UNIVERSITY OF CAPE COAST

PROCESSORS' PERCEPTION OF SOME PALM OIL PROCESSING TECHNOLOGIES IN THE CENTRAL REGION OF GHANA

BY

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STUDENT'S DECLARATION

I hereby declare that, this thesis is the result of my own original research and no part of it has been presented for another degree in this University or elsewhere.

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SUPERVISORS' DECLARATION

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ABSTRACT

This research was designed to find out about palm oil processors' perception of the technologies being used in the Central region of Ghana. The major variables of the study were the types of technology being adopted, extent of training provided, the relative advantages in terms of ease of use and maintenance of equipment, durability, effectiveness, appropriateness as well as the relative economic advantages. Constraints to palm oil production were also assessed, and an examination of associations between the variables of the study was performed.

Three categories of palm oil processing technologies were found to be adopted in the central region as follows:

1. The indigenous technology, which involved the use of mortar and pestle with or without screw press.
2. Motorised palm digester used with a screw press, and
3. Motorised digester-hydraulic press, which was the most technologically advanced of the three.

Adoption of these technologies was on-going although some processors, for various reasons expressed some dissatisfaction and indicated the desire to stop adopting. With the exception of the use of digester-hydraulic press, extension training was virtually absent for all processors. Training needs of processors were observed to be marketing, improved methods of processing as well as the operation and maintenance of equipment. Processors also

expressed desire for some skills in the detection and handling of faults on equipment.

The mortar and pestle technology was perceived to be the easiest to use and maintain and also the most appropriate. It was however perceived to be the least effective among the three technologies. The most effective equipment was the digester-hydraulic press, although it was perceived to be slightly less easy to use and maintain than the other equipment.

The major constraints facing the palm oil enterprise were insufficient credit, expensive equipment and raw materials for processing and limited market. Significant differences existed among the three technologies in terms of maintenance, effectiveness, appropriateness, availability of training labour use and economic advantages. In addition, significant associations were observed among the following variables of the study:

Ease of use, ease of maintenance, effectiveness, availability of training, labour and time required for processing of a given quantity of palm oil.

Among the recommendations offered are:

Improvement in agricultural extension training for women in palm oil processing.

Formation of co-operative groups of palm oil processors to enable them obtain such benefits as credit, procurement of equipment and means of marketing their products.

The development and dissemination of equipment for the separation of pulp kernel and fibre in order to reduce the labour requirement of this activity that often times is provided by children.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Agro-industries are essential to the development of a nation's agricultural sector because they are the primary methods of transforming raw materials into finished products for consumption. The characteristics of agricultural raw materials also make the processing industries very important. They are perishable, variable and seasonal.

Also, agro-industries constitute a majority of a nation's manufacturing sector, providing employment to a great number of its population, especially rural, women who are mostly in small-scale food processing. and the products are frequently the major exports from a developing country.

Due to the important role that agro-processing plays in the economy of Ghana, tremendous efforts are being made by the government and non-governmental organisations to improve the dissemination of technologies intended to reduce the effort needed for the various tasks in processing.

In the agro-industrial sector, one area that serves as an important source of income for a large number of Ghanaians, mostly women, is the oil-processing sector, an example being palm oil. Palm oil contains compounds of glycerol and fatty acids, which are principally palmitic, oleic and linolitic acids (Bencini, 1991). Palm oil is widely used in the developing countries for human consumption and soap manufacture, and it is extracted at both the local and industrial levels in Ghana. It is a major source of edible oil and also of carotenes, which are vitamin A precursors (UNIFEM, 1993).

Technologies that exist in Ghana for palm oil processing range from the indigenous or traditional methods that are solely operated manually, to highly mechanized plants or mills operated by factories. In-between these extremes exist the intermediate technologies, which are mainly manned by groups or co-operatives at the village level.

1.2 PROBLEM STATEMENT

In Ghana, while 87% of agricultural commodities are sold as primary products, only 13% go through processing activities. Post harvest losses are estimated to be in the region of 30% (Akyeampong, 1995). One reason that could be attributed to this is limited access to processing technologies. Traditional methods that are available may seem appropriate to users, but are drudgery, labour intensive and place a high demand on fuel for operating machines. Beyond these, such methods are usually unhygienic, and give poor quality products. To offset these problems improved processing technologies have been developed by institutions such as the International Institute of Tropical Agriculture (IITA) and firms including the Intermediate Technology Transfer Unit (ITTU). Such technologies are being transferred throughout the Central Region and other palm producing regions in Ghana by some non-governmental organisations including Technoserve and Sasakawa Global 2000.

Although various feasibility and pilot studies might have been undertaken before the inception of projects meant to disseminate these technologies, expectation might be different from the reality. Moreover, despite the drudgery involved in the use of traditional technology, the method of pounding and extraction with water is still being used. It is therefore important for studies such as this to be carried out to keep track of the progress in adoption by processors whose perception of the equipment is necessary for further improvement in research and extension. It would be interesting to know what constraints are posed to palm oil processors in the acquisition and use of these technologies. Another issue to consider in this research is why some women prefer using the indigenous technology in spite of the improved technologies that are supposed to be on the market. This study is therefore necessary to enable the assessment of the extent to which solutions to post harvest problems in the palm industry have been achieved through the introduction and the adoption of improved technologies.

1.3 OBJECTIVES OF THE STUDY

The main aim was:

To describe palm oil processors' perceived value of the technologies for processing palm oil.

SPECIFIC OBJECTIVES

1 To determine the characteristics of palm oil processors in terms of sex, age, marital status, educational background, years of experience and economic status.

2 To describe the main types of equipment used in palm oil processing.

3 To examine the pattern of adoption of the technologies.

4 To examine processors' perception of the technologies in terms of ease of use, ease of maintenance, durability, effectiveness, appropriateness and economic advantages.

5 To identify and assess palm oil processors' perception of the effectiveness of training related to the use of the palm oil processing technologies.

6 To ascertain the problems posed to processors in the acquisition and use of the technologies.

7 To compare the various technologies on the basis of the perceived ease of use, maintenance, effectiveness, appropriateness, training, labour and economic advantages.

8 To examine the existence of association between the following variables: ease of use, ease of maintenance, effectiveness, appropriateness, economic advantages, availability of training, labour required and duration of processing.

1.4 STATEMENT OF HYPOTHESES

The following hypotheses were stated for objectives 7 and 8. Hypotheses 1 to 7 were stated with regard to objective 7, while hypotheses 8 was stated for objective 8.

1 **H_0**: There is no significant difference in the ease of use among the technologies.

H_1: There is a significant difference in the ease of use among the téchnologies.

2 **H_0**: There is no significant difference in the ease of maintenance among the various technologies.

H_1: There is a significant difference in the ease of maintenance among the various technologies.

3 **H_0**: There is no significant difference in the effectiveness of the technologies.

H_1: There is a significant difference in the effectiveness of the technologies.

4 **H_0**: No significant differences exist in the perceived appropriateness of the technologies.

H_1: Significant differences exist in the appropriateness of the technologies.

5 **H_0**: No significant differences exist in the perceived availability of training for the processors.

H_1: Significant differences exist in the availability of training for the processors.

6 H_0: There is no significant difference in the labour required for use of the technologies.

H_1: There is a significant difference in the labour required for use of the technologies.

7 H_0: There is no significant difference in the economic advantages of the technologies.

H_1: There is a significant difference in the economic advantages of the technologies.

8 H_0: There is no significant relationship between any two of the following variables of the study: Ease of use, ease of maintenance, effectiveness, appropriateness, economic advantages, training, labour demand, time required for processing and the type of equipment used.

H_1: There is a significant relationship between any two of the following variables of the study: Ease of use, ease of maintenance, effectiveness, appropriateness, economic advantages, training, labour demand, time required for processing and the type of equipment used.

1.5 JUSTIFICATION OF THE STUDY

It is important that research into oil palm does not end at the cultivation stage but continues into processing, storage and marketing of its products. This study is intended to provide statistical information on the perceptions of palm oil processors with regard to the advantages and side effects of the improved equipment for processing. It is hoped that a comparison of the merits of existing technologies in palm oil processing would provide helpful information to the private entrepreneur in the choice of an appropriate technology for processing. Thus, useful information in making reliable estimates of the economic worth of the various technologies would be provided.

The data collected would be a source of information on the primary processing techniques to aid in research in the biological, physical and chemical as well as socio-economic factors that influence good quality products. It would also be useful to all stakeholders in the overall evaluation of projects involving palm oil processing for accountability and decision making purposes. On the whole, this research would contribute to the general effort by the government and non-governmental organisations to improve post harvest handling as well as the development and dissemination of technology in the country.

1.6 LIMITATION OF THE STUDY

The study was limited to the Central Region of Ghana. It covered palm oil processors' perceptions of the equipment for processing. Technical issues like design and fabrication of machines were not dealt with. For the sake of finance other technologies not present in the Central Region were not included and therefore generalizations were made to this region only.

1.7 OPERATIONAL DEFINITION OF TERMS

The following are the main terminology used, with definitions given within the contest of this study.

- **Characteristics**

Qualities describing a person. It includes demographics, economic status, that is access to capital, either personal or loans; and the type of equipment used for processing. Economic status also includes the proportion of income from the processing enterprise.

- **Equipment**

This refers to the mechanical or manual devices used in processing from splitting of palm fruit bunches to pressing of digested or pounded fruits for oil. Equipment is used interchangeably with machines and technologies.

- **Adoption**

This is the decision to make full use of the improved technologies as the best course of action. The pattern of adoption is used to mean the year in which the technology was first used and the desire to or not to continue using it.

- **Ease of Use**

Amount of skill, labour and fuel required by the technology as perceived by users.

- **Maintenance**

This is used to describe the ease with which spare parts are obtained locally, availability of repairers and the cost of repairs.

- **Durability**

The main items describing this are whether some components have been entirely abandoned and replaced.. It also describes the frequency of breakage, rust as well as wear and tear of components of machines or the complete breakdown of them.

- **Effectiveness**

Is used to mean the ability of the machines to be used to obtain maximum outcome of the various steps in processing with reduced labour and spillage.

- **Appropriateness**

This is the suitability, convenience and conformity of the technology to social conventions such as consumer acceptance of final product.

- **Advantages**

These are the technical and economic positive effects and include the ease with which the machines are paid for, p oductivity and profit.

- **Training**

The type and amount of information and skill given to processors to enable them effectively use improved technologies.

CHAPTER 2

LITERATURE REVIEW

2.1 THE OIL PALM

Oil palm, Elaeis guineensis is a monocotyledonous plant, largely cultivated in the equatorial regions of Africa, South-East Asia and America, Perseglove (1975), cited by Asiedu, (1992). It has been found to be the highest yielding oil bearing plant. FAO (1991), cited by Asiedu (1992) indicates that yields in the humid regions of West Africa amount to about 4.5 tones of oil per hectare per annum. Also, in 1985, slightly in excess of 7.6 million tones were produced worldwide with major contributing countries being Malaysia, the Philippines and Nigeria.

According to Kordylas (1991), the fruit of the oil palm usually forms in compact bunches in the axils of the lower leaves. The bunches are massive and nearly spherical, weighing about 10 to 90 kg, the average being about 18 kg. The bunches usually contain about 60-65 percent fruit. There are terminal spines or spikelets and hard modified leaves which are elongated and of various lengths.

The fruit, according to Asiedu (1992), is a drupe and the outer pulpy layer provides the palm oil. The pulpy layer, referred to as the fleshy mesocarp by Kordylas (1991), contains 45 to 55 percent oil. The oil melts over a range of temperatures between 25 and 50°C. Asiedu (1992) states that different varieties and types are characterised by the quantity and quality of the extractable oil and internal structure of the fruit. A palm fruit may be described as belonging to one of the following groups:

Dura, Tenera and Pisifera.

Dura

The International Commission for Agricultural Engineering (ICAE, 1994) has described this variety of palm fruit as having thick shell, thin mesocarp and big kernel. According to Asiedu (1992), dura is 2-8mm thick in endocarp, which constitutes 20-25 percent weight of fruit, and a mesocarp comprising 35-55 percent mass. Kordylas (1991) also states that fruits of dura variety are dark red with dark tips, which are often black when young, and are richer in oil than other varieties.

Tenera

According to ICAE (1994), Tenera is the type of palm nut that has thin shell, thick mesocarp and small kernel. Asiedu (1992) states that, this variety measurers 0.5 - 4mm thick in shell, has a medium to high mesocarp content representing 60 to 95 percent by weight of the fruit.

Pisifera

The third variety of palm nut has no shell and has little commercial value, but is important in the breeding of commercial palms.

2.2 USES OF PALM OIL

Kordylas (1991) states that goldsmiths use palm oil in their brass lamps for heating. It is used in cooking, for example in frying and baking. According to Kordylas (1991), people have developed a taste for unrefined palm oil. It is also used together with potash obtained from the ashes of burnt cocoa pods, plantain peelings or burnt palm fruit bunches to make soap. The 1984 Population Census Report on Ghana indicates that there is ample scope in the processing of palm oil into palm oil derivatives such as fatty acids, methyl ethers, fatty amides and glycerin for export.

2.3 FACTORS AFFECTING THE QUALITY OF PALM OIL

Hartley (1977) defines a poor quality palm oil as having any or both of the following characteristics:

High free fatty acid (FFA) content

Contamination with water and other impurities

These factors are interrelated. For instance, high water content can cause high FFA, which can in turn cause poor bleachability. When fruits are bruised, the concentration of FFA increases.

Formation of FFA is mainly caused by the action of lipase from palm fruit before pressing or by microbial lipases. The enzyme lipase breaks down fats to fatty acids and glycerol by disturbing the cellular structure of the fruit. Oil from fresh ripe fruit contains as little as 0.1% fatty acid (estimated as palmitic acid). But in bruised and crushed fruit, FFA may increase to 50 percent in few hours. Sterilized fruit, if left for more than 24 hours before further processing, is invaded by microorganisms. Sources of such microorganisms are palm fruit, bunch refuse, oily films on drums and other receptacles. Rises in FFA are likely to occur wherever oil is produced under generally dirty conditions and where the means of drum sterilization are inadequate.

The oxidation of unsaturated fatty acids produce compounds responsible for colour fixation in fats and this reduces bleachability. Oxidation is enhanced by prolonged heating in the presence of air and the availability of copper and iron traces in the oil. The use of equipment made up of copper and iron parts, the storage of oil in metallic containers, exposure to air and poor handling all contribute to poor bleachability of palm oil.

In manufacturing, oils must be bleached to definite specifications for the various uses to which they are put (Hartley, 1977). Difficulty in bleaching of palm oil, therefore, militates against its use in manufacture.

Kordylas (1991) indicates that traditional oil palm production techniques are only 50 percent efficient. The potential for oil palm production in Africa is so great that it is important that the techniques employed are carefully studied and improved wherever possible. According to Eggleston et al (1989), often the public will not accept food that has not been traditionally prepared although large scale processing guarantees much higher quality. Cleanliness of equipment used is very important to avoid contamination of oil by microbes, enzymes and fungi. The enzymatic breakdown of palm oil occurs very rapidly and the extent of degradation is related to the length of time the oil stays in touch with contaminated equipment. Kordylas (1991) puts it that, the smaller the amount of oil produced, the greater is the extent to which it degrades under contaminated conditions. The conditions under which oil is extracted also affect its yield and quality. In some cases, palm fruit bunches are sprinkled with water and left for some days to facilitate easy removal of fruits. During this time, large portions of the raw material are infested by microorganisms and this increase the rate of decay. A number of technologies with various levels of technological advancement have been developed for processing palm oil. These are presented in the next section.

2.4 TECHNOLOGIES FOR PALM OIL PROCESSING

Techniques and technologies for oil palm fruit processing exist in varying levels of sophistication, efficiency, scale and cost per unit weight of fresh fruit bunches processed. According to the International Commission of Agricultural Engineering (ICAE, 1994), these variations determine the product quality and quantity.

Traditional methods produce low-grade oil with high free fatty acid (FFA) content and a large quantity of dirt and water. Over time, as technology improved, electronically controlled automated mills have been imported into countries like Ghana. Improvement in technology has gone through small, medium and large-scale mills, manually assisted mills and semi-automated plants. Imported mill equipment is efficient using low labour inputs but giving high output. However, they are with many characteristic problems. They require very high investment cost per ton of fresh fruit bunches (FFB) processed and highly qualified maintenance engineering staff who use sophisticated equipment. The expensive infrastructure and logistic supports that accompany the use of such equipment are making their adoption difficult. It has been observed that such high technology imported palm oil mills have no place in, for instance, the Nigeria rural development schemes (ICAE, 1994), and this is true of Ghana.

Badmus (1991), cited by ICAE (1994), states that, the traditional manual oil extraction methods that are based on individual family manned operations are small scale. This has given rise to the development of the 0.25-ton FFB/hour small scale processing equipment (SSPE). It includes a non-presurised sterilizer, a manual rotary stripper, horizontal digester, a hydraulic hand press and an oil clarifier. The SSPE has been widely produced and sold to farmers in Nigeria and elsewhere in West Africa. There has been an improvement, which is the substitution of the hydraulic hand press with a screw press. Generally, technologies available for processing palm oil may be classified under two major groups. These groups are the non-mechanical or the traditional technologies and the improved technologies.

2.5 NON-MECHANICAL OR TRADITIONAL OIL PROCESSING TECHNOLOGIES

Traditional methods of palm oil processing are generally divided into two types, 'soft oil' and 'hard oil'.

According to Kordylas (1991), 'soft oil' processing technology involves softening of the mesocarp through boiling and loosening it by pounding or trampling. This breaks down and macerates the flesh. The pounded mass is stirred in hot water and the pulp is washed or squeezed out of the fibres. The process is repeated for several times until most of the pulp is washed out of the fibres. The pulp is boiled for several hours and the oil that floats on top is skimmed off. During boiling, the yellowish brown liquid appearing on the surface is also skimmed and clarified. The pounding method ensures the production of relatively good oil because it relies on using fruits that are not over-ripe.

In the trampling method, water is used in trampling the fruits. In the process, oil is released into the water, it is skimmed and boiled to clarify. The oil, which settles on top of the water as the product cools, is skimmed off and allowed to boil a second time to reduce the moisture content. This oil is also soft, however it has a lower quality than the one produced without trampling because the dugout, lined pit and the canoe in which trampling is done, provide an immediate source of contamination and degradation. It is difficult to keep them clean and sterile.

The technology that produces 'hard oil' involves the use of fermented palm fruit. During fermentation both enzymatic and microbial reactions take place to break down the pulp and the oil within the fibres. The fermented fruits are macerated or trodden on repeatedly and the oil extracted as above without further boiling. This oil contains 18 to 35% free fatty acids and it solidifies at 32°C. It is usually used for the manufacture of soap and candles. Production takes 10 to 14 days and the yield is quite high.

According to Hartley (1977), 'soft oil' was extensively produced in Eastern Nigeria, and the process employed gave rise to this name because greater part of the oil produced was liquid at room temperature. Hartley (1977) goes further to suggest that the amount of oil extracted in the 'soft oil' method depends largely on how far heat has been maintained throughout the process and how assiduous the women are in skimming and in teasing out the fibre. Usually the mass of pounded pulp is allowed to cool off and extraction rates are low. Figures like 6 to 10 percent oil to fruit of low mesocarp content, suggest that a normal efficiency (extracted oil to total oil in the fruit) would be 40 to 45 percent. Efficiency occasionally rises to 50 percent but sometimes falls as low as 30 percent. This method gives the average FFA content as 7 to 12 percent but lower FFA oils can be produced. Hartley (1977) lists the sequence for 'soft oil' production as boiling, pounding and separation and distinguishes it from 'hard oil' production, which involves the sequence of fermentation, treading and separation. The preference of hard oil production is due to the fact that it makes low demands on labour and firewood and much carrying and boiling of water is avoided. The extraction rate, however, is low, about 4 to 6 percent of oil to low mesocarp dura fruit, with a low efficiency of 20 to 30 percent. Due to fermentation, FFA content is usually between 30 to 50 percent.

Women commonly carry out traditional processing of palm fruit and other mesocarps and the methods used are time-consuming, arduous, and inefficient (UNIFEM, 1993).

2.6 SOME IMPROVED TECHNOLOGY IN PALM OIL PROCESSING

To help reduce the problem of time, labour and also to improve the quality of palm oil, many improved equipment have been developed for use in the palm oil industry. These equipment include strippers, boilers, digesters and pressers, some of which are described in this section.

Oil Plate Presses

Plate presses are used for extracting oil from mesocarp fruits such as oil palm but depending on the pressure applied, Oil seeds and nuts can also be processed using plate presses (UNIFEM, 1993). These are commonly of two types; screw presses and hydraulic presses. According to Hartley (1977), an example of the screw press is the curb press and hydraulic hand press is an example of the hydraulic press.

In a screw press, which is manually operated, the mesocarp from which oil is to be extracted is pressed slowly and with maximum pressure by a plunger (round steel plate), forced down by a screw, and into a cylinder with a large number of holes (GATE, 1979, cited by UNIFEM, 1993). This allows the extraction of about 65% oil and handling of a greater quality of oil (Kordylas, 1991).

According to UNIFEM (1993), oil presses can be mostly manufactured locally in rural areas with the exception of the screw which needs a special device probably found in an industrial area. The nut through which the screw operates should be of a softer metal so that it will be subject to wear and tear rather than the screw, which is more expensive to replace or repair. Hydraulic presses can also be manufactured locally if lorry jacks are available.

The Curb Press

This according to Hartley (1977), consists of a screwed steel shaft, fixed in the center of a base plate, and a cage, composed of strips of stout wood set vertically about 3mm apart, and looped externally with two iron bands. The cage, which is in two halves, can be opened and lifted off so that the pressed fibre can be easily removed. Pressure is applied by a ram and worked downwards on the shaft by a cross head turned manually by two long iron bars.

The base of the press is wooden and is surrounded by a metal through fitted with one spout. The oil is squeezed out of the digested material between the wooden strips into the through and runs through the spout into any collecting vessel. The press is often known as the cage or screw press, and it is widely used in Nigeria.

Hydraulic Hand Press

A ram, which is the cylinder of the hydraulic mechanism, moves downward into a perforated press cage when hydraulic fluid pressure is increased by the hand operation of a two-piston pump. Both pistons are operated until a considerable force is required and thereafter the small piston only is operated until full pressure is reached. On the release of pressure the press ram is withdrawn upwards by springs.

The cages are filled and emptied on a table in front of the press ram and with skilled operation, one pressing, including the insertion and withdrawal of cages, takes 6 to 10 minutes. It is possible to complete 6 to 10 pressings per hour when two cages are operated. Thus 270 - 450 kg fruit can be pressed per hour, equivalent to 0.45 - 0.75 tons of bunches per hour. Oil guards surround the cages while pressing is proceeding. The crude oil, which is heavily laden with sludge, is channeled into a spout and runs off into a bucket.

Intermediate scale equipment have also been developed to handle the production of 50 - 100 hectares of oil palm (Kordylas, 1991). Such equipment include a sterilizer, a hand operated rotary stripper, and a rapid digester, which is driven by a diesel engine for pulping the fruit. It has a hydraulic press and a continuous setting clarifier, with a heat exchanger for drying the decanted oil. A standard furnace is also included for sterilization, fruit cooking, clarification and nut drying. This equipment set up is between 75 and 85 percent efficient and is capable of producing high quality oil with FFA content of 2 to 3.5 percent.

Ofei (1996) gives the characteristics of some locally manufactured palm oil processing equipment as tabulated below:

Table Showing Some Locally Manufactured Equipment for Palm Oil Processing

Producer	Equipment	Use	Characteristic
Agricultural Engineers Ltd.	AGRIGO Palm Oil Press	To press oil from digested palm fruits	1500 lbs digested fruit/hr can be produced.
Agricultural Engineers Ltd.	AGRICO palm fruit digester	For digesting palm fruit	1 - 2 tons/hr of boiled fruits can be digested. Power requirement: 6hp diesel engine or electric motor.
Agricultural Engineers Ltd.	AGRICO palm fruit boiler	For boiling palm fruit	600/each process or 2000 kg/day of fruits can be boiled.
Agricultural Engineers Ltd.	AGRICO palm fruit stripper	For stripping nuts from palm bunches	2 - 3 tons/hr fresh fruit bunches can be stripped
SIS Engineering Ltd	Clarifying tank	For clarifying oil	Output capacity: 5 drums of oil/batch.
SIS Engineering Ltd	Screw Press	For extracting crude oil from digested fruits	Output capacity. 800/day. It is manually operated yield: 116 litre/day.

2.7 SOME STUDIES ON WOMEN AND OIL EXTRACTION TECHNOLOGIES

The production of fats and oils provides an important source of income for women not only in the direct production of oil but also through secondary products, for example soaps, cosmetics and foods. (UNIFEM, 1993).

The major problem perceived by many women in traditional oil processing is the tiring nature of the work and large modern mills have been seen to pose a threat to women's incomes. In Nigeria, for example, women demonstrated against modern power-driven palm oil mills because the whole palm fruit now went to the mill and the husbands received the money for the oil directly. This deprived the women of their income from palm kernel oil, the woman's reward for making palm oil. To be able to compete with the large mills it is crucial that they have access to improved oil extraction technologies (UNIFEM, 1993).

Case studies on the use of screw presses carried out in Sierra Leone, Tanzania, Senegal and Ghana revealed the following (UNIFEM, 1993):

In Sierra Leone, it was found that th demands on women to supply water for processing were considerable. The availability of water is, in fact, the biggest limitation on traditional processing as the peak period of production coincides with the dry season when water is scarce since palm oil processing is an important source of income for rural women, the need to relieve constraints on such processing and increase the productivity of women's labour was identified. The focus of research was now on the incorporation of women's priorities into the design and to introduce oil presses directly do women groups involved in oil processing. However results of field test were not favourable. The machine was reported to be too small; there were no time savings; output was actually lower than that obtained with the traditional method. Women could not easily operate the machine and the process used more fuel wood - a scarce commodity. In sum, the new 'improved' press was firmly rejected by the villages in the pilot scheme.

In Tanzania, although the introduction of an improved oil press was to reduce women's workload, they required too much strength or could only be operated using animal power. The women found the machine too strenuous to operate.

In Senegal, a screw-type palm oil press manufactured by the village Smith was introduced to women. This consisted of a steel screw spindle turning on a lathe and a cast bronze nut. The advantage of this method is that the screw is not subjected to excess wear and a new 'home-made' one at any time can replace the nut. It is simple, not welded and all parts are fixed exclusively by means of screws or home-made rivets. Although the project succeeded in achieving a promising improvement in palm oil processing while involving village craftsmen, there were marketing difficulties.

In Ghana, the main uses of palm oil are for consumption and soap making. In the 1970s, because tallow was in short supply, the demand for palm oil in soap manufacture increased. The Technology Consultancy Centre (TCC) designed and constructed a hand-operated screw press for the extraction of palm oil by adapting existing presses being used in Sierra Leone and Nigeria. The press operated by two people is capable of pressing 20kg of pounded boiled fruit at a time. A smaller type took a maximum of 6.8kg of fruit. The extraction time for each press is 12 minutes, and pressing is supposed to be done once as it has been found that second pressing yields little additional oil and at a high cost. The TCC has also developed a range of equipment, which is used with the press. The system consists of a boiling tank, a pounding machine, press, clarifying tank, and storage tank. The introduction of the TCC mini mills has made it possible to increase considerably the output of Ghana's small-scale oil palm farmers. Moreover, with the TCC mini mills, the farmers can process their own crop. Since the programme started in 1976, approximately 250 oil mills have been established, with an average output of half a ton per day. The success of any programme intended to disseminate a technology depends a great deal on a good understanding of the process of adoption and the factors that can influence it. These factors could be deduced from the preceding section to be technical or socio-economic, a few of which are further discussed in the next sections.

2.8 DIFFUSION AND ADOPTION OF INNOVATIONS

Van den Ban and Hawkins (1988) define an innovation as idea, a method or an object, which is regarded as new by an individual but which is not always the result of resent research. The concept of adoption has been defined as the decision to make full use of an innovation as the best course of action available. Van den Ban and Hawkins (1988) listed the stages of the adoption decision process as follows:

1 Awareness

2 Interest

3 Evaluation

4 Trial

5 Adoption

Awareness is the first stage and here, an individual first hears about an innovation. Next is the interest stage where the individual seeks further information about it. He or she then evaluates or weighs up the advantages and the disadvantages of using it. This is followed by the trial stage where the farmer tests the innovation on a small-scale for himself. The final stage is the adoption stage during which the individual applies the innovation on a large scale in preference to all other methods.

Van den Ban and Hawkins (1988) explain further that the adoption process does not always follow this sequence in practice. Thus, interest may precede awareness in for example, the search for a method to control a new disease. Rogers (1983), also describes this sequence of five processes as:

1. Knowledge
2. Persuasion
3. Decision
4. Implementation and
5. Confirmation.

Adoption has been described by writers as time bound process and that the percentage of farmers adopting an innovation could be described by a sigmoid curve which shows that there is a slow growth in adoption, followed by a more rapid increase and then a slowing down as the cumulative proportion of adoption approaches its maximum (CIMMYT, 1993; Rogers, 1983). According to Rogers (1983), people are often divided into five with respect to time of adoption of innovation. These categories are:

1 Innovators, who form 2.5% of the cumulative percentage,

2 Early adopters, who constitute 13.5%,

3 Early majority, forming 34.0%,

4 Late majority, forming 34.0% and

5 Laggards who, constitute 16 %.

Rogers (1983) further explains that the characteristics of an innovation determine its rate of adoption. Such characteristics are the relative advantage, compatibility, complexity, trialability and observability.

The relative advantage of an innovation is its ability to help a user achieve his goal better or on a lower cost than others. This can be improved by the addition of incentives to the technology.

An innovation which is compatible with socio-cultural values and beliefs, with previously produced ideas or with farmer's felt needs is likely to be adopted quite early.

Adams (1982) describes complexity as the degree to which an innovation is understood and can be used by farmers. According to Van den

Ban and Hawkins (1988) some innovations fail because they require complex knowledge or skills.

On the issue of trialability, Adams (1982) also suggests that a farmer will be more inclined to adopt an innovation which he has tried first on a small scale on his farm and which proved to work better, than an innovation he had to adopt immediately on a large scale.

Observability is the degree to which the results of an innovation are visible to the farmer. Van den Ban and Hawkins (1988) assert that farmers learn much from observing and discussing their colleague's experiences and this facilitates adoption. Several other factors have been found to affect adoption. Van den Ban (1963) cited by Van den Ban and Hawkins (1988), indicates that, the adoption index has been found to be substantially correlated with contacts with extension service, and influence on other farmers when discussing their farm problems. Rogers (1983) also shows a high positive relationship between adoption index and some variables including education, high social status, large-scale units, commercial economic orientation, more favourable attitude to credit and social participation.

Leagans (1979) also indicate tha adoption behaviour depends on physical, technical, economic, social, educational and political act that establishes and maintains a macro environment, which is favourable for farmers to translate their behavioural influences into action. He further stresses that the economic aspect of a technology is the main factor determining eventual success or failure of adoption. Section 2.9 gives the views of some other writers on the technical issues affecting the adoption of a technology.

2.9 SOCIO-ECONOMIC AND TECHNICAL CONSIDERATIONS FOR THE ADOPTION OF TECHNOLOGY

According to ITP and UNIFEM (1993) the efficiency of different methods, for example, the amount of losses prevented using a new method should be compared with losses prevented by use of equivalent existing methods. Austin (1992) considers the following as the factors that determine what technology agro-processors are likely to select: quality standard, revenue, and technical requirement of the transformation process.

Generally, women are the majority of agro-processors on the small-scale level and factors that give improved technologies an advantage over prevailing ones are those that are seen to be in line with women's expectations. According to UNIFEM (1995), the capacity of women to adopt or adapt improved technologies for product preservation or product refinement purposes will also depend on a number of social factors which shape their priorities and influence the decisions which they take, though these factors may vary from place to place and overlap with each other. Such factors are documented as: time, family responsibilities, skills and training, credit and economic considerations.

Time and Family Responsibilitles

Because of their many responsibilities, women may have little time to spare which affects their capacity to get involved in the well organized production processes that processing demands. Shortening of the overall time that the processing activity takes will count as an improvement even if the finished product is of the same quality. Other women would want to improve product quality that will not require extra time. To yet other agro-processors, flexibility of time use may be more important, so that processing activities can be undertaken at the same time as other tasks. Thus, a technology may be seen as an improvement to traditional techniques if its use is flexible or if it improves quality without increasing time.

Women's available time and ability to become involved in processing operations will depend on their family responsibilities. Older women who have grown up children and younger women without children may be more able to travel to work or to work a regular shift than their counterparts who have greater obligations to their small children and husbands.

Skills and Training

Improvement of agro-processing techniques usually builds on traditional knowledge but it is important that the techniques also recognize and build on women's existing skills. Women working on improved technology for agro-processing need to have direct technical skills for operation and maintenance of the machinery as well as for treatment and quality control of the product. It is also necessary that they obtain the associated skills of literacy, numeracy, accounting, business management and marketing. It is obvious that the adoption of new technologies is likely to require some technical training. This will only be possible if the women are in the position to invest the time in learning and developing new skills.

Ofei-Aboagye, (1996) asserts that only about 26% of people in post-secondary education and training in Ghana, are women and in tertiary education, women form about 19%. In the past two decades, as an attempt to employ more women, skills training for women has increased. Other forms of training have also been provided such as leadership training; awareness-raising sessions; financial and business management and legal rights education.

Training for women in Ghana has mainly been in the efforts to facilitate self-employment and entrepreneurship development (Ofei-Aboagye, 1996). Bodies like National Council on Women and Development (NCWD), NBSSI, departments of the Ministry of Employment and Social Welfare as well as some Non-Governmental Oragnisations (I GOs) have been involved in such training programmes. Very often, funding or credit giving agencies give training to facilitate business management and the management of funds. Difficulties in providing training have arisen through factors such as the relative illiteracy of the majority of the target group. Other factors include the inability of beneficiaries to be away from their businesses for long periods of time; lack of money to invest in training; and the need for such training to give answers to specific concerns.

Credit

The government's policy objectives towards the promotion and development of small and medium scale industries (SMI) in Ghana are basically creating an enabling environment for industrial growth, sourcing financing for utilization by the private sector, and providing non-financial and technical support for industrial growth (Boeh-Ocansey, 1996). To this end, a number of institutions have been set up with support from both international institutions and the local banking sector.

One such institution is the Fund for Small and Medium Scale Enterprise Development (FUSMED) from World Bank source. Agriculture and its allied industries are the main beneficiaries of the rural finance project, which is also from the World Bank.

The United Nation's International Fund for Agricultural Development (IFAD) supports group lending in Ghana for farmers with fewer than 3 hectares based on revolving fund and shared liability. Group credit schemes are gaining in popularity and most successful credit organisations tend to be tightly knit with members who know each other well and can apply peer pressure to ensure loan repayments. IFAD et al (1998) state that women's only real opportunities for land and credit in present circumstances are through women's groups. Such groups are active in countries like Burkina Faso, Senegal, Uganda, Zambia and Zimbabwe.

Senghore (1994) states that the intimate relationship between farmers and credit institutions has been key in Ghana's success. Banking has been brought to rural people's doorstep. The Bank of Ghana has recently instituted credit schemes to assist women. These include Ghana Women Fund Schemes (GWFS), Small-Scale Holder Credit Input Supply and Marketing Project (REP). Other lending institutions include the National Board for Small Scale Industries (NBSSI), which operates an elaborate scheme for women in food processing and other agro-based businesses. In Ghana, according to Duncan (1997), increased assistance is being given to women on a broad level with major beneficiaries being women in the "income generating" areas such as female small-scale industries, food processors, hairdressers, dressmakers and other women in entrepreneurial arrangements. A survey by women in agricultural development indicated that only a minute percentage of women farmers had benefited from loans from formal sources (Duncan, 1997). Many derive their capital from informal sources such as husbands, relatives, friends, moneylenders, traders or susu grouping. Others obtain resources through other activities such as trading. Duncan (1997) indicates that beneficiaries of formal sources of credit find the process of obtaining loans difficult with delays and excessive paper work.

Despite all these, however, IFAD/FAO/FAMESA (1998), state that credit is hardly available for any small farmer, man or woman in most African countries. But for women farmers, it is even less available than it is for men. This is because land and cultivation rights are ascribed almost exclusively to men, and so women can offer no collateral for loans. In addition, they are usually too burdened with farm and family chores to be able to travel to town and spend time on the bureaucratic process of obtaining credit. Also, their skills in literacy and numeracy are often lower than those of men, thus adding to their difficulties.

Munyako (1994) also indicates the biggest problem facing small entrepreneurs in most cases as access to credit at affordable interest rates. Although many can manage interest rates of 35 to 48 percent annually, they often have to resort to greedy moneylenders who charge up to 240 percent. Morna et al (1990) state that the reasons why the majority of small-scale African farmers still do not have access to formal credit vary. Small-scale farmers often lack assets that Commercial Banks require as collateral for loans. Poor infrastructure makes it difficult for farmers to get to banks and for banks to collect loans. Quite apart from the problem of illiteracy, banks that specialize on agricultural loans tend to favour large-scale commercial farms, which they see as safer investments.

Boeh-Ocansey (1996) also indicates that according to the Agricultural Development Bank (ADB), the following characteristics of SMI place them in the high risk categories of the bank's clientele and hence limit their access to credit:

High transaction cost involved in loan administration due to the smallness of such enterprises, inability of SMI to prepare business plans suitable for the bank's needs; lack of acceptable collateral; lack of owner's equity; poor management enterprise; and lack of sufficient information on the operations of SMI to facilitate the determination of their viabilities.

In spite of these problems however, ADB has designed lending strategies to SMI, particularly those in the agro-related business, to minimize the perceived risks. Agro-industrial activities financed by ADB include the processing of palm fruits into palm oil and palm kernel oil for domestic and industrial uses. The key ones are Anwiankwanta oil mills, Anyinase oil mills as well as 60 intermediate appropriate technology small oil mills in collaboration with Technoserve funded by the World Bank under the Agricultural Diversification Project. Others are seed cotton processing into grey baft and textile prints.

Economic considerations

Both traditional and modern technologies accomplish transformation through physical and chemical processes and use the same operations. However, the mix of factors of production and corresponding cost of the two technologies are quite different (Austin, 1992). Thus, the decision to adopt a particular technology will depend on what economic advantage it has over other technologies for similar purposes.

Bruinsma (1998) measures the efficiency of equipment in economic terms as reduction of time, investment cost and processing capacity. Comparing technologies in these terms, it was found that an improved equipment for shea butter processing, a SIS engineering machine was the most efficient. Another improved machine, the mockarite, despite giving the greatest reduction in workload, was found to be the most expensive option.

According to IITA (1990), profitability of an agro-processing industry depends on many factors quite independent of its technical viability. Among such intervening variables are government policy, supply and price of raw materials, and the comparative price of imported commodity, which may be substituted. Eggleston et al (1989) suggest that for economic reasons, factories may be located close to farms. This is because agricultural raw materials are so bulky that handling and transporting them in their raw state may cancel out any profits. Generally speaking, the cost of transporting farm produce to market centres is high in Ghana where there is an average feeder road density of only 89m/km (Duncan, 1997). The situation of low feeder road density is compounded in the rainy season when these roads become inaccessible. According to FAO (1993), cited by Duncan (1997), rural Ghana is largely a "foot-path economy" where farmers spend much time head-loading commodities from fields to homes and from village to markets. This is said to severely limit production potential at the farm level.

Bruinsma (1998) indicates that for economic reasons an agro-processing equipment must be appropriate. Because of insufficient basic information to allow the evaluation of possible technological alternatives, it becomes difficult to meet the needs and demands of women involved in a particular activity. Sometimes a technology which appears to be appropriate may not be profitable and manageable by a group of women because it may be expensive and with too big a capacity. This is because the processing capacity of equipment requires that a minimum amount of raw material be processed to run profitably. However, Austin (1999) suggests that where incremental revenue justifies the increased investment, the improved technology would be adopted.

Thus an equipment will be appropriate if sufficient amounts of raw material of the right quality is available and a market exists for the final product. Also, there must be available business management skills to cater for technical requirements and management activities.

One technical issue that is of utmost importance for the adoption of improved technology for processing is the design of the equipment. Kwateng (1999) indicates that the adoption of processing equipment depends on suitability to local conditions. Since the early 1970s, a number of innovations and technologies had been introduced into Africa with limited success because the technologies often did not fit the users' needs. Imported technologies introduced through development aids, grants or loans failed to consider the technical requirement for operating the technologies. Jeon and Halos-kim (1999) buttress this point indicating that the application potential of post harvest and agro-processing technologies introduced under African conditions should be based on whether these technologies are simple enough to be operated and maintained. This suggests that technology development approaches should be re-oriented to fully integrate socio-economic issues and technicalities in the design of improved equipment. Jeon and Halos-Kim

(1999) state the following as characteristics, which should be considered in the design of technology.

The equipment should be simple, easy to operate and to maintain. This is to ensure that the technology is manageable, even by women processors and also to reduce technical problems like mechanical breakdown.

The design of improved technology should take into consideration affordability, and be associated with low investment, operation and maintenance costs. It should also be gender sensitive empowering processors in their own rights. This is to eliminate dependency on vested groups and allow processors to manage their time and operations effectively. To achieve the aim of and reduced cost affordability, the technology should be based on existing technology, indigenous knowledge and locally available raw materials. This would enhance adoption and eliminate Importation cost.

PERCEPTION

Van d en Ban and Hawkins (1988) define the term perception as the process by which information or stimuli are received from the environment and transmitted in psychological awareness. Davies and Houghton (1991) describe social perception as being concerned with our interpretation of behaviour in social settings and generally refer to how we think of others, whether favourably or unfavourably. Worchel et al (1988) also talk about the theory of self-perception as being the way we perceive our own attitudes, preferences and feelings by considering two things that are our behaviour and the situation in which it takes place, especially whether there are situational constraints which explain the behaviour. Some of the general principles that underlie the concept of perception are as follows:

Our perceptions are relative rather than absolute.

According to Van den Ban and Hawkins (1988) our perceptions are relative rather than absolute. Thus, although we may not be able to tell the weight or surface area of an object, we may be able to tell whether it is heavier or lighter than another, indicating that the percuption of a message is influenced by its surroundings.

Worchel et al mention the primacy and recency effects on perception in relation to this theory of relativity. Primacy effect describes the possibility of first impression speaking a lot of the overall view whereas recency effect indicates that last impressions count better than the first in forming an overall impression about a situation. Van den Ban and Hawkins (1988) therefore suggest that because of primacy effect, messages in agricultural extension should be designed having in mind that a person's perception of any part of the message depends on the segment immediately preceding it.

Our perceptions are selective

Van den Ban and Hawkins (1988) state that the human nervous system cannot make sense of all the numerous stimuli it receives at a time. Hence, an individual pays attention only to a selection of these stimuli.

Our perceptions are organized

Van den Ban and Hawkins (1988) illustrate this with the figure and its background example indicating that the background of a figure helps the perceiver to organize his or her senses to interpret what he or she sees.

We perceive what we expect or are 'set' to perceive

Our mental sets influence what we select and how we organize and interpret it. Thus, the writer of an extension bulletin who starts with a brief summary of his article will set the reader to seek the key points in it. 'Sets' may cause farmers to place strong mystical phenomena on situations and the extension agent must learn to understand these perceptions before trying to change them.

In conclusion, Van den Ban and Hawkins (1988) argue that extension agents cannot be expected to understand the complex psychology of human perception, but they should appreciate why people interpret their surroundings differently and how these different perceptions influence their communication behaviour.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter gives a description of the methods and procedures that were used to collect and analyze data. A, description of the population and sampling methods as well as the instrument used in collecting data on the topic are also presented.

3.1 THE RESEARCH DESIGN

The design used for this research was descriptive–correlation. Questionnaire was used as an instrument for collecting data on indigenous and improved technologies for processing palm oil. This design was appropriate in the sense that it enabled the generation of information to describe existing processes, to establish the relative advantage of one technology over another and also to test for association between the main variables of the study.

3.2 POPULATION AND SAMPLING PROCEDURE

The target population for this study included palm oil processors in the Central Region of Ghana. Four districts were selected. These are Komenda-Edina-Eguafo-Abrem (KEEA) district, Assin district, Twifo-Heman-Lower Denkyira district and Asikuma-Odoben-Brakwa district.

A total of thirty respondents were selected from the Assin and KEEA districts. These were the beneficiaries of the Intermediate Technology Small Scale Oil Palm Processing Project by Technoserve. The major equipment used is a palm fruit digester-hydraulic press unit that is powered by a gas oil engine.

Thirty other respondents were also selected from Jukwa in the Twifo-Hemang – Lower Denkyira district. The main equipment in use are motorized or electric palm fruit digesters with separate screw presses.

In Breman Asikuma (Asikuma-Odoben-Brakwa district), thirty processors using mortar and pestle with or without screw press were included in the sample. In all, ninety respondents were randomly selected to form the sample for the research.

3.3 THE STUDY AREA

The study was conducted in the four selected districts in the Central Region of Ghana, whose geographical boundaries stretch from the south to the Atlantic Ocean, towards the northwest to Ashanti Region. It is bounded by Greater Accra in the southeast and by Western Region in the west. Its total land area is approximately 9,826 sq km, out of which 3,144 sq. Km is under cultivation. It is mainly characterised by a coastal savannah vegetation with predominant crops being oil palm, citrus, cocoa, coffee and sugar cane as the main cash crops and maize, cassava, plantain, pepper, cocoyam, yam, onion, tomatoes and okro as the food crops.

The four districts selected for the research are Komenda-Edina-Aguafo-Abrem, Asikuma-Odoben-Brakwa, Assin and Twifo-Heman-Lower Denkyira. Figure 1 shows a map of these areas.

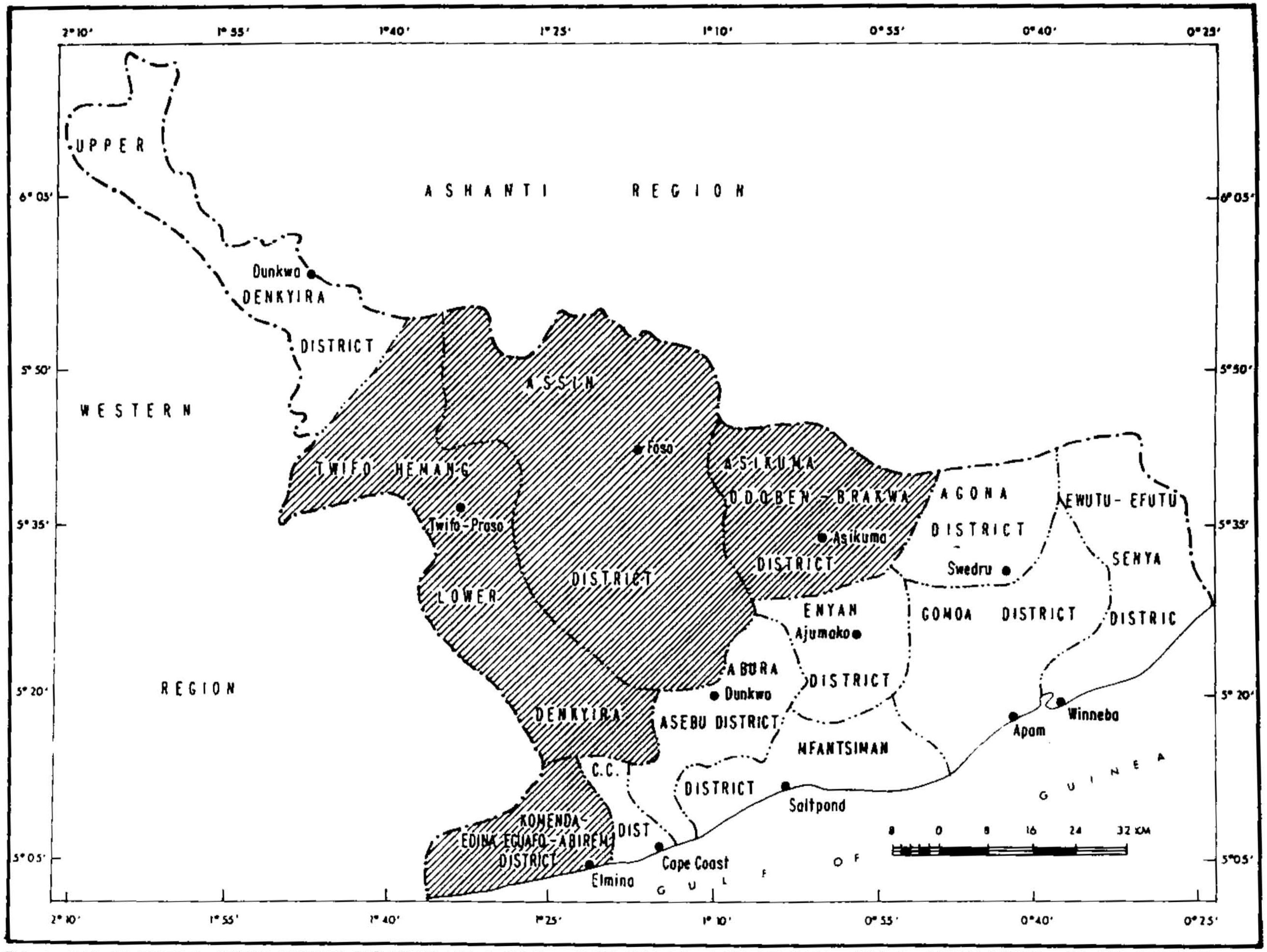

FIG. 1. MAP OF CENTRAL REGION SHOWING THE STUDY AREAS, K.E.E.A., TWIFO HEMANG/LOWER DENKYIRA, ASSIN & ASIKUMA ODOBEN-BRAKWA DISTRICT.

According to the 1998 Population Census data the population of these districts are 111,985; 87,796; 193,888; and 107,787 respectively Food processing is the principal manufacturing activity in these districts employing about 50% of the manufacturing labour force.

The 1998 population data of Ghana shows that about 52% of farmers in the Central Region are women mostly engaged in agro-processing. The region also ranks third after western and eastern regions in the production of palm oil and kernels.

3.4 RESEARCH INSTRUMENT

Questionnaires were used to collect data on palm oil processors' perceptions of the technologies for processing. The variables of the study were the characteristics of processors and the type of equipment they used. Also included were the ease of use, ease of maintenance, durability, effectiveness, appropriateness, socio-economic advantages, training and the constraints associated with the use of the equipment.

Characteristics of processors included gender, age, marital status, educational attainment, years of experience, group membership and economic status. The ease with which equipment are used was determined with items like the amount of labour required, the needed skill and the availability of fuel for running the machines. Perceptions of ease of maintenance were also described with questions such as the availability and cost of spare parts as well as the availability of local artisans to effect repairs. Perceptions of durability were measured with questions that determined the rate of breakage, rust or wear of some components of the machines. Questions on what components had been replaced and the rate of replacement were also asked. Items used to measure effectiveness included perceptions of quantity of oil produced within a certain time, labour requirement, output – input comparisons and spillage.

Appropriateness was measured with items such as suitability of the method in terms of consumer acceptance of taste and physical appearance. It also included conformity of the technologies to traditional principles of processing. Socio-economic advantages included questions on productivity, group status, labour and marketing issues. Questions on training also included the availability and importance of training on improved methods of processing. On the issue of constraints, processors were asked to indicate to what extent labour and marketing were limiting factors to production.

The questions were generally close-ended but some, for instance questions on training and constraints, were partially open-ended. The 5-point likert scale was also used to score some of the questions with 1 meaning "strongly disagree", 2 "disagree", 3 "somewhat agree", 4 "agree" and 5 "strongly agree". A copy of the questionnaire is found in the appendix.

3.5 PRETEST

The questionnaire, having been reviewed by colleagues and then supervisors, was pretested on 12 palm oil processors at Daboase and Assorko both in the Western Region. The Cronbach's alpha reliability test was performed on the likert scale type of questions to test for statistical validation. The reliability coefficient ranged from 0.64 to 0.86. The other types of responses were also studied and a final questionnaire was developed for the main data collection.

3.6 DATA COLLECTION AND ANALYSIS

The researcher administered the final questionnaire personally. This was to make filling easier to respondents who might have had it difficult to understand due to the low level of education. It was also to ensure hundred percent retrieval of filled questionnaires. The filled questionnaires were screened, coded and the data entered into the Statistical Package for social Sciences (SPSS) which was used for the analysis with respect to objectives stated for the research.

Descriptive statistics, including frequencies, percentages, means and standard deviations, were used to analyze data on characteristics of palm oil processors, adoption of palm oil processing equipment, processors' perception of advantages of palm oil processing technologies, training and problems facing processors.

The ANOVA test, including the Scheffe test was used to evaluate differences between pairs of technologies with a confidence level of 0.05. The following variables were included in the ANOVA test:

Ease of use, ease of maintenance, effectiveness, appropriateness, training, labour demand and economic advantage of the technologies.

CHAPTER FOUR

RESULTS AND DISCUSSION

In this chapter, the major findings and discussion in relation to the objectives of the study are presented. The chapter has been organized into seven sub sections that present the results of the statistical analysis as follows:

1. The characteristics of palm oil processors.
2. The pattern of adoption of equipment for palm oil processing.
3. The ease of use, ease of maintenance, effectiveness, appropriateness, durability and socio-economic advantages of the technologies.
4. Processors' perception of the training accompanying the use of the technologies.
5. Problems processors face in the acquisition and use of the technologies.
6. Comparison of processors' perception of the three technologies.
7. Partial correlation for association between the variables of the study.

4.1 CHARACTERISTICS OF PALM OIL PROCESSORS IN THE STUDY AREA

This section discusses the characteristics of palm oil processors in the study area with regard to the following variables: sex, age, marital status, educational background, years of experience in palm oil processing, economic status of processors including access to capital and the proportion of respondents' total income that is obtained from palm oil processing.

Table 1: Sex of Respondents

Sex	Frequency	Percentage
Male	10	11.1
Female	80	88.9
Total	90	100

Most of the palm oil processors included in the sample were females, forming 88.9% whereas only 10.1% were males. This indicates that palm oil processing in the Central Region is a female dominated enterprise. It was observed that the job description for the men was mainly the operation of equipment and managerial duties such as simple record keeping for processors who were in groups. This observation is in line with the finding by UNIDO (cited by Austin, 1992) that food processing is in actual fact a major source of employment for women. Also, in the Ghanaian society, women usually take up the final place in the process of provision of food, that is food preparation, and thus the direct involvement in the processing of palm fruits to palm oil would seem convenient to women.

Table 2: Age Distribution of Respondents

Age	Frequency	Percentage	Cum. %
20 – 30	5	5.6	5.6
31 – 40	29	32.2	37.8
41 – 50	28	31.1	68.9
51 – 60	17	18.9	87.8
Above 60	11	12.2	100
Total	90	100	

People aged between 31 and 50 years, with a total percentage of 63.3 formed the majority. All the remaining 36.7% were people of ages 20 to 30 years and above 50 years. Out of the 90 respondents, only one person had the highest age of 70 years.

On the issue of marital status, it was realized that the majority of the respondents were married. These formed 67.8%. Only 4.4% of the respondents were divorced, singles formed 18.9% and widows, 8.9%.

Table 3: Educational Background of Respondents

Educational Level Attained	Frequency	Percentage	Cum. %
No formal education	32	35.6	35.6
Basic education	50	58.9	94.4
Secondary school	1	1.1	95.6
Training college	4	4.4	100
Total	90	100	

About 36% of the respondents had no formal education, 59% of them had up to middle school leaving certificate and only 6% went beyond middle school to ordinary level and training college.

Table 4: Respondents' Years of Experience in Oil Processing

Years of Experience	Frequency	Percentage	Cum. %
1 – 3	16	17.8	17.8
4 - 6	26	28.9	46.7
7 – 9	18	20.0	66.7
10 – 12	14	15.5	82.2
13 – 15	9	10.0	92.2
16 – 18	6	6.7	98.9
Above 18	1	1.1	100.0
Total	90	100	

Respondents' years of experience ranged between 1 and 20 years, and majority of them had from 4 to 12 years of experience. These totaled 64.4%. Most of the respondents who had long years of experience in processing, often more than 12 years had been using mainly the indigenous technologies with little or no mechanisation.

Table 5: Source of Capital

Source of Capital	Frequency	Percentage
Personal funds	54	60.0
Bank loans	22	24.4
Family credit	9	10.0
Money lenders	5	5.6
Total	90	100

Sixty percent of the respondents used personal funds as their main source of capital. These make up the majority who are likely to find expansion of production difficult. About 24% of the respondents received bank loans. Munyako (1994) suggests that group credit schemes are becoming popular in small-scale enterprises. However, since group formation is low among the respondents, obtaining bank loan is difficult for them. Ten percent of the sample obtained loans from family members whereas 5.6 relied on moneylenders who often charged very high interest rates.

Table 6: Proportion of Income from Oil Processing

Proportion of Income	Frequency	Percentage	Cum. %
All	21	23.3	23.3
More than half	28	31.1	54.4
About half	29	32.2	86.7
Less than half	12	13.3	100
Total	90	100	

Whereas 86.7% of the processors obtained half or more than half of their livelihoods from processing oil, only 13.3% obtained less than half of their livelihoods from the enterprise. It could be inferred that for the majority of processors this business is an important source of income. Other sources of income mentioned included mostly farming and, to a lesser extent, petty trading. The importance of oil processing to the respondents was attributed to the fact that it was a constant source of income unlike farming for instance, which was seasonal. They also indicated that another advantage of palm oil processing was that, where marketing was not a problem, it gave bulk income.

4.2 PATTERN OF ADOPTION OF EQUIPMENT FOR PALM OIL PROCESSING

The study covered three main technologies at different levels of technological improvement for palm oil processing. The levels of improvement were associated with the power drive, capacity, repair and maintenance as well as economic advantages of the equipment. For the purpose of this discussion, the three technologies would be designated Technology 1, Technology 2 and Technology 3. Technology 1 comprises mortar, pestle with or without screw press. This is also referred to as the indigenous technology. Technology 2 is the use of moterised or electric digester with a separate screw press; and technology 3 is motorised digester-hydraulic press equipment.

In all three technologies palm nuts were boiled with firewood. Technologies 1 and 2 used big pots for boiling whereas Technology 3 made use of boiling tanks.

In the use of Technology 1, boiled nuts are pounded with mortar and pestle after which the pulp is either washed off or pressed to release crude oil. In the washing off method, pounded fruit is mixed with warm water and the crude oil, which consists mainly of oil and water is collected for clarification. Figures 2 and 3 show photographs of the pounding and washing off processes. In the pressing method, the pulp is first roasted to exclude water and also to ensure further rupturing of the oil-bearing cells, and then pressed. Figures 5 and 6 show the processes of roasting and pressing.

Figure 2 : Photograph showing the use of mortar and pestle to pound palm fruits.

Figure 3:Photograph showing washing off to separate crude oil from fibre.

Out of the 30 respondents who adopted the mortar and pestle technology, 17 used the screw press whereas 13 used the washing off method to extract oil. Table 7 shows the number of years of adoption of Technology 1.

Table 7: Years of Adoption of Technology 1

Years of Adoption	Frequency	Percentage
1 – 5	8	26.7
6 – 10	13	43.3
11 – 15	5	16.7
More than 15	4	13.3
Total	30	100

One of the 30 respondents had used the technology for 17 years, 3 of them had adopted it for 16 years and 5 had adopted for 11 – 15 years. The majority of processors (about 13 out of the 30) started with Technology 1 about 6 – 10 years ago. For the past 5 years, 8 of them have been using this technology. This is a possible indication that despite the existence of improved technologies and their associated advantages, some processors prefer the use of indigenous methods. Nine (30%) of the respondents indicated the desire to discontinue with the use of indigenous processing technologies, whereas Twenty-one (70%) of them expressed the desire to continue adoption. Reasons given for these decisions were as outlined in Table 8.

Table 8: Reasons to Continue Adoption of Technology 1

Reason	Frequency	Percentage
Improved technologies are expensive	7	23.0
Makes less use of water	6	20.0
Makes less use of labour	4	13.3
Makes processing quick	4	13.3
Total	21	69 6

Some of the reasons for respondents desire to continue using Technology 1 was the fact that it made less use of water. This was so in the case of respondents who used screw presses after pounding and they constituted 20%. These processors might have found the screw press beneficial because according to UNIFEM (1993), the availability of water is the biggest limiting factor to the use of indigenous technology. Four of the respondents (13.3%) indicated their desire to continue adopting because it reduced the use of labour, and 4 others said processing was made fast. Seven of the processors using Technology 1 indicated they knew about improved methods, but wished to continue with what they were using because they could not afford improved alternatives.

Out of the 9 processors who expressed discontinuation, 6 gave reasons that it was labour intensive whereas 3 said the technology required a lot of time. The issue of time is an important factor in women's decision to continue with Technologies 2 and 3. As stated by UNIFEM (1995), women have many responsibilities and thus any improvement in technology that takes into consideration reduction in time is welcomed.

Because processors using Technology 1 were not in co-operative groups, they did not have access to credit in cash nor were they able to purchase improved equipment for processing. Munyako (1994) comments about credit thus, most successful credit organizations tend to be tightly knit with members who know each other well and can apply peer pressure to ensure loan repayments. Thus women's inability to obtain credit for their activities including the purchase of improved equipment could be explained by the absence of associations among them. In the case of Technology 1, it was observed that those who used the screw press relied on the services of men who hired out the machines to them together with labour.

Technology 2 comprised two types of palm fruit digester used with separate screw press. One was powered by a diesel engine and the other was powered by an electric motor. Institutions and bodies like the Intermediate Technology Transfer Unit (ITTU) and some well established artisans locally manufactured these digesters. In both cases, boiled palm nuts are introduced into the machines through the hopper, digested by a horizontal auger and the pulp expelled through the chute. Figure 4 is a photograph showing this process. The pulp is then roasted and pressed to obtain oil as shown in Figures 5 and 6.

Figure 4: Photograph showing the use of diesel engine digester.

Figure 5: Photograph showing roasting of palm pulp.

Table 9: Years of Adoption of Technology 2

Years of Adoption	Frequency	Percentage
1	3	10.0
2	18	60.0
3	8	26.0
4	1	3.3
Total	30	100

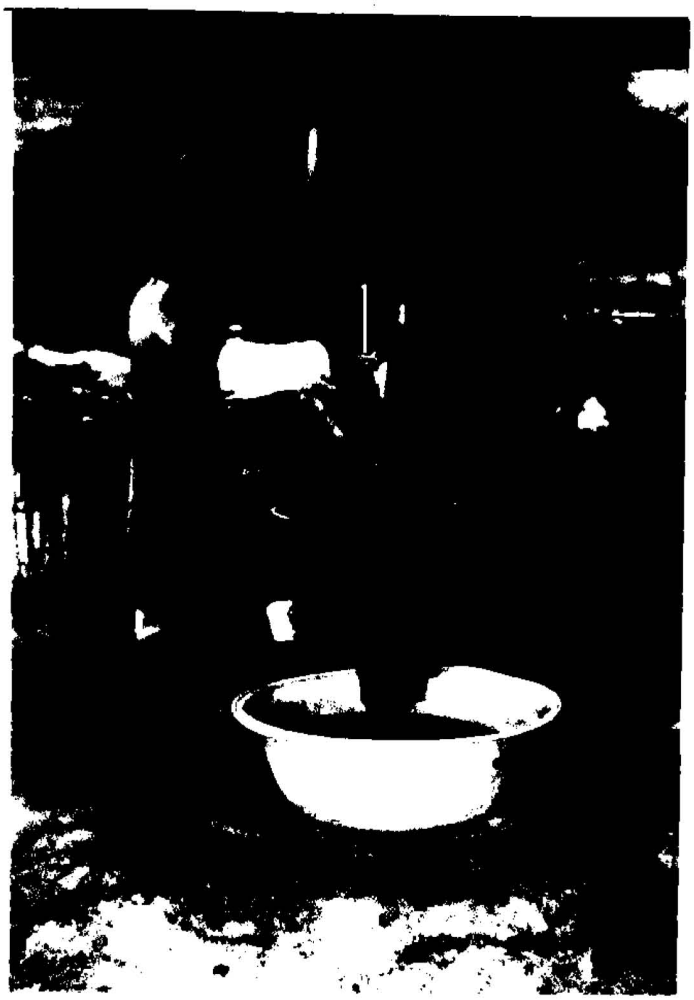

Figure 6: Photograph showing the use of screw press.

Table 9 shows that this technology has been adopted for a relatively short period. It was observed that only 1 person had adopted Technology 2 for 4 years, 8 persons had been using it for 3 years, and the highest adoption took place 2 years back with 18 processors using the technology. In addition, 3 persons had adopted these equipment during the past year. All 30 respondents indicated the desire to continue adopting with reasons given in Table 10 below.

Table 10: Reasons for Continuation of Adoption of Technology 2

Reason	Frequency	Percentage
Labour reduction	15	50.0
Time saving	8	26.7
Increased yield	5	16.7
Improved equipment is expensive	2	6.7
Total	30	100

While 50% of the respondents desired to continue using the technology because of the advantage of labour reduction, 26.7% did so because much time was saved with its use. It was observed that the amount of nuts that would require 4 men to pound using the traditional mortar and pestle for a period of four hours could be digested within half an hour and with only two men using the digester. According to 5 of the respondents, the equipment increased yield as a result of its efficiency in macerating the fruit mesocarp and thus making oil extraction more efficient than in Technology 1. Two processors indicated that their reason for continuing adoption was that better equipment could not be afforded.

The main component of Technology 3 was digester-hydraulic press equipment that was powered by a diesel engine and had the ability to digest and press at the same time. This was used together with a boiling tank of 1ton of palm fruit capacity.

Figure 7: Photograph of collection of palm fruits from boiling tanks.

The boiled palm nuts are scooped out of the boiling tanks with buckets and basins and transferred into the hoper of the digester. Digestion of fruits by a horizontal auger usually took 1 to 2 minutes to complete and the digested material was emptied into a perforated metal cage. Figure 8 shows the digester component of the equipment.

Figure 8: Photograph showing filling of hoper and the release of pulp from digester.

The perforated cage with its contents is then introduced into the hydraulic press component of the equipment where pressing results in the release of crude oil into a collecting basin as shown in Figure 9.

Figure 9: Photograph showing pressing of digested pulp to release crude oil.

After pressing, the liquid is allowed a few minutes to settle and the oil floating on top of the slurry is drained off and further boiled with low heat to exclude all traces of water. The slurry is also further boiled to extract the remaining oil.

With the exception of the washing off method in Technology 1, all the other methods involve final separation of palm kernel and fibre as shown in Figure 10.

Figure 10: Photograph showing separation of palm kernel from fibre.

The labour force for this activity, however, was observed to be mostly children of school going age and this is likely to affect the performance of such children in school or worse still to put them completely out of school.

Table 11: Years of Adoption of Technology 3

Years of Adoption	Frequency	Percentage
1	1	3.3
2	1	3.3
3	4	13.3
4	8	26.7
5	6	20.0
6	10	33.3
Total	30	100

Respondents using the Powered Digester-Hydraulic Press Machine (Technology 3) were members of well-organized oil processing groups. About 80% of them adopted the technology 4 to 6 years ago as members of processing groups. During the past three years, 13.3% of the respondents adopted the equipment whereas 6.7% did so within the last two years. All the 30 respondents indicated their desire to continue adopting due to the reasons shown in Table 12 below.

Table 12: Reasons for Continuation of Adoption of Technology 3

Reason	Frequency	Percentage
Time saving	11	36.7
Labour reduction	10	33.3
Increased yield	5	16.7
Large scale production	4	13.3
Total	30	100

According to 11 (37%) of the processors using Technology 3, one advantage that made them desire to continue adoption was that it was time saving. Ten of them (33.3%) said its use required less labour than other technologies. In the use of the digester and hydraulic press equipment, once the nuts are introduced into the hopper, minimum movement, both human and material, was required to complete digesting and pressing. The two processes required as little as 5 minutes to complete with a hopper full of boiled palm nuts. Hartley (1977) has stated that one pressing, including filling and emptying of cages, takes about 6 – 10 minutes. Five of the respondents also indicated that the advantage of Technology 3 was increase in yield and 4 (about 13%) said it allowed for large-scale production.

4.3 EASE OF USE, EASE OF MAINTENANCE, EFFECTIVENESS, APPROPRIATENESS, DURABILITY AND SOCIO-ECONOMIC ADVANTAGES OF THE TECHNOLOGIES

Table 13: Mean Rating of Equipment in Terms of Ease of Use and Maintenance, Effectiveness and Appropriateness

Variable	Technology	Mean	S.D
Ease of Use	1	3.0	0.30
	2	3.0	0.46
	3	2.9	0.46
Ease of Maintenance	1	3.7	0.28
	2	3.1	0.37
	3	3.4	0.34
Effectiveness	1	2.8	0.65
	2	3.8	0.26
	3	4.1	0.37
Appropriateness	1	4.0	0.38
	2	3.5	0.22
	3	3.8	0.40

Likert Scale: 1 = Strongly disagree, 2 = disagree,
3 = Somewhat agree, 4 = agree,
5 = Strongly agree

The mean ratings on the ease of use of the three technologies were approximately 3.0. All the groups somewhat agreed that the technologies were easy to use. The standard deviations of 0.30, 0.46 and 0.45 respectively for technologies 1 to 3 are an indication that most respondents were close to the mean in their perception of the ease of use of the technologies.

The mean ratings of the perception of maintenance were 3.7 for Technology 1, 3.1 for Technology 2 and 3.4 for Technology 3. Processors using Technology 1 generally agreed that the equipment were easy to maintain in that it required just washing with water without having to dismantle and reassemble parts. Processors perceived the maintenance of Technologies 2 and 3 to be more complex than Technology 1.

On effectiveness, Technologies 2 and 3 with means 3.6 and 4.1 respectively, rated higher than the indigenous technology, which had a mean of 2.8 indicating that the former were perceived to be more effective than the latter. Processors using mortar and pestle indicated that the method was drudgery and also led to losses through spillage. Also, because pounding could not ensure effective maceration of the cells containing oil, extraction was ineffective.

In response to the use of labour and time required for processing, Technologies 2 and 3 were perceived to be more efficient than Technology 1. While 4 workers could take 2.4 and 2.6 hours respectively for Technologies 2 and 3 to process a 15-gallon drum of oil, it took an average of 5 workers 5.9 hours to process the same amount of oil using technology 1.

The mean ratings of appropriateness were 4.0, 3.5 and 3.8 for Technologies 1 to 3 in that order. This finding is in line with Bruinsma's (1998) statement that although a technology may appear to be appropriate, it may not be profitable to a group of women. To the processors, although Technology 1 was the least effective it was the most appropriate because it conformed more to the traditional methods of processing oil than any of the other two Generally, the processors using Technology 1 said that the pounding method gave more tasty oil than the mechanized oil. It was stated that the popularly known 'dzormi' palm oil is best prepared by the indigenous method. For this reason, processors are likely to find it difficult to accept mechanized methods although they are time and labour saving as well as have several other advantages.

Table 14: Rate of Breakdown of Equipment

Rate of breakdown	Technology 1		Technology 2		Technology 3	
	Freq.	%	Freq.	%	Freq.	%
Seldom	2	6.7	13	43.3	13	43.3
Not often	16	53.3	6	20.0	15	50.0
Often	12	40.0	11	36.7	2	6.7
Total	30	100	30	100	30	100

Whilst 13 respondents each from Technologies 2 and 3 indicated the equipment seldom broke down, only 2 using Technology 1 said breakdown was seldom. However, 12, 11 and 2 respondents respectively using Technologies 1 to 3 indicated that breakdown was often. Thus, while the rate of breakdown was perceived to be generally high for Technology 1, it was low for Technology 3.

Respondents using screw press in Technology 1, indicated that the nut (or iron burns) through which the screw turned to exert pressure on the digested pulp had to be changed often because it wore out fast. This was the main cause of the breakdown of the equipment. UNIFEM (1993), comments on the durability of the screw press that, the nuts should be made of softer metal so that it will be subject to wear and tear rather than the screw, which is more expensive to replace or repair.

The major cause of breakdown in the use of technologies 2 and 3 was found to be wear and subsequent blunting of the horizontal auger which digests the palm nuts.

Table 15: Mean Rating of Socio-Economic Advantages of the Technologies

Rate of breakdown	Technology 1		Technology 2		Technology 3	
	Mean	S.D	Mean	S.D	Mean	S.D
Time to cover cost of equipment (years)	1.1	0.40	3.0	0.71	5.0	0.91
Group is financially strong	1.5	0.51	3.0	1.30	4.0	0.65
Increased productivity	2.6	0.56	4.0	0.74	4.0	0.55
Increased profit	2.2	0.54	3.3	0.92	4.0	0.76

Likert Scale: 1 = Strongly disagree, 2 = disagree,
3 = somewhat agree, 4 = agree
5 = Strongly agree

Respondents using Technology 3 were in well organized processing groups that were financially strong. Equipment were obtained on credit and were being paid for by members own contributions. They said it would take averagely 5 years to pay for the machines. Some groups had virtually finished payment and members said they were in the position to buy another machine to replace the current ones as they depreciated. Respondents agreed to the fact that the use of the equipment had increased their productivity and profit.

Of the 30 processors adopting Technology 2, only 11 were found in organized groups. Respondents somewhat agreed (3) that they were financially strong. It was observed that, the processors were not able to organize themselves to obtain their own digesters and presses. They depended on some individuals who owned the equipment to digest and press pulp for some fee. They however agreed (4) that their productivity had increased and somewhat agreed (3) that profit had increased.

Processors using the indigenous technology did not belong to any co-operative group on processing. They were mainly in individual production and few of them owned their own presses although they all owned mortars and pestles. The rest who had adopted the use of presses hired them for processing. The means for increase in productivity and profit are 2.6 and 2.2 respectively indicating Technology 1 was not efficient in enhancing productivity and profit.

4.4 PROCESSORS' PERCEPTION OF TRAINING ACCOMPANYING THE TECHNOLOGIES

Out of the 90 respondents, 60 had virtually no contacts with extension agents. These included those using indigenous technology that numbered 30 and the rest were processors using motorised digester. The little skills they had were acquired from machine operators who had in turn been trained by manufacturers. Their knowledge was however limited to feeding the machine with nuts and collecting digested pulp. In some few cases, women had skills on the operation of machines but were reluctant to apply them because such activities were thought of as a man's job. With the use of the screw press, it was found to involve more strength than skill and was operated solely by men. It was obvious that direct technical skills for operation and maintenance of the equipment were insufficient for women.

For an agro-based enterprise to be profitable not only the technical skills are important but the associated skills of literacy, numeracy, accounting, business management and marketing are also relevant (UNIFEM, 1995). To a majority of these women, skills in business management and marketing were found to be poor thus making them vulnerable to the rigours of the market. For example, training in produce procurement and bank transactions was absent. All the 60 respondents who indicated that extension was rare and also stressed that they needed training. Table 16 gives a summary of the training needs of processors using Technologies 1 and 2.

Table 16: Training Requirements of Respondents Using Technologies1 and 2

Training Need	Freq.	Percentage
Marketing issues	27	45.0
Improved methods of processing	20	33.4
Operation and management of faulty equipment	13	21.7
Total	60	100

Twenty-seven of the respondents requested for training in procurement and sale of palm oil. They also requested for training in the characteristics of the various varieties of palm fruits or nuts and how these can affect pricing. Twenty respondents also requested for all relevant improved methods of processing whereas 13 expressed the need for training in operation of machines and management of faults.

Training was made available to the 30 processors using Technology 3, which is the digester-hydraulic press equipment. Technoserve, a non-governmental organization under the Intermediate Technology Small Scale Project for palm oil processors, delivered it. Processors indicated that raining was frequent.

5 respectively show that some respondents strongly disagreed that training was frequent. While the processors also agreed (3.5) that training was adequate, they somewhat agree (3.2) on the need for more training.

Processors' perception on their ability to use the skills obtained in processing was rated 3.6. However, it was indicated that they combined skills obtained from training with their own skills. It is possible that processors' personal skill would be improved by the training acquired.

Table 18: Training Requirement for Processors Using Technology 3

Training Need	Frequency	Percentage
More regular	12	40
Marking	10	33.3
Operation and management of equipment	8	26.7
Total	30	100

Twelve of the 30 respondents using the motorised digester-hydraulic press indicated that training should be made more regular. They explained that often times improved skills where handed to them through the group leaders who in turn were trained by extension agents. Ten of the respondents expressed that they needed training on how the characteristics of the varieties can affect the price of palm fruits. For instance, it was expressed that the content of oil from a newly harvested farm was much lower than that from a farm which had been harvested about two or more times previously. It was observed that the palm oil production enterprise was not profitable to processors who had poor knowledge of marketing. Ten respondents also indicated that they needed to be trained on how to operate the machine as well as to maintain and be able to detect a fault. Although in all the groups using this technology men were there to operate the equipment, the women generally expressed desire to learn the technicalities of operation from time to time.

4.5 PROBLEMS PROCESSORS FACE IN THE ACQUISITION AND USE OF THE TECHNOLOGIES

FAO (1988) identifies the lack of raw materials, markets and finance as factors frequently constraining rural industrialization. A major problem, however, has been the lack of markets for these rural industrial products. Table 19 is a summary of the problems confronting palm oil processors in the study areas.

Table 19: Processors' Perception of the Most Important Problems they Face

Problems	Technology 1		Technology 2		Technology 3	
	Freq.	%	Freq.	%	Freq.	%
Insufficient capital	11	36.7	17	56.7	6	20
Expensive equipment	4	13.3	1	3.3	4	13.3
Expensive raw material	3	10.0	6	20.0	15	50.0
High demand for fuel	5	16.7	4	13.3	0	0
Limited market	7	23.3	2	6.7	5	16.7
Total	30	100	30	100	30	100

The most important problem for processors using Technology 1 was capital as indicated by 11 of them. Seven respondents indicating that palm oil was often sold on credit and payment delayed a lot expressed the problem of limited market. Since these processors did not get access to loans, this made the problem of capital even more compounded. This could be a reason why processors using the indigenous technologies often produce at a very low capacity. The next important problem was that processing required a lot of fuel, mainly firewood. This is because oil clarification goes through a long period of boiling using firewood, a situation that is environmentally unfavourable. This was followed by the cost of equipment. Although a few processors had acquired their own screw presses, others were just fortunate to hire screw presses from some owners and press for a fee. The most expensive equipment to them was the screw press and this was expressed by 4 of them. The cost of raw material was the least important problem and it was expressed by 3 of them. Most of the processors using Technology 1 had their own palm fruit farms, which served as sources of raw material.

For processors using Technology 2, the most important problem was insufficient capital, as indicated by 17 of them. The next important problem was the cost of palm fruit while the least important problem to them was limited market for oil.

Fifteen respondents using technology 3 expressed that their major problem was the cost of raw material. Other problems were insufficient capital, limited market and expensive equipment indicated by 6, 5 and 4 respondents respectively. Because this group of processors had organized themselves, they were beneficiaries of bank loans; they also had organized soap makers and market women who served as outlet for the palm oil produced. It was expressed by the group at Assin Dosii that market for palm oil used to be a big problem until quite recently when they teamed up with two buyers who were in turn suppliers to the Northern Region. An interview with one of the women showed that, although she had received some credit from a bank, it was inadequate for the business.

The only soap-making outlet for palm oil was found to be people involved in manufacture of indigenous soap known as in "alata" soap Apart from these, none of the 90 respondents supplied palm oil to soap making factories. They suggested that, their inability to produce for factories was due to the fact that, they could not meet the quality of oil required for soap making at the industrial level. According to them, soap manufacturers demand that the palm fruits are processed fresh but they preferred to keep them for 3 – 4 days or more to facilitate stripping. Hartley (1977) indicates that in manufacturing, oils must be bleached to definite specifications for the various uses to which they are put. Difficulty in bleaching of palm oil, which militates against its use in manufacture, may arise when palm fruits are kept for a number of days before processing.

Table 20: Rate of Breakdown of Equipment

Rate of breakdown	Technology 1		Technology 2		Technology 3	
	Freq.	%	Freq.	%	Freq.	%
Nil	7	23.3	1	3.3	3	10
Low	9	30	14	46.7	11	36.7
Medium	9	30	8	26.7	8	26.7
High	3	10	6	20	8	26.7
Very high	2	6.7	1	3.3	0	0
Total	30	100	30	100	30	100

Respondents who indicated that the rate of breakdown of the equipment was either low or medium totaled 60%, 73.4% and 63.4% respectively for Technologies 1 to 3. Only 5 respondents using Technology 1 indicated that it was of high importance with 7 stating that they did not experience equipment breakdown.

With Technology 2, 7 respondents said the equipment breakdown was high. Although the rate of breakdown was generally low in all 3 groups, it was high in Technology 3. This could be so because the digester-hydraulic press equipment is the most complex among the 3 and the machines have been in use for a longer time than other technologies.

At the time of data collection, the equipment at Assin Asamankese had temporarily broken down for about 2 days. The parts that broke down often were mainly the horizontal auger, as indicated by 27 respondents, and bolts and nuts as indicated by 3 respondents.

In the use of digesters with separate screw presses, 10 processors mentioned the parts breaking down as the auger, 10 others indicated bolts and nuts whereas 3 said the iron bar of the screw press most often broke. Seven processors with Technology 2 could not identify the parts that often broke down.

4.6 COMPARISON OF PROCESSORS PERCEPTION OF THE THREE TECHNOLOGIES

This section discusses the differences among the three technologies on the basis of the following variables:

Ease of use, ease of maintenance, effectiveness, appropriateness, training labour demand, economic advantage

Table 21: ANOVA Tests for the Differences in Mean Rating of Processors' Perception of the Three Technologies

	Type of Technology			
Dependent variable	1	2	3	F Value
Ease of use	3.00_a	2.96_b	2.94_c	0.16
Ease of maintenance	3.71_a	3.11_a	3.42_a	24.87
Effectiveness	2.82_a	3.58_a	4.02_a	53.89
Appropriateness	3.98_a	3.54_{ab}	3.79_b	12.63
Training	2.47_a	2.54_b	3.38_{ab}	46.32
Labour demand	2.65_a	2.43_a	1.79_a	113.55
Economic advantage	2.26_a	2.88_a	3.76_a	109.98

Scale: 1 = Strongly disagree 2 = disagree,

3 = Somewhat agree 4 = Agree

5 = Strongly agree

*$P \leq 0.05$ **$P \leq 0.01$

Note: Means with common alphabets diff r significantly from each other.

Means with different alphabets do not differ significantly from each other.

H_0: There is no significant difference in the ease of use among the technologies.

From the table, slight differences exist between the mean ratings of ease of use of the three technologies but the differences are not statistically significant. The probabilities for difference between any two technologies are all greater than the 0.05 confidence interval used for the test. Based on this, the null hypothesis is accepted. Therefore the three methods are not significantly different in terms of the ease of use.

H_0: There is no significant difference in the maintenance of the technologies.

The mean ratings of ease of maintenance for technologies are respectively 3.11 and 3.42. Probability for difference between technologies 1 and 2, 2 and 3 is 0.001. Since this probability is less than 0.05, the test shows the three technologies are significantly different in terms of the ease of maintenance. Thus Technology 1 is the easiest to maintain, followed by technology 3 and lastly 2. On the basis of this, the null hypothesis is rejected.

H_0: There is no significant difference in the effectiveness of the technologies.

Differences between the effectiveness of the technologies were statistically significant. The test showed a p of less than 0.05 for each comparison. The mean ratings of 2.82, 3.58 and 4.02 respectively for technologies 1 to 3 showed that the indigenous technology was the least effective and the motorised digester-hydraulic press technology was the most effective among the three. The null hypothesis is thus rejected.

H_0: There is no significant difference in the appropriateness of the technologies.

The mean ratings for the appropriateness of technologies 1 to 3 are respectively 3.98, 3.54, and 3.79. The difference between technologies 1 and 2 were statistically significant with a p of less than 0.01 and that between technology 1 and 3 was 0.06, greater than 0.05. This implies technology 1 is not significantly more appropriate than 3. The difference between technologies 2 and 3 is statistically significant with p (0.004) being less than the confidence level of 0.05. This means there exists a significant difference in appropriateness and the null hypothesis is rejected accordingly. The reason why processors using Technology 1 thought of it as the most appropriate could be that consumers preferred the taste of manually prepared palm oil to that produced with modern equipment. This is in line with the finding by Eggleston et al (1989) that often the public does not accept food that has not been traditionally prepared although large scale processing guarantees much higher quality.

H_0: There is no significant difference in the training accompanying the use of the technologies.

From the ANOVA table, the mean rating for training related to technologies in palm oil processing was highest for Technology 3 and least for Technology 1. Differences between Technologies 1 and 2 were not statistically significant ($p = 0.76$). However, significant difference exists between Technology 3 and any of 1 and 2 with a p (0.000) less than the confidence level. The null hypothesis therefore is rejected and the alternative accepted.

H_o: There is no significant difference in the labour required by the technologies for processing.

The test showed significant differences between Technology 1 and Technology 3 in terms of their labour requirement. The highest in labour demand was Technology 1 and the lowest was Technology 3. Thus, with an increase in mechanisation a significant amount of labour is saved. In effect, the null hypothesis cannot be accepted.

H_o: There is no significant difference in economic advantages associated with the use of the technologies.

Technology 3 had the highest rating on economic advantage (3.76), followed by Technology 2 (2.88) and the least advantage (2.26) was associated with Technology 1. The test showed a p (0.00) less than the confidence level of 0.05. This shows the differences are statistically significant and the null hypothesis is rejected.

4.6 PARTIAL CORRELATION FOR POSSIBLE ASSOCIATION BETWEEN CERTAIN VARIABLES OF THE STUDY

In this section a discussion is given on the possible associations and their direction and significance between pairs of some variables including:

Ease of use

Ease of maintenance

Effectiveness

Appropriateness

Economic advantages

Training

Labour requirement

Time required for processing

Table 22: Correlation for the Perception Variables for all Respondents

VARIABLES	Totease V_1	Totmaint V_2	Totefect V_3	Totaprop V_4	Totfnance V_5	Totraing V_6	Totlab V_7	Time V_8	Equipmt V_9
V_1	1.00								
V_2	-0.03	1.00							
V_3	-0.02	-0.20*	1.00						
V_4	0.13	-0.20	-0.19	1.00					
V_5	0.10	-0.25*	0.63**	-0.16	1.00				
V_6	0.03	-0.14	0.39**	0.08	0.57**	1.00			
V_7	0.22	0.18	-0.63**	0.05	-0.69**	-0.62**	1.00		
V_8	0.10	0.40**	0.47**	0.13	-0.35**	-0.24*	0.38**	1.00	
V_9	-0.08	-1.19*	0.68**	-0.18*	0.72**	0.46**	-0.66**	-0.39**	1.00

*P < 0.05 **P < 0.01 N = 90

Totease	=	Ease of use of technology
Totmaint	=	Ease of maintenance of technology
Totefect	=	Effectiveness of technology
Totaprop	=	Appropriateness of technology
Totnance	=	Economic advantages associated with the use of the technology.
Totraing	=	Availability of training associated with the use of technology.
Totlab	=	Labour requirement for use of the technology.
Time	=	Duraation of processing
Equipmt.	=	Type of equipment.

Whereas some variables did not show the existence of significant associations, others showed the existence of significant associations. For instance, it was observed that, the ease of use did not show any significant association when partially correlated with other variables. A discussion on the relevant associations is presented in the subsequent paragraphs.

Effectiveness and economic advantages correlated substantially, with r = 0.63 and being significant at the 0.01 probability level. It was found out that equipment that was perceived as effective also had high economic advantages associated with their use. Such economic advantages included increase in productivity and profit, reduction in labour use and the time required for processing, as well as availability of credit for processors. For economic benefits, policies on research should therefore look into improvement in effectiveness. Issues that could be considered in the development of processing equipment are increase in capacity, decrease in time needed to process a given quantity, reduction in labour use and reduction in spillage.

There was a moderate association between effectiveness and training (r = 0.39). It was significant at the 0.01 confidence interval. This is so say that processors who were given training on the use of improved technologies also perceived the kind of technologies they were using to be effective. From this it could be inferred that enhancing the effectiveness of an equipment or method should go with the necessary extension training that would make the innovation easy to adopt. This is in line with the finding by Rogers (1983) that the rate of adoption of an innovation has an association with education.

Technologies that were perceived to be less effective were also associated with high use of labour ($r = -0.63$, $p<0.01$). It was observed that although the use of mortar and pestle technology, for example, required a lot of labour, it was the least effective. Effectiveness and duration of processing also showed a moderate correlation ($r = 0.47$) and this was significant at the 0.01 probability level. Correlation between effectiveness and type of equipment was substantial and significant ($r = 0.68$, $P < 0.01$). Thus, effectiveness was found to be highly associated with improvement in technology, which also highly correlated with economic advantages ($r= 0.72$, $P < 0.01$).

Economic advantage correlated significantly ($P < 0.01$) with perceived availability of training, demand for labour and duration of processing using particular technologies. The respective coefficients of correlation were 0.39, -0.63 and -0.35.

Correlating perceived availability of training and labour requirement, showed a substantial association ($r = -0.62$, $P < 0.01$). Thus, where perceived training scored high, labour for processing scored low. This is in accordance with the findings that where processors used mechanised equipment like the digester-hydraulic press, labour use was low. In the case of the indigenous technology, the issue was not just a high demand of labour for the equipment used, but the high use of labour could also be due to the fact that no extension support is given on how best to process with the minimum labour possible. There was a substantial association between labour use and type of equipment ($r = -0.66$, $P < 0.01$). It could be deduced that increase in mechanisation is accompanied by reduction in labour. This is in line with the observation that labour required for use of Technology 1 was the highest among the three.

From the results and discussion presented it could be said that Technology 1 has been adopted for the longest number of years and despite its associated disadvantages, processors perceived its use as appropriate. The latest technology to have been adopted was Technology 2. Generally, Technology 3 was perceived to have more advantages than any of the other two equipment. Constraints facing processors were marketing, the seasonal nature of raw materials, the huge initial capital required to purchase equipment and the unavailability of credit from banks. Processors using Technology 3, however, due to the dynamic nature of groups they belonged to, had access to some credit for their activities.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

Oil palm has been branded the highest yielding oil-bearing plant, with even the poorer plantations of Africa out yielding the best fields of coconuts (Hartley, 1988 and Asiedu, 1992). The establishment of processing industries based on appropriate technologies, according to Austin (1992), is one of the most effective means of finding alternative employment in the rural areas. And in Ghana, research institutions and extension organisations work towards the generation and dissemination of technologies for small scale processing of palm oil as a priority area for the development of the agro based industries. For the processor, some of the benefits accruing to the use of such technologies include marketing and access to credit due to the associated small group formation.

This work was to cover indigenous and improved small-scale processing methods and equipment relevant to women for processing palm oil. The main aim was to describe the technologies available for processing palm oil on small scale and the value that processors place on them.

The specific objectives were:

- To determine the characteristics of palm oil processors.
- To examine the pattern of adoption of technologies.

- To examine the ease of use, maintenance durability, effectiveness, appropriateness and economic advantages of the technologies.
- To identify and assess effectiveness of training related to the use of the processing technologies.
- To ascertain the problems posed to processors in the acquisition and use of the technologies.
- To compare the various technologies on the basis of the perceived ease of use, maintenance, durability, effectiveness, appropriateness and economic advantages.
- To examine the possible associations between ease of use, maintenance, effectiveness, appropriateness, economic advantages and training available to processors in addition to labour and time needed for processing a given amount of palm oil.

The research was conducted from August 1999 to March 2000. The target population for the study was palm oil processors in the Central Region of Ghana. Four main districts were covered by the research. These were the KEEA, Assin, Twifo-Hemang-Lower Denkyira and Asikuma-Odoben-Brakwa districts. The main sampling method used was the simple random sampling and a total of 90 respondents were selected for the project.

Questionnaires were administered by the researcher to collect data on the perception of processors of the palm oil technologies they were using. Data thus collected were subjected to analysis using the SPSS software and the statistics used were descriptive, analysis of variance and correlation in relation to specific objectives. The results are summarised below:

Objective 1 was to determine the characteristics of palm oil processors in terms of gender, age, marital status, educational background, number of years spent in oil processing and economic status. Majority of the respondents were females, the ratio of male to female being 1to 9. Processors aged between 31 and 50 years formed the majority group (about 63%). Also, on the issue of marital status, most respondents were married (about 68%), with the rest being either single, divorced or widowed. Processors were found to have a low educational background, as 36% of them had no formal education, 59% had basic education and only 6% went beyond middle school. The number of years of being in palm oil processing ranged between 1 and 20 years with most of the respondents having 4 to 12 years experience. It was observed that credit availability was low for processors. Only about 24% of them had access to credit from banks. Sixty percent of them used personal funds and about 16% depended on other sources of credit. To a majority of the respondents, palm oil processing is a major source of income. This is because about 87% of them had all or up to half of their income from palm oil processing.

The second objective was to describe the pattern of adoption of the various technologies for processing palm oil. The results showed that the longest used technology was the indigenous methods (Technology 1), which included mainly, the use of mortar and pestle, which had been used for as long as 17 years. This technology was still being adopted because it was found that some adopted in 1999. Although some respondents desired to stop the use of this technology because it was labour intensive and slow, others wished to continue due to the fact that better technologies were not affordable.

Technology 2 involved the use of a digester, which was powered by either an electric motor or a diesel engine. This equipment was used together with a separate screw press, and its adoption was quite recent in the area of study. The range of years of adoption was 1 to 4 years, with most respondents adopting 2 years ago. The advantages for which all 30 respondents desired to use this technology were mainly labour and time saving as well as increased yield.

Respondents using Technology 3 were beneficiaries of the Intermediate Technology Small Scale Oil Palm Processing Project by Technoserve, a non-governmental organisation. The major equipment used by these women groups was a digester-hydraulic press unit. Three of such equipment had been distributed to three groups in the selected districts. Processors were found to be in organised women's groups and about 80% of them had adopted the technology since the past 4 – 6 years. All 30 respondents desired to continue adopting because it was time and labour saving, increased the yield of palm oil and allowed for large scale production.

Objective 3 was to assess the ease of use and maintenance of the technologies, their effectiveness, appropriateness, durability and socio-economic advantages associated with their use. It was observed that all three technologies were generally quite easy to use but with the ease of maintenance, Technology 1 scored the highest followed by Technology 3 and lastly Technology 2. The technology that scored the highest on effectiveness was 3, followed by technology 2 with 1 being the least effective.

Technology 1 scored the highest on the issue of appropriateness, and the least appropriate was technology 2 with Technology 3 being in-between.

The least durable equipment was found to be Technology 1. The rate of breakdown was quite higher than that of Technology 2 whose rate was in turn higher than that of Technology 3. It was also noticed that the main causes of breakdown in Technology 1 was the screw component of the screw press, whereas in the case of Technologies 2 and 3 it was blunting of the horizontal augers.

The highest socio-economic advantages were found to be associated with the use of Technology 3 where group formation made it easier for equipment to be purchased on credit and also for marketing of palm oil. Other benefits included increased productivity and profit. These benefits were reduced with the use of technology 2 and much more reduced with the use of Technology 1. The majority of the respondents using technologies other than Technology 3 had minimum or no credit at all.

Objective 4 was formulated to describe processors' perception of training accompanying technologies for palm oil production. Apart from the 30 respondents who were beneficiaries of the project under Technoserve, the processors did not have contacts with extension agents. Direct technical skills for the operation and maintenance of processing equipment were insufficient to some women and unavailable to others. Generally, the women had poor skills in business management and marketing as well. Those who received training from Technoserve however perceived it to be frequent and adequate.

The fifth objective was to determine the problems processors face in the acquisition and use of the equipment. Processors using Technology 1 expressed unavailability of credit and marketing facilities as their major problems. Processors using Technology 2 indicated that their major problems were low access to credit and high cost of raw material. Similarly, processors using Technology 3 perceived the cost of raw material and insufficient credit as the main setback to successful enterprise. Other problems mentioned included the cost, fuel consumption and frequent breakdown of equipment.

The sixth objective was to compare the three technologies on the basis of the ease of use and maintenance, effectiveness, appropriateness, availability of training, labour demand and some economic advantages. Significant differences existed between the technologies for all the variables except the ease of use. The most easy to maintain equipment was found to be Technology 1 and the least was Technology 3, which also rated highest in effectiveness, appropriateness, training, labour reduction and economic advantages.

The final specific objective was to determine if there exist any relationships between the following variables: ease of use, ease of maintenance, effectiveness, appropriateness, economic advantages, training, labour demand, duration for processing and type of equipment. Correlation performed at the 0.05 probability level indicated significant relationships between the following variables:

(i) Technologies that were perceived to be effective also had high economic advantages; good extension training and were also accompanied with the advantages of labour and time saving.

(ii) Economic advantage correlated positively with perceived availability of training, and negatively with labour use and the duration for processing.

(iii) A high level of training was perceived to be associated with low use of labour and short period for processing.

(iv) The higher the demand for labour for a particular technology, the higher its requirement of time for processing.

(v) It was observed that ease of use and appropriateness of the technologies did correlate significantly with other variables.

5.2 CONCLUSIONS

From the findings of this research, the following conclusions can be made.

1 The processors were found to have the following characteristics.

Processors are largely females, with the few males being directly involved with operation of processing equipment.

i. The oil processing enterprise is an employer of the youth with the modal age being 31 to 50 years.

ii. Majority of the processors are married with dependants.

iii. The level of formal education of processors is low but there is a high amount of experience among them.

iv. Palm oil processing is a major source of income to the processors, however majority of them do not own or belong to groups that own improved equipment for processing.

2 With regard to the pattern of adoption of the technologies for processing palm oil, the following conclusions are made.

i. The indigenous technology of using mortar and pestle has been adopted for as long as 17 years and processors desire to continue adopting due to their inability to afford improved ones and also the fact that it is more appropriate than improved methods when taste of oil is concerned.

ii. Improved technologies for processing have been used for a maximum of 6 years and their advantages of time and labour saving as well as increase in productivity makes users desire to continue adopting.

3 Perceived effectiveness of extension training available for processing palm oil.

Only processors who are in formal groups using the digester-hydraulic press equipment have access to frequent and adequate training. The rest virtually have no extension contacts at all.

4 Problems that processors face in the acquisition and use of the technologies for processing.

i. Credit to enable the adoption' of improved technologies is either unavailable or insufficient.

ii. The cost of raw material (palm fruit) is high.

iii. There is high fuel consumption, especially for the indigenous technology, which depends solely on firewood.

iv. There is frequent breakdown of equipment.

v. Market for palm oil is limited.

5 Comparing the perceived value of the technologies.

i. Significant differences exist between the technologies in the ease of maintenance. The easiest to maintain is the indigenous technology, whereas the most improved is the most difficult to maintain.

ii. While the improved technologies are significantly more effective than the indigenous, the latter is perceived as the most appropriate.

iii. Women who belong to organized groups receive more training than others who are not in groups and the difference is significant.

iv. There are significant differences in the labour required for use of the three technologies. Mortar and pestle demands the highest labour whereas the digester-hydraulic press demands the least labour.

v. The differences in economic advantages associated with the use of the technologies are significant. The greatest economic advantage is with the use of digester-hydraulic press whereas the least is with the use of mortar and pestle.

6 Relationships between the variables of the study. Significant associations exist between the following variables:

i. Ease of use

ii. Ease of maintenance

iii. Effectiveness

iv. Availability of training

v. Labour required for processing

vi. Time required for processing.

5.3 RECOMMENDATIONS

1 Improving agricultural extension training for women in palm oil processing.

i. Palm oil processing is an area that needs extension attention from bodies like the NGO's and the women in Agricultural Development (WIAD), which works under the Ministry of Food and Agriculture.

ii. Education on the advantages of using time and labour saving technologies in processing.

iii. Technologies in marketing, especially in the area of procurement of palm fruit should be transferred to both palm fruit growers and processors. These should include the pricing of palm fruit bunches based on weight and the variety.

iv. There is the need also for training in simple business management skills for the women.

2 Elimination or reduction in the problems that affect the success adoption of improved technologies.

i. Processors should be encouraged to form co-operative groups to make them credit worthy and also able to adopt improved equipment as groups.

ii. Funds should be made available from the district assemblies, for the procurement of improved equipment to replace the inefficient indigenous technologies. Once such equipment are in place, users could be made to pay in installments as is being done for groups under some NGO's.

iii. The marketing strategy adopted at Assin Dosii, where oil produced by individuals of the group is transported to the northern sector and wholesaled could be adopted elsewhere to improve market for palm oil.

iv. The local soap making enterprise should be improved to serve as an outlet for palm oil. This has worked for the group at Dabir, near Ayensodo and could serve as another door to employment or extra income.

3 For further research, the following suggestion could be considered.

i. Methods of processing that will ensure production of oil acceptable for soap making at the industrial level need to be developed and transferred to processors to enable them improve their outlets for palm oil. An approach that could enable a shift from the use of indigenous methods to mechanized methods is by considering the trade-off between technology improvement and organoleptic properties like taste and flavour of the product, which determines the appropriateness of the technology.

ii. Equipment for the removal of pressed kernel needs to be developed for small-scale processors to curtail the use of labour since manual separation is labour intensive.

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APPENDIX

UNIVERSITY OF CAPE COAST

SCHOOL OF AGRICULTURE DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION

QUESTIONNAIRE FOR PALM OIL PROCESSORS

The purpose of this questionnaire is to describe palm oil processors' perceptions of technologies in palm oil processing. The information obtained will help to improve processing technologies in palm oil. Any information you provide will be treated as confidential. Please be objective and indicate your response by ticking [√] where appropriate, or circling one of the figures 1 – 5 to indicate your response to the question.

District ....

Characteristics of Agro-Processors

1 Sex? Male [ ] Female [ ]

2 Age at last birthday .... years.

3 Marital Status: Married [ ] Single [ ] Divorced [ ]

Widowed [ ] Separated [ ]

4. Number of children ....

5. What is the highest educational level that you have attained?

No formal education [ ] Primary school [ ] Middle school [ ]

Ordinary level [ ] Advanced level [ ] JSS [ ] SSS [ ]

Commercial college [ ] University [ ] Other (specify) ....

6. For how long have you been in palm oil processing?

....

7. What is your status in this processing enterprise? Employee [ ] Sole owner [ ] Member of joint owners [ ]

8. What is the source of capital for your enterprise? Credit from bank [ ] Credit from susu [ ] Credit from family [ ] Money lenders [ ]

Personal funds [ ] Loan + Personal funds [ ]

9. What proportion of your income is from the processing business? All [ ]

More than half [ ] About half [ ] Less than half [ ]

10. Are you a member of a cooperative group? Yes [ ] No [ ]

11. Do you receive any form of support from your group or organization?

Yes [ ] No [ ]

12. If yes state the nature of the support? Loan [ ] Marketing [ ]

Labour [ ]

13. Indicate what equipment you use in processing palm oil and the year

you first used it (them) ....

14. Would you like to continue using the method you are practicing now?

Yes [ ] No [ ]

15. Kindly indicate your reasons for your decision in Q. 14.

Reduce labour [ ] Increase yield [ ] Processing made fast [ ]

Reduce labour & Increase yield [ ]

Indicate the extent to which you agree to the following statements by circling one of the figure 1 – 5

1 = Strongly disagree

2 = Disagree

3 = Some what agree

4 = Agree

5 = Strongly Agree

Ease of Use

16. The equipment is not easy to use	1	2	3	4	5
17. Many hands are needed to work	1	2	3	4	5
18. I need a lot of skill or learning	1	2	3	4	5
19. Fuel or power for processing is not readily available	1	2	3	4	5

Maintenance

20. Spare parts are readily available	1	2	3	4	5
21. Spare parts can be manufactured by local artisans	1	2	3	4	5
22. Cost of spare parts is high as compared to the cost of machine	1	2	3	4	5
23. Repairs are readily available	1	2	3	4	5
24. Cost of repairs is high	1	2	3	4	5

25. Have you abandoned any component of the machine because it was not working? Yes [ ] No [ ]

26. If yes, list those parts.

....

27. Which of these things affect your machine? Breakage [ ] Rusting [ ] Wear and Tear [ ]

28. How would you describe the frequency of breakdown of the machine within a year?

Seldom [ ] Not often [ ] Often [ ]

Effectiveness

29. I am able to produce large quantities within a short time	1	2	3	4	5
30. Labour required for use of the technology is reduced	1	2	3	4	5
31. The value of output compared to input is high	1	2	3	4	5
32. The technology is effective in reducing spillage	1	2	3	4	5

Appropriateness

33. The method is suitable for the kind of palm oil I am processing 1 2 3 4 5

34. Taste of oil is acceptable to consumers 1 2 3 4 5

35. The physical appearance of the oil is acceptable to the market 1 2 3 4 5

36. The method conforms to the traditional principles of processing 1 2 3 4 5

Socio-Economic Advantages

37. Is the cost of the machine managed on individual or group basis?

Individual [ ] Group [ ]

38. What length of time did it or will it take to cover the cost of the equipment?

....

39. The equipment has strengthened my co-operative or group financially 1 2 3 4 5

40. My productivity has increased. 1 2 3 4 5

41. My profit margin has increased 1 2 3 4 5

42. What variety of oil palm do you use in processing?

....

43. In terms of oil quality what advantage has this variety got over other varieties? ....

44. How long does it take to complete processing for one 15 gallon of container of oil from boiling to the end?

....

45. What quantity of palm fruits will give you one 15-gallon container of oil?

....

46. How much fuel do you need to complete processing for this amount of oil?

....

47. How many fuel workers do you employ to complete processing for one 15 gallon container of oil? ....

48. What are the sources of raw material?

....

49. What channels of marketing do you use? Export [ ] Factory [ ]

Local market [ ] others ....

50. Using the scale below, indicate the amount of labour required for the various stages of processing.

1 = Very low 2 = Low 3 = Medium 4 = High 5 = Very high

51. Labour for splitting palm bunches	1	2	3	4	5
52. Labour for boiling	1	2	3	4	5
53. Labour for pounding	1	2	3	4	5
54. Labour for pressing	1	2	3	4	5
55. Labour for removal of kernel	1	2	3	4	5

Training

56. I receive regular training on technology I am using for processing 1 2 3 4 5

57. I am given adequate training in the use of improved procedures for processing 1 2 3 4 5

58. I am able to work better when I apply knowledge gained together with my own experience 1 2 3 4 5

59. What do you think can be done to improve on training?

....

Constraints and Problems

60. What is the most important problem you face in palm oil processing?

....

Use the scale below to indicate the extent to which the following are problems or constraints to your productivity.

1 = Nil 2 = Low 3 = Medium 4 = High 5 = Very high

61. Machine is too expensive	1	2	3	4	5
62. Market for palm oil is limited	1	2	3	4	5
63. Some parts of the equipment spoilt easily	1	2	3	4	5
64. Labour is expensive	1	2	3	4	5