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Economics of alternative technologies of industrial processing of soybean into oil and feedcake in Nigeria

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ECONOMICS OF ALTERNATIVE TECHNOLOGIES OF INDUSTRIAL PROCESSING OF SOYBEAN INTO OIL AND FEEDCAKE IN NIGERIA

M.Sc. THESIS

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CERTIFICATION

This is to certify that this study was conducted and reported by Mr. Edamwen Monday Omoregie under our supervision and has been approved as partial fulfilment of the requirements for the award of Master of Science (M.Sc.) degree in Agricultural Economics of the University of Ibadan, Ibadan, Oyo State.

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DEDICATION

This research work is dedicated to God Almighty for all His love, protection and providence;

My mother, Late Madam Margaret Imuentinyan Omoregie and

My father, Mr. J.E. Omoregie, a strong advocate of western education.

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- Edamwen (1991)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (contd.)

ABSTRACT

The research project, conducted in 1991, examines the economics of industrial processing of soybean into oil and feedcake under alternative processing technologies namely Screw press, Hard press and Solvent extraction methods. Three (3) soybean processing mills of different scales of operation and oil extraction methods were covered in the study. These are Oja Farms Limited (Vegetable oil mill), Kofa Vegetable Oil Mills Ltd (Hard press) and Taraku Mills Ltd (Solvent extraction). Data on economic aspects of the different processing methods were collected through structured and unstructured questionnaires administered by the researcher in a number of visits to the Oil Mills. The data were collated and analysed using a variety of analytical techniques namely Marginal Analysis, Profit and Loss Account, Correlation Coefficients, Analysis of Variance (ANOVA), Coefficient of Variation (C.V), Hellwing's Variable Classification Technique, Projections, Graphical and Tabular analyses.

The data and analyses reveal that capacity utilisation levels across the three mills are very low ranging from 15% in Screw press, 16.1% in Hard press and 29.2% for Solvent Mill. Oil extraction efficiencies also differ among the mills from 31% in Screw press, 67% for Hard press and 94.4% for Solvent Mill. The three (3) mills are profitable in the processing of soybean into oil and feedcake based on 1989/90 figures at the gross margins of ₦434.6, ₦651.60 and ₦610.03 per tonne of soybean for Screw press, Hard press and Solvent mill respectively. Gross sales per tonne of soybean for Screw

press, Hard press and Solvent mill are ₦4271.26 ₦3935.81 and ₦2549.74 respectively. However, Oil sales per tonne is highest for Solvent mill at ₦1128.22, and ₦1068.,75 for Hard press and ₦687.50 for Screw press while cake/meal sales per tonne of soybean is highest for Screw press (₦3597.38), followed by Hard press (₦2856.00) and lowest at Solvent mill (₦1645.71).

The cost structure of the mills reveals that total variable cost (TVC) per tonne of soybean is lowest for Solvent extraction mill (₦185620) and the values for Screw press and Hard press are ₦4236.44 and ₦3284.20 respectively. On the other hand, total fixed cost (TFC) and administrative costs per tonne are highest for Solvent mill at the respective values of ₦393.70 and ₦154.18; the corresponding values for Screw press and Hard press are ₦185.87 and ₦19.20 and ₦123.27 and ₦10.50 respectively. The total cost (TC) per tonne is highest for Screw press (N4022.31) and is ₦3407.48 for Hard press and ₦2301.21 for Solvent mill. On financial management, Solvent mill has the highest administrative expense ratio, an indication of the highest administrative cost per tonne of soybean. However, it has the highest asset coverage ratio, a measure of the credit worthiness. But Screw press and Hard press had better performances in terms of profitability measures with return on sales of 25.54% and 28.5% and return on assets ratios of 32.67% and 43.60% respectively. The respective values for Solvent mill are 18.54% and 4.52%.

At the projected capacity utilisation levels of 1000; 11250 and 62,500 metric tons respectively for Screw press, Hard press and

Solvent mill at full capacity utilisation for 250 days, the mills are still profitable. TVC and TC per tonne decreased by ₦1150.84 and ₦886.83 for Screw press and ₦465.60 and ₦560.61 for Hard press respectively whereas the gross sales per tonne also decreased but at lower values of ₦203.76 and N9.28 for Screw press and Hard press respectively. On the other hand, TVC and TC increased by ₦1322.41 and ₦1129.72 per tonne respectively for Solvent mill and the gross sales and gross margin had more than proportionate increases of ₦1936.04 and ₦613.13 per tonne respectively. These trends suggest that Screw press and Hard press attained higher cost effectiveness and efficiencies at the projected utilisation capacities. However, since the gross sales per tonne decreased for both mills, they must be operating at the stage III (irrational stage) of the production function hence it is advisable that these mills reduce their mill utilisation capacities below the projected levels inorder to attain economic efficiencies (economic optima). Reversely, Solvent mill needs to increase its capacity above the projected level of 62,500 metric tons since the installed capacity is 72,000 metric tons annually.

Most of the processing cost and return parameters per tonne did not show significant differences across the mills except TVC per litre, TFC per tonne of soybean, TC per litre of oil and administrative cost per tonne of soybean. Also asset coverage ratio is significantly different across the three mills whereas the profitability and efficiency measures are not significantly different across the oil mills. These cost and return parameters were found to be highly dependent with high correlation coefficients. Hellwing's (1974)

classification technique showed that mill utilisation capacity, installed mill capacity, oil extraction efficiency, total cost per tonne and others are "compact" or core variables in determining the performance of the oil mills.

The problems of the mills include inadequacy of raw soybean, especially during the off-season, coupled with off-seasonal price hikes; inadequacy of working capital as well as low demand for the soya cake/meal. It is therefore recommended that governments and private agencies should be involved in financing soybean processing since it is highly profitable and capable of generating foreign exchange earnings. Also, the mills should devise better cost management techniques such as contractual purchasing arrangement and portfolio diversification and vertical integration with livestock ventures so as to ensure adequate market for the soya cake/meal.

CHAPTER ONE

1.0 INTRODUCTION

Soybean is a tropical crop but its proportion in an average Nigerian diet is still relatively minimal inspite of its nutritional advantages over all known plant-protein sources. This is because its inclusion into the Nigerian farming system is, indeed, very recent. The first successful cultivation was in 1937 with the Malayan variety, which was found suitable for commercial production in Benue State (Nyiakura, 1982). Since then many small scale farmers in this area of south-central Nigeria have incorporated soybean in their cropping system. (Root, Oyekan and Dashiell 1985). Other minor areas of production are in southern Kaduna State, Federal Capital Territory (Abuja) and adjacent Niger State. Also large scale farmers, particularly in the guinea savannah, on the Jos Plateau and in the derived savannah of Oyo State, have recently become interested in the prospect of soybean production (Root, Oyekan and Dashiell, 1985).

Soybean, the "golden bean", "God's sent golden bean" offers the best potential as a protein supplement from the nutritional point of view. Domestically, soybean is used as "Dawa dawa" (a local soup flavouring paste); soy milk, soy cakes etc are also obtained from soybean locally. The industrial uses in Nigeria include soybean meal (as animal feed component) and oil. However, its production thus far has failed to keep pace with demand in Nigeria. Higher price could lead to increased production, since the crop is well suited to the

climatic conditions and soils of the middle belt, where there is land available for its expansion (Obeya, 1988).

In a similar note, Shannon (1983) opined that the general climatic conditions of the southern guinea zone appear to be satisfactory for soybean production. The failure of local supply to keep pace with the demand for soybean has been attributed to two main factors, among others, namely:

i) the low yields obtained by Nigerian farmers, and
ii) the lack of attention commercial processing of the crop (Obeya, 1988).

The contention is that if both factors are attended to the full potential of soybean in Nigeria will be realised.

The production and utilization of soybeans are attracting national and continental attention, both industrially and domestically. In the words of Singh and Rachie (1987) *"recognising the key role of soybeans in national agriculture, especially for production of animal feeds and cooking oils, several subtropical and tropical countries have introduced this crop and have made determined efforts to adapt it to local conditions and needs".*

Nigeria and India with well-defined food preferences have developed several local dishes from both unprocessed and processed soybeans. Thus soybeans have become established as a market commodity in the growing regions of these countries (Singh and Rachie 1987).

In Africa, the estimated potential yields of soybeans for some selected African countries, including Nigeria, are considerably below

the average yields for all cereals and for maize. This is summarized in the table below:

Table 1.1: Comparison of estimated soybean yields (kg/ha) with recorded yield (kg/ha) of other selected crops in some African countries.

Country	All Cereals	Maize	Sorghum	Groundnut	Soybean
Algeria	599	500	2,500	-	355
Egypt	4,328	4,500	-	1,929	2,617
Nigeria	675	877	530	867	334
Zaire	821	835	714	711	1,092
South-Africa	1,178	1,302	899	419	948
Ethiopia	1,210	1,691	1,262	939	602

Source: FAO year-book, 1985.

Implicit in the table is that Nigeria's adventure in the production and utilization of soybean is greatly plaqued by the incessantly low yield, estimated at about 334 kilograms per hectare, compared with an average world yield of about 1,833 kilograms per hectare (FAO, 1986).

Nigeria's export-import situations vis-a-vis soybean products (soybean oil and soybean cake and meal) show the same negative trend as most other African countries. This is succintly demonstrated, and infact, depicted in Tables 2 and 3 below, with Nigeria having net exports of 21,000 metric tons and 47,767 metric tons of soybean cake and meal and soybean oil respectively.

Table 1.2: Trade (tonnes) in oil cake and meals (1982-84) for Nigeria and selected African countries.

	Oilseed cake and meal			Soybean cake and meal		
Country export	Import	Export	Net exports	Imports	Exports	Net
Nigeria	25034	36280	11246	21000	-	-21000
Egypt	150729	3850	-146879	150729	-	-150729
Zimbabwe	3237	6999	3762	-	5070	5070
South-Africa	130825	394000	263175	86334	-	-86334

Source: FAO Trade year-book 1984, 1985.

Table 1.3: Trade (tonnes) in soybeans and soybean oil (1982-84) for Nigeria and selected African countries.

	Oilseed cake and meal			Soybean cake and meal		
Country export	Import	Export	Net exports	Imports	Exports	Net
Nigeria	-	-	-	47767	-	-47767
Egypt	29078	-	-29078	44594	-	-44594
Zimbabwe	57	-	-57	2745	-	-2745
South-Africa	3536	-	-3536	9858	-	-9058

Source: FAO Trade year-book, 1984, 1985.

It is, however, worthmentioning at this juncture that the federal government ban on imports of edible oil (1986) is providing incentives for the production of soybeans locally (Weingartner, 1985). Consequently, increases in soybeans production have led to increased processing of soybeans into soya cake and soya oil, which if produced in large quantities, possess immense export potentials.

1.1. Problem definition

Nigeria's bid to be a self-sufficient nation in food production towards feeding her bourgeoning population and a major exporter of agricultural products is landmark. While the production and utilization of energy foods have recorded huge successes, at least, relatively, the case for the protein and oil soruces is dismally devoid of appreciable success. Granted that animal protein sources are generally expensive, especially in the developing countries (Nigeria inclusive), plant protein - sources seem the cheaper and ultimate products for the attainment of human and livestock protein requirements.

In Nigeria, an elaborate research and production system exist for plant protein and oil sources notably cowpeas, palm kernel, groundnut, pigeon pea, sunflower and of recent, soybean. The commercial production of soybean in Nigeria though recent, is becoming increasingly widespread among farmers especially in the middle belt states culminating in increasing output. Research efforts on the improvement and production aspects are also extensive, especially in institutions of higher learning and research institutes (e.g. International Institute of Tropical Agriculrure (IITA); Institute of

Agricultural Research (IAR), Zaria etc). What is however deficient and requiring "exploration" is the mode and pattern of industrial processing and utilization of soybean and its products in Nigeria.

The processing of and the existing industrial processing capacity for soybean in the country have not been ascertained. Besides, the profitability of the processing of the bean into oil and feed cake (meal) has not been analysed. These and many others form the exclusive assignments of this research project.

1.2. Justification for the study

The research project was carried out because of the following rationalisations:

(i) the realisation and recognition of the great quantum of propaganda that is being accorded the nutritional advantages of soybean and its products by public and private agencies (e.g. River Basin Development Authorities, Agricultural Development Projects (ADPs), International Institute of Tropical Agriculture (IITA); Schools, Hospitals etc) in order to increase its proportion of an average Nigerian diet.

(ii) the realisation that federal and state governments and international agencies (e.g. IITA) have committed huge resources to the improvement and production of soybean, especially in the middle belt states. This had led to greater output; but not enough effort has been given to the processing and utilisation aspects of the bean and its products.

(iii) the need to ascertain and provide data on profitability of the processing of soybean into oil and feedcake relative to other major oil seeds notably groundnut, palm kernel etc. especially as it would be of interest to oil mills.

(iv) the need to provide a guiding clue in the allocation of scarce research resources to soybean and/or other oil seeds especially in the areas of varietal and yield improvement, processing and utilization.

(v) the need to identify the constraints which impinge upon profitability of industrial processing of soybean and thus being able to bring them to the notice of policy makers capable of alleviating them.

(vi) the need to ascertain the export potentials of soybean and its principal products (soy oil and meal) in the generation of foreign exchange.

1.3. Objectives of the study

On a broad spectrum, the project involved an economic evaluation of industrial processing of soybean into oil and feedcake based on three methods of oil extraction namely screw press, Hard press and Solvent extraction.

Specific objectives of the work are:

(i) To determine and quantify the profitability of industrial processing of soybeans into oil and feedcake in Nigeria.

(ii) To compare and contrast three methods of soybean processing namely Screw press, hard press and Solvent extraction based on their oil extraction efficiencies and other processing parameters.

(iii) To examine the cost structure of selected soybean processing mills with a view to identifying their cost problems, especially as they impinge upon profitability of oil and feedcake enterprises.

(iv) To identify and examine the constraints on industrial processing of soybean.

(v) To make policy recommendations based on findings.

1.4. Hypotheses of the study

The following hypotheses were tested in this project namely:

(i) That the industrial processing of soybean into oil and feedcake is not a profitable venture.

(ii) That the three different methods of soybean processing namely Screw press, Hard press and Solvent extraction do not differ significantly in their oil extraction efficiencies and other processing parameters.

(iii) That significant differences do not exist among the three (3) soybean processing mills in terms of gross sales, gross margin, operating profit, profit after tax (PAT), soya oil and soya meal sales per tonne of soybean processed.

(iv) That there are no significant differences among the three (3) soybean processing mills in terms of efficiency, profitability and credit worthiness indicators.

(v) That there are no differences among the three (3) methods of soybean processing in terms of various cost components (elements) for every tonne of soybean processed.

(vi) That the value-added created in the processing of a metric tonne of soybean into oil and feedcake/meal does not differ significantly among the different soybean processing mills.

1.5. Plan of the study

The project report is organised into five distinct chapters. In chapter one, introduction to the project, problem definition, justification for the study, objectives of the study, hypotheses and plan of the study are presented. Chapter two presents literature review on soybean production in Africa and Nigeria, soybean uses and utilisation, processing and marketing of soybean, soybean export - import scenario in Nigeria, constraints in the production and utilisation of soybean, improvement of soybean, soybean research aspects, prospects of soybean production and utilisation as well as the analytical techniques employed for data analysis in the report. Chapter three discusses the methodology including the study area, sources of data, sampling techniques, data collection, data limitations, analytical techniques and model specification as well as the scope and limitations of the study. In chapter four,the historical background of the three (3) soybean processing mills is presented. Chapter five contains results and discussions and chapter six gives the summary, policy implications and conclusive remarks of the study.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1. Soybean Production Situation in Africa and Nigeria

Of the 89.9 million tonnes of soybean produced in 1984, the world-over, Africa was credited with 200,000 tonnes. Yields in Africa are lowest, at 660 kg/ha with the far East next lowest in productivity with 960 kg/ha in 1984 (Singh and Rachie, 1987). In fact, FAO study indicates a potential in Africa of about 145 million hectares where inputs would be low and up to 270 million hectares under high-input conditions (Singh and Rachie ibid). They also hold that demand and improvement undoubtedly will contribute to expanded production in tropical and subtropical Asia but not to the extent that could occur in Africa and the Americas.

Emphasising the low yield phenomenon, and hence the inadequate local supply of soybean in Africa, Singh and Rachie (1987 ibid) opined that even if only 10 percent of daily protein requirements (5g/day or 5kg/year) for 200 million Africans were met by soybean from average yields of 1 tonne/ha, an annual production of 1 million tonnes would be required or 4.2 times the 1984 production of this crop. Kolavall et al (1985) observed that commercial production of soybeans in Africa is significant, the average area being cultivated with soybeans between 1982 and 1984 was 389,340 hectares. However, they hold that it is hazardous to project yields in a continent in which experience with soybeans has been limited and in which some reports of commercial yields are of uncertain reliability.

In 1984 for instance, Egypt and Zimbabwe led the way in the production of soybean in Africa, with about 160,o00 tonnes and 90,000 tonnes respectively; Nigeria produced about 67,000 tonnes, south Africa, 27,000 tonnes and Zaire 19,000 tonnes (Kolavalli et al 1985). But Nigeria is the largest producer of soybeans for food in West and Central Africa (Root, Oyekan and Dashiell, 1985). Nigeria as the largest producer of soybean also has the most extensive research programme. Soybeans were first introduced to the country in 1908 (Fennel, 1966). Ecologically, it is known that soybean is well suited to zones where maize is grown; in the U.S., soybean has become a major crop in the corn belt within the last three decades (Wuayyum et al, 1983 p. 173). Soybean production has not spread widely to the humid and subhumid tropics in Nigeria, because stored seeds are rapidly degraded and lose their viability (IITA, 1984 p.106).

In Nigeria, production of soybean has increased steadily over the years, from about 58,000 metric tons in the 1960s to about 75,000 metric tons in the late 1970s (FAO, 1966-1986). This according to Obeya (1988 p.80), is as a result of government's incentives to farmers to increase or maintain their production levels, as well as the expansion of the poultry industry and the resultant increase in poultry feed demand. From 1982 to 1984, production appears to have dropped immensely from 75,000 metric tons to 60,000 metric tons (FAO, 1985 p.142). Again, this is because imported soybean meal proved less expensive than the domestically produced meal, farmers apparently lost interest in production (Obeya, 1988). However, with the ban on soybean meal importation, production appears to have

risen again as depicted by the 1986 production figure of 68,000 metric tons (FAO, 1986 p.109).

2.2. SoybeanUses and Utilization

Soybean and its products are, indeed, very useful. It produces high quality oil - about 20 percent of its content - and protein - about 40 percent of the bean. The oil is highly digestible, high in unsaturated fatty acids and contains no cholesterol (Singh, 1987); its protein content is superior, with substantial levels of most essential amino acids.

Soybean is a cheap substitute for meat and fish when consumed with carbohydrate foods. Soybean is known to be low in its content of Oligosaccharides, which cause flatulence and therefore idea for infants (Singh, 1987). It is a good dietary source of calcium and phosphorus. It is used in milk, tofu (a cheese-like product), a textured substitute for meat and flour (alone or with wheat) to improve the nutrients in bread and many snack foods. Soybean has also become the leading source of edible oils and fats, constituting about 20 percent of the world supply and more than any other single source of these essential nutrients (Singh and Rachie, 1987).

It has been suggested that soybean proved more useful than other grain legumes by virtue of its dual purpose - protein and oil - and mainly its protein as well as adaptation to temperate conditions (Singh and Rachie ibid). Soybean oil is attracting widespread acceptance because of the failure of the traditional sources - groundnut and oil palm - to meet up with the expanding demand for

vegetable oils. In addition, soybean meal contains about 50 percent palatible, high quality protein that can be sold for animal feed or processed for human food (Root, Oyekan and Dashiell 1985). According to Root, Oyekan and Dashiell (1985) soybeans may be the most practical means of relief from Kwashiokor (protein-calorie malnutrition), which is increasing in prevalence among young children in the densely populated humid tropics. According to them, the traditional sources of animal protein - wild animals - have disappeared because of indescriminate hunting, and domestic sources have become prohibitively expensive. Thus, the successes experienced by personnel introducing use of soybeans into villages in west and central Africa have been encouraging.

2.3. Soybean Processing and Marketing in Nigeria

The procesing of soybeans and the accompanying marketing arrangements in Africa and in Nigeria in particular, are deficient. At the individual level, the processing and subsequent utilization are offensive; crude and uneconomic. According to Nelson et al (1985), the use of soybeans at home is plaqued by the following factors:

i) Rapid spoilage when the soybeans or soybean products are soaked in water of poor quality at high ambient temperatures;

ii) The long cooking time, which wastes scarce fuel; and

iii) The lack of widespread appeal of the cooked whole soybeans, especially when improper preparation has catalysed the lypoxygenase enzyme, producing a beany flavour.

It has been opined that the main constraint to increased soybean production is the lack of attention that has been paid to the commercial processing of the crop (EIU, 1987 p.31). It is therefore recommended that government efforts may be necessary to increase soybean processing since the Federal Government has large ownership in agricultural processing industries (Obeya, 1988 p.86).

Obeya (1988 ibid) contends that the processing facilities to cope with increased amounts of soybean are available in Nigeria. According to her, there are 70-old vegetable oil mills in the country which were built to process groundnut, oil palm and cotton seed and that most of these mills are underutilised due to lack of raw materials and can therefore be converted for the processing of soybean. In her submission, the prospect for increasing the soybean processing capacity of Nigeria depends on the demand for and the supply of soybean as a raw material. This, in turn, will depend on the demand for the meal (as its food use is negligible) and the demand for the oil.

The ban on importation of vegetable oils has constrained some mills in the country to turn to soybeans as source of edible oil. An estimated 250,000 metric tons would be needed to supply all the old mills in the country (Jackai, 1985). An additional 72,000 metric tons of soybeans is now needed annually since 1987 when a new processing mill (Taraku Mill) began operation in Benue State.

Soybean marketing in Africa is grossly inefficient at the moment, albeit it possesses a promising future. For example, farmers who supplied soybeans to a manufacturer of a soy-product earned reasonable profits, but the market was limited (Lassitar, 1981) in

Eastern Upper Volta. This largely demonstrates the inherent advantages that are realisable under farmer-manufacturer contractual arrangement in the marketing of soybeans. This, in fact, is currently being practised by Taraku Mills limited in Benue State.

The poultry industry in Nigeria, for example, is growing rapidly and may enhance the market prospects for soybean (because of its product - soymeal). Obeya (1988, p.93) stressed this further when she contends that since poultry is the most commercialised livestock sector it is the major user of compounded feed, and the size of the poultry sector will be the main determinant of the demand for soybean meal. In 1982, Nigeria was reported to have 150 to 200 million birds (UNIDO, 1984). In 1985, about 85.2 thousand metric tons of protein were estimated to feed the poultry industry in Nigeria and this could be supplied by 245,000 metric tons of soybean meal (if soybean meal is to provide all the proteins) (Obeya, 1988, p.95). In that year only an estimated 68,000 metric tons of soybean was produced locally and if processed, would result in the production of about 54,400 metric tons of meal (soybean roughly contains 80 percent meal and 20 percent oil). According to her, the 54,400 metric tons would provide only about 22 percent of the total protein requirement, leaving an unsatisfied demand of 78 percent or 190.6 thousand metric tons. This immensely shows the enormous market that exists for soybeans in Nigeria.

Local market aside, soybean possesses a large scale market for its products - oil and meal - outside the country. In fact there seems to be a competition for soybean and its products, at the moment,

between local and international markets. For example, even though soybean exportation was highest in the 1960s and early 1970s it finally declined to zero in 1979. Considering the fact that production was highest during this time, Obeya, (1988 p.83) believes that the decrease and final cessation in export was mainly due to the rapid expansion of the poultry industry. This was due to the increase in the demand for feed ingredients and the low world market price for soybean that favoured the importation of soybean meal.

2.4. Soybean Export-Import Scenario

In the period preceding the civil war all the soybeans produced in Nigeria were exported; now nearly all the local production is used for "dawa-dawa", a traditional condiment, made and sold by women operating small businesses (Root, Oyekan and Dashiell, 1985 p.82). This was mainly because there was no substantial industrial use for the beans in Nigeria that could guarantee large market for total production. However, with the recent ban on the importation of vegetable oils (including soy oil) as well as the increasing use of soybean meal as animal feed for poultry and other livestock, the use of soybeans has increased considerably. It should be registered that in our bid to be an exporting nation, soybean products, especially soya oil (because of its high quality) could readily come handy as sources of foreign exchange earnings.

In Africa, most countries which are net exporters of animal and vegetable oils and fats are also net importers of soybean oil (Weingartner, 1987). For instance in the period 1982-1984, African

countries exported 5104 tonnes of soybean cake and meal and imported 461,514 tonnes annually. In Nigeria, soybean oil importation started in 1976 as a result of an increase in vegetable oil demand and a decline in local production (Obeya, 1988). The highest importation of soybean oil was recorded in 1982 at a whopping entry port amount of 70,000 tonnes. And recent increases and improvements in the processing of soybean into oil and feedcake would make their export potentials a reality.

Obeya (1988) in accounting for the decline in exportation of soybeans and the increase in subsequent importation, believes, that some of the soybean that was produced in the past was exported because the poultry and other livestock industries in Nigeria had not expanded to such a degree that the meal was required for feed use and that groundnut meal was produced in sufficient quantities to feed livestock industry.

2.5. Constraints in the production and utilization of soybean in Nigeria

Soybean production and utilization in Nigeria have been handicapped by biological, agronomic processing and marketing constraints. Soybean production is deterred in the tropics primarily because of biologic constraints on the crop and the lack of markets (Singh and Rachie, 1987). However, markets and uses did not develop mainly because production was not assured. Singh and Rachie (1987) hold that the lack of early progress on production (of soybeans) in the tropics is mainly attributed to the lack of a critical mass of researchers

working in a multi-disciplinary fashion, the lack of a clear understanding of the unique problems of the tropics (by scientists in both the tropics and the temperate regions), and the lack of improved germplasm.

According to them, the major biologic constraints identified by mid-1970s included:

(i) Seed longevity under ambient storage ... some of the seeds usually germinated and poor stands are common;

(ii) Poor nodulation where the appropriate Rhizobium species were not available or were poorly handled in application. This problem was particularly acute in Africa where inoculation was often not available for commercial use;

(iii) Shattering (of pods) in temperate varieties;

(iv) The pest complex; and

(v) Sensitivity to photoperiods and other environmental factors.

In addition, Singh and Rachie (1987 ibid) also identified some agronomic constraints; for example in general soybeans may be said to require, or respond better to, higher levels of management and inputs than do other grain legumes. They opined that soybeans are particularly sensitive to soil fertility, inadequate mositure, ineffective weed control etc. Soybeans also require more precise care (planting, weed control, inoculum application and harvesting) than do the rustic native species. Finally, they submited that the agronomic constraints to growing and handling soybean could be minimised by appropriate mechanical aids for sowing, intercultivation, weed control, harvesting,

and threshing; therefore mechanization has become a focus for research.

In a similar note, Obeya, (1988 op cit) advanced that low yields in Nigeria (average yields are 334kg/ha versus an average world yields of about 1,833kg/ha (FAO, 1986) as well as inavailability of market for soybeans have jointly hinder farmers' ability to increase production. Remedies, according to her, include pests and diseases control, the need for more research efforts on fertilizer requirements of soybean in the guinea savannah zone as ell as research on high yielding varieties.

2.6. Improvement of soybeans

Due to the relatively new entry of soybean into the farming system in Nigeria, its improvement has been dismally unsatisfactory. Soybean cultivation and utilization has been restricted in the developing world due mainly to failure to direct effort at the improvement of the crop's performance in the tropics (Singh and Rachie, 1987). In their own words, *"... after several decades of efforts, the progress to improve soybean is much slower than that of several species of the genera phaseolus and vigna"*.

Elsewhere, however, it has been suggested "that soybean was easier than its competitives to improve genetically as a consequence of its higher number of chromosomes (2n=40 compared with 2n=14 and 2n=20 for other grain legumes), (Singh and Rachie, ibid). However, they submitted that the "major credit for bourgeoning this plant into the 20th century must go to a small group of brilliant, highly

dedicated crop scientists, who began using modern methods of plant improvement during the past 50 years .....".

It is worth mentioning that numerous advances have been made in this regard; for instance, "lines (of soybean) that possess improved storability have been identified and this trait is now being routinely incorporated into IITA breeding lines" (IITA, 1983).

2.7. Soybeans: Research

The current expansion of soybeans in Nigeria is founded in years of research (Root, Oyekan and Dashiell, 1985). However, Singh and Rachie (1987) still believe that several "challengies remain for scientists, developers and promoters; the most immediate and crucial concern is to develop attractive, easily prepared local dishes from this bean in Africa and the Americas....." Accordingly, (research) focus should be in controlling pests, solving agronomic problems, removing stresses, which soybean is susceptible to, improving seed quality and developing appropriate mechanisation for planting, interrow cultivation, harvesting, processing etc. (Singh and Rachie, ibid).

However, some breakthroughs have been recorded in the researches done so far on soybeans. The Institute of Agricultural Research (IAR) initiated a breeding programme for soybeans and fostered the release in 1983 of two lines from a cross between Malayan and Clemson Non-shattering (Leleji and Adedzwa, 1983). These lines mature in 115-120 days and have given yields more than 2 tons/ha in the guinea savanna. They are capable to nodulating with indigenous Rhizobia - a trait of the local variety Malayan (Root,

Oyekan and Dashiell, 1985). In 1980, soybean scientists in Nigeria adopted a "nationally coordinated approach" to soybean research, endorsed by the Federal Government. The approach, through its multi-disciplinary and multilocational trials, has led to increased production of improved soybean varieties (Root, Oyekan and Dashiell, 1986 ibid).

In Nigeria three major institutes are directly involved in soybean research namely: Institute of Agricultural Research (IAR); the National Cereals Research and Training Institute and the International Institute of Tropical Agriculture (IITA).

2.8. Soybean production and utilization prospects

The potentialities of soybean in answering the Nigerian food question, are indeed, immense. What is, however, not very certain is the galaxy of incentives and enhancing factors that will bring this to bear. The "world's bourgeoning population is destined to reach 6 billion by the turn of the century. It will be much easier to meet human energy needs than to provide the protein and other nutrients (Singh and Rachie, 1987). Consequently, the need for boosting the production and utilization of the world's "cheapest" protein source - soybean - becomes increasingly widespread in acceptance.

Recent advances, according to Singh and Rachie (1987), have "opened the way for soybean to become a primary source of human food in the protein-deficient subhumid and humid tropics, where a large proportion of the world's population will live in the 21st century". No wonder, the huge financial and material resources that

are being devoted to soybean production, improvement and utilization in these countries, especially in the areas of research and propaganda on the nutritional advantages of the bean. In Nigeria, Federal and State Governments as well as research agencies (e.g. IITA) have committed huge resources towards the improvement, production and processing of the bean. In response to these huge investments, Nigeria had dramatically increased production from an estimated 30,000 ha in 1983 to 110,000 ha. in 1986. The increase, according to Root, Oyekan and Dashiell (1985), resulted from (i) government policy to produce food locally rather than import it; (ii) research to develop improved varieties and practices for all the agro-climatic zones in the country; (iii) emphasis on developing recipies that substitute or incorporate soybeans in traditinal foods; (iv) willingness of local manufacturers to use soybeans in baby foods, vegetable oils and animal feeds; and (v) promotion of soybeans by organisation such as the River Basin Development Authorities (RBDAs), Agricultural Development Projects (ADPs), Hospitals, schools and local governments.

The utilization of extraction capacity of oil mills in countries of Africa still remains low; in Somalia it is 11 percent (UNIDO, 1984). This statistic must be improved in future; increases in soybean production are one means to put more of the capacity to work as well as making available a valuable and a relatively low-cost source of protein (Kolavalli et al, 1985). It is heartening to note the move to scale down processing with appropriate machinery so that small industries can develop in the villages (Singh and Rachie, 1987). On soybean prospects, Kolavalli, et al (1985), opined that *"if soybeans are*

desired for home consumption, that strengthens the incentive to produce them; if they are produced mainly for sale, they must compete with other crops". Research institutions and governments, according to them, can improve the prospects of soybean in Nigeria through:

i) Increased efforts on varietal improvement and agronomic solutions to problems constraining soybean yields.

ii) Research methods of processing and utilization - low-cost, practices and ways to process and incorporate soybeans into indigenous foods and feeds to strengthen producers' incentives to grow soybeans; and

iii) Provide price incentives to commercial production to improve the competitiveness of soybeans in relation to other crops.

In a similar vein, Obeya, (1988) advises that accelerating both maize and soybean production has important policy implications for the government and that the following policies, among others, can be adopted to accelerate production, viz:

i) guaranteeing profitable prices to producers;

ii) improving transportation facilities (particularly in the relatively underdeveloped Middle Belt, where the envisaged rapid acceleration will mainly take place); and

iii) providing improved planting materials and equipment for harvesting, processing and storage.

2.9. Analytical techniques and their limitations

The techniques employed include marginal analysis, Analysis of Variance (ANOVA), coefficient of variation (C.V.), correlation coefficient. Marginal analysis involves the determination of gross margin (GM) which is defined as the difference between income of a mill and its variable costs thus:

$$TVP = \sum_{i=1}^{n} PiYi$$

$$TVC = \sum_{j=1}^{m} PjXj$$

$$GM = \sum_{i=1}^{n} PiYi - \sum_{j=1}^{m} PjXj$$

where m = number of variable cost component of the mills.

n = number of enterprises in the mills.

TVP = Total value of products (N)

TVC = Total variable cost (N)

GM = Gross margin (N)

Pi = Price of each product of the mills

Pj = Price of each variable input.

Gross margin analysis, though a straight forward and easily interpreted analytical tool, has some limitations such as:

i) neglects the limiting resources of the firm;

ii) failure to take care of the time-value of money since no discounting is allowed for,

iii) failure to consider fixed-resources and non-linearities in gross income and variable costs;

iv) lack of normative perspective as it does not consider what is best even though it gives an indication of a better option; and

v) it assumes only profit maximising goal of the firm among others (Dillon and Hardaker 1980). Because of these failures, they recommended the use of partial budget analysis as a more appropriate economic analysis of an enterprise.

In a similar recommendation, Pervaiz and Knipscheen (1989) highlighted that it could be tempting to conclude that farm profit can always be increased by expanding the enterprise(s) that possess higher gross margins per unit at the expense of those that have lower returns. This, according to them, could be erroneous because of resource and other constraints. They therefore hold that if the enterprise is increased without regard to these constraints, fixed expenses will probably increase, perhaps to the point that the total GM is more than offset.

Analysis of variance (ANOVA) is defined as the arithmetical technique of partitioning the total variability in a set of observations among the possible sources of variability. Analysis of variance therefore, estimates the fraction of the observed variability that are attributable to each of the known sources or causes (Wahua, 1980). Certain assumptions are usually made in ANOVA viz:

(i) That the error terms are randomly, independently and normally distributed; with a mean, zero and a constant

variance.

(ii) The variances of different samples are homogeneous.

(iii) Variances and means of different samples are not correlated.

(iv) The mean effects are additive.

These, in effect, also represent some limitations of the technique of ANOVA in statistical analysis. In this study it was used in estimating the source of variability of various cost and return parameters (per tonne) across the three Oil Mills based on actual and projected processing capacities.

Correlation coefficient technique was used to examine the relationship between the various cost and return components of processing soybean under different oil extraction methods while Chi-square was used in determining whether observed (actual) costs and returns of soybean processing differ from their expected (projected) values at the projected mill utilisation capacities. The weakness of correlation coefficient is that it does not give the cause-and-effect relationship between the variables (Olayemi and Olayide, 1981). However, correlation coefficient measures the direction and degree of joint movement of random variables.

CHAPTER THREE

3.0. METHODOLOGY

3.1 Study Area

The research project focused on soybean processing mills in the Middle belt states of the country. The choice of this study area is predicated on the recognition that the production and, perhaps, the utilisation of soybean at home and in industry, has the greatest and widespread acceptance in this region. Besides, Nigeria's annual output of soybean and its products - soya oil and cake - comes largely from the Middle belt states. Also a large number of soybean processing mills of diverse and contrasting scales of operation and oil extraction methods abound in this area, hence the suitability of the Middle belt for this study.

3.2 Sampling Techniques

Selective and purposive sampling technique was used in the choice of soybean processing mills of different scales of operation and oil extraction methods throughout the study area. This, of course, was preceded by a reconnaisance survey of the entire Middle belt states in order to identify soybean processing mills. Data on processing and utilisation parameters of soybean seeds were obtained from the mills under study for the entire period of operation so far since each of the Mills had barely more than a year of full scale operation.

3.3 Sources of Data

Overall, three (3) soybean processing mills were chosen for the study and hence data collection and are (a) Oja Farms Ltd, Ilorin (Screw press); (b) Kofa Vegetable Oil Mills Ltd, Lafia (Hard press or Expellers); and (c) Taraku Mills Ltd, Taraku (Solvent extraction). The choice of these three (3) processing Mills from different states and oil seeds producing areas, no doubt, broaden the geographical coverage of the research project and hence making the findings of the work of general application in policy formulation and implementation in the area of industrial processing of oil seeds in Nigeria. Moreso as these Mills presented interesting contrasts in scales of operation, types of oil seeds used and oil extraction methods. In addition secondary data were obtained from Reports, records and publications of the Mills, State and Federal Ministries of Agriculture, FAO Year Book as well as Federal office of statistics.

3.4 Data Collection

3.4.1 Types of Data

Socio-economic data and measurements on industrial processing and utilization parameters of soybean were collected from all sources mentioned above. Specifically, data and information on oil extraction techniques, Oil Mill ownership patterns and location, source of capital, capital cost, capital expenditures (fixed assets), Fixed costs, operating (running) expenses, types and sources of raw materials and other variable inputs, sales trends of products, output and input prices, actual and installed mill capacities, proportion of oil and feedcake from

a given measure of soybean processed as well as the actual and maximum number of working days per annum were collected from the three (3) Soybean processing mills. Also data on parameters such as life expectancy of the mill, mill maintenance costs, market size and structure of the mills, staff stength and labor costs, taxes, size and nature of input and output inventory, discounts on sales, additional mill investment as well as problems of the mills were sampled from the chosen soybean Mills throughout the period of the research.

3.4.2 Method of Data Collection

Both structured and unstructured questionnaires were used in the collection of primary socio-economic data mainly from the processing Mills namely, Screw press (Oja Farms Ltd); Hard press (Kofa Vegetable Oil Mills Ltd) and Solvent Extraction (Taraku Mills Ltd). The questionnaires were administered by the researcher through a series of personal visits to the sectional and departmental heads as well as owners of the Oil Mills. Secondary economic data on costs and returns of soybean processing were also collected and collated from annual reports, records, sales vouchers and other publications of the Mills. In addition, relevant measurements and observations were made throughout the period of the study in order to capture all relevant soybean processing and utilisation parameters in the industry.

3.4.3 Data Limitations

Even though all relevant socio-economic data required for testing the stated hypotheses were eventally obtained, the data collection was beset by a number of problems namely:

(i) inaccurate and incoherent record keeping by some of the mills;

(ii) the three mills had not operated for more than two (2) production years before the project was conducted hence inability to provide the data needed for trend analysis;

(iii) in one of the Oil Mills (namely Taraku Mills Ltd), other Oil seeds such as Rape seeds, Sunflower seeds and Maize germs are processed in addition to soybean under the same management. Therefore, there was the initial problem of disaggregating certain cost and revenue components which are common to all the Oil seeds ventures.

3.5.0 Analytical Techniques and Model Specification

The resultant data were than collated, processed and used in the analyses aimed at the realisation of the stated objectives and hypotheses using the following techniques.

3.5.1 Gross Margin Analysis

Cost - Benefit Analysis (Marginal Analysis) was used to evaluate the profitability of the processing of soybean into Oil and feedcake. Gross margin is defined in this work as the difference between gross income of a processing mill and its variable costs thus:

$$Tvp = \sum_{i=1}^{n} P_{ik} Y_{ik}$$

$$Tvc = \sum_{j=1}^{m} P_{jk} X_{jk}$$

$$\text{and } GM = \sum_{i=1}^{n} P_{ik} Y_{ik} - \sum_{j=1}^{m} P_{jk} X_{jk}$$

where m = number of variable cost components of the oil mill

n = number of enterprises (products) in each of the mills

TVP = Total value of products (gross income) (₦)

TVC = Total variable cost (₦)

GM = Gross margin (₦)

Pjk = Price of jth variable input in kth processing mill

Pik = Price of ith product in kth processing mill

Xjk = Variable input jth in kth processing mill

Yik = Product ith in kth processing mill

Decision rule: An oil mill is said to be profitable if the GM is capable of generating net positive returns (pure profit or economic rent) after paying for total fixed costs (TFC) such as rent, depreciation and administrative expenses. This analysis was carried out for each of the soybean processing mills based on 1989/90 actual processing capacities as well as estimated processing capacities based on 250 days of operation per annum. In this analysis, empahsis was placed on the determination of accounting profit thus:

TTa = TR - TEC

where TTa = accounting profit (in Naira)

TR = Total receipts (total income) in Naira

TEC = Total explicit costs (fixed and variable costs)

Deliberate effort was made to avoid the calculation of pure economic profit defined as:

TTp = TR - TEC - IC

where TTp = pure economic profit (₦)

TR = Total receipts (₦)

TEC = Total Explicit costs (fixed and variable costs)

IC = Implicit cost (amount that could be earned in the best alternative use of the resources).

3.5.2. Analysis of variance (ANOVA)

This technique was used to determine whether significant differences exist among the different soybean processing mills in terms of certain cost and return parameters for every tonne of soybean processed at actual and projected capacities. The method involves the following:

(a) Computation of the sum of squares for row means (row variation or variation of the Screw press, Hard press and Solvent mill in terms of some costs and returns per tonne) thus:

$$\text{Sum of squares row (SSR)} = \frac{Ti^2}{ni} - C$$

where $C = T^2/N$, also called correction factor

T = Grand total of all observations

N = Total number of observations

Ti = Row totals

ni = Number of observations that gave the row totals

(b) Rep = Replications of the costs and returns at actual and projected values.

(c) Total sum of squares (SST) = $\Sigma Xij^2 - C$

where Xij = Observation in row i and column j.

(d) Error sum of squares (ESS) = SST-SSR.

(e) Degrees of freedom (DF): This was computed for each of the sum of squares (variations) thus:

(i) Degree of freedom for SST was calculated by taking the total number of observations less one i.e. DF = N-1.

(ii) Degree of freedom for row variation (SSR) was calculated by subtracting one from the number of rows as:

Df = r-1

r = number of rows.

(iii) The degree of freedom for error sum of squares is given as [(N-1) - (r-1)]

(f) Mean squares: These were calculated by dividing the different sum of squares by their respective degrees of freedom.

For instance the mean squares (MS) for row means (treaments) is given as:

$$\frac{\text{Sum of squares row (SSR)}}{\text{Degree of freedom for rows}} = \frac{SSR}{r-1}$$

(g) A significance level (α) was chosen for the acceptance or otherwise of the computed F value(s). In this study, 5% (0.05) level of significance was chosen.

(h) The theoretical (computed) F value was calculated by dividing the row mean square by the mean square for error sum of square.

(j) ANOVA table was computed as shown below:

Source of variation	Sum of squares	DF	Mean squares	Computed F	Tabulated F*
Row means	SSR	r-1	$\frac{SSR}{r-1}$	$\frac{SSR}{r-1}\cdot\frac{(N-1)-(r-1)}{ESS}$	F_{α} (r-1,N-1)
Error	ESS	(N-1)-(r-1)	$\frac{ESS}{(N-1)-(r-1)}$		
Total	SST	N-1			

(k) Decision Rule:

(i) Where computed (calculated) F is greater than tabulated (critical) F* at the chosen level of significance then, the stated hypotheses were rejected and the alternatives accepted.

(ii) Where the computed F was less than the tabulated F* at the chosen level of significance, the stated hypotheses in section 1.4 were accepted.

3.5.3. Other techniques

Correlation coefficient technique was used to determine the pattern of correlation among the various cost and return parameters across the three oil mills. This is given by the formula:

$$rij = \frac{\Sigma XiYj}{\sqrt{\Sigma Xi^2 \Sigma Yj^2}}$$

where rij = correlation coefficient between any two of the cost and return paramters per tonne of soybean processed across the mills.

Yj, Xi = any one of the cost and return parameters.

Coefficient of variation (C.V.) was used to determine and evaluate the degree of variability among the different cost and return parameters across the three mills using the formula:

$$C.V. = \frac{Si^*}{Yi} \times 100$$

where C.V. = Coefficient of variation in percentage of each of the various cost and return parameters of soybean processing.

Si* = Standard deviation of each of the cost and return parameters across the three mills.

Yi = Mean of each of the parameters across the three mills.

and $$Si^* = \sqrt{\frac{(Xi-\bar{X})^2}{n-1}}$$

where Xi = values of each of the cost and return parameters across the three mills.

$\bar{X}$ = Mean of each parameters across the three mills.

n = Number of mills.

Hellwing's (1974) "compact" variables classification method was applied to the matrix of correlation coefficients to determine which of the mill characteristics are core in classifying the mills thus:

where n = total number of identified Oil mill performance variables

R = an inter-correlation matrix of dimension nxn or R(nxn)

Sij = elements of the inter-correlation matrix

$S^*ij = 1 - |Sij|$ ie the deviations of the absolute value of each element of the inter-correlation matrix from one

R* = an nxn matrix of the deviations Sij

Zi = the minimum S*ij in a given row vector in R*

Ci,ji = the numbers of the co-ordinates of Zi given as

C(1,j1,2,j2,3,j3, ... n,jn)

where i, and ji are nodes of the coordinates.

i, ––– j = the link of a particular node to the ith or jth node. The links could be direct or indirect. The greater the link the higher the power of the node.

$\bar{S}^*ij = \frac{1}{n-1} \sum_{j=1}^{n} S^*ij =$ mean of the S*ij in each row. This was used as a tie breaker when two or more nodes have equal link

$\bar{Z} = \frac{1}{n} \sum_{i=1}^{n} Zi =$ the mean of all minimum S*ij in the entire matrix R*

$\S\bar{z} = \sqrt{\frac{\Sigma(Zi-\bar{Z})2}{n}} =$ Standard deviation of Z

The classification equation for all variables is:

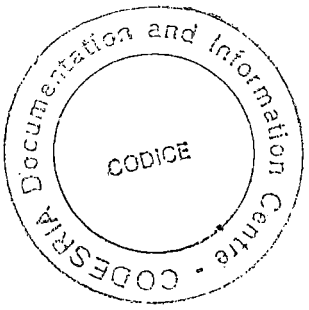
$$Z - \S\bar{z} \leq Zi \leq Z + \S\bar{z}$$

Decision Rule:

(i) The variables that fall within the one standard deviation confidence limit of Zi are the "compact" or core variables. They are the best indicators of performance.

(ii) If the inequality on the left hand side of the equation is reversed, the Zi that satisfies the reversal is a redundant variable.

(iii) The Zi that satisfies the reversed inequality on the right hand side of the equation is an irrelevant variable.



3.6. The scope and limitations of the study

The scope of the research project was limited to certain economic aspects of industrial processing of soybean into oil and feedcake using three methods of oil extraction namely: Screw press, Hard press and Solvent extraction. The limitations of the study include:

(i) the limited number (three) of soya mills visited for this study and hence generalisations across other mills may not be too correct;

(ii) the limited time which did not allow for inter-temporal study of certain cost and return indices of the three mills;

(iii) the failure of the oil mills to have adequate and accurate data on costs and returns of the mills' operations and this significantly affected the accuracy attained in data collection;

(iv) other limitations include those perculiar to the analytical techniques and procedures employed in the report as reviewd earlier on in chapter two

CHAPTER FOUR

4.0. HISTORICAL BACKGROUND OF THE SOYA MILLS

The three (3) types of soybean processing mills studied are (a) Oja Farms Limited, Ilorin (Screw Press), Kofa Vegetable Oil Mills (Hard press method) and Taraku Mills Limited (Solvent Extraction method).

4.1. Oja Farms Limited (Vegetable Oil Mill).

The mill was established in 1989 as a private limited company, a subsidiary of Oja Farms Ltd located at Ogbomosho. The shares are closely held made up of four (4) shareholders. The Mill is situated at Ilorin. The costs of mill and installation expenses are estimated to be ₦600,000.00 including ₦100,000.00 working capital. The soybean processing mill originally meant to process soybean also processes cotton seeds. It now has a Feedmill worth ₦100,000.00 attached for blending of feed ingredients for both the Farm's other livestock subsidiaries and public livestock farmers.

Oil Extraction Methods: The mill uses Screw press method in the extraction of oil from soybean and other oil seeds. Presently, it predominantly processes soybean into oil and feedcake at a capacity of between 2 and 2·5 metric tons daily as against an expected processing capacity of about 4 to 5 metric tons daily. This translates to roughly 50 percent capacity utilisation of the mill on any working day. The mill has two machines, each with a capacity of 2 to 2.5 metric tons daily but due to the single roasting chamber, only one machine can effectively be put to use at a time. On the whole, the mill had an actual annual processing capacity of 150 metric tons in 1990. In summary, the Screw press procedure involves the roasting of the

beans using a gas-fed roasting chamber, the crushing of the roasted beans and extraction of the oil from the cake. The oil is then refined using caustic soda in a refining chamber and canned in non-branded 1 1/2 litre container of twelve in a carton.

Operations of the Mill: The mill runs approximately for 24 hours daily with 3 shifts of 8 hours each. The Mill works for 6 consecutive days from Mondays through Saturdays under regular and adequate supply of the basic raw material (soybeans). However, maintenance of the mill is done after processing of about 8 tonnes of soybean which takes between 4 and 5 days of continuous running of the mill.

The management of the mill embarks on vigorous search for cheap sources of the basic raw material (soybean) which is purchased in the open markets in Benue and Kwara States. Since the mill commenced operation, the price of the bean ranged between ₦1,800 per tonne and ₦2,800 per tonne depending primarily on (a) the season of purchase and (b) the grade/quality of the raw bean. The oil which sells at ₦12 per litre, has high market demand and the management makes conscious effort to sell to domestic users rather than industrial users. However, the cake which contains between 7% and 8% residual oil does not seem to be cleared by the market demand as the mill is estimated to keep inventory of cake at 5 to 10 tonnes. This, the management sees as dampening the profitability of the firm and has therefore embarked on vigorous search for ready market for its cake within and outside the state. The adduced reasons for the low demand for its cake are (a) the availability of other ready sources (e.g. Groundnut, Palm Kernel etc.) of cake for Feedmillers (b) the high oil

content of the Mill's cake which in essence means low lean meat formation and high fat deposition by livestock fed on the cake and (c) the low commercial status of Ilorin, where the Mill is situated and hence few cake users. At the moment the mill sells its cake at ₦3,975 per metric ton on the average. The Mill is not involved in contractual arrangement in the purchase of raw materials and sale of soya oil and cake.

On staffing, the mill engages 15 (including 3 youth corpers) employees made up of a managing director, foremen and filter mates all of which are skilled. As the situation demands an average of 4 wage labourers are employed monthly especially during peak demands for labour.

Problems of the Mill: Oja Farms oil mill faces a number of problems and these include:

(i) Inadequate working capital which, according to the management, is a very serious one. This has militated against bulk purchase of raw materials especially soybean for stockpilling during the on-season when the price is lower. Thus the mill does not enjoy economies of scale.

(ii) Inadequate raw material (soybeans) which is a direct consequence of the inadequate working capital as well as the seasonality in the supply of the soybean seeds thus culminating in low capacity utilisation of the mill during off-season.

(iii) Location problem is also identified to be responsible for the inability of the Mill to dispose off its cake and the other by-product of oil refinery-mainly soap stock.

(iv) There is also sporadic power failure as the mill does not have a generating plant.

4.2. Kofa Vegetable Oil Mills Limited

The mill which commenced operation in February 1990, is a one-man (sole proprietor) business but run by a Management Consultancy based in Kano on behalf of the proprietor. It is division of KOFA Agro Allied Industries Nigeria Ltd. The management contract is phased for the first five years of operation. The Mill is financed by loan from financial institutions. The Soya Mill is located in about one and half hectares of land at Lafia in Plateau State. At the moment it processes mainly soybean; though cotton seeds and sunflower seeds are occasionally milled for oil and cake. The Mill has equally diversified into rice milling in order to reduce the overhead of the physical assets.

Oil Extraction Method: The mill uses the Hard press (expellers) method capable of extracting between 12% to 15% of the 16-20% oil content of the soybean seeds leaving a residual crude oil content of 4% to 5% in the resultant cake. The Mill has 4 machines or expellers, each capable of 1 tonne per hour but for operational and technical reasons not more than 3 of the expellers are put to use at a time. The machines are run for 8 hours daily though the mill is capable of working continuously for 24 hours daily for 6 working days. This under-utilisation of capacity is largely due to scarcity of the basic raw material - soybeans.

In summary, the extraction method entails the breaking of the beans into bits in order to expose the surface acrea for the action of the steam produced by a steam chamber (boiler). This helps in roasting the broken seeds for ease of crushing by the expellers which extract the oil from the cake. The oil goes into the refinery and the cake is carried by the conveyor belt to the point where it is bagged in 75 kilogramme-bags for sale. The crude oil is stockpiled in the refinery at a batch size of 50 to 70 drums (a drum of 201 litres) and this takes approximately 2 to 3 weeks for the normal 8 hours of milling per day. The refinery of a batch takes 2 to 3 days to accomplish resulting in the refined and purified oil and soap stock. The refinery also entails the use of caustic soda as in Screw press. The refined oil is not deodorised as their deordoriser was yet to be fully installed for operation at the time of data collection.

Operation of the Mill: The mill currently runs with 16 permanent staff (made up of 3 management staff) under the payroll of the Management Consultancy albeit the staff salaries and emolument come from the proceeds of the mill. The Mill has 2 generating plants estimated at ₦700,000.00 each with a capacity of 300 kilovolts hence power supply is fairly reliable. The mill can be said to be on test runs, hence most of the facilities are under utilised.

The Mill has 4 divisions namely - Administration, Engineering. Maintenance and Production Departments but the entire Mill is headed by a Project Manager who coordinates the day to day business of the mill.

The market for its oil is quite oversized and the mill has unfulfilled demand for its oil. The oil is mainly bought on a contractual arrangement by Vegetable Oil Sellers Associations mainly from Jos for domestic uses. The oil currently sells at between ₦1,600 and ₦1,800 per drum of 201 litres which translates to about ₦9 per litre. However the cake which sells at between ₦3,100/tonne to ₦3,700/tonne has not enough market demand resulting in the carriage of large inventory of cake. From January to March 1991 for instance, out of 400 metric tons produced, about 110 metric tons was yet to be bought and this is also capable of dampening the accruable profits. The cake is mainly bought by large scale Feedmillers from all over the country. The soap stock does not have significant market even though few drums are seldom sold to local buyers at ₦200.00 per drum. The soybeans is purchased through a contractual supply arrangement at between ₦2,400.00 and ₦2,900.00 per metric ton and the suppliers buy the bulk of the bean from Gboko in Benue State.

Mill Efficiency: The mill has the mechanical efficiency of extracting between 12 and 15% of the oil content of the bean leaving crude oil residual of about 4 to 5% in the cake. On the other hand it generates between 75% and 80% of cake from any given measure of the bean.

Problems of the Mill: According to the management, the problems of the Mill include:

(i) Insufficiency of staff, especially skilled staff.

(ii) Bottlenecks in the supply of the raw materials and this also makes the factory to close down operation for days and sometimes weeks.

(iii) lack of spare parts for the maintenance of the Mill.

(iv) Inadequacy of working capital.

(v) Frequent breakdown of the boiler and this sometimes leads to a shut-down of the mill for weeks.

4.3. Taraku Mills Limited

The Mill is a private limited liability company funded on a tripartite arrangement involving the Benue State Government (51%), private investors (29%) and Industrie Ban Nord Ges of Austria (IBM) with 20% shares. The company was incorporated on October 31, 1986 with an authorised share capital of ₦30 million. The design and engineering work was done in West Germany while contract for construction of the factory was awarded to Simon Food Engineers Limited of stock-port, United Kingdom, which also provided the machinery. The Mill is situated at Taraku, Benue State. The Mill processes locally sourced soybeans, maize germ and imported sunflower and rape seeds into oil and meal or cake.

Capacity: The Mill is a complex of two mills, the soya mill has capacity for processing 72,000 metric tons of soybeans and 12,000 metric tons of maize germ per annum into edible oil, meal and other by-products. The maize mill is capable of processing 12,000 metric tons of maize grain and 50,000 metric tons of cake from the soya mill into maize flour and feed concentrates. The soya mill has the daily processing capacity of 250 metric tons i.e. about 10 trailer loads of raw beans. At the moment capaity utilisation is estimated at about 20% but efforts

are currently being made to raise it to about 40 to 50% because of the increased supply of high quality soybean seeds.

Oil Extraction Method: The Soya Mill uses solvent extraction (chemical method) though it also has mechanical oil extraction machines (expellers) which are no longer being used because they are less efficient. The solvent extraction involves the use of a chemical (Hexane) for the extraction of the oil from the soybeans. This method is predominantly being used by the Mill because it has higher efficiency in terms of oil extraction. It is estimated to extract approximately the oil content of the bean to 1% oil residual in the meal. That is, it is capable of extracting about 18% of the 18 to 20% oil content of soybean leaving soya meal of longer shelf-life. About 82% of the beans comes out as the meal using solvent extraction. However, the method is more expensive due to Hexane which is imported thereby creating high foreign exchange component in the processing cost. The crude oil is then sent to the refinery where the processes of degumming (removal of phospholipids), neutralisation (using caustic soda in removing the free fatty acids), washing (using water). Bleaching and deordorisation take place giving the branded and high quality oil which meets the quality requirements of the Standard Organisation of Nigeria (SON) and international standards.

Operations of the Mill: The mill runs 3 shifts of 8 hours each and processing is done for 6 consecutive days from Monday throughout Saturday. The Mill with a total staff strength of 357 has large number of departments and divisions for operational convinience. These include Administration, General Management, Warehouses,

Maintenance, Power Generation, Quality Control, Purchasing, Marketing, Finance, Transport, Clinic, Fire and Security, Pressing and Feedmills.

The Purchasing Department is responsible for the purchase of the Mill raw materials. The mill uses contractual arrangement in the purchase of soybeans which range from ₦2,200 to ₦2,800 per tonne depending on the season and quality of the seeds. Most of their suppliers are within Benue State mainly from Gboko. The mill has recently embarked on Farmers' Support Scheme meant to ensure regular and adequate supply of soybeans aimed at achieving higher capacity utilisation.

The Marketing Department handles the sale of the company's products which is done through (a) appointed dealers (discounts given) and (b) wholesale buyers (no discounts). Since soya produts (oil and meal) are relatively new products in the market, the marketing department uses various sales promotional techniques (e.g. branding, advertisement etc.) aimed at creating market for the products. Though the demand for the oil is considerably high as the Mill does not maintain high inventory of oil, however the demand for the meal is very low creating huge inventory of meal currently estimated to at an average of 1,200 metric tons annually. At the moment, Taraku Mills sells its soya oil at approximately ₦16/litre for dealers and ₦20/litre for retailer sale. The soya meal sells at ₦3,300.00 per tonne and the soap stock at ₦400.00 per tonne. As in the other Mills, the demand for the soap stock is low.

Problems of the Mill: According to the management, the problems of the Mill include the following:

(i) Market constraints especially in the demand for its soya meal.

(ii) Raw material supply bottlenecks especially during the off-season of soybean.

(iii) High foreign exchange cost involved in the importation of Hexane used for the extraction of oil from the beans.

CHAPTER FIVE

5.0. RESULTS AND DISCUSSIONS

5.1. Processing characteristics of the oil mills

The field survey revealed a number of contrasting processing characteristics across the three (3) soya mills, namely Screw press, Hard press and Solvent extraction (Table 5.1).

In the table, it is evidenced that output capacities of the three (3) soya mills per tonne of soybean in terms of the proportions of soya oil and cake differ significantly. Screw press is capable of extracting about 5.5% of the oil content of soybean (16 to 18% of the dry weight), Hard press 12% and solvent extraction plant 17%. The proportion of soya cake/meal from a unit of soybean processed is approximately 90.5% for Screw press, 84% for Hard press and 81% for Solvent extraction. Hence Solvent extraction mill is capable of extracting about 94.4% of the oil content of the bean, Hard press, 67% and a low of 31% for Screw press. This shows that oil extraction efficiency is highest for Solvent method and lowest for Screw press.

Mill utilisation capacities among the mills are remarkably lower than installed capacities at 15% for Screw press, 16.1% for Hard press and 29.2% for Solvent mill. This is mainly due to the inadequacy of soybeans and hence high raw material cost during the off-season of soybeans. Also, none of the mills had inventory of soya oil because of the high demand for it. On the other hand, soya cake/meal inventory levels range from a low of 10 metric tons for Screw press to a high of 1,200 metric tons in Solvent extraction mill. The average purchase and sale prices of soybean and soya products respectively also vary

Table 5.1. Comparison of processing parameters of soybean mills.

Mill characteristic	Unit	Screw press	Hard press	Solvent Extraction
Year of establishment	-	1989	1990	1987
Installed daily input capacity[a]	tonnes	4	45	250
Annual input capacity[b]	tonnes	1000	11250	72,000
Actual annual input capacity (1989/90)	tonnes	150	1809	21,000
Output capacity:				
Soya oil	%	5.5	12	17
Soya cake/meal	%	90.5	84	81
Waste[c]	%	4	4	2
Mill utilisation capacity	%	15	16.1	29.2
Oil extraction efficiency	%	31	67	94.4
Oil lost in cake/meal	%	10	4	1
Proportion of crude oil lost in refinery	%	2	5	3
Average purchase price of soybean	₦/tonne	2,300.00	2650.00	2200.00
Average sale price of soya oil	₦/litre	12.00	9.00	20.00
Average sale price of soya meal	₦/tonne	3975.00	3,400.00	3300.00
Average annual inventory of meal/ cake	tonne	10	110	1200
Average soya oil inventory	litre	Nil	Nil	Nil
Estimated total fixed asset	₦	500,000.00	4,230,000.00	68,128,000

Total staff strength	-No-	15	18	357
Ratio of skilled to total staff strength	%	86.7	87.5	78.6

a: On the basis of 3-8-hour shifts daily.
b: On the basis of operation for 250 days annually for Screw press and Hard press and 288 days for Solvent extraction mill.
c: Losses in forms of evaporated soybean water and losses in handlng.
Source: Computation based on Field Survey data, 1991.

from one mill to another principally because of the differences in the location of the soya mills as well as quality of their respective products. The proportions of a unit of soybean lost as waste are 4%, 4% and 2% for Screw press, Hard press and Solvent extraction mill respectively. This advantage of solvent mill is due to the sophisticated method employed which allows for minimal handling losses.

5.2. Gross margin and profit and loss analyses

The computed gross margins for 1989/90 actual processing capacities of the three soya mills are shown in Tables 5.2. to 5.4. while the profit and loss acounts are shown in Tables 5.5 to 5.7.

From the tables, the gross margins are ₦65,202.75, ₦1178,746.00 and ₦12,810,546.10 for Screw press, Hard press and Solvent mill respectively. After paying for rent, the returns to all fixed assets and entrepretneurship across the three (3) soya mills are ₦55,202.75, ₦1,158,746.80 for Screw press and Hard press respectively while the return to land and fixed assets and entrepreneurship for Solvent mill is ₦7,793,853.90. The returns to entrepreneurship and management are ₦40,202.75, N974,746.80 and N7,793,853.90 respectively for Screw press, Hard press and Solvent methods. These income indices are reflective of the profitability of industrial processing of soybean into oil and cake/meal using the three (3) processing technologies. Worthy of note is the fact that the percentage gross sales from soya oil differ from a low of 15.80% (Screw press) to 27.2% (Hard press) and 35.40% in Solvent extraction in order of increasing oil extraction efficiency across the three mills.

Table 5.2. Revenue and cost components of a typical Screw press (Oja Farms Ltd) at actual processing capacity of 150 metric tons (1989/1990) annually.

Item	Amount (₦)
Revenue:	
Soya oil	101,062.50
Soya cake	539,606.25
Total gross sales	640,668.75
Variable costs:	
Wage	576.00
Staff salaries and emolument	72,000.00
Raw material (soybean) cost	345,000.00
Gas	13,200.00
Fuel and lubricants	4,800.00
Electricity bills	6,090.00
Maintenance costs	4,800.00
Caustic soda and other chemicals	3,000.00
Interest[a]	126,000.00
Total variable costs	575,466.00
Gross margin	65,202.75
Rent	10,000.00
Return to fixed assets and entrepreneurship	55,202.75
Depreciation allowance	15,000.00
Return to entrepreneurship[b] (Pure profit or economic rent)	40,202.75

a: Interest charged at 21% per annum.
b: Reward for entrepreneurship and management.
Source: Computed from Field Survey data, 1991.

Table 5.3. Revenue and cost components of typical Hard press (Kofa Vegetable Oil Mills Ltd) at an actual processing capacity of 1809 metric tons annually.

Item	Amount (₦)
Revenue:	
Soya oil	1,933,368.80
Soya cake	5,166,504.00
Soap stock	20,000.00
Total gross sales	7,119,872.80
Variable costs	
Wage	672.00
Staff salaries and emolument	108000.00
Raw material (soybean) cost	4,793,850.00
Water expenses	1080.00
Fuel and lubricants	9,360.00
Electricity bills	42,000.00
Black fuel	54,000.00
Caustic soda and other chemicals	4,000.00
Engine oil	27,000.00
Maintenance costs	12,864.00
Interest[a]	888,300.00
Total variable costs	5,941,126.00
Gross margin	1,178,746.80
Rent[b]	20,000.00
Return to fixed assets and entrepreneurship	1,158,746.80
Depreciation allowance	184,000.00
Return to entrepreneurship[c] (Pure profit or economic rent)	974,746.80

a: At 21% market rate of interest (opportunity cost of capital)
b: Imputed rent as the mill does not pay rent.
c: Reward for entrepreneurship and management.
Source: Field Survey data, 1991.

Table 5.4. Revenue and cost components of a typical soybean Solvent Extraction Plant (Taraku Mills Ltd) at an annual processing capacity of 21,000 metric tons.

Item	Amount (₦)
Revenue[a]	
Soya oil	18,954,073.00
Soya meal	34,559,838.00
Soap stock	30,640.00
Gross sales	53,544,551.00
Less sales discounts	1,763,511.60
Net sales	51,791,039.00
Costs of goods sold[b]	
Cost of goods sold (soya oil)	8,165,725.00
Cost of goods sold (soya meal)	30,806,243.00
Cost of goods sold (soap stock)	8,525.00
Total variable costs	38,980,493.00
Gross margin	12,810,546.00
Depreciation allowance	5,016,686.10
Return to land[d] and entrepreneurship[c] (Pure profit or economic rent)	7,793,853.90

a: Exactly 86% of the total sales for 1990 production year of the Mill accrued from soybean processing while the remaining 14% accrued from Animal feed, Rape, Maize and Sunflower seeds.
b: Soybean costs of goods sold (variable costs equivalent) constituted exactly 81% of the total costs of goods sold for the Mill during 1990 accounting year.
c: Reward for entrepreneurship use of land and management.
d: Grand rent is paid and hence no rent was paid for 1990.
Source: Field Survey data, 1991.

On the other hand, the proportion of soya meal/cake sales in the total gross sales decreases from a high of 84.20% in Screw press, 72.60% in Hard press and 64.54% in Solvent extraction. This trend is largely because as the oil extraction efficiency increases the less the proportion of cake/meal produced from a unit measure of soybean and the greater the volume of oil.

In the profit and loss statements, the three mills also performed creditably with profits before tax (PBT) of ₦37,322.75, ₦955,746.80 and ₦3,465,725.30 respectively for Screw press, Hard press and Solvent method. Again these profit indices indicate high performance levels for the three mills based on 1989/90 mill utilisation capacities of 150, 1809 and 21,000 metric tons for Screw press, Hard press and Solvent extraction methods respectively.

The gross margins and profits of the oil mills at estimated capacity utilisation are shown in Tables 5.8 through 5.13. With an assumption of full capacity utilisation of each of the three (3) mills for 250 days annually, the projected processing capacities are 1000, 11250 and 62,500 metric tons for Screw press, Hard press and Solvent extraction plant respectively. Variable costs of processing were extrapolated proportionately using the 1989/90 actual values and the gross margins are ₦981,904.00, ₦12,464,182.00 and ₦76,447,542.00 respectively for the Screw press, Hard press and Solvent mill (Tables 5.8to 5.10). The returns to entrepreneurship for risk-assumption are similarly of the increasing order of ₦946,904.00, ₦12,260,182.00 and ₦71,430,856.00 for the Screw press, Hard press and Solvent extraction mill respectively. The profit margins before tax (PBT) and after tax

Table 5.5. Profit and loss account of a soybean Screw press (Oja Farms Ltd) at an annual processing capacity of 150 metric tons.

Item	Amount (₦)
Net cash sales	640,668.75
Operating expenses:	
Materials and supplies	386,890.00
Wages and salaries	72,576.00
Total cost of goods sold	459,466.00
Gross profit	181,222.75
Selling, general and administrative expenses	2,880.00
Funds from operations (before interest and tax)	178,342.75
Non-cash operating expenses:	
Depreciation allowance[a]	15,000.00
Total operating expenses	477,346.00
Operating profit (PBIT[b])	163,322.75
Non-operating expenses:	
Interest on loan[c]	126,000.00
Profit before taxes (PBT)	37,322.75
Tax (40%)	14,929.10
Profit after tax (PAT)[d]	22,393.65

a: Depreciation calculated by straight line method.
b: Profit before interest and taxes.
c: Interest calculated at 21%.
d: Equals accounting profit.
Source: Computed from Field Survey data, 1991.

Table 5.6. Profit and Loss Account of a Soybean Hard press (Kofa Vegetable Oil Mill Ltd) at an annual processing capacity of 1809 metric tons.

Item	Amount (₦)
Net cash sales	7,119,872.80
Operating expenses:	
Materials and supplies	4,964,154.00
Wages and salaries	108,672.00
Total cost of goods sold	5,072,826.00
Gross profit	2,047,046.80
Selling, general and administrative expenses	19,000.00
Funds from operations (before interest and tax)	2,028,046.80
Non-cash operating expenses:	
Depreciation allowance[a]	184,000.00
Total operating expenses	5,275,826.00
Operating profit (PBIT)	1,844,046.80
Non-operating expenses:	
Interest on loan[b]	888,300.00
Profit before taxes (PBT)	955,746.80
Tax (40%)	382,298.72
Profit after tax (PAT)[c]	573,448.08

a: Using straightline method
b: At 21% interest rate.
c: Accounting profit
Source: Computation based on Field Survey data, 1991.

Table 5.7. Profit and Loss Account of a typical Soybean Solvent Extraction Plant (Taraku Mills Ltd) at an annual processing capacity of 21,000 metric tons.

Item	Amount (₦)
Revenue:	
Soya oil	18,954,073.00
Soya meal[a]	34,559,838.00
Soap stock	30,640.00
Gross sales	53,544,551.00
Less sales discounts	1,753,511.60
Net sales	51,791,039.00
Costs of goods sold:	
Cost of goods sold (soya oil)	8,165,725.00
Cost of goods sold (soya meal)	30,806,243.00
Cost of goods sold (soap stock)	8,525.00
Total cost of goods sold	38,980,493.00
Gross profit	12,810,546.00
Less selling, general and administrative expenses	3,250,977.00
Funds from operations (before interest and taxes)	9,559,569.00
Non-cash operating expenses:	
Depreciation allowance	5,016,686.10
Total operating expenses	47,248,156.00
Operating profit (PBIT)	4,542,882.90
Non-operating expenses:	
Interest on loans	1,077,157.62
Profit before taxes	3,465,725.30
Tax (40%)	1,386,290.10
Profit after tax (PAT)[b]	2,079,435.20

a: Meal is the term used for the residues after solvent extraction of oil from soybean seeds.
b: Equals accounting profit.
Source: Field Survey data, 1991.

Table 5.8. Revenue and cost components of a typical Screw press (Oja Farms Ltd) at a projected* annual processing capacity of 1000 metric tons.

Item	Amount (₦)
Revenue:	
Soya oil	673,750.00
Soya cake	3,373,750.00
Total gross sales	4,067,500.00
Variable costs**	
Wage	3,456.00
Staff salaries and emolument	72,000.00
Raw materials (soybean) cost	2,700,000.00
Gas	79,200.00
Fuel and lubricants	28,800.00
Electricity bills	36,540.00
Maintenance costs	21,600.00
Caustic soda and other chemicals	18,000.00
Interest paid	126,000.00
Total variable costs	3,085,596.00
Gross margin	981,904.00
Rent	10,000.00
Return to fixed assets and entrepreneurship	971,904.00
Depreciation allowance	25,000.00
Return to entrepreneurship*** (Pure profit or economic rent)	946,904.00

* Projected with an installed maximum capacity of 4 tonnes daily for 250 days of operations in a year.

** Variable costs were extrapolated based on the percentage increase in the capacity utilisation of the mill.

*** Reward for management and entrepreneurship.

Source: Field Survey data, 1991.

Table 5.9. Revenue and cost components of a typical Hard press (Kofa Vegetable Oil Ltd) at a projected[a] annual processing capacity of 11,250 metric tons annually.

Item	Amount (₦)
Revenue:	
Soya oil	12,023,438.00
Soya cake	32,130,000.00
Soap stock[b]	20,000.00
Gross sales	44,173,438.00
Variable costs	
Wage	4032.00
Staff salaries and emolument	108,000.00
Raw material (soybean) cost	29,812,500.00
Water expenses[c]	1080.00
Fuel and lubricants	56160.00
Electricity bills	252,000.00
Black fuel	324,000.00
Caustic soda and other chemicals	24,000.00
Engine oil	162,000.00
Maintenance costs	77,184.00
Interest[a]	888,300.00
Total variable costs	31,709,256.00
Gross margin	12,464,182.00
Rent	20,000.00
Return to fixed assets and entrepreneurship	12,444,182.00
Depreciation allowance	184,000.00
Return to entrepreneurship[d] (Pure profit or economic rent)	**12,260,182.00**

a: Projected at an installed maximum capacity of 45 tonnes daily for 250 days annually.
b: Capable of selling only 20 drums (at ₦200 each) annually irrespective of the quantity produced.
c: Flat rate irrespective of the water consumed.
d: Reward for management and entrepreneurship.
Source: Field Survey data, 1991.

Table 5.10. Revenue and cost components of typical soybean Solvent Extraction Plant (Taraku Mills Ltd) at a projected* annual processing capacity of 62,500 metric tons.

Item	Amount (₦)
Revenue:	
Soya oil	111,145,000.00
Soya meal	169,125,000.00
Soap stock	91,190.50
Gross sales	280,361,000.00
Less sales discounts	5,248,546.40
Net sales	275,112,000.00
Costs of goods sold:	
Cost of goods sold (soya oil)	47,883,086.00
Cost of goods sold (soya meal)	150,756,000.00
Cost of goods sold (soap stock)	25,372.03
Total cost of goods sold	198,664,000.00
Gross margin	76,447,542.00
Depreciation allowance	5,016,686.10
Return to land and entrepreneurship** (Pure profit or economic rent)	71,430,856.00

* Projected at installed daily processing capacity of 250 tonnes for 250 days annually.

** Reward for entrepreneurship, land and management.

Source: Field Survey data, 1991.

Table 5.11. Profit and Loss Account of a Soybean Screw press (Oja Farms Ltd) at an estimated annual processing capacity of 1000 metric tons.

Item	Amount (₦)
Projected cash sales	4,067,500.00
Projected operating expenses:	
Materials and supplies	2,894,140.00
Wages and salaries	75,456.00
Total cost of goods sold	2,969,596.00
Gross profit	1,097,904.00
Less selling, general and administrative expenses	14,880.00
Funds from operations (before interest and tax)	1,083,024.00
Non-cash operating expenses:	
Depreciation allowance	25,000.00
Total operating expenses	3,009,476.00
Operating profit (PBIT)	1,058,024.00
Non-operating expenses:	
Interest on loan	126,000.00
Profit before taxes (PBT)	932,024.00
Tax (40%)	372,809.60
Profit after tax (PAT)*	559,214.40

*Equals accounting profit.

Source: Computation based on Field Survey data, 1991.

Table 5.12. Profit and loss account of a soybean Hard press (Kofa Vegetable Oil Mills Ltd) at a projected annual processing capacity of 11250 metric tons.

Item	Amount (₦)
Net cash sales	44,173,438.00
Projected operating expenses:	
Materials and supplies	30,728,924.00
Wages and salaries	112,032.00
Total cost of goods sold	30,840,956.00
Gross profit	13,332,482.00
Less selling, general and administrative expenses	114,000.00
Funds from operations (before interest and tax)	13,218,482.00
Non-cash operating expenses:	
Depreciation allowance	184,000.00
Total operating expenses	31,138,956.00
Operating profit (PBIT)	13,034,482.00
Non-operating expenses:	
Interest on loan	888,300.00
Profit before taxes (PBT)	12,146,182.00
Tax (40%)	4,858,472.80
Profit after tax (PAT)*	7,287,709.20

*Equals accounting profit.

Source: Computation based on Field Survey data, 1991.

Table 5.13. Profit and Loss Account of a typical Soybean Solvent Extraction plant (Taraku Mills Ltd) at a projected processing capacity of 62,000 metric tons.

Item	Amount (₦)
Revenue:	
Soya oil	111,145,000.00
Soya meal	169,125,000.00
Soap stock	91,190.50
Gross sales	280,361,000.00
Less sales discounts	5,248,546.40
Net sales	275,112,000.00
Costs of goods sold:	
Cost of goods sold (soya oil)	47,883,086.00
Cost of goods sold (soya meal)	150,756,000.00
Cost of goods sold (soap stock)	25,372.03
Total cost of goods sold	198,664,000.00
Gross profit	76,448,000.00
Less selling, general and administrative expenses	9,675,526.80
Funds from operations (before interest and taxes)	66,772,473.00
Non-cash operating expenses:	
Depreciation allowance	5,016,686.10
Total operating expenses	213,356,000.00
Operating profit (PBIT)	61,755,787.00
Non-operating expenses:	
Interest on loans	1,077,157.62
Profit before taxes	60,678,630.00
Tax (0%)	24,271,452.00
Profit after tax (PAT)*	36,407,178.00

* Equals accounting profit.
Source: Field Survey data, 1991.

(PAT) are ₦932,024.00 and ₦559,214.40; ₦12,146,182.00 and ₦7,287,709.20 and ₦60,678,630.00 and ₦36,407,178.00 respectively for the Screw press, Hard press and Solvent mill.

A comparison of the return parameters across the three (3) mills at actual and projected utilisation capacities shows that each of the oil mills would at least benefit 3 times the actual values of the return parameters (Table 5.14). Screw press would operate at a level where gross sales, gross margin, operating profit, profit after tax, soya cake and soya oil sales will rise by at least 5,14,5,23,5 and 6 times their respective values at the low capacity utilisation of 1989/90. Hard press would have its gross sale, gross margin, operating profit, profit after tax, soya cake and soya oil sales increased by at least 5,9,6,11,5 and 5 times respectively. The increases would be at last 4,4,12,16,3 and 4 times for solvent extraction in the respective return parameters. Correspondingly, the profit after tax (PAT) per tonne of soybean processed would increase by approximately 3,2 and 5 times for Screw press, Hard press and Solvent extraction respectively (Table 5.21). These, no doubt, succintly indicate the whopping monetary gains forgone (opportunity cost) because of under utilization of the installed capacities of the oil mills. Hence the opportunity costs to the mill's for operating at the 1989/90 capacity utilisation levels are colossal and capable of dampening the profitability of industrial processing of soybean as well as entreprenurship in this aspect of agro-processing.

Table 5.14. Return parameters of the three (3) soybean processing mills at actual processing capacities (1989/90) and estimated* processing capacities.

Mill characteristic	Screw press	Hard press	Solvent Extraction
Gross sales (N):			
Actual (1989/90)	640,668.75	7,119,872.80	53,544,551.00
projected	4,067,500.00	44,173,438.00	280,361,000.00
Percentage change (%)	535	520.4	424
Gross margin (N):			
Actual (1989/90)	65,202.75	1,178,746.80	12,810,546.00
Projectd	981,904.00	12,464,182.00	76,447,542.00
Percentage change (%)	1406	957.4	497
Operating profit (N):			
Actual (1989/90)	163,322.75	1,844,046.80	4,542.,882.90
Projected	1,058,024.00	13,034,482.00	61,755,787,00
Percentage change (%)	548	607	1259.40
Profit after tax (N):			
Actual (1989/90)	22,393.65	573,448.10	2,079,435.20
Projected	559,214.40	7,287,709.20	36,407,178.00
Percentage change (%)	2396	1171	1651
Soya meal/cake sales (N):			
Actual (1989/90)	539,606.25	5,166,504.00	34,559,838.00
Projected	3,393,750.00	32,130,000.00	169,125,000.00
Percentage change (%)	530	522	389.40
Soya oil sales (N):			
Actual (1989/90	101,062.50	1,933,368.80	18,954,073.00
Projected	673,750.00	12,023,438.00	111,145,000.00
Percentage change (%)	567	522	486.40
Soap stock sales (N):			
Actual (1989/90)	-a-	20,000.00	30,640.00
Projected	-a-	20,000.00	91,190.50
Percentage change (%)	-	-	198

*Percentage change at maximum installed capacities of 1000 metric tons (Screw press), 11250 (Hard press) and 62,500 (Solvent extraction plant).

Source: Computation based on Field Survey data, 1991.

5.3. Cost and return parameters in soybean oil mills

The actual processing parameters of the three soya mills based on 1989/90 mill utilisation capacities are shown in Table 5.15 and the corresponding monetary values of the income parameters per tonne of soybean are depicted in Table 5.16.

Solvent extraction mill realised highest returns for every tonne of soybean from oil sales at ₦1128.21/tonne; followed by Hard press at ₦1068.75/tonne and Screw press at ₦687.50. On the other hand, the meal sales per tonne are ₦3597.38, ₦2856.00 and ₦1645.71 for Screw press, Hard press and Solvent mill respectively again depicting the negative correlation between soya oil and meal output per tonne across the mills. Gross sales per tonne is highest for Screw press at ₦4271.26 and lowest for Solvent extraction plant at ₦2549.74 whereas the gross margin per tonne is highest for Hard press at ₦651.60 per tonne and lowest for Screw press at ₦434.69. Furthermore, PAT per tonne is highest for Screw press at ₦149.29 and lowest for solvent plant at ₦99.02 (Table 5.17). These trends suggest the following:

(i) that the colossal overhead and administrative costs of the solvent extraction mill and hence large total cost of processing are capable of depleting the values of the return parameters;

(ii) that solvent mill could be of lowest cost-efficiency though it has the lowest cost per tonne which does not imply that it is more cost-efficient than any of the other mills;

Table 5.15. Processing parameters of soybean Screw press, Hard press, (expellers) and Solvent extraction mills based on 1989/90 figures.

Parameter	Unit	Screw press	Hard press	Solvent Extraction
Average daily input capacity	tonne	1.5	15	250
Actual annual input used	tonne	150	1809	21,000
Output capacity:				
Soya oil	litres	8593.75	214,818.75	1,184,629.6
Soya cake/meal	tonnes	135.75	1519.6	10,472.7
Waste	tonnes	6	72.36	4,200
Quality of oil lost in cake/meal	litres	15,625	113,062.	101,358.68
Quantity of oil lost in refinery	litres	171.875	10,741.0	105,000

Source: . Computation based on Field Survey data, 1991.

Table 5.16. Processing parameters (in Naira) per tonne of soybean processed at Screw press, Hard press and Solvent Extraction plant based on 1989/90 production figures.

Parameter	Screw press	Hard press	Solvent Extraction	C.V. (%)
Output capacity:				
Soya oil (refined) (₦/tonne)	687.50	1068.75	1128.22	21.57
Soya cake/meal (₦/tonne)	3597.38	2856.00	1645.71	36.49
Waste (₦/tonne)	92.00	106.00	440.00	92.63
Oil lost in cake/meal (₦/tonne)	1250.00	562.50	53.10	96.59
Oil lost in refinery (₦/tonne)	13.75	53.44	55.00	57.40

Source: Computation based on Field Survey data, 1991.

Table 5.17. Return parameters (in Naira) for the Screw press, Hard press and Solvent Extraction plant based on 1989/90 production figures.

Item	Screw press	Hard press	Solvent Extraction	C.V. (%)
Gross sales	640,668.75	7,119,872.80	53,544,551.00	-
Gross sales per tonne	4271.26	3935.81	2549.74	25.45
Gross margin	65,202.75	1,178,746.80	12,810,546.00	-
Gross margin per tonne	434.69	651.60	610.03	20.36
Operating profit	163,322.75	1,844,046.80	4,542,882.90	-
Operating profit per tonne	1088.95	1019.37	216.33	62.59
Profit after tax (PAT)	22,393.65	573,448.10	2,079,435.20	-
Profit after tax per tonne	149.29	317.00	99.02	60.56
Proportion of gross sales (%) from:				
Soya oil	15.8	27.2	35.40	NC
Soya meal/cake	84.2	72.6	64.54	NC
Soap stock	-a-	0.2	0.060	NC

-a- = No sale of soap stock yet.
NC = Not computed.
Source: Computation based on Field Survey data, 1991.

(iii) also Solvent mill incurred huge losses of crude oil as soap stock coupled with high costs of oil refining aimed at meeting international standards.

Notably, gross sales per tonne as well as profit after tax per tonne decreased with increases in the efficiencies of oil extraction. This is largely because of the differential scales of operation, capacity utilization, sales promotional techniques employed and other administrative and efficiency measures of the oil mills.

The cost components of soybean processing into oil and feedcake differ among the oil mills (Table 5.18). Total variable cost (TVC) per tonne of soybean as well as total cost (TC) per tonne of soybean decreased with increase in oil extraction efficiency across the mills. TVC per tonne of soybean decreased from ₦4236.44 with Screw press through ₦3284.20 for Hard press to ₦1826.20 for Solvent plant. Similarly, TVC per litre of oil and TVC per tonne of cake/meal decrease respectively from ₦68.33 and ₦4239.16 through ₦27.66 and ₦3909.77 to ₦22.60 and ₦3722.10 for Screw press, Hard press and Solvent plant respectively. On the other hand, total fixed cost (TFC) per tonne of soybean, TFC per litre of oil and TFC per tonne of cake/meal are ₦185.7, ₦3.31 and ₦205.38 respectively for Screw press, and are ₦123.27, ₦5.08 and ₦718.17 for Hard press and ₦393.70, ₦5.42 and N892.30 for Solvent extraction mill. However, it is noteworthy that TFC per tonne of soybean is highest with Solvent extraction mill because of the proportion of the total cost (TC) that is fixed cost. This is so because of the sophistication involved in the

Table 5.18. Comparison of processing cost parameters of soybean Screw press, Hard press and Solvent extraction based on 1989/90 production figures in Naira.

Mill characteristic	Screw press	Hard press	Solvent Extraction	C.V. (%)
Total variable cost per tonne processed	4236.44	3284.20	1856.20	38.33
Total variable cost per litre of oil	68.33	27.66	22.60	63.42
Total variable cost per tonne of cake/meal	4239.16	3907.77	3722.10	6.62
Total fixed cost	27,880.00	223,000.00	8,267,663.1	165.59
Total fixed cost per tonne of soybean	185.87	123.27	393.70	60.43
Total fixed cost per litre of oil	3.31	5.08	5.42	24.61
Total fixed cost per tonne of cake/meal	205.38	718.17	892.30	59.00
Total cost per tonne of soybean	4022.31	3407.48	2301.21	26.89
Total cost per tonne of cake/meal	4444.54	4056.52	4614.40	6.54
Total cost per litre of refined oil	71.64	28.69	28.05	58.38
Raw material cost as a proportion of TC (%)	57.2	77.8	76.60	16.40
Cost of caustic soda per tonne of soybean	20.00	2.21	2.59	122.94
Depreciation allowance per tonne of soybean	100.00	101.71	238.89	54.27
Fuel and lubricant cost per tonne processed	32.00	49.95	55.84	27.04
Hexane cost per tonne processed[a]	-	-	22.61	-

Water expenses per tonne processed[b]	9.60	0.597	26.50	107.51
Fixed asset per tonne of soybean processed	3333.33	2338.31	3.244.20	18.53
Salaries and emolument per tonne processed	480.00	59.70	84.20	113.44
Administrative cost per tonne processed	**19.20**	**10.5**	**154.81**	**131.58**
Interest on loan per tonne processed	840.00	491.05	51.30	85.77
Mill maintenance cost	32.00	7.11	NA	90.00

a: Only Solvent Extraction plant (Taraku Mills Ltd) uses Hexane in processing.
b: Imputed ₦120 monthly water rate as charged in the vicinity.
NA: Not available.
Source: Computation based on Field Survey data, 1991.

method of oil extraction necessitating large administrative and other fixed costs per tonne of soybean processed.

The total cost per tonne of soybean is highest with Screw press (₦4022.31) and lowest with Solvent extraction mill (₦2301.21). This, of course, cannot be interpreted as depicting highest cost efficiency of Solvent mill compared to the others moreso as the gross sales and profit after tax per tonne are lowest with Solvent mill based on 1989/90 figures. Therefore, a measure of cost efficiency must take into consideration the corresponding return parameter per tonne. In this case, however, the gross sa;es per tonne of soybean is disproportionately lowest for Solvent extraction (₦2549.74); the operating profit per tonne (₦216.33) and profit after tax per tonne (₦99.02) are lowest for Solvent mill hence the apparent gains in reduced cost of processing of a tonne of soybean using Solvent mill (₦2301.10) is offset by a dispproportionately lowest gross sales per tonne in Solvent mill. Consequently, Solvent mill cannot be said to be the most cost-efficient (largely because of the extensive production structure); rather the Hard press with the highest value added (Net profit) at ₦528.33 appears to be the most cost-efficient and Solvent mill next at a net value added of N474.19 per tonne of soybean (Table 5.19).

Cost and return parameters across the three mills exhibited high correlation coefficients (Appendix A). Also gross sales per tonne of soyban increase with increases in soya oil sales, total variable cost and total cost per tonne of soybean across the three proessing mills

Table 19. Estimated value-added created in the processing of a metric ton of soybean for the three(3) mills based on 1989/90 production figures.

Item	OIL MILL		
	Screw press	Hard press	Solvent extraction
Soya oil sales (₦)	687.50	1068.75	1128.22
Soya meal/cake sales(₦)	3597.38	2856	1645.71
Soap stock sales(₦)	-	11.06	1.46
Total sales per tonne of soybean (₦)	4,284.88	3935.81	2775.39
Total processing cost per tonne of soybean	4022.31	3407.48	2301.20
Net value added per tonne (₦)	262.57	528.33	474.18

Source: Computed from field data, 1991 and previous tables.

(Fig. 1). And gross sales per tonne also increase with increases in TVC and TC per tonne of cake produced (Fig.2).

5.4. Financial performance of the oil mills

Some financial ratios were computed for each of the mills in order to capture their financial performances in the areas of profitability, liquidity and credit-worthiness and efficiency of management (Table 5.20). Solvent extraction mill performed best in terms of asset coverage ratio, a measure of credit-worthiness, at a value of 110%. That means it's total assets secured its long term debts 1.1 times. The values are 1 and 0.83 times for Hard press and Screw press respectively. Similarly, Solvent mill had the highest operating ratio and administrative expense index. The high value of administrative expense control (6.3%) implies that the mill had relatively high administrative expenses at ₦154.81 per tonne of soybean (Table 5.18); approximately 6.3% of the total cost of processing per tonne. On the other hand, Screw press and Hard press had good performances in terms of profitability measures. Return on sales and return on asset (measures of profitability) are highest with Hard press at 28.50% and 43.60% respectively, followed by Screw press at the respectively values of 25.54% and 32.67% and lowest in Solvent mill at 18.54% and 4.52%.

On inventory management, a measure of efficiency of management, Solvent mill performed best at a value of 7.78% implying that Solvent mill keeps inventory of products worth 7.78% of the total annual sales as a result of insufficient demand for its products, mainly

Table 5.20. Comparison of efficiency, profitability and credit worthiness parameters for the three (3) soybean processing mills based on 1989/90 figures.

Parameter	Screw press	Hard press	Solvent Extraction	C.V. (%)
*Inventory turnover (%)	11.56	13.56	7.78	26.77
*Operating ratio (%)	74.51	74.10	91.23	12.23
**Return on sales(%)	25.54	28.50	18.54	21.14
**Return on asset(%)	32.67	43.60	4.52	74.87
***Asset coverage ratio (%)	83.00	100.00	110.00	13.98
*Administrative expense control(%)	0.50	0.27	6.3	144.99

*Efficiency ratios.
**Profitability ratios.
*** Liquidity and credit worthiness ratio.
Source: Computed from Field Survey data, 1991.

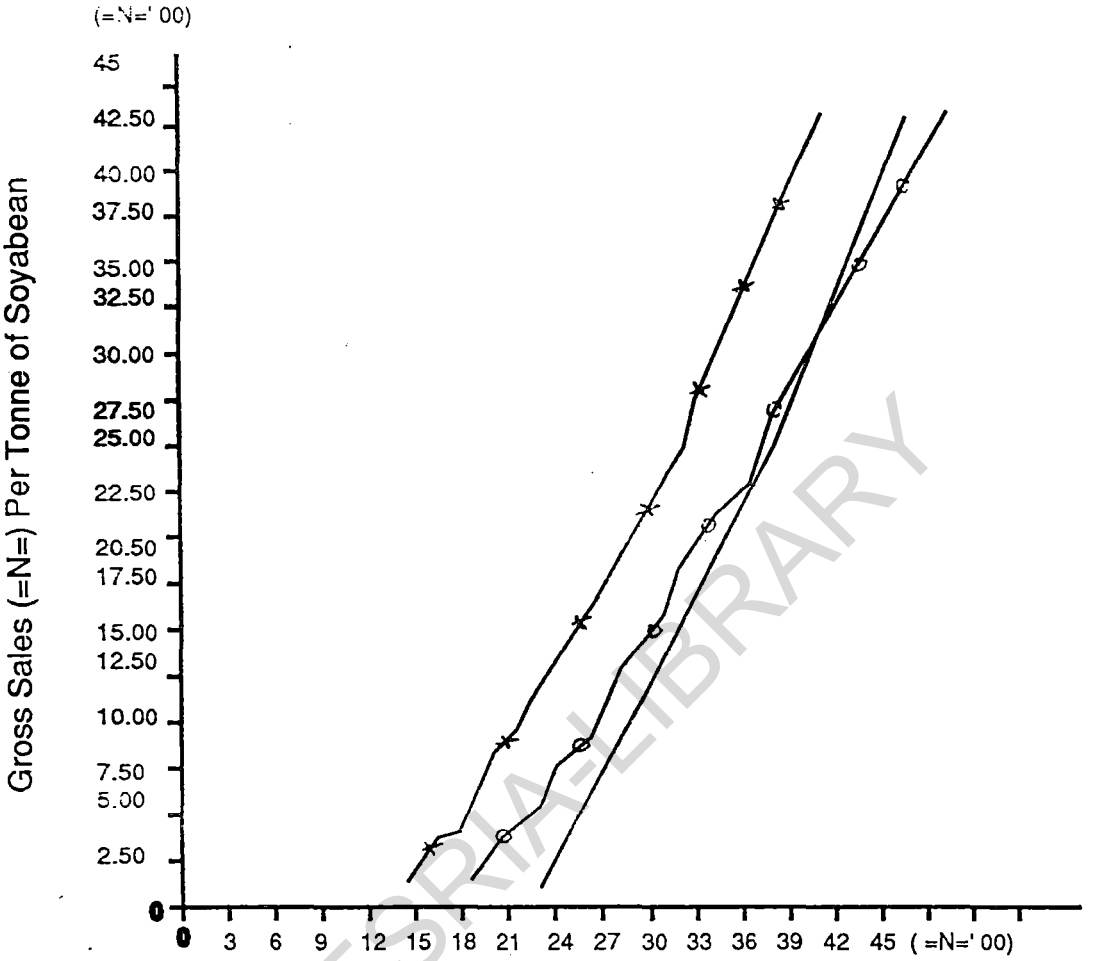
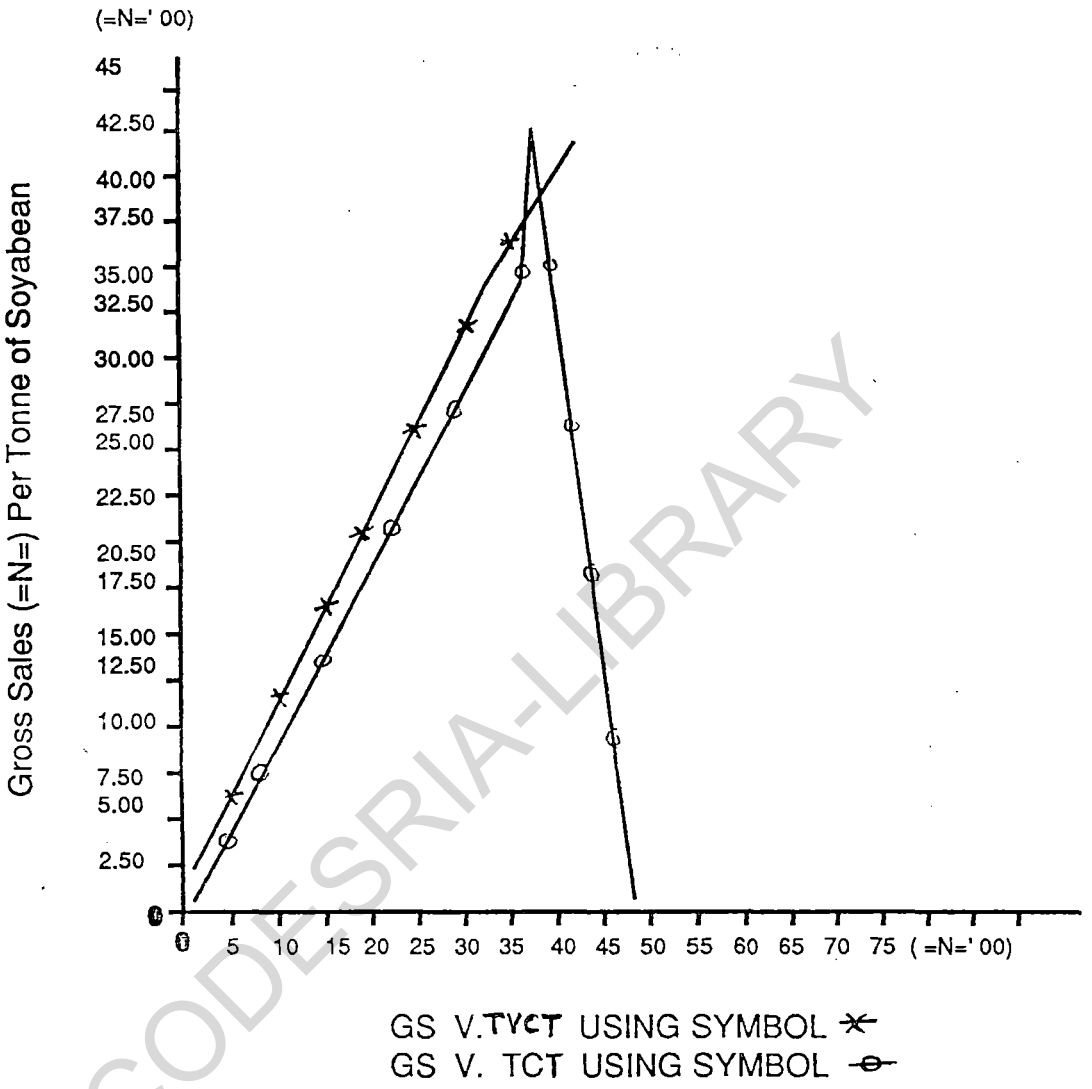


Figure 1: Relationship between gross sales and Soya Oil sales, TC/tonne and TVC/tonne of soybean.



SOS : Soyaoil Sales (=N=) Per Tonne of Soyabean
TC : Total Cost (=N=) Per Tonne
TVC : Total Variable Cost (=N=)
GS : Gross Sales (=N=) Per Tonne of Soyabean
TVCT: Total Variable Cost per tonne of cake
TCT: Total Cost per tonne of cake

Figure 2: Relationship between gross sales per tonne and total variable cost and total cost per tonne of cake.

soya meal. The respective figures for Screw press and Hard press are 11.56% and 13.56%, hence both mills kept high cake inventories in relation to the total sales during the 1989/90 production years.

5.5. Actual and estimated costs and returns

The costs and returns of the three oil mills at actual and estimated (projected) processing capacities are depicted in Tables 5.21 and 5.22.

The Tables reveal that most of the cost parameters (e.g. TC/tonne, TVC/tonne, administrative cost/tonne etc) decreased per tonne of soybean for Screw press and Hard press. On the other hand, TVC and TC per tonne of soybean and TVC/tonne of meal, all increased while administrative cost and total fixed cost (TFC) per tonne of soybean decreased for Solvent mill. TC and TFC per tonne of soybean processed decreased from ₦4022.31 and ₦185.87 to ₦3135.50 and ₦49.88 respectively for Screw press and decreased from ₦3407.48 and ₦123.27 to N2847.00 and ₦28.27 for Hard press. Solvent extraction mill had an increase from ₦2301.20 to ₦3431.00 of TC/tonne and a decrease from ₦393.70 to ₦235.10 of TFC/tonne. Also TVC/tonne of soybean decreased for Screw press (₦4236.44 to ₦3085.60) and Hard press (₦3284.20 to ₦2818.60). Solvent mill had an increase from ₦1856.21 to ₦3178.62. Obviously, the decreases achieved in the TFC/tonne for all the mills is due to the increased capacity utilisation which allowed for a more intensive use of the fixed resources and therefore greater spread.

In the same vein, the gross sales per tonne decreased for Screw press (₦4271.26 to ₦4067.90) and Hard press (₦3935.81 to ₦3926.53) but increased for Solvent mill (₦2549.74 to ₦4485.78). However, the gross margins and profit after tax (PAT) per tonne increased by ₦547.21 and ₦409.84 respectively for Screw press; and ₦456.33 and ₦330.80 for Hard press. The corresponding increases are ₦613.13 and ₦483.50 for Solvent mill. Precisely, Screw press at a capacity of 1000 metric tons would obtain a decrease of ₦203.76 in gross sales and an increase of ₦409.84 in after tax profit (PAT) for every tonne of soybean. Hard press at a capacity of 11250 metric tons would suffer a decrease of only ₦9.28 in gross sales and an increase of ₦330.80 in PAT for every tonne processed. The corresponding cost decreases are ₦1150.84 (TVC/tonne) and ₦886.83 (TC/tonne) for Screw press and ₦465.60 (TVC/tonne) and ₦560.61 (TC/tonne) for Hard press. In Solvent mill, the gross sales and PAT per tonne would increase by ₦1936.04 and ₦483.50 respectively while the corresponding cost increases are ₦1322.41 for TVC/tonne and ₦1129.72 for TC/tonne.

These trends suggest the following:

(i) that both Screw press and Hard press would have attained the point of decreasing returns to scale as the total sales decrease for every tonne irrespective of the cost reduction. They are, therefore, operating in stage III of the production function. This does not insinuate that they are not profitable as shown by the increase in profit after tax values of ₦409.84 and ₦330.80 for Screw press and Hard press respectively.

Table 5.21. Actual and projected return parameters of the three Mills.

OIL MILL	Gross sales	Gross margin	Operating profit	Profit after tax per tonne	Soya Meal sales	Soya Oil sales
Screw press:						
Actual	4271.26	434.69	1088.95	149.37	3597.38	673.75
Projected	4067.50	981.90	1058.02	559.21	3393.75	673.75
Change	-203.76[a]	547.21[b]	-30.93[a]	409.84[b]	-203.63[a]	0
Hard press:						
Actual	3935.81	651.60	1019.37	317.00	2856.00	1068.75
Projected	3926.53	1107.93	1158.62	647.80	2856.00	1068.75
Change	-9.28[a]	456.33[b]	139.25[b]	330.80[b]	0	0
Solvent mill:						
Actual	2549.74	610.03	216.33	99.02	1645.71	1128.22
Projected	4485.78	1223.16	988.10	582.52	2706.00	1778.32
Change	1936.04[b]	613.13[b]	771.77[b]	483.50[b]	1060.29[b]	650.10[b]

a: Decreases in values per tonne.
b: Increases in values per tonne.

Table 5.22. Cost parameters at actual and projected processing capacities of the oil mills.

OIL MILL	TVC/t of soybean	TVC/l of oil	TVC/t of cake	TFC/t of soybean	TFC/l of oil	TFC/t of cake	TC/t of soybean	TC/t of cake	TC/l of oil	ADC*/t of soybean
Screw press:										
Actual	4236.44	68.33	4239.50	185.87	3.31	205.38	4022.31	4444.54	71.64	19.20
Projected	3085.60	54.96	3409.50	49.88	0.89	55.12	3135.48	3464.61	55.85	14.88
Change	-1150.84[a]	-13.37[a]	-830.00[a]	-135.99[a]	-2.42[a]	-150.26[a]	-886.83[a]	-979.93[a]	-15.79[a]	-4.32[a]
Hard press:										
Actual	3284.20	27.66	3909.77	123.27	5.08	718.17	3407.48	4056.52	28.69	10.50
Projected	2818.60	23.74	3355.50	28.27	0.24	33.65	2846.87	3389.13	23.97	10.13
Change	-465.60[a]	-3.92[a]	-554.27[a]	-95.00[a]	-4.84[a]	-684.52[a]	-560.61[a]	-667.39[a]	-4.72[a]	-0.37[a]
Solvent mill:										
Actual	1856.21	22.60	3722.10	393.70	5.42	892.30	2301.21	4684.40	28.05	154.18
Projected	3178.62	19.70	3876.37	235.10	1.45	286.68	3430.93	4184.10	21.22	154.18
Change	1322.41[b]	-2.9[a]	154.27[b]	-158.6[a]	-3.97[a]	-605.62[a]	1129.72[b]	-500.30[a]	-6.83[a]	0

a: Decreases in values per tonne.
b: Increases in values per tonne.
ADC*/t: Administrative cost per tonne.

(ii) that both Screw press and Hard press would attain points of economic optima at processing capacities below the projected values/levels of 1000 and 11250 metric tons for Screw press and hard press respectively.

(iii) that Solvent extraction mill (Taraku Mills Ltd) would attain better and economic point of processing (economic optimum) at a utilisation capacity greater than 62,500 metric tons annually; this being smaller than the installed capacity of 72,000 metric tons. This is because at the projected capacity, the increase in gross sales per tonne (₦1936.40) is far greater than the increase in TC/tonne of soybean (₦1129.72), implying that the mill is at the stage of increasing returns to scale. Again, as in the other mills, the PAT per tonne is still great at an increased value of ₦582.52 (a difference of ₦483.50).

5.6. Results of Analysis of Variance (ANOVA)

The results of ANOVA computed for the three mills across a number of processing cost and return parameters are shown in Tables 5.23 to 5.25.

In Table 5.23, gross sales, gross margins, operating profits, profits after tax, soya meal sales and soya oil sales per tonne do not differ significantly across the oil mills. Hence in terms of returns the three mills are not significantly different. However, some of the cost parameters differ significantly from the others (Table 5.24). TVC per litre of oil for the Screw press is significantly different from the values for Hard press and Solvent mill. The TFC/tonne of soybean in Solvent

mill is highest and significantly different from the values for Screw press and Hard press largely because of the colossal administrative, depreciation and other fixed expenses of the Solvent mill. Also TC/tonne of cake, produced at Screw press is highest and significantly different from the values for Hard press and Solvent mill, whereas the corresponding values for Hard press and Solvent mill are not significantly different. Administrative expenses per tonne of soybean for Solvent mill is highest and significantly different from the values for Screw press and Hard press and the latter mills are not significantly different in terms of the cost per tonne for mill administration.

At the projected capacities, each of the mills also witnessed some improvements in certain financial management indices such as return on assets, return on sales, administrative expenses ratio etc. (Table 5.25). As depicted in Table 5.26, the computed financial ratios do not differ significantly across the oil mills. Specifically, the mills do not differ significantly in terms of profitability and efficiency measures. However, the mills differ significantly in terms of asset coverage ratio, a measure of credit worthiness, with each mill significantly different from the others. This shows that the number of times the long term debt is secured by net value of assets is signifiantly different among the mills and it shows that the mills have different abilities to repay long term debts in times of liquidation.

Table 5.23. Comparison of some selected return parameters per tonne of soybean across the three Soya Mills using Duncan's Multiple Range Test* (DMRT) at 5% level of probability.

OIL MILL	Gross sales	Gross margin	Operating profit	Profit after tax	Soya Meal sales	Soya Oil sales
	per tonne					
Screw press	4169.38[a]	708.30[a]	1073.49[a]	354.29[a]	3595.57	673.75[a]
Hard press	3931.17[a]	879.77[a]	1088.99[a]	482.40[a]	2831.00[a]	1063.75[a]
Solvent mill	3517.76[a]	916.60[a]	602.22a	340.77[a]	2175.86[a]	1340.45
Mean	3872.77	834.89	921.57	392.49	2834.14	1025.98
C.V. (%)	21.61	6.67	32.45	13.76	16.68	35.05

*: Within column, means of the same letter(s) are not significantly different by DMRT at 0.05.

Table 5.24. Comparison of some cost parameters of processing soybean across the three Soya Mills using DMRT* at 5%.

OIL MILL	TVC/t of soybean	TVC/l of oil	TVC/t of cake	TFC/t of soybean	TFC/l of oil	TFC/t of cake	TC/t of soybean	TC/l of oil	TC/t of cake	ADC/t of soybean
Screw press	3661.02[a]	61.65[a]	3824.50[a]	117.88[a]	2.10[a]	130.25[a]	3578.90[a]	3954.58[a]	63.75[a]	17.04[b]
Hard press	3051.40[a]	25.70[b]	3632.64[a]	75.77[a]	2.66[a]	375.91[a]	3127.18[a]	3722.83[a]	26.33[b]	10.32[b]
Solvent mill	2517.42[a]	21.15[b]	3799.24[a]	314.40[b]	3.44[a]	589.49[a]	2866.07[a]	4434.25[a]	24.64[b]	154.18[a]
Mean	3076.61	36.17	3752.12	169.35	2.73	365.22	3190.71	4037.22	38.24	60.51
C.V. (%)	29.35	11.29	9.57	13.46	31.73	55.84	23.99	4.26	10.87	2.80

TVC = Total variable cost; TFC = Total fixed cost; TC = Total cost; ADC = Administrative cost per tonne of soybean; t = tonne; l = litre.

*: Within column, means of the same letter(s) are not significantly different by DMRT at 0.05.

Table 5.25. Financial ratios at the actual and projected capacities for the Oil Mills.

OIL MILL	Return on sales	Asset coverage ratio	Operating ratio	Return on assets	Inventory turnover	Administrative expense control
Screw press:						
Actual	27.84	83	74.51	32.67	11.56	0.50
Projected	26.63	83	74.00	21.61	11.21	0.37
Hard press:						
Actual	28.50	100	74.10	43.60	13.56	0.27
Projected	29.92	100	70.50	308.00	13.26	0.25
Solvent mill:						
Actual	18.54	110	91.23	4.52	7.78	6.3
Projected	24.30	114	78	61.50	16.8	3.5

*: Within column, means of the same letter(s) are not significantly different by DMRT at 0.05.

Table 5.26. Comparison of efficiency, profitability and credit worthiness parameters across the three Mills using DMRT* at 5%.

OIL MILL	Return on sales	Asset coverage ratio	Operating ratio	Return on assets	Inventory turnover	Administrative expense control
Screw press	27.24[a]	83.00c	74.26[a]	122.14[a]	11.39[a]	0.44[a]
Hard press	29.21[a]	100.00[b]	72.30[a]	175.80[a]	13.41[a]	0.26[a]
Solvent mill	21.42[a]	112.00[a]	84.62[a]	33.01[a]	12.29[a]	4.90[a]
Mean	25.96	98.33	77.06	110.32	12.36	1.87
C.V. (%)	9.59	1.66	6.09	66.82	30.86	59.69

*: Within column, means of the same letter(s) are not significantly different by DMRT at 0.05.

5.7. Results of variable classification technique

The matrix of correlation coefficients shows that some of the variables are highly dependent (Appendix A). However, the degree of non-inter-correlation (non-correlation) is also high for some variables (Appendix B). The row means are the average level of non-correlation between the row variable and the other variables. The circled elements of the R* matrix show the Zi or the least level of inter-correlation between the row variable and column variables.

The Ci, ji's are (2,14); (3,13); (4,1);(4,5); (4,6); (4,11); (4,12); (5,4); (6,9); (7,8); (7,10); (8,7); (13,3) and (14,2).

The corresponding frequency table of the ji in Ci, ji is shown in Appendix C.

The variable classification equation empirically derived is given as:

$$O \leq Zi \leq 19.7$$

From this equation, the following variables are "compact" or core variables that can be used in determining the performance of soybean processing mills studied:

(i) Ownership patterns

(ii) Installed daily capacity of the mills

(iii) Finance variables such as total cost, gross sales, soya oil sales, soya meal sales, and administrative cost per tonne.

(iv) Mill utilisation capacity

(v) Oil extraction efficiency

(vi) Proportion of the staff strength that is skilled

(vii) Location of the mill (whether urban or rural)

(viii) Net value added per tonne of soybean processed.

Other variables such as degree of integration, and the type of management are irrelevant in determining the performance of the studied soya mills.

CHAPTER SIX

6.0. SUMMARY, POLICY IMPLICATIONS AND CONCLUSIONS

6.1. Summary of major findings

Across the three soya mills (Screw press, Hard press and Solvent extraction), utilisation capacities based on 1989/90 production figures were very low ranging from 15% for Screw press, 16.1% for Hard press and 29.2% for Solvent extraction. Oil extraction efficiency is highest for Solvent mill (94.4%) and lowest for Screw press (31%). The market demand for soya oil is very high as all the three mills had no inventory of oil but the soya cake/meal is presently under demanded as reflected in the inventory levels of 10, 110 and 1200 metric tons at monetary values of ₦265.00, N206.74 and ₦188.57 per tonne of soybean processed by Screw press, Hard press and Solvent extraction mill respectively. Also all the mills are profitable based on actual (1989/90) and projected utilisation capacities of 1000, 11250 and 62,500 metric tons annually with per tonne gross margins of ₦434.69, ₦651.60 and N610.03 for Screw press, Hard press and Solvent extraction respectively for the 1989/90 capacity. The corresponding operating profits per tonne are ₦1088.95, ₦1019.37 and ₦216.33 respectively for the mills. Therefore industrial processing of soybean into oil and feedcake is very profitable.

Oil sales per tonne is highest for Solvent mill (₦1128.22) and lowest for Screw press (687.50) while cake/meal sales per tonne is highest with Screw press (₦3597.38) and lowest with Solvent extraction mill (₦1645.71). TVC per tonne of soybean is lowest for Solvent extraction (₦1856.20) but highest for Screw press (₦4236.44)

whereas TFC is highest for Solvent plant at ₦393.70 and lowest for Hard press (₦123.27) per tonne. Administrative cost per tonne is also highest for Solvent extraction because of its extensive administrative and management set up. However, net value added (net profit) is highest for Hard press (₦528.33) and lowest for Screw press (₦262.57).

On financial management, Solvent extraction has the highest administrative expense ratio, an indication of highest administrative expenses per tonne of soybean. However it has the highest asset coverage ratio, a measure of high credit worthiness. But Screw press and Hard press had better performances in terms of profitability measures with return on sales ratios of 25.54% ad 28.50% and return on assets ratios of 32.67% and 43.60% respectively while the values for Solvent extraction mill are 18.54% and 4.52% for returns on sales and assets ratios respectively.

At the projected capacities of 1000 (Screw press); 11250 (Hard press) and 62,500 metric tons (Solvent mill), most cost parameters (per tonne) decreased from their actual values for Screw press and Hard presses. Specifically, TVC and TC (per tonne) decreased by ₦1150.84 and ₦886.83 resectively for Screw press and ₦465.60 and ₦560.61 for Hard press respectively for TVC and TC per tonne, whereas the gross sales (per tonne) also decreased by a smaller percentage at values of ₦203.76 and N9.28 respectively for Screw press and Hard press. On the other hand, TVC and TC increased by ₦1322.41 and ₦1129.72 per tonne respectively for Solvent mill whereas the gross sales and gross margin had more than proportionate

increases of ₦1936.04 and ₦613.13 per tonne. These trends suggest that Screw press and Hard press have attained higher cost effectiveness and efficiencies at the projected utilisation capacities. Also as the gross sales per tonne decreased for both mills with the decreases in total cost (TC) and total variable cost (TVC), it is also likely that Screw press and Hard press attained stage III (irrational stage) of the production function and therefore it is not economically advisable for both mills to exceed the projected capacities. Lesser capacity utilisation levels would attain economic optima for both mills at the prevailing technologies in the mills.

Solvent extraction mill on the other hand, with such trends of costs and returns, would probably be at the stage I (increasing returns to scale) where revenue increases at an increasing rate or at best in stage II (stage of decreasing returns to scale). However, further capacity utilisation is economically advisable for Solvent mill as the mill has an installed capacity of 72,000 metric tons compared with the projected 62,500 metric tons. This will enable the mill to attain the point of economic optimum where MC = MR since the gross sales per tonne increased more than proportionately with the corresponding increases in TVC and TC per tonne of soybean at the projected capacity.

Also the study reveals that the three mills did not differ significantly in a number of processing cost and return indices per tonne of soybean albeit TVC per litre of oil, TFC per tonne of soybean, TC per litre of oil as well as administrative cost per tonne of soybean showed significant differences across the oil mills. Also asset coverage

ratio (a measure of credit worthiness) differs significantly across the mills while profitability and efficiency ratios did not show any significant differences.

The work also revealed that the major problem plaguing industrial processing of soybean is inadequacy of the supplies of soybean. Others include inadequacy of working capital as well as the poor market demand for soya cake/meal and hence all the mills keep relatively large inventory of cake/meal.

6.2. Policy implications

Policy implications of the findings of this work an be examined under the following scenarios:

(i) Capacity utilisation: The capacity utilisation for the soya mills, as revealed in the study, is low and hence the need for an improvement. The major factor responsible for this is the inadequacy of the basic raw material - soybean-coupled with its off-seasonal price hikes. At the estimated processing capacities of the mills, a total of 74,750 metric tons would be required annually by the three soya mills. At full capacity utilisation of the Solvent extraction mill (Taraku Mills Ltd), the total soybean requirement is approximately 84,250 metric tons annually, which is well over two thirds of the total annual production in the country. With over 70 oil mills in the country, some using soybean, the low capacity utilisation phenomenon will be persistent. Therefore, governments and private agencies need to commit more resources towards the production of the "golden bean" in

order to enhance the utilisation capacities of oil mills in the country. Such efforts should include the following:

(a) encourangement of soybean farmers through price incentives so as to stimulate their urge to commit more hectarages to the production of the crop.

(b) encouragement of the crop of soybean researchers (especially soybean breeders) to explore more areas of improvement of the genetic qualities of the crop so as to raise the average yield per hectare as well as the oil output per tonne of soybean.

(c) the oil mills should also embark on measures aimed at stabilising the production and prices of the bean. This can be achieved through contractual marketing arrangment that will stabilise the price for both the producers and the mills hence stimulating greater outputs. The recently instituted approach of Farmer's Support Scheme of Taraku Mills Ltd is commendable in this regard.

(ii) Cost management: The various cost components of oil mills should made cost effective. Though the mills had good and adequate performances in terms of profitability, certain cost parameters (e.g. fixed costs, administrative cost etc) should be reviewed downwards and increases in capacity utilisation is one of such measures to bring this to bear. And since raw material cost forms over 50% of the total cost of processing soybean in most the mills, efforts should be made to reduce the per tonne cost of soybean. This can be achieved through bulk purchase during the on-season for storage.

(iii) Financing soybean processing: One of the ways to ensure adequate capacity utilisation is through the financing of soybean

processing ventures by governments and private agencies (e.g. banks and other financial houses). This, in no small measure, will boost the working capital base of existing oil mills as well as encourage propsective investors to venture into this aspect of agro-processing. Moreso as this study reveals the potentials of industrial processing of soybean in terms of profitability.

(iv) Integration and diversification: There is also the urgent need for the soya mills to embark on portfolio diversification so as to enhance the revenue base of the venture. Specifically, it is advisable that soybean mills integrate with users of its products, especially soya meal/cake, which does not command enough market at the moment. Integrating with livestock venture would ensure that soya meal/cake is cleared as soon as it is produced. This arrangement will serve the dual purpose of diversifying the revenue base as well as provide a ready market for the cake.

(v) Export implications: Soybean products, especially soya oil and cake have high foreign market. In particular, soy oil is capable of generating foreign exchange earnings if processed to international standards. Therefore, oil extraction efficiencies of the oil mills need to be improved so as to ensure that the proportion of oil content of soybean extracted is increased per tonne. Solvent extraction mill has already proved most efficient in this regard and if the processing capacities of the mills are increased as projected, approximately 8.3 million litres of refined soya oil will be produced by the three (3) mills as against the 1989/90 figures of about 1.5 million litres. This, in essence, implies several millions of soya oil litres when the envisaged

increases are extrapolated across all soybean processing mills in the country hence the export potentials of soya oil.

6.3. Conclusions

Soybean processing is a profitable venture and should be encouraged by both government and private agencies especially in the production of high quality soya oil for both local and foreign markets. The major problem affecting the capacity utilisation of the mills is inadequate raw material - soybean - as well as its off-seasonal price hikes.

Solvent extraction mill has the highest extraction efficiency with Hard press and Screw following in that order. Therefore, the extraction efficiencies of the latter mills should be enhanced through engineering improvement of the milling procedure so as to increase the oil ouput per tonne of soybean. Though each of the soybean processing technologies is profitable as revealed by the study, increases in capacity utilisation are capable of raising their profit margins per tonne and this can be achieved through adequate supply of the basic raw material-soybean-across all seasons at reasonable and stabilised producer prices.

Enough market can be created for the mills' soya meal/cake via portfolio diversification and integration in the area of livestock venture by the mills and adequate financial assistance in forms of long term loans can be of immense help in the amelioration of the working capital problems of the mills.

6.4. Suggested areas of research focus

This work covered certain aspects of the economics of soybean processing and also had limited scope in terms of the number of mills visited. Future research focus should address the comparison of the profitability of soybean and other oil seeds. Also the nutritional and economic implications of the consumption of soya oil relative to other oil types will be a laudable research venture.

There is also the need to evaluate the profitability of soybean processing across a large number of soya mills in the country and over many years with a view to identifying the spatial and temporal effects on the costs and returns of soybean processing. The export potentials of principal soybean products still need further evaluation so as to quality the social and economic benefits derivable from their exports. Lastly, there is also the urgent need to determine and evaluate resource allocation in the processing of soybean into oil and feedcake in Nigeria.

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Appendix A: Correlation matrix of selected performance characteristics* of the oil mills.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	-0.55	0.35	0.88	0.83	0.84	0.05	0.03	0.65	0	1.00	0.58	0.38	-0.50
2	-0.55	1	0.56	-0.13	-0.02	-0.01	0.81	0.78	0.28	0.57	-0.55	-0.35	0.48	0.99
3	0.35	0.56	1	0.63	0.72	0.75	0.91	0.91	0.90	0.42	0.35	-0.04	0.98	0.58
4	0.88	-0.13	0.63	1	0.99	0.98	0.46	0.35	0.90	0.44	0.88	0.67	0.60	-0.06
5	0.83	-0.02	0.72	0.99	1	1.00	0.56	0.47	0.95	0.48	0.84	0.60	0.68	0.05
6	0.84	-0.01	0.75	0.98	1.00	1	0.57	0.50	0.95	0.43	0.84	0.54	0.72	0.05
7	0.05	0.81	0.91	0.46	0.56	0.57	1	0.95	0.79	0.68	0.05	0	0.84	0.84
8	0.03	0.78	0.91	0.35	0.47	0.50	0.95	1	0.73	0.41	0.03	-0.28	0.92	0.78
9	0.65	0.28	0.90	0.90	0.94	0.95	0.79	0.73	1	0.53	0.65	0.37	0.86	0.33
10	0	0.57	0.42	0.44	0.48	0.43	0.68	0.41	0.53	1	0.00	0.58	0.25	0.65
11	1.00	-0.55	0.35	0.88	0.84	0.84	0.05	0.03	0.65	0.00	1	0.58	0.38	0.50
12	0.58	-0.35	-0.04	0.67	0.60	0.54	0	-0.28	0.37	0.58	0.58	1	-0.15	-0.25
13	0.38	0.48	0.98	0.60	0.68	0.72	0.84	0.92	0.86	0.25	0.38	-0.15	1	0.49
14	-0.50	0.99	0.58	-0.06	0.05	0.05	0.84	0.78	0.33	0.65	0.50	-0.25	0.49	1

* 1= Owneship pattern (zero-one variable; 2 = Installed daily capacity of mills (tonnes); 3 = Soya oil sales/tonne (₦/tonne); 4 = Meal/cake sales/tonne (₦/tonne); 5 = Total cost/tonne (₦/tonne); 6 = Gross sales per tonne (₦); 7 = Mill utilisation capacity (%); 8 = Oil extaction efficiency (%); 9 = Ratio of skilled to unskilled staff (%); 10 = Degree of integration (zero -one variable); 11 = Location of mill (zero-one variable); 12 = Type of management (zero-one variable); 13 = Net value added per tonne (₦) and 14 = Administrative cost per tonne (₦).

Appendix B: Non-correlation matrix of selected performance characteristics* of the oil mills.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	$\bar{S}^*_{ij}$
1	0	0.45	0.65	0.12	0.17	0.16	0.95	0.97	0.35	1	0	0.42	0.62	0.50	0.50
2	0.45	0	0.44	0.87	0.98	0.99	0.19	0.22	0.72	0.43	0.45	0.65	0.52	0.01	0.53
3	0.65	0.44	0	0.37	0.28	0.25	0.09	0.05	0.10	0.58	0.65	0.96	0.02	0.42	0.37
4	0.12	0.87	0.37	0	0.01	0.02	0.54	0.65	0.10	0.56	0.12	0.33	0.40	0.94	0.39
5	0.17	0.98	0.28	0.01	0	0	0.44	0.53	0.05	0.52	0.16	0.40	0.32	0.95	0.37
6	0.16	0.99	0.25	0.02	0	0	0.43	0.50	0.05	0.57	0.16	0.46	0.28	0.95	0.37
7	0.95	0.19	0.09	0.54	0.44	0.43	0	0.05	0.21	0.32	0.95	1.00	0.16	0.16	0.42
8	0.97	0.22	0.06	0.65	0.53	0.50	0.05	0	0.27	0.59	0.97	0.72	0.08	0.22	0.45
9	0.35	0.72	0.10	0.10	0.06	0.05	0.21	0.27	0	0.47	0.35	0.63	0.14	0.67	0.32
10	1	0.43	0.58	0.54	0.52	0.57	0.32	0.59	0.47	0	1.00	0.42	0.75	0.35	0.58
11	0	0.45	0.65	0.12	0.16	0.16	0.95	0.97	0.35	1	0	0.42	0.62	0.50	0.49
12	0.42	0.65	0.96	0.37	0.40	0.46	1	0.72	0.63	0.42	0.42	0	0.85	0.75	0.62
13	0.62	0.52	0.02	0.40	0.32	0.28	0.16	0.08	0.14	0.75	0.62	0.85	0	0.51	0.41
14	0.50	0.01	0.42	0.94	0.95	0.95	0.16	0.22	0.67	0.35	0.50	0.75	0.51	0	0.53

1= Owneship pattern (zero-one variable); 2 = Installed daily capacity of mills (tonnes); 3 = Soya oil sales/tonne (₦/tonne); 4 = Meal/cake sales/tonne (₦/tonne); 5 = Total cost/tonne (₦/tonne); 6 = Gross sales per tonne (₦; 7 = Mill utilisation capacity (%); 8 = Oil extaction efficiency (%); 9 = Ratio of skilled to unskilled staff (%); 10 = Degree of integration (zero-one variable); 11 = Location of mill (zero-one variable); 12 = Type of management (zero-one variable); 13 = Net value added per tonne (₦); and 14 = Administrative cost per tonne (₦).

Appendix C: End of node frequency table.

Variable	Frequency
2	1
3	1
4	5
5	1
6	1
7	2
8	1
13	1
14	1
Total	14

Appendix D: Analysis of variance (ANOVA) for selected return parameters in soybean processing.

Source of variation	Mean square[2]					
	Gross sales	Gross margin	Operating profit	Profit after tax per tonne	Soya Meal sales	Soya Oil sales
Rep.	494788.17	435603.65	129093.07	249753.12	137005.39	124917.63
Treatment[1]	217420.15(NS)	24715.771(NS)	153096.91(NS)	12218.01(NS)	870832.03(NS)	224383.93(NS)
Error	700069.70	3099.241	89447.51	2915.87	223542.32	129296.33
Total	465953.57	98246.73	122836.38	56004.17	465150.82	166455.63

1: Treatment (Oil Mills): Screw press (SP); Hard press (HP) and Solvent extraction (SE).
2: NS = Not significant.
* = Significant at 0.05 level of probability.

Appendix E: **Analysis of variance (ANOVA) for selected cost parameters in soybean processing.**

Source of variation	Mean square[2] TVC/t of soybean	TVC/l of oil	TVC/t of cake	TFC/t of soybean	TFC/l of oil	TFC/t of cake	TC/t of soybean	TC/t of cake	TC/l of oil	ADC/t o soybea
Rep.	14408.94	67.94	252150.00	25296.73	21.02	345792.03	16824.33	768,711.94	124.58	3.67
Treatment[1]	654869.64NS	984.20*	21735.35 NS	32446.39*	0.90NS	105622.21NS	260115.42NS	263307.23NS	977.45*	13183.2
Error	815291.60	16.66	128903.62	519.70	0.75	41584.31	585842.41	29637.11	17.27	2.87
Total	590946.28	413.93	110685.59	18245.78	4.86	128041.01	341748.00	270920.12	422.81	5275.18

1: Treatments (Oil Mills).
2: NS = Not significant at 0.05 level of probability.
* Mean squares of variables which are significantly different across the mill types.

Appendix F: Analysis of variance (ANOVA) for selected financial ratios based on 1989/90 figures.

Source of	Mean square[2]					
	Return on sales	Asset coverage ratio	Operating ratio	Return on assets	Inventory turnover	Administrative expense ratio
Rep.	5.94	2.67	50.11	41720.02	11.68	1.45
Treatment[1]	32.80(NS)	424.671*	87.60(NS)	10404.18(NS)	2.06(NS)	13.83(NS)
Error	6.19	2.67	22.01	5433.40	14.56	1.24
Total	16.79	171.47	53.87	14679.03	8.98	6.32

1: Treatment (Oil Mills).
2: Mean squares of variables.
* = Significant at 0.05 level of probability.