KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

DEPARTMENT OF AGRICULTURAL ENGINEERING

COLLEGE OF ENGINEERING, KNUST-KUMASI

A FEASIBILITY STUDY FOR THE ESTABLISHMENT OF AN INDUSTRIAL SHEA NUT PROCESSING FACILITY IN WA

BY

EMMANUEL AMOMBA SEWEH

JUNE, 2011

A FEASIBILITY STUDY FOR THE ESTABLISHMENT OF AN

INDUSTRIAL SHEA NUT PROCESSING FACILITY IN WA,

BY

EMMANUEL AMOMBA SEWEH BSc (Hons.) AGRICULTURE,

DEPARTMENT OF AGRICULTURAL ENGINEERING,

A THESIS PRESENTED TO THE DEPARTMENT OF AGRICULTUTAL ENGINEERING,

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

COLLEGE OF ENGINEERING,

DEPARTMENT OF AGRICULTURAL ENGINEERING,

KNUST-KUMASI

JUNE, 2011

DECLARATION

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

EMMANUEL AMOMBA SEWEH ……………………... …………………..

(PG 2689908)

(STUDENT'S NAME & ID) SIGNATURE DATE

1. DR. JOSEPH OFEI DARKO …………………… …………………..

(SUPERVISOR)

2. DR AHMAD ADDO …………………… …………………..

(SUPERVISOR) SIGNATURE DATE

CERTIFIED BY:

PROF. EBENEZER MENSAH …………………… ………………….

(HEAD OF DEPARTMENT) SIGNATURE DATE

ACKNOWLEDGEMENT

Glory be to God for the guidance and protection He granted me throughout this study. Special thanks also go to my supervisors, Dr Joseph Ofei Darko and Dr Ahmad Addo. Your patience, guidance and useful suggestions enabled me to complete this work. God richly bless you and your descendants.

My thanks also go to the staff and management of Ghana Nuts Ltd, Mr Kamara of Bosbel, Mr Mumuni of GRATIS, Tamale, Mr Mike of AKOMA, Bolgatanga and Madam Joana Cheffa of Christian Mothers Shea Butter Producers, Wa for their assistance during the data collection. To Dr Fialor (Department of Agricultural Economics, KNUST) and Mr Bright Asante (Crop Research Institute, Fumesua), God bless you for taking time to assist me in the financial analysis.

Finally, I wish to express my profound gratitude to my wife Modesta, Brother Ignatius, Ray and the whole Seweh family for their encouragement, support and prayers during the period of my work.

DEDICATION

This work is dedicated to the memory of my late parents especially my mum who saw me through thick and thin but did not live to see the fruit of her labour, my wife, children and the entire Seweh family.

ABSTRACT

This feasibility study was conducted by visiting three established medium to large scale processing facilities in the shea sector to find out the factors that led to the establishment of those facilities there. An economic and financial analysis of the small, medium and large scale facilities was conducted to determine the most suitable and profitable option worth investing. Finally, the research also investigated the impact of such a facility to the conservation of the most important economic tree in the area.The study was conducted to ascertain the possibility of establishing an industrial Shea processing facility in Wa. A cost-benefit analysis was performed on four different scales of production (small, medium–semi mechanized, medium-mechanized and large scale) to determine the most viable option to establish in the area. Using a Bank of Ghana (BOG) one year treasury bills discount rate of 12.65%, the net present value (NPV), benefit cost ratio (BCR) and internal rate of returns (IRR) of the four projects were determined. The NPV for the small, medium-semi mechanized, medium mechanized and large scales were GH¢ 192,125.18; GH¢ -29,080,290.00; GH¢ -72,355,077.98 and GH¢ 206,980,803.10 respectively. The BCR were 1.05; 0.80; 0.89 and 2.75 respectively, while the IRR were 22%, 20%, 31% and 39% respectively. Ranking the projects according to the results obtained, the large-scale facility is the most viable option to invest in with a very high NPV of GH¢ 20,690,803.10, BCR of 2.75 and IRR of 39%. All these values satisfy the decision criteria for selecting viable projects. The small scale local processors ranked second and also proved viable. But the remaining two projects (medium-semi mechanized and medium-mechanized) had two of the analyzed values less than the acceptable values and should be rejected. Other factors affecting the success of the project such as social, operational and biological also indicated that such a project is not only feasible but sustainable as it will raise the standard of living of the members of the community and hence be acceptable. Furthermore, the project will also lead to the protection of the shea tree.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

BOG	Bank of Ghana
CBA	Cost Benefit Analysis
CBR	Cocoa Butter Replacement
cm	Centimetre
CRE	Cocoa Butter Equivalent
DC	District of Columbia
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organisation
FAOSTAT	Food and Agriculture Organisation Statistics
FFA	Free Fatty Acid
GH¢	Ghana cedi
GT	Ghana Telecom
IITA	International Institute of Tropical Agriculture
kg	Kilogramme
km^2	Kilometer square
m	Metre
mm	Millimetre
mt	Metric tonne
MTN	Multi Telecommunication Network
NGO	Non Governmental Organisation
NRG	Northern Rural Growth
ppm	Parts per million
SADA	Savanna Accelerated Development Authority
US	United States
WATH	West African Trade Hub
yr	Year

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Shea butter is obtained from the processed nut of the shea tree (*Vitellaria paradoxa*) which constitutes the main vegetative cover of the three northern regions of Ghana. The international demand for shea butter by the cosmetic, confectionery and pharmaceutical industries far exceeds local shea butter production. This has resulted in the export of raw shea kernel nut for processing in Europe, Japan and America which poses a threat to the industry since importers have the tendency of dictating prices of the commodity as done in the cocoa industry.

Ghana is the leading exporter of raw shea nuts in the world (Lovett and Haq, 2000). FAO estimated that Ghana exported 42,424mt of shea worth 14.8 million dollars in 2008 (FAOSTAT, 2008). However this quantity of nuts could have yielded 21,212mt of shea butter at a premium value of 21.2 million dollars, a percentage increase in value of 42.9%.

Though there is a large market for processed butter from Ghana due to the quality of its nut, very few processing facilities exist in the shea sector. Notable among them are Ghana Nuts Ltd Techiman, Bosbel Oil Mill, Tamale and Shebu Ltd Savelugu. The international demand for unrefined butter over the raw kernel has led to the establishment of small to large scale processing plants by individuals, companies and NGOs in the Northern and Upper East Regions to process and add value to the kernel to guarantee fair prices from international buyers. These processing plants obtain their raw materials from communities within a specific radius from the project sites.

There is no medium to large scale processing facility established in Upper West Region. The region produces a third of the total annual volume in Ghana (field data, 2010). The bulk of butter is processed manually by individual women or co-operatives which are not only time consuming but also arduous. The shea industry has received little support in contrast to other cash crops like cocoa and oil palm, yet there is an increased international demand for shea butter The establishment of a large scale processing facility in Wa will not only improve the economic status of the people by creating jobs, but also yield significant returns capable of offsetting the investment cost within a short period.

Feasibility studies needed to be conducted to ascertain the viability of such a facility. Feasibility studies permit planners to outline their ideas on paper before implementing them. This can reveal errors in project design before their implementation negatively affects the project.

1.2 Statement of the Problem

The Upper West Region contributes a third of the total shea nuts picked in Ghana. Lovett and Haq (2000) documented that large volume of shea kernel remain unpicked and the quantity collected deteriorate due to lack of market and processing facilities. This further increase the poverty situation in the area, compelling the youth to migrate to other parts of the country in search of jobs.

1.3 Justification for the study

A large market exists for shea butter world-wide, particularly as it is organically produced. There is a growing interest in butter from Africa for use as ingredients in the cosmetics, pharmaceutical and confectionary industries, yet the commodity is in limited supply as much of it is processed by local women through crude and arduous means. Investment in the processing of the butter in large volume will not only be profitable, but will also create an avenue for employment to the youth in this part of the country and eventually protect and conserve the shea tree.

1.4 Objectives of the study

1.4.1 General objective

The general objective of the study was to determine the Cost-Benefit Analysis of establishing a medium to large scale shea butter processing facility in Wa.

1.4.2 Specific objectives

The specific objectives of the study were to:

1. Conduct economic and financial analyses on four scales of investments. These are:
    a) Small scale local processors;
    b) Medium scale (semi-mechanized);
    c) Medium scale (Mechanized) and
    d) Large scale.

2. Determine the effects of such a facility in the conservation of the shea tree.

CHAPTER TWO

2. 0 LITERATURE REVIEW

2.1 ORIGIN OF THE SHEA TREE

On the international market there are over 150 non-timber products of major importance, and one of these is shea butter (Carr *et al.*, 2000). Shea butter is processed from a nut of the shea tree (*Vitellaria paradoxa*) and it is sold on the local markets throughout the dry savannah regions of Africa, and on the international market for use in cosmetics and chocolate. The shea tree grows wild in twenty African countries, stretching from Senegal in the west to Ethiopia in the east. This region is known as the "Shea belt" as shown in figure 2.1. Throughout the "Shea belt", the trees are highly valued by the local communities not only for the economic and dietary value of the cooking oil, but also for the fruit pulp, bark, roots and leaves, which are used in traditional medicines (Vermilye, 2004).

Figure 2.1: The Shea belt of Africa
Source: The Shea Network (2010)

2.2 DESCRIPTION OF THE SHEA TREE

The shea tree is a member of the Sapotaceae family. It is a deciduous tree of medium size, with a spherical crown. It often reaches heights of 10-15m, with rare recorded occasions of up to 25m (Maydell, 1990). It is a light demanding, slow growing tree, with a thick and rough bark. The flowers, which appear from December to March, are greenish yellow and occur in terminal groups of approximately 30 to 40. It is insect pollinated and, as such, is often associated with bees (Maranz and Wiesman, 2003). A picture of the shea tree is shown in figure 2.2.

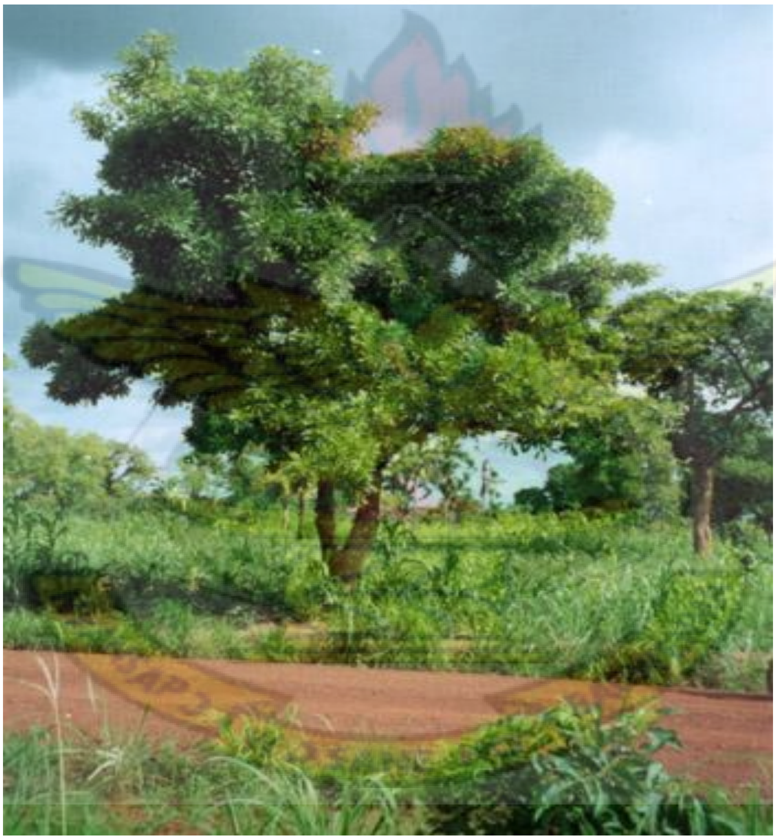

Figure 2.2: The Shea tree. (Source: Field data, 2010)

It thrives on dry sandy clay soils that have a good humus cover, but occurs on a variety of soil types (Hall *et al.*, 1996). It has an extensive root system, which helps it to tolerate the extended dry season (up to eight months) and occasional droughts of the savanna. The mean annual rainfall requirement for shea ranges from 600-1,500 mm (Maydell, 1990). It occurs mainly between elevations of 100-600 m. The seeds of shea have high moisture content and this makes storage of unprocessed seeds difficult. Viability is often lost by two to three weeks after fruit maturity (Danthu *et al.,* 2000). The fruit is yellow-green, elliptical, and about 5-8 cm long and 3-4 cm wide. Each fruit contains one large oval to slightly round, red brown to dark brown seed, which is usually referred to as the "shea nut" (Maranz and Wiesman, 2003) The shell of this nut is shiny, smooth, and fragile. This seed comprises about 50% of the weight of the fresh fruit, and is the part used in shea butter production (Maranz and Wiesman 2003).

Figure 2.3: Picture of the Shea nuts and fruits (Source: Field Data, 2010)

Fruit production usually starts when the tree is about 15 years old and often continues with longevity of 200 to 300 years (Joker, 2000). The fruit is harvested, depending upon the latitude, from May until September, which corresponds with the rainy season (Hall *et al.,* 1996).

The fruit yields do not become optimum until the tree is 25-40 years of age, although there have been some attempts to shorten this period by genetic improvements and grafting (Sanou *et al.,* 2004), which have met with some success, resulting in major reductions in time to fruiting. The fruit is eaten by people from rural and urban areas, and is usually allowed to become slightly overripe to improve the sweet pear-like taste. People, as well as cattle, bats, birds, and a wide range of other animals reportedly disperse the seeds (Hall *et al.,* 1996). Generally, the shea fruit reproduces naturally and, although it may be aided in its reproduction by being protected from fire or grazing livestock, it is not traditionally planted. Planted shea seedlings tend not to produce high quality nuts (Lovett and Haq, 2000).

2.3 STATUS OF THE SHEA INDUSTRY

2.3.1 The Raw Material

Africa produces about 1,760,000mt of raw shea nuts annually from its wild trees, mainly in the Savannah and Sahel regions, but producers harvest and process only a fraction, about 35% (about 600,000 mt), for export as butter or nuts. The West African variety, *paradoxa*, has been traditionally processed and locally used, as cooking oil or as butter for the skin and hair. Table 2.1 indicates estimated production, consumption and exports of shea kernel and butter in Africa.

Table 2.1: Estimates of Shea Kernel Production and Utilization (mt) p.a.

Country	Est.total potential production	Est.Actual Collection	Est. Consumption	Total Exports	exports as shea kernel	Exports as shea butter
Major Exporters:						
Benin	80,000	50,000	14,900	35,100	35,000	100
Burkina faso	150,000	75,000	35,000	40,000	37,000	3,000
Cote d'Ivoire	150,000	40,000	15,000	25,000	15,000	10,000
Ghana	200,000	130,000	70,000	60,000	45,000	15,000
Mali	250,000	150,000	97,000	53,000	50,000	3,000
Nigeria	250,000	100,000	80,000	20,000	20,000	0
Togo	50,000	40,000	10,000	30,000	15,000	15,000
WATH major exporters, Total	**1,130,000**	**585,000**	**321,900**	**263,100**	**217,000**	**46,100**
Minor Exporters:						
Gambia	100,000	0	0	0	0	0
Guinea Conakry	25,000	5,000	4,500	500	450	50
Guinea Bissau	1,000	100	100	0	0	0
Niger	5,000	5,000	4,000	1,000	0	10,007
Senegal	10,000	500	490	10	0	10
Sierra Leone	100	0	0	0	0	0
Cameroon	30,000	5,000	2,500	2,500	2,500	0
Chad	10,000	2,000	2,000	0	0	0
WATH minor exporters Total	**81,200**	**17,600**	**13,590**	**4,010**	**2,950**	**1,060**

Source: Addaquaye, (2004)

2.3.2 Processing Potential

Seven West African countries (Ghana, Burkina Faso, Benin, Cote d'Ivoire, Nigeria, Mali and Togo) produce about 500,000 mt of shea nuts, of which an estimated 270,000 mt are exported as raw nuts. Processors convert the remaining 230,000 mt into roughly 60,000mt of crude shea butter, half of which is then exported. Rural-based women, using manual traditional methods, process about 60% of all the crude butter produced in West Africa at a relatively low extraction rate. Table 2.2 shows the installed and estimated capacity utilization of processing plants in the sub-region. Mechanized processing, increasingly seen in the region yields 40-50% shea butter from raw nuts.

Together the processing plants listed in Table 2.2 show the capacity to convert 162,000 mt of nuts into about 50,000 mt of shea butter, assuming an average estimated extraction rate of 31%. However, most of the West African plants produce at less than 25% of their installed capacity, perhaps because they operate for only 6 months of the year to offset the high cost of storing raw nuts throughout the year.

Table 2. 2. Potential of Shea Nut Processing in West Africa (tonnes/Yr)

Country	Processing plant	Installation input (t)	Capacity utilization (t)	Capacity utilization (%)
GHANA	West African Mills	10,000	2,500	25%
	Juaben Oil Mills (JOM)	10,000	5,000	50%
	Ed OILS	5,000	500	10%
	Bosbel Oil Mills	5,000	500	10%
	The Pure Company	10,000	0	0%
MALI	Huicoma	25,000	6,000	24%
	Sika	25,000	6,000	24%
BENIN	Sinocog Bohicom	10,000	2,500	25%
	Sinocig Cotonou	5,000	1,000	20%
TOGO	Nioto	15,000	3,750	25%
IVORY COAST	Trituraf	10,000	2,500	25%
	Citec	15,000	3,750	25%
BURKINA FASO	Sofib	15,000	3,750	25%
TOTAL		**162,000**	**38,750**	**24%**

Sources: Addaquqye, (2004)

Ghana exports about 65,000 mt of shea nuts annually, making it the leading exporter in the sub-region. Most shea exports consist of crude butter, as virtually no significant refining occurs in West Africa.

Four major players control the global refining of shea: Aarhus United in Denmark, Fuji Oils in Japan, Karlsham in Sweden and Loders Croklaan in Holland, listed in the order of magnitude of size of operations in oils and fats. Table 2.3 shows the average sales values and employment levels of the major processors; however, the figures for Fuji Oil, with sales over $1,440 million, represent only their fats and oils operation, which forms just 33% of the larger consolidated Fuji Oil Group (Addaquaye, 2004).

Table 2.3. Leading Global Refiners of Oils and Fats (including shea) 2002/03

COUNTRY	COMPANY	ANNUAL SALE (in US $ million)	NUMBER OF EMPLOYEES
Denmark	Aarhus United	690	1700
Japan	Fuji Oil(oil and fats)	450	1100
Sweden	Karlsham AB	420	800
The Netherlands/Malaysia	Loders Croklaan	260	600

Source: Addaquaye, (2004)

2.4 USES OF SHEA BUTTER/NUTS

2.4.1 Local Uses of Shea Butter

There are many reported uses of shea in its range. Oil from the kernel of the shea seed is the principal source of fat in many local diets (Saul *et al.*, 2003). The wood from Vitellaria can be used as a high quality fuelwood and to make tools (Kristensen and Lykke, 2003).

The oil and butter are used as a lotion for the skin and hair, although in many areas these traditional products are being replaced by commercially produced lotions. Shea is also used medicinally for treatment of wounds, skin problems, reducing swelling (Boffa, 1999). The butter can also be used as a waterproofing material for huts and walls (Booth and Wickens, 1988).

The *paradoxa* species has a fat that is higher in stearin and lower in olien, thus producing a substance that has the consistency of butter, while the *nilotica* species produces a liquid. However, both are still referred to as shea butter (Boffa, 1999).

2.4.2 International Uses of Shea Butter

In 2004, four firms dominated the majority of the shea nut trade: Karlshams: A Swedish firm, Aarhus Olie (Danish), Loder Croklann (Malaysian owned) and Fuji Oil (Chalfin, 2004). Shea nuts and the oil from them are valued on the international market primarily for use as a cocoa butter equivalent (CBE), a substitute or supplement for cocoa butter in the manufacturing of chocolate (Boffa *et al.*, 2000). Shea butter is usually cheaper than cocoa butter, and also adds durability to the chocolate making it less crumbly and more uniform (Chalfin, 2004).

There has been debate in the chocolate sector over the levels of purity needed in chocolate to be able to call it chocolate (Lipp and Anklam 1998). Some countries, including the United States, France, and Belgium, do not allow any CBEs in chocolate production, while other countries such as Denmark, Sweden, Switzerland, Portugal, Ireland, Russia, and Japan allow up to 5% of the content, and some Eastern European countries allow up to 15%

(Boffa, 1999). Even though France and Belgium do not allow shea butter as a CBE, they do allow its use as a cocoa butter replacement (CBR) for cakes or other sweets not called chocolate (Hall *et al.*, 1996).

Furthermore, shea butter is being used increasingly in the cosmetic industry (Akosah-Sarpong, 2003). In cosmetics, shea is most often used as an ingredient in lotions, but it is also found in make-ups, baby ointments, hair care products, and soaps. The Body Shop and Estee

Lauder are two of the main international firms that sell a variety of shea products, although other companies such as Bare Essentials and Bed, Bath, and Beyond also display shea-based products on their shelves (Chalfin, 2004). Most stores purchase the shea butter from factories in Europe and the United States. In contrast, L'Occitane, a French perfume company, has opened cosmetic stores in the U.S. that provide a line specialising in products using butter bought directly from local producer groups in Africa (Harsch, 2001). The Body Shop, through is a Community Trade Programme has established partnerships to buy shea butter from community groups in Africa (Laird and Guillen 2002).

2.5 INTERNATIONAL DEMAND FOR SHEA NUT/BUTTER

Shea has become an important non-timber forest product on the international market. The products from shea are exported in one of two ways. Either the nuts themselves, after being roasted, are exported in bulk, or the nuts are processed into shea butter within the country of origin, and then exported (Boffa, 2000). Shea products were first recognised as an important export for West Africa during the Colonial period (Saul *et al.*, 2003). In the 1920's shea nut and butter exports increased as they began to be used in European chocolate, cosmetics, and soaps. In the main producing countries of Nigeria, Mali, Burkina Faso, Ghana, Côte d'Ivoire, Benin, and Togo, over 700,000mt of shea nuts are produced annually. Yet only about twenty percent of these nuts are processed and exported (FAOSTAT, 2008). In 2008, the FAO estimated that Ghana exported 42,424mt of shea nuts at a value of US$ 41,787,640 (FAOSTAT, 2008).

More than 700, 000mt of the dominant variety, *paradoxa*, are produced in West Africa with Nigeria being the leading producer (Table 2.5). Most of it is used as cooking oil or as butter for the skin and hair. FAO's export statistics of major supplying countries are provided in

Tables 2.4 and Figures 2.4 and 2.5 although they are not considered to be completely accurate and are primarily estimates.

Table 2.4: Shea Nut Production by volume, 2004-2008 (mt)

YEAR	2004	2005	2006	2007	2008
Benin	15,500	15,000	15,000	15,000	15,000
Burkina Faso	70,100	75,700	70,000	70,000	70,000
Côte d'Ivoire	26,194	27,058	27,951	28,874	28,874
Ghana	65,000	65,000	65,000	65,000	65,000
Mali	85,000	85,000	85,000	85,000	85,000
Nigeria	414,000	414,000``	414,000	425,000	425,000
Togo	8,000	9,000	9,300	12,000	12,000
TOTAL	683,794	690,758	686,251	700,874	700,874

Source: FAOSTAT, 2008

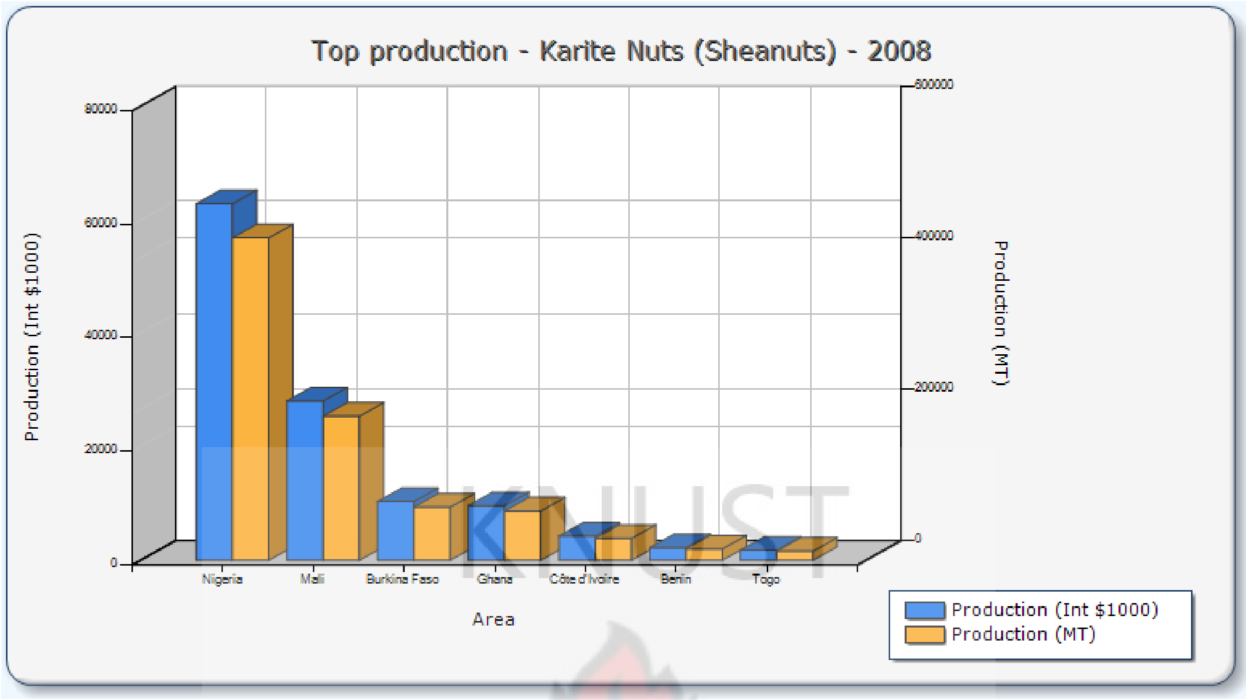

Figure 2.4: Worldwide Shea Nut Exports by Volume, 2008 (mt). Source: FAOSTAT, 2008.

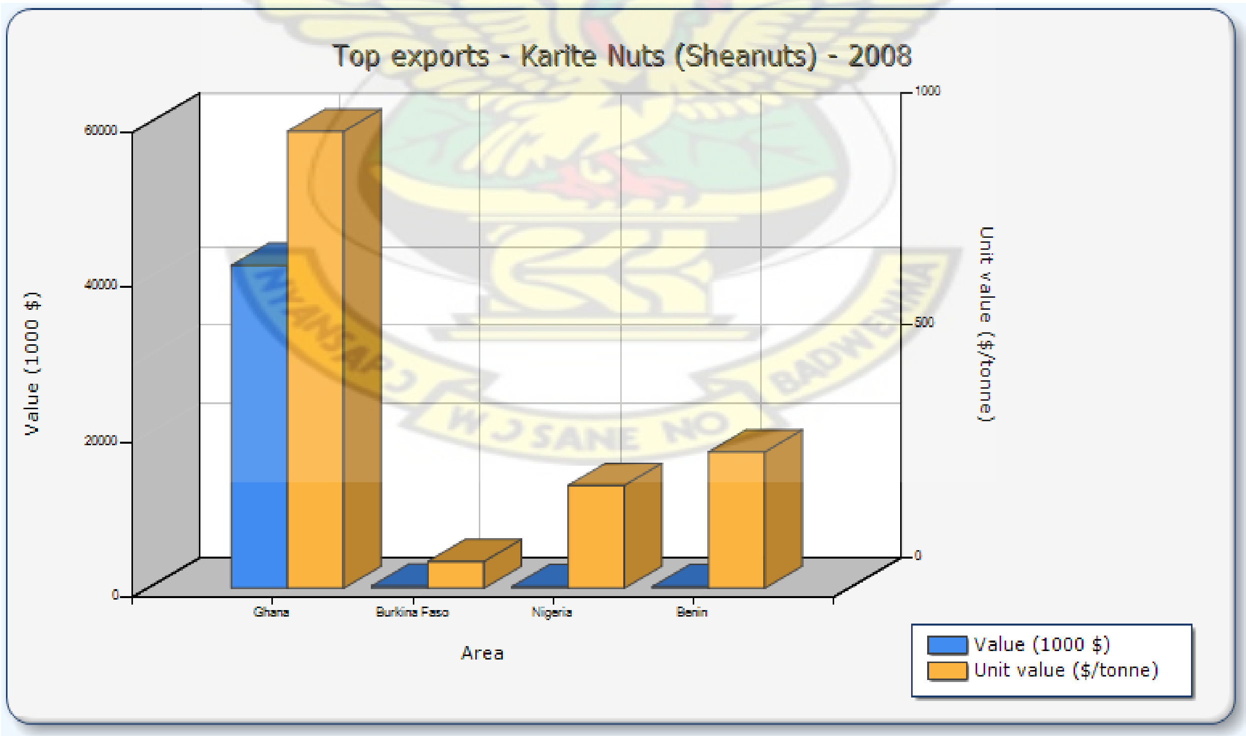

Figure 2.5: Worldwide shea Nut Exports by Value, 2008 (US$000s)
Source: FAOSTAT, 2008.

Although some authors expressed the concern that the supply of shea nuts surpasses the demand (Hall *et al.*, 1996) there is increasing interest in creating direct partnerships between African producers of shea butter and cosmetic companies (Boffa, 1999) as seen by the examples of L'Occitane and The Body Shop. This emphasis on village-processed shea butter, not only provides a market for rural women in Africa, but also increases the economic return (Chalfin, 2004). Early in 2003, a conference was held in Washington D.C. with representatives from several shea butter producing countries. Hosted by the US Agency for International Development, the participants came together to discuss the growing international demand for African produced shea butter in the cosmetics industry (Akosah-Sarpong, 2003). The cosmetics industry offers a market to producers from African countries due to the growing demand for natural and organic beauty products (Akosah-Sarpong, 2003).

To understand the shea butter projects that will be discussed, it is necessary to understand how shea butter is produced. Description of the traditional, semi-mechanized, and industrial shea processing methods follows.

2.6 SHEA NUTS PROCESSING

2.6.1 The Traditional/Local Production of Shea Butter

The process involves gathering of the fruits from the wild, pre-treatment (curing) and then extraction to obtain the butter. The process of gathering fruits from the wild brings with it unwanted foreign materials. Women and children harvest the fallen fruits starting at the commencement of the annual rainy season, which depending on latitude, begins in April or May and continue through September (Hall *et al.*, 1996). The fruits are then carried in loads of about 20 kg from the harvesting area back to the village. Depending on the distribution of the trees, this may be up to 10km away

(Chalfin, 2004).

2.6.1.1 Pretreatment/Curing

The first stage of pre-treatment, involves the removal of such unwanted materials. Shea fruits are then left in the open to ferment for between 3 – 5 days after which they are de-pulped to separate the fruit pulp (mesocarp and epicarp) from the nuts. The fermentation facilitates the removal of the fleshy pulp. The nuts are then sun-dried for 5 – 10 days to reduce their moisture content. The nut, which is made up of a hard outer shell with the kernel inside, is pounded in a mortar with a pestle, cracked between two stones or trampled upon with the feet to liberate the kernel (Salunkhe *et al.,* 1992). The nuts are then thoroughly dried for 10 - 20 days, depending on weather conditions, bagged and stored for sale or processed to obtain the butter. Figure 2.6: shows a flow chart of the pretreatment of the nuts.

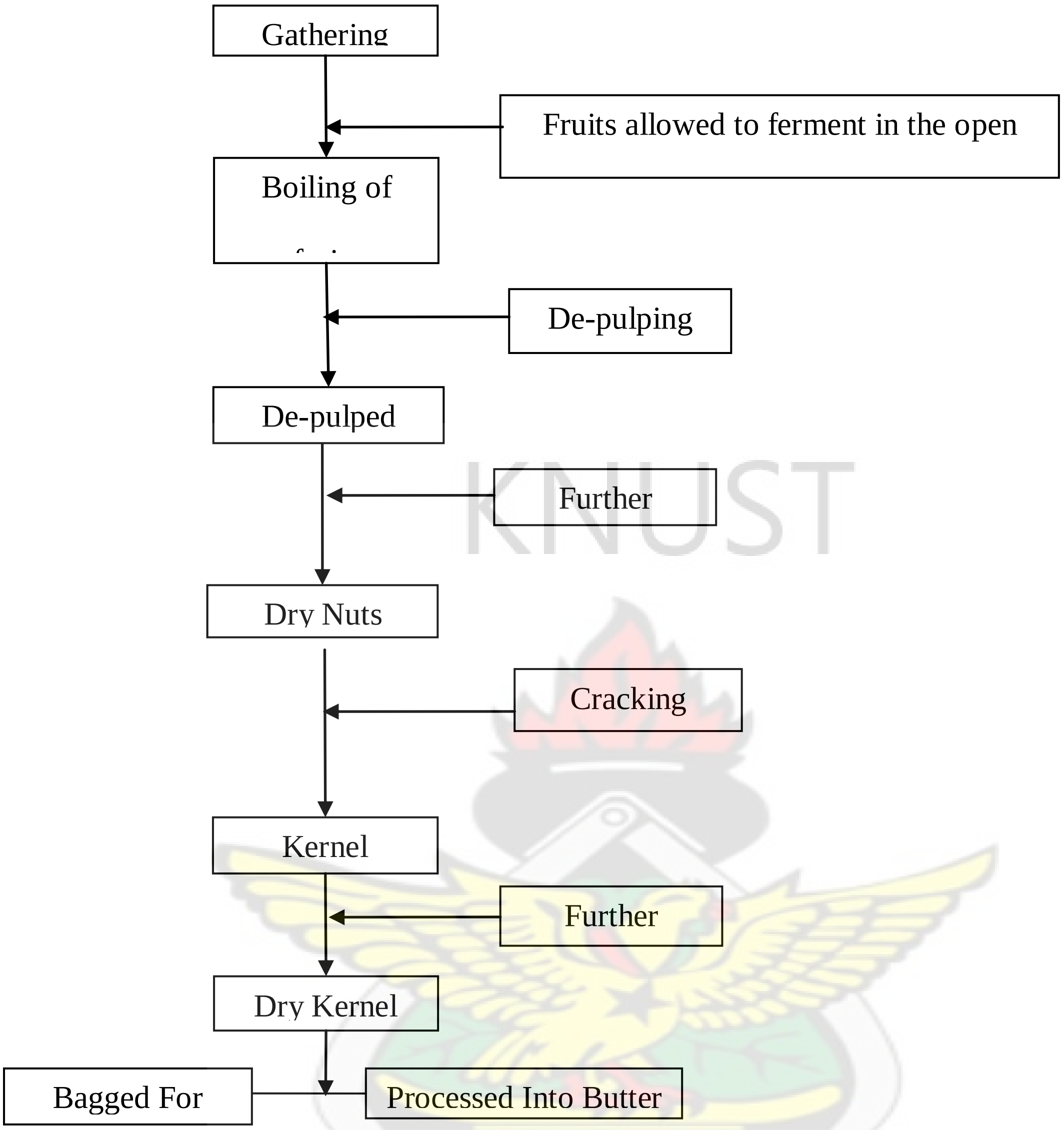

Figure 2.6: A flow chart for local collection and pretreatment of shea nuts (Source: Field data, 2010)

2.6.1.2 Butter extraction

When processing has to be done, the stored nuts are used. The kernels are crushed and roasted, ground into a paste which is then kneaded by hand with addition of water to separate the fat to the top. The fatty component is removed by scooping with the hand, into a separate container, clarified and crystallised. Kneading is the most crucial step which determines the yield of the final product. Its successful execution depends on the recognition of changes in appearance, colour, viscosity and temperature of the kneaded mass, possible only for the well-trained and experienced eye to see.

In the clarification and crystallisation phase, the cream is heated in a big pot. The clear oil that is formed is collected with a ladle into a smaller pot. Scum floating on top of the oil is discarded. The clarified oil is poured into clean, enameled basins and left to cool overnight. In the morning, the oil starts to crystallise or solidify, sometimes after seeding with a small lump of shea butter from a previous batch. The mass is stirred at hourly intervals with a wooden spoon until the oil has been transformed into a warm, thick but fluid state. The shea butter is then transferred into calabashes. This is covered with a piece of cloth and stored until it is taken to the market.

The traditional method of shea butter production is arduous and labor intensive. The total time required to process the shea butter, excluding the harvesting and drying times, is usually around 5-6 hours (Hall *et al.*, 1996; Boffa, 1999). The traditional method of shea butter production is not only labor intensive, but requires large amounts of water and fuel wood. Both of these items are often scarce resources in the arid regions where shea grows. Figure 2.7 is a flow chart showing the various stages involved in the local processing of shea butter.

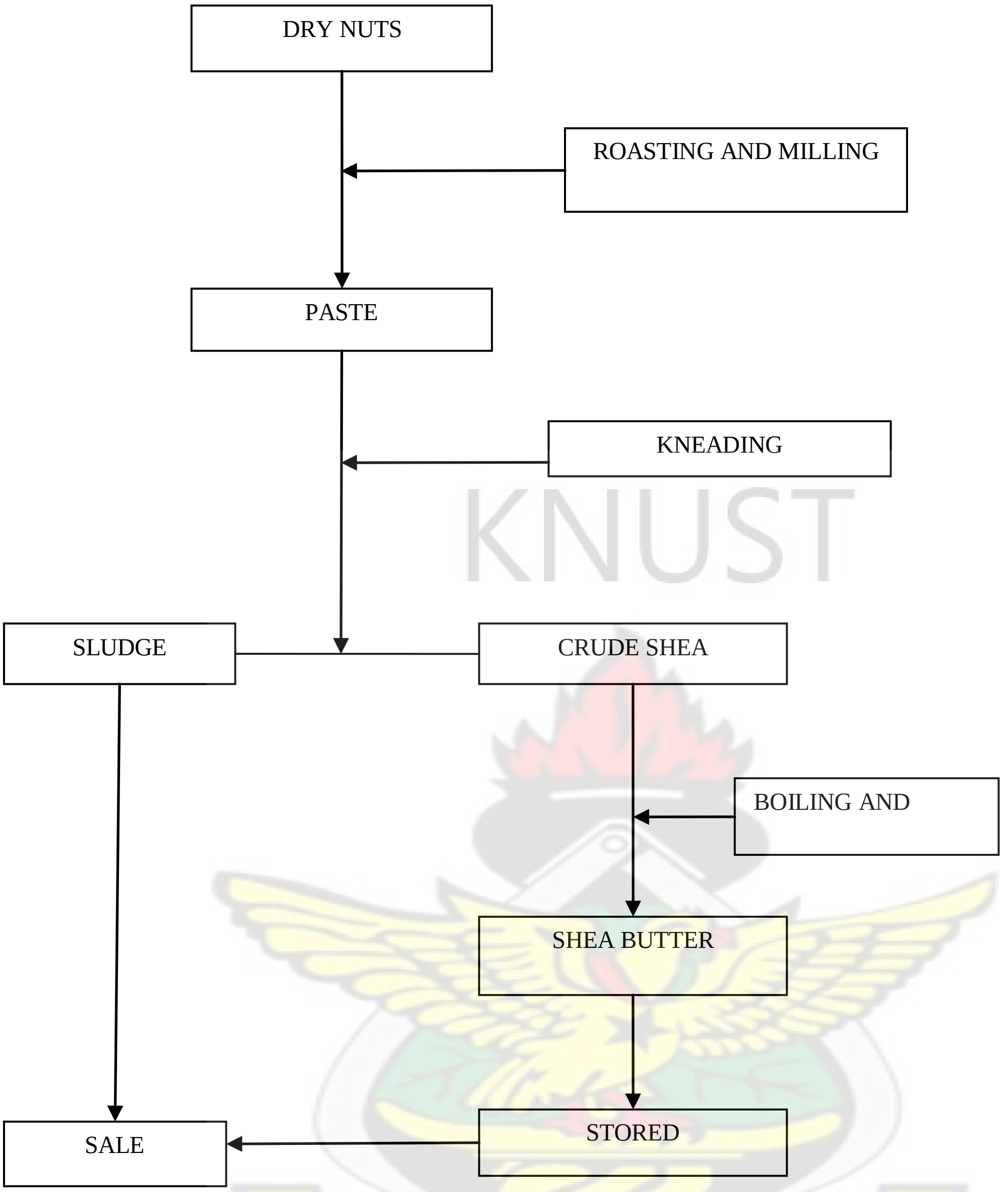

Figure 2.7: A flow chart for local processing of shea butter

(Source: Field data, 2010)

2.6.2 Semi-Mechanized Processing of Shea Nut

Due to the limitations of the traditional method, a second method of production has evolved at the village level in some areas. This method is semi mechanised with grinders and crushers taking the place of the mortar and pestles. Additionally, in some locations the process is further mechanised by the use of hand operated roasters and oil presses. This method reduces the fuel wood and water required for processing, and requires much less time and physical labour per batch of nuts processed. Even though semi-industrial methods achieve higher extraction rates than strictly traditional methods of extraction, traditional processors have been slow to adopt the various introductions of appropriate small-scale technologies due to the cost. Each of the above-noted process activities, once mechanised, improves efficiency to 35-40% per batch (Addaquaye, 2004).

Small-scale machines, such as roasters, milling machines, kneaders and boilers, have been introduced in an attempt to minimise or eliminate the drudgery of traditional manual methods.

2.6.3 Industrial Processing Of Shea Nuts

2.6.3.1 Extraction

There are fully mechanized industrial processing plants. These industrial processes use state-of-the-art mechanical and chemical technology to obtain both the highest yields (42-50%) and the highest quality of butter, in terms of stability for extended shelf-life and suitability for industrial and food processing. Such an industrial unit may combine an extraction plant with the refinery or may be a stand-alone refinery, using crude shea butter as raw material. The extraction process incorporates fully mechanical, as well as sometimes automated and computerised systems. For large-scale plants, producers add a refinery to the extraction plant. Figure 2.8 shows an industrial extraction plant combined with a refinery.

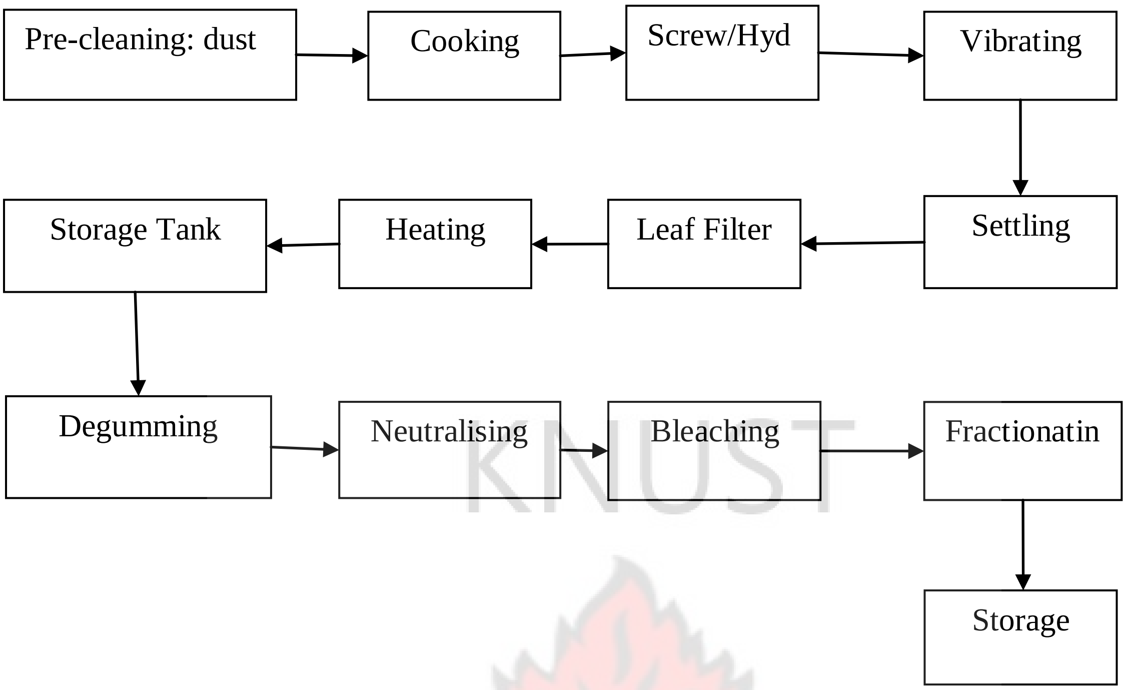

Figure 2.8: Flow chart for Industrial Shea Butter Extraction Plant and Refinery (Source: Field data, 2010)

2.6.3.2 Refining

After the extraction of the crude shea butter, also known as "natural shea butter" or "bulk shea butter", various options exist for modifying or cleaning, which is loosely described as "refining". In fact, every stage of the refining process takes any natural ingredients deemed unfit for human consumption out of the butter. In the process, harmful refining chemicals are introduced as catalysts and must be removed at the end of the process by "re-refining". Many popular natural products go through such dissections, as does traditional African shea butter, which has been modified into a myriad of marketable products. The variants may be classified as natural, refined, processed, industrialised, extra refined, ultra refined, etc (Addaquaye, 2004).

Producers use four major processes for modifying or cleaning crude shea butter: De-gumming, neutralisation, bleaching and deodorisation.

2.6.3.2.1 De-gumming (The Continuous Acid / Water Process)

Gums in edible vegetable oil must be removed to avoid colour and taste reversion during subsequent refining steps. The process involves a single-stage phosphoric acid treatment and a single-stage hot water treatment, followed by continuous removal of the hydrated gums in a de-gumming centrifuge.

2.6.3.2.2 Neutralisation

All crude vegetable oils destined for human consumption (e.g., as ingredients in chocolate and margarine) are neutralized to remove free fatty acids and latex-like matter and then washed to reduce the soap content of neutral oil. This produces a more stable product. Effective neutralisation results in enhanced effectiveness of subsequent steps, such as bleaching, deodorising and furthermore, results in high yields of a quality product.

Neutralisation also aides in the removal of phosphatides, free fatty acids, mineral and color bodies. Neutralisation (refining) occurs by mixing crude butter/oil with a water solution of sodium hydroxide at about 66-77 ^{0}C. Some plants use sodium carbonate or potassium hydroxide. The alkali reacts with the free fatty acids to form soap, which is an important by-product of vegetable oil. After refining, processors remove the undesirable traces of soap and moisture through water washing and vacuum drying. In the refining and washing steps, centrifuges separate neutral oil from soap-stock and wash water.

2.6.3.2.3 Bleaching and Deodorising

The neutral, washed and dried vegetable oil still contains some colour bodies and small traces of soap (<50 ppm) that have to be removed. Bleaching, the process for removing these pigments from fats and oils occurs when 1% bleaching clay is added to oil under vacuum at approximately 107-110 ^{o}C, which is later agitated and filtered to remove the clay. High temperature drives moisture from the clay, so that it will absorb the pigments. Some systems also use activated carbon.

A high-tech bleaching plant may be equipped with hermetic leaf filters which operate under vacuum to prevent oil oxidation. The oil is cold-mixed with metered quantities of bleaching earth and/or other bleaching agents and thereafter heated to the correct temperature and pumped to a bleaching chamber operating under vacuum where an adequate retention time is provided to ensure effective bleaching. The oil/earth slurry is further pumped through hermetic leaf filters operating in sequence to enable continuous bleached oil (filtrate) discharge.

Deodorisation represents the last major processing step in refining of edible oils and removes the compounds that cause undesirable odor, flavour and colour. Deodorisation separates out the impurities and creates three groups of compounds:

1. Saponifiable compounds: free fatty acids, partial glycerides, esters, gummy constituents,

2. Unsaponifiable compounds: parafinic hydrocarbons, olefinic and polyolefinic materials, sterols, triterpenic alcohols,

3. Oxidative reaction products: aldehydes, ketones, peroxides. This highly specialised process uses a type of steam distillation under high vacuum to remove objectionable volatile components, such as ketones, aldehydes and alcohols. The bleached oil pumps through a de-aerator where the pretreated oil is de-gassed. This de-aerated oil passes through a heat exchanger where the oil is heated by exchanging the heat of the deodorised oil.

Deodorisation further heats the oil to the stripping temperature in a pre-heater. The oil then flows to a flash chamber and thereafter to an oil distributor inside the falling film deodoriser. The oil descends counter-current to the stripping steam in the form of a very thin film and becomes completely deodorised. The process condenses, cools and stores the distilled fatty acids. The oil from the bottom flows to an intermediate vessel containing an arrangement for dosing citric acid. This deodorised oil pumps through a heat exchanger to the polishing filter and thereafter passes through a cooler. It is then discharged for collection. The resulting product lacks flavour, odour, minerals and vitamins.

2.6.3.2.4 Fractionation

Shea butter has two main components – the stearin (the creamy fat) and the olein (the runny oil). The production of cosmetics mainly uses olein, while the stearin goes into margarines and chocolates. The process which separates the two components is "fractionation". Two methods of fractionation exist – the chemical/mechanical method and physical method.

The former requires the creation of a vacuum (airless condition) and applies a chemical reagent to separate the olein from the stearin at different temperatures. After separation, the oily part can then be poured out through decantation or siphoning. The physical process involves a process of sedimentation or a centrifugal method to cause the stearin to separate from the olein. This process, however, proves more difficult when working with the West African shea butter because of the higher ratio of stearin to olein.

Although there are a few in Africa, the vast majority of fully mechanized processing facilities occurs in Europe, Asia, and North America (Chalfin, 2004). Generally, the nuts are purchased in African markets through wholesalers and then exported to overseas processing plants. The introduction of mechanised processing is gradually picking up in Africa, particularly Ghana, because the country is relatively stable and marketing channels are well established. Also nuts from Ghana are of high quality. Furthermore, the European Union now limits the processing of shea nut in member countries due to the introduction of strict environmental laws regarding waste disposal from factories. This explains why this study is necessary to bring out the potential of the Upper West region in the shea trade concerning industrial butter production.

2.7 Characteristics Of Shea Butter.

The chemical and physical properties of shea butter have been documented by Adomako (1985) as shown in Table 2.5.

Table 2.5: Chemical and Physical Properties of Shea Butter and Cocoa Butter

Composition	**Shea butter**	**Cocoa butter**
Fat content (%)	52.1	53.4
Ash content (%)	3.2	2.8
Melting point (ºC)	38.0 – 39.5	34.3
Slip point(ºC)	36.7 – 37.4	33.3 – 33.5
Iodine number	64.2	36.1
Acid number	13.4	1.8
Free fatty acids (as oleic) (%)	6.8	0.9
Saponification number	179.6 – 190.0	190.6 – 195.0
Unsaponifiable matter (%)	7.3 – 9.0	0.1 – 0.3
Solidification point (ºC))	26.5 – 30.0	28.0 – 28.6
Linoleic acid (%)	6.9	3.2
Linolenic acid (%)	1.6	1.2
Degree of unsaturation	0.59	0.42

Source: Adomako, (1985)

The high iodine number, acid number and free fatty acids, as presented in Table 2.5, result in the pungent odour or taste characteristic of shea butter within a short period during storage (Adomako, 1985). Fatty acid composition of shea butter is shown in Table 2.6, an indication that palmitic, stearic, oleic, linoleic and linolenic acids are the main fatty acids in shea butter and that it has a relatively high degree of unsaturation.

Table 2.6: Fatty acid characteristics of tallow fat, shea butter and cocoa butter.

Fatty acids (%)	**Tallow fat**	**Shea butter**	**Cocoa butter**
Myristic	Nil	Nil	0.2
Palmitic	3.1	4.8	26.8
Palmitoleic	0.2	Nil	0.3
Stearic	45.5	45.5	36.1
Oleic	50.5	40.8	31.9
Linoleic	0.4	6.9	3.2
Linolenic	Nil	1.6	1.2
Degree of Unsaturation	0.51	0.59	0.42

Source: Adomako, (1977)

2.8 Quality Standards Of Shea Butter

Individual companies specify their own quality standards for purchases of shea nuts. Table 2.7 shows the benchmark for the composition of the shea nut required for import:

Table 2.7: Quality standards of Shea butter

Parameter	Value
Free Fatty Acids (FFA)	Less than or equal to 6%
Moisture content	Less than or equal to 7%
Oil Content	Greater than or equal to 45%
Latex	4-10%

(Source: Lipp and Anklan,1998)

Ghana standards board ensures that butter for export is thoroughly examined to meet this internationally accepted standard.

2.9 ECONOMIC AND FINANCIAL APPRAISAL

The economic and financial appraisals are considered to be the most important tools for helping decision makers to choose or select a project. To understand fully the financial and economic analysis that will be discussed in the next chapter, one needs to have an idea of the project.

2.9.1 Meaning of project appraisal

"A project is a group of activities which can be planned, financed (funded), implemented, and analysed as a unit" (Amman-Jordan, 2005). Project appraisal includes economic, financial, and social evaluation for a project before its implementation to have enough understanding whether the project is feasible or not. According to Amman-Jordan, (2005) a project in general includes the following factors:

- Outflows: Also known as; inputs, resources, costs or investments
- Inflows: Also known as: output, production, benefits or revenues.

- Life Span of the Project: The time or the life of the project. It is a specific activity (ies) with a specific starting point and specific ending point intended to accomplish a specific objective(s).
- A Space: A geographical location or a place with a boundary forming the project space.
- The Management: The administrative structure, the individuals (cooperative, corporation., entities) and the participants. It is better to keep the project close to the minimum size that is economically, technically, and administratively feasible.

2.10 COST-BENEFIT ANALYSIS

Cos–Benefit Analysis is a quantitative technique to help guide investment decision in a systematic approach. The costs and benefits of the investment are compared in order to determine whether on a balance, the investment is worthwhile; or whether it's worth could be increased by altering design parameters such as the location, timing, scale composition, technology, or method of implementation; and whether the policy environment bearing on the project is or could be made conducive to its successful implementation and operation.

2.10.1 STEPS IN COST ANALYSIS

Cost analysis involves trying to identify and value all the costs associated with a project. The costs associated with a particular project depend on whether they are viewed from the stand point of the individuals concerned or of the society as a whole. Thus, in project analysis, there is a distinction between economic analysis and financial analysis.

Economic analysis deals with costs and benefits from the view point of the country as a whole. This is called Economic Costs – Benefits Analysis. Financial analysis deals with costs and benefits from the view point of the individual (or an agency or enterprise)

According to Oppong (2008), the steps involved in cost analysis are; identify all costs, calculate incremental project costs, exclude non-economic items, value economic items, estimate externalities and add cost by year.

2.10.1.1 Identifying Project Costs

All the costs associated with the project are identified as the first step in cost analysis. Costs comprise all of the expenses related to the construction and operation of the project facilities or system. Costs related to construction are often referred to as investment costs. These include the cost of land, buildings (and other civil works), and equipment. Costs related to the operation of the project are also referred to as operation and maintenance costs. These include;

1. Direct materials: - raw materials, auxiliary materials, utilities, spare parts, tools to mention a few.
2. Direct man-power:- salaries and wages, benefits and social security contributions overheads man-power:- management, functional staff, and indirect labour Factory and administrative overheads: - utilities, communication, repairs and maintenance, rents, etc.
3. Depreciation

2.10.1.2 Incremental Project Costs

The second step is to calculate the project incremental costs. Incremental costs can be calculated by subtracting "without" project costs from "with" project costs

2.10.1.3 Exclude Non-Economic Items

The third step in cost analysis is to decide which project costs are non-economic and are excluded from the analysis. Economic items are those that meet these three criteria:

a. They represent the real use of resources such as land, labour, or capital;

b. They have an alternative use in the economy and

c. They could produce benefits to society in an alternative use.

Non-economic items do not use up resources, they do not have alternative uses in the economy, or they would not produce benefits to society in alternative uses. Typical example of non-economic items to be excluded in economic analysis (cost analysis) is direct transfer payments such as taxes, duties, subsidies and interest. Depreciation, which is an internal book-keeping transaction, is also a non-economic item since the investment to which it refers would already have been included under investment costs. But in financial analysis, these items are included as costs.

2.10.1.4 Value Economic Items

The forth step is valuing economic items. Financial costs may be adjusted if they are based on market prices that often do not reflect the true value of the item to society. Financial prices are also adjusted if they are administered or kept at a level that is higher or lower than the true value of the item in its alternative use. This step in cost analysis is to value each cost from an economic point of view. That is, the value of the resources to society in an alternative use is calculated in economic analysis. That is not true with financial analysis.

Calculated economic value (for use in economic analysis) begins with identifying a correction factor defined as:

$$\text{Correction Factor} = \frac{\text{Sales Revenues} + \text{Consumer's Surplus}}{\text{Sales Revenue}} \qquad (2.1)$$

The correction factor reflects the amount by which to adjust a cost expressed in financial prices. The financial cost is multiplied by the correction factor to give the economic cost. For example, if the consumer's surplus is estimated to be equal to 33% of the sales revenue of 10 million, Then, **correction factor** = $\frac{10+3.3}{10} = \frac{13.3}{10} = \mathbf{2.33}$

$$\text{Economic Price} = \text{Financial Price} \times \text{Correction factor} \quad (2.2)$$

2.10.1.5 Estimate Externalities

The fifth step in cost analysis is to identify the externalities, or external costs, associated with the project. Externalities are costs that are borne by someone other than a direct project beneficiary. Externalities are measured and valued like any other project costs. That is, they are separated into "with" and "without" external costs so that the incremental external costs can be calculated.

2.10.1.6 Add Costs by Year

The sixth step is to obtain totals for the costs in each project year. Annual totals are convenient summaries of expected project costs. They facilitate the comparison of the total cost in each project year.

2.10.1.7 Taxes

In economic analysis, taxes are considered as a transfer payment, a part of the net return from the project which is turned over to the government to spend on behalf of the society as a whole rather than by the individuals or project management. Therefore, taxes in economic analysis are not deducted from the income stream as cost.

2.10.1.8 Subsidies

A subsidy, in effect, is a transfer payment to the project from the society. For example, a subsidy on fertiliser reduces its cost to the farmer and thereby increases his income. Thus, subsidy reduces cost and the money transfer goes to those who participate in the project.

In economic analysis, one must adjust market prices to reflect the amount of any subsidy. If subsidies operate to reduce input costs, they must be added to the market price of the commodity. For example, if a fertiliser is subsidised so that it sells at only 80% of its true cost to the society, then if we are to compare our agricultural project with alternative investment in the society, we must add 20 percent to the cost of the fertiliser used in the project.

2.10.1.9 Inflation

There are two alternative ways of coping with inflations in project analysis. To inflate all costs and returns by what you expect will be an average rate of inflation. This alternative seems cumbersome. Another alternative is to assume that all prices on both the cost side and the benefit side will rise uniformly by the same proportion and that they will not change their relative values. This is considered equivalent to deflating all costs and benefits by some kind of price index.

2.10.1.10 Sunk Costs

Sunk costs are costs incurred before the start of the appraisal period and for which there is no value to the resources in some alternative use. Common examples include the costs of policy development or feasibility studies undertaken at an earlier date. Sunk costs are not included in an economic CBA because there is no opportunity cost involved and their inclusion may distort the analysis at hand by requiring a very high return on the investment. In another way, sunk costs are irrelevant because they are the outcome of past decisions and should therefore be excluded from future decisions.

2.10.1.11 Shadow Prices

A shadow price may be defined as that price which would prevail in the economy if it were in perfect equilibrium under conditions of perfect competition. Market prices of goods or services do not always reflect the true cost or value of those goods or services. For example, a subsidy on a particular good is likely to make the price of the good lower than the true cost of the resources that went into making it. The true cost would instead be the price of the good, plus the per unit value of the subsidy.

2.10.1.12 Revealed Preference Testing

Revealed Preference Testing compares situations where people have historically made trade-offs between a cost and some form of benefit. For example, farmers who have contributed towards some form of flood protection works to reduce the risk of their farm being flooded. This information can give an indication of the extent to which people are prepared to pay for a given benefit. Examples of this method include:

i. Hedonic pricing use the different characteristics of a traded good to estimate the value of a non-traded good. For example, the value of a piece of lakefront could be calculated by comparing the price of a house on the lakefront with the price of a similar house located elsewhere.

ii. Travel Cost Analysis uses the value of traded goods and services to estimate the value of non-traded goods. For example, the value of a recreational park to people might be calculated as the sum of the costs incurred by people traveling to the park (including travel time). This may result in a minimum value for the park, as it ignores what is likely to be a significant value to the consumer above what is paid (consumer surplus).

2.10.1.13 Stated Preference Testing

Stated Preference Testing uses survey to identify their preference for trading off costs and benefits under certain hypothetical scenarios. The approach simulates a market by estimating a consumer's:

i. Willingness to pay for a good or service,

ii. Willingness to accept compensation to tolerate a negative or bad economic outcome.

2.10.1.14 Contingencies

To improve upon the accuracy of cost estimates, it is important to include contingency. Thus, cost estimates usually have a base estimate and contingency added to it. The base estimate represents the best judgment as of the date specified of what the project will cost. It assumes that the project will be implemented as planned and that the quantities of works, goods and services and their prices are known with reasonable accuracy and will not change during implementation. Contingencies normally consist of physical contingency and price contingency. Physical contingencies reflect how much costs are expected to rise above the base estimates as the project progresses, owing to changes in the quantity of work performed; in the amount or type of equipment purchased, or the method of implementation. Price contingencies allow for expected increases in project costs due to changes in unit prices for the various components after the date of the base estimate.

In determining the appropriate level of price contingencies, two of the factors to be considered are the extent of expenses of local and international inflation during project execution, and the extent to which local or foreign prices for particular types of works, goods, or services are expected to depart from general inflation trends.

2.10.1.15 Dead weight Losses

A deadweight loss is the net cost to society attributable to a move away from an economy's competitive equilibrium, usually through the imposition of a tax or regulation. For example, imposing a tax on a particular good or service causes some consumers to purchase less of that good or service than they would in the absence of the tax. The deadweight loss (sometimes termed excess burden) is the loss of welfare resulting from the tax-induced behavioural change. The recommended approach is to consider whether or not to include deadweight losses on a case-by-case basis. As a general rule, deadweight losses should be included if they are of sufficient size relative to the overall costs and benefits of the proposal that they are capable of altering the decision as to whether or not to proceed with the proposal. Having said this, deadweight losses are notoriously difficult to quantify.

2.10.2 STEPS IN BENEFIT ANALYSIS

Benefit Analysis involves trying to identify and value all the benefits associated with a project. The main steps in benefit analysis are:

1. Identify all benefits,

2. Calculate incremental project benefits,

3. Exclude non-economic items,

4. Value economic items,

5. Estimate externalities and

6. Add benefits by year.

2.10.2.1 Identify all Project Benefits

A benefit is any good or service that is produced by a project. Benefit can also represent cost savings or reductions. Good initial sources of information on benefits are historical and projected financial statements. Benefits associated with water supply projects often include sales revenue, investment income, increased production capacity and delivery capacity.

2.10.2.2 Calculate Incremental Project Benefits

Incremental project benefits are calculated by subtracting "without" project benefits from "with" project benefits. Incremental benefits represent the net results of a project use of scarce resources. It should be noted that "with" and "without" benefits are not necessarily the same as benefits that are received "after" and "before" the project. Comparing the situation with and without the project constitutes the basic method of measuring the additional benefits that can be attributed to the project.

The situation without the project is often not simply a continuation of the status quo since some changes in input and output levels and price are likely to take place anyway. In general, the assessment of the without case, should rest on the best judgment as to the future scenario if the proposed project were not undertaken. Proper specification of the with and without situations; including a total understanding of the relationships between project inputs and outputs and their phasing over time, is a prerequisite to any cost – benefit analysis.

2.10.2.3 Exclude Non-Economic Benefits

Non-economic items are those that do not influence the level of benefits from a project. Examples include interest income, investment income and subsidies. These are direct transfer payments from one entity to another and are not relevant to a benefit analysis.

2.10.2.4 Value Economic Items

The forth step in benefit analysis is to value all the benefits from an economic point of view. Financial benefits, such as sales revenue, often must be revalued to reflect their economic value. Economic prices are those that also take into account benefits such as the consumer surplus.

The consumer surplus represents the additional benefits to the community that are received free of charge. Consumer surplus is the difference between what consumers are prepared to pay for a product or service and what they actually pay. Such surplus is common in pubic utility projects such as power, water supply, sanitation and telecommunications.

In many developing countries, governments set regulated prices below the market clearing prices, as evidenced by large unsatisfied demand and queues for access to the service. In some cases estimating the consumer surplus poses a serious problem. The usual practice for some analysis is to ignore the consumer surplus and equate the benefits with the revenues received from the consumers which can be estimated with some confidence.

It should be noted, however that, consumer surplus is an important part of the economic benefit, leaving it out can lead to serious underestimation of overall project returns. Therefore, efforts should be made to get at least a rough idea of its likely magnitude. One important method for estimating the consumer surplus is to multiply the sales revenue by a correction factor. Economic benefits are financial benefits in sales revenue corrected by a factor that takes into account the consumer surplus. The correction factor is obtained by adding the sales revenue and the value of the consumer surplus and dividing that sum by the sales revenue (see equation 2.1).

2.10.2.5 Estimate Externalities

The fifth step in benefit analysis is to estimate externalities associated with the project. Externalities are benefits received by those who are not direct project beneficiaries. Externalities are often intangible and difficult to quantify, but they should be estimated, if possible and considered in the analysis. When externalities cannot be quantified, they should be discussed in qualitative terms. Contemporary discussions of secondary effects generally distinguish among these three types of benefits:

(i) The customary variety of stemming, which are generally treated analytically by adjusting price relationships to reflect opportunity costs more adequately,

(ii) Those due to economics of scale, and

(iii) Dynamic secondary effects which actually change the form or productivity of the resources involved.

The most commonly mentioned secondary benefits in developing countries are that of employment. By investing in a project new employment opportunities are created and new wealth is generated. Further, as newly employed people spend their wages additional employment is created as new service and production opportunities open up – a multiplier effect arising from the project investment which could properly be attributed to the project as a secondary benefit.

2.10.2.6 Add Benefits by Year

The sixth step is to obtain totals for the benefits in each project year. Then subtract the total costs from the total benefits in each project year to calculate the net benefits, or the net benefits streams.

2.10.2.7 Non-Quantifiable Benefits

Very often the benefits of a project cannot be fully quantified. It may be difficult to assess how much beneficiaries would be willing to pay for the project output on the basis of observable market data. For example, in public utility projects there is the problem of lack of data for measuring the increase in consumers' surplus resulting from the project.

In cases where the benefits cannot be quantified or can be quantified only partially, other approaches are often helpful. One approach is to analyze the plausibility of achieving the minimum benefits required for the project to be acceptable. Another is reliance on predetermined physical or cost standards for the service to be provided.

2.10.2.8 Double Counting

In calculating benefits (or costs) care should be taken that they are not recorded twice. It is very important to avoid double counting of costs or benefits. Often external costs/benefits are no more than transfers of internal costs/benefits, which should not be included as this would be double counting. An example of this is development of a new railway linking two towns. The increase in value of houses in close proximity to the two railway stations may be accepted as a measure of the expected benefits of the railway. If this measure is used, it is important not to also include benefits such as reduced travel times, better access to shopping and other amenities, and an extension of job opportunities. To do so would be double counting because these benefits have been capitalized into the value of house prices.

The economic life of the project is established based on the technical life of the major investment items. However, for some projects, even though the technical life of the major investment items is quite long, the economic life is considered shorter because the item may become obsolete after some time. Careful consideration should be given to the existence and relevance of possible externalities.

2.10.3 Comparing Costs and Benefits

After costs and benefits have been analyzed, the next step in costs –benefit analysis is to compare them in order to determine the worthiness or profitability of the project. The benefits and the costs of most projects are spread over a fairly long period. Therefore, a decision has to be made as to the length of period over which project benefits and costs are going to be compared.

2.10.3.1 Project Life / Period of Analysis

The general rule is to choose a period of time which is roughly comparable to the economic life of the project. The economic life of a project is established based on the technical life of the investment item.

However for some projects, even though the technical life of the major investment item is quite long, the economic life is considered shorter because the item may become obsolete after some time. This is particularly true with industrial projects, where rapidly changing technology can make the major investment item obsolete after some time. Even where obsolescence of the major investment item is not a limiting factor, the economic analysis is not carried out for more than 20 to 25 years. This is because at high discount rates, which often prevail in developing countries, any return to investment beyond about 25 years will probably make no difference in the ranking of alternative projects. For instance, with a discount rate of 35% the discount factor becomes zero after 25 years. At the rate of 40% the discount becomes zero after 22 years, at 45% the discount factor is zero after 20years, etc.

2.10.3.2 Salvage Values

At the end of the project period, some of the capital items might not have been used up. For instance, in Ghana the economic life of a building is considered to be about 50 years. This means that if a project is analyzed over a period of say 25 years, at the end of that period, the building will still have some value, which is called the salvage value or residual value. The salvage is often added to the benefit received during the last year of the analysis.

2.10.3.3 Discounting

In comparing costs and benefits it will be realized that they occur at different points in time during the life of the project. The question which arises is, how can the costs and benefits which occur at different periods be compared? Clearly, simple summation of the costs and the benefits would be inappropriate, since it will ignore the almost universal preferences of an individual, or society as a whole, to gain benefits earlier rather than later. What it means is that, 1 million cedis spent today represent a greater cost or sacrifice than a million cedis spent a year from now because the money could be invested elsewhere to earn an interest or profit. This leads to the concept of time preference, which relate to the fact that the values received earlier are worth more than those received later. With this in mind, it will be realized that comparing costs and benefits in project analysis is not a straight forward matter, since the costs and benefits are to be realized at different points in time. To make the costs and benefits occurring at different points in time comparable, they have to be brought to a common period. Usually they are brought to the present value.

The technique for doing that is called time discounting. Time discounting is the technique by which the values to be realized at different points in time are adjusted to their present values to make them comparable.

The first step in discounting is to choose an appropriate discount rate. Discount rate is the rate by which benefits that accrues in some future time period must be adjusted so that they can be compared with values in the present. There are practical problems in determining the appropriate discount rate. Several different approaches are possible. One alternative is to refer to the returns available in domestic and international capital markets. An alternative approach is to consider rates of return on a representative sample of projects undertaken in the recent past or those estimates for projects proposed for implementation over the next few years. However, none of these approaches seems to provide a very satisfactory solution.

Thus, the most appropriate discount rate is the opportunity cost of capital. The opportunity cost of capital is a measure of the benefits forgone by applying resources to one use instead of the next best alternative use. This opportunity cost of capital is usually expressed as an annual interest rate.

Once the discount rate has been determined, the next step is to multiply the cost or benefit streams occurring in each year (year t) by the appropriate discount factor. Mathematically, this can be expressed as;

$$PV = FV\left[\frac{1}{(1+r)^t}\right] \quad (2.3)$$

Where PV = the present value, FV = the future value occurring in the year 1

r = the discount rate/the opportunity cost of capital

t = time in (years/months) and t = 1, 2, 3,….,n

2.11 Methods of Project Appraisal

Several measures are commonly employed to determine the value of a capital project. These are:

(1) The payback method,

(2) Discounted payback method,

(3) Internal rate of return (IRR) method,

(4) Net present value (NPV) method.

(5) Benefit Cost Ratio

2.11.1 Payback Method

The payback method is the simplest measure to calculate and the least consistent with the criteria. The payback method simply calculates how many periods into the future it takes for a capital project to repay the initial investment. For example, suppose a potential project give cost-benefit flow streams for each year (Table 2.8).

Table 2.8 Example of how Payback is calculated

Year	Project A Cash Flow (GH¢)
0	-1200
1	500
2	400
3	400
4	300

The project would repay the initial investment of GH¢1200 during or at the end of year 3. Taking into account the entire cash flow, the sum of the benefits exceeds the sum of the cost by an undiscounted GH¢100. The payback method for determining value does not take into account all cost and benefit flows. Further, the payback method does not take into consideration the time value of money. Finally, payback does not consider risk.

2.11.2 Discounted Payback Method

The discounted payback method attempts to rectify one of the shortcomings of the payback method, by the incorporation of the time value of money and risk through the discount rate. The cost-benefit flows are discounted to reflect the value of time. For example, suppose the appropriate discount rate is 5%. The net benefit stream for the project above can be recalculated to reflect this new piece of information. The present value is calculated using the following formula:

$$PV = FV\left[\frac{1}{1+r}\right]^t \quad (2.4)$$

where the symbols represent present value (PV), future value (FV) and the discount rate (r) expressed as a percentage. The number of periods from today (period 0) the net benefit accrues is the number of discounting periods, t. Again, let us examine the cost-benefit flow streams of the project in Table 2.9.

Table 2.9 Example of how discounted payback is calculated

Year	**Net Benefit (GH¢)**	**Discounted Cash Flow GH¢** $PV = FV\left[\frac{1}{1+r}\right]$	**Running Total (GH¢)**
0	-1200		
1	500	476	476
2	400	363	839
3	300	247	1432

By incorporating the time value of money into our calculations, it can be seen that the project still pays back in year 3. While the discounted payback method is consistent with part of our criteria it fails to take into account all of the cost-benefit flows generated by the proposed project.

Both the payback and discounted payback methods for determining value of capital projects are inconsistent with our criteria. Although occasionally employed in industry as a thumbnail measure of a project's value, neither is consistent or fully acceptable for evaluating capital projects.

2.11.3 Net Present Value (NPV) Method

Net present value (NPV) is similar to the discounted payback method in that the cost-benefit flows are discounted to reflect the time value of money. However, unlike the discounted payback method, NPV considers all future cost-benefit flows.

The method yields one value that is easily interpreted. If the value is positive, the project yields benefits that exceed its costs. If the value is negative, costs exceed benefits. The discounting calculations are based on the same formula

$$PV = FV\left[\frac{1}{1+r}\right]^t \tag{2.5}$$

that is, used to discount cost-benefit flows in the discounted payback method. The method is illustrated by the example in table 2.10. In this case a discount rate of 15 percent is assumed.

Table 2.10 Example of how Net Present Value (NPV) is calculated

Year	Net Benefit (GH)	Discounted Cash Flow (GH) $PV = FV\left[\frac{1}{1+r}\right]$
0	-12000	-12,000
1	5,000	4348
2	4,000	3025
3	4,000	2630
4	5,000	2859
	Net Present Value	**862**

From table 2.10, the project has positive NPV of GH¢862 and is considered beneficial. However, NPV easily allows us to compare projects. NPV is also consistent with our criteria.

The method accounts for the time value of money through discounting. It also considers all of the expected future cost-benefit flows. Further, the discount rate can be adjusted on a project by project basis to reflect the inherent risk of each.

2.11.4 Internal Rate of Return (IRR) Method

It is often difficult to determine the rate at which future benefits should be discounted to today's values. In addition, decision makers are often more comfortable with value expressed in percentage terms. The internal rate of return (IRR) is a method for determining value that does not depend on the determination of a discount rate and that expresses value in terms of a percentage. Essentially, the method requires the calculation of a discount rate such that the discounted value of future cost-benefit flows exactly equals the initial investment. In other words, the present value of costs minus the present value of benefits equals zero. Let us look again at the example in Table 2.11.

Table 2.11 Example of how Internal Rate of Returns (IRR) is calculated

Year	**Net Benefit (GH¢)**	**Discounted Cash t Flow (GH¢)** $PV = FV\left[\frac{1}{1+r}\right]$
0	-12000	-12000
1	5,000	4348
2	4000	3025
3	4000	2630
4	5,000	2859
	Net Present Value	**862**

To calculate the IRR it is necessary to find the discount rate that would equate the initial investment with the future cost-benefit flows. This can be expressed mathematically as

$$C_{total} = B_1\left[\frac{1}{1+irr}\right] + B_2 \times \left[\frac{1}{1+irr}\right]^2 + B_3 \times \left[\frac{1}{1+irr}\right]^3 + \cdots + B_n \times \left[\frac{1}{1+irr}\right]^n$$

(2.6)

where,

$Cost_{total}$ = Total initial capital investment, B_t = Benefit for each period.

t = 1, 2……n and irr = internal rate of return

Cost Total initial capital investment, Benefit for each period,

1, 2, …, n and = irr internal rate of return.

Therefore from Table 2.11, we have,

$$1200 = 5000 \times \left[\frac{1}{1+irr}\right]^1 + 4000 \times \left[\frac{1}{1+irr}\right]^2 + 4000 \times \left[\frac{1}{1+irr}\right]^3 + 5000 \times \left[\frac{1}{1+irr}\right]^4$$

This calculation requires a financial calculator, computer, or trial and error. The calculated value of Internal Rate Return (IRR) is about 3%. To determine whether the project is viable, the calculated IRR must be compared to a minimum acceptable rate of return that should reflect the time value of money, risk, etc. The minimum acceptable rate of return is referred to as the “hurdle rate” or “cut-off rate”. The decision to accept or reject project depends upon whether or not the IRR exceeds the hurdle rate. Any project that has relatively large positive cost-benefit flows early in its life will generate a relatively large IRR.

Finally, the use of IRR as a measure for choosing between projects is inappropriate when capital rationing exists. Capital rationing refers to the existence of a fixed capital budget, with an inability to exceed that budget, even if the chosen projects would yield positive returns to the company. For example, a city may have a fixed budget for the creation of a recreational center and cannot exceed that budget even though the social benefits of recreational center exceed the costs. This problem is again due to the assumption that the cost-benefit flows are reinvested at the internal rate of return rather than at the cost of capital as in NPV. What this implies for the decision maker is that the ranking of projects will depend as much on their relative size and the timing of their cost-benefit flows as it will on the actual cost-benefit flows, where the actual flows should be the only determinant of acceptance or rejection. For example, suppose we are comparing the following set of projects in Table 2.12:

Table 2.12 Comparing Projects different IRRs

Project	Investment (GH¢)	NPV (GH¢)	IRR/Year
A	1,000,000	50,000	20%
B	2,000,000	150,000	18%
C	4,000,000	300,000	16%
D	7,000,000	800,000	15%

If there were no capital rationing, we would select all four projects since each has a positive NPV and would increase our wealth by GH ¢1.3 million. However, if we impose a capital budget of GH¢7 million, the choice depends on the method of examination. If we use internal rate of return, projects A, B, and C would be chosen. However, if we use NPV, project D would be chosen. The choice of Project D is optimal because it increases our wealth by GH¢ 800,000 rather than GH¢ 500,000.

The inconsistency implies that the usefulness of the IRR method is limited. Further difficulty arises when calculating the IRR of a project that has negative cost-benefit flows after the first period. Due to the mathematics of the calculations, it is possible under these circumstances to calculate multiple IRR that equate the net present value of costs with the net present value of benefits.

2.11.5 Benefit Cost Ratio (BCR)

This is calculated by expressing as a ratio the present gross value of benefits and the present gross value of costs. If the ratio is greater than or equal to 1, the project is said to profitable.

2.12 Investment Decision Criteria

A number of techniques have been developed for expressing the worthiness or profitability of a project by a single number or index. The index can be used to decide whether a project is acceptable or not, and to compare one project to another. The three most commonly used indices are;

i) the Net Present Value (NPV) or Net Present worth
ii) the Benefit-Cost Ratio (BCR),
iii) the Internal Rate of Return (IRR).

2.12.1 Net Present Value (NPV) as a Decision Criterion

There are two alternative ways of calculating NPV.

(i). it can be calculated as the difference between the present value of total benefits and the present value of total costs.

(ii). by calculating the present value of the net cash flow.

Mathematically, $$\boldsymbol{NPV} = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} \qquad (2.7)$$

Or $$\boldsymbol{NPV} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t} \qquad (2.8)$$

Where B_t = benefits in each year, C_t = costs in each year, t = 1, 2,…n, and n = number of years and r =discount rate.

The formal selection criterion for the net present value index is to accept all projects with an NPV greater than or equal to zero when discounted at the opportunity cost of capital.

2.12.2 Benefit – Cost Ratio (BCR) as a Decision Criterion

The benefit –Cost Ratio is obtained by dividing the present value of gross benefits by the present value of gross costs.

$$\textbf{BCR} = \frac{\textbf{Sum of Present Values of Benefits (Cash inflows)}}{\textbf{Sum of Present Values of Costs (ash outflows)}} \quad (2.9)$$

Mathematically, this can be expressed as;

$$\boldsymbol{BCR} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}} \quad (2.10)$$

Where B_t = benefits in each year, C_t costs in each year, t = 1, 2….n, and n = number of years and r = discount rate. When the benefit – cost ratio is used to evaluate projects the formal decision criterion is to accept all projects with a ratio of one or greater.

Though projects with high Benefit-Cost Ratios are often regarded as being preferable, ranking by benefit –cost ratio can lead to an erroneous investment choice in practice. This is because the BCR discriminates against projects with relatively high gross returns and operating costs even though there may be shown to have a greater wealth generating capacity than alternatives which have a higher benefit-cost ratio. BCR is sensitive to the way costs and benefits are classified, and there is no fixed rule in this respect. Simply by grouping costs separately or deducting them from gross benefits, the benefits - cost ratio for the same project can be changed substantially.

When the benefit – cost ratio is used as a criterion for evaluating projects in a country, it is desirable that all analysis follow common netting out convention to derive their cost and benefit streams

2.12.3 Internal Rate of Return (IRR) as a Decision Criterion

The IRR is the discount rate which would give an NPV of zero, given expected cash flows. It presents the average earning power of money used in the project over the project life. The IRR can be calculated by discounting the net-benefit streams at different rate until finding the rate at which the present net benefits equal zero. Under many typical circumstances the IRR produces sensible results, and may be calculated easily using a spreadsheet package or equation 2.6 or 2.7.

$$\boldsymbol{C_{total}} = \boldsymbol{B_1}\left[\frac{1}{1+irr}\right] + \boldsymbol{B}_2 \times \left[\frac{1}{1+irr}\right]^2 + \boldsymbol{B}_3 \times \left[\frac{1}{1+irr}\right]^3 + \cdots + \boldsymbol{B_n} \times \left[\frac{1}{1+irr}\right]^n$$

$$\boldsymbol{Cost_{total}} = \sum_{t=1}^{n} \frac{B_t}{(1+irr)}$$

The formal selection criterion for the IRR index is to accept all projects having an internal rate of return above the opportunity cost of capital. Projects can be ranked in order of the value of the IRR. The lowest acceptable IRR is often referred to as the “cut-off rate” or “hurdle rate” and normally is set slightly above the opportunity cost of capital.

2.13 Sensitivity and Risk Analysis

The economic analysis of projects is based on assumptions about future events. Again, the data on cost and benefit evaluations are generally imperfect. Therefore, in cost –benefit analysis, it is desirable to take into consideration the range of possible variations in the values of the basic elements, and the extent of the uncertainties attaching to the outcome be clearly reflected in presenting the analysis.

Sensitivity analysis is a form of quantitative analysis that examines how net present values, total cost, or other outcomes vary as individual assumptions or variables are changed. It determines how sensitive the present value or internal rates of returns vary in selected costs and benefits. Sensitivity analysis helps us to test what happens to earning capacity if something goes wrong. For instance, how sensitive is a projects' IRR to increased project costs? How sensitive is a projects' IRR to stretch – out or delays in implementation period, fall in prices, etc. Sensitivity analysis involves reworking an analysis to see what happens under these changes. It is desirable that all projects are subjected to sensitivity analysis, because in reality the projections in project analysis are subject to a high degree of uncertainty about what will happen.

2.13.1 Sensitivity Analysis of Benefits

There are many factors that influence the level of benefits that a project will actually produce. Some of these factors are: the average internal increases in demand and the projected shea butter sales revenue.

2.13.2 Sensitivity Analysis of Costs

Project costs are also influenced by a number of factors that are important to analyze. Some of these factors are: decreases in out-put due to depreciation; the local increase in the price of shea kernel as a result of competition or low yield due to pest and diseases attacks; increases in utility tariff rates and cost increases in operations and maintenance.

2.14 Feasibility and Sustainability Factors

A viable project does not necessarily mean it is feasible. Therefore other feasibility and sustainability factors should be considered during the appraisal stage. The project, must also be biologically, socially and operationally feasible. Biologically feasible projects conserve the environment. Socially, projects should provide jobs for the society to raise the standard of living of the people around the project site. The benefits of a project must flow sustainably. Operationally, a project will be feasible if source of raw material and skilled labour to man the facility are available. These factors should be thoroughly examined to pass a project as feasible.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 MATERIALS

Data was collected principally by questionnaire administration at selected project sites. A calculator and computer soft ware (Excel) was used for the analysis of data.

3.1.1. The Study Area

3.1.1.1 Geographic location and size

The Wa Municipal Assembly is the only municipality out of the nine assemblies in Upper West Region. It is bordered to the north by the Nadowli District, to the east by Wa East District, to the West by Wa West District and to the South by both Wa East and West Districts. It lies within latitudes 1º40'N to 2º45'N and longitudes 9º32' to 10º20'W. It has a landmass area of approximately 23,474 km^2, which is about 6.4% of the region.

3.1.1.2 Climate and Vegetation

The vegetation is of the Guinea Savanna grassland type, made up of short trees and shrubs of varying heights and luxuriance, with grass ground cover in the wet season. Commonly occurring trees are shea trees, "dawadawa", "kapok" and baobab. The shea tree dominates the entire vegetation of Wa. Cashew and mango are exotic species growing well in the area. Generally, the municipality has two marked seasons namely, the wet and dry seasons. The South-Western Monsoon winds from the Atlantic Ocean bring rains between May and September, whilst the North-Eastern Trade winds from the Sahara Desert bring the long dry season between October and April. The mean annual rainfall varies between 840mm and 1400mm. Most of the rainfall occur, between June and September, and is generally low and unreliable both in its timing and duration. It has been calculated that there are four humid months, in terms of soil moisture conditions which is only adequate for the cultivation of crops such as millet, guinea corn, yam, groundnuts and beans.

3.1.1.3 Soils

The most extensive soil type is the laterite soil. The second type is the Savanna orchrosols found along the Black Volta. The soil is generally shallow and gravelly on the undulating terrains. The soils support a variety of crops especially cereals, tubers and economic trees like shea and "dawadawa".

3.1.1.4 Existing shea processing groups in the study area

Many of the processors in the study area operate singly in their homes. However, some groups have been formed by individuals, religious bodies, governmental and non-governmental organisations. The municipal assembly has established small scale village level shea processing facilities in Chegli, a community 10 km from Wa, Kperisi, 8 km, Wa Sombo, and Wapaani. Christian Mothers Association of the Catholic Church has also established a women's group in the processing of shea nuts at Dokpong.

3.2 METHODS:

3.2.1 Field Data Collection

Both qualitative and quantitative methods of data collection were conducted. Selected project sites were visited and questionnaires administered. Interviews were also conducted with production officers in Ghana Nuts Ltd, Bosbel Oil Mills and Akoma. Direct measurements were made to determine the quantity of butter obtained per unit quantity of dry kernel processed by the local processors. At the selected sites the projects were evaluated using the four feasibility factors; biological, operational, social and economic as well as the three sustainability factors; biological, social and economic factors.

Total annual quantity of butter processed by all the local women in and around Wa was compared with total annual butter produced by the different scales of mechanised extraction. The butter obtained was quantified monetarily using prevailing market prices to determine the annual revenues for each of the facilities.

Lastly the Cost-Benefit Analysis of all the facilities was done to determine which technology is ideal for the location, based on the factors discussed.

3.2.2 Butter Yield Determination

3.2.2.1 Yield from local shea processors

The annual yield from all the 237 processors is calculated by the following relation:

Annual yield= Annual quantity of nuts processed ×Yield per kilogramme nuts ×Estimated number of processors.

Annual yield by local processors=2880kg ×0.425375kg yield × 237 processors = 290,343.96kg.

3.3 Yield, Duration and Estimated Local Processors

The yield, duration for processing 80kg nuts by each local processor and the estimated number of local processors is tabulated in Table 3.1a-c.

Table 3.1a: Yield from Local Processors, Duration and Estimated No. of Processors in Study Area

Location	**Processors**	**Qty of nuts processed (kg)**	**Yield per 80kg kernel**	**Duration (days)**	**Estimated shea processors**
	1	80	30	3	45
	2	80	30	2	55
	3	80	37.5	3	45
	4	80	30	2	45
	5	80	37.5	4	60
CHEGLI	6	80	35	4	50
	7	80	35	3	65
	8	80	30	3	50
	9	80	35	2.5	45
	TOTAL:	**720**	**300**	**26.5**	**460**
	1	80	25.5	3.5	30
	2	80	25	3	20
	3	80	27.5	4.5	25
	4	80	30	3	25
	5	80	25	2.5	23
DOBILE	6	80	30	3.5	25
	7	80	25	3	23
	8	80	25	3	25
	9	80	30	3.5	25
	10	80	25	4	25
	TOTAL	**800**	**26.8**	**3.35**	**246**

(Source: Field data, 2010)

Table 3.1b: Yield from Local Processors, Duration and Estimated Number of Processors in Study Area

Location	Processor	Qty of nuts processed (kg)	Yield/80kg kernel (kg)	Duration (days)	Estimated shea processors
KPAGURI	1	80	30	3.5	45
	2	80	30	3	38
	3	80	35	5	45
	4	80	30	3	45
	5	80	35	3	45
	6	80	35	4	60
	7	80	30	3	40
	8	80	30	3	40
	9	80	30	3.5	35
	TOTAL	**800**	**313**	**34**	**436**
WA SOMBO	1	80	30	4	60
	2	80	40	4	50
	3	80	40	7	47.5
	4	80	32.5	3	55
	5	80	32.5	7	60
	6	80	37.5	3	50
	7	80	37.5	7	55
	TOTAL	**560**	**250**	**37**	**377.5**

(Source: Field data, 2010)

Table 3.1c: Yield from Local Processors, Duration and Estimated Number of Processors in Study Area

Location	Processor	Qty of nuts processed(kg)	Yield/80kg kernel (kg)	Duration	Estimated No. of processors
MANGU	1	80	30	3	30
	2	80	35	3.5	2
	3	80	28	4	23
	4	80	30	3	25
	5	80	25	4	25
	TOTAL	**400**	**148**	**17.5**	**123**
WAPAANI	1	80	40	3	23
	2	80	35	4	25
	3	80	40	3	30
	TOTAL	**240**	**115**	**10**	**78**
DOKPONG	1	80	37.5	3	15
	2	80	45	3	13
	3	80	40	3	15
	4	80	47.5	3	12
	5	80	45	3	10
	6	80	47.5	3	10
	7	80	40	3	10
	TOTAL	**520**	**302.5**	**21**	**85**

(Source: Field data, 2010)

3.3..1: Yield from Selected project Site

The total yield and quantity of nuts processed from each selected project site was easy to determine since records were kept by these highly organized companies. Direct information from the questionnaire provides enough data for each facility. The yields from Akoma, Bosbel and Ghana Nuts were 50,000kg, 400,000kg and 8,500,000kg respectively.

3.3.2 Analysis of Data

Analysis of data was done on each of the production scales using a discounting rate of 12.65% (Bank of Ghana 1-year note Treasury Bills rate per annum) using computer software (Excel). The analysis period is 25 years (2008 to 2033). The Internal Rate of Returns, Net Present Value and Benefit-Cost Ratio are computed using equations 2.6, 2.7 and 2.9 respectively.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS:

The mean yield, duration and estimated local processors in the study area are tabulated in tables 4.1.

Table 4.1: Mean yield, duration and estimate number of processors.

LOCATION	QUANTITY PROCESSED (kg)	YIELD/80kg KERNEL (kg)	DURATION (DAYS)	TOTAL No. OF PROCESSORS IN STUDY AREA
CHEGLI	80	33.30	3.30	51
DOBILE	80	26.80	2.95	25
KPAGURI	80	31.30	3.40	44
WA SOMBO	80	35.70	5.00	54
MANGU	80	29.60	3.50	25
WAPAANI	80	38.30	3.30	26
DOKPONG	80	43.20	3.00	12
MEAN	**80**	**34.03**	**3.49**	**237**

(Source: Field data, 2010)

4.1.1 Yield Of Local Processors And Selected Projects

The annual yield in kg of the local processors was compared with the annual yield from each mechanised facilities as shown in Table 4.2.

Table 4.2: Comparison yield of local processors and selected projects

FACILITY	TOTAL NUTS PROCESSED/Yr (kg)	YIELD/Yr (kg)
LOCAL PROCESSORS	682,560	290,344
AKOMA	150,000	50,000
BOSBEL	420,000	400,000
GH.NUTS	20,000,000	8,500,000

(Source: Field data, 2010)

4.1.2 Total Cost, Total Revenue And Cash Flow

The initial costs of the various facilities, the revenue for year one and the cash flows are shown in table 4.3.

Table 4.3 Initial cost, revenue and cash flows for the various facilities

FACILITY	TOTAL COST (GH¢)	TOTAL REVENUE (GH¢)	CASH FLOW (GH¢)
Small scale processors	289,849.5	290,343.96	494.46
Medium scale-Semi mechanised	42,061	72,500	30,439
Medium scale-mechanised	3,280,929	5,800,000	2,519,071
Large scale	11,716,500	12,325,000	608,500

(Source: Field data, 2010)

4.1.3. Analysis of Small Scale Local Shea Butter Processors

Table 4.4 Cash flow analysis for small scale local processors.

Discounted rate	Year	Total cost	Total Revenue	Cash Flow	Discounted Factor	Discounted Cost	Discounted revenue
12.65%	0	28914		-28914			
0.1265	1	289849.5	290343.96	494.46	0.8877	257299.4012	257738.3333
	2	317606.94	322281.7956	4674.8556	0.78802	250280.6209	253964.5006
	3	316450.36	325185.2352	8734.8752	0.69952	221363.3558	227473.5757
	4	315293.79	328088.6748	12794.8848	0.62097	195787.9848	203733.2244
	5	314137.22	330992.1144	16854.8944	0.55123	173161.8598	182452.7832
	6	339915.63	333895.554	-6020.076	0.48933	166330.9152	163385.1114
	7	338759.06	336798.9936	-1960.0664	0.43438	147150.1605	146298.7468
	8	337602.49	339702.4332	2099.9432	0.38559	130176.1441	130985.8612
	9	336445.92	342605.8728	6159.9528	0.34229	115162.074	117270.5642
	10	335289.35	345509.3124	10219.9624	0.30386	101881.0219	104986.4597
	11	366339.5925	330992.112	-35347.481	0.26973	98812.77829	89278.50237
	12	365183.0225	333750.3796	-31432.643	0.23944	87439.42291	79913.19089
	13	364026.4525	336508.6472	-27517.805	0.21255	77373.82248	71524.91296
	14	362869.8825	339266.9148	-23602.968	0.18868	68466.28943	64012.88148
	15	361713.5525	342025.1824	-19688.37	0.16749	60583.40291	57285.7978
	16	360556.9825	327544.275	-33012.708	0.14868	53607.61216	48699.28281
	17	359400.3525	330164.6292	-29235.723	0.13199	47437.25253	43578.42941
	18	358243.6525	332784.9834	-25458.669	0.11717	41975.40876	38992.4165
	19	357087.2725	597440.7576	240353.485	0.104	37137.07634	62133.83879
	20	355930.7025	600061.1118	244130.409	0.09233	32863.08176	55403.64245
	21	373492.4491	572547.395	199054.946	0.08196	30611.44113	46925.98449
	22	372335.8391	575036.7315	202700.892	0.07276	27091.15566	41839.67258
	23	371179.2591	577526.068	206346.809	0.06459	23974.46835	37302.40873
	24	370022.6891	580015.4045	209992.715	0.05733	21213.40077	33252.28314
	25	368866.1191	582504.741	213638.622	0.050894	18773.07227	29645.99629
		8737512.081				**2485953.224**	**2588078.401**

∑(Discounted Costs)	**2485953.22**
∑(Discounted Revenue)	**2588078.4**
Net Present value (NPV)	**102125.177**
Benefit Costs Ratio (BCR)	**1.04108089**
Internal rate of Return (IRR)	**22%**

4.1.3.1 Calculating the Net Present Value (NPV) – (Small scale)

The net present value can be determined by two ways:

1. Finding the difference between the present value of total benefits and the present value of the total costs.

2. Calculating the present value of the net cash flows.

   However, given the present value of total cost (discounted cost) and present total benefit (discounted revenue) in Table 4.4, it is easier using the first method;

$$NPV = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}$$

NPV= GH¢ 2,588,018.40 – GH¢ 2,485,953.22= GH¢ 102,125.18

4.1.3.2 Calculating the Benefit-Cost Ratio-BCR (Small Scale)

The benefit cost ratio is calculated using the following equation:

$$\textbf{BCR} = \frac{\textbf{Sum of Present Values of Benefits (Cash inflows)}}{\textbf{Sum of Present Values of Costs (Cash outflows)}}$$

Mathematically, this can be expressed as; $\boldsymbol{BCR} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}}$

$$\boldsymbol{BCR} =, \frac{2,588,078.40}{2,485,953.22} = \mathbf{1.04}$$

4.1.3.3 Calculating the Internal Rate of Returns-IRR (Small scale)

This calculation requires a financial calculator, a computer spreadsheet or trial and error.

Using equation 3.14, IRR is calculated as follows;

$$C_{total} = B_1\left[\frac{1}{1+irr}\right] + B_2 \times \left[\frac{1}{1+irr}\right]^2 + B_3 \times \left[\frac{1}{1+irr}\right]^3 + \cdots + B_n \times \left[\frac{1}{1+irr}\right]^n$$

$$8737,512. = 290,343.96\left[\frac{1}{1+irr}\right] + 322,281.80 \times \left[\frac{1}{1+irr}\right]^2 \ldots + 582,504.71 \times \left[\frac{1}{1+irr}\right]^{25}$$

Microsoft spreadsheet computes the **IRR as 22%.**

4.1.4 Analysis of medium scale (memi mechanised)

Table 4.5 Cash flows analysis for medium scale-semi mechanised.

Discount rate	Year	Total cost	Total Revenue	Cash Flow	Discounted Factor	Discounted Cost	Discounted revenue
12.65%							
0.1265	0	107510		-107510			
	1	42061	72500	30439	0.8877	37337.5497	64358.25
	2	145318.6	74314	-71004.6	0.78802	114513.9632	58560.91828
	3	141269.4	742350	601080.6	0.69952	98820.77069	519288.672
	4	136967	74740	-62227	0.62097	85052.39799	46411.2978
	5	132698.1	75990	-56708.1	0.55123	73147.17366	41887.9677
	6	128395.7	102000	-26395.7	0.48933	62827.86788	49911.66
	7	124607.17	103515	-21092.17	0.43438	54126.8625	44964.8457
	8	120304.77	104030	-16274.77	0.38559	46388.31626	40112.9277
	9	116002.37	105560	-10442.37	0.34229	39706.45123	36132.1324
	10	112503.97	106080	-6423.97	0.30386	34185.45632	32233.4688
	11	108725.8	106575	-2150.8	0.26973	29326.61003	28746.47475
	12	104423.4	107100	2676.6	0.23944	25003.1389	25644.024
	13	100121	109180	9059	0.21255	21280.71855	23206.209
	14	95818.6	109710	13891.4	0.18868	18079.05345	20700.0828
	15	92051	102960	10909	0.16749	15417.62199	17244.7704
	16	88442.7	103455	15012.3	0.14868	13149.66064	15381.6894
	17	92511.6	102900	10388.4	0.13199	12210.60608	13581.771
	18	88209.2	103880	15670.8	0.11717	10335.47196	12171.6196
	19	83906.8	103305	19398.2	0.104	8726.3072	10743.72
	20	79604.4	103790	24185.6	0.09233	7349.874252	9582.9307
	21	1922218.9	86000	-1836219	0.08196	157545.061	7048.56
	22	1917916.5	103680	-1814237	0.07276	139547.6045	7543.7568
	23	1913614.1	103075	-1810539	0.06459	123600.3347	6657.61425
	24	1909311.7	103550	-1805762	0.05733	109460.8398	5936.5215
	25	1905009.3	102930	-1802079	0.050894	96953.54331	5238.51942
		11809523				**1434093.256**	**1143290.404**

∑(Discounted Costs)	**1434093.3**
∑(Discounted Revenue)	**1143290.4**
Net Present value (NPV)	**-290802.9**
Benefit Costs Ratio (BCR)	**0.7972218**
Internal rate of Return (IRR)	**20%**

4.1.4.1 Calculating the Net Present Value-NPV (Medium scale-Semi mechanised)

Net Present Value for the medium scale (semi mechanised) facility is computed as follows;

$$NPV = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}$$

NPV= GH¢1,143,290.40 - GH¢ 1,434,093.26 = GH¢ -290,802.90

4.1.4.2 Calculating the Benefit Cost Ratio –BCR Medium Scale (Semi Mechanised)

$$\boldsymbol{BCR} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}}$$

$$\boldsymbol{BCR} = \frac{1{,}143{,}290.40}{1{,}434{,}093.30} = 0.80$$

4.1.4.3 Calculating the IRR (semi mechanised);

$$\mathbf{11{,}809{,}523} = \mathbf{72{,}500}\left[\frac{1}{1+irr}\right] + \mathbf{74{,}314} \times \left[\frac{1}{1+irr}\right]^2 + \cdots + \mathbf{102{,}930} \times \left[\frac{1}{1+irr}\right]^{25}$$

IRR=20%

4.1.5 Analysis of medium scale (mechanised)

Table 4.6 Cash flow analysis for medium scale- mechanised.

Discount rate	Year	Total cost	Total Revenue	Cash Flow	Discounted Factor	Discounted Cost	Discounted revenue
12.65%	0			-842000			
0.1265	1	3280929	5800000	2519071	0.8877	2912480.673	5148660
	2	4897569	5840000	942431	0.78802	3859382.323	4602036.8
	3	4894255.1	5938800	1044544.9	0.69952	3423629.328	4154309.38
	4	4826895.1	5979200	1152304.9	0.62097	2997357.05	3712903.82
	5	4820489	6138800	1318311	0.55123	2657198.151	3383890.72
	6	12172175.5	8240000	-3932175.5	0.48933	5956210.637	4032079.2
	7	12229815.5	8529684.24	-3700131.26	0.43438	5312387.257	3705124.24
	8	12162455.5	8572120.48	-3590335.02	0.38559	4689721.216	3305323.94
	9	12220095.5	8959139.07	-3260956.43	0.34229	4182816.489	3066623.71
	10	12152735.5	9003272.76	-3149462.74	0.30386	3692730.209	2735734.46
	11	12085375.5	9407095.11	-2678280.39	0.26973	3259788.334	2537375.76
	12	12018015.5	9453435.48	-2564580.02	0.23944	2877593.631	2263530.59
	13	11950655.5	10118882.74	-1831772.76	0.21255	2540111.827	2150768.53
	14	12008295.5	10168003.53	-1840291.97	0.18868	2265725.195	1918498.91
	15	11940935.5	9706268	-2234667.5	0.16749	1999987.287	1625702.83
	16	11914574.8	9752932.75	-2161642.05	0.14868	1771458.981	1450066.04
	17	11847214.8	9309617.1	-2537597.7	0.13199	1563713.881	1228776.36
	18	11904854.8	9398280.12	-2506574.68	0.11717	1394891.837	1101196.48
	19	11837494.8	9064907.25	-2772587.55	0.104	1231099.459	942750.354
	20	11770134.8	9107465.5	-2662669.3	0.09233	1086736.546	840892.29
	21	12114823.7	8875522.5	-3239301.2	0.08196	992930.9505	727437.824
	22	12172463.7	8916804	-3255659.7	0.07276	885668.4588	648786.659
	23	12105103.7	8778923.79	-3326179.91	0.06459	781868.648	567030.688
	24	12037743.7	8819379.66	-3218364.04	0.05733	690123.8463	505615.036
	25	11970383.7	877123.47	-11093260.2	0.050894	609220.708	44640.3219
		263335484.7				**63634832.92**	**56399755**

∑(Discounted Costs)	**56399754.9**
∑(Discounted Revenue)	**63634832.92**
Net Present value (NPV)	**-7235077.98**
Benefit Costs Ratio (BCR)	**0.8863**
Internal rate of Return (IRR)	**31%**

4.1.5.1 Calculating the Net Present Value (NPV)-(Mechanised)

NPV= GH¢56,399,754.90 - GH¢63,634,832.92 = GH¢-7,235,077.98

4.1.5.2 Calculating the Benefit Cost Ratio (BCR) – (Mechanise)

$$\boldsymbol{BCR = \frac{56,399,754.90}{63,634,832.92}} = \mathbf{0.89}$$

4.1.5.3 Calculating the Internal Rate of Returns (IRR) –(Mechanise)

$$262,225,484.70 = 5,800,000\left[\frac{1}{1+irr}\right] + 5,840,000 \times \left[\frac{1}{1+irr}\right]^2 + \cdots + 877,123.47 \times \left[\frac{1}{1+irr}\right]^{25}$$

IRR =31%

4.1.6 Analysis of large scale

Table 4.7 Cash flow analysis for the large scale.

Discount rate	Year	Total cost	Total Revenue	Cash Flow	Discounted Factor	Discounted Cost	Discounted revenue
12.65%	0	5699300		-569930			
0.1265	1	11716500	12325000	608500	0.8877	10400737.05	10940902.5
	2	17194740	12325000	-4869740	0.78802	13549799.01	9712346.5
	3	16966480	12448250	-4518230	0.69952	11868392.09	8707799.84
	4	16738220	12448250	-4289970	0.62097	10393932.47	7729989.803
	5	16509960	12821697.5	-3688262.5	0.55123	9100785.251	7067704.313
	6	16882525	13462782.38	-3419742.625	0.48933	8261125.958	6587743.3
	7	16654265	14001293.67	-2652971.33	0.43438	7234279.631	6081881.944
	8	16426005	14001293.67	-2424711.33	0.38559	6333703.268	5398758.826
	9	16197745	14561345.42	-1636399.583	0.34229	5544326.136	4984202.923
	10	15969485	14561345.42	-1408139.583	0.30386	4852487.712	4424610.418
	11	15741225	16053933.4	312708.3993	0.26973	4245880.619	4330227.456
	12	16128831.25	16053933.4	-74897.85073	0.23944	3861887.355	3843953.813
	13	15900571.25	161501348.8	145600777.5	0.21255	3379666.419	34327111.68
	14	15672311.25	161501348.8	145829037.5	0.18868	2957051.687	30472074.48
	15	15444051.25	151811268.6	136367217.4	0.16749	2586724.144	25426869.38
	16	15215791.25	182151680.8	166935889.5	0.14868	2262283.843	27082311.9
	17	14987531.25	173044096.8	158056565.5	0.13199	1978204.25	22840090.33
	18	14759271.25	173044096.8	158284825.5	0.11717	1729343.812	20275576.82
	19	14531011.25	166122332.9	151591321.6	0.104	1511225.17	17276722.62
	20	14302751.25	166122332.9	151819581.6	0.09233	1320573.023	15338075
	21	14074491.25	161138662.9	147064171.7	0.08196	1153545.303	13206924.81
	22	14492890.56	161138662.9	146645772.3	0.07276	1054502.717	11724449.11
	23	14264630.56	157916081.5	143651450.9	0.06459	921352.4881	10199799.7
	24	14036370.56	157916081.5	143879710.9	0.05733	804705.1244	9053328.95
	25	13808110.56	156336920.6	142528810.1	0.050894	702749.979	7956611.239
		390315064.8				**118009264.5**	**324990067.7**

∑(Discounted Costs)	**324990068**
∑(Discounted Revenue)	**118009264.5**
Net Present value (NPV)	**206980803.1**
Benefit Costs Ratio (BCR)	**2.753936896**
Internal rate of Return (IRR)	**39%**

4.1.6.1 Calculating the Net Present Value -NPV –(Large scale)

NPV = GH¢ 324,990,068 – GH¢ 118,009,264.50 = GH¢ 206,980,803.10

4.1.6.2 Calculating the Benefit Cost Ratio- (large scale)

$$\boldsymbol{BCR} = \frac{\mathbf{324{,}990{,}068.00}}{\mathbf{118{,}009{,}264.50}} = \mathbf{2.75}$$

4.1.6.3 Calculating the Internal Rate of Returns (IRR) – (large scale)

$$\mathbf{390{,}315{,}064.80} = \mathbf{12{,}325{,}000}\left[\frac{1}{1+irr}\right] + \mathbf{12{,}325{,}000} \times \left[\frac{1}{1+irr}\right]^2 + \cdots + \mathbf{156{,}336{,}920.60} \times \left[\frac{1}{1+irr}\right]^{\mathbf{25}}$$

IRR=39%

4.1.7 Comparing the four projects

Results of analysis of the four projects are organized into a table for easy comparison. A summary of the analysis is shown in Table 4.8.

Table 4.8 Summary of analysis of four projects

Project	Initial investment (GH¢)	NPV (GH¢)	BCR	IRR %	Decision
Small scale	28,914	192,125.18	1.04	22%	Accept*
Medium scale (Semi-mechanised)	107,510	-290,802.90	0.80	20%	Reject
Medium scale (mechanised)	842,000	-72,355,077.98	0.89	31%	Reject
Large scale	5,699,300	206,980,803.10	2.75	39%	Accept

Source: Field Data, 2010

* Project is accepted but the capacity to produce in industrial level requires support in the form of improved extraction technology, funding, organization and access to the international market.

4.1.8 Feasibility and Sustainability Studies

The feasibility and sustainability factors affecting the establishment of projects in the selected project sites are presented in Tables 4.9a-c. The projects are evaluated using biological, operational, social and economic feasibility factors; and biological, social and economic sustainability factors. Responses from participants in the selected project sites are used to develop this frame work. Comparison of the projects in respect of the component in each of the feasibility and sustainability factors will be highlighted and used to determine the feasibility base for the establishment of a shea project in Wa.

Table 4.9a: Feasibility and sustainability factors affecting project establishment (Akoma)

PROJECT	FEASIBILITY FACTORS	SUSTAINABILITY FACTORS
AKOMA INT. TRADE CENTRE, PUSUNAMONGO	**Biological-** 40-59% of the vegetative cover consist of the Shea tree	**Biological-** The Shea tree is conserved for its useful nuts which serve as a source of income.
	Operational- Trees are owned by the community. Semi-mechanized extraction method of extraction. Women have undergone training in using the machinery and equipment.	**Social-** Participants are empowered economically since they are sure to receive salary at the end of each month.
	Social- Majority of the community members accept the project.	**Economic**- Returns from the sale of nuts and wages from the company provide sufficient incentive to conserve the Shea tree. Standards of living of participants have been increased drastically.
	Economic- Shea collectors groups have been formed to collect and sell nuts to the facility. Funding is by AKOMA UK.	

Table4.9b: Feasibility and sustainability factors affecting project establishment. (Bosbel)

PROJECT	FEASIBILITY FACTORS	SUSTAINABILITY FACTORS
BOSBEL OIL MILL	**Biological-**Between 60-80% of the vegetation cover constitutes the Shea tree.	**Biological-**Fruits are picked when they ripe and fall down, trees are conserved and use of the shea tree for fuel has reduced
	Operational- Communal ownership of trees. Highly mechanized extraction plant, including a refinery. Skilled labour employed	**Social-** The project is socially accepted and has empowered participants. There is employment creation for the community members.
	Social- Majority of the community members accept the project. Part of the processed butter is used for cooking	**Economic-**Income from wages and salaries is used to pay school fees and other needs of the family. Women now know that the shea tree is a good source of income for the livelihood of the rural women.
	Economic- There is creation of employment to the community members. The company also gives donations as part of their social responsibility.	

Table 4.9c: Feasibility and sustainability factors affecting project establishment.

PROJECT	FEASIBILITY FACTORS	SUSTAINABILITY FAC TORS
GHANA NUTS LTD	**Biological-**Between 60-80% of the vegetation cover constitutes the Shea tree.	**Biological-**Fruits are picked when they ripe and fall down, trees are conserved and use of the Shea tree for fuel has reduced
	Operational-No rights of ownership of the Shea tree. Less than 30% of the vegetation cover is the shea tree. Highly skilled labour is employed for the operation of machinery and other services. Casual include women and other unskilled labourers. High-tech machinery automated and computerized.	**Social-**The project is socially accepted and has empowered participants. Employees get regular income from wages and salaries to buy their needs. Over 5,000 local women are involved in the purchase of shea nuts and groundnuts and enjoy free meals and medicare.
	Social-The project conforms to the norms of the community. Employees earn a living by way of wages.	**Economic-**The standard of living of participants and their dependents are improved considerably as they can pay for school fees.
	Economic-Funding is self raised in addition to international partners. Butter is sold internationally and locally.	

4.2 DISCUSSION

4.2.1 Project Selection criteria

The net present value (NPV), benefit cost ratio (BCR) and internal rate of returns (IRR) were used for the analysis. The formal selection criteria in projects appraisal are discussed below:

Net Present Value (NPV) Selection criterion-Accept a project as economically viable when the NPV is greater than or equal to zero. Comparing the NPVs of the four projects in Table

4.8, it is observed that the two medium scale facilities had negative NPVs of GH¢ -290,802.90 and GH¢-7,235,077.08 respectively. These are less than zero; therefore, using NPV as the sole criterion, the two projects should be rejected. The NPV of the small and large scales processors are GH¢ 192,125.18 and GH¢ 20,690,803.10 respectively. These however are by far greater than zero and should be accepted. With positive NPV, the two projects are economically viable to undertake. Since the NPV of the large scale facility is far greater than the local small scale, the large scale facility is selected at the expense of the small scale processor, given budget constraints. It should be noted that a high NPV suggests a very high returns to the society.

Benefit Cost Ratio Selection criterion-Accept an investment project with BCR greater than or equal to one. The BCR of the semi-mechanised facility and the mechanise facilities are 0.80 and 0.89 respectively. These values are less than one and should be rejected. The BCR for the small and large scales are 1.04 and 2.75 respectively. This implies that the benefits society will derive from the establishment of a large facility exceed the cost.

Internal Rate of Returns Selection criterion- Accept an investment project with IRR greater than the discounted rate. From Table 4.8; all projects had an internal rate of returns greater than the Bank of Ghana (BOG) discount rate for one year Treasury bills of 12.65%. Following the formal selection criterion, a project with an IRR greater than 12.65% is viable and qualified for selection. All the four projects by this criterion qualify for selection since they all have IRR greater than the discount rate of 12.65%. However, the project with the highest IRR is the best option for selection. Comparing the IRR of the four projects, the large facility once again had the highest of 39%, followed by the medium scale (mechanised): 31%, small scale: 22% and medium scale (semi-mechanised): 20%. With this selection criterion the large scale facility is selected over the other three alternatives.

4.2.2 Comparing Feasibility and Sustainability Factors

All three projects are compared by highlighting some components mentioned in each feasibility and sustainability factors and their similarities drawn to form the basis for examining the feasibility of establishing a project in Wa.

Biological feasibility-From the Table4.9a-c, it is realized that apart from the Ghana Nuts project which is located in the transitional zone, but strategically located along the Kumasi-Techiman main trunk road, the rest are located within the guinea and Sudan savannahs with a shea population above 60%. The shea tree should not only be present in the area to make a project feasible, but must be dominant in the landscape.

Biological sustainability- At Bosbel (Tamale) and Akoma International (Pusunamongu), the shea tree is conserved for its useful nuts and the introduction of the projects had resulted in the reduction of the use of the shea tree for fuel. Operational feasibility-All the projects utilized the services of skilled and unskilled labour in their operations. The semi-mechanised technology is practiced at Akoma International. A women group has been trained in the production of quality nuts and post harvest handling of nut to obtain the best nuts from the wild. This group supplies nuts to the facility. Some women are trained in operating the machines while others manually process the nuts.

At Ghana nuts and Bosbel Oil mlls, a highly mechanized technology is used. Members have skills to operate the machinery. Social feasibility-The projects conform to the norms of the community as part of the butter is used by women in cooking. Women participants were initially involved in shea butter extraction. Social sustainability-All projects are socially accepted because jobs have been created for participants and hence empowered women participants as they can afford to buy basic need. Women are tasked for picking, purchasing and selecting of good quality nuts while the men are engaged on the machinery.

4.2.3 Feasibility of Establishing a Facility in Wa

Establishing a large scale shea nut processing plant in Wa will be biologically, economically, socially and technically feasible. The following factors make Wa an excellent location for such a facility:

Availability of Raw Materials: Wa is located in the guinea savannah ecological zone with the shea tree constituting over 80% of the vegetation cover. The raw material could be supplied by companies like Olam and Karssardjian which deal in the purchase and sale of the shea and cashew nuts in the three regions of the north. Local women and the bulk of the unemployed youth could also be organized and trained to form network of shea collectors in the various communities. This will reduce the cost of the raw material as nuts will be purchased at relatively cheaper prices because transportation cost is eliminated.

Availability of utility services: Wa Township is connected to the national grid and has reliable and uninterrupted supply of power for both domestic and industrial use. Furthermore, an excellent underground water supply system is available for industrial use. Telecommunication networks (GT Land lines and GSMs, Vodafone, MTN, Zain and Tigo) are available, connecting the town to the rest of the world and making business activities faster and efficient.

Availability and low cost of land: There is a vast parcel of land, about 20ha at the outskirts of Wa, off the Tumu road earmarked for industrial use. This site is equipped with utility services like electricity and water which has resulted in the springing up of small, medium and large scale commercial activities. The cost of land in Wa is relatively cheap as a commercial plot could cost as low as GH ¢3,000.00. A land size of 5ha will be enough for a large scale processing plant. The industrial area should be considered during site selection for the facility.

Availability of laboratories: The laboratories of the Navrongo and Nyankpala campuses of the University for Development Studies are excellent resources for conducting qualitative tests on the butter to ensure that it meets international standards.

Transportation: The region is connected to the rest of the country by the recent tarring of the Bole-Bamboi road, easing the transportation problem hitherto confronted by the people of the region. This will ease transportation of the butter from Wa to the port of Tema.

Finally, the numerous women's shea butter processing cooperatives could be encouraged to become client suppliers as well as shareholders in the proposed processing plant. This arrangement will empower and strengthen the women's groups, enhance their commitment to the project, as well as enrich the rural poor.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

The Bank of Ghana (BOG) one year Treasury bill discount rate of 12.65% was used for the analysis on a 25 year costs and benefits (revenue) from the four projects. The Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal Rate of Returns were criteria used for the cost benefit analysis. The analyses shown by the three criteria indicate that, establishing a large scale shea nut processing facility in Wa is viable. The NPV, BCR and IRR of the large scale facility were; GH¢ 20,690,803.10, 2.75 and 39% respectively. All these values meet the selection criteria for selecting a project as viable. The NPV, BCR and IRR of the remaining projects-(small-scale, medium-scale (semi-mechanised), medium-scale mechanised) were GH¢ 192,125.18, GH¢ -290,802.90 and GH¢ -723,507.98; 1.04, 0.80 and 0.89: 22%, 20% and 31% respectively. Comparing the remaining projects the small scale local processors proved profitable. In this case, the need for sophisticated equipment for processing the nuts is not necessary. The small scale project is accepted but the capacity to produce in industrial level requires support in the form of improved extraction technology, funding, organisation and access to the international market. The remaining two projects proved unprofitable and should be rejected.

Establishing a large scale sea nut processing facility in Wa will not only be economically viable but will protect the shea tree and improve in the overall standard of living of the people. Though the initial startup cost of a large scale processing plant is high, it is worth venturing since, and the payback period is short. A facility similar to that of Ghana Nuts Limited can employ 50 technical and administrative staff and engage about 2,000 pickers. The facility can also process other oil seeds during off-season periods, which will add to the profitability of the plant. With the government programmes on Northern Rural Growth

(NRG) and block farms in which large quantities of soya beans are produced, a market value chain will be established between the Northern Rural Growth (NRG) and the factory where the latter will be fed with soya bean for oil extraction, a new opportunity for farmers in the locality.

5.2 Recommendations

The challenges faced during the course of the studies include the inability to meet all local individual shea butter processors and the fact that local processors are scattered all over the region.

The fat content of the nuts was assumed to be uniform and an average of 50% used though there exists variations in the fat content of the nut depending on the post harvest handling and treatment. These notwithstanding, the study were successfully done and the following recommendations made:

- As a way of reducing poverty in the three regions of the north, bridging the north-south disparities, and hence curb the inflow of the youth from the north to the south, Savannah Accelerated Development Authority (SADA) should consider the establishment of an industrial shea nut processing plant in Wa. This facility will process between 5,000mt to 20,000mt and reduce the large quantity of nuts that get spoilt each year due to lack of market and processing equipment and provide jobs for over 2,000 workers.
- Both local and international investors should channel their resources to the promising shea sector by way of establishing processing plants and be assured of rapid returns.
- Governments must institute a fund for research aimed at reducing the gestation period of the main economic tree of the people of the north. The main research institution currently working on the shea tree is the Cocoa Research Institute of Ghana (CRIG).

Other national institutes that have been or are interested in being involved on research on shea, include the Food Research Institute (FRI), Savannah Agricultural Research Institute (SARI) and the University for Development Studies (UDS).

- Government should decouple the shea industry from the Cocoa industry by establishing the **Shea Board** to manage the production, processing and selling of shea nuts in the country.
- Further research in the following areas is recommend;
  - A study on a thorough environmental impact assessment of an industrial shea butter extraction plant in Wa.
  - Studies on the actual population of the shea tree, annual production, local and international marketing of the nuts and butter.
  - Study on the postharvest handling of the nuts by shea collectors and the resultant yield of butter.

REFERENCES

Addaquaye J. (2004). The shea butter value chain. Refining in West Africa WATH Technical Report No, 3: pp 2-8

Adomako, D (1985). Prospects for the development of the shea nut industry in Ghana. Cocoa Research institute, Ghana Technical bulleting. 11: pp 8-10

Adomako, D, (1977). Fatty acid composition and characteristics of *Pentadesma buteracea* fat extracted from Ghana seeds.*Journal of Science of Food and Agriculture* 28: 384-386.

Akosah-Sarpong, K. (2003). Demand for West Africa's shea butter in cosmetic industry. West Africa, 4360, 34-36.

Amman- Jordan (2005). Project analysis and appraisal (electronic version), IWRM workshop. Retrieved on the 24/08/2010). Page 4-6

Boffa, J.M. (1999). Agroforestry parkland systems in sub-saharan Africa : FAO conservation guide 34. Rome: Food and Agriculture Organization of the United Nations.

Boffa, J.M. (2000). West African agroforestry parklands: keys to conservation and sustainable management. Unasylva, 51, 11-17.

Boffa, J.M.; Taonda, S., Dickey, J., Knudson, D. (2000). Field-scale influence of karité (Vitellaria paradoxa) on sorghum production in the Sudan zone of Burkina Faso Agroforestry Systems, 49, 153-175.

Booth, F. & Wickens, G. (1988). Non-timber uses of selected arid zone trees and shrubs in Africa: FAO conservation guide 19. Rome: Food and Agriculture Organization of the United Nations.

Carr, M., Chen, M., Tate, J. (2000). Globalization and home-based workers. Feminist Economics, 6(3), 123-142.

Chalfin, B. (2004). Shea Butter Republic: state power, global markets, and the making of an indigenous commodity. New York: Routledge.

Danthu, P.; Gueye, A.; Boye, A.; Bauwens, D.; Sarr, A. (2000). Seed storage behavior f four sahelian and sudanian tree species (*Boscia senegalensis, Butyrospermum parkii,*

Cordyla pinnata, and *Saba senegalensis*). Seed Science Research, 10, 183-187.

FAOSTAT 2008. Key statistics of food and agriculture external trade (for karité nuts in 2010). Last accessed, April 12, 2010, from http://www.fao.org/es/ess/toptrade/trade.asp

Hall, J., Aebischer, D.,Tomlinson, H., Osei-Amaning, E., Hindle, J. (1996). *Vitellaria paradoxa*: a monograph. School of Agriculture and Forest Sciences publication number 8. Bangor, Wales: University of Wales.

Harsch, E. (2001). Making trade work for poor women. Africa Recovery, 15(4).

Joker, D. (2000). Seed leaflet no. 50: *Vitellaria paradoxa* Gaertn. f. Denmark: Danida Forest Seed Centre.

Kristensen, M., & Lykke, A. (2003). Informant-based valuation of use and conservation preferences of savanna tress in Burkina Faso. Economic Botany, 57(2), 203-217.

Laird, S and , Guillén A. (2002). Marketing issues. In P. Shanley, A.Pierce, S.Laird, & A. Guillén (Eds.). Tapping the green market: certification and management of non-timber Forest Products (pp. 322-336). Sterling, Virginia: Earthscan Publications Ltd.

Lipp, M.; Anklam, E. (1998). Review of cocoa butter and alternative fats for use in chocolate--Part A. Compositional data.[Electronic version]. Food Chemistry, 62(1), 73-97.

Lovett, and Haq, N. (2000). Diversity of the sheanut tree (*Vitellaria paradoxa* C.F. Gaertn.) in Ghana. Genetic Resources and Crop Evolution, 47, 293-304.

Maranz, S.; Wiesman, Z. (2003). Evidence for indigenous selection and distribution of the shea tree, Vitellaria paradoxa. Journal of Biogeography, 30, 1505-1516.

Oppong F. (2008). Cost benefit analysis of water supply: Case study of Ghana Water Company Ltd, Ashanti Region Thesis, KNUST, Kumasi, pages 18-50

Maydell, H. von. (1990). *Butyrospermum parkii* (G.Don) Kotschy 202-207. Trees and shrubs of the Sahel: Their characteristics and uses. English text revised J. Brase. Eschborn, Germany: Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ).

Salunkhe D.; Chavan, J.K Addae, R.N Kadam, S.S. (1992). Worlds Oils: Chemistry, Technology and Utilization, Van Nostrand Reinhold, New York. P 554

Sanou, H., Kambou, S., Teklehaimanot Z., Dembélé, M.; Yossi, H.; Sibidu, S., Djingdia, L., Bouvet, J. (2004). Vegetative propagation of Vitellaria paradoxa by grafting. Agroforestry Systems, 60, 93-99.

Saul, M., Ouadba, J., Bognounou, O. (2003). The wild vegetation cover of Western Burkina Faso colonial policy and post-colonial development. In T. Basset & D. Crummey (Eds.), African Savannas: global narratives and local knowledge of environmental change (pp.121-160). Portsmouth NH: Heinemann, a division of Reed Elsevier.

Vermilye K. (2004) A *Vitellaria Paradoxa* and the Feasibility of a Shea Butter Project in the North of Cameroon (pp 6-20)

APPENDICES

APPENDIX I: Questionnaire For Local Shea Processors

This questionnaire is meant to evaluate the local shea processors in Wa and to determine the feasibility of establishing a Shea project there.

I would be grateful if you could fill in the spaces provided with precision and clarity. Information gathered is meant for academic purposes and every effort would be made to treat responses with utmost confidentiality.

Please tick where applicable.

1 Name of Respondent……………………………………………………………………….
2 Age……………………………….. 3. Sex Male [ ] Female [ ]
4 Marital status: Single [ ] Married [ ] Divorced [ ] Widowed [ ]
5 Educational level: No formal education [ ] Primary [ ]

Middle J H S [ ] Secondary [ ] Tertiary [ ]

6 Name of community village…………………………
7 District/Municipality/metropolis……………………
8 Region…………………………………………
9 Distance in Km from major towns:

Major Town Distance

……………………… ………………………….

Demography of the community/village

10 Population: Men…………………………..Women………………………….
11 Ethnic group……………………………………………………………………
12 Does the village have any economic activity for women? Yes [ ] No [ ]

If yes, what type of economic activity is/are there? …………………………

13 Is there any Shea project in the community? Yes [ ] No [ ]
14 Is the Shea tree common in the area? Yes [ ] No [ ]

If yes, how do you process the nuts?

Singly [ ] Groups [ ]

15 Are there Shea processing co-operatives in your area? Yes [ ] No [ ]

If yes mention some ……………………………………………………………….

16. What technology is used in processing the nuts? ....

Traditional [ ] Mechanical [ ] Chemical [ ]

17. How long would you use to process 80kg (one bag) Shea nut? …………………
18. How much yield would be obtained from 80kg (one bag) Shea nuts?

19. Do you have special training in Shea processing? Yes [ ] No [ ]

If yes where did you train?

20. Are you supported financially in your work? Yes [ ] No [ ]

If yes state source……………………………………………

21. What form is the support?

Grant [ ] Loan [ ]

22. Would you be willing to join others processors to expand you scope?

Yes [ ] No [ ]

23. If assistance is provided in the form of processing equipment, how will you use and maintain them? …………………………………………

24. Do you have expertise in commercial Shea processing activity?

Yes [ ] No [ ]

25. If a Shea project is to be established in your area, rate the level of success.

Very poor [ ] Poor [ ] Good [ ] Very Good [ ] excellent [ ]

26. What factors would ensure the sustainability of a Shea project in your locality?

…………………………………………………………………………….

27. Would the establishment of a Shea project benefit the community?

If yes to what extent? ……………………………………………………

Low [ ] High [ ] Higher [ ] Highest [ ]

28. Would there be ready market for large quantity of Shea butter? Yes [ ] No [ ]
29. Is the community accessible to vehicles? Yes [ ] No [ ]
30. Do you have any other comment? State it………………………………………….

APPENDIX II**: Questionnaire for Selected Shea Project Sites**

This questionnaire is meant to evaluate the factors that let to the establishment of the Shea project in selected communities. The responses will serve as the basis for establishing a Shea processing facility in Wa.

I would be grateful if you could fill in the spaces provided with precision and clarity. Information gathered is meant for academic purposes and every effort would be made to treat responses with utmost confidentiality.

Please tick where applicable.

1. Name of Respondent………………………………………………………
2. Age……………………………….. 3. Sex Male [ ] Female [ ]
4. Marital status: Single [ ] Married [ ] Divorced [ ] Widowed [ ]
5. Educational level: No formal education [ ] Primary [ ]

   Middle J H S [ ] Secondary [ ] Tertiary [ ]

6. Name of community village……………………………………………………
7. District/Municipality/metropolis………………………………………………….
8. Region………………………………………………………………………….
9. Distance in Km from major towns:

Major Town	Distance
………………………	……………………………
……………………….	……………………………

10. What is the name of the Shea project in your locality? ....
11. When was it established? ....
12. Which organization established it? ....

Factors that led to the establishment of the project in your locality.

FEASIBILITY FACTORS

Biological factors

13. Is the Shea tree available in your locality? Yes [ ] No [ ]
14. If yes what extent of the vegetation cover is the Shea tree? 30% [ ] 20 – 39% [ ] 40 – 59 [ ] 60 – 80 [ ] > 80% [ ]

Operational factors

15. What is the tree tenure regarding harvesting rights?

    Trees are owned by individual i.e. individual rights [ ]

    Trees are owned by families i.e. family rights [ ]

    Trees are owned by the community i.e. communal rights [ ]

No right over ownership [ ]

16. What extraction technology is used?

    Local extraction method [ ]

    Semi modern extraction method [ ]

    Modern highly mechanized extraction method [ ]

    Modern chemical extraction method [ ]

    Social factors

17. Does the majority of the community accept the project?

    Yes [ ] No [ ]

18. Does the project adhere to the social norms and culture of the people?

    Yes [ ] No [ ]

    Economic factors

19. Has the project increased the standard of living of the people in the community?

    Yes [ ] No [ ]

20. Source of funding…………………………………………………….
21. Form of funding: Grant [ ] Loan [ ] community raised funds [ ]

SUSTAINABILITY FACTORS

Biological sustainability

22. Is the Shea tree conserved because of the project? Yes [ ] No [ ]
23. What harvesting technique is used to ensure the continuous supply of the Shea nut for the project? ....
24. Has the project reduced the use of firewood in the locality, and by what percentage? ....
25. Doe the economic returns from extraction provide sufficient incentive to conserve the Shea tree? Yes [ ] No [ ]

Social sustainability

26. Is the project socially acceptable? Yes [ ] No [ ]
27. Does the project empower participants? Yes [ ] No [ ]

    If yes how ……………………………………………………………………

28. Has the project reduced your daily work load? Yes [ ] No [ ]

    If yes what do you use your extra time for?

    ………………………………………………………………………………………

Economic sustainability

29. Has the standard of living of participants been increased? Yes [ ] No [ ]

If yes state how…………………………………………………………………………

30. Does the benefits of the projects outweigh other alternative activities?

Yes [ ] No [ ]

FACILITY ESTABLISHMENT

31. State the costs in Ghana Cedis of the following:

Land……………………………………………………………………………….

Building ……………………………………………………………………………

Equipment/Machinery………………………………………………………………

Salary/Wage of workers……………………………………………………………

32. Scale of operation

Small scale [ ] Medium scale [ ] Large scale [ ]

33. Quantity (tonnes) of butter produced annually………………………………….
34. Value in Ghana Cedis of butter produced annually………………......................
35. What is the staff strength? Casual……………… Permanent…………..

Marketing

36. How do you market your produce?

Local market in the community [ ]

Local market in the urban centers [ ]

Exported to other countries [ ]

37. Do you have a firm(s) that purchases your batter? Yes [ ] No [ ]

If yes name the firm(s)……………………………………………………………

38. What quantity of butter is purchased annually…………………………………….
39. Which country/countries are the butter exported to ……………………………..

……………………………………………………………………………………

40. Do you encounter some challenges? Yes [ ] No [ ]

If yes mention some of the challenges you are encountered with

……………………………………………………………………………………..

41. What efforts have you made to tackle the challenges?

………………………………………………………………………………………..

42. What benefits have you derived from participating in the project?

………………………………………………………………………………………..

43. Would you recommend the similar projects in other communities?

Yes [ ] No [ ]

If yes State reason(s)

………………………………………………………………………………………..
………………………………………………………………………………………..
………………………………………………………………………………………..

APPENDIX III-**Cash Flows Analyses For Various Production Levels**

SMALL SCALE

					SMALL SCALE							
Year	237pots	711 Basins	237Stirrers	Fuel	Water	Milling	Crushing	Input cost	Total Cost	Output	Price/kg	Revenue
0	-14220	-14220	-474						-28914			
1				1185	237	1185	592.5	286650	289849.5	290343.96	1	290343.96
2	13651.2	13651.2	455.04	1185	237	1185	592.5	286650	317606.94	290343.96	1.11	322281.796
3	13082.38	13082.4	436.08	1185	237	1185	592.5	286650	316450.36	290343.96	1.12	325185.235
4	12513.57	12513.6	417.12	1185	237	1185	592.5	286650	315293.79	290343.96	1.13	328088.675
5	11944.76	11944.8	398.16	1185	237	1185	592.5	286650	314137.22	290343.96	1.14	330992.114
6	11375.95	11376	379.2	13686.75	248.9	1244.25	622.13	300982.5	339915.63	290343.96	1.15	333895.554
7	10807.14	10807.2	360.24	13686.75	248.9	1244.25	622.13	300982.5	338759.06	290343.96	1.16	336798.994
8	10238.33	10238.4	341.28	13686.75	248.9	1244.25	622.13	300982.5	337602.49	290343.96	1.17	339702.433
9	9669.52	9669.6	322.32	13686.75	248.9	1244.25	622.13	300982.5	336445.92	290343.96	1.18	342605.873
10	9100.71	9100.8	303.36	13686.75	248.9	1244.25	622.13	300982.5	335289.35	290343.96	1.19	345509.312
11	8531.91	8532	284.4	15739.7625	273.7	1268.68	628.35	331080.75	366339.5925	275826.76	1.2	330992.112
12	7963.1	7963.2	265.44	15739.7625	273.7	1268.68	628.35	331080.75	365183.0225	275826.76	1.21	333750.38
13	7394.29	7394.4	246.48	15739.7625	273.7	1268.68	628.35	331080.75	364026.4525	275826.76	1.22	336508.647
14	6825.48	6825.6	227.52	15739.7625	273.7	1268.68	628.35	331080.75	362869.8825	275826.76	1.23	339266.915
15	6256.91	6256.8	208.56	15739.7625	273.7	1268.68	628.35	331080.75	361713.5525	275826.76	1.24	342025.182
16	5688.1	5688	189.6	15739.7625	273.7	1268.68	628.35	331080.75	360556.9825	262035.42	1.25	327544.275
17	5119.23	5119.2	170.64	15739.7625	273.7	1268.68	628.35	331080.75	359400.3525	262035.42	1.26	330164.629
18	4550.29	4550.4	151.68	15739.7625	273.7	1268.68	628.35	331080.75	358243.6525	262035.42	1.27	332784.983
19	3981.67	3981.6	132.72	15739.7625	273.7	1268.68	628.35	331080.75	357087.2725	262035.42	2.28	597440.758
20	3412.86	3412.8	113.76	15739.7625	273.7	1268.68	628.35	331080.75	355930.7025	262035.42	2.29	600061.112
21	2844.1	2844	94.8	16526.7481	287.4	2600.794	659.74	347634.84	373492.4491	248933.65	2.3	572547.395
22	2275.25	2275.2	75.84	16526.7481	287.4	2600.794	659.74	347634.84	372335.8391	248933.65	2.31	575036.732
23	1706.43	1706.4	56.88	16526.7481	287.4	2600.794	659.74	347634.84	371179.2591	248933.65	2.32	577526.068
24	1137.62	1137.6	37.92	16526.7481	287.4	2600.794	659.74	347634.84	370022.6891	248933.65	2.33	580015.405
25	568.81	568.8	18.96	16526.7481	287.4	2600.794	659.74	347634.84	368866.1191	248933.65	2.34	582504.741
									8679684.081			10053573.3

MEDIUM SCALE SEMI-MECHANISED

MEDIUM SCALE

Year	Grinding mill	Crusher	Kneader	Boiler	Drum Roaster	Clarifier	8 HP Diesel Engine	Installation a	Buiding	Land	Total Fixed c	Input cost	O &M	Total variabl cos	Total Cost	Out put(kg	price/k	Total revenue
0	700	420	680	420	200	470	950	670	85000	18000	107510							
1												25312.5	16748.5	42061	42061	50000	1.45	72500
2	672	403.2	652.8	451.2	192	451.2	912	643.2	81600	17280	103257.6	25312.5	16748.5	42061	145318.6	50900	1.46	74314
3	644	386.4	625.6	432.4	184	432.4	874	616.4	78200	16560	98955.2	25565.7	16748.5	42314.2	141269.4	50500	1.47	74235
4	616	369.6	598.4	413.6	176	413.6	836	589.6	74800	15840	94652.8	25565.7	16748.5	42314.2	136967	50500	1.48	74740
5	588	352.8	571.2	394.8	168	394.8	798	562.8	71400	15120	90350.4	25565.7	16782	42347.7	132698.1	51000	1.49	75990
6	560	336	544	376	160	376	760	536	68000	14400	86048	25565.7	16782	42347.7	128395.7	51000	2	102000
7	532	319.2	516.8	357.2	152	357.2	722	509.2	64600	13680	81745.6	26079.57	16782	42861.57	124607.2	51500	2.01	103515
8	504	302.4	489.6	338.4	144	338.4	684	482.4	61200	12960	77443.2	26079.57	16782	42861.57	120304.8	51500	2.02	104030
9	476	285.6	462.4	319.6	136	319.6	646	455.6	57800	12240	73140.8	26079.57	16782	42861.57	116002.4	52000	2.03	105560
10	448	268.8	435.2	300.8	128	300.8	608	428.8	54400	11520	68838.4	26079.57	17586	43665.57	112504	52000	2.04	106080
11	420	252	408	282	120	282	570	402	51000	10800	64536	26603.8	17586	44189.8	108725.8	52500	2.03	106575
12	392	235.2	380.8	263.2	112	263.2	532	375.2	47600	10080	60233.6	26603.8	17586	44189.8	104423.4	52500	2.04	107100
13	364	218.4	353.6	244.4	104	244.4	494	348.4	44200	9360	55931.2	26603.8	17586	44189.8	100121	53000	2.06	109180
14	336	201.6	326.4	225.6	96	225.6	456	321.6	40800	8640	51628.8	26603.8	17586	44189.8	95818.6	53000	2.07	109710
15	308	184.8	299.2	206.8	88	206.8	418	294.8	37400	7920	47326.4	27138.6	17586	44724.6	92051	49500	2.08	102960
16	280	168	272	188	80	188	380	268	34000	7200	43024	27138.6	18280.1	45418.7	88442.7	49500	2.09	103455
17	252	151.2	244.8	169.2	72	169.2	342	241.2	30600	6480	38721.6	35509.9	18280.1	53790	92511.6	49000	2.1	102900
18	224	134.4	217.6	150.4	64	150.4	304	214.4	27200	5760	34419.2	35509.9	18280.1	53790	88209.2	49000	2.12	103880
19	196	117.6	190.4	131.6	56	131.6	266	187.6	23800	5040	30116.8	35509.9	18280.1	53790	83906.8	48500	2.13	103305
20	168	100.8	163.2	112.8	48	112.8	228	160.8	20400	4320	25814.4	35509.9	18280.1	53790	79604.4	48500	2.14	103790
21	140	84	136	94	40	94	190	134	17000	3600	21512	36141.9	1864565	1900706.9	1922219	40000	2.15	86000
22	112	67.2	108.8	75.2	32	75.2	152	107.2	13600	2880	17209.6	36141.9	1864565	1900706.9	1917917	48000	2.16	103680
23	84	50.4	81.6	56.4	24	56.4	114	80.4	10200	2160	12907.2	36141.9	1864565	1900706.9	1913614	47500	2.17	103075
24	56	33.6	54.4	37.6	16	37.6	76	53.6	6800	1440	8604.8	36141.9	1864565	1900706.9	1909312	47500	2.18	103550
25	28	16.8	27.2	18.8	8	18.8	38	26.8	3400	720	4302.4	36141.9	1864565	1900706.9	1905009	47000	2.19	102930
															11702013			2445054

MEDIUM SCALE (MECHANISED)

MEDIUM SCALE BOSBEL

Year	Precleaner	Boiler	Filter Press (2)	Vibrating Scre	Storage tank	Special tanl	Building	Land	Tot fixed cost	Input cost	O &M	Total Cost	Out put(k	price/kg	Total revenu
0	-7250	-174000	-217500	-43500	-36250	-108750	-72500	-10000	-669750			-1339500			
1										140625	780929	921554	4000000	1.45	5800000
2	6264	150336	187920	37584	31320	93960	62640	9600	579624	140625	780929	1501178	4000000	1.46	5840000
3	6003	144072	180090	36018	30015	90045	60030	9200	555473	122031	780929	1458433	4000000	1.47	5880000
4	5742	137808	172260	34452	28710	86130	57420	8800	531322	122031	780929	1434282	4000000	1.48	5920000
5	5481	131544	164430	32886	27405	82215	54810	8400	507171	144871.9	780929	1432971.9	4000000	1.49	5960000
6	5220	125280	156600	31320	26100	78300	52200	8000	483020	144871.9	8199976	8827867.4	4000000	2	8000000
7	4959	119016	148770	29754	24795	74385	49590	7600	458869	149218.1	8199976	8808062.6	4000000	2.01	8040000
8	4698	112752	140940	28188	23490	70470	46980	7200	434718	149218.1	8199976	8783911.6	4000000	2.02	8080000
9	4437	106488	133110	26622	22185	66555	44370	6800	410567	155186.8	8199976	8765729.3	4000000	2.03	8120000
10	4176	100224	125280	25056	20880	62640	41760	6400	386416	155186.8	8199976	8741578.3	4000000	2.04	8160000
11	3915	93960	117450	23490	19575	58725	39150	6000	362265	162946.1	8199976	8725186.6	4000000	2.03	8120000
12	3654	87696	109620	21924	18270	54810	36540	5600	338114	162946.1	8199976	8701035.6	4000000	2.04	8160000
13	3393	81432	101790	20358	16965	50895	33930	5200	313963	172722.7	8199976	8686661.2	4000000	2.06	8240000
14	3132	75168	93960	18792	15660	46980	31320	4800	289812	172722.7	8199976	8662510.2	4000000	2.07	8280000
15	2871	68904	86130	17226	14355	43065	28710	4400	265661	162359.5	8199976	8627996	4000000	2.08	8320000
16	2610	62640	78300	15660	13050	39150	26100	4000	241510	162359.5	8240975	8644844.3	4000000	2.09	8360000
17	2349	56376	70470	14094	11745	35235	23490	3600	217359	154241.6	8240975	8612575.4	4000000	2.1	8400000
18	2088	50112	62640	12528	10440	31320	20880	3200	193208	154241.6	8240975	8588424.4	4000000	2.12	8480000
19	1827	43848	54810	10962	9135	27405	18270	2800	169057	148071.9	8240975	8558103.7	4000000	2.13	8520000
20	1566	37584	46980	9396	7830	23490	15660	2400	144906	148071.9	8240975	8533952.7	4000000	2.14	8560000
21	1305	31320	39150	7830	6525	19575	13050	2000	120755	143629.8	8653024	8917408.5	4000000	2.15	8600000
22	1044	25056	31320	6264	5220	15660	10440	1600	96604	143629.8	8653024	8893257.5	4000000	2.16	8640000
23	783	18792	23490	4698	3915	11745	7830	1200	72453	143629.8	8653024	8869106.5	4000000	2.17	8680000
24	522	12528	15660	3132	2610	7830	5220	800	48302	143629.8	8653024	8844955.5	4000000	2.18	8720000
25	261	6264	7830	1566	1305	3915	2610	400	24151	143629.8	8653024	8820804.5	4000000	2.19	8760000
												181362391			196640000

LARGE SCALE

			LARGE SCALE													
Year	Precleaner	Cooking Kettle	Screw Press	Vibrating screen	Leaf filter	Storage Tank	2 Special Tankers	Refinery plant	Building	Land	Input cost	O &M	Total Cost	Out put(kg)	price/kg	Total revenu
0	-58000	-174000	-507500	-217500	-319000	-145000	-290000	-3625000	-362500	-8000			-5706500			
1											6250000	5466500	11716500	8500000	1.45	12325000
2	55680	167040	487200	208800	306240	139200	278400	3480000	348000	7680	6250000	5466500	17194740	8500000	1.45	12325000
3	53360	160080	466900	200100	293480	133400	266800	3335000	333500	7360	6250000	5466500	16966480	8585000	1.45	12448250
4	51040	153120	446600	191400	280720	127600	255200	3190000	319000	7040	6250000	5466500	16738220	8585000	1.45	12448250
5	48720	146160	426300	182700	267960	121800	243600	3045000	304500	6720	6250000	5466500	16509960	8842550	1.45	12821698
6	46400	139200	406000	174000	255200	116000	232000	2900000	290000	6400	6577500	5739825	16882525	8842550	1.5225	13462782
7	44080	132240	385700	165300	242440	110200	220400	2755000	275500	6080	6577500	5739825	16654265	9196252	1.5225	14001294
8	41760	125280	365400	156600	229680	104400	208800	2610000	261000	5760	6577500	5739825	16426005	9196252	1.5225	14001294
9	39440	118320	345100	147900	216920	98600	197200	2465000	246500	5440	6577500	5739825	16197745	9564102.1	1.5225	14561345
10	37120	111360	324800	139200	204160	92800	185600	2320000	232000	5120	6577500	5739825	15969485	9564102.1	1.5225	14561345
11	34800	104400	304500	130500	191400	87000	174000	2175000	217500	4800	6577500	5739825	15741225	10042307	1.5986	16053933
12	32480	97440	284200	121800	178640	81200	162400	2030000	203000	4480	6906375	6026816	16128831.3	10042307	1.5986	16053933
13	30160	90480	263900	113100	165880	75400	150800	1885000	188500	4160	6906375	6026816	15900571.3	101024846	1.5986	161501349
14	27840	83520	243600	104400	153120	69600	139200	1740000	174000	3840	6906375	6026816	15672311.3	101024846	1.5986	161501349
15	25520	76560	223300	95700	140360	63800	127600	1595000	159500	3520	6906375	6026816	15444051.3	94963355	1.5986	151811269
16	23200	69600	203000	87000	127600	58000	116000	1450000	145000	3200	6906375	6026816	15215791.3	94963355	1.9181	182151681
17	20880	62640	182700	78300	114840	52200	104400	1305000	130500	2880	6906375	6026816	14987531.3	90215188	1.9181	173044097
18	18560	55680	162400	69600	102080	46400	92800	1160000	116000	2560	6906375	6026816	14759271.3	90215188	1.9181	173044097
19	16240	48720	142100	60900	89320	40600	81200	1015000	101500	2240	6906375	6026816	14531011.3	86606580	1.9181	166122333
20	13920	41760	121800	52200	76560	34800	69600	870000	87000	1920	6906375	6026816	14302751.3	86606580	1.9181	166122333
21	11600	34800	101500	43500	63800	29000	58000	725000	72500	1600	6906375	6026816	14074491.3	84008383	1.9181	161138663
22	9280	27840	81200	34800	51040	23200	46400	580000	58000	1280	7251694	6328157	14492890.6	84008383	1.9181	161138663
23	6960	20880	60900	26100	38280	17400	34800	435000	43500	960	7251694	6328157	14264630.6	82328315	1.9181	157916081
24	4640	13920	40600	17400	25520	11600	23200	290000	29000	640	7251694	6328157	14036370.6	82328315	1.9181	157916081
25	2320	6960	20300	8700	12760	5800	11600	145000	14500	320	7251694	6328157	13808110.6	81505032	1.9181	156336921
													384615765			2.295E+09

APPENDIX IV: 2010 Price List of Shea Nut Processing Equipment By GRATIS Tamale

No.	Description	Qty	Unit Price (GH¢)	Total Amount (GH¢)
1	Grinding Mill	1	700.00	700.00
2	Crusher	1	420.00	420.00
3	Kneader	1	680.00	680.00
4	Boiler	1	470.00	470.00
5	Clarifier	1	470.00	470.00
6	Drum Roaster	1	200.00	200.00
7	Installation Materials & Charges	1	720.00	720.00
8	Training	1-week	370.00	370.00
9	8HP Diesel Engine	1	950.00	950.00
	TOTAL			**4,980.00**

APPENDIX V: Prices of Traditional Shea nut Processing Equipment

EQUIPMENT	QUANTITY	UNIT PRICE (GH¢)	TOTAL (GH¢)
Cooking Pot	1	60	60
Basins (3)	3	20	60
Stirrer	2	2	4

APPENDIX VI: Major Shea Butter Refineries

1. FUJI OIL, JAPAN

Founded in 1950, the Fuji Oil Group serves the world as a specialist in intermediate food ingredients. The Group's research and development has led to numerous innovative, high value-added specialty products. Sales for our oils and fats business yield about 50,475 million yen ($454 million). Total consolidated sales of Fuji Oil are 160,000 million Yen ($1,440 million).

Fuji Oil Group Kuhlmannlaan 36 9042 Gent

Belgium

Tel: + 32 (0) 9 343 0202

Fax: + 32 (0) 9 344 2610

www.fujioileurope.com

www.fujioil.co.jp.

Contact: Mr. Jan Sintobin, Procurement Director

2. LODERS CROKLAAN

The company was part of the Anglo-Dutch consumer goods conglomerate Unilever but has been sold at €217m to IOI Corp Berhad of Malaysia. The Loders Croklaan Group unit employs 600 people, with posted FY 2001 sales of €267m (US$262.53m).

IOI GROUP IOI is one of Malaysia's homegrown business conglomerates. Within a relatively short span of years, the IOI Group has firmly established itself as a leader in its core business areas of Plantations, Property Development and Investment and Manufacturing. From an oil palm plantation entity, the IOI Group has transformed itself to become a leading integrated palm oil player in the country.

Moreover through the acquisition of Loders Croklaan, IOI is now a strong global player with a strategic focus on growth in the area of palm based oil products. It is one of the largest plantation groups in Malaysia with a sizeable plantation holding of over

160,000 hectares. Annual production of CPO is in excess of 800,000 tonnes. To gain further leverage as a key palm oil producer, IOI has also ventured into downstream value-added palm oil based manufacturing activities such as palm oil refining, palm kernel extraction, oleo chemicals and specialty fats and oils.

www.ioigroup.com: www.croklaan.com

IOI Group (Malaysia/Netherlands)

Level 8, Two IOI Square

IOI Resort, 62502 Putrajaya

Malaysia

Tel : +60 3 8947 8668 Fax : +60 3 8943 2899

Contact: Mr. Christopher R Donough, Research Controller (Plantation Division)

3. AARHUS UNITED - VEGETABLE OILS AND FATS

Aarhus was established in Denmark in 1871.It has 1,700 employees worldwide. In 2003, turnover totaled approximately $687 million, with profits reaching some $13 million. Aarhus United comprises 14 subsidiaries with four manufacturing companies in Denmark (head office), Mexico, the United Kingdom (UK), and the US. An affiliated company - United Plantations - is based in Malaysia. Aarhus United Denmark extracts and refines vegetable oils for use primarily in the confectionery industry.

Shea nut represents one of the most important raw materials to Aarhus United Denmark, which provides a network of suppliers in the sub-region. Aarhus United A/S M. P. Bruuns Gade 27, DK-8000 Arhus C, Denmark

Tel: +45 87 30 60 00 Fax: +45 87 30 60 44

Email: dk.sales@aarhusunited.com

URL: www.aarhusunited.com

4. KARLSHAMS (SWEDEN)

Karlshamns, one of the world’s four leading manufacturers of high value-added specialty vegetable fats leads the market in Nordic countries and Eastern Europe.

The food industry embodies Karlshamns’ largest customer segment and Sweden its largest single market. The Group consists of three business areas – Edible Oils, Technical Products and Feed Materials. The company purchases raw materials like seed, nuts, and crude vegetable oils globally, directly from plantations or on the major commodity markets.

With a turnover of roughly SEK 3,200 million (US$ 421 million?) and nearly 800 employees, of whom about 600 are in Sweden, the Group maintains three plants for refining oils and fats within the Edible Oils business area. These are located in Karlshamn, Sweden, in Hull, the UK, and in Zaandijk, the Netherlands.

Karlshamns AB, 37382 Karlshamn, Sweden

Tel: +46-454-82-137

Fax: +46-454-82-838 www.karlshamns.se Contact: Mr. Jan-Olof Lidefelt, Strategic Marketing Manager, Oils and Fats Division

APPENDIX VII: Equipment Manufacturers & Consultants

1. WESTFALIA (GERMANY)

Westfalia Separator builds state-of-the-art machines to the highest quality standards working to DIN ISO 9001 standard since 1989. Further, all domestic and foreign subsidiaries have been certified to the highest ISO standard since the beginning of the year 2000. In 2001 the new ISO 9001:2000 standard will be implemented.

Over 2000 applications in the field of separation technology have been successfully tested in practice. The core competence of the new Westfalia Separator combines separators and decanters with process engineering. This strategy has generated a turnover of 400 million EURO making Westfalia Separator a key player in the field of centrifugal separation technology.

Equipment offered include separators with a daily capacity of 50 t for small mill operators up to the separator with a capacity over 1000 t per day for large refineries- for the following:

• Press oil clarification

• Dewaxing

• Degumming

• Fractionation

• Neutralization

• Soap stock splitting

• Washing

Applications in oleo chemistry include:

• Epoxidized oils

• Glycerin

• Mono/diglycerides

• Soaps • Fatty acids

• Fatty alcohols

• Trans-esterification

• Methyl ester

• Transesterification (e.g., for the production of biodiesel)

TECHNOCHEM, INC. (USA)

TECHNOCHEM, an expert in designing and processing of vegetable oils, was founded in India in 1972 by Krishna Agarwal. The company was transformed into a limited liability company by the name of Technochem Engineers (India) Private Limited and was incorporated in the USA in 2000 as Technochem International Inc.

The company specializes in supplying plant and equipment for hydrogen generation, hydrogenation, and vegetable-oil refining companies. The company serves more than 150 factories in India and neighboring countries.

SERVICES

Oil Refining Plants

Crude Oils

Plants for processing of canola oil, castor oil, coconut oil, cottonseed oil, palm oil, peanut oil, rapeseed oil, rice bran oil, soybean oil, sunflower oil, and others. Capacity

Offers commercial refining plants of any capacity ranging from 5 tons/per day to 500 tons/day. Construction Plans to build on site, assemble equipment and test for clients and offers consultancy services as well.

International, Inc.

3320 Goldenrod Circle

Ames, IA 50014 USA

Tel: (515) 292-2891

Fax: (515) 292-5572

Email: technocheminc.com

3. TROIKA (INDIA)

TROIKA, an ISO 9001 company in operation since 1971, specializes in the field of Oils and Fats technology. TROIKA equipment operates at more than 250 projects spread over 22 countries . TROIKA offers services in all aspects of the industry; including commercial and operational safety aspects, international quality standards, and the latest design trends in the industry.

Installations TROIKA has installed the following numbers of different types of units:

SOLVENT EXTRACTION LINE	96
VEGETABLE OIL REFINING LINE	53
OIL MILLING SECTION	12
INTERNATIONAL CLIENTELE	47

PILOT / SPECIALLY DESIGN LINE	20
TAILOR MADE EQUIPMENT	18

TROIKA has supplied equipment in Bangladesh, Ceylon, Ethiopia, Germany, Greece, India, Iran, Kazakhstan, Kenya, Kuwait, Macedonia, Malaysia, Myanmar, Nepal, Nigeria, Philippines, Russia, South Africa, Tanzania, Turkey, U.A.E. and Yemen.

Contact:

6th Floor, Embassy Centre

Nariman Point

Mumbai-400 021

India.

Tel: 00-91-(22)-2834429, 2834334, 2834515

Fax: 00-91-(22)-2823778

Email: troika@vsnl.com

4. GLAMPTECH (INDIA)

This engineering company was founded in 1990 to provide service in the field of Continuous Solvent Extraction / Vegetable Oil Refining and allied industries. The firm provides efficient engineering, technical and project management services for the process and related industries. These services include process development, technical evaluation studies, the design of plants, improvement and expansion of existing facilities, pollution prevention studies, energy conservation and staff training.

SERVICES

Provide turn-key projects services in the following fields:

- preparatory section
- solvent extraction plant
- neutralizing section
- bleaching section
- dewaxing section
- continuous deodorizing & physical refining (cpo)
- dry fractionation plant(for olein & stearin separation)

5. GA EXPERTISE, INC. (FLORIDA)

GA EXPERTISE, INC. Provides engineering and construction consultancy in plant design and upgrading. The company was established over 30 years ago and has been involved in the design, construction, and operation of oil mills worldwide, but especially in the Far East, Latin America, and Africa. The plants operate to ISO/9000 standards.

6. JDC GLOW COMMERCIAL, INC. (PHILIPPINES)

This company deals in new and used vegetable oil technologies and production units. They provide various processing equipment, such as oil seed extraction, oil seed refining, oil seed degumming, and oil seed bottling. Equipment is suitable for the following oil seeds:
Avocado, babaco, cotton seed, bilberry, borage, stinging nettle, beech nut, calendula, cashew nut, copra, sunflower, groundnut, spurge, rubber seed, rose hip, hemp seed, hazel nut, raspberry, elderberry, raspberry, blackcurrant, jojoba, coffee, cocoa, shea nut, coriander, pumpkin, linseed, maize germs, macadamia nut, almonds, melon seed, poppy seed, nutmeg, evening primrose, neern seed, niger seed, palm kernel, red pepper, brazil nut, passion fruit, pecan nut, rape seed, castor beans, mustard seed, sesame seed, soybean, sunflower seed, tropho plant, grape seed, walnut, citrus fruit kernels

USED EQUIPMENT

Buyers can purchase the following equipment on their website:

Extracting plant (oil mill for edible oil)	EUR 667.000
Edible oil processing plant EUR 1.450.000 to	EUR 2,350,000
Hydrogenated vegetable oil	US$ 95,000 to USD 1.900.000
75.000	
Vegetable oil refining unit with a capacity of 200 m tones/day	No price available
Used vegetable oil extraction and refining plant	USD 4.800.000
New vegetable oil screw press capacity 70 to 120 kg/h seed	EUR 28.900
New vegetable oil screw press cap. 120 to 200 kg/h seed	EUR 46.500
New KOMET oil extraction plant capacity 3 to 5 t/day	EUR 130.750
Vegetable oil Refining 120 to/day	EUR 389.000,

28, A. Ricarte St.
Las Piñas
Metro Manila
PHILIPPINES
Tel / Fax: 63 - 2 - 800 3128.
E-Mail: jdccntr@info.com.ph; jdc@ph.inter.net
Web: http://www.jdc-international.com

7. DE SMET (BELGIUM)

The De Smet Group (est. 1946), a world leader in extraction technology for fats and oil products, specializes in the supply of equipment and services to the Oil and Fat Industries. Based in Belgium, the group employs more than 500 people and operates in 27 languages, and boasts a turnover of more than 200 million US dollars (excess of 120 million Euros). The De Smet Name is well-respected all over the world, where it stands for experience, innovation, first class project management, customer service, and environmental protection. De Smet has supplied over 780 extractors, and De Smet equipment processes 40 raw materials, of which Soya beans, sunflower seed, rapeseed, groundnuts, cottonseed, and palm oil are probably the most popular. The company has also supplied small and large plants to some 1,500 oil millers. http://www.desmetextraction.com

8. SA FRACTIONNEMENT TIRTIAUX

This company specializes in the following processes:

Fractionation

Physical refining/Deodorizing

Degumming

Degumming & dewaxing

Interesterification

Batch Deodorizing

Bleaching

rue de Fleurjoux, 8

6220 FLEURUS

BELGIUM

Phone: +32-71-813787

Fax: +32-71-817024

Email: tirtiaux@tirtiaux.com

9. AGP HASTINGS (USA)

Started in 1983 as "Ag Processing Inc" a cooperative which adopted the corporate logo AGP® as its company trademark, AGP currently represents the fourth largest vegetable oil refiner in the United States.

Phone: (800)247-1345, (402)496-7809

Ag Processing Inc.

PO Box 2047

Omaha, NE 68103-2047

12700 West Dodge Road

Omaha, NE 68154

Web: www.AGP.com

Email: info@agp.com

10. OILTEK SDN BHD (Malaysia)

This company manufactures vegetable oil refining plants that conform to ISO9001 international standards and has clients in Bangladesh, China, Honduras, Indonesia, Kenya, Philippines, Thailand, Vietnam.

Lot 6 Jalan Pasaran 23/5

Kawasan MIEL, Phase 10

40000 Shah Alam

Selangor Darul Ehsan

Malaysia

Phone Number: 0355428288

Fax Number: 0355418288

Website: http://www.oiltek.com.my

Email Address: oiltek@oiltek.com.my

Contact Person: Mr. Wong Seong, Mr. Teh Pek Boon

11. PENNWALT INDIA, LTD.

Pennwalt India, LTD. was established in 1959 under the name Sharples Process Engineers(P) Ltd. It has worked in collaboration with Feld & Hahn,Gmbh,Germany, Wallace & Tiernan Division, Pennwalt Corporation, USA M/S Bredel, Netherlands and M/S Alois Gruber, Austria.

Products include:

- Super-D-Canter
- Vibrating Screens
- Super Centrifuge

Vegetable Oil Refining services include:

- Mineral oil purification
- Soya protein isolate & concentrate
- Safflower protein concentrate
- Fluoroplastic linings

• Hose pumps

• Chlorination equipment Pennwalt India Ltd.

D-221, MIDC, TTC

Thane Belapur Road,Nerul

Navi Mumbai 400706 ,India

Phone : 91 - 22 - 27632503 / 27632529 / 27632528

Fax : 91 - 22 - 27632560

Email: pennwalt@vsnl.in

Mr. Ashish Kashyap (Director)

Mobile: 9820080114

Phone: 91 22 55906630 (Direct)

12. GEBAFA GMBH (GERMANY)

This Germany based company is dedicated to bolster investments in energy and production facilities in sub- Saharan African countries by offering technical expertise as well as by financial and marketing assistance.

Gebafa provides turn-key projects with procurement, installation, testing and management services. They also offer financial assistance up to 50% of the essential mobile equipment. Gebafa also guarantees the successful start up of the production line they supply. Services are in the following areas:

• food processing

• photovoltaic systems; solar home systems (SHS)

• cosmetics and pharmaceuticals

• water supply

13. AUM CONSULTANCY

Aum Consultancy Pvt. Ltd. caters to various edible oil industries, chemical process industries and projects relating to specialty fats, essential oils and oleo resins, phytochemicals and herbal extractions, industrial enzymes, bulk drug units, etc. Aum works in agro oil extraction and refining, especially in the separation field for heat sensitive products and distillation for liquids and pastes. In the vegetable oil extraction line,

Aum has designed the unique Distillation System to distill oil from hexane, which improves the yield and saves in the subsequent refining process.

Aum was recognized as an internationally certified ISO 9001 company for its quality system in execution of design and turn-key projects.

Services are in the following areas:

- Conceptual Design & Process Engineering
- Feasibility Studies and Economic Evaluation
- Detailed Engineering, Design and Specification
- Equipment Fabrication and Procurement
- Construction and Installation Management
- Plant Commissioning and Troubleshooting
- Environmental Permitting Assistance & Adherence to International Standards.
- Market Development

Contact:

89 A,Santhome High Road

Chennai - 600 028

Telephone : + 91 (044) 24943826, 24957220, 24950664.

Fax : + 91 (044) 4951217.

E-Mail: info@aumicon.com