FACTORS INFLUENCING ADOPTION OF RECOMMENDED PALM OIL PROCESSING TECHNOLOGIES IN UGHELLI-NORTH AND ISOKO-NORTH LOCAL GOVERNMENT AREAS OF DELTA STATE, NIGERIA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN AGRICULTURAL EXTENSION AND RURAL SOCIOLOGY.

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DECLARATION

I hereby declare that this thesis titled **"Factors Influencing Adoption of Recommended Palm Processing Technologies in Two Local Government Areas of Delta-State"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All borrowed ideas have been duly acknowledged in the text and a list of references provided.

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CERTIFICATION

This thesis titled **"Factors Influencing Adoption of Recommended Palm Oil Processing Technologies in Two Local Government Areas of Delta-State"**byPatience **GUNN** meets the regulations governing the award of degree of Master of Science in Agricultural Extension and Rural Sociology, Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This work is dedicated to my husband, whose boundless love and relentless effort and encouragement enabled me to persevere in this program to the end.

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ABSTRACT

The influence of respondents' socio-economic characteristics along with other factors on adoption of the recommended palm oil processing technologiesin Delta State, Nigeriawas investigated. This study was carried out in order to determine the specific factors that significantly influence adoption of recommended palm oil processing technologies in the study area. Multistage sampling procedure, (in conjunction with purposive and random sampling techniques) was used in selecting respondents for this study. Data were collected, using structured questionnaire, and analyzed, using descriptive statistics and multiple regression analysis. Results revealed that processors were mostly female (62%), with mean age of 39 years and were 95% literate. The respondents had mean processing experience of 14 years and they also had low access to credit facilities (9%). All the socio-economic characteristics of the respondents influenced adoption of recommended technologies except sex. The study has revealed that adopters of recommended palm oil processing technologies had increase in both their income and output. Respondents reported that the technologies were compatible, complex and very expensive. The specified socio-economic and institutional predictor variables collectively contributed 87% to the variation in the levels of adoption of the recommended palm oil processing technologies. It was discovered that none of the processors had contact with extension agents, while accessibility to credit facilities was another serious constraint facing the processors. There were no functional social groups among the processors also. It is therefore recommended that credit scheme should be instituted and made available to processors by government and other financial institutions. It is also recommended that processors should form cooperative societies to enable them take advantage of the credit scheme being advocated for and enjoy the benefit of group dynamics.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The oil palm (*Elaeisguineensis)* is one of the most important economic crop in the tropics. Oil palm is the most important source of vegetable oil of all oil bearing plants, and is the highest yielding too (Kolaosoye, 2005; Odior, 2007). This important economic tree is generally agreed to have originated from the tropical rain forest region of West Africa. The main belt runs through the southern latitudes of Cameroon down to Nigeria and through Togo. The oil palm is indigenous to the Nigerian coastal plain, having moved inland as a staple crop. In Nigeria, oil palm cultivation is part of the way of life of most people living in the southern part of the country. It is like their culture (FAO, 2007). Additionally, every part of the oil palm can be put to advantageous use, such as palm ribs and fronds for roofing and thatching, brooms, baskets, wickerwork and mats while its residue can be used for fire lighting and as energy source, and is particularly suitable for low-cost and low-technology activities. Due to all these uses, it offers an almost unlimited scope for employment and thus a source of livelihood and income for many (Oladipo, 2008). According to Ayodele (2010) oil palm production provides jobs for at least 1.8 million Nigerians.

The increase in demand for oil palm products has necessitated the improvement of the crop in various ways, from its method of cultivation to its harvesting and processing, in harmony with recommended agronomic practices. For this harmony to be realized, the Nigerian Institute for Oil Palm Research (NIFOR) was established in Benin City, Edo State in 1981 to genetically improve oil palms. This involves improving its agronomic practices, including planting, cultivation and harvesting techniques, to

develop control measures for pests and diseases of palms, processing, preservation, storage and utilization of palm products among other functions that NIFOR is committed to carry out (Ayeni*et al.*, 1996).

Food and Agriculture Organization (2003) asserted that due to the economic importance of the oil palm as a high-yielding source of edible and technical oils, the oil palm is now grown as a plantation crop in most countries with high rainfall like Nigeria. The oil palm is said to be rich in oil production, and one of its products namely palm oil, is in high demand world-wide. This fact is made clearer by what is stated in (www.tropentag.de/2003) that: 90% of the palm oil produced finds its way into food products, with industrial uses accounting for the other 10% of palm oil produced. For instance, palm oil is used in a wide variety of food products such as margarine and cooking oil.

Over the last four decades, palm oil has been the driving force in the world of edible oil and fats (Ugwu, 2009). He further opined that palm oil is endowed with good technical attributes and economic advantage as one of the most produced and consumed oil. Palm oil is also said to beckon on its users by its price and technical superiority among multitude of edible oil applications due to its availability all year round (Ugwu, 2009). For the palm oil processing industry to sustain this competitive edge, continued research is very crucial in regard to appropriate processing technology to pave the way forward in shaping the future of the palm oil industry. However, in Nigeria, 80% of palm oil processors comes from dispersed smallholders who harvest semi-wild palm fruits and use manual processing techniques, a processing technique that is labour intensive and highly inefficient, with a low palm oil extraction rate and

high free fatty acid (ffa) content that can be up to 30% in some instances (Orewa*et al.*, 2009; Ugwu, 2009). From 2000-2008, Nigeria's palm oil production increased, but still unable to meet up with local demand how much more, global demand (www.crnindia.com). Nigeria was one of the world's exporters of palm oil in the 60s, but today can no more meet up with local demand for palm oil; rather she is now a net importer of the product.

1.2 Problem Statement

Nigeria is the third largest producer of palm oil in the world, yet she imports palm oil to meet her domestic demand. Nigeria's goal therefore, should be to meet the domestic demand and if possible, compete with other countries such as Malaysia and Indonesia known as the leading countries in palm oil processing (Ayodele, 2010). In line with this, the Nigerian Institute for Oil Palm Research (NIFOR) has made various efforts as a research institute to improve the processing of palm oil in Nigeria. NIFOR, for instance, had made some efforts to improve on the traditional milling methods by producing Small-Scale Palm oil Processing Equipment (SSPE) (Ayeni*et al.*, 1996; Ugwu, 2009) which could remove the tedium and drudgery, and improve the quality of the palm oil extracted (FAO, 2005; Odior, 2007). Observably, most literatures either focus on the labour intensiveness of traditional method of palm oil processing, along with its low quality and high free fatty acid content (Ayeni*et al.*, 1996; Olagunju, 2008; Ugwu, 2009) or are silent about the efficiency of traditional method of palm oil processing. The Food and Agricultural Organization (1984) however, puts it at between the rates of 20% to 30% of oil extraction when using the traditional method.

On the other hand, Orewa (2009) and Wahid *et al*. (2010) opined that traditional methods, which use rural techniques, are primitive, labour intensive and highly inefficient, producing negligible quantities of low quality and unstable palm oil with a limited shelf life. Orewa (2009) further showed that traditional methods in Nigeria, on the average, yield about 4% crude palm oil of fresh fruit bunch (FFB) compared to 18% - 23% achieved by industrial and intermediate scale technologies. This means that 80% of the oil that could potentially be recovered is never recovered and therefore goes to waste (Wahid *et al*., 2010). Additionally, Nigeria's extraction rates, in comparison with other countries of the world, are very low. It was rated 18%, as against 25% in Thailand and 90% in Malaysia (WRM, 2001; Chavalparit, 2006). Small scale farmers in Nigeria, produce over 80% of the total production of palm oil, using traditional methods. However, the traditional methods usually yield high rate of free fatty acid (FFA) that can be as high as between 5% - 30%; as against 5% or less, which is the internationally acceptable standard (Orewa*et al.,* 2009; Ayodele, 2010). They further assert that the high rate of FFA occur as a result of using traditional processing method, where bunches are kept for about 7-9 days or even more to allow for the fruits to get loosened from bunches before processing. This delay causes a build-up of FFA (Orewa*et al.,* 2009; Ayodele, 2010).

Additionally, processors level of adoption of the recommended technologies in the study area is not known. Factors influencing their decision on either to adopt the new technologies or not, is not known also. This study revealed factors influencing processors' decision on adoption of the recommended technologies. An investigation was carried out to ascertain the constraints associated with processing activities in order to identify areas in which processors require assistance and empowerment to

enable them adopt the recommended processing technologies and if possible, own them. It was also observed that there are no extension agents in these communities to inform and guide these processors in their use of the processing machines. Therefore, one is tempted to ask, from where do these processors get their awareness of the use of these machines? In order to examine these issues, the following research questions were put forward:

i. what are the socio-economic characteristics of palm oil processors in the study area?

ii. what are their sources of information?

iii. what is the level of adoption of recommended palm oil processing technologies in the study area?

iv. what are the factors influencing adoption of the recommended palm oil processing technologies?

v. what are the effect(s) of adoption of recommended palm oil processing technologies on output and income of respondents

vi. what are the constraints faced by the respondents in adoption of recommended palm oil processing technologies?

1.3 Objectives of the Study

The broad objective of this study is to assess factors influencing adoption of recommended practices in palm oil processing in Ughelli-North and Isoko-North Local Government Areas (LGA) of Delta State. The specific objectives are to:

i. describe the socio-economic characteristics of palm oil processors in the study area;

ii. identify processors' sources of information on the recommended palm oil processing technologies;

iii. determine the level of adoption of recommended palm oil processing techniques by processors;

iv. identify the factors influencing the level of adoption of recommended palm oil processing technologies in the study area, and

v. examine the effect of adoption of recommended palm oil processing technologies on output and income of respondents

vi. identify the major constraints to adoption of recommended palm oil processing technologies.

1.4 Justification of the Study

Traditional method of palm oil processing is not only tedious and inefficient but also time consuming and low in palm oil quality and quantity. There has also been expressed concern by various agencies, particularly Nigeria Institute for Oil palm Research (NIFOR), on the need to improve the quality of processing technologies of palm oil. It is therefore, expected that the findings of this research can serve as feedback to researchers in the institutes and other stakeholders on areas improvement can be made in the palm oil processing machines. It is hoped that the improved technologies for palm oil processing would bring relief to small-scale palm oil

processors that uses the processing technologies, by improving their level of productivity.

However, the factors influencing adoption of these improved technologies cannot easily be determined in Ughelli-North and Isoko-North local government areas without carrying out a study of this nature. This study helps to determine palm oil processor's source of awareness and their adoption level of the recommended technologies. This is done with the aim of suggesting ways in which small-scale processors can be better equipped to adopt the improved technologies en mass. Thus, this study is aimed at investigating the possible constraints to palm oil processing, in order to identify the problems encountered by the processors and proffer solutions on how to boost their productivity, reduce inefficiency and improve level of living.

Information gathered from this work will guide policy makers on how to direct government towards effective palm oil production in the nation with specific reference to palm oil processing especially, in the study area since they will be better equipped in areas where the constraints to the adoption of new technologies in palm oil processing lie. The study is also designed to investigate the constraints of palm oil processors in adopting the recommended practices of palm oil processing. The result of this study will serve as a guide to extension agencies to form a data base for continuous research aimed at improving the efficiency of the small scale palm oil processor. This research work will also be a base for statistical inference to other works and research analysis, also as an inferential guide for manipulation of the variable(s) which hinders adoption of palm oil processing. The findings from this

research will serve as a framework for further research on small scale palm oil processing in the area.

1.5 Hypotheses

H_o 1. Socio-economic characteristics of respondents have no significant influence on the level of adoption of recommended palm oil processing technologies

H_o 2. Institutional factors have no significant influence on the level of adoption of recommended palm oil processing technologies

H_o 3. Technological attributes have no significant influence on adoption of recommended palm processing technologies.

H_o 4. Adoption of palm oil processing technologies has no significant effect on output and income of the processors.

CHAPTER TWO

LITERATURE REVIEW

2.1 Historical Perspective of Palm Oil Production in Nigeria

There is a consensus that the oil palm (*Elaeisguineensis*) is a native of West Africa. Many reports cited Nigeria among the most probable place where the fruit was first domesticated before the 14th century. Palm tree is found predominantly in southern Nigeria especially in the wet rain forests and savanna belt. It also exists in the wet parts of North central Nigeria, in areas like Southern Kaduna, Kogi, Kwara, Benue, Niger, Plateau, Taraba and Nasarawa States as well as the Federal Capital Territory (FCT) (Orewa*et al.,* 2009; Ayodele, 2010). Ayodele (2010) opined that as early as 1901, Nigeria was producing all palm oil sold in the world market and it was a dominant source of foreign exchange until the 60s. However, due to over-reliance on traditional production methods, excessive tapping of palm tree for palm wine, break up attempt in 1967-70, Nigeria was unable to meet up with the global rise in demand.

Moreover in Nigeria, an early planting of oil palm was undertaken near Calabar between 1912 and 1916, but it was only in 1939 that an oil palm research station was established near Benin City which was later known as Nigeria Institute for Oil Palm Research (NIFOR) in 1981 (Orewa*et al.,* 2009). In the early 40s, both Jacquemard (1998) and Orewa*et al.* (2009) alluded to the fact that the British government pursued a policy of developing the production of oil palm, like that of other crop, on indigenous farms so as to produce more palm oil. According to them, several plantations were established in Nigeria in the 50s by the Unilever Company to produce palm oil, but not until independence that the first national development plans for oil

palm were drawn up, based on the establishment of industrial plantations. However, the economic and political problems that accompanied independence triggered a decline in the exportation of palm oil in Nigeria. In spite of the efforts of governments and donor agencies, Nigeria's palm oil output has grown more slowly than human population (Orewa*et al.,* 2009). Furthermore, Nigeria was one of the world's largest producers of palm oil and more than 82 percent of the country's total value of domestic exports was from palm oil before the advent of petroleum oil in the last quarter of the 20th century (Wahid, 2010). He also added that in the 60s, palm oil production in Nigeria accounted for 43% of world's production, but today, Nigeria accounts for just 7 percent merely trailing Malaysia and Indonesia the world's largest exporters of palm oil currently. Palm oil also remains the major source of edible oil in Nigeria (Nnamdi, 2010; Wahid, 2010).

2.2 Economic Importance of Palm Oil

In Africa, Ayodele (2010) noted that no part of the oil palm is considered waste; the leaves of oil palm are used for making brooms, roofing and thatching, basket and mats. Additionally, sap tapped from the flower is processed into a drink, called palm wine, which is a rich source of yeast. The palm wine can in turn be allowed to ferment and then distilled into a gin known as "*Ogogoro".* The empty fruit bunch, the shell and fibre that remain after palm oil extraction are used for manure, mulching, and as fuel. Palm oil is an essential food item because about 90 percent of the palm oil produced ends in food products, while the remaining 10 percent is used for industrial production (www.tropentag.de/2003). Due to its many uses, demand for palm oil is growing fast as the world's population increases and standards of living rises (Aghalino, 2000; Ayodele, 2010).

Aghalino (2000) in his assertion emphasized that the motivation for individual participation in the processing of palm oil in pre – colonial period stemmed from the individual's view of what he or she stands to gain from the exercise. Due to its economic value, palm oil processing is considered as a traditional source of revenue for people. For example, most men processed palm oil to meet domestic consumption needs and partly for satisfying social obligation such as payment of bride's price, buying of essential item such as salt or luxury item like gin. He also stressed that palm oil processing made immense contribution towards meeting the socio–economic needs of pre-colonial Isoko and Urhobo people of the western delta. Furthermore, palm oil processing serves as a source of livelihood, income and also provides food for its processors (Oladipo, 2008).

Nigerians have also been found to consume more palm oil than they produce because local demand for palm oil has increased over the years (Ayodele, 2010). They further estimated that for every five people in Nigeria, perhaps two liters of palm oil or more are consumed each month for cooking, this has resulted to rapid domestic consumption than production. Therefore, since Nigeria could not meet the demand for her palm oil consumption, importation then became imperative (Olagunju, 2008; Ayodele, 2010). From 2000 to 2008, Nigeria production increased but not at a rate that could meet up with rising global demand and consumption, though the global production also increased in 2004, Nigeria merely produced 3 percent of global production and consumed 4 percent thereby, making Nigeria a net importer of palm oil (www.crnindia.com). The palm oil is also a source of raw material for several industries which lie within the scope of domestic manufacturing including: soaps and

detergents, bakery and confectionary fats. Hence, palm oil production and processing has been acclaimed as good business not only for its self-sufficiency but also for the increasing gap between local demand and supplies (Oladipo, 2008).

2.3 The Concept of Technology

Technology is the application of knowledge for practical purpose, which is generally used to improve the condition of human and natural environment and carry out some other socio-economic activities (Tologbonse*et al.,* 2005). It is a complex blend of material processes and knowledge. Technology has made pertinent contributions to national progress and its usefulness has attained universal recognition, both at national and international levels. In many developing countries including Nigeria, lack of appropriate technological and scientific knowledge application limits agricultural and economic progress (Odebode, 2008).

In Nigeria, improved agricultural technology has contributed significantly to agricultural development and the gap between developed and developing countries in the area of agricultural production can be attributed largely to differences in the level of technological development, adaptation and transfer process. In developed nations, there is an advanced level of technical know-how and widespread application of technological innovations resulting in high productive capability in agriculture as well as in industry. This is not so in Nigeria where these technologies are not often available to farmers. Where they are made available, few farmers usually have access to them (Adekanye, 1983). The relevance of the above discussions is to help in understanding the type of technologies being used in the study area and their adoption rates.

2.4 Processing Technologies

In order to make efficient use of foods, many foods have to be processed before consumption to convert foods into more convenient and usable forms (USDA, 1999). Through processing, there are reductions in food preparation time and other delays associated with unprocessed food. Processing helps to provide more varied and higher quality meals, reduces waste in the food preparation process, and stabilizes costs through price control. Processing brings about significant cost savings. These cost savings can be in the form of a discount in the normal commercial price as a result of mass processing. Processing has become an integral part of day-to-day service operations (USDA, 1999). Village level agro-processing activities are responsible for the preservation and distribution of the bulk of agricultural produce, playing a major role in the post harvest food system. These activities constitute the main occupation of rural dwellers (IFAD, 2007)

2.4.1 Palm oil processing

Palm fruit in its natural form is highly perishable, unless it undergoes processing to convert it to palm oil and other by-products. Processing therefore becomes necessary since oil palm fruits require processing within 48 – 96 hours after harvest (Owolarafe and Arumughan, 2007). The most appropriate processing technology is one that produces the highest quality of oil with the highest extraction rate and lowest cost given the available capital. Palm oil processing enterprise is mainly dominated by small scale processors. Palm oil is processed from the fruit of the oil palm (*Elaeisguineensis*), palm oil is extracted from the mesocarp of the fruit. The mesocarp is about 70 - 80% by weight of the fruit and about 45 -50% of this mesocarp is oil (www.palmoilrefinary.htm). The rest of the fruit comprises the shell, kernel, moisture

and other non fattyfibre. The extracted oil is known as crude palm oil (CPO) which until quite recently was known as the golden commodity (http/www.palmoilrefinery). Both the pulp and the kernel yield oil and each have a different fatty acid composition. The pulp makes up 60–90% of the fruit's weight.

On the other hand, Ejemba confirmed that more than 70% of the pulp consists of oil, and a fruit bunch can yield about 20% palm oil (Ejemba, 1989). The fresh fruit bunches of oil palm are usually processed by several people in order to get palm oil (Ekine and Onu, 2008). The palm oil produced can also be used by other industries as a by-product to process more than 50 different products in the form of foods, cosmetics, fuel, and even explosive (Maryani and Irawanti, 1997). Aghalino (2000) further added that, the principal product of oil palm is the palm fruit, which is processed to obtain three commercial products, which are; palm oil, palm kernel oil and palm kernel cake.

2.4.2 Traditional processing technologies

In the Southern States of Nigeria (Cross River, AkwaIbom, Rivers, Edo, Delta and Bayelsa) palm oil processing has become a major source of income (Taiwo*et al.*, 2000). They further stated that, production of palm oil forms part of agricultural and farming preoccupations. However, different communities have evolved diverse methods for processing palm oil, most of these methods, though rudimentary, are effective and low cost. The local method, according to Taiwo*et al.* (2000) involved a sequence of processes. Though very simple, the exercise is tedious and time consuming and the total result of efficiency depends largely on the expert and skill of manpower involved. Traditional methods employed are simple and convenient for their

scale of production. The equipment used for the traditional processes are cheaper compared to the requirements for improved high technology processes. However, these traditional technologies are low yielding, time consuming, labour intensive and give products of relatively low quality (Dziedzoave*et al*., 1999; Scott *et al.*, 2002; Westby 2002).

The Food and Agricultural Organization (1984) pointed out that there is much variation from district to district in the traditional methods of palm oil processing for human consumption; however, these methods tend to fall into two particular groups; the "hard oil" and the "soft oil" process (FAO, 1984; Orewa, 2009). The hard oil process is also referred to as fermentation process (FAO, 1984). To process "hard oil", the United Nations Development Fund for women (UNIFEM,1987) explained that bunches are usually broken up to some degree, after which the fruits are separated from the broken bunches and placed in old or disused canoes, specially constructed wooden troughs or occasionally in clay-lined pits. The fruits are covered with water and allowed to ferment for a period of several days under the influence of the natural fungi, yeasts and enzymes present in the fruit. The fruits are later mashed, the oil gradually rises to the surface of the water and is skinned off at regular intervals, and it is then boiled to remove water and often filtered through basket work to remove excessive pieces of extraneous material (UNIFEM, 1987; Orewa, 2009). Also, this process is considered to be exceedingly inefficient in terms of oil yield, with only about 20% to 30% of the oil present recovered (Food and Agricultural Organization, 1984). The process is referred to as "hard oil" process because the oil contains a high percentage of free fatty acid (FFA) in it, which may exceptionally be as high as 50% and commonly around 10% to 20%, it thus has a very firm consistency (Cornelius,

1984; FAO, 1984). The FAO (1987) and Orewa (2009) however, asserted that oil which has less than 5-7% of free fatty acid (FFA) is generally preferred for cooking purposes whereas oil produced through the fermentation method has FFA content of about 10-30%.

The "soft oil" process is however described by Food and Agricultural Organization (FAO) (1984) to involve: boiling of the fruit after their separation from the Bunch. They are then pounded in wooden mortars with wooden pestles till mass containing oil, fiber and unbroken nuts is obtained after kneading, the mass is sieved to remove unbroken nuts and fibers. United Nations Development Fund for Women (UNIFEM) (1987) further stated that the liquid mixture must then be boiled to break the oil and water emulsion. Oil then floats to the surface and is skimmed off. UNIFEM added that this process yields oil with a lower FFA content which is acceptable for food use. The "soft oil" or "hard oil" processes are both practiced traditionally. Food and Agricultural Organization (1984) and UNIFEM (1987) both alluded to the fact that both traditional methods of palm oil production namely the "hard oil" and the "soft oil" process have a low extraction efficiency of under 50% and are both labor intensive and time consuming.

Whatever choice of palm oil one chose to process traditionally involves the use of tools such as mortar and pestle for the processing. This fact was better clarified by FAO (2005) which stated that the two methods of fruit maceration common in traditional processing technique of oil palm extraction are:

- pounding cooked/soaked fruits in large wooden or concrete mortars with a wooden pestle; or

- Foot trampling of the cooked but cold fruits in canoes or specially constructed wooden troughs.

Whichever processes a processor chooses to use, FAO (2005) asserted that they must use the following procedure:

- Cutting down of ripe palm fruits;
- Stripping or removing fruit from bunches;
- boiling of loosed fruits in pots or drums;
- pounding in a wooden mortar until the cooked fruit are macerated;
- mixing the pounded fruit mash in hot or cold water;
- removing fibre and nuts with a small baskets;
- filtering out residual fibre from the oil/water emulsion with a perforated metal or baskets;
- boiling and skimming palm oil from the oil/water mixture; and
- drying the recovered oil.

According to Omereji (2005) processing palm fruit bunches into palm oil is one of the most difficult activities in traditional food processing in Nigeria, this is due to the fact that the process is usually carried out slowly to avoid much loss of oil that may likely result from lack of care taking in carrying out the process.

2.4.3 Improved processing technologies

The operations of the traditional methods of processing palm oil necessitated the improved technique being promoted. The promotion and adoption of the mechanized operations is aimed at reducing drudgery, enhancing processing efficiency and avoiding the hazards associated with the traditional techniques. The success or failure of

processing depends largely on the efficiency of the processing technology used. An efficient processing technique according to Ukpabi (2004) increases the quality and quantity of palm oil available for consumption and trade. The objective of any palm oil processor as noted by Oladipo (2008) is to obtain the highest percentage of palm oil possible and palm oil processors from their individual stand points must be convinced and satisfied that their personal gains from palm oil processing should be more than their cost of processing for them to remain in the palm oil processing business.

Furthermore, Food and Agricultural Organization (FAO) (2005) asserted that a matured oil palm can produce between 9,000-10,000 kg of fresh fruit bunches (FFB) per hectare (ha) when a plantation is well managed, and with good extraction technologies, these will yield approximately 2,000 liters of palm oil per year and per ha. However, the efficiency of processing techniques here in Nigeria is lower, when compared to the ones use by their Asian counterparts. As put by World Rainforest Movements, palm oil extraction rates in Nigeria ranges from 20% to 50% as compared to 90% in Malaysia (WRM's, 2001). Chavalparit (2006) for instance, reported that in Thailand the average yield is 15.6 tonnes of fresh fruit bunch (FFB) per hectare in a year, while efficiency of FFB production and oil yield per hectare of Thai oil palm plantations were put at 15% and 28% respectively. This extraction efficiency rate can be used as a yard stick in assessing the performance of a technology and how well a plantation is doing, because it is the quantity of oil realized per hectare that will determine if the venture is profitable or not (Chang *et al.*, 2003). Technological efficiency can however, be achieved by employing improved processing technologies for the extraction of palm oil soon after the fruits are harvested by using some of the technologies stated below:

Bunch reception: Fresh fruit arrives from the field as bunches or loose fruit. The fruit is normally emptied into wooden boxes suitable for weighing on a scale so that quantities of fruit arriving at the processing site may be checked (FAO, 2005).

Threshing: It is the removal of fruit from bunches. The fresh fruit bunch consists of fruit embedded in spikelet growing on a main stem. In a mechanized system, a rotating drum or fixed drum equipped with rotary beater bars, detach the fruit from the bunch, leaving the spikelet on the stem (FAO, 2005).

Sterilization: This means sterilizing or cooking of the palm fruit, by using high temperature wet-heat treatment on the loose fruit, cooking normally uses hot water while sterilization uses pressurized steam. The heat treatment destroys oil-splitting enzymes and arrests FFA. The cooking action serves several purposes. Heat treatment destroys oil-splitting enzymes and arrests hydrolysis and autoxidation. Heat helps to solidify proteins in which the oil-bearing cells are microscopically dispersed. The protein solidification (coagulation) allows the oil-bearing cells to come together and flow more easily on application of pressure. Fruit cooking weakens the pulp structure, softening it and making it easier to detach the fibrous material from the oil during the digestion process. The high heat is enough to partially disrupt the oil-containing cells in the mesocarp and permits oil to be released more readily.

The moisture introduced by the steam acts chemically to break down gums and resins. The gums and resins cause the oil to foam during frying. Some of the gums and resins are soluble in water. Others can be made soluble in water, when broken down by wet steam (hydrolysis), so that they can be removed during oil clarification. Starches

present in the fruit are hydrolyzed and removed in this way. When high-pressure steam is used for sterilization, the heat causes the moisture in the nuts to expand. When the pressure is reduced the contraction of the nut leads to the detachment of the kernel from the shell wall, thus loosening the kernels within their shells. The detachment of the kernel from the shell wall greatly facilitates later nut cracking operations. Air increases oil oxidation considerably at high temperatures; hence oxidation risks are high during sterilization. Over-sterilization can also lead to poor bleach ability of the resultant oil (Wahid, 2010).

Digester: It is the process of releasing the palm oil in the fruit through the rupture or breaking of cells. The digester consists of a steam-heated cylindrical vessel fitted with a central rotating shaft carrying a number of beaters and the fruit at high temperature, this helps to reduce the viscosity of the oil, pounds the fruits outer covering, and completes the whole process of the pounding that began during the sterilization phase.

Extraction of the palm oil: There are two methods of extracting oil from the digested material. One system uses mechanical or screw presses and is called the dry method. The other called the wet method, uses hot water to leach out the oil. In the dry method, the objective of the extraction is to squeeze the oil out of a mixture pressured on the digested mash. In a screw press, the mashed fruit is drawn into a perforated cage, the outlet of which is partially obstructed by an adjustable cone. The pressure built up inside the cage by the continuously rotating central screw causes the crude oil to be extracted. Crude oil is a mixture of water, oil and sludge. While still in the press, it is diluted with hot water, and by pressing, three products are obtained, a mixture of fibres, nuts and the crude oil. The fibres are separated from the nuts by a breaker-

conveyor and are used as a fuel in specially designed boilers. The crude oil on the other hand is then clarified (Jacquemard, 1998; FAO, 2005; Orewa*et al.*, 2009).

Clarifier: This means the separation of oil from its unstrained impurities, because the fluid coming out of the press is a mixture of palm oil, water, debris, fibrous material and non-oily solids. But by clarification, the oil is purely separated from its impurities. The aim of clarification is to extract impurities from the crude oil so as to recover the maximum possible yield of pure oil (Jacquemard, 1998). Crude oil according to him, contains approximately 35 percent oil, the remaining however, consist of water and suspended matter (sludge). Clarification is therefore effected using settling tanks. Temperature on other hand plays an important part in the process, influencing both the viscosity and the density of the oil. The degree of dilution introduced at the pressing stage also affects settling speed (Jacquemard, 1998).

Following clarification, the oil obtained cannot be stored as such, because it still contains impurities and water. The impurities contents are reduced to below 0.01 percent by a second clarification process or by means of a purification centrifuge. The water content of the oil should be brought to below 0.1 percent to avoid any risk of acidification by hydrolysis during storage. Since water is partially soluble in oil, drying must be carried out. To do that, the oil is first heated to a temperature just above 100^{o}C before being sent to a natural drier, where it is spread in a thin layer and exposed to air ventilation. Vacuum driers, which are also widespread, operate in the same way but at a lower temperature (Jacquemard, 1998; FAO, 2005).

2.5 Profitability of Palm Oil Processing

Profit is considered to be a major indicator of viability of any business. The amount of revenue realized after deducting operating cost of any business venture determines how much gain or loss an enterprise can achieve within a certain period. However, the determination of a producer's profit or loss is difficult in a small scale palm oil enterprise since producers have several objectives including meeting their consumption need which is not usually measured.

According to Ekine and Onu (2008) the quantity and amount of revenue realized by processors are usually under estimated mainly due to inadequate recording and improper accounting procedures. The level of gross margin of small scale palm oil processors is influenced by determinant which include, cost of palm fruit, cost of hiring equipment, transportation of the palm bunches, availability of labour, price of palm oil among other expenses. These determinants are crucial because the survival of the enterprise is highly dependent on these important variables. While, Ekine and Onu (2008) revealed that the cost of processing one thousand fresh fruit bunches (FFB), into palm oil in Ikwerre local government area is N84, 000.00 with a gross margin of thirty seven thousand, two hundred naira (N37, 200.00) for palm oil processors after deducting cost of processing.

2.6 Socio-Economic Characteristics of Processors

A study that was undertaken to evaluate the technologies in use for the production of palm oil from gender perspective in Osun and Ondo States of Nigeria showed that palm oil processing is female dominated (Ajibola, 2000). Nnamdi (2010) also pointed out that palm oil processing is commonly done by women. According to

Olagunju(2008), about 80% of the palm oil processed comes from dispersed small holders, who harvest semi wild plants and use manual processing techniques. Olagunju also revealed that 79% of the processors were male, while 24% were female, with mean age of 56 years and their mean processing experience was 13 years. Therefore, if policy makers actually want to boost production of palm oil in Nigeria, they will need to attract more young people into the business by discouraging rural-urban drift, and making policies that has incentives attached to palm oil processing (Olagunju, 2008).

Similarly, Ugwu (2009) estimated that about 800,000 hectares are under wild oil palm groves while more than 60,000 hectares have been cultivated with improved varieties. The area under cultivation with oil palm in Cross river State is about 715,502 hectares with an estimated total production of 5,366,265 metric tones (ffb). Most of the oil palm enterprises in the state are small to medium scale in size. However, Agwu (2006) revealed that in Abia state, the average number of years of experience of the respondents in oil palm production was approximately 14years. Additionally, 62% of the farmers had between 0.1-5.99 hectares of oil palm plantation hence, they could be regarded as small-scale farmers. In a similar vein, Akangbe (2011) found out in his study conducted in Afijo local government area of Oyo state that majority (60%) of the respondents obtained their oil palm farms as an inherited family possession, while very few of them obtained theirs as gift (3.8%). The remaining respondents however, bought their own land, while other respondent were operating on rented oil palm farms.

According to the Food and Agriculture organization (FAO, 2005) quoted in Ekine and Onu (2005) small-scale oil palm farm may cover 7.5 hectares. Their study revealed

that the average size of palm plantation of the processors was 2.2 hectares and majority of the respondents had 6years and above processing experience, with high rate of plantation inheritance in the study area. Their result also revealed an average household size of processors to be 8 persons per household while, the processing industry was dominated by men and the most prominent source of labour was family members. Furthermore, Agwu (2006) asserted that, majority (92%) of the farmers belonged to one or more social/farmers organizations. These organizations could serve as channels for extension contact with large number of the farmers, as well as, offer opportunities for participatory interaction with extension organizations. Result from the study also shows that 38% of the respondents financed their farming activities through private savings. The average farming experience of the respondents was 14 years.

Similarly, Olagunju (2008) found out that out of 120 sampled processors, 20% has been in processing for 1-5 years, 50% had 6-14 years processing experience, the remaining 30% had been processing for 15 to 20 years. The mean processing experience is 13 years. About 76% of processors acquired their plantation through inheritance, while 24% was acquired theirs through rentage. The average household size of processors was 8 persons while the processing industry was dominated by men. In a study conducted by Iwala*et al*. (2004) most of the farmers were old with a mean age of 53 years and 94.4% being male, almost all the farmers were married (94%). The farmers were also sufficiently educated as 61.2% of them had a minimum of primary school education and most of the farmers had at least 20 years farming experience. Therefore, the socio-economic characteristics of the respondents in this study are not expected to be any different from the ones enumerated in this section.

2.7 Sources of Information to Farmers

Knowledge and information are basic ingredients for increased agricultural production and productivity (Opara, 2008). According to him, information is a critical resource in the operation and management of the agricultural enterprise. He further stated that access to the right information at the right time and from the right source, may shift the balance between success and failure of farmer. It is against this background that Hossain (1998) quoted in Opara (2008) noted that communication of agricultural information is a vital factor in the change process of the farming community. Farmers must have access to information about new technologies before they can consider adopting them. Since extension services are one important means for farmers to gain information on new technologies, access to extension is often used as a measure of access to information. Little wonder Opara (2008) found out that farmers in Imo State ranked extension agents highest as their source of credible information and advice, thereby emphasizing the importance of the extension agent in the agricultural information transfer chain.

The most preferred and most important information source on improved oil palm technologies used by the farmers in Imo State was the extension agents (Agwu, 2006). Manu (2003) quoted in Arokoyo (2005) alluded to the fact that, experience has shown that for most developing countries extension agents have used all sorts of traditional information communication technologies including radio, drama, and video/television. Presently, both the extension service and other service providers and their clients are experimenting with newer digital opportunities that can be effectively used to exchange, process, manage and communicate information and knowledge. The digital camera with video capabilities is becoming very popular because according to

Arokoyo, “a picture is worth a thousand words and will enable them even those constrained by literacy to communicate” (Arokoyo, 2005).

According to the International Finance Corporation (IFC) (2010) access to quality technical assistance and extension services is a critical factor for successful smallholder production. The Corporation further asserts that, extension allows for better agricultural practices to be disseminated to smallholders who may not have technical knowledge and/or specific experience with oil palm production and processing. Little wonder Agwu (2006) in his study conducted on adoption of improved oil palm production and processing techniques found out that, 42% of the respondents gave preference to extension agents as the most important source of information. While 25% prefer information from NIFOR staff since they are the manufacturers of the improved technology. Agwu further stated other sources of information for farmers to include: information from fellow farmers, neighbours, friends, relatives and programs from television and radio. The study also shows that 40% of the respondents prefer discussing with extension agents on issues involving production and processing of oil palm (Agwu, 2006).

In another development, Ignacio (2011) reported the use of mobile phones in Ghana. Mobile phones are used to connect cocoa farmers in order to pass on important information to them, through a program called “cocoalink”. Huggins (2009) also reported the use of radio program in gathering and sharing information with farmers in most African countries such as Mali with over 300 stations, Uganda with over 150 and Ghana with 150. The use of radio stations became imperative because, for many

African farmers, the only source of information outside their community is radio (Huggins, 2009).

2.8 Adoption of Improved Technologies

Adoption is defined as the acceptance and continued use of new technologies, while level of adoption can be defined as the extent of usage of the recommended technologies by the respondents. Adoption of new ideas or practice by individuals or groups of people is not very easy. It is not a snap shot decision but a mental process over a period of time (Akangbe*et al*., and Onoh and Onoh, 2012). According to Agbamu (2006), adoption is a process with many possible scenarios. Farmers do not accept innovations immediately, they need time to think over it before making a decision. The reluctance of a farmer to adopt an innovation or not, depend on the farmer's perception of the innovation. The adoption of a technology depends on how appropriate it is to the farmer, that is how acceptable, feasible, available, affordable and profitable the farmer perceive the technology to be that will determine his/her adoption of the improved technology.

Farmers easily adopt new technologies when the technology addresses their need, all the needed input associated with the new technologies are readily available and can be easily obtained, when the gains of using the new technologies out weight the cost of its usage, when the new technology does not conflict with the norms and values of the farmer, if the new technology does not increase farmers' risk. Farmers always try to avert risk whenever it is necessary. Hence, the less risk involved in its adoption the higher the level of its adoption by farmers

A study on effect of down mildew resistance maize technology by Ojo*et al.* (2003) reported that 57% of the farmers adopted the maize. This led to a proportional production increase of 14% among the maize farmers. In another study conducted by Agwu (2006) 98% of the respondents adopted improved oil palm cultivation technology, while 32% of the respondents adopted the improved palm oil processing technologies. In a similar vein, a study by Okoro (1991) quoted in Agwu (2006) shows that only 19% of the respondents adopted improved palm oil processing technologies, because of the high cost of the technologies in use (Agwu, 2006).

2.9 Factors Influencing Adoption of Improved Agricultural Technologies

A number of factors have been identified by researchers that influence adoption. For instance, Bolorunduro*et al*. (2005) asserted that generally in agriculture, factors that affect adoption of recommended practices include profitability, compatibility and viability of such technologies (among others). In their study, certain socio-economic factors of respondents (variables) were tested on the adoption of improved fish smoking kilns disseminated in the zone. Their result revealed the mean age of 32 years, 89% males, 83.7% had only koranic education, mean year of experience was 17.5 years. Only about 43.1% of respondents were aware of improved fish smoking kilns disseminated in the zone, with about 32% adopting one kiln or the other.

A study conducted by Akpoko and Kudi (2007) revealed that age had influence on adoption of improved farming techniques among youths, because the result showed that 79% of the participants were either 30 years of age or younger. In a similar vein, Maiangwa*et al.* (2007) also stated that age had influence on adoption of chemical fertilizer for land management. In both studies, it was confirmed that age had influence

on adoption of improved technologies. Both surveys therefore show that the younger the farmer', the more the willingness to try out new technologies.

Similarly, Akpoko and Kudi (2007) and Maiangwa*et al.* (2007) revealed that education also had influence on adoption of improved farming techniques among youths, and chemical fertilizer for land management. Therefore, both studies tend to confirm the assertion of Maigida and Okerhe (1995) that illiteracy makes it difficult for farmers to comprehend simple instructions for food processing and preservation, and to adopt innovation. Little wonder Oluyole and Sanusi (2009) states that, education is a good pointer to improved productivity, as one's level of education is a tool with which an individual could be efficient at whatever endeavour he/she undertakes.

Result from another study conducted in the South-western Nigeria byOlagunju (2008) revealed that most of the palm oil processors (67%) were in their active years of between 31 and 60 years of age, which makes them to be very active, and willing to try out new technologies to boost their productivity. Nnamdi (2010) also found out that contact with extension services also has a positive influence on adoption. While Ekene and Onu (2008) added that high cost of new technologies on the other hand, has negative influence on adoption. They noted that high cost tends to discourage potential adopters of improved palm oil processing technologies from adopting them. On the other hand, Nwangi (1998) stated that, the degree to which the technology is perceived to be better than the idea it supersedes in terms of economic profitability, social prestige, physical convenience, low initial cost, lower perceived risk, decreasing discomfort, psychological satisfaction or saving of time is what will determine a technology's adoption. While Roling cited in Nwangi (1998) stated that a cheaper

technology will be adopted faster than a more expensive one. Nwangi (1998) further stated that the more viable a new practice is and the easier its results are to observe, describe, and communicate to others, the more rapidly it will be adopted. Material innovations and concrete ideas that are easily observable are adopted faster than less concrete ones (Nwangi, 1998).

In a study conducted by Weir and Knight (2000) on the role of education in adoption and diffusion of Innovation, they reported that education played a significant role in adoption of new technologies introduced to the farmers. The experiment was carried out at different sites in different locations; the result however shows that the site whose respondents were the most learned adopted the new technology more than in other sites. They had adoption level of over 90% as against less than 50% in other less educated cites of the survey (Weir and Knight, 2000).

According to Baffoe-Asare*et al*. (2013) experienced farmers are more risk averse and more likely to adopt new technology, This suggests that farmers with rich experience of cocoa growing activities under various policy initiatives of past farmers are less risk averse and willing to adopt an innovative technology that is perceived to come with high financial rewards and improve their lot. In addition, experience equipped the farmers with sound agronomic competencies and skills that enhance adoption of new technology. They also asserted that older farmers are more experienced and more likely to adopt new technology because older farmers according to them, are more experience and have accumulated more capital as results they are more likely to invest in innovation thus, the age of household head is positively related to adoption because older farmers are perceived to be more experienced and have witnessed the benefits of

various government interventions over the years. On the other hand, age of the household heads either male or female, had strong influence on the adoption of innovative and proven technologies in agriculture. Age as a factor of influencing adoption depends on other latent characteristics of the individual farmers. Hence young farmers tend to be more innovative and more apt to adopt new technology due to their longer planning and lower risk aversion characteristics.

Additionally, Baffoe-Asare*et al*. (2013) further stated that, large household increase availability of labour and hence have high influence on adoption. Farmers with large farm sizes are usually wealthy and there is more likelihood that they would readily adopt any high inputs innovation. Secondly, they also said that large farm size would facilitate easy realization of the benefits of adopting an innovation on a large scale. Moreover, farmers with large farm size are likely to adopt new technology due to significant realization of the benefit of doing that. They further added that social societies enhance farmers access to information and more likely to innovate or adopt a new technology. Membership to social organization or clubs, can also increase the capacity of an individual access to credit facilities, information about current innovation and its benefit. It also increases individual farmer's awareness and as a result increases the likelihood for adoption of new technology (Baffoe-Asare*et al.*, 2013).

2.10 Constraints to Adoption of Palm oil Processing Technologies

A research undertaken by Ugwu (2009) revealed some constraints to palm oil processing and storage in Cross River State. He concluded that palm oil productivity in Nigeria has not grown sufficiently due to under-investment in new technology and

slow adoption of existing improved technologies. According to Ugwu, the constraints specifically includes: low output of palm oil as a result of low yielding varieties of palm fruits and unattractive market prices for palm oil. He further added that, high cost of labour and unavailability of skilled and unskilled labour, high cost of palm oil extraction technologies and low output and low quality of palm oil were among the constraints faced by palm oil processors (Ugwu, 2009).

Ugwu (2009) further asserted that high cost of processing equipment and inadequate fund are the serious problems faced by processors in Cross River state. This problem had discouraged intending processors from establishing their own mills. Therefore majority of the processors in the area resort to hiring of processing equipment and this had resulted to delay in processing of the palm fruits. This delay also resulted to build-up of free fatty acid (FFA) stated the United Nations Development Fund for Women (1987). In Imo State, Chinedum and Akinsami (2003) asserted that, scarcity of fuel wood and water are the major problems encountered by processors. While Ugah (2004) recorded that in Benue State, processors encountered problems such as unimproved technology, irregular supply of fresh fruit bunch (FFB), transportation, harvesting of FFB, credit/fund, lack of water and unsteady labour. In a study conducted by Akangbe*et al*. (2011) in Oyo state, they reported that the constraints of palm oil processor in the study area are; non-contact with extension agents, poor and inadequate transportation, water scarcity, crude and poor palm oil extraction technology, as well as inadequate labour supply .

The sharp decline in palm oil production has been traced to the following reasons, among others: low yield variety of oil palm seeds being planted, lack of financial

assistance/infrastructure for small scale farmers, high cost of labour, high cost of improved processing machines and inefficient processing technologies (Oladipo, 2008; Orewa*et al.*, 2009; Wahid, 2010). All these factors have contributed to making the palm oil industry unattractive to the youths because, the study conducted by Olagunju (2008) revealed that the mean age of the 120 processors sampled was 56 years, implying that those involved in palm oil processing were no longer young, and 76% of the processors acquired plantation through inheritance, while 24% acquired through rentage. The factors identified above may likely relate to reasons why palm oil processors do not readily adopt improved technologies in palm oil processing (Olagunju, 2008; Orewa*et al.*, 2009).

However the greatest constraint to adoption of improved oil palm technologies in Imo State as revealed by Agwu (2006) was lack of finance, others were high cost of processing palm fruits in mechanized mill, high cost of labour to carryout necessary farming operations, unavailability of labour to carry out necessary farming operations and the complexity of recommended improved technologies makes it difficult for respondents to understand, this according to Agwu also serve as a constraint to the adoption of the recommended technologies.

According to Truong Thi (2012) constraints to adoption of new technology include: lack of confidence in the innovation because it was new to them; lack of result demonstration fields (seeing is believing), risking low yield and low education level of farmers. Sometimes, aged farmers do not believe in new technology but only believe their own experience, or when old behavior of cultivation practices embedded in farmers for long period could not be changed when persuaded to use new technology.

They further added that when large land holding farmers are feeling not so sure about new technologies, they may feel that the yield loss due to the new technologies will be great and that may also serve as a constraint to adopting the new technology.

Furthermore, Sulo *et al*. (2012) enumerated the following as factors Constraining against adoption of agricultural technologies, lack of access to land, lack of capital and credit facilities, non-membership of group or societies, non-provision of information by the agricultural officers on agricultural production technologies, ineffective extension services and coverage among others, as major hindrances to effective achievement of the set objectives of improving the socioeconomic wellbeing of farmers. A study conducted by Ajayi and Solomon (2010) also shows that the perceived major constraints for the adoption of major oil palm technologies were inadequate information, lack of capital, high cost of input, and irregular extension contact.

2.11 Theoretical Framework

According to Scott and Marshall (2005) theory embraces a set of interrelated definitions and relationships that guide our and understanding of the empirical world in a systematic way. This study is guided by the social change theory, using adoption and diffusion as the conceptual framework.

2.11.1 Social change theory

Both Rogers (1995) and Ekong (2005) defined social change as the process by which alteration occurs in the structure and function of a social system. Based on this definition therefore, any change that occurs in the norms, values, culture, ideas, roles and social habit of a people can be referred to as social change. Social change can be planned and unplanned. Planned change involves human intervention in controlling the direction of change toward a definite set goal (Salawu, 2007). The recommended palm oil processing technologies for instance, is a planned change that is geared toward reducing the drudgery associated with palm oil processing and to boost output of adopters of the technologies. Most social change in the society occur through adoption and diffusion process. Therefore, social change can better be explained by adoption and diffusion perspective.

2.11.2 Conceptual framework

According to Rogers (1995) adoption is the decision to make full use of innovation or technology as the best course of action available. Adoption of a new farm practices requires that the farmer may be aware of the practices, become interested in it, evaluate it, try it out, and then take the steps to adopt it. Tologbonse and Adekoya (2005) further explained that a farmer's decision to adopt a recommended agricultural practice or not, is recognized to have occurred over a period of time in stages rather than instantaneous. The adoption process, consists of five stages or steps that an individual goes through before adopting an innovation, the stages are; awareness, interest, evaluation, trial and adoption which is the final stage. Adoption therefore, occurs when an individual apply the innovation and continue to use it in preference to old methods. Abalu*et al.* (1979) noted that when farmers find recommended farm innovations not to be technically feasible, economically viable and culturally

compactable, they often reject such innovation. According to Rogers (1995), for adoption to take place, potential adopters of a technology must pass through five stages in the adoption process. The stages are; awareness, interest, evaluation, trial and adoption which is the final stage. Adoption therefore, occurs when the individual apply the innovation and continue to use it in preference to old methods (Roger, 1995).

Rogers (1995) presented four adoption/diffusion theories. These are:

Innovation decision process theory: Potential adopters of a technology progress over time through five stages in the diffusion process. First, they must learn about the innovation (knowledge); second, they must be persuaded of the value of the innovation (persuasion); then, they must decide to adopt it (decision); the innovation must be implemented (implementation); and finally, the decision must be reaffirmed or rejected (confirmation). The focus is on the user or adopter.

Individual innovativeness theory: Individuals who are risk takers or otherwise innovative will adopt an innovation earlier in the continuum of adoption/diffusion.

Diffusion theory: Diffusion takes place over time with innovations going through a slow, gradual growth period, followed by dramatic and rapid growth, and then a gradual stabilization and finally a decline.

Perceived attributes theory: There are five attributes upon which an innovation is judged: that it can be tried out (triability), that results can be observed (observability), that it has an advantage over other innovations or the present circumstance (relative advantage), that it is not overly complex to learn or use (complexity), that it fits in or is compatible with the circumstances into which it will be adopted (compatibility).

According to Rogers (1995) diffusion is a process by which an innovation is communicated through certain channels over time, and among members of a social system. According to Rogers, a numbers of factors interact to influence the diffusion of innovations. These factors are:

- The innovation itself;
- Communication channels;
- Time in which the innovation is being introduced.

Addressing the complains/suggestions of the early-adopter/early majority when modifying the technology can greatly enhance the likelihood that a technology will be successfully integrated into the curriculum by groups beyond the innovators and early adopters (Geoghegan, 1994).

2.11.3 Conceptual model

According to Haralambos and Holborn (2008) a model is a general conception of a phenomenon. while Ekong (2003) defined a model as a broad system of explanation which is found not so much on prior research finding but largely on untested and unproved assumptions about social realities. The conceptual model to be used in explaining this study has three components as shown in Figure 1: the independent, dependent and expected effects variables. The independent variables consist of; age, sex, educational level, household size and processing experience of respondents. The dependent variables, on the other hand, are the levels/extent of adoption of the recommended processing technologies recorded. The dependent variables comprises of all components of the recommended palm oil processing technologies, and they are;

threshing machine, sterilizer, digester, separator, manual/motorized press and oil clarifier.

The dependent and independent variables are linked by a blocked arrow, indicating an influence or course-effect relationship. For instance, it is expected that age would have an influence on the extent of adoption of recommended technologies. The apriori expectation is that the older you are, the less the level of adoption of recommended technologies, since young people often like experimenting with new technologies. These influences are expected to have an effect on the adopter, which is shown by dotted arrow in the model. It is dotted because it is not part of this study to investigate the effect of adoption on the adopter. However, some expected effects are envisaged and so estimated in this study.

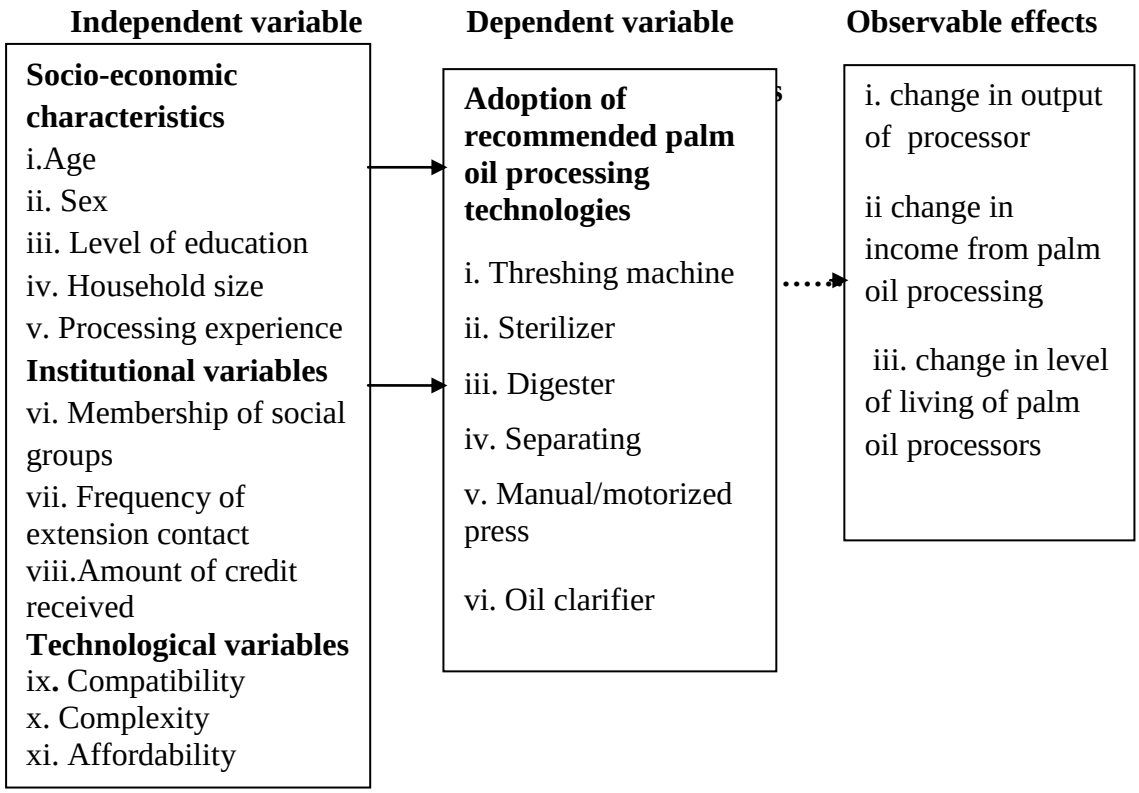

Figure 2.1: A model of factors influencing adoption of recommended palm oil processing technologies

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

This study was conducted in Delta State. The State is made up of 25 Local Government Areas (LGAs), out of which Ughelli-north and Isoko-north were chosen for this study. The State stands on latitude 5^0 and 30' in the North and longitude 5^0 and57 in the East (Encarta, 2009) sharing a common boundary with Anambara State in the east, Edo State in the south west, and Bayelsa State in the south. Ughelli-North is expected to have a total population of 374239 by the year 2013, according to the projection from 2006 census figure of 320,687. On the other hand, Isoko-North is expected tohave a total population of 83569 by 2013, according to the projection from the 2006 census figure of 71,611 using 3% population growth rate (NPC Census, 2006 and NPC 2013). The study area has a humid tropical climate, with a very long rainy season lasting from April to October. The study area has rain forests, swamps and rivers. The predominant occupation of the people are both trading and farming. Their major food crops are cassava, plantain, banana, melon (*egusi*), maize, yam, vegetables, pineapple, and cocoyam. They also plant tree crops such as oil palm, citrus, guava, rubber and mango, never to be forgotten also is fish farming (Ugwu, 2009).

The major ethnic groups in Delta State are Urhobo, lgbo, lzon, Isoko and Itsekiri. Many of the people claim a common ancestry; consequently, their cultures are similar. These similarities are manifested in their religious worship, music, dance, festivals, arts and crafts. The practice of Christianity, Islam and traditional worship like lgbe and Ebura, flourishes in varying degrees among the people of Delta State. Identical

features of the mode of dressing common to the four tribes of Urhobo, Isoko, Itsekiri and lzon include a pair of wrapper on which you have shirt-like attire, topped with a bowler hat. Coral beads or gold chain around the neck is complemented with a walking stick (Men). Women, in addition to coral beads or gold chain, wear what is known as 'up and down' (called "OsibaGbaaniku" among the Urhobos). The music, which is in the form of singing and drumming, dictates the dance steps. These include: Ulu Omi Masquerade dance, such as Oda (Itsekiri) and Mmanwu (Ndokwa); Regatta, a canoe dance among the Itsekiri, and various social dances such as ItsekiriOmoko dance, lka moonlight dance, Urhobo dance of the maidens and lseleUkuEgwuOshusku. Others include war and rituals dances. The festivals of Delta State include Okere Juju (Itsekiri), Ikenga and Ukunta (Aboh), lwuyi and OsoeziAborebeleOge, (Agbor) Idju and Ekene (Agbarha festivals) and Sogbein festivals (lzon). These festivals mark the harvest seasons, appeals to gods for purification of the town, commemoration of ancient expeditions or reminiscences of or tribute to tribal heroes. The common dishes sheared by the Deltans include palm fruit soup (*Banga* soup), palm oil soup (*Oghwo* soup), peper soup, starch (processed from cassava), *Bole* (roasted plantain), *tapioca (kpokpogarri),eba, (garri)* porridge (*ukodo*)
(http://www.onlinenigeria.com/links/deltaadv.asp?blurb).

3.2 Sampling Techniques

The study focused on the population of people involved in palm oil processing in Ughelli North and Isoko-North Local government Areas of Delta State. The study made use of multi-stage sampling procedure. Firstly, four communities were purposively selected from the study area based on their level of involvement in palm oil processing which were identified during a reconnaissance survey. The communities

are Agbarha-otor and Orogun from Ughelli-North, while Emevor and Iyede were selected from Isoko-North. The reason for the selection is based on the fact that there are more processors in these LGAs compared with others which mainly focus their agricultural activities on cassava production and fish farming. All the palm oil processors in each of the four (4) communities were purposively selected for the study. There are 79 processors in Agbarha-otor, 29 in Emevor, 13 in Iyede and 43 in Orogun, making a total of 164 respondents who were used as the sample size for the study.

3.3 Method of Data Collection

Data were collected from primary sources. These were collected through the use of structured questionnaire, observation, and interview. Data were collected on socio-economic characteristics of the respondents, such as age, sex, family size, marital status, years of processing experience, membership of social group, amount of credit received, awareness and contact with extension agents. Also, information on improved palm oil processing technologies was collected from the respondents, such as information concerning the use of threshing machines, digesters, sterilizers, separating, manual/motorized press, and clarifiers and the observable effects on the respondents.

3.4 Analytical Techniques

3.4.1 Descriptive statistics and multiple regression analyses

The collected data were analyzed using descriptive and inferential statistics, which include measures of central tendencies such as; mean, charts, percentages and frequency distribution to achieve objectives (i), (ii), (iii) and (vi). In order to achieve objective (iv), multiple regression model was chosen for this study. The multiple regression model is specified as follows:

$Y_i = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \text{-------- } n_{11} + U$

Where:

Y = Adoption (Number of recommended technologies a processor has been using for the past two years)

X_1 = Sex

X_2 = Age (years)

X_3 = Household size (number)

X_4 = Education (years)

X_5 = Processing experience (years)

X_6 = Extension contact (number of visit)

X_7 = Membership of social group (1 = member; 0 = non member)

X_8 = Amount of credit received (naira)

X_9 = Affordability (very affordable=1, affordable=2, not affordable = 3)

X_{10} = Compatibility (very compatible = 1, compatible = 2, not compatible =3)

X_{11} = Complexity (not complex = 1, complex = 2, very complex = 3)

a = Constant term

U = Error term

β_1-β_{11} = coefficients to be estimated

3.4.2 Z – test statistic

In order to achieve objective (v), Z-test was used to examine the effect of adoption of recommended palm oil processing technologies on processors output and income before and after adoption of the recommended technologies. The Z-test model was used to determine the differences in output and income of processors before and after adoption of the technologies. The Z-test is specified as shown bellow:

$$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Where:

Z = the calculated Z-test value

$\bar{X}_1$ = Mean output and income of palm oil processors after adoption of the recommended technologies

$\bar{X}_2$ = Mean output and income of palm oil processors before adoption of the recommended technologies

S_1 = Standard deviation of output and income of palm oil processors before adoption of recommended technologies

S_2 = Standard deviation of output and income of palm oil processors after adoption of recommended technlogies

n_1 = Number of palm oil processors before adoption of recommended technologies

n_2 = Number of palm oil processors after adoption of recommended technlogies

The calculated Z value was compared with the tabulated Z value at 5% level of significance for decision making.

3.5 Measurement of Variables

Socio-economic, institutional and technological variables that were examined in this study are: age, sex, education, household size, membership of social organization, extension contact, cost, complexity, compatibility of the technology, output, income and level of living.

3.5.1 Independent variables

Age: This is the number of years a respondent had lived. In this study, age Was measured by the actual number of years the respondent has lived as at the time of the study.

Sex: Sex is the set of characteristics that determine whether the reproductive role of an animal or plant is male or female. It was measured as male or female by assigning "1" for male; "0" for female.

Education: This refers to acquisition of knowledge through formal means. Individual's level of education was measured by the total number of years a respondent have spent in formal education.

Household size: This is the total number of people living in a household. Most palm oil processors may still depend on the strength of the family labour to increase productivity. Household size in this study was measured by actual number of wives, children, husband and other dependents of the respondents.

Processing experience: It is a general concept which comprises of knowledge or skill(s) gained through involvement or exposure to a particular thing or event. However, in this study, processing experience refers to the number of years a processor has spent in palm oil processing. This was measured by the actual number of years the respondent has been processing palm oil.

Membership of social groups: Social group refers to a group of people or organizations joined together for a common purpose. This was measured by the total number of social groups the respondent claim to belong to as at the time of data collection. Each of the social group were scored 1, then, the sum made up the total number of social group a respondent belongs.

Contact with extension agents: Contact is a state or relationship where communication happens or is possible. Contact can also be referred to as an act of communication with somebody (Microsoft student with Encarta Premium, 2009). Contact with extension agent enables the farmer to be aware of new technology, which will improve his production. This was measured by the total number of times a processor has been visited, or visited any place in connection with improved palm oil processing technologies.

Amount of credit received: This refers to the external sources of fund received by processors, either from institutions or non institutional organizations. This was measured by the reported amount (in Naira) received by the respondent.

Affordability: This is the extent to which the recommended technologies are affordable. This variable was measured in form of a likert scale with questions arranged in scores of 1, 2 and 3 which stands for "Very affordable", "Affordable" and "Not affordable" The mean score of 2 was obtained by adding 1 + 2 + 3 = 6, and then divided by 3. If the weighted mean is greater than 2, the implication is that, the technology is expensive, otherwise it is not expensive.

Compatibility: Is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. It is also the degree to which a technology is perceived to be consistent with the farmer's goals and aspirations; socio-cultural values, norms and beliefs, and past experiences; needs; and existing farm practices. This was measured using a 3 point likert scale with scores of 1, 2 and 3 for "Very compatible", "Compatible" and "Not compatible" respectively. The mean score of 2 was obtained by adding 1+2+3 = 6, and then divided by 2. If the weighted mean is greater than 2, the implication is that, the technology is compatible, otherwise it is not compatible.

Complexity: Is the degree to which a technology is perceived to be relatively difficult to understand and use. This means a situation where an innovation is difficult to understand or to use, a relatively simple to use and understand technologies are likely to be adopted more than the ones that are complex. This was measured in a likert scale, with scores of 1, 2 and 3 for "Not complex", "Complex" and "Very complex" respectively. The mean score of 2 was obtained by adding 1+2+3= 6, and then divided by 3. If the weighted mean is greater than 2, the implication is that, the technology is complex, otherwise it is not complex.

3.5.2 Dependent variable

Level of Adoption: adoption is defined as the acceptance and continued use of new technologies. Level of adoption on the other hand, can be defined as the intensity or the extent of usage of the recommended technologies by the respondents. In this study, adoption is measured by the number of component parts of the technological package a processor is using. Six recommended technological packages were studied.

An adopter is any processor who uses any of the components of the recommended technologies on a continuous basis. Level of adoption was measured by summing up the total number of respondents who adopted a particular component of the recommended technologies, the total number of adopters where then multiplied by 3 (3 was used to multiply the total adopters because the question was asked in the form of a 3 likert scale) and divided by the total number of all respondents in the study so as to get the adoption score for each component.

3.5.3 Observable outcomes

Output: the total palm oil processed with the recommended palm oil processing technologies within a year. This was measured in litres.

Income from palm oil production: Thris is the profit realized from the sale of palm oil products. This was measured in naira. Respondents were asked to give their average income per year, and their expenditure for the palm oil processing venture was subtracted from their gross income, after which their net income was deduced.

Level of living: The level of living is generally used to describe the level of material comfort that an individual enjoys. This comfort is in form of the quantity and quality of goods and services that is consumed by an individual and his family members. This was measured by the number of items owned and procured from the proceeds of palm oil processing.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter contains detailed analysis of all statistical results and their interpretation that the collected data (from the field) were subjected to.

4.1 Socio-economic Characteristics of Respondents

Sex: The pie chart shown in Figure 4.1 indicates that female respondents were 62% while males were 38%. The reason may be due to the fact that females are more in processing activities than males. This is in line with Ajibola's (2000), who reported that palm oil processing in Nigeria was female dominated.

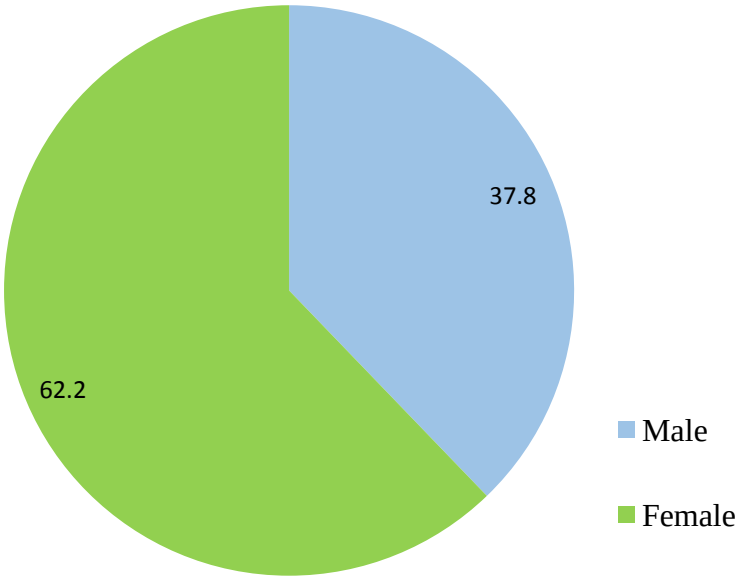

Figure 4.1: Distribution of respondents by sex

Age: The results in Table 4.1 show that the mean age of the processors was 39 years, and more than half (61%) of the processors were in their middle age, while some (22%) were in their youthful age. However, the others (17%) were aged. This imply that majority of the processors were young and in their middle age (83%), their active productive years. This is at variance with several studies which reported that

palm oil processing is often associated with the aged (Nnamdi, 2010; Akangbe, 2011; Onoh, 2012). The reason for this age difference may be linked to the low life expectancy that is prevalent this days.

Household size: Results in Table 4.1 show that the mean household size of the respondents was 12 persons. Household size is of importance to farmers since the consumption unit is also the production unit. Therefore, the larger the household size, the more labour that will be available for family use for productive purpose (centrisperibus). This is in agreement with Rogers (1995) assertion that giving birth to many children or having large household is of advantage to farmers since they will be of assistance in the farms in terms of labour availability.

Years of schooling: As shown in Table 4.1, majority of the respondents (70%) spent 7years and above in schooling, while 8% of the respondents had no formal education. This is an indication that the enterprise had a good proportion of literate people. This may aid processors to be more efficient in their palm oil processing enterprise since processors can read and understand information concerning adoption and usage of recommended technologies. Education was also affirmed by Maigida and Okerhe (1995) to be a good pointer to improve productivity and income since farmers will be able to read and understand what it takes to adopt new technologies.

Processing experience: Results in Table 4.1 reveal that about 77% of the respondents had palm oil processing experience ranging from 1 – 18 years, while the average processing years of experience of respondents was approximately 14years. This result shows that most palm oil processors in the study area are not new in the

processing enterprise. This suggests that the respondents had experience in adopting the recommended technologies. This supported the finding of Sanni (2009) who found that experience in fish farming influenced the adoption of recommended fish practices and led to high economic return.

Table 4.1: Socio-economic characteristics of palm oil processors in Delta state

Class	**Frequency**	**Percentage**
Age		
19-28 – Young	36	22.0
29-38 - Middle Age	44	28.8
39-48 - Middle Age	56	34.1
49-58 - Old	23	14.0
59 and Above – Old	5	3.0
Average = 39, Max = 68, Min = 19		
Household size		
1-6	56	34.1
7-12	63	38.4
13-18	30	18.3
19-24	10	6.1
25-30	3	1.8
31 – 36	2	1.2
Average = 12, Max = 36, Min = 1		
Years of schooling		
0	13	7.9
1 – 6	37	22.5

7 – 12	58	35.4
13 – 18	56	34.1
Average = 10, Max = 18, Min = 1		
Years of processing experience		
1 – 6	33	20.1
7 – 12	46	28.0
13 – 18	47	28.7
19 – 24	22	13.4
25 – 30	11	6.7
31 – 36	5	3.0
Average = 13.6, Max = 32, Min = 1		
Total	100	100

Marital status: Results in Figure 4.2 show that 73% of the respondents were married, while 16% were single. On the other hand, 6% were divorced while 4% were widowed. Married people may have accounted for 73% of the respondents since they have more responsibilities of caring for their families than single people. This assertion agrees with Soyebo*et al.* (2005) statement that married people often try to make ends meet in order to cater for their families effectively.

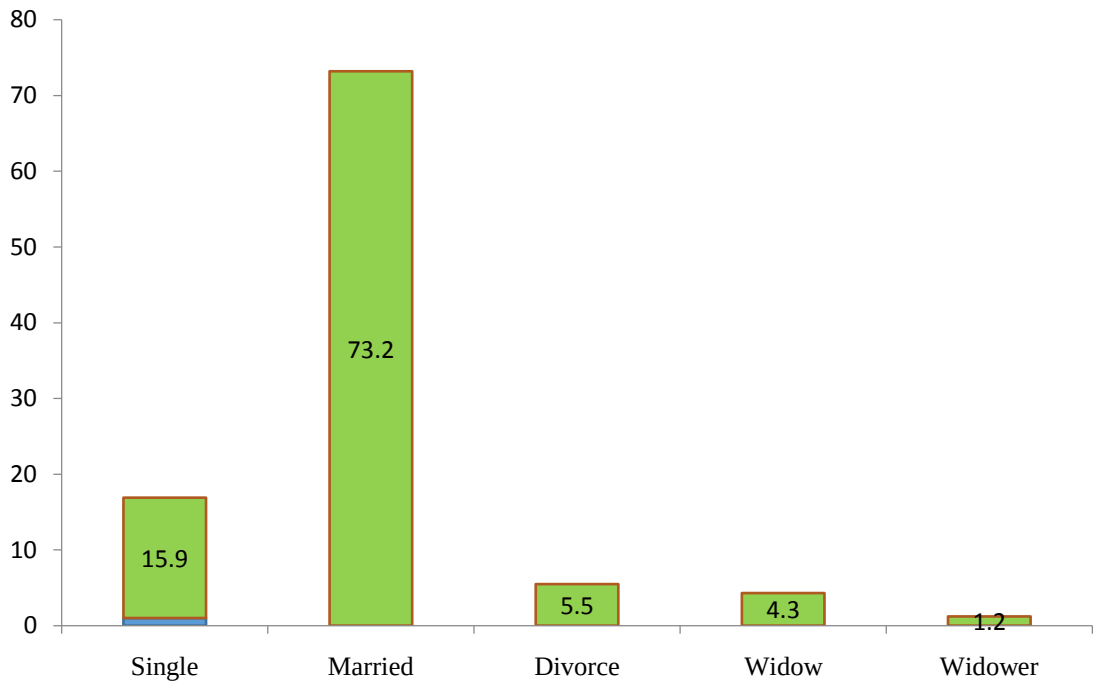

Figure 4.2: Marital status of respondents

Membership of association

The results in Figure 4.3 show that almost all the processors (98%) do not belong to any association, and the 2% of the processors that belong to an association were not palm oil related association(s). Therefore, they may not be able to meet as a group to discuss their welfare as fellow processors. According to Onweremadu and Njoku (2007) being a member of an association encourages social participation, which serves as a forum where farmers could exchange ideas about new farm practices. An association can also serves as an avenue where processors can share ideas. Unfortunately, none of the respondents belong to a palm oil related organization.

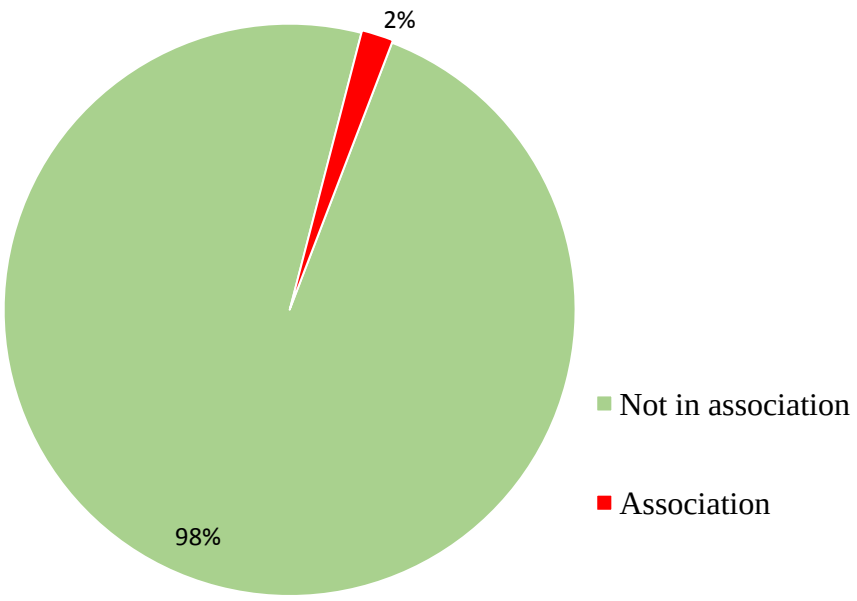

Figure 4.3: Membershipof Association

Access to credit: The result in Figure 4.4 shows that 91% of the respondents were unable to access credit facilities, while only 9% of the respondents had access to credit facilities. This implies that majority of the palm processors in the study area had not been fortunate enough to experience the benefit of accessing credit facilities to aid their business. The importance of access to credit facilities was emphasized by Ekong (2003) assertion that credit is a very strong factor needed to acquire or develop enterprise, it is not surprising then that FAO (1997) noted that credit should be considered as a human right, a basis which allows men and women to face life.

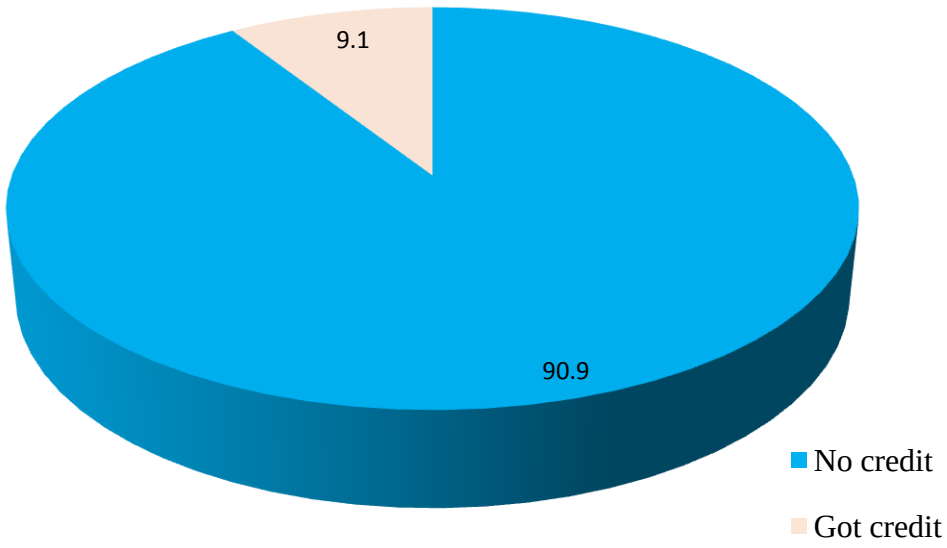

Figure 4.4: Distribution of respondents according to accessibility to Credit

Extension contact: None of the respondents had contact with an extension agent in all their years of palm oil processing. In a similar vein, Akangbe*et al*. (2011) reported that the respondents who had been processing palm oil for over 35years on the average, never came in contact with extension agent(s). Therefore, these processors will not benefit from the experience/knowledge that extension agents ought to have shared with them.

4.2 Sources of Information

Results in Table 4.2 show that 90% of the respondents got their information about the recommended palm oil processing technology from fellow processors. A brief interview with most respondents confirmed that they got all they know about the recommended palm oil processing technologies from their fellow processors. Respondents also affirmed that they would have preferred extension agents (what they call government people) to educate them about the technologies, unfortunately, that

was not possible since there was no contact with extension agents in the area. Additionally, 42% of the respondents learnt about the recommended technologies from their friends, while 16% got their information from their relatives.

Table 4.2: Distribution of Respondents according to their sources of information

Variables	***Frequency (N = 164)**	**Percent**
Relatives	26	15.9
Friends	69	42.1
Fellow processors	141	90.0
Media	8	4.9

*Multiple responses.

4.3 Level of Adoption of Recommended Palm oil Processing Technologies

As shown in Table 4.3, both the digester and the mechanical press were adopted by all the processors, with a very high weighted mean of 3.0 each. This is because both technologies reduce the drudgery associated with the traditional method of either pounding of the palm fruits with mortar and pestle or the stress of mashing them with their feet in a wooden trough. Little wonder both technologies were adopted by all the processors.

On the other hand, the sterilizer has a weighted mean of 2.4, indicating a high level of adoption. The result also shows that 79% of the respondents used and adopted this technology. The separator had a weighted mean of 1.0, implying that the technology has a low level of adoption. Thresher had a very low level of adoption and has a weighted mean of 0.1. Only 2% of the respondents use this technology on a regular basis. The reason for the low level of adoption may likely be that, respondents felt paying extra money for threshing may be expensive, and may cut down their profit

margin. Additionally, the result further shows that the oil clarifying machine was not adopted at all. Oil clarifier may not have been adopted because processors prefer to use the traditional method of clarifying, which involves boiling of the pressed oil to dry it and removing its impurities with small baskets. Hence, processors need not spend their resources on the oil clarifier.

Table 4.3: Adoption level of respondents

Technologies	**Adoption scores**	**Mean weighted scores**	**Percentages**	**Overall perception**
Thresher	9	0.1	2	Low
Sterilizer	388	2.4	79	High
Digester	492	3.0	100	High
Separating machine	162	1.0	33	Low
Mechanical press	492	3.0	100	High
Oil clarifier	0	0	0	No adoption

4.4 Factors Influencing Adoption

Adoption of any technology is expected to be influenced by several factors. This section examines the socio-economic, institutional and technological factors that influenced the level of adoption of recommended technologies for palm oil processing. The section also examines the testing of the hypotheses I, II and III of the study, as depicted in Table 4.4.

4.4.1 Socio-economic factors influencing adoption

The fourth objective of this study was to determine factors influencing adoption of recommended palm oil processing technologies in the study area. This was achieved by testing the hypotheses drawn for this study, through the use of multiple regression model to analyze the socio-economic and institutional variables, as well as the technological factors influencing adoption of the recommended technologies.

Hypothesis I: The first hypothesis states that socio-economic characteristics of respondents has no significant influence on their level of adoption of recommended palm oil processing technologies. However, the results of the regression analysis in Table 4.4 show that age (0.0298), household size (0.0612), marital status (0.2734), years of schooling (0.0665) and processing experience (0.0472) all had positive coefficients and were all significant. Age and marital status are significant at 5% level of probability while others were significant at 10% level of probability. The implication is that all the socio-economic variables except sex were positively influential to adoption of recommended palm oil processing technologies in the study area. However, sex on the other hand had a negative coefficient. This implies that respondents' sex does not determine their adoption of the recommended technologies. In other words, being a male or female does not influence the adoption of the recommended technologies. However, since almost all the socio-economic characteristics of the respondents had significant influence on the level of adoption of recommended technologies, then the null hypothesis is rejected.

Table 4.4: Factors influencing levels of adoption of recommended technologies

Variable	Coefficient	Std. Error	T-ratio
Age	0.0298*	0.0119	2.49
Sex	-0.1615	0.1576	-1.02
Marital Status	0.2734*	0.1107	2.47
Household Size	0.0612**	0.0154	3.96
Years of Schooling	0.0665**	0.0161	4.13
Processing experience	0.0472**	0.0148	3.17
Membership of Association	0.2400	0.6034	0.40
Amount of credit	0.5406*	0.2541	2.13
Compatibility	0.0352*	0.0150	2.34
Complexity	-0.0120	0.0254	-0.47
Affordability	0.0294	0.0261	1.13
$R^2 = 0.93$			
$R^{-2} = 0.87$			

*, **, Significant at 5% and 10% level of probability

4.4.2 Institutional variables influencing adoption

Hypothesis II: The second hypothesis states that institutional variables of the respondents have no significant influence on their adoption of recommended palm oil processing technologies. The institutional variables in the study are; membership of associations, amount of credit received and extension contact. The result of the analysis revealed that extension contact is not appearing in Table 4.4 because the respondents never had contact with extension agents. This implies that respondents may not be able to benefit from the experience and knowledge that extension agent ought to have shared with them. Similarly, Akangbe (2011) found that women who have been processing palm oil for about 35years, never had contact with extension agents in all their years of processing.

From Table 4.4, the coefficient (0.5406) of amount of credit received had a positive and significant influence on level of adoption at 5% level of probability. This implies that increase in the amount of credit received would increase adoption of recommended technologies in the study area. This supports Ekong (2003) assertion that credit is a very strong factor that is needed to acquire or develop farm enterprise, its availability could determine the extent of production capacity. Membership of association has positive (0.2400) coefficient, though not significant. This implies that association had a positive influence on adoption of the recommended technologies, and being a member of an association can induce processors to adopt the recommended technologies. These findings concurred with that of Benjamin (2010) that social organizations serve as fora where members exchange ideas and learn about new farm practices. These findings, therefore, revealed that institutional variables do influence level of adoption of recommended technologies. Therefore, the null hypothesis is rejected.

4.4.3 Technological attributes influencing levels of adoption

Hypothesis III: The third hypothesis states that technological attributes have no significant influence on the levels of adoption of recommended palm oil processing technologies. However, the regression result in Table 4.4 shows that the extent of compatibility of the technologies with existing ways of processing has 0.0352 influence on levels of adoption, and also significant at 5% level of probability. It implies that the more compatible the technology is with existing ways of processing, the more the level of adoption. Similarly, affordability had a positive coefficient of 0.0294 though not significant. This implies that the more affordable a technology is, the more farmers will likely adopt it. This finding is in line with Ojo (2009) who found

positive contribution of technology affordability to adoption of recommended practices.

The, complexity of the technologies is not significant but has a negative coefficient of -0.0120. This implies that respondents considered the recommended technologies to be complex, but may not significantly affect potential adopters from adopting the recommended technologies. Since compatibility significantly influenced the level of adoption, the null hypothesis, is therefore rejected.

The result also shows R^{-2} value of 0.87, implying that the explanatory variables included in the model contributed 87% variation in the levels of adoption of palm oil processing technologies.

4.4.4 Respondents rating of recommended technologies

The result in Table 4.5 shows that respondents rated the recommended technologies to be complex. Respondents' perception of the recommended technologies as complex can be a constraint to adoption of these technologies because a simple technology will likely be adopted faster than a complex one. Respondents also rated the recommended technologies as very expensive. This is an indication that it is not affordable. Affordable technologies serve as an attraction to potential adopters. Hence, Vogel, (2002) asserted that an appropriate technology is one that is efficient yet at low in cost. Therefore, high cost of the recommended technologies can be regarded as another constraint to adoption of these technologies. However, the recommended technologies were rated to be compatible with existing practices.

Table 4.5: Respondents rating of recommended technologies

Variable	Weighted Mean	Decision
Complexity	2.31	Complex
Affordability	2.93	Not Affordable
Compatibility	2.01	Compatible

4.5 Observed Effects of Adoption

The sixth objective of this study was to examine the effect of adoption of the recommended palm oil processing technologies on output, income and level of living of palm oil processors. When the level of adoption is influenced by processors socio-economic characteristics, institutional and technological variables, some effects are expected to occur, including changes in the level of output (litres of palm oil), changes in income (₦) and changes in the levels of living.

4.5.1 Effect of adoption of recommended palm oil processing technologies on output and income

Hypothesis IV: states that adoption of palm oil processing technologies has no significant effect on output and income of the processors. This was tested using Z-test statistic. The results show that the calculated Z for output is 2.35, while that of income is 3.48, with critical Z-values of 1.96 at 5% level of probability. Since the Z-calculated is higher than the Z-critical, the null hypothesis is rejected, implying that adoption of recommended technologies has significant effect on output and income of palm oil processors. This corroborates Abudu (2013) who reported that, adoption of recommended practices has significant effect on processors output and income.

Table 4.6: Result of Z-test of output and income before and after adoption of recommended palm oil processing technologies

Mean	SD	Z- Calculated	Z- Critical	Level of Probability
Output after 753.1ltr/day	422.6	2.35		
Output before 697.14ltr/day	418.0		1.96	5%
Income before ₦398.08/day	224.25		1.96	5%
Income after ₦1095.57/day	1416.90	3.48		

4.5.2 Effect of adoption of palm oil processing technologies on the level of living of respondents

Results in Table 4.7 show that palm oil processors in the study area have used the proceeds from their palm oil processing to acquire a number of items, to improve their living conditions. From the Table, nearly all the respondents (78%) use the proceeds from the processing on household feeding. Verbal interviews revealed that the processors severally claimed to be food secure, as they could use their income to purchase food that were hitherto lacking at home. This is an improved level of living to the adopters.

Similarly, about 62% of the respondents used the proceeds to acquire spraying machine, which is a productive asset used to spray their farms against insects and other

pests, which hitherto, they claimed, is borrowed or hired from fellow farmers or agro-dealers.

Cell-phone is another important asset purchased by about 43% of the respondents. The importance of cell phone cannot be over-emphasized in this information age, more so that the processors have no contact with extension agents. With the help of the cell phones, they could easily access information from fellow processors, even outside their countries. This is an enhanced livelihood.

Other improved livelihood effects of the adoption of the processing technologies include acquisition of motor cycle (34% of respondents). Interestingly, about 5% of the respondents were able to build houses from their proceeds while, 3% were able to buy cars from theirs. All these are indication that adoption of recommended palm oil processing technologies have positive effects on adopters. Therefore, the null hypothesis is rejected.

Table 4. 7: Items acquired with palm oil proceeds

Items	**Frequency**	**Percentages**	**Rank**
Feeding	128	78.05	1st
Spraying machine	102	62.20	2nd
Cell-phone	71	43.29	3rd
Motor-cycle	57	34.76	4th
Bicycle	21	12.80	6th
House	9	5.49	7th
Car	5	3.05	8th
Television	2	1.22	9th
Total	420*		

***Multiple responses

4.6 Constraints to Adoption of Recommended Technologies

This section discusses the constraints to adopters of recommended palm oil processing technologies. The results from Table 4.8 show that 77% of the respondents perceived that cost of processing palm oil is high. They attributed this to the cost of cutting the palm fruit bunch from the palm tree; cost of transporting the bunches to where a vehicle can convey them to the mill **(**estimated to be ₦100 per trip) depending on the distance; cost of splitting the bunches (estimated at ₦100/bunch), and cost of processing, all of them depends on quantity of palm fruit to be processed. Adding the cost of buying the palm fruit or of renting the farms, end up reducing the profit margin to the minimum, especially for those who process very little quantity of palm fruits. This is in harmony with Ugwu (2009) who found high cost of palm oil processing as one of the major constraints facing palm oil processors.

About half (52%) of the respondents perceived lack of access to credit as a problem. This has brought untold hardship to these processors, in that even when they have an opportunity to buy or rent farms at a relatively low rate, they will not be able to access fund to buy or pay for it. This problem of lack of credit facility was linked to their inability to have a functional association. Respondents confirmed that each time they try to get credit individually, the banks usually ask them the trade union they belong to, or collateral to cover for the credit facilities, either of which they do not possess. This finding corroborate Ugah (2004) findings which revealed that among other constraints facing processors was lack of credit facilities.

Another constraint identified by 35% of the respondents was lack of government support. This constraint was linked to the inability of the processors to have a

functional association too. Lack of capital was another constraint identified by 27% of the processors. Most processors expressed willingness to own their individual processing mills but lacking the capital to establish it. Even those who owned the few mills available, complained of inadequate equipment to operate them. Most mill owners express concern about their inability to equip their staff properly. This problem is also linked to inaccessibility to credit facilities.

Respondents (20%) also perceived lack of extension visit as a problem. These respondents complained of not being visited by extension agent (what they call government people).

Furthermore, processors (17%) also complained about fluctuation in prices of palm oil. These processors asserted that buyers of palm oil are the ones that determine the price of processed palm oil. They were able to control the price for the processors because they have a functional association in place.

Additionally, 15% of the respondents considered bad feeder roads to be a constraint to the adoption of recommended technologies. These respondents alluded that bad roads lead to high transportation fare, and this increases processors' hardship and also cuts down on their profit margin. However, if the feeder roads are accessible to motorists, processors will likely pay less and earn more profits in their processing enterprise. They explained that most of the farms where the palm fruits are gotten are not accessible to vehicles. Besides, most drivers often object to carrying palm fruit bunches because they complained that the oil from the fruits get their vehicle stained

and dirty thereby leading to high transportation fare. All these contribute to the high cost of transportation complained about by 4% of the respondents.

Other respondents (3%) mentioned that their adult family members do not support them with their labour since, these family members consider palm oil processing a dirty job. Hence, they are not willing to help their parents in the processing enterprise. These findings is in harmony with Akangbe*et al.* (2011) study which revealed that transportation and labour are among the constraints facing palm oil processors. Inaccessibility to palm oil processing technologies was also mentioned by 4% of the respondents as one of the constraints facing the palm oil processors in the study area.

Table 4. 8: Constraints to adoption of recommended technologies

Variables	***Frequency (N= 164)**	**Percent**
High cost of palm oil processing	127	77.4
Access to credit facilities	85	51.8
Lack of government support	57	34.8
Lack of capital	45	27.4
Lack of extension contact	32	19.5
Fluctuation of selling prices	27	16.5
Bad feeder road	25	15.2
High cost of transportation	6	3.7
Inaccessibility to processing technologies	6	3.7
Lack of family Support	5	3.0

*Multiple responses.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This research was conducted to find out the factors influencing adoption of recommended palm oil processing technologies in Ughelli-North and Isoko- North Local Government Area of Delta- state. Multi-stage sampling procedure was used to select 164 respondents in the study area. Descriptive statistics and multiple regressions were used in the data analysis.

It was found in this study that majority of the respondents were female, with an average age of 39 years. About 73% were married, with an average household size of 11 persons. Also, processors' average years of schooling was 10years, and almost all the respondents (98%) do not belong to any association. About 91% of the processors had no access to credit facilities and the average processing experience of the respondents was 14 years. Palm oil processors in the study area also alleged that they have not been contacted by extension agent at any time.

The results for this study further revealed that almost all the respondents (90%) got to know about the technologies from their fellow processors, while others got their information from friends, relatives and neighbours.

However, the digester and the mechanical press had 100% level of adoption, while the oil clarifier was not adopted by any respondent.

Age, processing experience, household size, marital status, years of schooling, amount of credit received and compatibility were positively and significantly influential to the adoption of recommended technologies in the study area.

The major constraints perceived by the respondents as affecting their processing in order of magnitude includes: high cost of processing or expenses incurred in the course of processing palm oil (77%), lack of credit facilities (52%), lack of capital (35%) and lack of government support (27%).

5.2 Conclusion

The study revealed that palm oil processors do not have functional association in place therefore, they will not be able to experience the benefit of group dynamics. However, since some of them were able to acquire cell-phones from the proceeds of their palm oil processing, the importance of cell phone cannot be over-emphasized in this information age, more so that the processors have no contact with extension agents hence, respondents will not be able to benefit from the experience and training they ought to have received from the extension agent. However, with the help of the cell phones, they could easily access information from fellow processors, even outside their communities. This is an enhanced livelihood.

The result of this finding also revealed that most of the respondents were in their middle age and therefore in their active productive years. This implies that they are not too old to try out recommended practices.

Majority of the respondents were literate. This implies that respondents may be able to read and have good understanding of the recommended technologies and their usage. The result also shows that the palm oil processors have large household size, implying that they have available labour for palm oil processing.

The socio-economic characteristics of respondents were found to have influenced the adoption of recommended palm oil processing technologies hence, they are important factors to consider in adoption of recommended palm oil processing technologies in the study area. This implies that any strategy for palm oil processors aimed at high level of innovation adoption in the study area, should not fail to put these factors into consideration.

5.3 Recommendations

The following recommendations are therefore made:

i The results of the study revealed that all the processors do not belong to palm oil related trade unions or association. It is therefore recommended that processors should come together, form themselves into association and approach the Ministry of Commerce for registration so as to take advantage of the benefit of group dynamics, for example: accessibility to loan and capacity building.

ii Processors confirmed that they had not come in contact with extension agents in the study area. It is therefore recommended that government should make effort to extend extension services to the study area so that they can benefit from their wealth of experience as well.

iii. Inaccessibility to credit facilities has been identified as one of the major constraints facing palm oil processors in the study area. In order to ameliorate this problem, processors should appeal to financial institutions, non-governmental organization and private individuals through their association for assistance in form of soft loans to assist processors cope with finance related constraints.

iv. Respondents opined that the recommended technologies for palm oil processing are very expensive. The implication of this finding is that the recommended technologies are not affordable. For this reason, it is recommended that non-governmental agencies should assist the processors by subsidizing the technologies.

v. The recommended technologies are allegedly considered to be complex to operate by respondents. This may be due to the fact that processors do not get the right training from the right sources, as it was found in this study that education is a significant factor affecting adoption of the recommended technologies. Therefore, training workshops should be organized by government agencies, non-governmental organizations, and private individuals on best practices and management of small scale palm oil mills in the study area.

vi. Not all components of the recommended technologies were fully adopted (100%) by the respondents, yet they experienced increase in output and income as a result of adopting some components of the recommended technologies. Therefore, it is recommended that palm oil processors should be encouraged to adopt all the components of the recommended technologies, so that they would

likely have more output and income. This can be done in form of seminars and workshop by extension agent and non-governmental agencies to showcase the advantages of adopting all the components of the recommended technologies.

5.4 Contribution to Knowledge

The work has contributed the following to existing body of knowledge in agriculture, extension and processing fields:

i. It has revealed that socio –economic, institutional and technological variables contributed 87% to the variation in adoption of recommended palm oil processing technologies

ii. This study established that the technologies are significantly compatible (2.01), not affordable (2.93) and complex (2.31).

iii. This study established the absence of extension influence, credit facilities and social formations in the palm oil processing industry.

5.5 Suggestions for Further Research

i. It is suggested that similar research should be conducted in other palm oil producing and processing areas in the state, and Nigeria generally to validate the findings of this research.

ii. Since there are many other products generated from oil palm, the study is suggesting further studies into the socio-economic, institutional and technological factors affecting the adoption of recommended production and processing of these products.

iii. This study also suggests the study of comparative analysis into these oil palm products to ascertain their socio-economic, institutional and technical feasibilities. This will enable small-scale as well as large scale investors decide which part of the products to invest.

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Appendix I: PICTURES

Picture 1: palm fruit bunches Picture

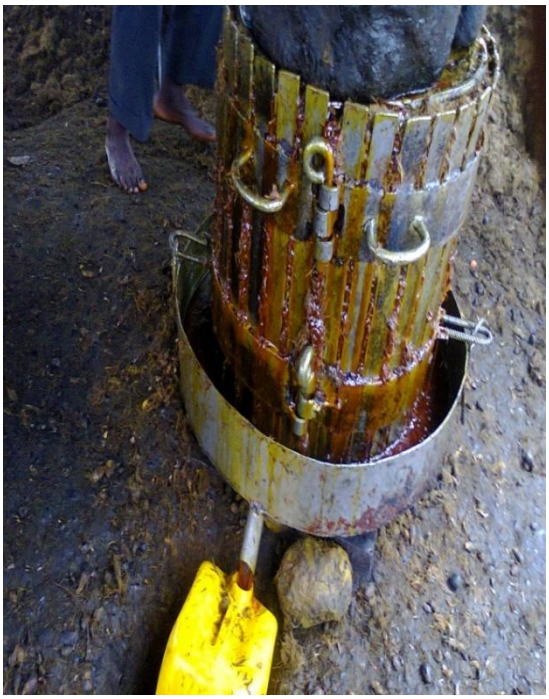
2: splited palm fruit bunches

Picture 3: sterilization of loosed palm fruit

Pic 4 : removal of digested palm fruit from digester

Picture 5: loading of mechanical press with digested fruit

Picture 6 : pressing of digested fruit with mechanical press



Picture 7: palm oil gushing out of mechanical press

Picture 8: pouring of palm oil into drum for clarifying

APPENDIX II: QUESTIONNAIRE FOR PALM OIL PROCESSORS IN UGHELLI-NORTH AND ISOKO-SOUTH L.G.A. OF DELTA STATE, NIGERIA

Dear Respondents,

This questionnaire is for research purpose only. All information given will be considered confidential. You are therefore requested to sincerely answer the following questions. Kindly tick (√) or fill in the blank space(s) as appropriate.

Questionnaire for Recommended Palm oil Processing Technologies Users

Village ……

A DEMOGRAPHIC DATA

1. Sex: Male ( ) Female ( )
2. How old are you ……. (years)
3. Marital status: (i) Single ( ) (ii) Married ( ) (iii) Divorced ( )
   (iv) Widow ( ) (v) Widower ( )
4. How many people are in your house? ……
5. How many years have you spent schooling?.....
6. How many years have you been in palm oil processing business?.....

B. INSTITUTIONAL VARIABLES

7. Do you have contact with extension agents as regard palm oil processing?
   Yes ( ) No ( )
8. If yes, how often were you contacted? ……..
9. Do you belong to any palm oil processing association(s)? Yes ( ) No ( )
10. If yes how many? …….
11. Mention the benefits you derive from the association(s)? …….
    ……
    ……
12. Have you received any credit in the last 2 years? Yes ( ) No ( )
13. If yes, give total amount received (in naira) ……
14. Where did you get the credit from? (i) Family members ( ) (ii) friends ( )
    (i) Banks ( ) (iii) Agricultural agencies ( ) (iv) Co-operatives ( )
    (v) Others please specify ……

C. TECHNOLOGICAL VARIABLES

15.

S/N	Which of these technologies are you using? (please tick)	Years of usage	Agency/sources of knowledge (please tick)
1.	Thresher		Relatives
2.	Sterilizer		Neighbours
3.	Digester		Friends
4.	Separating machine		Fellow processors
5.	Manual/motorized press		Shell petroleum
6.	Oil clarifier		Research institutes/universities
7.	Others (please specify)		Delta state ADP
			Others (please specify)

16. How will you rate the technologies, are they:

S/N	**Technologies**	**Affordable?** (please tick)			**Compatible?** (please tick)			**Complex?** (please tick)		
		VA	A	NA	VC	C	NC	NC	C	VC
1.	Thresher									
2.	Sterilizer									
3.	Digester									
4.	Separating machine									
5.	Manual/motorized press									

6.	Oil clarifier									

17. Do you own any of the technologies above? Yes ( ) No ( )
18. If no, why? Give reason(s) ……..... ……
19. If yes, which one of them? (please tick) (i) Thresher ( ) (ii) Sterilizer ( ) (iii)Digester ( ) (iv) Separating machine ( ) (v) Manual/motorized press ( ) (vi) Oil clarifier ( )
20. Can you operate the machines personally? Yes ( ) No ( )
21. Do you have formal training on how to use the processing machines? Yes ( ) No ( )
22. If yes, by whom? (i) Delta state ADP ( ) (ii) Shell petroleum ( ) (iii) research institutes/universities ( ) (iv) Relatives (v) Neighbours ( ) (vi) Friends ( ) (vii) Fellow processors ( ) (viii) Others please specify……
23. What are your reasons for using the technologies mentioned above?
    (i) Process faster than previously known technologies ( )
    (ii) Yield more palm oil than other known technologies ( )
    (iii) Yield higher quality palm oil than previously known technologies ( )
    (iv) Less tedious than other previously known technologies ( )
    (v) Others (please specify) …….

D EFFECTS OF ADOPTION

24.

How do you get your palm fruits?	Quantity processed last season (in 20 litres)	Cost of processing per 20 litres	Quantity consumed	Price per 20 litre	Net profit for the season
Hired farms					
Buy fruit bunches					
Owned farms					

25. Are there difference in your output as a result of adoption of recommended technologies?

Yes ( ) No ( )

26. How many 20 litre of palm oil do you process per week before the use of these technologies? ……..

27. After adoption, how many 20 litres of palm oil do you process in a week?.....

28. Please tick as appropriate: Which of the following item(s) did you possess from your palm oil processing business?

S/N	List of Items	Number of Items
1.	House	
2.	Television	
3.	DVD	
4.	Radio	
5.	Cell-phone	
6.	Motor-cycle	
7.	Car	
8.	Spraying machine	
9.	Sewing machine	
10.	Set of chairs	
11.	Bicycle	
12.	Rubber mattress	
13.	Other (please specify)	

E. CONSTRAINTS TO ADOPTION

29. What are your major constraints in using the recommended palm oil processing technologies? (i) High cost of processing ( ) (ii) They are complex to use ( )

(iii) Inaccessibility ( ) (iv) Lack of credit facilities ( ) (v) Bad feeder roads ( ) (vi) Lack of adequate capital ( ) (vii) Others please specify

……

……

30. What other challenge(s) do you face as palm oil processor generally? (Please specify)

……

……

31. Suggest way in which the constraints and challenges can be minimized?

(i)……

(ii) ……

(iii)……

THANK YOU FOR YOUR TIME AND CO-OPERATION