THE SHEA BUTTER VALUE CHAIN

REFINING IN WEST AFRICA

WATH Technical Report No. 3

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TABLE OF CONTENTS

EXECUTIVE SUMMARY V

1. INTRODUCTION 1

2. STATUS OF THE INDUSTRY 1
2.1 The Raw Material 1
2.2 Processing Potential 2

3. PROCESSING ACTIVITIES 3
3.1 Traditional and Semi-mechanized Processing 4
3.1.1 Curing 4
3.1.2 Extraction 4

3.2 Industrial Processing of Shea Nuts 5
3.2.1 Extraction 5
3.2.2 Refining 6
3.2.2.1 Degumming 6
3.2.2.2 Neutralization 7
3.2.2.3 Bleaching and Deodorizing 7
3.2.2.4 Fractionization 8

4. THE SHEA VALUE-CHAIN MATRIX 9

5.0 CONCLUSIONS AND RECOMMENDATIONS 11

ANNEX 1 MAJOR SHEA BUTTER REFINERIES 13

ANNEX 2 EQUIPMENT MANUFACTURERS & CONSULTANTS 16

ANNEX 3 INTERNET RESOURCES 24

ANNEX 4 PRO FORMA EQUIPMENT COST BENEFIT ANALYSES (US$) 28

LIST OF FIGURES

Figure 1 Flow Diagram: Traditional Shea Butter Processing 5
Figure 2 Flow Diagram: Industrial Shea Butter Extraction Plant + Refinery 6
Figure 3 Shea Value Chain Matrix 10

LIST OF TABLES

Table 1 Potential Shea Nut Processing in West 2
Table 2 Leading Global Refiners of Oils and Fats 3

EXECUTIVE SUMMARY

According to the Institute of International Tropical Agriculture, Africa produces about 1,760,000 metric tonnes (t) of raw shea nuts annually (IITA, March 2002) from its wild trees mainly in the Savannah and Sahel regions. Producers, however, harvest only a fraction, about 35% (about 600,000 t), which is then transformed into butter or exported as nuts.

The shea tree grows naturally in the wild of the dry Savannah belt of West Africa. Its range stretches from Senegal in the west to Sudan in the east, and into the foothills of the Ethiopian highlands. Shea trees thrive in 19 countries across the African continent.

Seven West African countries (Ghana, Burkina Faso, Benin, Cote d'Ivoire, Nigeria, Mali and Togo) produce a total of about 500,000 t of shea nuts. These countries export an estimated 270,000 t as raw nuts and convert the remaining 230,000 t into roughly 60,000 t of crude shea butter, half of which is later exported.

Shea Butter Production Processing and Technologies

In West Africa shea production, the process of extraction falls into 3 main categories: manual traditional, semi-mechanized (using hydraulic/screw presses) and fully mechanized industrial systems. The traditional method predominates. Rural-based women using manual traditional methods extract about 60% of all the crude butter produced in West Africa at an extraction rate of about 20%.

The semi-mechanized system of extraction utilizes appropriate technology to mechanize some of the unit operations of the manual traditional system. A nut crusher, a kneader or a hydraulic/screw press oftentimes complements the manual process and reduces drudgery of the traditional system. This semi-industrial method achieves extraction rates of 35-40%.

Mechanized processing in West Africa yields 30-40% of shea butter from raw nuts. Together, processing plants located in Mali, Burkina Faso, Togo, Benin, Ghana and Cote d'Ivoire have the capacity to convert 162,000 t of nuts into about 50,000 t of shea butter, at an extraction rate of 31%. More efficient, fully mechanized systems achieve extraction rates of between 42% and 50%. However, most of the exports of shea from West Africa consist of crude butter with virtually no significant refining (less than 1,000 t /per annum).

Four major players control the refining of shea in the world market: Aarhus United in Denmark, Fuji Oils in Japan, Karlsham in Sweden and Loders Croklaan in Holland, in order of the size of operation in oils and fats.

The processing of shea, in general, involves many activities that start soon after wild-harvesting, through refining to manufacturing. The major processes involve: curing, extraction, refining, fractionation and manufacturing.

The processing of shea starts with curing, which occurs soon after the picking of ripened wild fruits from the fields. Predominantly rural women do the wild harvesting and dry of the raw nuts in the ambient in- or outdoor air.

Extraction describes the process of removing oil/butter from seed and may rely on a totally manual system, or it may be partly mechanized with diesel or electricity powered attrition mills, crushers and kneaders. The industrial process uses state-of-the-art mechanical and chemical technology to obtain the highest yields and quality of butter, in terms of stability for extended shelf-life and suitability for industrial and food processing applications.

Shea Butter Refining

After the extraction of the crude shea butter, also known as "natural shea butter" or " bulk shea butter", there are various options for modifying or cleaning loosely described as refining. Every stage of refining takes natural ingredients, usually deemed unfit for human consumption, out of the butter. The process then introduces harmful refining chemicals as catalysts, which have to be removed at the end of the process by "re-refining".

Traditional and organic forms of processing hold an important market niche for the ever-increasing demand for pristine natural products. The four major processes for modifying or cleaning crude shea butter are: De-gumming, Neutralization, Bleaching, and Deodorization.

Economics of the Stages of Production

The different stages of shea processing introduce many different permutations of technology, scale, cost and efficiency. The lower end of nut curing tends to be highly labor-intensive and cheaper to set up. As the process moves toward the consumer, the technology and costs go up along with processing efficiency.

Set-up cost ranges from $200 for a 1.2 t per annum capacity, extracted manually, to about $19 million for a 50,000 t /year at the top end in a fully mechanized extraction/refinery system. A more detail feasibility study would generate more accurate figures.

Observations and Recommendations

- Industrial processing tends to alter the very true nature of shea, rendering it sterile and lifeless. However, that is what the markets buy, strengthening prospects of establishing a high-tech refinery to produce and supply to the existing market.
- In the long run, indications are that the market will opt for more natural and organic products. This may be the selling edge over other refined shea butter.
- West Africa's extraction plants are mechanized but not modern and efficient. Upgrading of existing plants may require heavy capital investments for equipment replacements. On the other hand, the cumulative production of about 40,000 t per annum from these plants is sufficient to feed a 50,000 t /yr capacity refinery.

- It will be advantageous to court existing West African extraction plants to be part of the scheme, as suppliers but also as equity partners. This sort of arrangement will ensure the commitment of raw materials to the refinery and open a sustainable market for the struggling extraction plants in West Africa.
- The numerous women's shea butter processing cooperatives should also be encouraged to become client suppliers, as well as shareholders in the proposed refinery plant. This arrangement will empower and strengthen the women's groups and enhance their commitment to the project, as well as enrich the rural poor.

Recommendations

A refinery plant, set up in West Africa, would serve both as a hub market for the region's crude shea butter and as an industrial strategy to control production and marketing of shea and its derivatives on the world market. Pending a more in-depth economic analysis, this author suggests that the plant be set up in Tema, Ghana for the following reasons:

1. Ghana is the leading shea export country in West Africa.
2. Tema is centrally located in the sub-region with sea and road linkages to the she producing countries.
3. Tema has the entire infrastructure needed for industrial production – reliable electricity, water and technical labor Tema is an industrial city and boasts a port facility for export.

The ideal scale for a West Africa refinery plant should be 50,000 t of butter per annum and should represent an integrated process with an extraction plant capable of converting 50,000 t of shea nuts into about 25,000 t of shea butter. This internal capacity would be augmented by supplies from the existing extraction plants and from artisanal women processors.

1. INTRODUCTION

This author identifies two major components and a third sub-component in the proposed supply chain analysis for the export promotion of both refined shea products and bulk shea butter to the US marketplace:

- Identifying the major supply side bottlenecks downstream from village-level collection and/or processing
- Understanding the US market elements of distribution chains, quality requirements, pricing and current and projected demand for shea butter within the natural beauty care industry and as a confectionary ingredient
- Defining the economic potential and opportunities for a commercial, state-of-the art refining of shea butter within West Africa, representing an adjunct to the first component. Currently, Europe transforms virtually all shea nut or unrefined bulk shea butter imports into an ingredient in natural beauty care products and chocolates.

This study forms the third sub-component, which this author expects to be combined with the two other components and integrated into a single comprehensive analysis, which would serve as a reference to the West African shea industry and to technical assistance providers.

2. STATUS OF THE INDUSTRY

2.1 The Raw Material

Africa produces about 1,760,000 t 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 t), for exportation as butter or nuts.(IITA, March 2002) The West African variety of shea, *Vitellaria paradoxa*, has been traditionally processed and locally used, as cooking oil or as butter for the skin and hair. A subspecies *nilotica*, found in northern Uganda and southern Sudan produces superior quality oil for the cosmetics industry, but is not found in food preparation or as a food ingredient.

2.2 Processing Potential

The shea tree grows naturally in the wild Savannah belt of West Africa, from Senegal in the west to Sudan in the east, and into the foothills of the Ethiopian highlands, as well as in 20 countries across the African continent: Benin, Ghana, Chad, Burkina Faso, Cameroon, Central African Republic, Ethiopia, Guinea Bissau, Cote D'Ivoire, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo Uganda, Zaire, Guinea and The Gambia. Seven West African countries (Ghana, Burkina Faso, Benin, Cote d'Ivoire, Nigeria, Mali and Togo) produce about 500,000 t of shea nuts, of which an estimated 270,000 t are exported as raw nuts. Processors converted the remaining 230,000 t into roughly 60,000 t 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 of about 20%,. The table below shows the installed and estimated capacity utilization of processing plants in the sub-region. Mechanized processing, increasing seen in the region, yields 30-40% shea butter from raw nuts. Together the processing plants listed below show the capacity to convert 162,000 t of nuts into about 50,000 t of shea butter, assuming an on average estimated extraction rate of 31%. However, most of the West African plants produce at less than 25% of their installed capacity, perhaps because any plants operate for only 6 months of the year to offset the high cost of storing raw nuts throughout the year.

Table 1. Potential Shea Nut Processing in West Africa (Tonnes/Year[1])

Country	Processing Plant	Installed Input (t)	Capacity Utilization (t)*	Capacity Utilization (%)
Mali	Huicoma	25,000	6,000	24%
	Sika	25,000	6,000	24%
Burkina Faso	Citec	15,000	3,750	25%
	Sofib	15,000	3,750	25%
Togo	Nioto	15,000	3,750	25%
Ivory Coast	Trituraf	10,000	2,500	25%
Ghana[2]	West African Mills	10,000	2,500	25%
	Juaben Oil Mills	12,000	6,000	50%
	The Pure Company* (2005)	10,000	0	0%
	Ed Oils	5,000	500	10%
	Bosbel Oil Processing	5,000	500	10%
Benin	Sinocog Bohicon	10,000	2,500	25%
	Sonicog Cononou	5,000	1,000	20%
TOTAL		**162,000**	**38,750**	**24%**

Sources: TechnoServe, industry contacts by consultant, and Communiqué de Presse from the Embassies of Burkina Faso and Mali.

[1]Given in metric tons on dry kernel

[2] Details not available on the Savelugu Mill (product name Sheaba)

Although the Food and Agriculture Organization of the United Nations (FAO) reports that Nigeria produces about 355,000 t of West Africa's crop, official export statistics from Nigeria are not available. In addition, producers export a large but unreported quantity of Nigerian shea nuts through neighboring Benin. Ghana produces about 55,000 t of shea nuts and exports about 40,000 t of nuts annually, making it the leading exporter in the sub-region. Most shea exports consist of crude butter, as virtually no significant refining (i.e., greater than 1,000 t /pa) 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. (See ANNEX 2 for profiles of these companies.) The table below 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 & oils operation, which form just 33% of the larger consolidated Fuji Oil Group.

Table 2. Leading Global Refiners of Oils and Fats (including shea) 2002/03

COMPANY	ANNUAL SALES (in US$ million)	NUMBER OF EMPLOYEES
Aarhus United	**690**	**1700**
Fuji Oil (fats&oils)	**450**	**1100**
Karlsham AB	**420**	**800**
Loders Croklaan	**260**	**600**

3. PROCESSING ACTIVITIES

Most often West Africans use three different methods for the processing of shea butter: traditional manual processing, semi-mechanized (using hydraulic/mechanical presses) and fully mechanized industrial methods. The processing of shea, in general, involves many activities that start soon after wild-harvesting advancing the process through refining to manufacturing. Workers mainly use curing, extraction, refining, fractionation and manufacturing in the shea refining process. (See Figure 1). The traditional and semi-industrial methods usually stop after extraction, while the industrial process covers the whole gamut of activities from extraction to fractionation. Medium- to large-scale food and cosmetic industries complete the final stage of product manufacturing, using the derivatives of processing. This report, while looking at the entire chain, focuses on the fully mechanized, industrial processes, which begin after curing.

3.1 Traditional and Semi-mechanized Processing

3.1.1 Curing

The processing of shea starts with curing, begun soon after the harvesting of ripened, wild fruits, a task performed predominantly by rural women. This manual process involves the following: de-pulping the fruit, boiling it, sun-drying the nuts, cracking the shells to remove the kernel, sun-drying the kernels again and finally storing the kernels until they are sold or further processed. The process stabilizes the nuts for more than a year, if they are stored in a dry, aerated room.

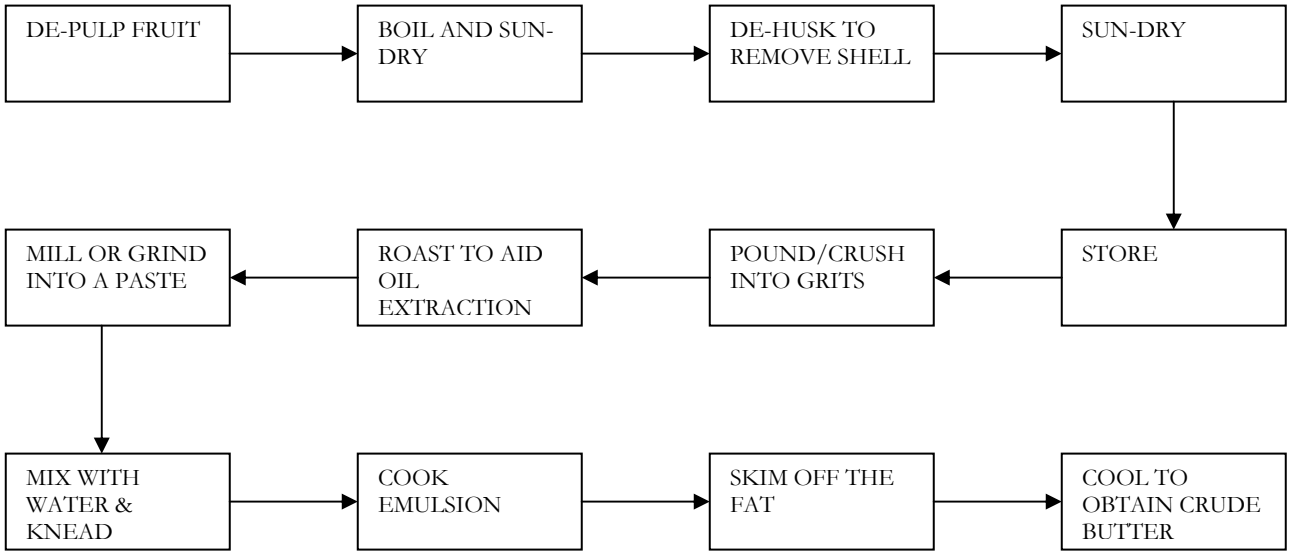
3.1.2 Extraction

Extraction, the process of removing oil/butter from the shea seed, may involve a totally manual system or be partly mechanized, through the use of diesel- or electrically-powered attrition mills, crushers and kneaders. The continued production of butter from dried shea nuts using manual traditional techniques proves tedious, labour-intensive and inefficient. This demands large quantities of water and wood fuel and creates a significant drain on scarce resources in the semi-arid areas where shea grows. The processing input of 18.5 kg of raw shea nuts requires 48 kg of wood and 67 litres of water. Currently, semi-industrialized processes develop alongside traditional methods in the shea producing areas of Mali and Burkina Faso, where 80% of the butter is made traditionally. This situation reflects trends in other countries throughout the sub-region.

The manual process used by rural women continues as it has for generations. In the labor- intensive method women pound the kernel with pestle and mortar to break the seed into grits, roast the kernel to facilitate easy extraction of the butter or fat and grind the grits into a paste. The women continue the process by kneading the paste in water to capture the fat into an emulsion, boiling the mixture to separate the fat and skimming off the fat. The final cooling process leads to shea butter.

The flow chart on the next page illustrates the processes.

Figure 1. Flow Diagram: Traditional Shea Butter Processing



Source: John Addaquay

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. Each of the above-noted process activities, once mechanized improves efficiency to 35-40%. Recently, small-scale machines, such as roasters, milling machines, kneaders and boilers, have been introduced in an attempt to minimize or eliminate the drudgery of traditional manual methods.

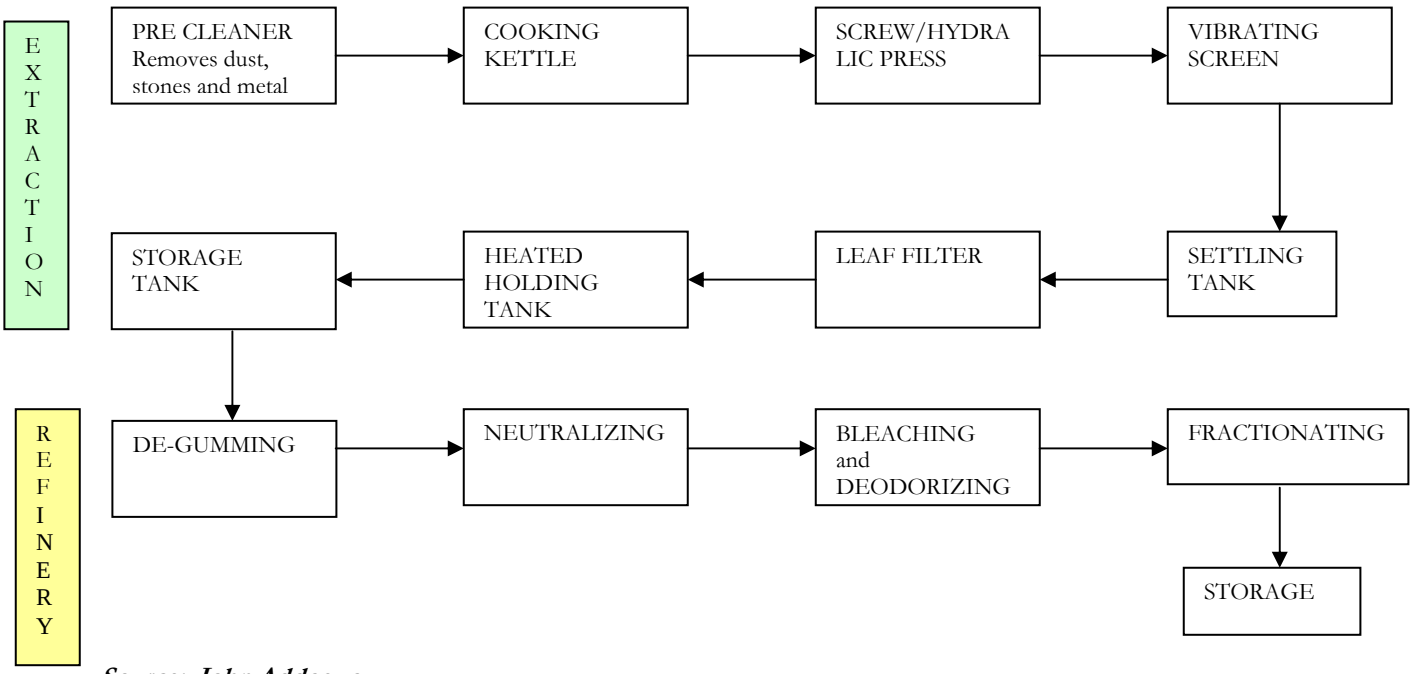
3.2 Industrial Processing of Shea Nuts

3.2.1Extraction

The industrial process uses 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 computerized systems. For large-scale plants, producers add a refinery to the extraction plant. The following chart shows the flow in the industrial extraction plant combined with a refinery.

Figure 2. Flow Diagram: Industrial Shea Butter Extraction Plant + Refinery



Source: John Addaquay

3.2.2 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, industrialized, extra refined, ultra refined, etc.

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

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

Gums in edible vegetable oil must be removed to avoid color 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.

3.2.2.2 Neutralization[3]

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 neutralization results in enhanced effectiveness of subsequent steps, such as bleaching, deodorizing and furthermore, results in high yields of a quality product. Neutralization also aides in the removal of phosphatides, removal of free fatty acids, mineral and color bodies.

Neutralization (refining) occurs by the mixing crude butter/oil with a water solution of sodium hydroxide at about 66-77 degrees Celsius. Some plants use sodium carbonate or potassium hydroxide. The alkali reacts with the free fatty acids to form soap, which is an important byproduct 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.

3.2.2.3 Bleaching and Deodorizing

The neutral, washed and dried vegetable oil still contains some color 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 degrees Celsius, which is later agitated and filtered to remove the clay. High temperature drives moisture from the clay (Fuller's Earth), 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 and operates 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.

Deodorization represents the last major processing step in refining of edible oils and removes the compounds that cause undesirable odor, flavor and color. Deodorization 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 specialized process uses a type of steam distillation under high vacuum to remove objectionable volatile components, such as ketone, 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 deodorized oil. Deodorization

[3] Shea producers in the U.S. call the neutralization process "refining," which leads to misunderstanding among the users who use "refining" to describe the entire process.

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 falling film deodorizer. The oil descends counter-current to the stripping steam in the form of a very thin film and becomes completely deodorized. 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 deodorized 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 flavor, odor, minerals and vitamins.

3.2.2.4 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.

4. THE SHEA VALUE-CHAIN MATRIX

The different stages of shea processing introduce many different permutations of technology, scale, cost and efficiency. The lower end of nut curing tends to be highly labor-intensive and less expensive to set up. As the process moves toward the consumer, the process becomes more complex and costs go up exponentially, as so does yield efficiency.

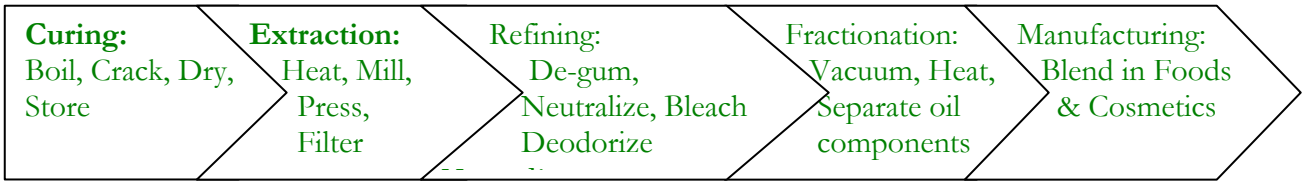
At the high end of the spectrum, the set-up cost reaches an estimated $7 million for a 20,000 t/year extraction cum refining facility. A larger plant in this category, producing 50,000 t/annum, will cost about $19 million to set up (See ANNEX 3). These plants resemble those used by the major processing plants in Europe and the Far East.

More detailed plant specifications from equipment vendors and processing consultants allow for more realistic pricing. Many vegetable oil equipment manufacturers, suppliers and processing consultants provide needed services worldwide for such ventures and should be consulted for detailed advice and firmer quotes once producers determine the scale of intervention. See ANNEXES 3 and 4 for profiles and addresses of such service and equipment providers.

Figure 3 provides a matrix of the interplay and inter-relations in the shea value chain. It also shows the different scales of operation in the value chain and the indicative set-up cost.
ANNEX 5 explains an equipment pro-forma for the various levels of production. Set-up cost ranges from $200 for a 1.2 t per annum capacity, traditional manual extraction method to about $19 million for a 50,000 t/year, top end fully mechanized extraction/refinery system. A more detail feasibility study needs to be conducted to arrive at more accurate figures.

Figure 3. Shea Value Chain Matrix

PROCESSES:



Product	Raw Nut	Raw Butter,	Dehydrated/ Bleached/ Deodorized oil or butter.	Olein – oil and Stearin - butter	Foods: Chocolates, margarine Cosmetics: hair and skin formulations
Type of Producers	Rural Farmers Mainly women	Rural Farmers Med/Large Scale Firms	Medium/ Large Scale firms	Large scale refineries – usually combined with extraction and refinery	**Chocolate:** Medium/large **Cosmetics:** Small/Med/ Large processors
Technology Small Scale (1-100 t nuts per year) :	Traditional manual Est. Set up Cost: <$100-800 per t	Traditional manual <$200-800 per t Mechanized Traditional $150-700 per t			Crude butter sold as food oil and also as skin cream locally. Some processors are processing, blending and packaging as skin creams and soaps in urban shops. <$1-2,000- per t ?
Technology Medium Scale (100-10,000 t per year)		Mechanized: Using mills, presses and filters. Start-up Cost $150,000- $2,000,000	COMBINED EXTRACTION & REFINERY Star-up Cost: $1,000,000 – $1,500,000		Medium scale food and cosmetics companies using both refined and crude oils. Supplying specialty shops e.g. Body Shop.Start-up Cost: $200,000 - $2,000,000
Technology Large Scale (Over 10,000 t per year) **Source:**		COMBINED EXTRACTION & REFINERY High-tech machinery, automated, computerized. E.g. Aarhus, Fuji Oil			Mainstream Brand-name manufacturers e.g. Cadbury's, Avon Start-up Cost: >$5,000,000

5.0 CONCLUSIONS AND RECOMMENDATIONS

Industrial processing tends to alter the very true nature of shea, rendering it sterile and lifeless. However, demand exists, and therefore prospects, for establishing a high-tech refinery to produce and supply to the existing market. In the long run, the market will likely opt for more natural and organic products. This author therefore advises that any longer term intervention into processing should consider the use of organic methods of refining, and more importantly, purification processes, which would leave the 'refined' shea butter as a true natural product. This may represent the selling edge over other refined shea butter. However, the feasibility of this strategy requires further market investigations.

West Africa's extraction plants, while mechanized, are not modern and efficient. Extraction rates (31%) barely reach above those from semi-mechanized plants. Modern plants can extract 42-50% of oil from shea nuts. Upgrading existing plants may require heavy capital investments for equipment replacements. On the other hand, the cumulative production of about 40,000 t per annum from these plants is sufficient to feed a 50,000t/yr capacity refinery. Such a refinery can produce at levels high enough to compete effectively in Europe and the US, because of locational advantage, cheaper labor and access to the raw material. It will prove advantageous to involve existing West African extraction plants in this scheme, both as suppliers and as equity partners. This sort of arrangement will ensure the commitment of raw materials to the refinery and open a sustainable market for the struggling extraction plants in West Africa.

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

This author recommends that a refinery plant be set up in West Africa to serve as a hub market for the region's crude shea butter, and additionally as an industrial strategy to control production and marketing of shea and its derivatives on the world market. Pending a more in-depth economic, the port of Tema, Ghana represents an excellent location option for the following reasons:

- Ghana exports more shea than any other country in West Africa.
- Tema is centrally located in the sub-region with sea and road linkages to the shea producing countries.
- As an industrial city, Tema has all the infrastructure need for industrial production – reliable electricity, water, technical labor and a port facility for export.

Ideally, a West Africa refinery plant would produce 50,000 t of butter per annum. The plant would use an integrated process with an extraction plant capable of converting 50,000 t of shea nuts into about 25,000 t of

shea butter. This internal capacity would be augmented by supplies from the existing extraction plants and from artisanal women processors.

A complete country comparative study would evaluate the above conclusions. Actual capacity, production and commitment of the existing plants need to be ascertained first hand through visits and a production audit before any conclusions can be made definitively. The scope and budget for this study did not cover such scrutiny, as there was virtually no budget for travel, even within Ghana.

Many vegetable oil equipment manufacturers, suppliers and processing consultants provide detailed advice and firmer quotes for such ventures and should be contacted when the scale of intervention is determined. This author recommends two consultants, Mr. Wolf Hamm, UK and Mr. Alex Owusu, MD Juaben Oil Mill, as reputable experts for use in further studies.

ANNEX 1 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 30 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

ANNEX 2 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)

2. 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

12. 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)

10. 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

14. MR. WOLF HAMM - CONSULTANT[4]

Senior Chemical Engineer specializes in food processing. The industry recognizes Mr. Hamm as a authority on edible oil production (crushing, solvent extraction) and oil processing, margarine and spreads, and processing of dairy products, including ice cream and yoghurt.

Date of Birth:	31 July 1928
Nationality:	British
Languages:	Fluent in German and Dutch, basic French, basic Russian (mainly reading).
Qualifications:	Graduated from Chemical Engineering University of the Witwatersrand, Johannesburg, 1949. Mr. Hamm holds the title of chartered engineer in the UK.

Institutes & Affiliations:

Fellow, Institution of Chemical Engineers
Member, American Oil Chemists Society
Member, Society of Chemical Industry

[4] No contact details were available on the Internet for vegetable oil processing engineer Wolf Hamm

Current Position at CWA

Wolf Hamm works as an external consultant with the CWA Food Technology Department.

Work Experience

Mr. Hamm has worked extensively in various aspects of oil production (crushing, solvent extraction) and the processing of edible oil in South Africa, UK, Holland and Malaysia, margarine and spreads processing in the UK and South Africa, and processing of dairy products, including ice cream and yoghurt. His more recent experience has included processing of butterfat and palm/palm kernel oil, market studies in the oleo-chemicals field and work on the possible use of edible oil in non-edible applications.

Projects undertaken include:

- Analysis of performance of edible oil refinery
- Fat fractionation process assessments for vegetable oil and butterfat processors
- Study of process equipment used for cold pressing of oils
- Assessments of scope for improved process control and management information systems in food processing
- Study of oleo-chemicals production and the marketing needs of S.E Asian oleo-chemicals producers

Mr. Hamm's consultancies in the UK, mainland Europe, USA, SE Asia, New Zealand and India, have covered a number of engineering fields, including edible oil production and processing (refining and fractionation), pharmaceuticals processing, food, oleo-chemicals and novel uses of vegetable oils. Additional clients include the United Nations, Bangkok. Leatherhead Food RA , Aarhus, Denmark, Unilever Research in the UK and Holland.

ANNEX 3 INTERNET RESOURCES

NAME	DESCRIPTION	ADDRESS	TELEPHONE	EMAIL
Fuji Oil Group. :.	Processors of fats & oil Imports shea nut and butter	1-5, Nishi Shinsaibashi 2-chome, Chuo-ku Osaka 542 JAPAN Kuhlmannlaan 36 9042 Gent Belgium (US subsidiary) 120 Brampton Road Savannah, GA 31408 USA	Tel: +81-724-631364 Fax +81-724-631601 Tel : + 32 (0) 9 343 0202 Fax : + 32 (0) 9 344 2610 Tel: +1(912) 966-5900 x 315 Fax (912) 966-6913	www.fujioileurope.com www.fujioil.co.jp fvo_finance@gapcdr.com
IOI Group (Loders Croklaan)	Processors of fats & oils Imports Shea nut and butter	Level 8, Two IOI Square IOI Resort, 62502 Putrajaya Malaysia Hogeweg 1 P.O. Box 41520 AA Wormerveer THE NETHERLANDS	Tel : +60 3 8947 8668 Fax : +60 3 8943 2899 Tel. +31-75-6292911 Fax +31-75-6292421	www.ioigroup.com www.croklaan.com

Aarhus United A/S	Processors of fats & oils Imports shea nuts and butter	M. P. Bruuns Gade 27, DK-8000 Arhus C, Denmark	Tel: +45 87 30 60 00 Fax: +45 87 30 60 44	dk.sales@aarhusunited.com URL: www.aarhusunited.com
Karlshamns AB	Processors of fats & oils Imports shea nuts	, 374 82 Karlshamn Sweden	Tel : +46 454 82 137 Fax : +46 454 82 839	www.karlshamns.se mh@karlshamns.se
Westfalia Germany	Equipment manufacturer			
Technochem International, Inc.	Equipment Manufacturer	3320 Goldenrod Circle Ames, IA 50014 USA	Tel: +515 292 2891 Fax: +515 292-5572	technocheminc.com
Troika India	Equipment Manufacturer	6th Floor, Embassy Centre, Nariman Point, Mumbai-400 021.India.	Tel: +91 22 2834429, 2834334, 2834515 Fax: +91 22 282 3778	troika@vsnl.com
Glamptech India				
GA Epertise, Florida				
JDC International:		28, A. Ricarte St., Las Piñas, Metro Manila / PHILIPPINES	Tel / Fax:+ 63 2 800 3128	jdccntr@info.com.ph; jdc@ph.inter.net Web: http://www.jdc-international.com

OILTEK SDN BHD	Equipment Manufacturers	Lot 6 Jalan Pasaran 23/5, Kawasan MIEL, Phase 10, 40000 Shah Alam, Selangor Darul Ehsan. Malaysia	Tel: +35 542 8288 Fax:+35 541 8288	oiltek@oiltek.com.my Website: http://www.oiltek.com.my
Pennwalt India Ltd,		D-221, MIDC, TTC, Thane Belapur Road,Nerul, Navi Mumbai - 400706 , India	Tel: 91 222 763 2503 / 276 32529 / 276 32528 Fax+91 22 276 32560	pennwalt@vsnl.in
Mr. Wolf Hamm	Consultant			
SA FRACTIONNEMENT TIRTIAUX :		rue de Fleurjoux, 8 6220 FLEURUS-BELGIUM	Tel: +32 71 813 787 Fax: +32 71 817 024	tirtiaux@tirtiaux.com
De Smet, Belgium	Equipment Manufacturers			http://www.desmetextraction.com
The Shea Butter Company, Ltd.	Cosmetics Processing & Retail	16781 Torrence Avenue Lansing, IL 60438 USA	Tel:+877 489 2700 (toll free) Fax +708 481-3144 or +877 489 9917 (toll free)	trivers@naturalessence.com

AFAJATO, Inc.	Shea Butter Importer & Distributor	6455 E. Briar Drive Lithonia, GA 30058 USA	Tel: +770 482-4451 Fax +770 413 6389	afajato@aol.com
D2E	Buys refined shea butter for to manufacture cosmetics	202, rue de la Croix Nivert 75015 Paris FRANCE	Tel: +33 1 537 85858 Fax +33 1 537 85850	
EXA Cosmetics	Buys shea butter for cosmetics manufacture	112 rue de Lagny 93100 Montreil FRANCE	Tel: +33 1 428 79698 Fax +33 1 48708870	
Aarhus Olie Côte d'Ivoire (subsidiary of Aarhus Oliefabrik A/S, Denmark)	Processing shea butter	Résidence de la Tour B.I.A.O 8-10 rue Joseph Anoma (entrée avenue Lamblin) Abidjan 01 BP 1730 COTE D'IVOIRE	Tel: +225 327052/53 Fax +225 327055	ghb@africaonline.co.ci
Euro broker	Broker in tropical nuts	30, rue d'Astorg 75008 Paris FRANCE	Tel: +33 1 449 48787 Fax +33 1 400 60313	michael@eurobroker.fr
Agritropic s.a.r.l.	Aahus agent	Rue des Moulins 43100 Vieille-Brioude FRANCE	Tel: +33 4 717 49790 Fax +33 4 717 49282	sla@africaonline.co.ci
Brittania Food Ingredients Ltd.	Raw materials supplier for Cadbury's UK	Goole DN14 6ES UK	Tel. +44 1405 767 776 Fax +44 1405 765111	office@britfood.demon.co.uk

ANNEX 4 PRO FORMA EQUIPMENT COST BENEFIT ANALYSIS (US$)

TECHNOLOGY	CAP/YR (t)	EQUIPMENT	PRICE	INPUT COST	OVERHEAD	TOTAL COST	YIELD t	PRICE per t	REVENUE per year	BREAKEVEN YEAR
EXTRACTION										
Traditional Manual	1.2	Cooking pots	40							
		Mortar & Pestle	10							
		Pans	20							
		Total	**70**	130	13	**213**	0.24	800	**192**	2nd Year
Mechanized Manual	30	Roaster	100							
		Shed	1,200							
		Mill	600							
		Cooking Pots	100							
		Total	**2,000**	3,261	2,772	**8,033**	9	900	**8,100**	1st Year
Mechanized	10,000	Pre Cleaner	5,000							
		Cooking Kettle	20,000							
		Screw Press	85,000							
		Vibrating Screen	30,000							
		Leaf Filter	40,000							
		Tanks	25,000							
		Building	50,000							
		Total	**255,000**	1,086,957	923,913	**2,265,870**	3,000	900	**2,700,000**	1st Year
EXTRACTION + REFINERY										
Medium Scale	20,000	Pre Cleaner	12,000							
		Cooking Kettle	35,000							
		Screw Press	150,000							
		Vibrating Screen	55,000							
		Leaf Filter	80,000							
		Tanks	50,000							
		Building	120,000							
		Special Tanker	100,000							
		Refinery Plant	500,000							
		Total	**1,102,000**	3,260,870	2,771,739	**7,134,609**	4,500	1,100	**4,950,000**	2nd Year

Large Scale	50,000	Pre Cleaner	40,000							
		Cooking Kettle	120,000							
		Screw Press	350,000							
		Vibrating Screen	150,000							
		Leaf Filter	220,000							
		Tanks	100,000							
		Building	250,000							
		Special Tankers	200,000							
		Refinery Plant	2,500,000							
		Total	**3,930,000**	8,152,174	6,929,348	**19,011,522**	16,875	1,100	**18,562,500**	2nd Year