the i^{th} firm can subsequently be expressed as:

$$\exp(u_i) = \frac{Y_i}{Y_i^*} \qquad 2.3$$

Expression (3.3) represents the ratio of the actual output to maximum feasible output, and is the basic model used in the measurement of technical efficiency. As defined, the actual output is observable whilst the feasible output is not. Accordingly, a number of methods, premised on different assumptions, have been suggested to estimate the unobserved output, and hence, the component *exp(u_i)*.

The two methods commonly used in literature are the programming or deterministic methods (based on the pioneering work of Farell (1957) and the statistical or stochastic methods (developed by Aigner, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977), independently). A third approach also exist, this is, the Bayesian methods. However, this study is built upon the stochastic frontier method.

2.10.1 Stochastic Approaches

Timmer (1971) pointed out a way by which the latent statistical deficiency of the DEA model can be circumvented. He introduced the concept of probabilistic approach to the deterministic frontier used by Aigner and Chu (1968). It entailed the deletion of three percent of the observation based on the rationale that they were affected by statistical errors. He applied linear programming technique to the remaining observation to estimate the frontier production function.

Afriat (1972) proposed a specification that explicitly stated the distribution for output observations from the frontier values. The model can be represented as,

$$Y = f(X_i;b)\exp(-u_i) \qquad 2.4$$

Where, the random variable *exp(u$_i$)* is defined to have a flexible distribution, such as, beta or gamma distribution. The range of the random variable is between zero and one. This ensures that no observation lies below the frontier. With the Cobb-Douglas functional form, *E[exp(u$_i$)]* can be considered to be a natural measure of the mean technical efficiency of the firms, as suggested by Timmer (1971). The above expression (2.4) can be transformed, linearly, into

$$y_i = \beta + \sum \beta_j x_{ij} - u_i \qquad 2.5$$

Where X_i is the vector of the logarithms of inputs and β_J are a vector of unknown parameters. The parameters can be estimated using maximum likelihood estimation procedure. Richmond (1974) suggested the corrected ordinary least squares method. Imposing Cobb-Douglas production type, he introduced an error term with zero expectation, namely, $e_j = n - u_i$ where n = $E(u_i)$. Thus, the Expression ( ) can thus be re-written as,

$$y_i = \gamma + \sum \beta_j x_{ij} - (u_i - e_i) \qquad 2.6$$

Essentially, the new error term satisfies all the standard OLS assumptions except the normality and $\gamma = \beta_0 - n$. The OLS estimators can be expected to be unbiased except the constant term. Richmond (1974) suggested using the moment of error distribution as a way of adjusting the intercept term. The main problem with this method is that the correction may not always yield non-negative error values for all the residuals $(u_i - e_i)$ thus failing to satisfy the frontier hypothesis of efficiency. Greene's (1980) suggestion is that the intercept term should be corrected by shifting it up until no residual is positive and one is zero. An alternative technique is the stochastic frontier approach. This is discussed below. Schmidt (1976) invoked specific distribution assumptions for the error term *U;* and applied maximum likelihood to estimate the unknown parameters. He noted that if the disturbance term had an exponential distribution, then the maximum likelihood estimators of the unknown parameters are obtained by the use of the linear programming method. Conversely, assuming that the disturbance term has a half normal distribution, obtained by a truncation at zero of a normal distribution with zero mean and finite variance, the maximum likelihood estimators of the parameters can be obtained using quadratic programming methods.46 The asymptotic properties of these maximum-likelihood estimators are unknown as the restrictions given by $Y \leq f(X_i, \beta)$ depend upon the parameters to be estimated (Schmidt, 1976). This, however, violates a condition for the variance of the maximum-likelihood estimators to be obtained using standard methods (Theil, 1971).

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Given assumptions analogous to the standard regression in which the errors are identically and independently distributed with μ and the variance σ^2, and *x's* are uncorrelated, Schmidt (1976) observed that ordinary least squares (OLS) methods yield unbiased and consistent estimators of all parameters except for the intercept term. There is another method that takes account of statistical errors explicitly in the estimation of the frontier function as follows:

$$y_i = \beta_0 + \sum_{j=1}^{m} \beta_j x_{ij} + v_i + u_i \qquad 2.7$$

Where, *u* is the difference between the individual firm's practice and the best practice technique. The disturbance term, *u,* can be zero or negative. The term, V, is the statistical error and other random factors, and it can be positive, negative or zero. Thus, the above equation means that a firm's frontier function can be defined by

$$y_i = \beta_0 + \sum \beta_j x_{ij} \qquad 2.8$$

Provided it uses the best practice technique *(u* = 0) and there are no statistical errors, and the influence of external factors like impact of government employment policy on production is negligible (v = 0). If a firm uses the best practice technique, but there are either statistical errors, such as measurement errors or influence of external factors, then the firm's frontier function can be calculated as

$$\beta_0 + \sum \beta_j x_{ij} + v \qquad 2.9$$

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Where, v indicates that the frontier is stochastic with random disturbance v. The implication is that the frontier function may vary randomly across firms or over time for the same firm. If there are no statistical errors and no influence of external factors on production, the firm's actual output will be equal to or less than the potential frontier output depending on whether the firm uses best practice. In other words, u is zero or negative respectively.

The frontier function may be estimated by maximum likelihood techniques. An advantage of specifying the density functions for *u* and v is that it is possible to identify whether the deviation from potential output can be attributed to not using best practice technique or to some other external random factors. It is, therefore, possible to infer about the cause of the anomaly between the potential and observed output. Assuming that *u* is non-positive, a number of density functions can be specified. Technical efficiency for cross-sectional data can then be estimated as the ratio of actual output to the potential frontier output.

The stochastic frontier approach described above, however, only provides average technical efficiency measures for the sample observations. Observation-specific technical efficiency measures are more useful from a policy viewpoint. Estimation of the stochastic frontier production function for a single cross-section of firms requires the explicit specification of distribution of statistical noise and inefficiency variable terms. Common distributions in the literature are the positive half-normal and the exponential.

Criticisms leveled against the estimates of the production frontier focus on the assumption of the error distribution and the sensitivity of the results to alternative distributional specifications, particularly with regard to the measurement of technical efficiency. These problems can be circumvented with the use of panel data. In a panel data framework, the stochastic frontier model involving *n* firms observed over *T* period can be represented as:

$$y_{it} = \beta_0 + x_{it}^{'}\beta + v_{it} - u_{it} \qquad 2.10$$
$$i = 1, 2, ..., n$$
$$t = 1, 2, ..., T$$

As defined, U_{it} can be decreasing, remain constant or increasing, which means that technical efficiency may be improving, remain constant or deteriorating over time respectively.

Thus, the model can be written as follows,

$$y_{it} = \beta_{0i} + x_{it}^{'}\beta + v_{it} \qquad 2.11$$

where $\beta_{0i} = \beta_0 - u_i$

Stochastic frontier can be estimated by either of two methods. First, the estimation of the parameters of the production frontier is done conditionally on fixed values of the U_i, which leads to the 'fixed effects' model, and the 'within' estimator of the frontier coefficients. Second, the estimation is carried out marginally on the firm-specific effect U_{it}, which leads to the 'random effects' model and either the generalised least squares

(GLS), or the maximum likelihood (maximum likelihood) estimation of the parameters. The 'within' estimator of β is obtained by the ordinary least squares (OLS) method as follows:

$$(y_{it} - \bar{y}_i) = \beta' (x_{it} - \bar{x}_i) + v'_{it} \qquad 2.11$$

Thus, measures of technical efficiency can be expressed as $TE = \exp(\hat{u}_i)$.

In spite of the obvious advantage of the 'fixed effects' models in allowing correlation between the inefficiency term and the independent variables, and the fact that it does not require the imposition of a distribution form on the error term, caution need to be exercised when interpreting the results. This is because there is the possibility that the firm-specific effects would include the influence of variables that vary across firms but may be invariant over time. According to Simar (1992), the 'fixed effects' model provides a poor estimation of the intercepts and of the slope coefficients of frontier production functions. The consequence, therefore, is unreliable measures of technical efficiency.

In the 'random effects' model, the stochastic nature of the efficiency effects is explicitly taken into account in the estimation process. The GLS estimation provides consistent and unbiased estimates of the parameters if the regressors, X_{it}, are not correlated with the technical efficiency effects U_{it}. If correlation does exist, then another estimation procedure proposed by Hausman and Taylor (1981) can be used. First, a test of the 'within' and GLS estimator, leading to the case in which all or none of the regressors are correlated with individual efficiency effects, is carried out. Then, an instrumental variable (IV) method is used to obtain unbiased and efficient estimators under the assumption that all or some of the variables are correlated with observation-specific individual efficiency effects.

A number of models, defined in terms of the assumptions made regarding the firm specific technical efficiency effects, U_{it}, were considered by Pitt and Lee (1981). The first model assumes that the U_{it} are time-invariant, that is $U_{it} = U_i$. The second model assumes that the U_{it} are uncorrelated, that is $cov(u_{it}\text{-}u_{it'}) = 0$ for all i, $t \neq t'$ and $i \neq j$. The third model assumes that the U_{it} for some observation are correlated over time, that is $\text{cov}(u_{it}, u_{it'}) = \sigma$ and $\text{cov}(u_{it}, u_{it'}) = 0$ for all $i \neq j$.

Assuming a truncated normal distribution, the maximum likelihood estimation procedure, is suitable for estimating the first two models. Zellner's (1962) seemingly unrelated regression can be used to estimate the third model. This method, however, is not straightforward as it is premised on the assumption that the slopes are equal across time periods due to the intractability of the likelihood function when multivariate truncated normal distribution is specified. Invoking the assumption that the time invariant non-negative firm-specific U_{it} are truncated with distribution $N(u, \sigma^2)$, Battese and Coelli (1988) used maximum-likelihood as the method of estimation.

2.10.2 The Stochastic Varying Coefficients Frontier Approach

Khalirajan and Obwona (1994) developed the SVFA model as an alternative approach of modelling firm-specific production behaviour and of measuring firm-specific technical efficiency. This approach provides a different perspective in the methodology of efficiency measurement. As we would expect, different levels of outputs are obtained with same factor inputs when different methods of application of the same technology are used. The implication is that diversity of firm behaviour leads to variations in the production response coefficients, which include not only the intercept but also slope coefficients.

A general formulation of the varying coefficients stochastic production frontier in terms of panel data can be expressed as,

$$y_{it} = \beta_0 + \sum \beta_{ijt} x_{ijt} + \varepsilon_{it} \qquad 2.13$$
$$i = 1, 2, ..., n$$
$$t = 1, 2, ..., T$$

As defined *Yit* is the logarithm of output of the ith firm in the tth period; x_{ijt} is the logarithm of the *J*th input used by the *i*th firm in the *t*th period when $j \neq 1$; β_{iIt} is the intercept of the ith firm in the tth period; and, β_{ijt}, when $j \neq 1$, is the slope coefficient concerning the *jth* input used by the *ith* firm in the tth period, and 8 is the disturbance term.

The expression (2.23) implies that production response coefficients are specific to each individual decision making unit and to each time period for the same decision making unit. As expressed, (2.23) cannot be estimated as the number of parameters to be estimated exceeds the number of observations. Imposing certain restrictions on the structure of (2.23), using for instance, and analysis of variance approach circumvents this problem,

$$\beta_{ijt} = \bar{\beta}_j + u_{ij} + v_{ij}; \quad j=1,2,....,m \qquad 2.14$$
$$\sum_i^n u_{ij} = 0 \quad \text{and} \quad \sum_i^T v_{ij} = 0$$

Where u_{ij} and V_{jt} respectively denote cross-sectional and temporal variation of the production coefficients β_{ijt}.

Drawing on Kalirajan and Obwona (1994), the assumptions underlying the model represented by (2.23) can be used as the basis of estimating the individual response coefficient. Hence, technical efficiency is attained when best practice technique that involves the efficient use of inputs is adopted. Thus defined, technical efficiency stems from two sources. First, efficient use of each input contributes individually to technical efficiency and can be measured by the magnitudes of the varying slope coefficient β_{ijt}. Second, any other firm-specific intrinsic characteristics, which are not explicitly included, may produce a combined contribution over and above the individual contributions. This 'lump sum' contribution, if any, can be measured by the varying intercept term.

Alternatively, the Size of each response coefficient and the intercept, form the production coefficients of the stochastic frontier production function. Let β^* be the estimates of the coefficients of the frontier production function, that is,

$$\beta^*_{jt} = \max\{\beta_{ijt}\} \quad 2.15$$
$$i = 1, 2, ..., n;$$
$$j = 1, 2, ..., m;$$
$$t = 1, 2, ..., T$$

Where β^*_{jt} , is the frontier coefficient of the j^{th} input in the t^{th} period, and β_{ijt} is the coefficient of the j^{th} input of the i^{th} firm in the t^{th} period. The maximum possible frontier output for individual firms can be calculated as

$$y^*_{it} = \sum \beta^*_{jt} x_{ijt} + \varepsilon_{it} \quad 2.16$$
$$i = 1, 2, ..., n$$
$$t = 1, 2, ..., T$$

The measure of technical efficiency of the i^{th} firm can be expressed as,

$$(TE)_{it} = \exp(y_{it}) / \exp(y^*_{it}) \quad 2.17$$

Where, y_{it} is the logarithm of the observed output of the i^{th} firm in the t^{th} time period and y^*_{it} is the logarithm of the estimated frontier output of the i^{th} firm in the t^{th} time. An advantage of the above methodology is that the analysis can also be carried out with cross-sectional data.

2.10.3 Determinants of Technical Efficiency

Determination of the factors affecting technical efficiency was started early1990s by Caves and Barton (1990) and Lovell, (1993). It was evaluated by using both parametric and non-parametric techniques (Seiford & Thral, 1990). The non-parametric technique constitutes Data Envelopment Analysis (DEA) and requires linear programming based on the input and output quantities (Farrell, 1957). The parametric technique is also based on the stochastic frontier analysis (SFA), which were first proposed by Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977). The SFA uses assumptions on the distribution of an unobserved productivity component to separate productivity from the deterministic part of the production function and the random error. Estimating relative technical efficiencies of firms are thus, based on information extracted from extreme observations from a body of data to determine the best practice production frontier to achieve the relative measure (Farrell, 1957; Lewin & lovell, 1990).

Battese & Coelli (1995), evaluating technical efficiency of Indian paddy rice producers found a positive relationship between the degree of inefficiency and the producer's age and a negative relationship with the educational level of the producer. Weir and Knight (2000) established in Ethiopia that household education positively influenced the level of technical efficiency in cereal crop farms.

Kadurumba *et al.* (2009) used a translog stochastic production function to measure the level of technical efficiency and its determinants in traditional palm oil processing in Imo State, Nigeria. They concluded that palm oil processors in the study area were technically inefficient because of allocative inefficiency. In their study, they found out that processing experience and educational level have significantly positive influence on technical efficiency. The implications are that the more experienced a processor is, the higher the level of technical efficiency and educated processors are more efficient than those who are not educated. Ojo (2005) studied productivity and technical efficiency of palm oil extraction mills in Nigeria and reported a varied TE between 0.32 and 0.96 with a mean of 0.75 indicating a relatively high TE. The technical inefficiency analysis showed that experience and education led to decrease in technical inefficiency. He also highlighted that the FFB milled and labour were the most significant variables in the operations of the mills and increasing their use would lead to increase in output. Chukwuji *et al.* (2007) used a translog stochastic frontier model to estimate the technical efficiency of Gari processing in Delta State, Nigeria, reported a wide variation in the level of technical efficiency in Gari processing, ranging from 25% to 88%, with a mean efficiency level of 65%. The technical inefficiency level of processors is attributed to socio-economic characteristics including age of processor, family size, level of formal education, access to production credit, availability of alternative sources of income and membership of Gari Processing Associations (Chukwuji *et al* ., 2007). In their study, they reported that the inefficiencies of individual processors were statistically significant ($P < 0.05$), except age of processor. Abdulazeez *et al* (2012) also conducted a study in Kwara State on economics of small scale agro-enterprises using Stochastic Frontier Model and reported a mean technical efficiency of groundnut processing to be 88.26%. The major factors affecting the efficiency of groundnut processing were farming experience and household size.

Obwona (2000), using translog stochastic production function, investigated technical efficiency differential between small and medium scale tobacco farmers in Uganda.

Results showed that credit accessibility, extension service access and farm assets contributed positively to technical efficiency. The differences between farmer groups were explained with socio-economic and demographic factors. Helfand (2003) also pointed out that access to credit institutions, supply of public sector utilities, technical assistance, and use of modern inputs like fertilizers and practice of irrigation are the factors responsible for significant differences in the level of inefficiency between plantations. Nchare (2007) also made a similar observation that access to credit has positive influence on technical efficiency. He highlighted that, it actually reduces the financial constraints farmers face at the beginning of the crop year, thus enabling them to buy inputs for effective production.

Owen *et al*. (2001) has examined the impact of extension services on agricultural production in Zimbabwe and suggested that farmer's access to extension services increases the value of output by 15%. However, their result was opposed by Weir and Knight (2000) who stressed that neither extension visits nor visits and trainings could bring about significant increases efficiency levels. They argued that the development agents could remain at the edge, never reaching the farmer and that the training packages may not be the best for the agro ecological settings. Again it is not extension services in terms of visits but the relevant of extension information and training.

Tchale (2009) reported about improved efficiency with the quantity and productivity of household labour, which directly contradicts findings by Masterson (2007), who also observed that efficiency was inversely related to productivity of household labour.

The gender of the farmer is also important variable that can influences technical efficiency. Kibaara (2005) highlighted that male farmers reduce technical inefficiency. This could probably be explained by the fact that men have greater access to credit, probably because of cultural prejudice and hence men are closer to the frontier. In addition men are most likely to attend agricultural extension training seminars (Kibaara, 2005). However, Mochebelele and Winter-Nelson (2000) found no significant effect of gender of the household head on technical efficiency.

2.11 Constraints to Small Scale Palm Oil Processors

According to Fold & Whitfield (2012), the impediments in the small scale palm oil sector in Ghana include low-yielding oil palm variety, low productivity of farm and mill, low quality of crude palm oil, lack of access to finance (including working capital and capital investments) as many of the small scale processors have poor financial records with the banks. Efficient utilization of resources; and training and retaining skilled workers are also problems in the sector. The assertion made by the (FAO, 2005) that, many of the small scale processors do not attempt to find out what their production costs are, because they believe that it is too complicated or too difficult and this affects their output is not much different from that of Fold & Whitfield (2012) as they all point to inefficiencies in the sector leading to low productivity. Ibekwe (2008) has studied the role of women in palm fruit processing and marketing and identified lack of access to capital, limited access to extension services, lack of ownership of land, high processing cost, price fluctuations and women domestic activities as problems militating against the small scale palm oil sector in Nigeria.

Ayodele (2010), in his study on palm oil and economic development in Nigeria and Ghana reported that the main problems that hinder increased palm oil production, to at least meet the local demand, includes land acquisition, infrastructure, finance and out of date production techniques. According to Ayodele (2010), 73 percent of palm oil producers in Nigeria and Ghana rank higher poor infrastructure and lack of access to finance as their biggest challenges in the sector. Olagunju (2008) also stressed that factors such as lack of access to improved infrastructure and finance are major downsides of the palm oil industry. The assertions made by Olagunju (2008) on the constraints facing the small scale palm oil processors are in consonance with that of (Ayodele, 2010). Ekine and Onu (2008) also studied economics of small scale palm oil processing in Nigeria and reported that inadequate fund is the major problem faced by palm oil processors hence most of them could not establish their own processing mill. Omoti (2001) stated that Nigeria has enormous potential to increase her production of palm oil and palm kernel primarily through application of improved processing techniques which are limited in the sector. Alufohai & Ahmadu (2012) affirmed that major problems confronting the small scale palm oil processors in the Edo State, Nigeria were inadequate capital/lack of credit (88%), high cost of labour (58%) and lack of transportation facilities (50%). The problem of inadequate capital was the most severe because of lack of credit facilities (Alufohai & Ahmadu, 2012). Adjei-Nsiah *et al* (2012) found problems related to marketing and finance as the major setbacks to the players in the small scale palm oil industry in the Kwaebibrem District of Ghana.

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CHAPTER THREE

METHODOLOGY

3.1 Introduction

The methodological framework is presented in this chapter. It consists of three main sub-sections. Section one describes the study area, data type, source of data and sampling procedure. The second section describes the theory behind the study and empirical model specification, data collection procedure and methods of data analysis are described in detail in the third section.

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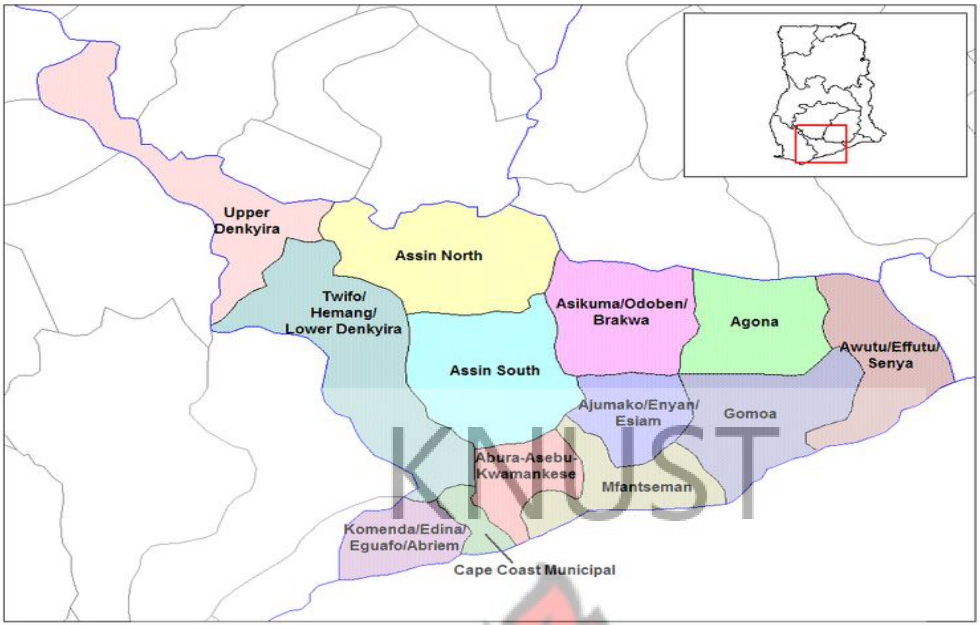
3.2 Study Area

The study areas include Assin North Municipality (ANM) and Assin South District (ASD) in the Central Region of Ghana. The total land areas for the ANM and ASD are 1,500 and 1,187 square kilometres respectively. The ANM and ASD share some common features with respect to rainfall, temperature, relative humidity and socio-economic activities. The annual average rainfall amount ranges from 1500mm to 2000 mm and the mean temperature figures between 23^{0}C and 30^{0}C. The average relative humidity also ranges between 60% and 70%. These climatic conditions are suitable for the production of oil palm. In addition, the vegetation types are evergreen and semi-deciduous forest zones. The total population of ANM is 161,341 and that of ASD is 104,244 (GSS, 2012). Pictorial map of the districts are shown in the central regional map below:

Figure 3.1: Central Regional Map showing the study area



Source: Town and Country Planning Department, Cape Coast, 2012.

Agriculture, which comprises farming and animal husbandry, is the major economic activity in the study area employing about 62.8 percent of the working population (MLGRD, 2006). Crops of substantial economic significance in the districts are cocoa, oil palm, Cassava, plantain, cocoyam and citrus. Oil palm is the second largest industrial crop cultivated in the districts after cocoa. The total land area under oil palm cultivation in the ANM is 12,345ha and that of ASD being 8,064.94ha. The farming activities undertaken by oil palm farming households include farm establishment involving land clearing and preparation as well as planting of seeds (seedlings); farm maintenance entailing weeding, pruning, control of pests; crop harvesting; processing; storage and sale of farm produce. The districts benefited from the President's Special Initiative (PSI) on oil palm with oil palm nursery established at Assin Akonfudi in ANM which distributed Tenera seedlings to many farmers in the ANM and ASD (PSI, 2004). This initiative led to expansion of oil palm cultivation in the area. However, infrastructural development has been a major militating factor against the industry in the study area.

3.2.1 Palm Oil Processing Industry in the Study Area

Palm oil and palm kernel oil processing is the nucleus of economic activity for most of the women in the ANM and ASD; few men give them technical assistance. Dura and Tenera are the varieties of oil palm mainly processed in the two districts. Few of the oil palm producers have their own processing units; however, majority of the farmers sell their fresh fruit bunches (FFB) to small scale palm oil processors in the study area. Moreover, there is one medium scale processing unit (Amber-pan palm oil Co. Ltd.) established at Assin Akropong Odumasi. This company operates in two ways; they process FFB from their own plantation and also buy the fresh palm fruits from farmers and process them. There exist three different mechanized systems for digestion and pressing of fruits in the study area. These include; digester with separate hand-operated screw press, digester screw press and combined digester with hydraulic press propelled by diesel-powered engine. These facilities are owned by private individuals and a number of them are also supplied by NGOs such as World Vision International and Red Cross Society to some of the communities. Nyakomasi Methodist Church Society also donated combined digester and motorized hydraulic press to the small scale processors in Assin Brofoyedur community to enhance the livelihood activities of the women in the community. Although, the digester screw press is most economical in terms of labour, material and floor space requirements and also revenue generated, most mill operators are of the view that the digester screw press is generally too expensive and not within the reach of most small scale operators. In the study area, processing centres process palm fruits for small scale processors and charge them a processing fee based on the quantity they process. Normally, privately owned facilities charge a higher fee than community owned facilities. The private owned facilities charge an average of sixty to eighty Ghana pesewas (GHp60-GHp80) per a hydraulic press as compared to thirty-five Ghana pesewas (35GHp) charged by the community owned facilities. However, some of processors still depend on mortar and pestle for digesting the palm fruits and extract the oil through Spindle press (manual).

3.2.2 Processing Seasons and Market Opportunities

The palm oil industry in the study area is characterized by three seasons namely; major, mid and minor seasons due to availability of the palm fruit. The major season (peak season) starts from January to June, the mid-season starts from July to September and the minor season (lean season) starts from October to December. The palm fruit is abundant in the major season and the larger quantity of the palm oil is produced in this period. The minor season is characterized by scarcity of palm fruit with processors foraging a lot to get the fruit to process. The mid-season is a period between the major and minor seasons. For the purpose of this study the seasons were grouped into two (major and minor) since the conditions in the minor season are not much different from those in the mid-season. Marketing of crude palm oil (CPO) in study area is not much of a problem to the processors. The processors have access to both local and international markets. For local market, they sell to soap makers and retailers for food uses. Larger volume of the palm oil processed in the study area is destined for export to neighbouring countries like Nigeria, Benin and Togo.

3.3 Data Type and Source of Data

This study was based on data obtained from both primary and secondary sources. Primary data was collected through administration of structured questionnaires among one hundred and fifty small scale palm oil processors. The collected data covered information on input usage and output levels of small scale palm oil production in the 2011 production year and socio-economic data of the processing households. The secondary data for the study were obtained from Statistics, Research and Information Directorate (SRID) of MOFA, FAO website (FAOSTAT), Assin North Municipal Assembly (ANMA) and Assin South District Assembly (ASDA). Journals, books and past dissertations also served as sources of useful secondary information for this study.

3.4 Sampling Procedure

The study was conducted in Assin North Municipality (ANM) and Assin South District (ASD) in the Central Region of Ghana where oil palm production is ranged second to cocoa production and small scale palm oil processing is the main economic activity of most of the women in the two districts (MoFA, 2011).

A two-stage simple random sampling technique was adopted to select the respondents for this study. In the first stage, simple random sampling technique was used to select ten (10) towns from the ANM and fifteen (15) towns from the ASD from a list of palm oil processing towns in the Districts. In the second stage, six (6) small scale palm oil processors were selected from each town using simple random sampling technique. A total of 60 processors were selected from ANM and 90 processors from the ASD. More processors were selected from the ASD basically because there are many processing centres and oil palm plantations in the area than the ANM. In total a sample size of one hundred and fifty (150) palm oil processors were selected for the study as shown in Figure 3.2.

Figure 3.2: Illustration of the sampling procedure

3.5 Data collection techniques

The data for the study was collected through personal interviews based on structured questionnaires. This was administered among the random sample of one hundred and fifty (150) small scale palm oil processors to generate primary data for analysis. The questionnaires were administered by six (6) enumerators who were recruited and trained, with the researcher serving as the field supervisor during data collection. Direct observations were made of palm oil marketing, weighing and measurement, as well as prices which provided important sources of information for the study.

3.6 Method of Data Analysis

Simple descriptive statistics such as percentages, arithmetic mean, mode and ratios as well as frequency distribution tables were employed to describe the socio-economic characteristics of the respondents. A combination of Likert scale and Kendall's coefficient of concordance was used to examine the degree of agreement among the small scale palm oil processors as far as constraints were concerned. The constraint with the least mean was ranked as the most pressing problem with highest mean being the least pressing. The agreement in the ranking of the constraints was also tested. The Kendall's W statistics can be obtained from the formulas below:

$$W = \frac{12S}{p^2(n^3 - n) - pT} \qquad 3.1$$

Where, n is the number of objects, p the number of judges. T is a correction factor for tied ranks (Siegel, 1956). It was estimated with the aid of the non-parametric test of K-related sample which gave the various mean rank values attached to the challenges. It also provides the Kendall's W, which is their agreement level and the associated p-value. The significance of the P-value indicates that the judges are in concordance or agreement which is drawn from the rejection of the null hypothesis. However, insignificance indicates otherwise.

Gross Margin and Benefit/Cost Ratio were used to assess the profitability of small scale palm oil processing. The gross margin was computed with the aid of Microsoft excel. It is a useful planning tool in situations where fixed capital is negligible portion of the farming enterprises in the case of small scale subsistence agriculture (Olukosi & Erhabor, 1988). This analysis shows the difference between the total value of production per unit and the total variable cost incurred. The processors' GM is obtained by using the expression:

$$M = \sum_{j=1}^{m} P_j Y_j - \sum_{i=1}^{n} P_i X_i \qquad 3.2$$

Where *M*, gross margin; P_j, unit price of output of small scale palm oil processing product, Y_j, quantity of palm oil; P_i, unit price of variable inputs used in small scale palm oil processing ; X_i quantity of variable inputs; i, j…n, m is the total sample size.

The non-discounted Benefit/Cost Ratio (BCR) was also computed using excel. The formula utilized for the computation is stated below:

$$BCR = \sum_{i=1}^{n} \frac{Benefits}{\cos t} \qquad 3.3$$

A BCR result of greater than one is an indication of the financial profitability of the small scale palm oil processing enterprise. The study used non-discounted Benefit/Cost Ratio (BCR) because primary data was obtained for both major and minor seasons for analysis and there was no need to discount since the analysis was done on per production cycle basis.

The stochastic production frontier analysis was used to examine the TE of the processors. The stochastic frontier function assumes the presence of technical inefficiency effects in the production function, that is, it assumes the error term has two components, V and U. The Cobb-Douglas production function form of the stochastic frontier model proposed by (Battese & Coelli, 1988) was used. This study specified the stochastic frontier production function using the double log specification. The model is specified as follows.

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \varepsilon \quad 3.4$$

$$\varepsilon = V_i - U_i \quad 3.5$$

Where, Ln denotes natural logarithms, Y is the output variable in a specified unit, X_i is a vector of explanatory variables, β's are parameters to be estimated and ε is the error term that is decomposed into two component parts, V_i and U_i. The V is the normal random error term that is independently and identically with zero mean and constant variance (σ_v^2). It is introduced to capture the random error in the production which is due to factors that are not within the control of the producers. It is independent of U. The U measures the inefficiency relative to the frontier production function, which is attributed to controllable factors. It is a half normal distribution with zero mean and constant variance (σ_u^2). The variance of the random error term (σ_v^2) and that of the technical inefficiency effects (σ_u^2) and the overall model variance (σ^2) are related thus: $\sigma^2 = \sigma_v^2 + \sigma_u^2$. The inefficiency model is estimated from the equation given below.

$$u_i = \delta_0 + \sum_{m=1}^{7} \delta_m z_i \qquad 3.6$$

Where U_i is the non-randomise error term (the inefficiency), the variables Z_i are the explanatory variables in the inefficiency model and δ_m is the coefficient of the explanatory variables. Equation 3.4 shows a joint estimation of a stochastic frontier production function in STATA (Greene, 2002). The first section is the stochastic frontier production function while the second part captures the inefficiency variables. The model generates variance parameters, (i.e.) Gamma $\gamma = (\sigma_u^2 / \sigma^2)$; variance of the model (Sigma square σ^2), variance of the stochastic model (σ_v^2) and variance of the inefficiency model (σ_u^2).

3.6.1 Empirical Model Specification

The stochastic frontier production function was specified as;

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + V_1 - U_1 \qquad 3.7$$

Where,

Y = Output of crude palm oil (litres),

X_1 = oil palm fruit (kg),

X_2 = labour (in man days),

X_3 = quantity of water used (in litres),

X_4 = quantity of firewood used (in bundles),

β_0 = the constant and

$\beta_1, \beta_2\ \beta_3,\ \beta_3$ = coefficients of the various inputs with respect to output level.

V_1 = random error due to mis-specification of model and variation in output due to exogenous factors outside the processor's control. The Cobb Douglass functional form was used in this study. The partial elasticity equal to each of the parameters and linearized in log function is easy to fit and coefficients are direct elasticity.

U_I = inefficiency component of the error term. The inefficiency model was specified as:

$$U_1 = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 ... \delta_n Z_n \quad 3.8$$

Where,

U_1 = Technical inefficiency,

Z_1 = Access to credit (Yes=1, No = 0),

Z_2 = Extension contact (Yes=1, No=0)

Z_3 = Membership of association (Yes =1, No = 0),

Z_4 = Processing experience (years)

Z_5 = Household size (in numbers)

Z_6 = Marital status (single=0, married=1)

Z_7 = Years of schooling

Z_8 = Age (Years)

Z_9 = Gender (male=1, female=0)

$\delta_0, \delta_1 ... \delta_8$ = Parameters to be estimated

In the inefficiency model, a positive sign of the estimated parameter implies that the associated variable has a negative effect on efficiency but a positive effect on inefficiency and vice versa. Table 3.1 provides *apriori* expectation about the explanatory

Table 3.1: Apriori Expectation of Variables in the Inefficiency Model

Symbol of variable	Explanation of variable	Hypothesized effects
Z_1	Access to credit	Negative (-)
Z_2	Extension contact	Negative (-)
Z_3	Membership of association	Negative (-)
Z_4	Processing experience	Negative (-)
Z_5	Household size	Negative (-)
Z_6	Marital status	Negative (-)
Z_7	Years of schooling	Negative (-)
Z_8	Age	Negative (-)
Z_9	Gender	Negative (-)

3.6.2 Measurement of Variables

Production cycle was defined as the period from threshing of palm fruits to clarification of crude palm oil. (CPO)

Output of crude palm oil (CPO) was measured as the quantity of CPO produced in litres per production cycle during the 2011 production year.

Fresh palm fruit was defined as quantity of palm fruit processed per production cycle; it was measured in kilograms (kg).

Labour was measured as the number of man-days spent per processing cycle from threshing of palm fruit to clarification of crude palm oil (CPO). This was made up of both family and hired labour.

Firewood was defined as quantity of firewood used per production cycle and it was measured in bundles, that is, number of bundles used. A typical bundle contains 5-8 pieces of firewood (bamboo) weighing about 32-35kg.

Water was defined as quantity of water used per production cycle and it was measured in litres.

Measurement of costs, prices and revenues were done in Ghana cedis.

Measurement of processing specific technical efficiency was based on deviations of realized output from the frontier output. The observed deviations from the frontier production are assumed to result from processing specific factors which are modeled in equation 3.2 (Coelli, 1996b).

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter is presented in four sections. The first section presents result on socio-economic characteristics of respondents; the next section consists of results on profitability analysis of small scale palm oil processing business in the study area while the third and fourth sections are made up of the TE results which entail the maximum likelihood estimates, elasticities and returns to scale, distribution of TE and determinants of TE and constraints militating against the small scale palm oil processors in the study area respectively.

4.2 Socio-economic Characteristics of Respondents

This section is made up of two parts. The first part describes respondent's demographic profile and the second part describes economic activities of the respondents.

4.2.1 Demographic profile

The demographic profile of the sampled small scale palm oil processors are shown in Table 4.1. The gender of the respondents was skewed: 144 (96%) were female while 6 (4%) of them were males. Adjei-Nsiah *et al* (2012) reported 89% women dominance in the industry in Kwaebibrem District of Ghana. The dominance of women in the small scale palm oil processing industry is not peculiar to Ghana as Ibekwe (2008) and Akangbe *et al.* (2011) reported of similar observation (94%) in Nigeria.

Table 4.1: Demographic Profile of respondents

Variable	Freq (n=150)	Percent (%)	max	min	mean
Gender					
Male	6	4.0			
Female	144	96.0			
Age			76	21	42
21-34	26	17.3			
35-44	72	48.0			
45-60	47	31.3			
>60	5	3.3			
Level of education					
No formal education	37	24.7			
Basic education	108	72.0			
Secondary education	5	3.3			
Tertiary	0	0.0			
Years of schooling			12	3	8
Training status					
Ever been trained	47	31.3			
Never been trained	103	68.7			
Marital status					
Single	27	18.0			
Married	123	82.0			
Household size			12	2	6
1-5	67	44.7			
6-10	78	52.0			
10-15	5	3.3			
Experience in processing (years)			30	1	9
1-7	69	46.0			
8-15	41	27.3			
16-22	34	22.7			
23-30	6	4.0			
Membership of association					
Affiliated	50	33.3			
Non-affiliated	100	66.7			

Source: Field Survey, 2012

It is an indication that the nature of the operations does not encourage male participation. A mean age of 43 years was recorded for the processors, with the youngest processor being 21 years old and the oldest being 76 years. The majority (48%) of the processors were between 35 and 44 years of age while the remaining 17% and 38% of the processors were below 35years and above 44 years respectively. This shows that the young and adults were actively involved in the small scale palm oil processing business. This indicates the importance of the small scale palm fruit processing into palm oil as economic activity for most women in rural communities where oil palm plantations are common. Education plays an important role in palm oil processing operations since it will facilitate the adoption of innovations that will improve palm oil processing. The study revealed that 72% of the respondents had basic/elementary education; 3% had secondary education, and the remaining 25% had no formal education. The mean years of schooling among the respondents stood at eight (8) years; which is higher than the average Ghanaian schooling years of 5.1 (GLSS5, 2008). The study shows that the sampled small scale processors did not have enough training as only 31% had extension training while 69% had never benefited from any extension training. About 82% of the respondents were married and the remaining 18% were single, divorced or widowed. About 52% of the respondents had their household size ranging between six and ten persons. The mean household was six people (6); this is higher than the national average of four (4) members per household (GLSS5, 2008).

Out of the 150 sampled processors 46% had been in processing for between 1-7 years, 27.3% had 8-15 years processing experience, 22.7% had been in the business for 16-22 years and the remaining 4% had been in processing business from 23 to 30 years. The mean processing experience was estimated at 13 years which implied that the processors had enough experience to manage the business well to maximize profit. Palm oil processing based association is important in the palm oil processing industry as members of the associations learn from each other to enhance their knowledge in the business and they also stand to get financial assistance from the group members as well as group credit from financial institutions. However, results of the study shows that only 33% of the respondents were affiliated to associations. This could partly explain why more than 77%

of processors relied on personal savings as the main source of capital for their processing business.

4.2.2 Economic Activities of Respondents

The economic activities of the respondents are presented in Table 4.2. Palm oil processing was found to be the primary occupation for 99% of the respondents. The main secondary occupation of processors was found to be farming and trading.

From Table 4.2, about 75% of sampled processors sourced the palm fruits for processing through purchase, 11% through own farm production and the remaining 15% through both purchase and own farm production. The most common type of labour used was hired labour and it was reported by 86% of the respondents. Results from the study showed that personal savings was the primary source of capital for the processing business. For 23% of the processors, borrowed funds were mainly used for palm oil processing.

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Table 4.2: Economic Activities and other information of Respondents

Economic Activities	Freq (n=150)	Percent (%)	Max	Min	Mean
Primary occupation					
Palm oil processing	149	99.3			
others	1	0.7			
other occupation					
Farming	99	66.0			
Trading	22	14.7			
others	29	19.3			
Source of palm fruit					
Own farm	16	10.7			
Purchased	112	74.7			
Both	22	14.6			
Type of labour					
Hired	129	86.0			
Family	6	4.0			
Both	15	10.0			
Type of capital					
Personal savings	116	77.3			
Borrowed funds	34	22.7			
Source of credit					
Money lenders	26	17.3			
Susu scheme	1	0.7			
Credit union	2	1.4			
Banks	5	3.3			
Relatives/friends	0	0.0			
Rental arrangement					
Community	42	28.0			
Private	108	72.0			
Amount of credit accessed			2,000	100	620
Interest rate			50%	10%	43%

Source: Field Survey, 2012

About 77% of respondents who used borrowed funds sourced the credit from private money lenders with a mean interest rate of 43%. The technology for processing used by the sampled processors was power propelled combined digester and hydraulic press as well as manual pressing method. About 28% of the processors accessed this mill through community rental arrangement while 72% accessed it through private rental arrangement.

4.3 Profitability Analysis of Small Scale Palm Oil Processing in ANM and ASD

This section of the study assesses and compares the financial profitability of palm oil production in Assin North Municipality (ANM) and Assin Soutth District (ASD). The financial figures computed and compared include average gross margin per cycle, average profit per season, and Benefit/Cost Ratio. It also further assesses their production capacities of crude palm oil and palm kernel in the two seasons. Table 4.3 provides the income statement for small scale palm oil processing.

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Table 4.3: Income Statement for Small Scale Palm Oil Processing Per Cycle in Major Season

Variable	ASD	ANM
Average Quantity of CPO (Litres)	520.97	666.75
Average Quantity of PK (Kg)	143.73	194.23
Revenues		
Sale Of Crude Palm Oil (GH¢)	345.43	433.31
Sale Of Palm Kernel (Gh¢)	15.89	20.13
TR (Gh¢)	**361.32**	**453.44**
Cost		
Variable Cost (Gh¢)		
Palm Fruit (Kg)	164.87	212.43
Transportation (cost of carting palm)	26.65	28.85
Labour cost for threshing (man-days)	31.39	36.95
Cost of firewood (bundles)	1.47	1.45
Water (litre)	0.93	2.56
Extraction/Milling cost (per hydraulic press)	30.80	31.66
Removing of nuts from fibre (man-days)	8.99	13.05
TVC (Gh¢)	**265.10**	**326.95**
Average Gross Margin Per Cycle	**96.22**	**126.49**
Fixed Cost		
Average Annual Depreciation (Gh¢)	13.85	13.46
Average Depreciation Per Season (Gh¢)	6.93	6.73
Average Depreciation Per Cycle (Gh¢)	0.46	0.56
Interest On Loan Per Cycle	17.0	18.63
TFC (Gh¢)	**17.46**	**19.19**
Net Profit Per Cycle (Gh¢)	**78.76**	**107.3**
Average Number Of Cycles Per Season	15	12
Average Profit Per Season (Gh¢)	**1,181.4**	**1,287.6**
BCR	**1.28**	**1.31**

Source: Authors' computations (2012). NB A bag of palm fruit =90Kg and a tin of CPO = 30litres

From Table 4.3, the average palm oil processor in the ASD is capable of producing 520.97 litres of crude palm oil per cycle in a major season and therefore could make Gh¢361.32 crude palm oil sales per cycle in a major season. The average processor in the ASD also has the capacity to produce 143.7 Kg of palm kernel per cycle in a major season which culminates into a per cycle sales of Gh¢15.89. Therefore, the average pam oil processor in ASD makes total revenue of Gh¢361.32 per cycle in the major season. The average palm oil processor in the ASD also incurs a total variable cost of Gh¢265.10 per cycle in a major season with the cost of palm fruits constituting the biggest portion (62%) of the production cost. This finding is consistent with the results obtained by Ekine and Onu (2008) who reported that oil palm fruit cost constitutes 65% of the total production cost. Olagunju (2008) also established that oil palm fruit cost accounts for about 56% of the total cost of production. Therefore, the average palm oil processor in the AS makes an average gross margin of Gh¢96.22 per cycle in a major season.

On the other hand, the average palm oil processor in the ANM's average quantity of crude palm oil production capacity of 666.75 litres is higher than their ASD counterparts. This therefore culminates into a relatively better position in terms of crude pam oil sales (Gh¢433.31) per cycle in a major season for the average processor in the ANM relative to their counterparts in the ASD. Similarly, the average palm oil processor in the ANM also produces 194.23 Kg of palm kernel that earns him major season cycle sale of Gh¢20.13, which is relatively more than that in the ASD. The average gross margin per cycle of Gh¢126.49 per processor in the major season is relatively higher in the ANM. More so, the average profit per season in a major season in the ANM (Gh¢1,287.6) is better than their ASD (Gh¢1,181.4) counterparts. Furthermore, the BCR value of the average ANM processors per cycle (1.31) in the major season is greater than their ASD (1.28) counterparts, which indicates a relatively high financial profitability in the processing of palm oil in the ANM. This indicates that processors in ANM make a profit of 31 percent on their investment in the major season while their counterparts in ASD make 28 percent profit of their investment. Majority of the processors of ANM were using community based processing facilities supplied by World Vision International, and this relatively reduces their cost of production. Moreover, the road network of ANM is also relatively better resulting in a lower cost of transportation.

From Table 4.4, the average palm oil processor in the ASD is capable of producing 268.7 litres of crude palm oil per cycle in a minor season and therefore could make Gh¢255.82 crude palm oil sales per cycle in a minor season. The average processor in the ASD also has the capacity to produce 75.46 Kg of palm kernel per cycle in a minor season which culminates into a per cycle sales of Gh¢10.25. Therefore, the average pam oil processor in ASD makes total revenue of Gh¢266.07 per cycle in the lean season.

Table 4.4: Income Statement for Small Scale Palm Oil Processing Per Cycle in Minor Season

Variable	ASD	ANM
Average Quantity of CPO (Litres)	268.7	386.28
Average Quantity of PK (Kg)	75.46	120.17
Revenues		
Sale Of Crude Palm Oil (Gh¢)	255.82	358.68
Sale Of Palm Kernel (Gh¢)	10.25	15.31
TR	**266.07**	**373.99**
Cost		
Variable Cost (Gh¢)		
Palm Fruit (Kg)	132.18	193.67
Transportation (cost of carting palm fruit)	14.10	16.00
Labour cost for threshing (man-days)	15.05	18.4
Firewood (litres)	2.81	6.17
Water (litres)	1.40	2.13
Extraction/Milling cost (per hydraulic press)	15.65	17.28
Removing Nuts from fibre (man-days)	4.46	6.64
TVC (Gh¢)	**185.65**	**260.29**
Average Gross Margin Per Cycle	**80.42**	**113.7**
Fixed Cost		
Average Depreciation Per Season (Gh¢)	6.93	6.73
Average Depreciation Per Cycle (Gh¢)	0.46	0.56
Interest On Loan Per Cycle	17.0	18.63
TFC	**17.46**	**19.19**
Net Profit Per Cycle (Gh¢)	**62.96**	**94.51**
Average Number Of Cycles Per Season	15	12
Average Profit Per Season (Gh¢)	**944.4**	**1,134.12**
BCR	**1.31**	**1.34**

Source: Authors' computations (2012). NB A bag of palm fruit =90Kg and a tin of CP = 30litres

The average palm oil processor in the ASD also incurs a total variable cost of Gh¢185.65 per cycle in a minor season. Therefore, the average palm oil processor in the ASD makes an average gross margin of Gh¢80.42 per cycle in a minor season.

On the other hand, the average palm oil processor in the ANM's average quantity of crude palm oil production capacity of 386.28 litres is relatively more than their ASD counterparts in the minor season. This therefore culminates into a relatively better position in terms of crude pam oil sales (Gh¢358.68) per cycle in a minor season for the average processor in the ANM relative to their counterparts in the ASD. Similarly, the average palm oil processor in the ANM also produces 120.17 Kg of palm kernel that earns him minor season per cycle sale of Gh¢15.31, which is relatively greater than that in the ASD. The average gross margin per cycle of Gh¢113.7 per processor in the minor season is relatively higher in the ANM. More so, the average profit per season in a minor season in the ANM (Gh¢1,134.12) is better than their ASD (Gh¢944.4) counterparts. Furthermore, the BCR value of the average ANM processors per cycle (1.34) in the minor season is greater than their ASD (1.31) counterparts, which indicates a relatively more viability in the processing of palm oil in the ANM.

The financial figures are comparatively better in the ANM than ASD and BCR values are better in the minor season than in the major season. This actually depicts the price fluctuation nature of agricultural commodities with higher prices in the minor season. This is consistent with the findings of Adjei-Nsiah *et al* (2012) that small scale palm oil processing is more profitable in the minor season than it is in the major season.

4.3.1 Comparison of Mean Gross Margins in ANM and ASD

This section of the study compares the mean gross margins per processing cycle of ASD and ANM in both the major and the minor seasons. The comparative statistical figures are shown in Table 4.5.

Table 4.5: Comparison of Mean Gross Margins of the ANM and ASD

Gross margin per processing cycle	Mean for ANM (n=60)	Mean for ASD (n=90)	t-statistics	P-value
Major season (GH¢/Cycle)	126.96	96.22	19.654	0.000
Minor season (GH¢/Cycle)	113.7	80.42	8.033	0.000

Source: Field Survey, 2012

Whereas palm oil processors in the ANM were found to make a profit of about GH¢ 126.96 and GH¢ 96.22 in the major and minor seasons respectively, their counterparts in the ASD make about GH¢113.7 in the major and about GH¢ 80.42 in the minor season. These differences accordingly, translate into a higher annual gross profit for processors in the ANM. The test for significance in the results discussed above reveal that, gross profits in the major season are significantly different between ANM and ASD at a 1% level of significance (t-value of 19.654). Similarly, the gross profits of the two districts are different at a significance level of 1% (t-value of 8.033) in the minor season.

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4.4 Cobb-Douglas Frontier Function for palm oil production

The maximum likelihood estimates of the parameters of the stochastic frontier production function and the inefficiency model are presented in Table 4.6. The analysis of the variance parameters showed that the estimate of sigma squared (σ^2 =0.0126) was large and significantly different from zero, indicating a good fit and the correctness of the specified model.

Table 4.6: Maximum Likelihood Estimates of the Cobb-Douglas Frontier Function for palm oil production

Stoc. Frontier Normal/Half-Normal Model				
Variables	**Parameters**	**Coefficient**	**Std. Err.**	**Z-Stats**
General model				
Constant	β_0	-0.7732***	0.1443	-5.36
lnPalm fruit (Kg)	β_1	1.1910	6.1638	0.193
lnLabour (man days)	β_2	8.9866***	0.5582	16.1
lnWater (litre)	β_3	2.5033***	0.6196	4.04
lnFirewood (bundles)	β_4	-8.8409***	0.4426	-19.9
Technical Inefficiency				
Gender	δ_9	-0.0188	0.0215	-0.88
Age	δ_8	0. 0001	0 .0005	0.24
Years of schooling	δ_7	-0.0072***	0.0012	-6.30
Marital status	δ_6	-0.0072	0.0055	-1.31
Household Size	δ_5	0.0026	0.0021	1.24
Experience	δ_4	-0.0016**	0.0007	-2.18
Membership of association	δ_3	-0.0253***	0.0095	-2.67
Extension Contact	δ_2	0.0025	0.0099	0.25
Credit Access	δ_1	0.1409**	0.0549	2.57
Constant	δ_0	0.1204***	0.0421	2.86
Diagnostic statistics				
Sigma-square σ^2		0.0126***		7.00
Gamma γ		0.9729***		48.60
Lambda		0.0067		
Log likelihood	235.27			
Mean Technical Efficiency	0.924			

Source: Computed from frontier 4.1 MLE Results/Field survey data (2012)
* = Significant at 10% level; ** = Significant at 5% level; *** = Significant at 1% level.

Gamma (γ) is also a measure of level of the inefficiency in the variance parameter; it ranges between 0 and 1. For the Cobb-Douglas model used for the study, the gamma estimate was large (γ=0.9729) and significant at 1% level indicating the presence of technical inefficiency effects in the operations of the small scale palm oil processors. The high value of γ indicates that about 97% of the variation in output of the processors was due to technical inefficiency effects and not to random effects. It also means that technical inefficiency is an important factor in explaining output differences among small scale palm oil processors in the study area.

The production elasticities of small scale palm oil processors in both ASD and ANM is displayed in Table 4.7.The regression coefficients in double log production function are the production elasticities and their sum indicate the returns to scale.

Table 4.7: Elasticity of Input Parameters with respect to quantity produced

Variable	Elasticity
Palm fruit (Kg)	1.1910
Labour (man days)	8.9866
Water (litre)	2.5033
Firewood (bundles)	-8.8409

Source: Computed from frontier 4.1 MLE Results/Field survey data (2012)

The coefficients of the stochastic frontier model indicates that, all except firewood show positive increasing function to the factors indicating that allocation and utilization of the variables are in the stage l of the production function. The high coefficient (8.9866) of labour indicates the importance of this variable in the palm oil industry. A unit increase in water usage in CPO production will lead to 2.5033 units increase in output at statistical significance level of 1%. However, estimated elasticity of mean output with respect to firewood was -8.8409. This means a unit increase in firewood will decreases CPO output by 8.8409 at a statistical significance level of 1%. The negative decreasing function of firewood to CPO output indicates that an extra increase in the use firewood input would lead to a decrease in the yield of CPO. This suggests that small scale palm oil processors in the study area should be conscious in the use of firewood in order to obtain the maximum yield from their investment in the industry.

The return to scale was estimated to be 3.84, signifying a positive increasing return to scale. This signifies an increasing marginal return among the small scale palm oil processors in the study area and that the investment on the variable input in palm fruit processing outweighs the cost of producing an additional crude palm oil at an increasing rate.

4.4.1 Technical Efficiency Analysis

Table 4.8 shows that there was some amount of variation in the efficiency levels at which different small scale palm oil processors in the study area were operating. The technical efficiency indices were obtained from the MLE results of the stochastic production function, using computer programme "FRONTIER 4.1".

Table 4.8: Distribution of Technical Efficiency Indices among Processors in the Study Area

Efficiency Class Index	**Frequency**	**Percentage**
0.00 - 0.10	0	0
0.11 – 0.20	0	0
0.21 – 0.30	0	0
0.31 – 0.40	0	0
0.41 – 0.50	0	0
0.51 – 0.60	1	0.7
0.61 – 0.70	0	0
0.71 – 0.80	4	2.6
0.81 – 0.90	41	27.3
0.91 – 1.00	104	69.3
Total	150	100
Mean	0.9236	
Maximum value	0.9940	
Minimum value	0.5419	

Source: Computed from MLE Results

The indices in Table 4.8 show that the technical efficiency levels of most small scale palm oil processors were between 91% and 100%. The most efficient processor obtained technical efficiency of 0.9940 (99%) while the worst processor had a technical efficiency of 0.5419 (54%). The mean technical efficiency was found to be 0.9236 (92%), implying that on the average, small scale palm oil processors in the study area were able to obtain approximately 92.4% of potential CPO output from the current mix of production inputs. This means that the small scale processors in the study area were relatively technically efficient. However processors still have room to increase technical efficiency so that greater percentage of them could produce at the frontier. The findings disagreed with Kadurumba *et al.* (2009) who reported a mean technical efficiency of 0.86 for traditional palm oil processors in Nigeria. The study, therefore, rejected the hypothesis that small scale palm oil processors are technically inefficient in the use of production factors.

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4.4.2 Determinants of Technical Efficiency among Small Scale Palm Oil Processors

The estimated coefficients of the inefficiency function provide some explanations for the relative technical efficiency levels among the small scale palm oil processors in the study area. The results in Table 4.6 show that processing experience had a negative effect on technical inefficiency indicating positive influence on technical efficiency. The estimated coefficient was -0.0016 and it was statistically significant at the 5% level. The implication is that the more experienced a processor is, the higher the level of technical efficiency. This is in consonance with the results of Kadurumba *et al.* (2009) who found a positive impact of processing experience on technical efficiency among traditional palm oil processors in Imo State, Nigeria. It also conforms to the finding of Ojo (2005) who indicated that experience decreased inefficiency in productivity and improved technical efficiency of small scale palm oil extraction mills.

Education (years of schooling) had a negative sign and was statistically significant at 1% level, implying a positive effect on technical efficiency in palm oil processing. This means processors who are better educated tend to be more efficient than those who are less educated. This is in agreement with the *apriori* expectation and the findings of Dzene

(2010) that education positively influenced the level of technical efficiency. The result is also consistent with Kibaara (2005), Kadurumba *et al*. (2009); Weir and Knight (2000) who found TE to be an increasing function of education.

Access to credit contrary to *apriori* expectation, had positive coefficient (0.1409) and was statistically significant at 5% level implying negative effect on technical efficiency. This means that processors who have access to credit were less efficient than those who did not have access to it. Access to credit in the study area had negative effect on technical efficiency probably because only 34 processors out of the 150 processors have access to credit and 26 processors out of the 34 processors sourced their credit from money lenders with high interest rate (an average of 43%) charged on the loans. The average quantum of credit accessed by the processors was six hundred and twenty Ghana cedis (Gh¢ 620) and some of them accessed as low as hundred Ghana cedis (Gh¢ 100). The credit accessed is insufficient and the processors might use the money for other purposes. Processors have to repay the loans they accessed from private money lender fortnightly which constraints them since they have to hurry the production process in order to meet the repayment agreement. These are some of the factor that explained why access to credit negatively influenced technical efficiency in the study area.

This is consistent with Chukwuji *et al*. (2007) who reported that access to credit has negative effect on technical efficiency but contradicts the findings of Helfand (2003) and Nchare (2007) who reported that access to credit has positive influence on technical efficiency.

Membership of processing based association had the expected negative sign and was significant at 1%. Therefore belonging to an association reduces inefficiency of small scale palm oil processor in the study area. This finding agreed with Kadurumba *et al.*

(2009) and Ojo (2005) who reported that membership of association positively influenced TE levels of small scale palm oil processors in Nigeria.

4.4 Constraints to palm oil processing

Respondents were presented with a list of 10 constraints identified through the reconnaissance survey and those usually reported in the literature as hindering efficient palm oil processing. The task of each respondent was to rank the problems from most pressing to least pressing constraint to production. Table 4.9 displays the results of the rankings.

Table 4.9: Constraints to Small Scale Palm Oil Processing

Ranks	Mean Rank	Rank
Access to credit	1.93	1st
Cost of carting	2.51	2nd
Cost of labour for processing	3.9	3rd
Labour scarcity	4.75	4th
Limited market opportunity	4.89	5th
Bad state of roads	6.24	6th
Competition from larger scale processors	7.02	7th
Limited training on quality standards	7.13	8th
Price fluctuation	7.45	9th
Non-ownership of processing machines	9.17	10th

Source: Field survey, 2012
The scale used for ranking: 1 = the most encountered problem, 2= the second most encountered problem, 3=the next and so on.

Access to credit was ranked first by 107 (71%) processors whereas non- ownership of processing facility was adjudged the least constraint. Cost of carting, cost of labour for processing and labour scarcity fell in second, third and fourth positions with mean ranks of 2.51, 3.90 and 4.75 respectively. These constraints are more related to financing and production (cost of transportation and labour) than marketing which is in consonance with finding from Ekine & Onu (2008) on the constraints facing small scale palm oil processors in Nigeria. The remaining constraints centered on marketing and other facilitating services to the palm oil processing industry with limited market opportunity topping the category and ranking fifth, closely followed by bad state of the roads leading to source of markets for palm fruits.

The level of agreement on the constraints among the 150 palm oil processors was tested using the Kendall's coefficient of concordance is provided in Table 4.10.

Table 4.10: Kendall's Coefficient of Concordance

Test Statistics	**Value**
N	150.00
Kendall's W	0.58
Chi-Square (χ^2)	780.59
Degree Of Freedom	9.00
P-Value	0.00

Kendall's coefficient of concordance (W), testing the null hypothesis that there is no agreement among the palm oil processors with respect to how constraining the inventory of problems affect production was rejected at the 1% significance level. The degree of unanimity as measured by the W-statistic was 58% since the score is zero for random ranking and 100% for perfectly unanimous ranking. Small scale palm oil processors in the study area can therefore, be said to be in some agreement that the most constraining factors to efficient palm oil processing are more related to financing, production and marketing issues in order of decreasing importance. This result gives credence to the findings of Alufohai & Ahmadu (2012) that constraints facing the palm oil processors in Nigeria included inadequate capital, high cost of labour, lack of transportation and marketing of CPO.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter consists of summary of the main findings, conclusions drawn and recommendations based on findings emanating from the study. Finally, suggestions were made for future research.

5.1 Summary of findings

The study was carried out to assess profitability and technical efficiency level of 150 small scale palm oil processors in the ASD and ANM of Ghana.

Small scale palm oil processing was found to be the primary occupation of 99% of the respondents. Majority (72%) of the processors accessed the processing mills through private rental system. Personal savings was the primary source of capital for majority (77%) of the processors. Small scale palm oil processing in the study area was dominated by women who were economically active but had low level of formal education. Majority (86%) of the processors used hired labour to process palm oil in the districts.

To assess profitability and technical efficiency of small scale palm oil processing in study area, a primary data was collected during the 2011/ 20012 production season for analysis. The data was collected through the use of structured questionnaires administered on one hundred and fifty (150) small scale palm oil processors who were selected through a simple random sampling technique.

The results from the financial analysis revealed that small scale palm oil processing in ANM and ASD was a profitable venture in both the major and the minor seasons. Gross Margins (GM) of GH¢96.22 and GH¢126.49 were obtained in the major season for ASD and ANM respectively and Benefit/Cost Ratios of 1.28 and 1.31 were obtained by processors per production cycle. In the case of the minor season, processors in ASD and ANM obtained Gross Margins of GH¢ 80.42 and GH¢ 113.70 and Benefit/Cost Ratio of 1.31 and 1.34 respectively. It was also found that processors sold the crude palm oil only at the processing centre which might affect their revenue since agricultural commodities are normally cheaper at the farm gate. Cost of palm fruits was found to form about 62% of the total cost of processing.

The study found variations in crude palm oil output among the processors interviewed and the results of the stochastic production function showed that the variation in output was due to technical inefficiency among the processors but not random effects. The coefficients of the stochastic frontier model indicated that, quantity of palm fruits processed, units of labour employed and quantity of water showed positive increasing function with respect to crude palm oil output. Quantity of firewood used, however, had a negative relationship with crude palm oil output. The return to scale was found to be 3.84, implying a positive increasing return to scale. Results of the TE analysis indicated that the level of TE varies among processors and ranges from 54.2% - 99.4% with a mean of 92.4% suggesting that on the average crude palm oil output falls 7.6% short of the maximum possible level. Education (years of schooling) and membership of association were found to positively influence technical efficiency at the 1% significant level and processing experience was also found to positively influence technical efficiency at 5% significant level. However, access to credit was found to have a negative effect on technical efficiency at a 5% significant level.

Kendall's Coefficient of Concordance analysis was employed to access the constraints militating against the small scale palm oil industry in the study. The results revealed that access to credit is the most critical constraining factor followed closely by transportation and labour costs as well as deplorable state of rural roads. Marketing constraints were not found to be very critical to the small scale palm oil processing industry.

5.2 Conclusions

The results of the study revealed that small scale palm oil processing in ANM and ASD was profitable however, the industry was relatively more profitable in the ANM than the ASD and the difference was statistically significant at 1% level. It was also found that processors earned more on their investment in the minor season than the major season in both Districts but could not process more due to scarcity of raw materials (palm fruit) during that period of the year.

The mean TE of 92.4% of small scale palm oil processors in Assin North and South districts of Ghana is very encouraging but there is still a room for improvement in order to produce at the maximum (100% efficient) level. This implies that with little support and technical advice a larger percentage of the processors will be able to get very close to 100% efficiency level. The study revealed that education, experience and membership of association positively influence TE but access to credit negatively influences TE.

Inadequate fund and high cost of carting palm fruit were ranked first and second respectively as the major problems faced by small scale palm oil processors in the study area.

5.3 Recommendations

Based on the findings of the study, a number of recommendations have been made.

Access to credit was found to decrease TE level of the processors mainly due to unfavourable credit terms and insufficient amount of credit accessed from private money lenders. Access to credit should be improved in the study area through community cooperative credit schemes, extension of financial services of rural banks to palm oil processors and proper targeting of government credit scheme to favour players in cottage industries. Processors should be encouraged to open bank accounts to enable them have access to credit from formal financial institutions and also benefit from various agricultural credit schemes at favourable terms in order to reduce the cost of interest pay on loans. This will improve TE level of the small scale palm oil processors and their profit margins.

Processing experience was found to have positive effect on TE level of the processors. New processors should be encouraged to join active processing based association and cooperatives to increase the chances of new entrants to get technical and managerial assistance from more experienced ones in the industry. This will also increase the chances of the small scale palm oil processors to access credit from formal financial institutions and also benefit from various agricultural credit schemes.

Education was another variable found to increase TE. The District Assemblies should build the capacities of small scale processors periodically to enhance productivity and efficiency. The capacity building programmes should focus on production (processing techniques and load acquisition procedures) through financial literacy programmes.

Bad state of road networks and high transportation cost were identified to hinder the operations of the processors in the study area. Therefore, District Assemblies should extend construction of roads to the rural areas by improving the conditions of feeder roads which will help reduce transportation problems faced by small scale palm oil processors.

5.4 Suggestions for Future Research

There are a number of ways in which this study can be extended. This study only focused on the technical efficiency among processors using the same technology (combined digester with hydraulic press propelled by diesel-powered engine). However, a comparative study could be done to assess technical efficiency among the three different technologies (digester with separate hand-operated screw press, digester screw press and combined digester with hydraulic press propelled by diesel-powered engine) used in the study area. In addition, future study should examine the economic efficiency in the small scale palm oil processing industry with a special focus on allocative efficiency which was not considered in the current study.

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APPENDIX: QUESTIONNAIRE

Dear Respondent
My name is ………………………… and I am a student of the Department of Agricultural Economics, Agribusiness and Extension, KNUST. The researcher/interviewer is conducting a study on the PROFITABILITY AND TECHNICAL EFFICIENCY ANALYSES OF SMALL SCALE PALM OIL PROCESSING IN THE ASD AND NORTH DISTRICTS OF GHANA. The information required from you is for academic and research purposes. The answers you give will be kept absolutely confidential and anonymous. I would really appreciate it if you could spare some of your time for this interview. I am looking forward to your kind cooperation. Thank you very much.

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Date of interview…………......................................……………...................

Time of interview: Started..........................Ended................................

NAME OF DISTRICT 1.ASD 2. ANM

Section A: Personal and household characteristics

1.Name of respondent	2.Gender	3.Age	4.Education	5.Marital status	6.Household size	7.Experience
....	1.Male [ ] 2.Female [ ]	....	# of years .... Level [ ]	1.Single [ ] 2.Married [ ] 3.Divorced [ ] 4.Separated [ ] 5.Widowed [ ]	Number of people in the household ...... people	Number of years in palm oil processing ....

Level of education 1.No formal education 2.Elementary/JHS 3.Secondary/SHS 4.Tertiary

8. Do you belong to any Palm oil processing based association?
Yes [ ] No [ ]

i. If yes, do you receive any of the following assistance from the association?
Tick the appropriate box.

Assistance	Yes	No
Technical		
Access to inputs		
Machinery services		
Equipment		
Credit in kind		
Credit in cash		
Storage		
Marketing services		
Transportation of inputs and products		

9. a. Is palm oil processing your primary occupation? Yes [ ] No [ ]

b. If no, what is your main occupation?...

c. What other economic activity are you engaged in?..

10. Do you get any training on palm oil processing from extension officers?

Yes [ ] No [ ]

11. a. What is your main source of capital for palm oil processing?

1 Personal Savings [ ]

2. Borrowed funds [ ]

b. If borrowed funds in 3 above, in which form was credit obtained?

1. Cash [ ]

2. Kind [ ] Specify...

c. If cash, specify amount of loan taken last year, GH¢............Interest rate ....

d. From which source did you acquire the loan last year?

1. Relatives [ ]

2. Moneylenders [ ]

3. Credit Unions [ ]

4. Susu Schemes [ ]

5. Banks [ ]

6. Others specify...

12. What is the source of palm fruit for processing?

1. Owned farm [ ]
2. Purchase [ ]
3. Both [ ]

13. a. Do you own the processing facility?

Yes [ ]

No [ ]

b. If No, under which rental arrangement do you access the facility?

1. Private rental [ ]

2. Community rental [ ]

14. a. What type of labour do you use in your palm oil processing business?

1. Family labour [ ]

2. Hired labour [ ]

3. Both family and hired [ ]

15. Where do you sell your palm oil and kernel?

1. Processing centre [ ]

2. Village market [ ]

3. District market [ ]

4. Markets outside the district,

Specify...

5. Delivery to institutions, Name institutions...

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SECTION B: Problems facing small sale palm oil processors

How do you RANK these problems often encountered in the palm oil processing Business? Indicate using numbers, where 1 indicates the most encountered problem, 2, the next and so on.

PROBLEM	RANK
Bad state of feeder roads for carting oil palm fruit	
Price fluctuation	
Limited access to credit facilities	
Scarcity of labour in the study area	
High cost of carting oil palm fruit	
High cost of labour for processing FFB	
Competition from large scale processors for palm fruit	
Limited access to market opportunities of palm oil	
Non-ownership of palm oil processing machines	
Limited training on quality standards and production techniques	

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SECTION C: Revenue and expenditure account for small-scale palm oil processors

Prototype revenue and expenditure account for small-scale palm oil processing per production year.

$$\prod = TR - TVC - TFC$$

Components	Major Season Processing (Number of cycles in the Major season ....)			Total Revenue and production cost in the major season	Minor Season Processing (Number of cycles in the Minor season ....)			Total Revenue and production cost in the minor season
Revenue	Qty	p/unit	TR		qty	p/unit	TR	
Crude Palm Oil								
Palm Kernel								
Fibre								
Variable cost	Qty	p/unit	TC		Qty	p/unit	TC	
Palm fruits								
Carted cost(tnt/trip)								
Labour in man-days (carting/trip)								
Threshing cost (Labour in man-days)								

Par boiling								
Cost of water in litres								
Cost of firewood								
Extraction*(Digester and Presser)								
Clarification								
Firewood								
Labour(man-days)								
Cost of selling palm oil								

SECTION D: Input usage by small-scale palm processors

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Inputs used in processing	Quantity
Oil palm fruit (in Kg)	
Labour (in man days)	
Water (in litres)	
Amount of loan borrowed GH¢	
Diesel/petrol (in litres)	
Firewood(in bundles)	
Depreciation of capital item	

Probe for input usage in processing a tonne of crude palm oil in the study area.

To calculate the depreciation value probe the processor for the following information

Name of capital item	Life span	Salvage value	Purchasing cost of item	Depreciated value
Bucket				
Head pan/Pan				
Tank/Boiler				
Wheel barrow				
Hand glove				
Shovel				
Threshing tools				

NYANSAPO WO SANE NO BADWENMA