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ZAMBIA : ANALYSIS OF THE PRODUCTION POTENTIAL FOR INDIGENEOUS VEGETABLE OILS AND PROTEIN CAKE

PROJECT XA/ZAM/90/627

FINAL REPORT

MARCH 1992

INTER G

S U M M A R Y

PREFACE

A potential Zambian entrepreneur, Mr. MUNDIA F. SIKATANA, Manager of "ZAM-TAKE" 78 Ltd" was very interested by the abundance of Zambian forest species that give oil (nuts and berries) with a very high oil content approximatived for Zambian forest population traditionally.

In 1990, UNIDO gave a positive response to Mr. SIKATANA through listing into their program an incentive project to the establishment of a pilot unit that would process and trade three plants identified by Mr. SIKATANA, and that would supply substantial materials as Mr. SIKATANA concluded on the basis of his own investigations.

By virtue of contract XA/ZAM/90/627, french INTER G Company is in charge of the project.
The main objective of the project is to assist Zambian government to assess the viability of developping in Zambia vegetable oil and protein cake production based on three indigeneous plants : Mungongo, Mubula and Nunyele-Nyele.

An infield mission was carried out by a market specialist, a vegetable oil technologist and an agronomist essentially dedicated to collect :

- all available data concerning raw material resources
- data for the market survey
- local technology assessment
- data for the prefeasibility study.

Chemical and Physical tests were carried out on available materials i.e. Mubula, Mungongo nuts and Munyele Nyele fruits.

This prefeasibility report was based on all these available data.

The industrial valorisation study of these indigeneous plants is a first experience therefore three major factors are unknown :

- nut purchase price (currently collected, dehulled and processed manually by rural populations with a low purchassing power
- dehulling price (due to hard nut specific equipment is required))
- kernel purchase price.

Then a two stage price calculation approach was adopted :

1st stage : a pre-feasibility study based on dehulled raw material (kernels) and determination of a kernel purchase price.

2nd stage : assessment of kernel dehulling costs and determination of nut purchase price

As the market survey showed that there was a real edible oil shortfall in Zambia in this study two valorisation possibilities were contemplated :

. a small scale plant of 600-800 T of oil/year
. the processing of these indigeneous raw materials in existing plants

The first option offers several advantages :

. a small pilot plant will be developped in raw material production areas

. as raw material yields are still unknown a small scale plant is much more adapted in a first stage

. the limited oil production requires reduced kernels supply and allows on first stage, to develop specific dehuiling equipments for mungongo and mubula nuts

. the project can be repeated in various areas of the country, it would meet local population needs and offer employement.

The second option is interesting because of surplus processing capacities of existing oil processing plants but it means higher quantities of kernels and more transportation.

Considering the small scale plants study showed that a containerized small scale plant should be envisaged since it would be easily transferable from one place to another one, and without erecting and assembling investrents.

I - SUMMARY

Zambia land-locked country of 753.000 square kilometers has a population estimated at 7,8 millions inhabitants in 1990 ; national population density is very low which is a major constraint for rural activities development.

Moreover the G.D.P per capita is low US $ 390 which means a low purchasing power.

The analysis of the production potential for indigeneous vegetable oils and protein cake took place in this context.

The main steps of this study are :

- a market survey
- a indigeneous law material resources and local technology assessment
- chemical and technical tests
- prefeasibility study.

Market survey

Today, the current level of vegetable oil consumption is about 28 000 to 30 000 tons per year i.e. an average consumption per capita of 4 kg/year (including imports and the whole zambian production (selfconsumption ...).

Two hypotheses were made for future demand projections :

- low hypothesis = 42 000 tons in year 2000
- high hypothesis = 52 000 tons in year 2000.

Therefore the shortfall is likely to vary between 19 000 an 29 000 tons.

Currently, local edible oil output is about 15 000 tons/year, 10 imports of crude and refined oil represent 50 % of national consumption.

Local technology and raw material assessment

In 1991 crushing and refining planned capacity are respectively 190 000 tons and 51 000 tons.

Processing capacities are far more than required for the amount of oilseeds produced at this time : these one meet about 50 % of the planned processing capacities.

The oilseeds processing industry is dominated by two parastatal companies : R.O.P. (Ndola) and Premium Oil (Lusaka). Both companies utilization rate is very low = 30 %.

The major constraints to full capacity utilization are lack of skilled personnel, lack of readily available foreign exchange, irregular availability of spare parts and a poor working environment.

The private medium scale processors operate far below their planned capacity, besides constraints hereabove mentionned they also suffer of poor management, equipment of poor quality (very high wear out) insufficient

infrastructure of seed storage, and lack of funds for future expansion especially auxiliary equipment.

Due to current situation only Premium Oil plant could easily process indigeneous kernels. Nethertheless, they will be required to at least invest in a light decorticating equipment for partial removal of the mungongo testa.

The available data and collected information for raw materials enabled to locate the production areas but it was not possible to obtain information on density and yields output of production then could not be assessed.

It will be important to get data enabling an estimation of crop potentialities per hectare to determine the collection areas, locate the depots in according to the communication roads, and estimate village crop capacities.

During the population survey, women's motivation for collecting activities, i.e. price proposed for the purchase of the nuts or fruits, will also have to be tested.

Chemical and Physical Tests

Mubula and Mungongo have a high oil content 63.3 % and 57.3 % respectively while for Munyele Nyele it reaches 24.2 % of which only 11 % is estimated recoverable.

The high content in linoleic acid of mungongo and mubula oils is very interesting, it is searched for dietetic purpose.

Munyele Nyele oil is essentially a concrete oil which must be winterized for cold utilizations.

Main difficulties for mungongo and mubula nuts are dehulling and dehusking promisory tests were performed and it will be necessary to study adapted dehulling equipments.

Prefeasibility studies

These studies were performed with the double aim of determining raw material purchase price, and producing a competitive edible oil.

It has been calculated that mungongo and mubula processed oil would be sold at US $ 1 500/Ton and munyele nyele oil at US $ 1 200/Ton.

On this basis :

. mubula and mungongo kernel purchase prices proposed were respectively : US $ 871 and US $ 576 per ton for a 12 % Internal Rate of Return.

. mubula and mungongo nuts purchase price was US $ 94/T for a 12 % I.R.R.

Mungongo kernel purchase price is hampered by the complementary dehulling phase necessary to remove the testa.

Concerning munyele nyele, due to the very short time of fruit processing induced by the fragility of the fruit (about 3 months) we proposed a plant processing alternatively munyele nyele and mubula.

Even in this case it was not possible to propose a purchasing price which would allow a 12 % internal rate of return with a purchasing price estimated at US $ 50/Ton, which is very low. The I.R.R. is 5,3 %.

Existing plants supply was also studied : we have compared the cost price of extractable oil and compared with others raw material resources :

Sunflower =	US $/M.T.	1.510
Soya =	"	953
Cotton	"	1.769
Groundnut	"	1.563
Mubula	"	1.392
Mungongo	"	1.682.

Mubula kernel is a quite interesting raw material, Mungongo kernel is hampered by the "testa" which lowers the oil production, but Mungongo products -oil and cake- are of superior quality (oil dietetic qualities and cake richness).

Nethertheless, existing plants supply will lead to the gathering and dehulling of very important volumes.
For instance the supply of 20.000 Tons of kernels means gathering and dehulling of 100.000 Tons to 120.000 Tons of kernels.

Conclusions - recommendations

Upgrading of mubula and mungongo nuts is very interesting for Zambia, and economically possible but therefore the following points need complementary studies or investigations :

. to get a detailed census of raw material production : areas, yields, ... These data will allow to quantify potential resources and then their upgrading (large or small scale industries ...) and to precise implementation of dehulling sites and small scale plants.

. to assess the women disponibilities for gathering and dehulling the nuts :

- importance of the population in these areas,
- women availibility and motivation
...

. to check if proposed nut purchase price is inciting enough for the women

. to study adapted dehulling equipments and improve "testa" removal for mungongo kernels in order to increase oil extraction rates.

Munyele Nyele upgrading is hampered by :

- the low oil extracted rate
- the short foreseen time for oil production (3 months)

Therefore the project is not profitable enough even with a fruit purchasing price of US $ 50/M.T. and can not be achieved within this environment.

II - COUNTRY OVERVIEW

II.1 - LAND

Zambia is a land-locked country, covering an area of about 753,000 square kilometers. It shares borders with Zaire and Tanzania in the North; Malawi and Mozambique in the East; Zimbabwe and Botswana in the South; Namibia in the South-West and Angola in the West.

Generally, Zambia lies on the great central African plateau with an average altitude ranging between 1,000 and 1,300 metres. In the east (particularly the Muchinga Escarpment) the land rises to a height of about 2,000 metres above sea-level. Broad depressions are to be found on the edges of the plateau which form lakes Tanganyika, Mweru and Bangweulu in the North, the Luangwa river in the east, Kafue basin and the alluvial plains of the Zambezi river in the Western province. The Zambezi river forms Zambia's southern boundary with Zimbabwe. Other important physical features are the lake Kariba on the Zambezi river, one of the biggest man-made lakes in the World; the Victoria Falls on the Zambezi river is one of the greatest tourist attractions in the country. Luapula river in the Luapula province forms the boundary between Zambia and Zaire.

Administratively the country is divided into nine provinces and fifty-seven districts as illustrated in the map next page.

II.2 - CLIMATE

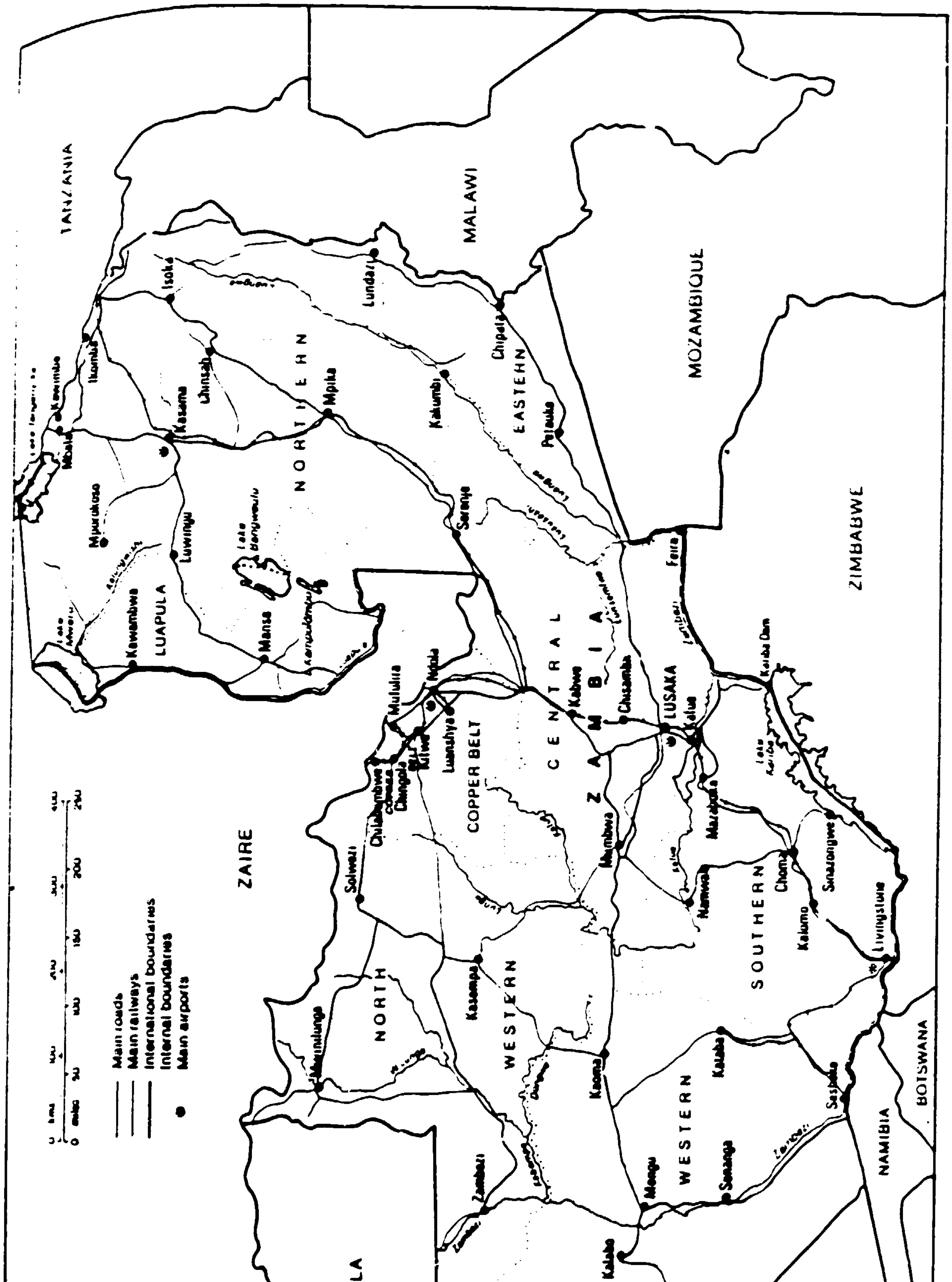
Lying between 8th and 18th degrees latitude south and 22nd and 34th degrees longitude east, Zambia has tropical climate and vegetation. There are three distinct seasons; the warm-wet season stretching from November through April, a cool dry winter season from May to August with the mean temperature varying between 14 c° and 30 c°, and a hot dry season during September and October.

The Copperbelt, North-Western, Northern and Luapula Provinces receive the highest precipitation with the annual average ranging from 1,100mm to over 1,400mm, while there is a systematic decrease towards the south and east with an annual average ranging between 600mm and 1,100mm.

II.3 - VEGETATION

Zambia's Vegetation may be very broadly classified as woodland savanna which are a mixture of various trees, tall grass, herbs and other woodlands which are mainly of the deciduous type usually to be found on the main plateau. However, these also occur in the other areas especially the successful maize-farming areas of the North-Western parts of the country. These areas are a major source of timber in Zambia. Thick forests are also to be found in some parts of Northern Province. Grasslands occur mainly in the seasonal flood plains of Western province, the Kafue flats and Bangweulu swamps.

ZAMBIA



TANZANIA
MALAWI
MOZAMBIQUE
ZIMBABWE
BOTSWANA
NAMIBIA
ANGOLA
ZAIRE
ZAMBIA
NORTHERN
EASTERN
LUAPULA
CENTRAL
COPPER BELT
NORTH WESTERN
WESTERN
SOUTHERN
LUSAKA
Isoka
Lundazi
Chipata
Kakumbi
Petauke
Mpika
Chinsali
Kasama
Mbala
Mporokoso
Luwingu
Kawambwa
Mansa
Serenje
Kabwe
Ndola
Mufulira
Chingola
Kitwe
Luanshya
Solwezi
Kasempa
Mumbwa
Mazabuka
Choma
Namwala
Kalomo
Sinazongwe
Livingstone
Kariba Dam
Feira
Kafue
Chisamba
Mongu
Kaoma
Kalabo
Senanga
Sesheke
Kataba
Zambezi
Lake Bangweulu
Lake Mweru
Lake Kariba
Main roads
Main railways
International boundaries
Internal boundaries
Main airports

II.4 - POPULATION SIZE

The estimated population size in 1990 is 7.8 millions.

The average growth rate per year is 3.2 percent, it is one of the highest in the world.

The national population density in 1990 is of 10.4 persons per km²;this very low density is a major constraint for rural activities development which are quite often intensive labour activities.

Population distribution varies considerably with provincial densities ranging from 2.4 to 4.0. Urbanisation rate is about 42 %.
Western and Southern provinces, the main areas concerned by our study ,have following respectives rates 4,8 and 11,1%

II.5 - BASIC ECONOMIC INDICATORS

The GDP in 1989 was per capita US $ 390.Real per capita G.D.P is estimated to have declined by 1% between 1987 and 1989.

Price inflation has been increasing as follows in %:

	1985	1986	1987	1988	1989	1990
+	37.4	52.6	43	55.6	110	105

Origins of GDP % of total	1989
Agriculture	13.6
Mining	12.5
Manufacturing	34.7
Constructions	1.4
Commerce	14.3
Government and other services	14.5

It has to noted that due that to the weight of mining activities in Zambian economy agriculture only represents 13,6% of gross domestic product,percentage quite low for a low income economy.

Principal Exports 1988	US $ m°
Copper	1,014
Cobalt	57
Zinc	25

Main destination of exports	% of total
Japan	35
Italy	10
France	8
India	6

Principal Imports	US $ m° FOB
Intermediate goods	284
Capital goods	275
Consumer goods	148
Fuel & energy	73

Main origins Imports 1988	% of total
South Africa	23
UK	19
West Germany	9
Japan	9

III - MARKET SURVEY

The aim of this market survey is to investigate about possibilities for developping new equipments for edible oil production from indigeneous nuts or fruits.

III.1 - EDIBLE OIL AND BY-PRODUCTS CONSUMPTION ASSESSMENT

Due to the scanty avalaible data, the market assessment has been done on the base of:
- the evaluation of current edible oil production.
- the imports.
- the data collected from international organisations, which have evaluated the current situation.

III.1.1 - Edible Oil Production

Edible oil in Zambia is made out of four major sources : sunflower, soyabeans, cottonseeds and ground nuts.

Sunflower is the most popular oilseed followed by cottonseeds and soyabeans. Groundnuts are grown in small quantities in relation, to demand for direct consumption and food processors, they are mostly used for confectionary purposes.

Maize is locally produced but does require a very complex extraction process and high investment to produce maize germ oil. Thus, in current technical and economical environment, this process is still not developped.

The oilseeds processing industry is dominated by two major parastatal companies :

- ROP (Refined Oil Products), Ndola
- Premium Oil Industries, Lusaka

The major medium scale oil expressors in the private sector are:

- BRR Industries, Kabwe
- Southern African Oil Mills, Lusaka
- Unified Chemicals, Lusaka

There are some small scale expellers but their production level is very low, and do not modify the main trends of the Zambian market.

ROP and Premium Oil Industries account for more than 60% of the total crushing capacity of Zambia.

ROP in Ndola was equiped for crushing cottonseeds and soyabeans and refine crude oils. Today only refining equipment is used.

Premium Oil crushes sunflowers and soyabeans and has solvent extraction facilities to produce refined oil and oilseeds cakes. Premium Oil should start building a new vegetable oil production unit which would process cottonseeds. This unit should be operating in 1992/93. Currently both units run at about 30% of planned capacity.

BRR crushes cottonseeds and producees refined oil.

Southern African Oil Mills processes sunflower and soyabeans and produces filtered oil, Unified chemicals refines oil from imported soyabeans crude oil. Private medium scale processors operate far below their planned capacity.

The total crushing capacity is 190.000 tonnes per year of planned capacity taking into account 85% of installed capacity.
A detailed review of the oil seed processing industry is presented in chapter V.

Edible oil production

Edible oil prod ction is made of:

- Local raw material crushed and filtered or refined
- Crude oil imported and refined

It has been quite difficult to get detailed data and more over, the break down production from local raw material, or from crude oil imported.

Edible oil produced from local raw material has been evaluated in table 1.

Total edible oil output and seed-cakes output include rural production (small scale expellers) estimated to 7600T/year. These outputs have been evaluated, considering the different oil extraction rates and assuming that:
- the whole production of sunflower and cottonseed was crushed.
- 60% of the groundnuts production was crushed.
- 80% of the soyabeans production was crushed.

There assumptions were based on the fact that in available statistics there is a real difference between oilseeds crops and oilseeds marketed and processed.

Indeed a part of soyabeans production is sometimes unofficially exported to Zaïre, and a part of groundnuts are directly consumed by rural population without any transformation.

Main part of produced edible oil is marketed without any treatment or only refining

OILSEEDS PRODUCTION TABLE 1

in MT	1986	1987	1988	1989	1990
Soyabeans	15.906	13.455	21.224	21.158	26.811
Sunflowerseeds	30.576	17.000	15.773	15.033	19.965
Cottonseeds	33.254	20.155	58.529	34.814	30.666
Groundnuts	18.184	47.424	33.400	26.646	25.085
TOTAL	97.920	98.034	128.926	97.651	102.527
EDIBLE OIL OUTPUT	15.887	18.206	19.636	15.661	16.758
SEEDCAKES OUT PUT	50.892	44.894	63.150	48.458	52.209

Oil extraction rate:		Seedcake extraction rates
Soyabeans:	17%	67%
Sunflowerseeds:	20%	60%
Cottonseeds:	16%	50%
Groundnuts:	38%	58%

EDIBLE OIL PRODUCTION BY PARASTATAL COMPANIES TABLE 2

in MT	1986	1987	1988	1989	1990
Refined oil sold	15.390	15.730	20.358	16.479	14.283
Refined oil produced locally	10.630	7.944	9.103	9.818	7.831
Total crude oil imported and refined locally	12.563	10.000	10.000	11.500	13.000

TOTAL EDIBLE OIL CONSUMPTION TABLE 3

in MT	1986	1987	1988	1989	1990
Edible oil Consumption	28.450	28.206	29.636	27.161	29.758

III 1.2 - Edible oil Imports

Due to the shortage of edible oil production, imports of crude oil were made in Zambia through special food aid program from the USAID. This program is called PL 480 and supply Zambia with soyabeans crude oil at a cheap price. The cost is US$ 548/ton. The country has imported large quantities of crude oil through this program about 8 to 10,000 tons per year.
However, this year the USAID has decided to stop the program due to poor financial conditions of the parastatal companies. Those companies will be required to import crude oil commercially but they are facing large difficulties to get foreign currency allocations. They are estimated to import 4,000 to 6,000 tons per year. In 1991, due to the parastatal company decision of not increasing vegetable oil price, the quantities imported commercially might be much smaller.

The private sector also imports crude oil commercially in particular Unified Chemical. This company manages to import through the PL 480 program as well as commercially. The annual imported quantity vary from 4,000 to 5,000 liters per year. This year, they are importing crude soyabeans oil from Argentina.

Imports of refined oil are performed from the parastatal company NIEC (National Import and Export Company) from 600 to 1,500 tons per year depending on their foreign exchange allocations. They usually import US$ 300,000 worth of refined oil and it lasts for several months. This year, this parastatal company has not been allocated any foreign currency yet therefore, and is required to buy refined oil through the private sector.

Imports of refined oil through the private sector are very limited less 1,000 Mt per year.

Table 2 presents figures on refined oil both from local oilseeds and crude oil importe. This table concerns only parastatal companies which represent around 80 % of the marketed refined oil

Losses from refining of crude oil are estimated around 6%.

III.1.3 Total Oil Consumption and Habits

Total oil consumption is presented in Table 3. It totals edible oil output from local oilseeds as well as crude oil imported and refined locally. Figures presented are estimates since it was not possible to gather production from each medium-scale oil expressor.

Current level of vegetable oil consumption is about 28 000 to 30 000 tons per year taking into account small-scale oil expressors located all around the country.

The average consumption per capita is 4 kg/year/capita and includes the whole zambian production estimated (autoconsumption, ...).

If we consider only the refined oil sold by parastatal companies the average consumption falls to 2 kg/year.

Although weak if we compare with the human needs estimated by F.A.O. this average consumption places Zambia in a not too bad position compared with neighbouring countries :

Zimbabwe	:	7 Kg/capita
Zaire	:	1,5 Kg/capita
Malawi	:	1 ou 1,5 Kg/capita
Uganda	:	1 Kg/capita.

With the production of refined oil in Zambia for over ten years, local population have developed a slight preference for refined oil especially in urban centers. Locally produced cooking oil is sold as output comes out, there is no specification of origin, it is usually not blended since sunflowers or soyabeans are processed separately but on the same equipment, cottonseeds oil can be produced simultaneously since it is a different process. In rural areas, filtered as well as refined cooking oil is sold, the local population tends to prefer darker vegetable oil with a stronger taste. Nevertheless it has to be pointed out that the consumer preference is less significant, the emphasis is on vegetable oil availability.

In urban areas, packaging materials most commonly used are 5 L plastic containers. Smaller plastic containers are also available in 2.5 L and 750 ml bottles. In rural areas, edible oil is sold decanted from 200 L drums. The local population buys small quantities at one time since the buying power is very limited.

III.1.4 - By-products production and imports

III.1.4.1 - Oil seedcakes

The current processing system has a higher refining capacity in relation to the crushing capacity. This means that more crude oil can be refined than domestically crushed. To utilise the surplus refining capacity , Premium Oil needs large quantities of crude oil from overseas. The problem with refining crude oil is that the by-product is not available.
The farmers and stock feed manufacturing companies therefore lose this very valuable import substitute for feeding the livestock.

There is very limited information on seedcake production. The output could be estimated from the oilseeds production level taking into account extraction rate. Production figures are presented in Table 1.

These figures include seedcake production by small scale processors.

Soyacake is preferred to sunflower cake because of its higher nutrientional value for stock feed, especially dairy and poultry.

PREMIUM OIL Lusaka produces only about 30 MT of double toasted soya cake per day. Most of this is used by the National Milling Company and very little is sold to the farmers directly. At present animal feed production is estimated at 60 - 70 000 T/year.

Current animal foodstuff usually includes 12 to 14 % of seedcake.
For some animal breeding (dairy and poultry) concentrates of seedcake are used, but in low quantities.

Potential stockfeed demand is far from being met, it is estimated that current production represents about 50 % of potential demand.

There is an important potential market for animal feed, but hampered by the low buying power.

There are very little imports of seedcakes due to the low buying power of farmers. These imports are not organised by any organisation.

III.1.4.2 - Soaps

Soaps production is mainly performances by Premium Oil Rop and Unified Chemicols. Their current productions level is as follows :

Premium Oil produces about 200 T/Year
Unified Chemicals about 2 800 T/Year.

The total market is estimated to more than = 000 T/year.

It is broken down as follows :

- 30 % of toilet soaps
- 70 % of laundry soaps.

There are some imports of soaps essantially from Zimbabwe and RSA

		1986	1987	1988
Soaps	(in Tons)	440	280	750.

The figures show that importated quantities are very limited.

III.1.4.3 - Soaps prices

Soap prices are from Unified Chemicals, and are average prices.
Indeed several brands exist and prices are slightly different between brands.

- Laundry soap : 1 000 $/T
- Toilet soap : 1 500 $/T

III.1.5 - Consumption centers

Large consumption centers are located in urban areas. Population for major districts are presented in the following page.

Major districts after Lusaka, are Ndola and Kitwe in the Copperbelt. These districts represent about 70 % of the refined oil consumption.

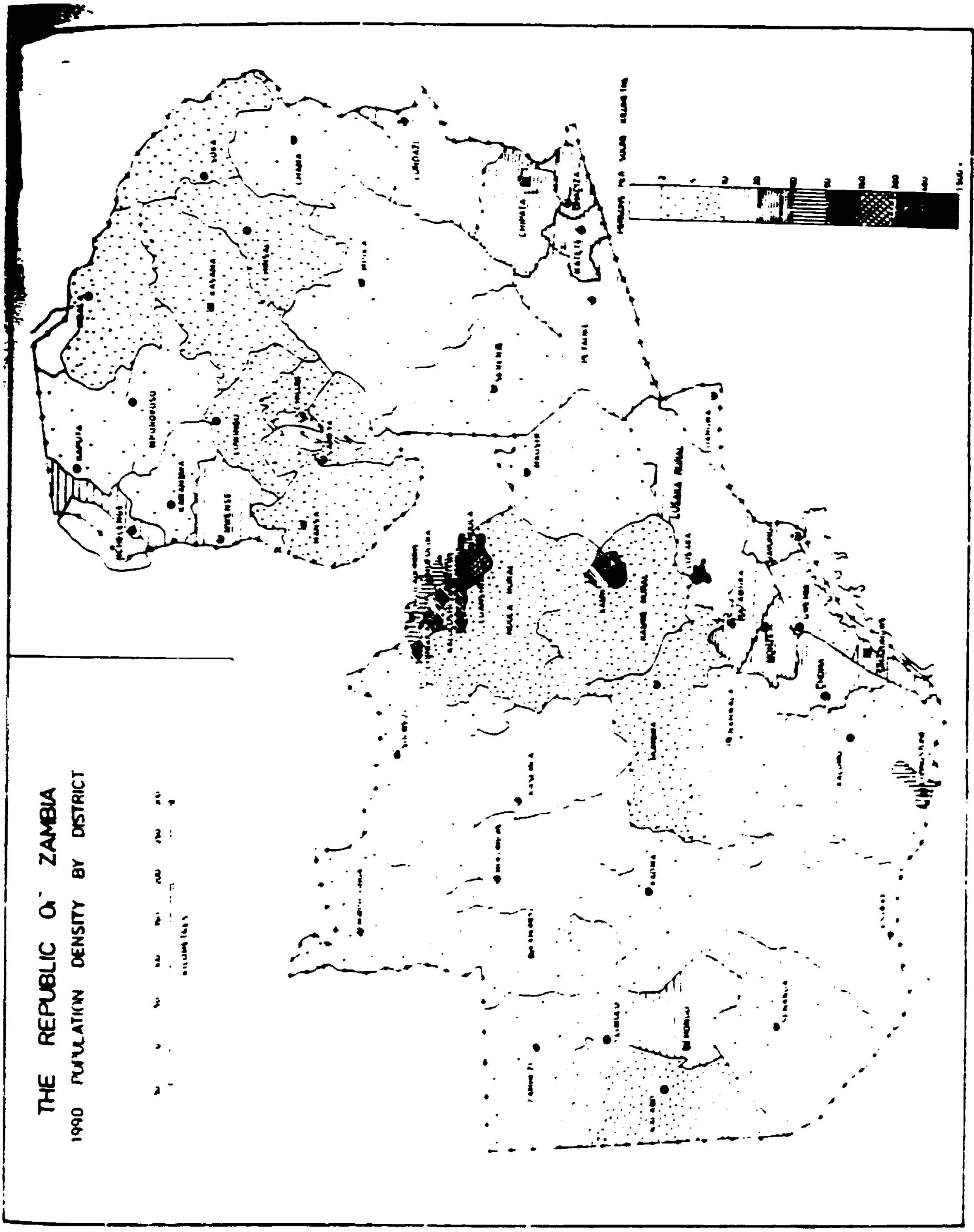
If we consider the map representing population density by district we notice that the regions concerned by mubula, mungongo and munyele-nyele plants are among the less populated zambian regions.

It appears that Western is a province with a low population density 4,8 %, and there is only one district, Mongu, with a density superior to 10 %.

Southern province includes more urban centers

Population density by province and district is presented in table 4.

THE REPUBLIC OF ZAMBIA - POPULATION DENSITY



POPULATION FOR MAJOR DISTRICTS, 1990

CENTRAL	
Kabwe-Rural	219985
Kabwe-Urban	166619
COPPERBELT	
Chigonia	186769
Kitwe	348571
Ndola-Rural	167853
Ndola-Urban	376311
EASTERN	
Katete	139679
Petauke	251144
LUSAKA	
Lusaka-rural	209318
Lusaka-urban	982362
NORTHERN	
Kasama	192046
SOUTHERN	
Choma	164387
WESTERN	
Mongu	142213

TABLE 4 POPULATION DENSITY BY PROVINCE AND DISTRICT, 1969, 1980 AND 1990

PROVINCE/DISTRICT	1969	1980	1990
CENTRAL			
Kabwe-Rural	4.3	5.7	8.5
Kabwe-Urban	42.0	86.5	106.0
Mkushi	2.5	3.2	4.7
Mumbwa	2.9	4.0	6.1
Serenje	2.3	3.2	4.5
TOTAL (Province)	5.4	5.4	7.7
COPPERBELT			
Chililabombwe	43.7	60.5	84.4
Chingola	61.6	87.0	111.3
Kalulushi	44.5	81.7	125.0
Kitwe	257.1	412.3	448.6
Luanshya	118.7	159.8	182.2
Mufulira	65.8	91.7	106.9
Ndola-Rural	3.1	4.3	7.1
Ndola-Urban	144.9	255.1	341.2
TOTAL (Province)	26.1	39.9	50.4
EASTERN			
Chadiza	12.5	17.4	24.7
Chama	1.8	2.0	3.0
Chipata	12.4	17.1	24.5
Katete	20.2	23.6	35.0
Lundazi	6.6	8.2	12.3
Petauke	6.6	9.3	13.4
TOTAL (Province)	7.4	9.4	14.1
LUAPULA			
Kawambwa	2.8	3.3	4.3
Mansa	5.0	6.9	8.8
Mwense	7.9	9.8	12.1
Nchelenge	7.1	10.0	13.9
Samfya	8.8	9.7	10.5
TOTAL (Province)	6.6	8.3	10.4
LUSAKA			
Luangwa	2.3	3.3	4.7
Lusaka-Rural	4.6	8.0	11.6
Lusaka-Urban	729.0	1488.4	2728.8
TOTAL (Province)	16.2	31.7	55.2
NORTHERN			
Chilubi	- (1)	7.2	8.6
Chinsali	3.8	4.3	5.6
Isoka	5.6	6.8	8.8
Kaputa	- (2)	3.4	4.0
Kasama	5.2	7.2	9.3
Luwingu	8.9	5.9	7.5
Mbala	5.2	6.2	7.5
Mpika	1.4	2.0	2.8
Mporokoso	5.6	3.4	4.5
TOTAL (Province)	3.7	4.6	5.9
NORTH-WESTERN			
Kabompo	2.3	2.8	3.5
Kasempa	1.6	1.5	1.8
Mufumbwe	- (3)	0.5	1.1
Mwinilunga	2.4	3.3	3.9
Solwezi	1.8	3.1	4.0
Zambezi	3.3	3.3	3.8
TOTAL (Province)	1.8	2.4	3.0

TABLE 4 POPULATION DENSITY BY PROVINCE AND DISTRICT, 1969, 1980 AND 1990 (CONT'D)

PROVINCE/DISTRICT	1969	1980	1990
SOUTHERN			
Choma	13.4	17.9	22.5
Gwembe	3.8	1.6	2.9
Kalomo	2.5	3.1	5.0
Livingstone	34.4	50.1	58.9
Mazabuka	23.3	16.4	23.1
Monze	- (4)	22.8	32.4
Namwala	1.7	2.6	3.8
Siavonga	- (5)	11.3	17.5
Sinazongwe	- (5)	8.8	12.6
TOTAL (Province)	5.8	7.9	11.1
WESTERN			
Kalabo	6.0	5.6	5.8
Kaoma	2.4	3.0	4.8
Lukulu	- (6)	2.8	3.1
Mongu	10.9	11.4	14.1
Senanga	3.0	3.4	4.5
Sesheke	1.7	2.0	2.2
TOTAL (Province)	3.3	3.9	4.8
TOTAL ZAMBIA	**5.3**	**7.5**	**10.4**

(1) Part of Luwingu District
(2) Part of Mporokoso District
(3) Part of Kasempa District
(4) Part of Mazabuka District
(5) Part of Gwembe District
(6) Part of Mongu/Kaoma Districts

III.1.6 - Edible oil and seed cakes prices

The government policy regarding the oilseeds producer prices has not been very effective, indeed incentives to grow oilseeds at attractive prices are very limited.

Crop Producer prices are presented in Table 5 below.

GUARANTEED CROP PRODUCER PRICES 1985-91

(in KWACHA)	UNIT	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
SUNFLOWER	50 KG	41.95	70	90	291.3	556.1	830.94
SOYABEANS	90 KG	112.1	148	217	280	577.2	801.49
SEED COTTON	KG	0.99	1.9	3	3.6	9.7	15.53
GROUNDNUTS	80 KG	277.37	354	641	815.4	1681.92	2614.73

Source: Ministry of Agriculture

When looking at the table, and taking into account the inflation rate, producer prices increases are far from following the inflation rate. This situation does not lead the farmers to increase production and as it was mentioned earlier their bargaining power in front of oil expressors is very limited.

Manufacture prices are presented for the Major oil expressors in Table 6.
Premium Oil retail prices for edible oil are presented in the following table 7.
It has to be noted that private prices from table 8 are not representative, since listed private stores only concern a higher standard of a part of the population . Reference prices are prices from drums for the private sector since they concern about half of the total sold production (see table 6)
Prices are ex-factory and do not include distribution costs
Table 8 gives retail price in the parastatal sector and the private sector.
Prices in the private sector are about 50% more expensive than in the parastatal sector.
Imported refined oil prices are higher than local oil about 20% as illustrated in the table 8.

Prices of seedcakes are US$ 403/MT in the private sector and
US$ 446/MT in the parastatal sector.

TABLE 6

EDIBLE OIL EX FACTORY PRICES

In US$

	PREMIUM OIL	UNIFIED CHEMICAL	SOUTHERN AFRICAN MILLS
Packsize	Manufacture price Refined oil	Refined oil	Filtered oil
250 MLS	0,72		
600 MLS	0,99		
750 MLS	1,18		
2.5. LTS	3,67		
5 LTS	7,26		
20 LTS	29,05		
200 LTS	259,45	259,00	247
2.5 LTS*	4,46		
5 LTS*	8,92		

TABLE 7

EDIBLE OIL RETAIL PRICES - PARASTATAL SECTOR

PREMIUM OIL In US$

	Urban area	Rural area
Packsize	Retail price/pack	Retail price/pack
250 MLS	0,95	1
600 MLS	1,30	1,37
750 MLS	1,54	1,61
2.5. LTS	4,75	5,04
5 LTS	9,42	9,94
20 LTS	37,70	39,78
200 LTS	336,33	356,12
2.5 LTS*	4,32	4,46
5 LTS*	8,63	8,92

* DECANTED

TABLE 8

EDIBLE OIL RETAIL PRICES - PARASTATAL AND PRIVATE SECTORS

In US$

Producer	Origin	Type of Oil	Brand name	Pack size	Container	Stores name			
						NHS	MELISSA	ALBATROS	COSMOS
Premium oil	Local	Cooking oil	N.A.	5L	Plastic	9,42			
Olivine	Zimbabwe	Vegetable	N.A.	2.5 L	Plastic	6,47			
Olivine				0.75 L	Plastic	1,73	2,59		2,88
South African oil mills	RSA	Sunflower	Somol	0.75 L	Plastic	2,59		3,02	
Lever Brother	Zimbabwe	Vegetable	Covo	0.75 L	Plastic	2,73	2,81	2,59	2,73

In August 1991 Premium Oil seedcake selling price ex factory were :

- Sunflower cake : 28 000 K/T i.e. 375 US $
- Soyabean cake : 35 000 K/T i.e. 460 US $.

III.1.7 - Distribution Network

Consumer goods are sold essentially through a national network of wholesalers and retailers.

The private sector for consumers goods sales is rather limited and is essentially made of small retail stores.

The major parastatal wholesalers are:

- Zambia National Wholesale and Marketing Company Ltd.
- NIEC agencies Ltd

The major retailers are

- National Home Stores
- Consuming Buying Corporation of Zambia Ltd
- Mwaiseni Stores Ltd

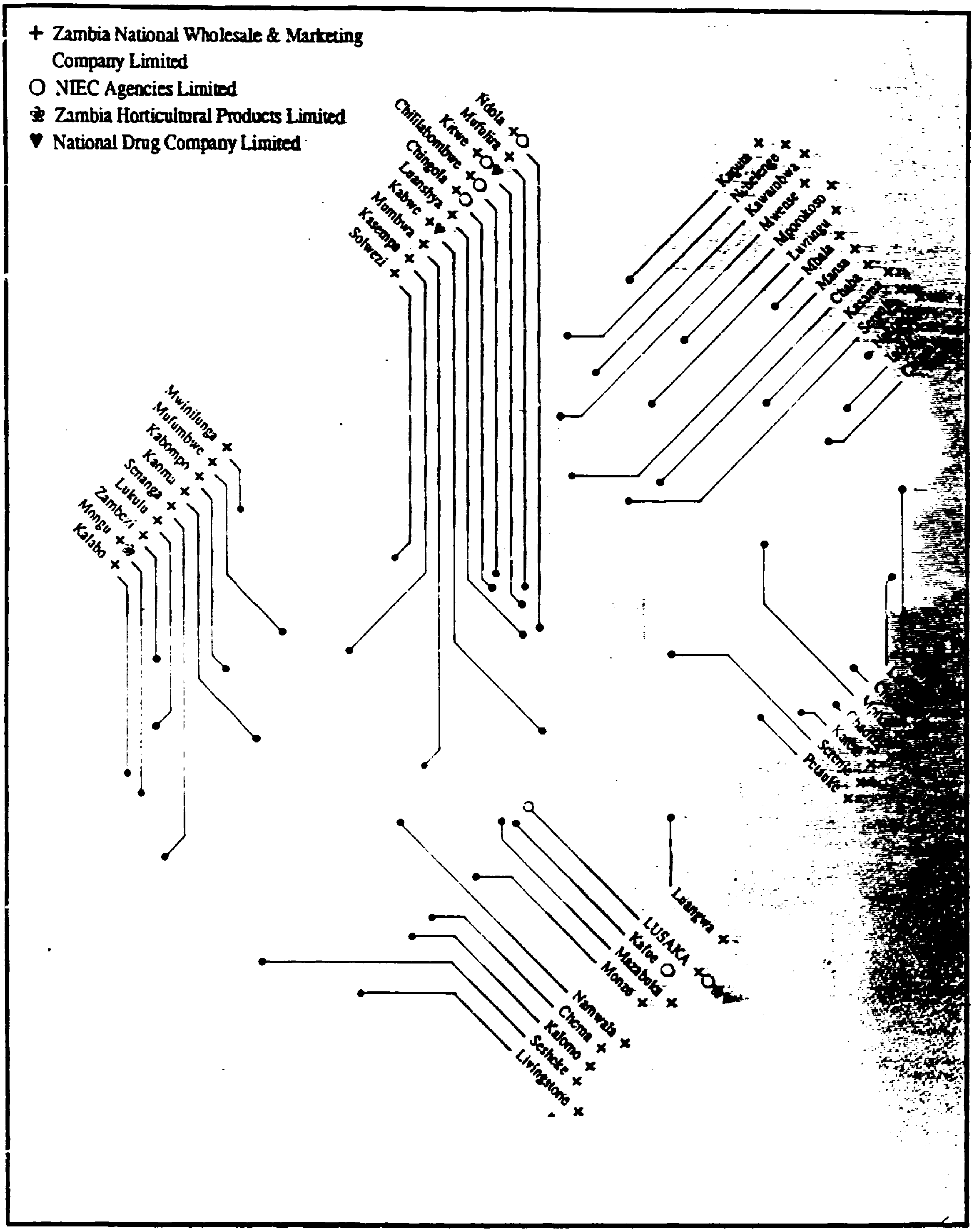
Wholesale outlets are spread out in the country at the provincial level and at the district level.

Wholesale outlets sell consumer goods to national retail stores and private stores in rural areas.

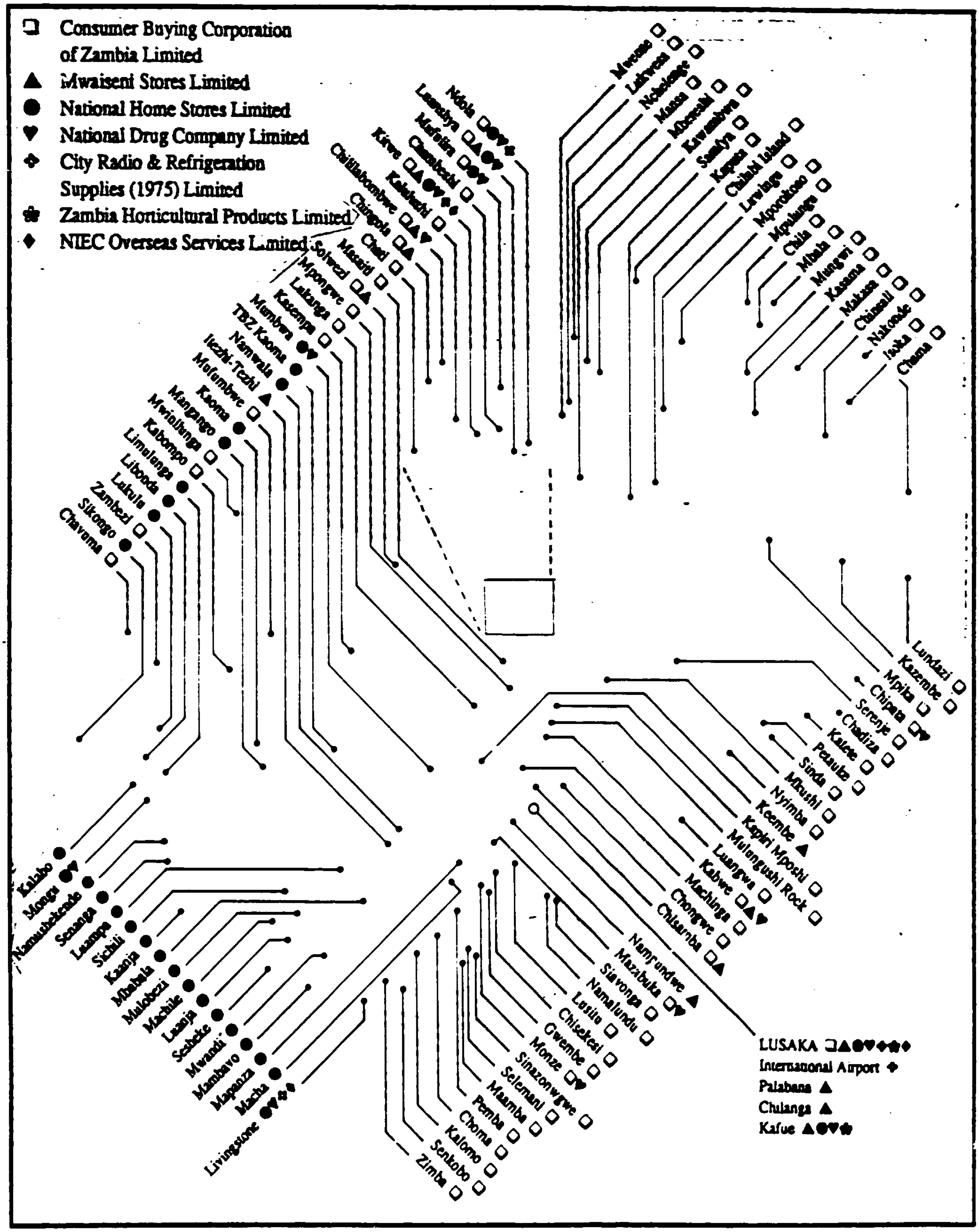
The map presented next page illustrates the national network of wholesalers and retailers.

Imports of oil seeds, refined oil products and by-products are not done through one organisation. Private traders, farmers and milling companies imports their requirement directly whenever there is a shortfall locally. Margins on imported oil are of 26 %.

NIEC Group Wholesale Outlets



NIEC Group Retail Outlets



III.2 - EDIBLE OIL DEMAND ASSESSMENT

III.2.1 - Present demand assessment

In precedent chapters we have evaluated current edible oil consumption, but it does not represent real demand or real potential market.

The available information on the demand for edible oil and oilseeds by-products is very limited. Numerous estimates have been made by international organizations such as the FAO/ADB, but the latest figures available are from the Prices and Income Commission.

According to the nutritional norms, the potential demand is evaluated at 46,800 mt which means about 6 kg/capita/year.

It was already showed up that currently this demand is not met ; the edible oil output only meets about 50 % of national requirements.

III.2.2 - Future demand

The future for edible oil demand in Zambia depends on two parameters:

- the population growth which is estimated to 3.1% / year.
- the income level and its share of income spent to buy edible oil products.

Population projections, are presented in table 9 based on 1990 population census.

The following assumptions have been made:

- district population growth rates will not decline
- the rate of rural urban migration will not decline
- rural living conditions will not improve significantly.

Considering the forecasted evolution of the edible oil demand two hypothesis have been elaborated :

- a low hypothesis assuming that due to high increases and low pay increments, the consumption/capita will remain static and that consequently the income elasticity coefficient will have no impact on the consumption of edible oil in a short or medium term.

- a high hypothesis assuming that the income level will increase and then the demand increases at a rate superior to the population rate and that the consumption/capita will grow by 0,10 kg per annum.

Future demand for edible oil is presented in the following page Table 9.

The shortfall calculation is based on vegetable oil production forecasted from local oilseeds production.

Oilseeds crop projection, presented in table 9, were made with the data communicated by the Ministry of Agriculture.
The evaluation of edible oil output was realized with the same assumptions than for the evaluation of current edible oil production (cf § 3.1.1)

It appears that in year 2000 the shortfall will vary between 19 000 tons and 29 000 tons in function of the evolution of the demand (low or high hypothesis).

III.3 - RECONCILIATION OF DATA

The edible oil demand and existing oilseeds crushing capacity has to be balanced to identify potential needs for an increase in vegetable oil production.

The table 9 presented next page exhibits the following figures:

- edible oil demand projections
- edible oil production
- crushing and refining capacities projections

The figures call for the following comments:

The crushing capacity is large enough to process traditional oilseeds, but there is a need for additional vegetable oil production. The technical study will determine if indigenous oilseeds could be processed with the upgrading of the existing technology or in small scale oil plants and the pre-feasibility study will identify the minimum purchasing price of indigenous oilseeds to the local population in order to verify the economic viability of this project.

EDIBLE OIL DEMAND ESTIMATES

TABLE 9

('000)	1991	1992	1993	1994	1995	2000
POPULATION CONSUMING EDIBLE OIL (millions)	8034	8275	8523	8779	9042	10483
Low Hypothesis (kg/cap/yr)	4	4	4	4	4	4
High hypothesis (kg/cap/yr)	4,1	4,2	4,3	4,4	4,5	5
TOTAL DEMAND: LOW HYPOTHESIS(tons)	32.136	33.100	34.093	35.116	36.169	41.930
TOTAL DEMAND: HIGH HYPOTHESIS(tons)	32.939	34.755	36.650	38.627	40.691	52.413

OILSEEDS PROJECTIONS

in MT	1.991	1.992	1.993	1.994	1.995	2.000
Soyabeans	40.000	42.000	44.100	46.305	48.620	62.053
Sunflowerseeds	21.000	22.050	23.153	24.310	25.526	32.578
Cottonseeds	40.000	42.000	44.100	46.305	48.620	62.053
Groundnuts	25.000	26.250	27.563	28.941	30.388	38.783
Total	126.000	132.300	138.915	145.861	153.154	195.467

EDIBLE OIL OUTPUT

in MT	1.991	1.992	1.993	1.994	1.995	2.000
Soyabeans	5.440	5.712	5.998	6.297	6.612	8.439
Sunflowerseeds	4.200	4.410	4.631	4.862	5.105	6.516
Cottonseeds	3.840	4.032	4.234	4.445	4.668	5.957
Groundnuts	1.140	1.197	1.257	1.320	1.386	1.769
Total	14.620	15.351	16.119	16.924	17.771	22.680

SHORTFALL IN LOCAL OIL PRODUCTION (tons)

	1991	1992	1993	1994	1995	2000
Low Hypothesis	17.516	17.749	17.975	18.191	18.399	19.250
High Hypothesis	18.319	19.404	20.532	21.703	22.920	29.732

SEEDCAKES PRODUCTION

in MT	1.991	1.992	1.993	1.994	1.995	2.000
Soyabeans	21.440	22.512	23.638	24.819	26.060	33.260
Sunflowerseeds	12.600	13.230	13.892	14.586	15.315	19.547
Cottonseeds	20.000	21.000	22.050	23.153	24.310	31.027
Groundnuts	8.700	9.135	9.592	10.071	10.575	13.497
Total	62.740	65.877	69.171	72.629	76.261	97.330

OILSEEDS CRUSHING CAPACITY

in MT	1.991	1.992	1.993	1.994	1.995	2.000
Crushing installed capacity	190.000	250.000	250.000	250.000	250.000	250.000
Crushing planned capacity	160.000	210.000	210.000	210.000	210.000	210.000
Planned Refining Capacity	51.000	51.000	51.000	51.000	51.000	51.000

IV - INDIGENEOUS RAW MATERIAL RESOURCES ASSESSMENT

Mungongo, Mubula and Munyele Nyele resources have been investigated. There is no detailed information on these tree populations, and the data collected come from professors the expert met at the University and from informations collected from the villagers.

IV.1 - IDENTIFICATION OF GROWING AREAS

There is scarce information concerning these tree-population since the Forestry Department is essentially interested in timber and charcoal and not in the nuts or fruits.

IV.1.1 - Mungongo (Ricinodendron Rautaneii)

Mungongo grows in a band accross Africa from about 15° to 21° S
The species also grow in Angola, Namibia, Bostwana, Zimbabwe, Mozambique, Southern Africa.

In Zambia the mungongo tree grows profusely in the semi-kalahari sandy soils of the whole of the Western Province and parts of the Southern Province and parts of the Southern Province. It is also found less frequently in the Northern Province, which may be resuit of introductions rather than part of its natural range. In these areas it form large forests over long distances.

Trees are said to start bearing fruits at age 3 or 4. Estimates of crop size were hard to do, old trees are said to produce a sizable quantity up to 80 kg/tree. The fruit has a dry pulp occasionally eaten by human beings and popular to wild animals and cattle.
Beneath the dry pulp there is a very hard shell encasing a riche oil kernel.

IV.1.2 - Mubula (Parinari Curatelli)

The mubula tree grows everywhere in Zambia. In Western and Southern provinces the tree grows huge and yields profusely the fruit matures fresh and wet from late June to November annually.

Mubula trees grow on deep sandy soil but they can also grow on sufficiently drained soils as it was evidenced during the field mission to Kalomo and Pemba : on either sides of the road we could see mubula and masuko trees growing together thought in sometimes scarce formation. Professor Phiri (Taxonomist - botanist) of Lusaka University said that yields in quantity and quality depend dreadfully on the soils answer to the requirements of the trees.

During the mission we noted that the nuts of a same tree had not reached the same of ripeness : this distribution allows for relatively long time-crop.

The fruit pulp is eaten fresh by the rural human populations and extremely popular with the cattle. The fresh fruit pulp is known for its rich nutritional value and can be patted into flat cakes and easily dried.

Upon shelling the nut the oil kernel is found encased in a furry coating. The oil kernel can easily be mistaken for groundnuts both from the colour and shape and size.

IV.1.3 - Munyele-Nyele

Munyele Nyele tree has the same environment conditions as the Mungongo tree i.e : deep-kalahari sands.
Western Province is an area of high density of munyele-nyele trees.

There appear to be at least two species : the one that maintains a shrub size, slightly above human height average, the other that grows into a huge tree.

Munyele Nyele flowers in early August, or even much later if early flowering was disturbed by bush fires.

Munyele Nyele fruit grows into green and ripens into very dark purplish berries, with an extremely delicate oily skin.

The berries are so oily that a mere touch exhibits rich oil. There is a thin oily pulp just under the thin skin which is the main carrier of the oil.

The fruit ripens between November and January. The fruit is more like the olives.
Munyele Nyele fruit is a fleshy fruit (oliveoil or palm fruit type) which behaviour in oil extraction is not known and will require a technological identification through experimentations to choose the right oil extraction process : olive oil or palm oil process.

IV.2 - GROWING AND COLLECT METHODS

IV.2.1 - Mungongo

Mungongo is usually propagated by stem plantation and grows to a full plant within five years, without any irrigation or nursing whatsoever.
It may also grow from its seeds : to germinate the nuts, the fleshy mesocarp must be removed, the hard endocarp cracked, and the thin, but tough, testa broken.

Once the seed is extracted, very rapid germination can apparently be obtained by exposure to ethrel solutions for 48 hours. ($2.1x10^{-2}$M).
This method gives 100 % germination in 6 days in RSA. Since the tree can be propagated with branch or root cuttings, however, seed germination is not important to the oil production proposal.

The propagation is simple and inexpensive.
Without any expensive investiments in land tillage, irrigation, machinery or other inputs the country is capable of expanding quite quickly the mungongo tree population.

The tree flowers "Testa" October and the fruit matures and falls dry in April to June annually. These fruit are quite easy to collect and once de-pulped it withstand rains for at least a year without risking the kernel. After dehulling, a hard skin remains on the kernel and requires a second decortication.

National Council for Scientific Research (Kitwe Office) had planned a plantation of Mungongo in Western Province but it is not confirmed if it had been implemented.

Because of the fragile ecological system of the sandy soils of the Western Province, Mungongo plantations must not be developped to the exclusion of other plants.

It must be stressed on the fact that currently around Mongu in Western Province heavy operations of undergrowth clearing are realised to facilitate cashew nuts plantations for exportations.

As these cashewnut trees are not indigeneous, chemical products are used for their protection and then no more indigeneous bushes or trees grow up.

These operations destroy the indigeneous plant patrimony.

IV.2.2 - Mubula

Mubula as Mungongo grows widely and wildly. There are no plantations at the moment. The expert was informed on a Mubula experimental plantation at Miobuyu (near Masabuko) but he couldn't get a confirmation on its implementation. Yields depend on the soil, some splendid trees have a very low yield, mubula-trees prefer sandy soils.

People pick the fruit immediately it falls to the ground, to avoid worms and other insects that swarm and feed on it.

It seems that after the depulping of the mubula the shell, though hard, can be wasted by the rains.

After shelling the nut, the oil-kernel has a light skin which does not require a complementary decortication.

We will recall that in Western region Mubula tree population development is in some places hampered by industrial cashew nuts plantations.

IV.2.3 - Munyele-Nyele

Munyele-Nyele starts yielding at bush age 4 or 5 years and the maximum yield is at middle age, with yields decreasing as the tree grows old and big.

Sometimes villagers cut the trees to pick up the fruit. This collecting method is very destructive, as whole branches are ripped down and the berries picked there from. In extreme cases whole trees are felled down and thus trees, that took years to grow, are lost.

When the berries are very ripe, they fall to the ground. If they are left on the ground long, the berries shrivel, lose oil, and if it rains moisture.

Being a delicate fruit the safe storage and the transportation means of the berries are of importance.

Munyele-Nyele propagation is made from samples obtained from the forest which must be nursed for a year before transplantation.

IV.3 - GENERAL COMMENTS

It appears that up to day no detailed study has been achieved on any of these three indigeneous plants.

The available data and collected information for raw materials allowed to place the production areas but it was not possible to obtain information on density and yields output of production then could not be assessed.

Besides the village crop capacities have never been assessed ; the issue is critical for the viability of the project.

It is important to get data allowing an estimation of crop potentialities per hectare (filled nuts or "choro nuts" i.e. empty nuts), and to locate tree populations easily collectable on regional maps to determine the collection areas, define the deposits in function of the communication roads, and estimate village crop capacities.

During the population survey, women's motivation for collecting activities, i.e. price proposed for the purchase of the nuts or fruits, will also have to be tested.

V - LOCAL TECHNOLOGY ASSESSMENT

V.1 - PRELIMINARY COMMENTS

Before any analysis it is necessary to precise some definitions :

Installed capacity :

Theoritical yearly production according to the oil extracting system when operating at maximum hourly output on 24 hour/52 weeks basis. For example :
4 expellers x 2 x 24 = 192 Mt per day x 365 = 70 000 Mt/year.

Planned capacity :

Percentage of installated capacity taking into consideration a certain number of days a year for breakdowns and scheduled maintenance. For instance for a usual rated capacity of 85 % (280 days) :
192 Mt x 280 = 53.760 Mt.

Operational capacity :

Actual capacity utilised by the processor depending upon their work schedule and the efficency of technical management including maintenance.

Total processing capacities are presented here below

	1987	1988	1989	1990	1991
Crushing planned capacity	160 000 T	190 000 T	190 000 T	190 000 T	190 000 T
Planned Refining capacity	51 000 T	51 000 T	51 000 T	51 000 T	51 000 T.

Only ROP, BRR and Southern African Oils have refining capacities.

In 1988 crushing planned capacity increased, after improvements at Premium Oil Industries (in equipment for processing soyabean) and the implementation of medium scale processors.

If we consider current raw material resources these one meet about 50 % of planned processing capacities. Processing capacity is far more than required for the amount of oilseeds produced at this time.

Moreover processing plants are not well distributed over the country, 80 % are located in the Copperbelt and Lusaka Provinces, Central and Eastern each have a 12 000 T mill and Southern a small 4 500 T at Choma.

Western, Northern-Western, Luapula and Northern Provinces have no processing capacity and oilseeds produced in these provinces must be transported to plants in other provinces.

V.2 - LARGE SCALE PROCESSORS

The oil seed processing industry in Zambia is dominated by two parastatal companies pertaining to the state holding INDECO.

- ROP, Ndola. Only refining activity (Batch process) is being maintained at a rated capacity of 6 000 T/y. The operational capacity is mainly settled in accordance with supplying from imports.

- Premium Oil, Lusaka. Mainly equiped to crush sunflower and soyabeans on 4 Krupp expellers at a rated capacity of 80 t/day followed by a Bernardini solvent extraction completed with a separate desolventizer for soyabeans from Simon Rosedown (UK)

  Other equipments are :

  . Oil refining continuous plant Westfalia of 120 T/day which works only when volumes to refine lead to it

  . Batch refinery facilities of 40 T/day for special refining of hardened fish oil and for formulating margarine based oil.

  . An old continuous Sharples refinery of 30 T/day whose batch bleacher and deodoriser are being used for margarine production.

  . Margarine production small unit ot 20 T/day supplied with imported hardened oil an its packing unit in 200 g plastic pots.

  . Packaging plant which consist of a Ronchi bottling line with adequate facilities for packing small and large plastic bottles.

  . Soap making plant capacity 15 MT/24 hours using the batch process equiped with a Mazzoni continuous conditionning-packing unit.

A cotton seed delinting and decorticating workshop of 200 T/day installed capacity to complete the Lusaka facilities has been recently commisionned to bring in its activities the processing of a zambian production of cotton in progress.

The utilisation level for both Premium Oil and ROP Ndola are very low 30 % on average.

V.3 - MEDIUM SCALE PROCESSORS

V.3.1 - BRR Industries Limited KABWE

Privately owned company which activites started in 1985 on cottonseed for a crushing installated capacity of 50 MT per day, equiped with :

- A two stage delinter and 3 dehullers from Murray-Carver (USA).

- A complete line of flaking cooking and three stage conditionning in front of a two barrel expeller from Anderson (USA).

- A batch refining, installed capacity 15 MT/24 hours from Bernardini.
- A bottling plant of 15 MT/day, for packing in 5 liters and 2.5 liters cans.

V.3.2 - ZATCO (Zambian Agricultural Trading Co), Choma

Privately owned company equiped for the crushing of sunflower (installed capacity : 25 MT/day) and the refining of crude oil. The plant has been purchased from Kumar (India). Packing is carried out manually in 210 liters drums and 2.5 plastic bottle.

Zatco use soyabeans and sunflower for making stockfeed and the crude oil is just a by-product.

The machinery is of a poor design and badly installed.

V.3.3 - Southern African Oil Mills (SAOM) Lusaka

Privately owned compagny (Mr Constantinidou) reputed to crush sunflower to produce crude oil packed in 210 liter drums. The plant was crushing soyabeans to produce cake as an opportunity for formulating an breakfeast mix (100 MT) and an infant food base (50 MT) contracted on a World food programme. The plant is equiped with :

- Two second hand expellers from India only fitted to produce an oily soyabean cake.
- One super Duo anderson expeller bought in 1987 which has not been used for lack of complementary equipement.
- A batch Bernardini refining line of 30 MT installed capacity.
- A elementary friction cooker.

V.4 - CONCLUSIONS

The major constraints to full utilisation of capacity are lack of skilled personnel, lack of readily available foreign exchange, irregular availability of spare parts and a poor working environment.

The private medium scale processors operate far below their planned capacity, besides constraints hereabove mentionned they also suffer of poor management, equipment of poor quality (very high wear out) insufficient infrastructure of seed storage, and lack of funds for future expansion especially auxiliary equipment.

Due to current situation only Premium Oil plant could easily process indigeneous kernels. Nethertheless they will have at least to invest in a light decorticating equipment for partial removal of the mungongo testa.

VI - TECHNICAL TESTS

The aim of these tests was identify all the physical and chemical characteristics of Mubula, Mungongo and Munyele-Nyele fruits to determine the oil extraction process.

VI.1 - CHEMICAL TESTS

Chemical tests have been achieved by Laboratories Wolff which have a large experience and use to work with main french oils expressors.
The interpretation of results was made in collaboration with Mr. Michel BLANC Head of the Agricultural Division of Laboratories Wolff. Detailed results are presented in Annex 1A.

VI.1.1 - Mubula kernels

- **Global results**

Oil content (63,3 %) specially high amongst the highest of the vegetable kingdom.

Low cellulose content : 5 %.

Interesting protein content : 65,5 % of defatted material or 22,5 % as it is.

- **Profile of composition**

- Concrete oil ratio is represented by palmitic acid (9 %) and stearic acid (8,8 %).

- Fluid oils are essentially represented by :

  . Oleic acid (C 18 : 1) 30,3 %
  . Linoleic acid (C 18 : 2) natural fatty acid 15,1 %. This essential fatty acid gives to this oil interesting dietetic qualities
  . Linolenic acid (C 18 : 3) 0,4 %
  Low content for this linoleic fatty acid which presents interesting dietetic value in spite of its oxydability.
  . Total saturated acids (C 22) 34,1 %.

  Due to the high chromatographic retention delay for this class of acids, which are not classical ones the components idenfification cannot be obtained through chemical analysis. A complementary documentary study, by chemical experts would be necessary but it lies outside the scope of this study.

- It is interesting also to note the very low percentage of non saponifiable products.

- **Qualitative assessment**

It is a "balanced oil", excellent for seasoning and frying.

This oil is not very oxydable. It must be stressed that mubula almonds which were analysed, were collecte several months ago, fact which points out the very low oxidability of the fluid oils.

The monocotyledone kernel wears a light red testa (skin) which make it look as groundnut. Due to its composition mubula kernel would react as ground nuts when crushing

VI.1.2 - **Mungongo kernels**

- **Global results**

Two series of chemical tests have been realized :

- first ones with the corneous skin, or ligneous testa, adhering to almond albumen due to the laboratory failure to remove it : Results 1
- second ones without the ligneous testa manually removed after weakening it by a thermical treatment : Results 2.

Results n° 1 (see analysis Annex 1B)

MUNGONGO ; Whole kernel

		% / Raw material	% / dry material	% / delapidated dry material
Water + evaporation	*	5,6		
Dry material		94,4	100,0	
Oil on raw material	*	37,3		
Oil on dry material			39,5	
Delipidated dry material		54,9		100,0
Raw proteins	*	15,6		28,4
Fibers	*	25,8		47,0
Total		84,3		75,4 %
Others and starches		15,7		24,6% (=13,5)
		100,0		100,0 %

Fairly low fat content - 37,3 % - due to the laboratory failure to remove corneous skin adhering to almond albumen. Nethertheless this low fat content is still better than in soya.

- fiber content (including ligneous matter) is high (47 %) due to previous cause. Fiber content results from the ligneous cuticule with a thickness of about 1 mm and very hard.

In this case the nutcake fiber content after oil extraction will limit its use in animal foods to horned cattle and more especially to dairy cattle because of the high protein content : 28, 4 %.

<u>Results n° 2</u> (see analysis Annex 1B)

Given figures are related to nuts "just as it is" but without "Testa"

MUNGONGO ; decorticated kernels

		% / raw matérial	% / dry material
Water + evaporation	*	4,6	
Dry material		96,0	100,0
Oil on raw material	*	57,3	
Oil on dry material			59,9
Delipidated dry material		36,9	
Raw proteins	*	28,2	
Fibers	*	2,1	
Total	*	91,8	
Others and starches		8,2	
		100,0.	

These figures were calculated by Wolff Laboratories on dehulled samples after nut heat treatment in controlled heat furnace. Heat treatment homogeneisation was obtained by adding sand to nuts. Hammer nut crushing then allows easier Testa dehulling.

Mungongo perfectly dehulled kernel is very close to Mubula kernel as far oil content is concerned (57,5 % vs 63,3 %), but its protein content is much higher (28,2 % vs 15,6%), and gives cakes with exceptional feeding qualities

Composition profile and qualitative assessment

. Although the qualitative profile is similar to the one of Mubula nut but oleic and lineolic acids have reversed figures giving Mungongo oil (43.3 % of linoleic acid) a specially interesting constitution in dietetic oil blends or as corrector of oils with low essential patty acide content (C 18 : 3) 0.2 %.

. The proportion of total insaturated, 18.2 %, is high as for mubula it is recommended a complementary documentary research

. As mubula oil this oil has a very low content in non saponification matters : 0.54 %.

VI.1.3 - **Munyele Nyele fruits**

▪ **Global results**

Two series of chemical tests have been performed :

- first ones with the whole fruit, like we received the samples - Results 1

- second ones with the products obtained from the extraction tests (pulp, stones, sludges, and oil) to determine water and fat content.

Indeed fat distribution in the differents phases will allow to adjust the technical selection - Results 2.

It has to be stressed on the fact that when the samples arrived at the Wolff Laboratory, most of the fruit were in a fermentation state. This fermentation started during the transportation : time between collection and arrival to laboratories has been of 18 days.

Results 1 (See Analysis Annex 1 C)

MUNYELE NYELE Whole fruit

Fat content (24.2 %) on raw material is to be compared with the whole fruit, of which water content is 33.5 % coming essentially from the fatty pulp surrounding the stone.

Fat content on dry material is 36.4 %.

Protein content is 7.8 % on raw material i.e. 11.7 % on dry material.

High oleic acidity (19 %) is due to the transportation time necessary from the production area to Wolff Laboratories and shows up the chemical fragility of the fruit.

▪ **Composition profile**

Concrete fat are represented by :

- palmitic glycerids : 38.6 %
- stearic glycerids : 15.1 %.

Fluid oils are represented by oleic glycerids 41,6 %.

- **Qualitative Assessment**

Concrete oil is very similar to palm oil of which palmitics, stearics, and oleics content is respectively = 45 %, 10 %, 40 %.

The drupe type fruit is between olive and oil palm fruit and, although its fat extraction will require technological adaptations referring to oil production techniques applicable to said fruit, its output will not satisfy the operation profit.

Results 2 (See Analysis Annex 1C)

Analysis results with extraction products are as following :

Phase	**Weight**	**Humidity %**	**Oil**	**Oil/dry matérial**
Pulp	215 g	6,5 %	33,7	36
Stones	975 g	15,6	25	29,6
Sludges	95 g	2,8	72,8	74,4
Oil	90 g	1		
	1.375 g.			

Oil repartition in the different phases will allow to adjust technical hypotheses and then industrial process selection and also to confirm the raw material oil content.

Phase	**Weight**	**Oil/dry material**	**Oil content**
Pulp	215 g	36,0	77,4 g
Stones	975 g	29,6	288,6 g
Sludges	95 g	74,4	70,6 g
Oil	90 g		89,1 g
	1 375 g		525,7 g.

Then rebuilded oil content on raw material would be :

525,7 / 2,200 ———> 23,9

This figure is quite similar to the first analysis results : 24,2 %.

VI.1.4 - Conclusions, recommendations

Mungongo and Mubula

. These two nuts give an oil of high quality. We will emphasize on the very high fat content of mubula.

The high content in linoleic acid of each one of the oils is very interesting, it is searched for dietetic.

Mungongo oil dietetic qualities, point out the interest of using it for blending mubula oil or other edible oils local or imported.

. Even if at the moment these oils would essentially be orientated to national market as edible oils their good suitability for soap processing must be underligned and allows to forecast different industrial valorizations, but due to their dietetic value it seems better to valorize these oils in human alimentation.

. The nutritional qualities of almond cakes (mubula and mungongo) haven't still been analysed the first quantity of almonds we received being insufficient.

Munyele Nyele

Munyele Nyele oil is essentially a concrete oil quite suitable for soap processing.

In domestic uses, munyele nyele oils can only be used in cooking. For cold utilisations (salad ...) this oil must be winterized first in order to extract the fluid fraction "oleine", as for palm oil.

VI.2 - PHYSICAL TESTS

As the consultant did not receive the samples necessary for semi-industrial physical tests, therefore the only tests were carried out were manual tests.

VI.2.1 - Traditional decorticating

Traditional dehulling at present, only hand method are used in rural area. To be broken, nuts are hit between stones or cut open with a coping saw.

At present, simply dried nuts are dehulled by women in the following way : nut peduncule is put on the cutting side of a simple axe, then hit with another axe which cutting part opens the hull, then the kernel is removed with two fingers. Consequently this operation is extremely slow and dangerous with an output of about 1 kg/hour, i.e. 160-180 gr. of kernels.

Nut fragilization by heat treatment consisting of toasting nuts blended with sand in a cast-iron or clay caldron is only used with Mungongo nuts, for very small quantities required for consumption, after cuticle "testa" removal. As regard Mubula nuts, heat fragilization is required in all cases due to the floss that surrounds kernels.

VI.2.2 - Manual tests of nut decorticating

Although the lack of nuts limited the tests it was possible to check the positive results of a nut cooking-heating related to hull cracking by sharp compression applied on the pedoncule-apex axis, leading to neat kernel separation.

The results of these manual tests seem to be satisfactory for Mungongo as for Mubula

VI.2.3 - Manual tests of Kernel decorticating

Additional dehulling problem arises for Mungongo since, as was previously mentionned, the cuticle (or "testa") represents about 30 % of Kernel weight.

Promisory dehulling manual tests were carried out through toasting in riversand, followed by quick cooling under water flow. Then splitting is easily obtained by hammer percussion.

Chemical results obtained on Kernels free of "testa" confirm the interest of Mungongo nut complete dehulling.

VII - PROJECT IDENTIFICATION AND GENERAL PRINCIPLES

The market survey showed up that in Zambia, there was an important shortage of edible oil, and that the traditional raw material crops projection won't allow in a medium term to meet the total demand.

Mungongo, Mubula and Munyele-Nyele resources are obvious but crop yields estimates have not been achieved and on the same time the village crop capacities have never been assessed. Issues of these problems are critical for the valorization of the nuts and berries. Indeed depend on these data many parameters such as the nut purchase price that collecting villagers can accept, the number of collection points, the average distance between collection points and processing units and then transportation costs...

As market for edible oil is far from being saturated it appeared necessary, in this prefeasibility study to contemplate two possibilities of valorisation :

. a small scale plant of 600-800 T of oil/year

. the processing of these indigeneous raw material in existing edible oil plants

The first option offers several advantages :

. a small scale plant will be a pilot project which first will be put at village level in raw material production areas

. as raw material yields are still unknown a small scale plant is much more adapted in a first stage

. the limited oil production means reduced supply of kernels and will allow on this first stage, to develop specific dehulling equipments for mungongo and mubula nuts

. the project can be reproduced in various areas of the country and meet local population needs and offer employement to local populations.

The second option is interesting due to the fact that to-day existing oil processing plants have surplus processing capacities, but it means higher quantities of kernels and more transportation.

Considering the small scale plant it appeared interesting to contemplate a containerised small scale plant, i.e. easily transferable from one place to another one, and without erecting and assembling investments.

As 1
seen previously, in Zambia oil manufacturing based on indigeneous nuts is a unique experience, therefore some data are missing.

Four major factors are unknown:

- mungongo and mubula nut purchase price (currently collected, dehulled, and processed, manually by rural populations with a low purchasing power)

- dehulling price (due to hard nut specific equipment required)

- kernel purchase price

- munyele-nyele fruit purchase price

Due to its specificity (very hard kernel), for mubula and mungongo a two stage price calculation approach was adopted :

1st stage : pre-feasability study, based on dehulled raw material (kernels) and determination of a kernel purchase price.

2nd stage: Assessment of kernel dehulling cost and nut purchase price Indeed as there are no industrial dehulling equipment adapted to mubula and mungongo nuts, specific equipment must be conceived. At this stage of the study the dehulling cost can only be estimated through a dehulling hypothesis resulting from physical tests (tecnical and cost). This approach will allow to determine the investment acceptable for the dehulling equipment.

An investigation will remain necessary to verify if this proposed prices are acceptable by collecting villagers.

This study is based on data collected in August 1991. Because of Zambia high inflation rates, prices are mentioned in US dollars, at the rate of US $1. = kw 75.

Due to the shortfall in oil and to the fact that this project will be a pilot project it has been considered that the project, through negociations with government of Zambia, will be entitled to a ten years tax income exemption

VIII - MUNGONGO AND MUBULA PROCESSING : PRE-FEASIBILITY STUDY

VIII.1 - FIRST STAGE : PRE-FEASIBILITY STUDY "SMALL SCALE" PLANT PRODUCING EDIBLE OIL FROM KERNEL PROCESSING

The main goal of this first stage is to determine kernel purchasing price, so as to guarantee the project rentability.

VIII.1.1 - Project location

According to field study, the project location depends essentially on 3 factors:

- resource location
- population density in high potential regions
- population availability and motivation for nuts collection.

Results of the resource study under development in January, do not yet allow to determine a final project location.

However, some elements related to resource and population location for each type of nut were obtained, based on field surveys.

Mungongo nuts

In the geological structure of Southern Zambia (Livingstone) and South Eastern (Zambeze basin) regions, abundantly infiltrated by Kalahari woodlands, population density is very low.

The map of tree populations of appropriate density should be compared with the map of populations and with the study of their availability for nut harvest. At present, collect is limited to the consumption of underdeveloped forest populations who have no guaranteed income and who, therefore, accept time consuming manual dehulling.

Due to the very low population density, to the fact that there is no community development to support such a project and even the absence of dense forest zones (which have the best harvest potentialities, in quantity and in quality), labour and sustained gathering organization may be difficult.

Mubula nuts

The tree grows on the whole Zambian territory, but population density is only found on soils with a profile similar to deep sandy soils, with reduced leaching and more regular water availability within average horizon.

Survey made on both parts of Livingstone road between Kalomo and Pemba shows the presence of many more or less scattered trees associated, in some places with masuko of lands.

Taking into account resource location and population geographical distribution, the pilot oil plant may be located in the Livingstone area, Choma or Pemba area at about 100 km from Livingstone.

These areas have the advantages of market proximity, basic infrastructure, etc.

Within the framework of the study, the project location is planned in Livingstone area at about 470 km from Lusaka.

The location will have to be confirmed by the resource study under development, initiated by UNIDO.

VIII.1.2 - Technology options

VIII.1.2.1 Production hypothesis

Planned production is 600 to 800 T oil/year according to the kind of nut processed.

We have considered that the plant production will be made from mungongo (2/3 of the production) and from mubula (1/3 of the production).
This breakdown can be modified in function of local yields.

Based on a processing capacity of 300 kg/h of kernels and an activity of 5,000 h per year (5 working days/week for 10 months), kernel yearly consumption is 1,500 tons (2/3 from Mungongo and 1/3 from Mubula).

Output determination

According to Mungongo gross kernel and Mubula dehulled kernel analysis results, the output may be determined as follows. Data presented here below are interesting as scale of results but they take into account analysis results which have been obtained from single samples, but which could not be statistically adjusted. Nethertheless they are quite relevant to highlightend technical options.

DESCRIPTION		**MUBULA**	**MONGONGO**	
		Whole kernel	Decorticated kernel	
	%	%	%	
1. Required raw material less losses 2 water + evaporation 4	100,00			
2. Recoverable dry material less	94,00	94,00	94,00	94.0
3. Oil on dry materials		39,5	59,9	64,8

4. Delipidated dry matters(DDM) i.e. 86% of cake weight, 10% fat and 4% water + evaporation	54.5	34.1	29.2
5. Cakes: DDM/0.86 =	63.4	39.6	34.0
thus oil in cake to be deducted from (3)	6.3	3.9	3.4
6. Extracted oil	33.2	56.0	61.4

Mungongo kernel is coated with a cuticle "Testa" that reduces oil output. In consequence, when determining the process equipements, it has been provided with an equipment that will partially remove the cuticule (40 %) by screening and air separation after crushing.

After a 40% cuticle removal, Mungongo kernel fiber content is lowered by 10.3% (25.8 x 0.4) and dry material oil content is increased to 44% (39.5/(100 - 10.3)). Therefore, oil and cake distribution is the following :

cake	58%
oil	39%

The following table shows yearly oil and cake production based on Mungongo and Mubula dehulled kernel output and on a yearly volume of processed raw material (2/3 Mongongo, 1/3 Mubula).

Due to the simple process, and the containerized plant type equipment the company should work at full capacity right from the first year.

Production equation

OUTPUT (%)	**MUNGONGO**	**MUBULA**	TOTAL
oil	39	61.4	-
cake	58	34.0	-
CONSUMPTION (M.T.)	1000	500	1500
PRODUCTION (M.T.)			
oil	390	307	697
cake	580	170	750

VIII.1.2.2 - Process

Mungongo kerne dehulling

A knife crusher just set for hull breaking is used.

At machine output, product mixture falls on a two level screening table equipped with ventilated sieves, for good kernel and cuticle fragment separation. Separation note is about 40 %.

Oil extraction

Crushed Mungongo kernel fragments and Mubula whole kernels are sent to a two cylinder pressing grinder that produces pressed pieces gathered in rough dough.

The dough is then directed towards a dryer-cooker to prepare oil release. Oils and warm dough is then introduced in a press through an adjustable flow distributor that optimizes extraction ratios.

Oils recovered under the continuous press include rough muds, due to un unavoidable dough introduction between cage bars, when progressive compression is applied. Compression is adjustable according to products and expected results and transforms partially deoiled material in scale shapped cakes.

Solids separated through a screw device in oil reception tank, under the press are manually recycled by being reintroduced in press input.

Oils are sent to a framed press filter covered with filtering cloth. Filtered oils are then pumped to the storage tank.

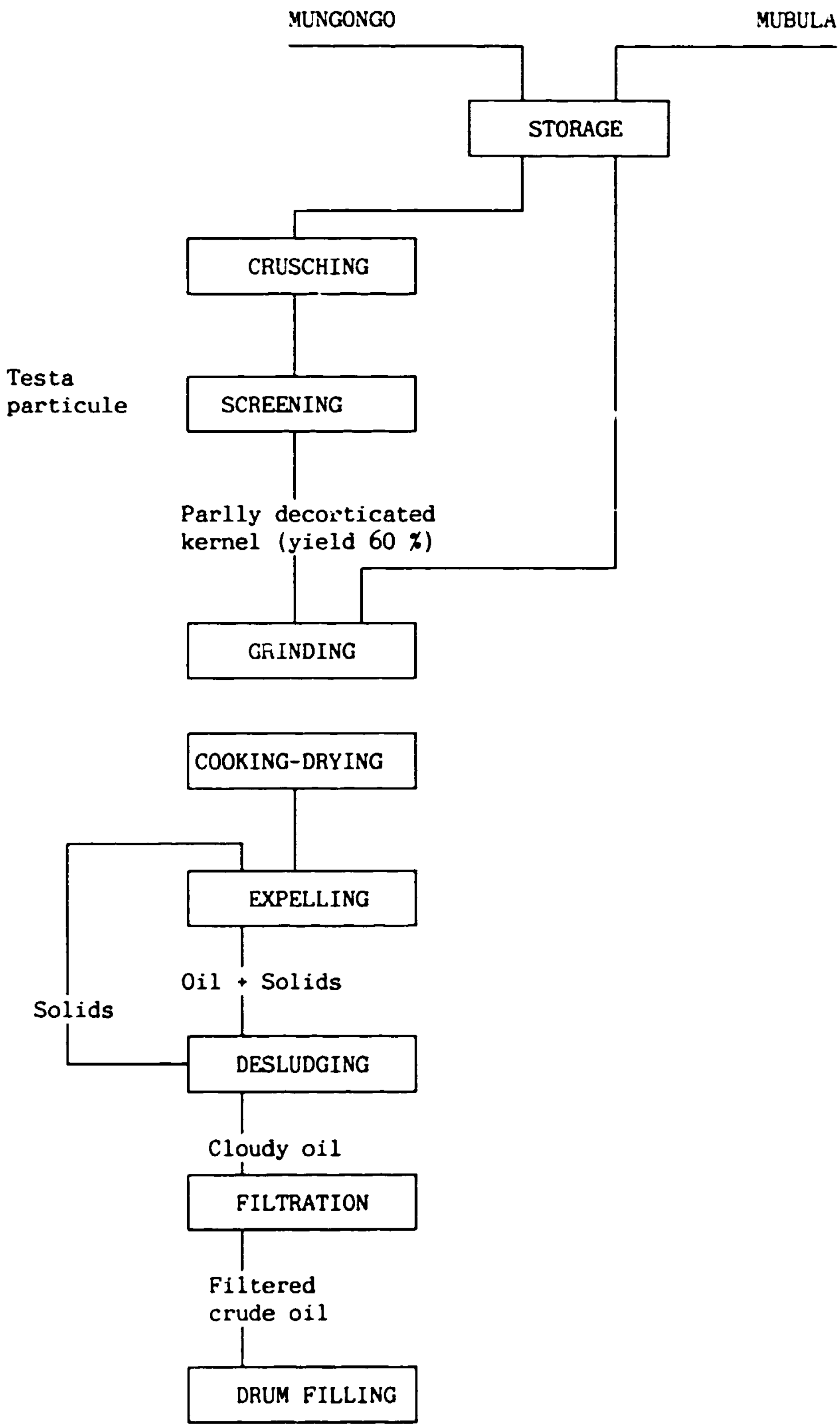
Scales are recevered by a screw elevator and sent to the storage hopper, on charge on bagging and weighing station.

VIII.1.2.3 - Flow Sheet

The following diagram is a summary of oil and cake manufacturing steps, using kernels. It does not include nut collect and dehulling which are studied in the next chapter (VII.3).

PRODUCTION SCHEME

FLOW SHEET



VIII.1.3 - **Project description**

VIII.1.3.1 - Equipment

A. Production equipment

Kernel extracted oil production is a new, therefore experimental operation, as far as economical, technical and delivery aspects are concerned. Therefore, production unit should be of small capacity and should be moved easily, at low price, until the ideal style of stabilized operation is determined.

A container oil plant perfectly answers that goal, and a 300 kg/h output unit heating and mechanical needs can be fulfilled with one single power source. If network connection is not possible, a 80 KVA diesel generator will be supplied and its consumption may be reduced by 50% with the addition of a heat furnace on heating fluid network.

Thes two options were studied and are presented in annex 1 :

- Power supply from a 80 KVA generator
- Power supply from electrical network connection and addition of a hull boiler allowing 30 KVA savings.

The unit is supposed supplied with shelled nuts (kernel).

The dehulling is studied and developped in a further chapter : VII.3.

Processing equipments are listed herebelow :

1. Additive decorticating equipment for Mungongo-whole kernel :

   * Oblique screw conveyor with feeding container
   * Knife type crusher (Concasseur DC 300)
   * 2 screen separation to remove the broken "Testa" particles
   * Vertical screw conveyor towards mechanical preparation.

2. Mechanical preparation

   * Stand hopper with feeding flow electrical control of the unit.
   * Roller grinder

3. Heating treatment

   * Vertical feeding hooper with control electrical
   * Cooker drier heated by dowtherm circulation with electrical level control of the product

4. Oil extraction

   * Expeller equipped with special integrated screw desludger

5. Filtration

* Framed press filter and accessory equipments :

  - Pump under cloudy oil buffer tank, sediment and dripping collecting tank.

6. Miscelleanous :

* necessary tools
* dowtherm provision
* spareparts
* full piping
  - container. All equipment is installed in a mobile container
  - oil conditionning
* electrical panel

* 10 tons buffer tank on charge on barelling station including:
  - Dial scale with 300 kg load
  - Rolling path

7. Cake bagging

* Recovery tilted screw, under the press, yielding on

  - 10 ton hopper on charge on:
  - dial scale with 200 kg load

8. Optionnal equipment

* 80 KVA generator (optionnal)
* brasero "heat furnace"

B. Transfer equipment

Two vehicles types are envisaged:

* a pick up 4 x 4 single cab 1 Ton load
* a truck TOYOTA 3 - 4 Tons load.

VIII.1.3.2 - <u>Civil works</u>

Since this is an oil plant containerized, buildings are not required. However, a 600 m2 building is planned, with the following distribution:

- 40 m2 offices
- 40 m2 warehouse (spare parts, packagings)
- 520 m2 warehouse (raw materials, finished products)

Buildings will have a simple design, closed shelter type.

VIII.1.4 - **Evaluation of investments**

VIII.1.4.1 - Equipments

A. Production equipment

Containerized small scale oil plants are relatively recent equipment. So it was not possible to find second hand equipment.

Nethertheless it has to be stressed on the fact that this kind of equipment really limits transportation and implementation costs (there are no erecting costs).

Production equipment cost is the following:

	US$
Oil plant in container basic equipment	191.012
Screening with ventilation and cyclone	10.418
Grinder DC 300	19.575
Cake outlet screw	4.157
Spare parts (one year)	35.455
Sub-total	260.617
transportation	7.054
Total	267.671

i.e. a rounded amount of US $268.000

B. Transportation equipment

Vehicles will be locally purchased. The total cost of transportation equipment is the following :

- Pick up 4 x 4 (1 Ton) = 18.000 US $
- Truck Toyota (3-5 Tons) = 21.000 US $

VIII.1.4.2 - Civil works

It has been planned that the building would be realized with local materials and manpower.

Total building cost:

US $ 200/m2 x 600 m2 = US$ 120.000

It must be precised that, to limit investments, it would be interesting to rent inoccupied buildings.

As it was not possible to define exactly the site, it was not possible to look for such buildings. In this prefeasibility study, we considered then a new building erection.

VIII.1.4.3 - Pre-production expenditures

Pre-production expenditures include all expenses prior to production (besides working capital and fixed investment).
The following table shows the breakdown according to main expense categories.

Items		Value
Training by foreign technicians		15.000
Pre-production management		4.500
Local staff		5.000
Administration, travels		3.500
Cost of finance (provision)		20 900
Total	US$	48.900

VIII.1.4.4 - Packaging

Oil will be packed in 200 liter drums. Drums are recovered by the company through a deposit system. Therefore, packaging is included in investments. A yearly 20% drum loss is planned.
Taking into account these observations and rotation time during the first operation year, 500 200-liter/drums are planned at US$ 20, per drum, i.e. a total of US$ 10.000).
In addition, a 20% yearly renewal of drums will cost US$ 2,000/year.

VIII.1.4.5 - Working Capital

Net working capital shows the financial means which are necessary for the operation of the plant. It is usually defined as the difference between circulating assets and current liabilities.

Current liablities are mainly included in debit account (amounts to be paid).

Therefore, working capital essentially depends on customer and supplier payment conditions, delivery time, realizable and available values.
It is supposed that customers and suppliers will support cash payments.

The following table shows the calculation of net working capital and its variations for the whole time of the project.

Finished product stocks are planned at manufacturing costs.

CALCULATION OF WORKING CAPITAL (US$)

Item Years	Number of months	1	2	3	4	5	6	7	8	9	10
Inventory		**269 554**	**269 720**	**269 720**	**269 720**	**268 702**	**268 702**	**268 702**	**268 702**	**268 702**	**268 702**
...Raw materials	2	165 000	165 000	165 000	165 000	165 000	165 000	165 000	165 000	165 000	165 000
...Power and fuel	1	2 465	2 465	2 465	2 465	2 465	2 465	2 465	2 465	2 465	2 465
...Spare parts	1	688	688	688	688	688	688	688	688	688	688
...Finished products	1	101 401	101 568	101 568	101 568	100 549	100 549	100 549	100 549	100 549	100 549
Cash in hand		**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**
...administrative costs	0,5	1 075	1 075	1 075	1 075	1 075	1 075	1 075	1 075	1 075	1 075
...Labour	1	6 500	6 500	6 500	6 500	6 500	6 500	6 500	6 500	6 500	6 500
Net working capital		**277 129**	**277 295**	**277 295**	**277 295**	**276 277**	**276 277**	**276 277**	**276 277**	**276 277**	**276 277**
Increase in working capital			**167**	**0**	**0**	**-1 019**	**0**	**0**	**0**	**0**	**0**

VIII.1.4.6 - Investment summary

The following tables show:

- initial investment global cost, including acquisition values, currency share, depreciation time and execution year.

- investment and replacement schedule

- depreciation schedule.

The first year net working capital value was included in the initial investment, and it was supposed that the net working capital increase would be met by the operating results. In consequence this net working capital increase is taken into account in the Cash flow table.

VIII.1.5 - **Kernel purchase price and determination profitability survey**

VIII.1.5.1. Turnover determination

Sold production is defined each year as production less stock variations.

Oil will be sold in 200 l drums, at an expected price of US$ 274.5/drum, i.e. US$ 1,500 M.T. (ex factory, on Zambia market).

In Zambia, cake price is between US$ 400 and 450/ton.

According to cake energy value, the following prices may be determined:

- Mungongo cakes - US $ 300 M.T.
- Mubula cakes - US$ 400 M.T.

This prices have been fixed in function of the prices recorded during the infield mission (see chapter III.1.6).

The following table shows finished product stock (in M.T.), sold production (in M.T.) for the first 3 years and product price (in US$/M.T.), according to production, consumption and yield.

Production sold on the first year is planned to be lower than the following years, because of end product stock setting up. Yearly sales values are the following:

	YEAR 1	YEAR 2 and following
Oils	958.375	1.045.500
Cakes	221.833	242.000
Total: US $	1.180.208	1.287.500

TOTAL INITIAL INVESTMENT COSTS (US $)

INVESTMENTS	Acquisition Values (US$)	Currency Share (%)	Depreciation time (years)	Schedule (%/year) Year 0	Year 1
Building and civil works	120 000	0	25	100	0
Equipments	268 000	100	8	100	0
Vehicles	39 000	0	5	100	0
Working capital	277 129	0		0	100
Pre-production capital expenditures	48 900	0	4	100	0
Packagings*	10 000	0		0	100
TOTAL	763 029				

* 20% of packagings are yearly renewed

INVESTMENTS AND REPLACEMENTS SCHEDULE (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Building and civil works	120 000	0	0	0	0	0	0	0	0	0	0
Equipments	268 000	0	0	0	0	0	0	0	268 000	0	0
Vehicles	39 000	0	0	0	0	39 000	0	0	0	0	39 000
Working capital	0	277 129	0	0	0	0	0	0	0	0	0
Pre-production capital expenditures	48 900	0	0	0	0	0	0	0	0	0	0
Packagings*	0	10 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000
TOTAL	475 900	287 129	2 000	2 000	2 000	41 000	2 000	2 000	270 000	2 000	41 000

DEPRECIATIONS PLAN (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Building and civil works	0	4 800	4 800	4 800	4 800	4 800	4 800	4 800	4 800	4 800	4 800
Equipments	0	33 500	33 500	33 500	33 500	33 500	33 500	33 500	33 500	33 500	33 500
Vehicles	0	7 800	7 800	7 800	7 800	7 800	7 800	7 800	7 800	7 800	7 800
Pre production capital expenditures	0	12 225	12 225	12 225	12 225	0	0	0	0	0	0
Packagings*	0	0	2000	2000	2000	2000	2000	2000	2000	2000	2000
TOTAL	0	58 325	60 325	60 325	60 325	48 100	48 100	48 100	48 100	48 100	48 100

YIELDS (%)	Mungongo	Mubula
Oil	39.0	61.4
Cakes	58.0	34.0

	Mungongo	Mubula	Total
CONSUMPTION (MT)	1000	500	1500
PRODUCTION (MT)			
Oil	390	307	697
Cakes	580	170	750
INVENTORY			
Raw materials (two months)	167	83	250
Finished products (one month)			
...Oil	33	26	58
. Cakes	48	14	63

SALES (MT)	YEAR 1	YEAR 2	YEAR 3
Oil			
Mungongo	358	390	390
Mubula	281	307	307
Total Oil	639	697	697
Cakes			
Mungongo	532	580	580
Mubula	156	170	170
Total Cakes	688	750	750

PRICES (US$/MT)	Mungongo	Mubula
Oil	1500	1500
Cakes	300	400

VIII.1.5.2 - Kernel and raw material total cost

In order to determine kernel price, we proceeded by iteration, so as to guarantee an internal rate of return higher than loan rate which, as mentioned in the next profitability section is planned at 12%.

In the second stage, we must check if this kernel purchase price covers dehulling and nut collect costs.

According to the above calculation, the average price of 1 ton of kernels is US$ 660/per M.T. to garantee an internal rate of return of 15,3 %.

Purchase products prices are :

- Mubula : US $ 854,5/M.T. kernels (855 US $)
- Mungongo : US $ 562,2/M.T. Kernels (562 US $).

Yearly raw material total price, based on 1,500 MT of kernels, is US$ 990.000.

VIII.1.5.3 - Maintenance

Maintenance and repair rates are calculated at 2.5% of equipment acquisition value and 4% of vehicle value, i.e. a yearly amount of US$ 8.260

VIII.1.5.4 - Power and Fuel

Electricity

Equipment established capacity is 80 KVA. Based on an hourly consumption of 70 Kwh at US $ 0.07/Kw/h, for 5,500 hours/year, yearly electricity cost is US $ 26,950.

Fuel, lubricant

It is assumed that due to supply proximity. Mungongo kernel gathering is done by the company. Based on 25,000 km/year and a diesel consumption of 21 1/100 km, at US$ 0.5/1 yearly diesel cost is US$ 2,625.

Yearly power and diesel oil total cost is US $ 29,575.

VIII.1.5.5 - Labour

The following table shows job numbers and total yearly labour charges by staff category (including social expenses calculated at 12.5% of labour).

This table indicates yearly labour charges of US $ 78,000.

Item	No of jobs	Yearly cost (US$)
Production Manager	1	17.000
Accountant	1	10.000
Secretary	1	4.000
Store Keeper	1	4.000
Mechanics	1	6.000
Operators	3	10.000
Skilled Workers	3	12.000
Drivers	2	5.000
Unskilled Workers	4	5.000
Watchman	2	3.000
Total	19	78.000

VIII.1.5.6 - Administrative costs

A yearly lump sum of US$ 1,800 is planned for management costs (travels, telex, etc.).

Furthermore, a local partner is supposed to be hired by the private company for management and marketing assistance. Services yearly cost is US $ 24,000.

Yearly administrative costs total cost is US$ 25.800.

VIII.1.5.7 - Insurance

Planned insurance premium is 5.% of building, equipment and vehicles rates, i.e. a yearly amount of US $ 21.350.

VIII.1.5.8 - Transport services

With the present knowledge of production sites it is assumed that a local hauler will be hired by the company for Mubula Kernel supply due to long distances and supply site scattering.

On an estimated base of 50.000 Tkm for 500 M.T. of Mubula kernel supply at US $ 0,11 per T.K. yearly cost of transportation is US $ 5.500.

VIII.1.5.9 - Depreciation allowances

As calculated in section VII.2.4.7 yearly allowances are :

US $ 58.325 for the first year
US $ 60.325 for the three following year
and US $ 48.100 after the fifth year of operation.

VIII.1.5.10 - Finished products inventory variation

According to adopted methodology stock creation is taken into account with the investments or the first year, and "working capital variation" for the following years are indicated in cash flow table in item "increase an working capital".

In order not to redundantly account these charges in operating statement, a "finished product inventory variations" item is taken into account.
It allows to deduct from production cost stocks/charge/related which are taken into account in working capital and investment

As regards raw materials, we directly considered consumed quantities instead of including both "raw material purchase" and "raw material stock variations" items.

VIII.1.5.11 - Provisional operating account before financing

Provisional operating account before financing (without financial charges and return on capital) is presented on the following page.

This table shows that on the first year the company makes a sales gross profit of 5 %.

VIII.1.5.12 - Profitability

The Internal Rate of Return (I.R.R) measures project specific profitability, irrespective of financing scheme.

Cash account and internal rate are presented on the following page. It must be reminded that it has been considered the project will benefit of a ten years taxes exemption.

If it was considered that the I.R.R. limit acceptable was equivalent to the loan interest rate (12 %) the kernel average purchase price would be of US $ 674.5 (675)/M.T.

Due to the difference of oil yield when Mungongo kernel is not completely decorticated (40 % "Testa" left) it seemed interesting to evaluate the limit purchase price for each nut in the frame of a I.R.R of 12 %

- Mubula US $ 871/M.T.
- Mungongo US $ 576/M.T.

PROVISIONAL OPERATING ACCOUNT BEFORE FINANCING (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
SALES VALUES	**0**	**1 180 208**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**
Oil	0	958 375	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500
Cakes	0	221 833	242 000	242 000	242 000	242 000	242 000	242 000	242 000	242 000	242 000
COSTS	**0**	**1 115 409**	**1 218 643**	**1 218 810**	**1 218 810**	**1 207 604**	**1 206 585**	**1 206 585**	**1 206 585**	**1 206 585**	**1 206 585**
Raw materials	0	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000
Maintenance and repair	0	8 260	8 260	8 260	8 260	8 260	8 260	8 260	8 260	8 260	8 260
Power and fuel	0	29 575	29 575	29 575	29 575	29 575	29 575	29 575	29 575	29 575	29 575
Finished products inventory variation	0	-101 401	-167	0	0	1 019	0	0	0	0	0
Administrative costs	0	25 800	25 800	25 800	25 800	25 800	25 800	25 800	25 800	25 800	25 800
Insurance	0	21 350	21 350	21 350	21 350	21 350	21 350	21 350	21 350	21 350	21 350
Labour	0	78 000	78 000	78 000	78 000	78 000	78 000	78 000	78 000	78 000	78 000
Transport services	0	5 500	5 500	5 500	5 500	5 500	5 500	5 500	5 500	5 500	5 500
Depreciation	0	58 325	60 325	60 325	60 325	48 100	48 100	48 100	48 100	48 100	48 100
GROSS RESULT	**0**	**64 799**	**68 857**	**68 690**	**68 690**	**79 896**	**80 915**	**80 915**	**80 915**	**80 915**	**80 915**

CASH FLOW TABLE BEFORE FINANCING (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
CASH INFLOW	**0**	**123 124**	**129 182**	**129 015**	**129 015**	**127 996**	**129 015**	**129 015**	**129 015**	**129 015**	**1 004 420**
..Cash flow	0	123 124	129 182	129 015	129 015	127 996	129 015	129 015	129 015	129 015	129 015
..Recuperation of Working capital	0	0	0	0	0	0	0	0	0	0	276 277
..Residual value	0	0	0	0	0	0	0	0	0	0	599 129
CASH OUTFLOW	**475 900**	**287 129**	**2 167**	**2 000**	**2 000**	**39 981**	**2 000**	**2 000**	**270 000**	**2 000**	**41 000**
..Investments	475 900	287 129	2 000	2 000	2 000	41 000	2 000	2 000	270 000	2 000	41 000
..Increase in working capital	0	0	167	0	0	-1 019	0	0	0	0	0
SURPLUS/DEFICIT	**-475 900**	**-164 005**	**127 015**	**127 015**	**127 015**	**88 015**	**127 015**	**127 015**	**-140 985**	**127 015**	**963 420**
CUMULATIVE CASH BALANCE	**-475 900**	**-639 905**	**-512 890**	**-385 875**	**-258 860**	**-170 845**	**-43 830**	**83 185**	**-57 800**	**69 215**	**1 032 636**

INTERNAL RATE OF RETURN	15,3%

Based on a kernel average purchase price of US $ 660/M.T., project profitability 15.3 % is higher than loan interest rate. This average purchase price has been considered for the carrying out of the study.

VIII.1.6 - Financial analyses

VIII.1.6.1 - Financing program

After consultation with various international organizations, the following financing program is proposed :

- Equity	: 40 %
- Foreign loan	: 60 %
- Repayment period	: 8 %
- Grace period	: 1 year
- Interest rate	: 12 %.

Tables next page show up :

- a summary of the project financing
- a schedule of interest and principal repayments.

VII.1.6.2 - Financial statements

The following data are presented on the following page :

- Operating account after financing
  (calculation base for the new cash flow table)
- Cash flow table after financing
- Gross profit/total sales ratio calculated each year
- Nominal capital single profitability rate, per year
- Shoreholder profitability rate based on cash balances.

Gross profit/total sales ratio is an indicator of project profitability since it dedicates the various steps of project profitability and shows production process efficiency, this ratio is quite relevant for shareholders.

This ratio regularly increases due essentially to overhead and depreciation decrease.

In our case this ratio varies from 0.84 % to 6.28 %.

Yearly profitability ratio of nominal capitals measures the efficiency of the company to use shareholders capitals. Here, this ratio regularly increases from 3.23 % to 26.51 %.

Yearly net cash flow calendar allows shareholders to determine project profitability.
It consists of calculating profitability rate that balances contribution of capital and cash flow developped by the project (without dividends).

According to accounting rules, shareholder profitability rate is higher than IRR when loan interest rates are lower than IRR, therefore they have a lever effect on nominal capital yield.

It our case, shareholder profitability rate is slightly higher than IRR (15.6% vs 15.3 %) cash flow, of negative net cash flow on 5th and 8th year of operation (due to some investment renewal).

In addition, 8th year is the only one that generates negative cumulated net cash flow. This means that to cover that year needs for equipment renewal, the company must obtain a short term loan, or increase its nominal capital

Sensitivity analisis :

A sensitivity analisis was performed to show how the profitability of the project alters with different values assigned to unit sales price and to unit raw material purchase price.

Test 1 : 10 % of increase in sales price
Test 2 : 10 % of increase in kernels purchase price

Results are :	IRR
Test 1	35.2 %
Test 2	1 %.

In the study kernel purchase price was determined by iteration. If the complementary study forecasted to precise dehulling costs, leads to an increase in kernel purchasing price, then oil sales price will have to be increased.

This increase may be contemplated because oil sales price ex-factory considered in this study is US $ 274.5/drum when current parastatal retail price in rural area is US $ 356.12, leaving a distribution margin of 30 %.

SOURCES OF INITIAL FUNDS (US$)

Items	Values (US$)	Resources Share (%)	Currency Share (%)	Schedule (%) Year 0	Year 1
CAPITAL	305 212	40	0	100	0
LOAN	457 817	60	100	38	62
...Grace period (Year)	1				
...Interest rate (%)	12				
...Duration (Year)	8				

REPAYMENTS OF LOANS IN YEAR 0 (US$)

LOAN AMOUNT IN YEAR 0 173 971

Item / Years	0	1	2	3	4	5	6	7	8	9	10
Interests	20 876	20 876	17 894	14 912	11 929	8 947	5 965	2 982	0	0	0
Repayments (principal)	0	24 853	24 853	24 853	24 853	24 853	24 853	24 853	0	0	0
Capital balance due	173 971	173 971	149 118	124 265	99 412	74 559	49 706	24 853	0	0	0
Annuity	20 876	45 729	42 747	39 765	36 782	33 800	30 818	27 835	0	0	0

REPAYMENTS OF LOANS IN YEAR 1 (US$)

LOAN AMOUNT IN YEAR 1 283 847

Item / Years	0	1	2	3	4	5	6	7	8	9	10
Interests	0	34 062	34 062	29 196	24 330	19 464	14 598	9 732	4 866	0	0
Repayments (principal)	0	0	40 550	40 550	40 550	40 550	40 550	40 550	40 550	0	0
Capital balance due	0	283 847	283 847	243 297	202 748	162 198	121 649	81 099	40 550	0	0
Annuity	0	34 062	74 611	69 745	64 879	60 013	55 147	50 281	45 415	0	0

REPAYMENTS RECAPITULATIVE (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
Interests	20 876	54 938	51 956	44 107	36 259	28 411	20 563	12 714	4 866	0	0
Repayments (principal)	0	24 853	65 402	65 402	65 402	65 402	65 402	65 402	40 550	0	0
Capital balance due	173 971	457 817	432 964	367 562	302 159	236 757	171 354	105 952	40 550	0	0
Annuity	20 876	79 791	117 358	109 510	101 662	93 813	85 965	78 117	45 415	0	0

PROVISIONAL OPERATING ACCOUNT AFTER FINANCING (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
SALES VALUES	**0**	**1 180 208**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**	**1 287 500**
Oil	0	958 375	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500	1 045 500
Cakes	0	221 833	242 000	242 000	242 000	242 000	242 000	242 000	242 000	242 000	242 000
COSTS	**0**	**1 170 347**	**1 270 599**	**1 262 917**	**1 255 069**	**1 236 015**	**1 227 148**	**1 219 299**	**1 211 451**	**1 206 585**	**1 206 585**
Raw materials	0	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000
Maintenance and repair	0	8 260	8 260	8 260	8 260	8 260	8 260	8 260	8 260	8 260	8 260
Power and fuel	0	29 575	29 575	29 575	29 575	29 575	29 575	29 575	29 575	29 575	29 575
Finished products inventory variation	0	-101 401	-167	0	0	1 019	0	0	0	0	0
Administrative costs	0	25 800	25 800	25 800	25 800	25 800	25 800	25 800	25 800	25 800	25 800
Insurance	0	21 350	21 350	21 350	21 350	21 350	21 350	21 350	21 350	21 350	21 350
Labour	0	78 000	78 000	78 000	78 000	78 000	78 000	78 000	78 000	78 000	78 000
Transport services	0	5 500	5 500	5 500	5 500	5 500	5 500	5 500	5 500	5 500	5 500
Depreciation	0	58 325	60 325	60 325	60 325	48 100	48 100	48 100	48 100	48 100	48 100
Interests	0	54 938	51 956	44 107	36 259	28 411	20 563	12 714	4 866	0	0
GROSS RESULT	**0**	**9 861**	**16 901**	**24 583**	**32 431**	**51 485**	**60 352**	**68 201**	**76 049**	**80 915**	**80 915**
Dividends	0	1 085	1 859	2 704	3 567	5 663	6 639	7 502	8 365	8 901	8 901
Cash flow	0	68 186	77 226	84 908	92 756	99 585	108 452	116 301	124 149	129 015	129 015

CASH FLOW TABLE AFTER FINANCING (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
CASH INFLOW	**479 182**	**352 033**	**77 226**	**84 908**	**92 756**	**99 585**	**108 452**	**116 301**	**124 149**	**129 015**	**1 004 420**
Equity	305 212	0	0	0	0	0	0	0	0	0	0
Loans	173 971	283 847	0	0	0	0	0	0	0	0	0
Cash flow	0	68 186	77 226	84 908	92 756	99 585	108 452	116 301	124 149	129 015	129 015
Recuperation of Working capital	0	0	0	0	0	0	0	0	0	0	276 277
Residual value	0	0	0	0	0	0	0	0	0	0	599 129
CASH OUTFLOW	**475 876**	**313 066**	**69 428**	**70 107**	**70 970**	**111 047**	**74 041**	**74 905**	**318 915**	**10 901**	**49 901**
Investments	455 000	287 129	2 000	2 000	2 000	41 000	2 000	2 000	270 000	2 000	41 000
Increase in working capital	0	0	167	0	0	1 019	0	0	0	0	0
Dividends	0	1 085	1 859	2 704	3 567	5 663	6 639	7 502	8 365	8 901	8 901
Repayments (principal)	0	24 853	65 402	65 402	65 402	65 402	65 402	65 402	40 550	0	0
Cost of finance	20 876	0	0	0	0	0	0	0	0	0	0
SURPLUS/DEFICIT	**3 306**	**38 966**	**7 798**	**14 801**	**21 786**	**-11 462**	**34 411**	**41 396**	**-194 766**	**118 114**	**954 520**
CUMULATIVE CASH BALANCE	**3 306**	**42 272**	**50 070**	**64 871**	**86 657**	**75 195**	**109 606**	**151 002**	**-43 763**	**74 351**	**1 028 871**
RATIOS											
Gross profit / sales (%)	0	0,84	1,31	1,91	2,52	4,00	4,69	5,30	5,91	6,28	6,28
Gross profit / equity (%)	0	3,23	5,54	8,05	10,63	16,87	19,77	22,35	24,92	26,51	26,51

RETURN ON EQUITY 15,6%

VIII.2 - ASSESSMENT OF NUT PRICE AND RENTABILITY

This second phase has two main goals :

- to determine nut purchase price that can be proposed,
- to determine kernel supply cost paid by existing extraction units currently working below capacity with other raw materials.

Both valorization possibilities may be envisaged since present traditional raw material productions (soya, sunflower, cotton, groundnut) are much lower than processing capacities, therefore national needs are far from being satisfied.

In order to determine nut purchase price, we used the previous kernel purchase price assessment method. Therefore, we proceeded by iteration, to determine a purchase prise which guarantee dehulling profit.

Due to the specific dehulling problem which is detailed hereunder, at this stage of the study it was not possible to make any accurate equipment assessment. Therefore, the goal is to determine a dehulling admissible investment.

An additional study will allow to identify and to define equipment specifications (quantities etc), and to make a first evaluation of the equipment cost. Then we will be able to see under which conditions dehulling equipment investment is acceptable.

VIII.2.1 - Technological options

VIII.2.1.1 - Nut specific features

Tests shows that Mungongo nuts give, in average, 16% of gross kernels and that Mubula nuts have a slightly higher average yield of 20% of kernels.

In order to answer the yearly needs of the new oil extraction unit (1,500 T. of kernels - 2/3 from Mungongo and 1/3 from Mubula). 6,250 M.T. are required from Mungogo and 2,500 M.T. from Mubula, i.e. a total of 8,750 M.T. of nuts (rounded to 8,800 M.T.).

At present, simply dried nuts are dehulled by women in the following way : nut peduncule is put on the cutting side of a simple axe, then hit with another axe which cutting part opens the hull, then the kernel is removed with two fingers.
This operation is extremely slow and dangerous , with an output of about 1 kg/hour, i.e. 160-180 gr. of kernels.

Nut fragilization by heat treatment consisting of toasting nuts blended with sand in a cast-iron or clay caldron is only used with Mungongo nuts, for very small quantities required for consumption, after cuticle (testa) removal. As regard Mubula nuts, heat fragilization is required in all cases due to the floss that surrounds kernels.

VIII.2.1.2 - Heating and mechanical parameters of dehulling sequential operations

Unfortunately, tests were limited because of insufficient quantities of nuts, but they allowed to check the positive effect of nut cooking-heating related to hull cracking by sharp compression applied on the pedoncule - apex axis, leading to neat kernel separation.

VIII.2.1.3 - Dehulling equations

In spite of the lack of samples to carry out dehulling physical tests, to achieve the study, it was necessary to evaluate the time, the cost and the labour in function of the dehulling process.

Following estimates will be precised if funds are available to realize a "unitary device"

Option A - Traditional process

125 8 g of nuts/hour = 1 kg = 170 g of kernels - 1 employee.

Option B - With of "unitary device"

250 nuts/hour = 2 kg = 340 g of kernels - 2 employees.
Plus 0.5 cooking hour.

Option C - With of improved manual device

Sequential admission of 20 nuts
3.500 nuts/hour = 28 kg = 4.7 kg of kernels - 3 employees
Plus 1 cooking hour.

Option D - With of motorized equipment (2 anvils).

Sequential admission - 2 x 30 nuts
Speed - 15 knocks/mn
54,000 nuts/hour = 430 kg = 73 kg of kernels - 4 employees
Plus 7 cooking hours.

VIII.2.1.4 - Assessment of human and materials means

Based on women availability of 10 hours/week (two operations of 5 hours each) and a permutation of 3 teams per week on the same machine, the season lasts 25 weeks, i.e. 10 h x 25 = 250 hours/team and 750 hours/machine.
Only options C and D will be kept in this assessment.

As regards nut cooking-toasting using equipment mounted on a hull furnace and applying an "alternative" scraping, hourly capacities are 30 kg for case C and 67 kg for case D In both cases 2 employees are required.

Dehulled kernel production program is 1.500 M.T.

A) DEHULLING

	OPTION C	OPTION D
kernel weekly production		
per team	47 kg	730 kg
per machine	141 kg	2.190 kg
kernel yearly production		
per team	1.175 kg	1.825 kg
per machine	3.525 kg	54.750 kg
Number of teams	1.276	82
Number of employees	3.830 (4000)*	328 (350)*
Number of machines	425 (450)*	28 (30)*

* Figures between brakets are rounded.

B) COOKING-TOASTING

	OPTION C	OPTION D
Yearly production		
per team	7.500 kg	16.570 kg
per machine	22.500 kg	50.250 kg
Number of employees	400	180
Number of machines	70	30

C) REQUIRED TIME

	OPTION C	OPTION D
Cooking-toasting		
400 x 250 h	100.000	
180 x 250 h		45.000
Dehulling		
4000 x 250 h	1.100.000	
350 x 250 h		87.500
TOTAL	1.200.000 h	132.500 h

D) INVESTMENT (US $)

	OPTION C	OPTION D
Cooker unit cost	700	1.600
Global cost		
US $ 700 x 70	49.000	
US $ 1600 x 30		48.000
Dehuller unit cost	1.250	6.500
Global cost		
US $ 1250 x 450	562.500	
US $ 6500 x 30		195.000
TOTAL	611.500	243.000

These estimates show up the number of employee necessary in each option

- Option C : 4 400 in a maximum of 70 sites
- Option D : 530 in a maximum of 30 sites

Indeed we have considered that each dehulling point could be equipped with at least a cooking toasting equipement

This highlightes the importance of the production areas survey actually carried out by a national expert in women in development to assess the women's availibility and participation.

The following tables show for each option :

- Total initial investment costs. including acquisition values. currency share, depreciation time
- Investments and replacements schedule
- Depreciation plan.

VIII.2.1.5 - Location

Location of dehulling units, which are different from oil manufacturing unit, remain to be defined. They will be located close to gathering places to avoid heavy transportation costs. Indeed hull represents 80 to 84 % of the nut volume according to the material : mubula or mungongo.

OPTION C

TOTAL INITIAL INVESTMENT COSTS (US $)

INVESTMENTS	Acquisition Values (US$)	Currency Share (%)	Depreciation time (years)
Building and civil works	0		
Equipments	611 500	100	10
Vehicles	0		
Working capital	0		
Pre-production capital expenditures	0		
TOTAL	611 500		

INVESTMENTS AND REPLACEMENTS SCHEDULE (US $)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Building and civil works	0	0	0	0	0	0	0	0	0	0	0
Equipments	611 500	0	0	0	0	0	0	0	0	0	611 500
Vehicles	0	0	0	0	0	0	0	0	0	0	0
Working capital	0	0	0	0	0	0	0	0	0	0	0
Pre-production capital expenditures	0	0	0	0	0	0	0	0	0	0	0
TOTAL	611 500	0	0	0	0	0	0	0	0	0	611 500

DEPRECIATIONS PLAN (US $)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Building and civil works	0	0	0	0	0	0	0	0	0	0	0
Equipments	0	61 150	61 150	61 150	61 150	61 150	61 150	61 150	61 150	61 150	61 150
Vehicles	0	0	0	0	0	0	0	0	0	0	0
Pre-production capital expenditures	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	61 150	61 150	61 150	61 150	61 150	61 150	61 150	61 150	61 150	61 150

OPTION D

TOTAL INITIAL INVESTMENT COSTS (US $)

INVESTMENTS	Acquisition Values (US$)	Currency Share (%)	Depreciation time (years)
Building and civil works	0		
Equipments	243 000	100	8
Vehicles	0		
Working capital	0		
Pre-production capital expenditures	0		
TOTAL	243 000		

INVESTMENTS AND REPLACEMENTS SCHEDULE (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Building and civil works	0	0	0	0	0	0	0	0	0	0	0
Equipments	243 000	0	0	0	0	0	0	0	243 000	0	0
Vehicles	0	0	0	0	0	0	0	0	0	0	0
Working capital	0	0	0	0	0	0	0	0	0	0	0
Pre-production capital expenditures	0	0	0	0	0	0	0	0	0	0	0
TOTAL	243 000	0	0	0	0	0	0	0	243 000	0	0

DEPRECIATIONS PLAN (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Building and civil works	0	0	0	0	0	0	0	0	0	0	0
Equipments	0	30 375	30 375	30 375	30 375	30 375	30 375	30 375	30 375	30 375	30 375
Vehicles	0	0	0	0	0	0	0	0	0	0	0
Pre-production capital expenditures	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	30 375	30 375	30 375	30 375	30 375	30 375	30 375	30 375	30 375	30 375

VIII.2.2 - Operating account

VIII.2.2.1 - Turnover

Production is 1.500 T of kernels at a price of US $ 660/M.T. (as determined by phase I iteration), i.e. a yearly turnover of US $ 990.000.-

VIII.2.2.2 - Production costs

A. Nut purchase price and raw material total cost

To guarantee that Internal Rate of Return is higher than loan interest (here, we have retained an internal rate of return of 15,3 % as in the oil prefeasability study), nut purchase price must be of :

US $ 44,45/M.T. in option C (US $ 45/M.T) and
US $ 93,86/M.T. in option D (US $ 94/M.T).

These prices guarantee an 13,07 % IRR.

Therefore, with the same profit, nut purchase price is much more incentive in option D than in option C. This is due to the very important labour and the high number of dehulling equipment necessary in option C.

It must be precised we assumed that women will collect dry nuts or dry manually the nuts still bearing fresh pulp (mubula).
If a depulping equipment was necessary for mubula nuts the depulping cost would be US $ 6,3/M.T.

This depulping cost has been evaluated on the following basis :

- Depulping equipment out put is 800 kg/h i.e. 3,2 T per 5 hours work day (1 cleaning hour). In order to take into account the crop production period (6 months) we have considered that yearly output of each equipment is 400 Tons.
- Investment for such equipment is US $ 4.800
- Three persons are required for the manutention at a hourly rate of US $ 0,35
- Fuel consumption is 1,5 l/working hour
- Maintenance represents 5 % of equipment value
- Insurance is 5 % of equipment value
- Depreciation time is 8 years.

B. Repair and maintenance

Repair and maintenance price was determined as follows (in percentage of equipment value)

- Option C 2,5% (US $ 15.288)
- Option D 5,0% (US $ 12.150) = higher maintenance costs are due to the motorisation of the equipment

C. Administrative costs

For this item, a global amount of 1% of turnover was calculated for each option, i.e. a yearly amount of US $ 9.900.

D. Insurance

For insurance premium, an amount of 5% of equipment purchase value is calculated, i.e.

- Option C : US $ 30.575.-
- Option D : US $ 12.150.-

E. Labour cost

Dehulling and cooking staff for each option is determined in section VII.3.1.4.

Yearly payroll (including taxes and charges) is estimated at US $ 800.- for 2000 hours in option C, at US $ 0,35/hour. In option D, an additional motorist is required, therefore hourly rate is US $ 0,40.-

Total yearly charges are the following :

- Option C (for 1.200.000 hours) US $ 420.000.-
- Option D (for 132.500 hours) US $ 53.000.-

F. Fuel and lubricant

This item only concerns option D, which is motorized.
30 diesel, 8 H.P., working 750 hours/year (for program fulfillment).
Specific consumption : 0.220 liters.
i.e. consumption per machine is :

0,220 l x 8 x 750 =		1.320 l at US $ 0,5/l
for 30 machines :		1.320 l x 30 = 39.600 l
The cost is :	0.5 x 39,600 =	US $ 19.800
Plus lubricant : --------->		US $ 1.200
	TOTAL	US $ 21.000

G. Depreciation

Depreciation time and value are the following :

- Option C 10 years US $ 61.150.-
- Option D 8 years US $ 30.375.-

H. Overheads

For both options, we adopted the same financing plan as in phase I. Financing and repayment plans are presented in the following tables.

I. Return on capital

As in phase I, we envisage a yearly dividend payment corresponding to 11% of profit.

OPTION C

SOURCES OF INITIAL FUNDS (US$)

Items	Values (US$)	Resources Share (%)	Currency Share (%)
CAPITAL	244 600	40	0
LOAN	366 900	60	100
...Grace period (Year)	1		
...Interest rate (%)	12		
...Duration (Year)	8		

REPAYMENTS (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Interests	44 028	44 028	37 738	31 449	25 159	18 869	12 579	6 290	0	0	0
Repayments (principal)	0	52 414	52 414	52 414	52 414	52 414	52 414	52 414	0	0	0
Capital balance due	366 900	366 900	314 486	262 071	209 657	157 243	104 829	52 414	0	0	0
Annuity	44 028	96 442	90 153	83 863	77 573	71 283	64 994	58 704	0	0	0

OPTION D

SOURCES OF INITIAL FUNDS (US$)

Items	Values (US$)	Resources Share (%)	Currency Share (%)
CAPITAL	97 200	40	0
LOAN	145 800	60	100
...Grace period (Year)	1		
...Interest rate (%)	12		
...Duration (Year)	8		

REPAYMENTS (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Interests	17 496	17 496	14 997	12 497	9 998	7 498	4 999	2 499	0	0	0
Repayments (principal)	0	20 829	20 829	20 829	20 829	20 829	20 829	20 829	0	0	0
Capital balance due	145 800	145 800	124 971	104 143	83 314	62 486	41 657	20 829	0	0	0
Annuity	17 496	38 325	35 825	33 326	30 826	28 327	25 827	23 328	0	0	0

VIII.2.2.3 - Operating statement and economical rentability

Following tables present operating forecast, dehulling cost price, and cash flow before financing, allowing to calculate internal rate of return for both options.

These tables show that, with a similar profit rate (15.3 %) :

- Dehulling average cost over the period (10 years)
  is US \$ 370/M.T. in option C
  US \$ 97/M.T. in option D.

Consequently Option D generates a higher amount to pay the nuts collects.

- Option C generates a higher margin than option D.

But it must be reminded that to make comparable the two options the same I.R.R. has been researched.

This led to obtain a much more incentive nut purchase price in option D.

Therefore, with a similar rentaBility option C is more profitable than option D, at the cost of a very low nut purchase price, which means a very low payment for nuts gathering.

If it was considered that the I.R.R. limit acceptable was equivalent to the loan interest rate (12 %) the nuts purchase prices would be of :

Option C : US \$ 46/M.T. Nuts
Option D : US \$ 95/M.T. Nuts.

OPTION C

PROVISIONAL OPERATING ACCOUNT (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
SALES	0	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000
COSTS	0	972 101	965 811	959 521	953 231	946 942	940 652	934 362	928 073	928 073	928 073
Raw materials	0	391 160	391 160	391 160	391 160	391 160	391 160	391 160	391 160	391 160	391 160
Maintenance and repair	0	15 288	15 288	15 288	15 288	15 288	15 288	15 288	15 288	15 288	15 288
Power and fuel	0	0	0	0	0	0	0	0	0	0	0
Administrative costs	0	9 900	9 900	9 900	9 900	9 900	9 900	9 900	9 900	9 900	9 900
Insurance	0	30 575	30 575	30 575	30 575	30 575	30 575	30 575	30 575	30 575	30 575
Labour	0	420 000	420 000	420 000	420 000	420 000	420 000	420 000	420 000	420 000	420 000
Depreciation	0	61 150	61 150	61 150	61 150	61 150	61 150	61 150	61 150	61 150	61 150
Interests	0	44 028	37 738	31 449	25 159	18 869	12 579	6 290	0	0	0
GROSS PRODUCT	0	17 900	24 189	30 479	36 769	43 058	49 348	55 638	61 928	61 928	61 928
Dividends	0	1 969	2 661	3 353	4 045	4 736	5 428	6 120	6 812	6 812	6 812
Cash flow before interests	0	123 078	123 078	123 077	123 078	123 078	123 078	123 077	123 078	123 078	123 078
Cash flow after interests	0	79 050	85 339	91 629	97 919	104 208	110 498	116 788	123 078	123 078	123 078

COST PRICE CALCULATION (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
Dehulling cost	0	580 941	574 651	568 361	562 071	555 782	549 492	543 202	536 913	536 913	536 913
Cost price / mt kernels	0	648	644	640	635	631	627	623	619	619	619
with dehulling	0	387	383	379	375	371	366	362	358	358	358
Average cost price / mt kernels	630										
with dehulling	370										

CASH FLOW TABLE BEFORE FINANCING (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
CASH INFLOW	0	123 078	123 078	123 077	123 078	123 078	123 078	123 077	123 078	123 078	734 578
Cash flow	0	123 078	123 078	123 077	123 078	123 078	123 078	123 077	123 078	123 078	123 078
Residual value	0	0	0	0	0	0	0	0	0	0	611 500
Cash outflow	611 500	0	0	0	0	0	0	0	0	0	611 500
Investments	611 500	0	0	0	0	0	0	0	0	0	611 500
SURPLUS/DEFICIT	611 500	123 078	123 078	123 077	123 078	123 078	123 078	123 077	123 078	123 078	123 078
CUMULATIVE CASH BALANCE	611 500	488 423	365 345	242 268	119 190	3 887	126 965	250 043	373 120	496 198	619 275

INTERNAL RATE OF RETURN 15.3%

OPTION D

PROVISIONAL OPERATING ACCOUNT (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
SALES	0	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000	990 000
COSTS	0	982 039	979 540	977 040	974 541	972 041	969 542	967 042	964 543	964 543	964 543
Raw materials	0	825 968	825 968	825 968	825 968	825 968	825 968	825 968	825 968	825 968	825 968
Maintenance and repair	0	12 150	12 150	12 150	12 150	12 150	12 150	12 150	12 150	12 150	12 150
Power and fuel	0	21 000	21 000	21 000	21 000	21 000	21 000	21 000	21 000	21 000	21 000
Administrative costs	0	9 900	9 900	9 900	9 900	9 900	9 900	9 900	9 900	9 900	9 900
Insurance	0	12 150	12 150	12 150	12 150	12 150	12 150	12 150	12 150	12 150	12 150
Labour	0	53 000	53 000	53 000	53 000	53 000	53 000	53 000	53 000	53 000	53 000
Depreciation	0	30 375	30 375	30 375	30 375	30 375	30 375	30 375	30 375	30 375	30 375
Interests	0	17 496	14 997	12 497	9 998	7 498	4 999	2 499	0	0	0
GROSS PRODUCT	0	7 961	10 460	12 960	15 459	17 959	20 458	22 958	25 457	25 457	25 457
Dividends	0	876	1 151	1 426	1 701	1 975	2 250	2 525	2 800	2 800	2 800
Cash flow before interests	0	55 832	55 832	55 832	55 832	55 832	55 832	55 832	55 832	55 832	55 832
Cash flow after interests	0	38 336	40 835	43 335	45 834	48 334	50 833	53 333	55 832	55 832	55 832

COST PRICE CALCULATION (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
Dehulling cost	0	156 071	153 572	151 072	148 573	146 073	143 574	141 074	138 575	138 575	138 575
Cost price / mt kernels	0	655	653	651	650	648	646	645	643	643	643
with dehulling	0	104	102	101	99	97	9	94	92	92	92
Average cost price / mt kernels	648										
with dehulling	97										

CASH FLOW TABLE BEFORE FINANCING (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
CASH INFLOW	0	55 832	55 832	55 832	55 832	55 832	55 832	55 832	55 832	55 832	238 082
sh flow	0	55 832	55 832	55 832	55 832	55 832	55 832	55 832	55 832	55 832	55 832
dual value	0	0	0	0	0	0	0	0	0	0	182 250
sh outflow	243 000	0	0	0	0	0	0	0	243 000	0	0
stments	243 000	0	0	0	0	0	0	0	243 000	0	0
PLUS/DEFICIT	-243 000	55 832	55 832	55 832	55 832	55 832	55 832	55 832	-187 168	55 832	238 082
MULATIVE CASH BALANCE	-243 000	-187 168	-131 336	-75 504	-19 672	36 160	91 992	147 824	-39 344	16 488	254 570

INTERNAL RATE OF RETURN	15,3%

VIII.3 - SUPPLY OF EXISTING EDIBLE OIL PROCESSING PLANTS (e.g. Premium Oil)

In Zambia, all oil extraction units operate at very reduced capacity, due to the lack of local raw materials generally used (groundnut, soya, cotton, etc.).
Kernel supply of these units, subject to appropriate resources availability, would obviously improve their capacity utilisation rate.

Though to day there are no available data on raw material resources, and that there are no industrial dehulling equipment exist, in the frame of this study it was interesting to evaluate the supply cost in kernels for these plants on the basis of the option D for dehulling process presented in chapter VII.3.

The existing plants assessment showed that in Southern region there was only one plant and in a poor state : ZATCO in Choma.

Consequently due to the existing plants distribution throughout the country, we only calculate here Premium Oil supply cost (70% edible oil market).

Supply cost includes kernel purchase price and transportation cost.

If Choma plant wanted process mubula or mungongo nuts the transportation costs would be quite reduced.

Premium Oil capacity is about 65.000 M.T./year. At present, less than 60% of this capacity is used so kernel potential demand is at least 26.000 M.T./year.

Though production areas and dehulling sites cannot be still defined, average distance between supply sites and Premium Oil unit has been estimated at 300 km. Therefore, kernel yearly transportation cost, calculated at US $ 0.11/M.T. is the following :

26.000 x 300 x 0.11 = US $ 858.000.

Kernel price adopted in chapter VII.2, per product type ex production area, is the following :

- Mubula - US $ 855/M.T.
- Mungongo - US $ 562/M.T.

It must be reminded that this difference of price is due to the higher oil content of mubula kernels (61.4 % us 33.2 %).

Kernel yearly supply cost depends on the type of kernel.

With three different cases, yearly costs are the following :

- Case 1 Mubula supply US $ 22.230 000.-
- Case 2 Mungongo supply US $ 14.612 000.-
- Case 3 Mixed supply US $ 18 421 000.-
  (50% Mungongo, 50% Mubula)

Yearly total supply cost, including transportation, is the following :

US $	Total value	Average value (per M.T. Kernels)
Case 1	23.088.000.-	888
Case 2	15.470.000.-	595
Case 3	19.279.000.-	742

This average value has been calculated as a guide but this prices would vary in function of the transport distance.

The above cost price does not take into account kernel oil content which is a major factor.

To take into account this factor, we calculated an extractable oil cost price based on purchase price and oil content of each type of kernel.

As a comparison, we also calculated the cost price of extractable oil for all other available products on the basis of the purchase prices.

Items	Price/ton (US $/MT)	Extraction rate (%)	Cost price (US $/MT)
Sunflower	302	20	1.510
Soya	162	17	9.53
Cotton	283	16	1.769
Groundnut	594	38	1.563
Mubula	855	61,4	1.393
Mungongo *	562	33,4	1.683

* gross kernels

These figures show that although Mubula kernels have a very high purchase price, they offer the most interesting cost price of extractable oil.

The case of soya is more specific, since soya oil is considered as a by-product.

Mungongo kernels are more expensive than the other products, it is hampered by the "Testa" which lowers the oil extraction rate but it must be stressed that mungongo oil has better dietetic qualities and that mungongo cake is very rich and then interesting for livestock

These figures highlight the interest of :

- detailed census of raw marerial production (area, yields ...)
- studying adapted dehulling equipments
- verifying if the nut purchase price is enough inciting for the women
- assess the women disponibilities for collecting and dehulling the nuts
- an improvment in "Testa" removal for mungongo kernels, which will ameliorate oil extraction rate.

At the moment but there were no semi-industrial dehulling tests still performed on the nuts, mubula seems to be a very interesting oil resource for oil industry.

Netnertheless it must be stressed on the fact that :

- 1 ton of mubula kernels means 5 tons of mubula nuts collected and dehulled
- 1 ton of mungongo kernels means 6 tons of mungongo nuts collected and dehulled.

So supply 20.000 tons of kernels to Oil Premium which represents about 30 % of its crushing capacity, would mean the collect and dehulling of 100.000 tons to 120.000 tons of nuts.

Such quantities would need a heavy industrial dehulling equipment. If such equipment was installed in Premium Oil plant, transportation costs would be very important.

Medium scale industries as ZATCO in Choma could be more easily supplied with these indigeneous nuts, but it would need a rehabilitation of the plant.

IX - MUNYELE NYELE PROCESSING : PREFEASIBILITY STUDY

IX.1 - OUTLINE

Since the Munyele Nyele drupe is a fragile fruit (because of lipase intense activity in a highly hydrated pulp), has a short preservation period and cannot be stored, it appeared that this raw material should be processed as soon as it is harvested.

Presently there is no accurate information on available quantities and on harvest season time, therefore the study is based on the following hypothesis :

- 3 months harvest season
- Munyele Nyele fruit processing capacity of 400 kg/hr
- continuous operation, 5 days/week.

In order to maintain staff permanent employment and to guarantee a better profitability, it was considered that the remaining 7 months (with 2 months leave for vacation and maintenance) would be dedicated to Mubula oil production.

Indeed, although we have no accurate assessment of quantities available, we know that there are many Mubula populations in the region.

Therefore, the following project guarantees Munyele Nyele and Mubula oil production.

IX.2 - PROJECT LOCATION

According to field study, the project location depends essentially on 3 factors :

- resource location
- population density in high potential regions
- population availability and motivation for nuts collection.

Results of the resource study under development in January, do not yet allow to determine a final project location.

The project would be located in Mongu area.

However, it will also be necessary to take into account the cashew nuts production development project forecasted in the same region, which will lead to harvesting competition.

IX.3 - TECHNOLOGY OPTIONS

IX.3.1 - Oil extraction conditions and output

Extraction tests made on a 2,2 kg sample allowed to check the product behaviour and oil distribution in various phases (see VI.1.3).

Fat fixation of the "pit" phase is essentially due, in the case of experimental tests, to pit adhering pulp.

Its 29,6 % oil content on dry material is only slightly lower than the 35 % oil content of the whole fruit. Because of its importance (71 % of all phases) this sub-product is supposed to offer the best extraction output increase target. It is necessary to determine the components of depulped pits, in order to make the technical choices best leading to the maximum content recovery. The risk of extracting pulp oil to fix it on a poor grinded pit material should be avoided.

Pulps include a mixture of pulp and shell pieces debonded from the pit, during the cutter phase that somewhat dilute the fat content of the pulp alone.

Therefore, apparently, techniques that may be applied to Munyele Nyele oil extraction are similar to those used in olive oil production, which can be used as reference for the grinding economical feasibility study.

Tests made in an olive oil production unit would enable to check in practice fruit oil extraction limits and constraints.

Extraction output calculation in a traditional process

The figures obtained from analysis report rates correspond to a total delipidation that cannot be reproduced during solvents deoiling , since the latter does not reach the same perfection.

Extraction tests made on 2,2 kg sample were inspired by palm oil extraction with washing and centrifugation technology developed by IRHO (Research Institut for Oils) in Mopoyem, Ivory Coast, in the 50s, then replaced by the STORK technique using pressure, which was easier to use and had a higher profitability.

The extraction output obtained by simple decantation is ridiculously low (5,41). But supposing it was obtained by centrifugation, it does not seem that taking into account the product behaviour and separated phases, a figure higher than 11 % can be obtained. This figure is calculated in the following way :

Extracted oil	90 g
Oil recoverable from sludge by centrifugation or by hydraulic pressure, according to oilive oil production technique, i.e. 85 % of mud weight 95 g x 0,85	81 g

Oil supposed to be recoverable by hydraulic pressure in pulps and pits, i.e. 20 % of the total :	
(77.4 + 288.6) x 0,20	73 g
	244 g
Output : 244/2200	11 %

Within the framework of the study, we took a 10 % rate.

IX.3.2 - **Process**

As indicate hereabove, the technical choices are related to olive oil extraction process.

There are two types of processes :

- The traditional process, including :
  - . Grinding with millstone and rotating bed plate
  - . Hot mixing
  - . Hot hydraulic pressing
  - . Oil clarification by centrifugation.
- The ALFA-LAVAL continuous process, by hot water extraction
  - . Hammer grinding
  - . Mixing under water at 80°C
  - . Separation of liquid and solid phases on centrifugal extractor with horizontal axis
  - . Oil clarification by centrifugation.

Due to the continuous process, investment costs (US $ 230 000), facilities, operation constraints and to Munyele Nyele supply capacities, this choice cannot be adopted, in spite of its estimated output increase of 13 %, compared with the one of the traditional process, estimated at 10 %.

For the same reasons, the economical constraint remains in the development of the traditional process, which cost is US$ 100 000.

Therefore, the second solution will be adopted in order to assess the Munyele Nyele oil extraction economical feasability taking into account an output based on analysis which should, however, be confirmed by tests in the equipment manufacturing plant.

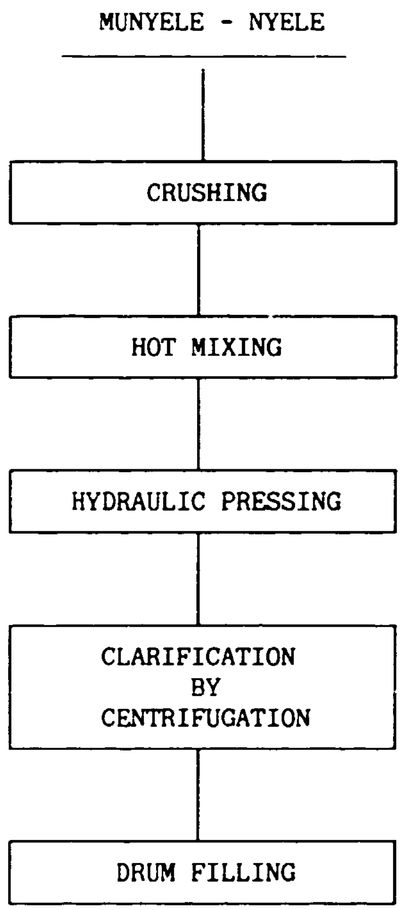
IX.3.3 - **Flow sheet**

The following diagram presents Munyele Nyele different manufacturing steps.

Mubula processing flowsheet is presented in chapter VIII.2.3

PRODUCTION SHEME

FLOW SHEET



IX.3.4 - Production hypothesis

As already mentioned, the Munyele Nyele fruit processing is supposed to be carried out on a site equipped for the mubula processing, which contribution is necessary for the profitability of a mixed oil production which investment will be increased by the purchase of specific equipment for munyele nyele oil extraction.

In this framework, it is supposed that the unit will turn during 10 months, as follows :

- 3 months : munyele nyele oil production (1 500 hr)
- 7 months : mubula oil production (3 500 hr).

Based on an hourly capacity of 400 kg for Munyele Nylele and 300 kg for Mubula, the fruit and kernel yearly consumption is 1 550 tons.

The following table shows the yearly oil and cake production, taking into account mixing and output capacities.

Production equation

Yields (%)	Munyele Nyele	Mubula	Total
Oil	10,0	61,4	-
Cake	0,0	34,0	-
CONSUMPTION (M.T)	600	1 050	1 650
PRODUCTION (M.T)			
Oil	60	645	750
Cake	0	357	375.

IX.4 - PROJECT DESCRIPTION

IX.4.1 - Equipment

Mubula oil extraction specific equipment is presented in section VIII.2.3.1

For the Munyele Nyele fruit, the unit operations are in phase with the organization chart of tradition manufacture using the following equipment :

- Grinder with 2 granit millstones diameter 1,4 ; width 0,4 m ; stainless steel bowl

- Mixing-dosing unit : stainless steel container with 450 kg capacity, heated by incorporated electrical resistance ; mixing by helicoidal ribons with counter-steps ; vertical automatical mix screw dosing unit on press feeding repartition disk.

- Bow overpress with double casing ; diameter 350 mm;ram stroke 11 000 mm ; double hydraulic network with pumps with quick foward movement ; supplied with 75 feeding repartition disk.

- Centrifugal separator ; rotation speed 6 200 Rpm ; all parts in contact with liquids are in stainless steel ; supplied with feed pump on platform.

IX.4.2 - Civil works

Since this is an oil plant containerized, buildings are not required. However, a 650 m^2 building is planned, with the following distribution :

- 40 m^2 office
- 40 m^2 warehouse (spare parts, packagings)
- 570 m^2 warehouse (raw materials, finished products).

Buildings will have a simple design, clesed shelter type.

IX.5 - EVALUATION OF INVESTMENTS

IX.5.1 - Equipments

A. Production equipments

At the Mubula production equipment cost presented in chapter VIII.2.4, Munyele Nyele specific equipment cost must be added.

Then total production equipment cost is the following.

		US $
- Mubula equipment cost (transportation included)		268 000
- Munyele Nyele equipment costs (F.O.B.)		100 000
- Munyele Nyele equipment transportation		3 000
	TOTAL AMOUNT	371 000.

B. Transportation equipment

Vehicles will be locally purchased. The total cost of transportation equipment is the following :

- Pick up 4 x 4 (1 Ton) = 18.000 US $
- Truck Toyota (3-5 Tons) = 21.000 US $.

IX.5.2 - Civil works

It has been planned that the building would be realized with local materials and manpower.

Total building cost:

US $ 200/m2 x 650 m2 = US$ 130.000

It must be precised that, to limit investments, it would be interesting to rent inoccupied buildings.

As it was not possible to define exactly the site, it was not possible to look for such buildings. In this prefeasibility study, we considered then a new building erection.

IX.5.3 - Pre-production expenditures

Pre-production expenditures include all expenses prior to production (besides working capital and fixed investment).
The following table shows the breakdown according to main expense categories.

Items		Value
Training by foreign technicians		15.000
Pre-production management		4.500
Local staff		5.000
Administration, travels		3.500
Cost of finance (provision)		20 900
Total	US$	48.900.

IX.5.4 - Packaging

Oil will be packed in 200 liter drums. Drums are recovered by the company through a deposit system. Therefore, packaging is included in investments.
A yearly 20% drum loss is planned.
Taking into account these observations and rotation time during the first operation year, 500 200-liter/drums are planned at US$ 20, per drum, i.e. a total of US$ 10.000).
In addition, a 20% yearly renewal of drums will cost US$ 2,000/year.

IX.5.5 - Working Capital

Net working capital shows the financial means which are necessary for the operation of the plant. It is usually defined as the difference between circulating assets and current liabilities.

Current liablities are mainly included in debit account (amounts to be paid).

Therefore, working capital essentially depends on customer and supplier payment conditions, delivery time, realizable and available values.
It is supposed that customers and suppliers will support cash payments.

The following table shows the calculation of net working capital and its variations for the whole time of the project.

Due to the instability of oil in Munyele Nyele fruit, it has been considered that there would not be raw material storage, this one being processed as it arrives.

CALCULATION OF WORKING CAPITAL (US$)

Item Years	Number of months	1	2	3	4	5	6	7	8	9	10
Inventory		**250 222**	**250 388**	**250 388**	**250 388**	**249 370**	**249 370**	**249 370**	**249 370**	**249 370**	**249 370**
...Raw materials	2	149 625	149 625	149 625	149 625	149 625	149 625	149 625	149 625	149 625	149 625
...Power and fuel	1	1 910	1 910	1 910	1 910	1 910	1 910	1 910	1 910	1 910	1 910
...Spare parts	1	817	817	817	817	817	817	817	817	817	817
...Finished products	1	97 869	98 036	98 036	98 036	97 017	97 017	97 017	97 017	97 017	97 017
Cash in hand		**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**	**7 575**
...administrative costs	0.5	1 075	1 075	1 075	1 075	1 075	1 075	1 075	1 075	1 075	1 075
...Labour	1	6 500	6 500	6 500	6 500	6 500	6 500	6 500	6 500	6 500	6 500
Net working capital		**257 797**	**257 963**	**257 963**	**257 963**	**256 945**	**256 945**	**256 945**	**256 945**	**256 945**	**256 945**
Increase in working capital			**167**	**0**	**0**	**-1 019**	**0**	**0**	**0**	**0**	**0**

IX.5.6 - Investment summary

The following tables show:

- initial investment global cost, including acquisition values, currency share, depreciation time and execution year.

- investment and replacement schedule

- depreciation schedule.

The first year net working capital value was included in the initial investment, and it was supposed that the net working capital increase would be met by the operating results. In consequence this net working capital increase is taken into account in the cash flow table.

TOTAL INITIAL INVESTMENT COSTS (US $)

INVESTMENTS	Acquisition Values (US$)	Currency Share (%)	Depreciation time (years)	Schedule (%/year) Year 0	Year 1
Building and civil works	130 000	0	25	100	0
Equipments	371 000	100	8	100	0
Vehicles	39 000	0	5	100	0
Working capital	257 797	0		0	100
Pre-production capital expenditures	48 900	0	4	100	0
Packagings*	10 000	0		0	100
TOTAL	856 697				

* 20% of packagings are yearly renewed

INVESTMENTS AND REPLACEMENTS SCHEDULE (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Building and civil works	130 000	0	0	0	0	0	0	0	0	0	0
Equipments	371 000	0	0	0	0	0	0	0	371 000	0	0
Vehicles	39 000	0	0	0	0	39 000	0	0	0	0	39 000
Working capital	0	257 797	0	0	0	0	0	0	0	0	0
Pre-production capital expenditures	48 900	0	0	0	0	0	0	0	0	0	0
Packagings	0	10 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000	2 000
TOTAL	588 900	267 797	2 000	2 000	2 000	41 000	2 000	2 000	373 000	2 000	41 000

DEPRECIATIONS PLAN (US$)

Item Years	0	1	2	3	4	5	6	7	8	9	10
Building and civil works	0	5 200	5 200	5 200	5 200	5 200	5 200	5 200	5 200	5 200	5 200
Equipments	0	46 375	46 375	46 375	46 375	46 375	46 375	46 375	46 375	46 375	46 375
Vehicles	0	7 800	7 800	7 800	7 800	7 800	7 800	7 800	7 800	7 800	7 800
Pre-production capital expenditures	0	12 225	12 225	12 225	12 225	0	0	0	0	0	0
Packagings	0	0	2000	2000	2000	2000	2000	2000	2000	2000	2000
TOTAL	0	71 600	73 600	73 600	73 600	61 375	61 375	61 375	61 375	61 375	61 375

IX.6 - MUNYELE NYELE FRUIT PURCHASE PRICE AND DETERMINATION PROFITABILITY SURVEY

IX.6.1 - Turnover determination

As in former chapter prices of Mubula products - oil and cake - are respectively of 1 500 US $/M.T and 400 US $/M.T.

Due to its different characteristics, Munyele Nyele oil cannot be sold at the same price than Mubula oil.

In the frame of this study we have estimated than it would be sold at 1 200 US $/T which is quite a high price but which takes into account Mongu distance from Lusaka.

Munyele Nyele process does not produce cake which could be valorized.

The following table shows finished product stock (in M.T.), sold production (in M.T.) for the first 3 years and product price (in US$/M.T.), according to production, consumption and yield.

Production sold on the first year is planned to be lower than the following years, because of end product stock setting up. Yearly sales values are the following:

	YEAR 1	YEAR 2 and following
Oils US $	952.463	1.039.050
Cakes US $	130.900	142.800
Total: US $	1.083.363	1.181.850

YIELDS (%)	Munyele Nyele	Mubula
Oil	10,0	61,4
Cakes	0,0	34,0

	Munyele Nyele	Mubula	Total
CONSUMPTION (MT)	600	1050	1650
PRODUCTION (MT)			
Oil	60	645	705
Cakes	0	357	357
INVENTORY			
Raw materials (two months)	0	175	175
Finished products (one month)			
...Oil	5	54	59
...Cakes	0	30	30

SALES (MT)	YEAR 1	YEAR 2	YEAR 3...
Oil			
...Munyele Nyele	55	60	60
...Mubula	591	645	645
Total Oil	646	705	705
Cakes			
...Munyele Nyele	0	0	0
...Mubula	327	357	357
Total Cakes	327	357	357

PRICES (US$/MT)	Munyele Nyele	Mubula
Oil	1 200	1 500
Cakes	0	400

IX.6.2 - Raw material total cost

In former chapter (VIII) Mubula kernel purchasing price has been fixed at 855 US $/T.

In order to determine Munyele Nyele purchase price we proceeded by iteration so as to guarantee a positive internal rate of return.
According to this iteration, we observed that even for a low purchase price i.e. US $ 50/M.T. the I.R.R. remained low = 5,2 %.

IX.6.3 - Maintenance

Maintenance and repair rates are calculated at 2.5% of Mubula equipment acquisition value, 1,5 % of Munyele Nyele equipment acquisition value and 4% of vehicle value, i.e. a yearly amount of US$ 9.805.

IX.6.4 - Power and fuel

Electricity

Based on an hourly consumption of 70 Kwh for Mubula processing during 7 months (3 500 h/year) and of 40 Kwh (of which 25 Kwh for heating) for Munyele Nyele processing during 3 months (1 500 h) at the price of US $ 0,07/Kwh yearly electricity cost is US $ 21.350.

Fuel, lubricant

It is assumed that due to supply proximity. Munyele Nyele fruit gathering is done by the company. Based on 15 000 km/year and a diesel consumption of 21 l/100 km, at US$ 0.5/l yearly diesel cost is US$ 1 575.

Yearly power and diesel oil total cost is US $ 22 925.

IX.6.5 - Labour

The following table shows job numbers and total yearly labour charges by staff category (including social expenses calculated at 12.5% of labour).

This table indicates yearly labour charges of US $ 78.000.

Item	No of jobs	Yearly cost (US$)
Production Manager	1	17.000
Accountant	1	10.000
Secretary	1	4.000
Store Keeper	1	4.000
Mechanics	1	6.000
Operators	3	10.000

Skilled Workers	3	12.000
Drivers	2	5.000
Unskilled Workers	4	5.000
Watchman	2	3.000
Total	19	78.000

IX.6.6 - **Administrative costs**

A yearly lump sum of US$ 1,800 is planned for management costs (travels, telex, etc.).

Furthermore, a local partner is supposed to be hired by the private company for management and marketing assistance. Services yearly cost is US $ 24,000.

Yearly administrative costs total cost is US$ 25.800.

IX.6.7 - **Insurance**

Planned insurance premium is 5.% of building, equipment and vehicles rates, i.e. a yearly amount of US $ 27.000.

IX.6.8 - **Transport services**

With the present knowledge of production sites it is assumed that a local hauler will be hired by the company for Mubula Kernel supply due to long distances and supply site scattering.

On an estimated base of 105.000 Tkm for 1.050 M.T. of Mubula kernel supply at US $ 0,11 per T.K. yearly cost of transportation is US $ 11.550.

IX.6.9 - **Depreciation allowances**

As calculated in section VII.2.4.7 yearly allowances are :

US $ 71.600 for the first year
US $ 73.600 for the three following year
and US $ 61.375 after the fourth year of operation.

IX.6.10 - **Finished products inventory variation**

According to adopted methodology stock creation is taken into account with the investments or the first year, and "working capital variation" for the following years are indicated in cash flow table in item "increase an working capital".

In order not to redundantly account these charges in operating statement, a "finished product inventory variations" item is taken into account.
It allows to deduct from production cost stocks/charge/related which are taken into account in working capital and investment

As regards raw materials, we directly considered consumed quantities instead of including both "raw material purchase" and "raw material stock variations" items.

IX.6.11 - Provisional operating account before financing

Provisional operating account before financing (without financial charges and return on capital) is presented on the following page.

This table shows that profit is very low : 2 %.

IX.6.12 - Profitability

The Internal Rate of Return (I.R.R) measures project specific profitability, irrespective of financing scheme.

Cash account and internal rate are presented on the following page. It must be reminded that it has been considered the project will benefit of a ten years taxes exemption.

IX.6.13 - Conclusions

This preafisibility study shows that such a project has not a sufficient rentability. To get a 5 % rentability, Munyele Nyele fruits purchase price is only of 50 US $/M.T which is very low.

Different factors have to be considered :

- low oil extraction rate 10 %
- Munyele Nyele sub products cannot be valorized
- specificity of Munyele Nyele equipment does not allow scale savings, but on the contrary induces complementary investments not rentable because of the short processing time and the low oil extraction rate.

So it appears that in the present context, such a project cannot be achieved.

PROVISIONAL OPERATING ACCOUNT BEFORE FINANCING (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
SALES VALUES	**0**	**1 083 363**	**1 181 850**	**1 181 850**	**1 181 850**	**1 181 850**	**1 181 850**	**1 181 850**	**1 181 850**	**1 181 850**	**1 181 850**
Oil	0	952 463	1 039 050	1 039 050	1 039 050	1 039 050	1 039 050	1 039 050	1 039 050	1 039 050	1 039 050
Cakes	0	130 900	142 800	142 800	142 800	142 800	142 800	142 800	142 800	142 800	142 800
COSTS	**0**	**1 076 561**	**1 176 263**	**1 176 430**	**1 176 430**	**1 165 224**	**1 164 205**	**1 164 205**	**1 164 205**	**1 164 205**	**1 164 205**
Raw materials	0	927 750	927 750	927 750	927 750	927 750	927 750	927 750	927 750	927 750	927 750
Maintenance and repair	0	9 805	9 805	9 805	9 805	9 805	9 805	9 805	9 805	9 805	9 805
Power and fuel	0	22 925	22 925	22 925	22 925	22 925	22 925	22 925	22 925	22 925	22 925
Finished products inventory variation	0	-97 869	-167	0	0	1 019	0	0	0	0	0
Administrative costs	0	25 800	25 800	25 800	25 800	25 800	25 800	25 800	25 800	25 800	25 800
Insurance	0	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000
Labour	0	78 000	78 000	78 000	78 000	78 000	78 000	78 000	78 000	78 000	78 000
Transport services	0	11 550	11 550	11 550	11 550	11 550	11 550	11 550	11 550	11 550	11 550
Depreciation	0	71 600	73 600	73 600	73 600	61 375	61 375	61 375	61 375	61 375	61 375
GROSS RESULT	**0**	**6 802**	**5 587**	**5 420**	**5 420**	**16 626**	**17 645**	**17 645**	**17 645**	**17 645**	**17 645**

CASH FLOW TABLE BEFORE FINANCING (US$)

Item / Years	0	1	2	3	4	5	6	7	8	9	10
CASH INFLOW	**0**	**78 402**	**79 187**	**79 020**	**79 020**	**78 001**	**79 020**	**79 020**	**79 020**	**79 020**	**999 011**
...Cash flow	0	78 402	79 187	79 020	79 020	78 001	79 020	79 020	79 020	79 020	79 020
...Recuperation of Working capital	0	0	0	0	0	0	0	0	0	0	256 945
...Residual value	0	0	0	0	0	0	0	0	0	0	663 047
CASH OUTFLOW	**588 900**	**267 797**	**2 167**	**2 000**	**2 000**	**39 981**	**2 000**	**2 000**	**373 000**	**2 000**	**41 000**
...Investments	588 900	267 797	2 000	2 000	2 000	41 000	2 000	2 000	373 000	2 000	41 000
...Increase in working capital	0	0	167	0	0	-1 019	0	0	0	0	0
SURPLUS/DEFICIT	**-588 900**	**-189 395**	**77 020**	**77 020**	**77 020**	**38 020**	**77 020**	**77 020**	**-293 980**	**77 020**	**958 011**
CUMULATIVE CASH BALANCE	**-588 900**	**-778 295**	**-701 275**	**-624 255**	**-547 235**	**-509 215**	**-432 195**	**-355 175**	**-649 155**	**-572 135**	**385 876**

INTERNAL RATE OF RETURN	5.2%

ANNEX A

CHEMICAL ANALYSIS RESULTS

ANNEX 1.A

MUBULA

Laboratoires Wolff analyses - expertises - recherches

DIVISION AGRICOLE

15, rue Charles Paradinas F 92110 CLICHY - Tél (1) 47 30 04 40 - Télex 610 867 F - Télécopieur (1) 47 30 40 96

IDENTIFICATION :
REF. : MUBULA
PARINARI CURATELLE FOLIA - KERNELS
REMIS PAR INTER G

INTER G

168-172, Bd de Verdun

F 92400 COURBEVOIE

CACHET :

Clichy le 03/10/91

NATURE AMANDES

ANALYSE : 11/09/91-0051-CL

DIVISION AGRICOLE
Productions agricoles
Oléagineux
Céréales
Protéagineux
Café Cacao
Huiles et corps gras alimentaires
Origine animale
Origine végétale
Aliments pour animaux
Matières premières
Additifs
Produits finis
Produits de mouture
Farines
Semoules
Gruaux
Produits glucidiques
Sucres
Mélasses
Produits de traitement des cultures
Terres agricoles - Engrais
ORGANISATION DE LABORATOIRES
ACTIONS DE FORMATION
Stages Séminaires

DIVISION AGRO - ALIMENTAIRE
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SERVICE DE MICROBIOLOGIE
DIVISION SANTE
DIVISION INDUSTRIE
DIVISION ENVIRONNEMENT
LABORATOIRE CENTRAL DE L'EAU
LABORATOIRE CENTRAL DE L'AIR
SERVICE RECHERCHE & DEVELOPPEMENT

Laboratoires agréés par :
la SIDO Oléagineux Protéagineux
le Syndicat de Paris
le SYNACOMEX
le Comité Technique du Marché International du Cacao en fèves de Paris
la DGCCRF pour la délivrance de certificats d'analyses à l'exportation
la FOSFA (full member)
le NOFOTA (Nofota Laboratories)
l'AOCS (referee chemist)
le Conseil Oléicole International
le Ministère de la Recherche et de la Technologie

EAU ET MATIERES VOLATILES (Norme ISO 665)	2.3	%
HUILE SUR GRAINES BRUTES (Norme ISO 659 à l'hexane)	63.3	%
SUR HUILE EXTRAITE	*	
INSAPONIFIABLE (NORME NF T 60 205)	0.20	%
ACIDITE OLEIQUE (NORME ISO 660)	0.20	%
COMPOSITION DES ESTERS METHYLIQUES D'ACIDES GRAS (Norme ISO 5508-ISO 5509)		
C 16	9.0	%
C 17	0.1	%
C 18	8.8	%
C 18 1	30.3	%
C 18 2	15.1	%
C 18 3	0.4	%
C 20	0.6	%
C 20 : 1	1.5	%
C 22	0.1	%
C 22 INS. TOTAUX	34.1	%
SUR MATIERE SECHE ET DELIPIDEE:	*	
PROTEINES BRUTES Norme NF V 18 100	65.5	%
MATIERE CELLULOSIQUE	5.0	%
AMIDON 3e Directive CEE 72/199	*	%

Michel BLANC
Chef de la Division

Paul ROYE
Adjoint au Chef de la Division Agricole

ANNEX 1.B

MUNGONGO

MUNGONGO - RESULTS 1

Laboratoires Wolff analyses - expertises - recherches

DIVISION AGRICOLE

15, rue Charles Paradinas F 92110 CLICHY - Tél : (1) 47 30 04 40 - Télex : 610 867 F - Télécopieur : (1) 47 30 40 96

IDENTIFICATION :
REF. : MUNGONGO
RICINODENDRON RUTANERII
UNDEPULPES, UNSHELLED NUTS
REMIS PAR INTER G

INTER G
168-172, Bd de Verdun
F 92400 COURBEVOIE

CACHET :

Clichy le 03/10/91

NATURE : NOIX

ANALYSE : 11/09/91-0049-CL

DIVISION AGRICOLE
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Oléagineux
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Matières premières
Additifs
Produits finis
Produits de mouture
Farines
Semoules
Gruaux
Produits glucidiques
Sucres
Mélasses
Produits de traitement des cultures
Terres agricoles - Engrais
ORGANISATION DE LABORATOIRES
ACTIONS DE FORMATION
Stages, Séminaires

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DIVISION SANTE
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DIVISION ENVIRONNEMENT
LABORATOIRE CENTRAL DE L'EAU
LABORATOIRE CENTRAL DE L'AIR
SERVICE RECHERCHE & DEVELOPPEMENT

Laboratoires agréés par :
- la SIDC Oléagineux-Protéagineux
- le Syndicat de Paris
- le SYNACOMEX
- le Comité Technique du Marché International du Cacao en fèves de Paris
- la DGCCRF pour la délivrance de certificats d'analyses à l'exportation
- la FOSFA (full member)
- le NOFOTA (Nofota Laboratories)
- l'AOCS (referee chemist)
- le Conseil Oléicole International
- le Ministère de la Recherche et de la Technologie

EAU ET MATIERES VOLATILES (Norme ISO 665)	5.6	%
HUILE SUR GRAINES BRUTES (Norme ISO 659 à l'hexane)	37.3	%
SUR HUILE EXTRAITE:	*	
INSAPONIFIABLE (NORME NF T 60-205)	0.50	%
ACIDITE OLEIQUE (NORME ISO 660)	0.50	%
COMPOSITION DES ESTERS METHYLIQUES D'ACIDES GRAS (Norme ISO 5508-ISO 5509)		
C 16	11.2	%
C 17	0.1	%
C 18	7.2	%
C 18 : 1	19.0	%
C 18 : 2	43.3	%
C 18 : 3	0.2	%
C 20	0.2	%
C 20 : 1	0.5	%
C 22	0.1	%
C 22 INS. TOTAUX	18.2	%
SUR MATIERE SECHE ET DELIPIDEE:	*	
PROTEINES BRUTES Norme NF V 18.100	28.4	%
MATIERE CELLULOSIQUE	47.0	%
AMIDON 3e Directive CEE 72/199	*	%

Michel BLANC
Chef de la Division

Paul ROYE
Adjoint au Chef de la Division Agricole

MUNGONGO - RESULTS 2

COURRIER DU 28.10.91
REMIS PAR JEAN VICTOR PAULET

INTER G

168-172, Bd de Verdun

F 92400 COURBEVOIE

Clichy le 29/11/91

AMANDES DECORTIQUEES DE MONGONGO	08/11/91-0176-CL

)TEINES BRUTES me NF V 18.100	28.2	%
IERES GRASSES BRUTES me NF V 18.104 (procédé A)	57.5	%
IERE CELLULOSIQUE	2.1	%

hel BLANC
f de la Division

Paul ROYE
Adjoint au Chef de
la Division Agricole

Laboratoires Wolff analyses - expertises - recherches

DIVISION AGRICOLE

15, rue Charles Paradinas F 92110 CLICHY - Tél : (1) 47 30 04 40 - Télex : 610 867 F - Télécopieur : (1) 47 30 40 96

IDENTIFICATION :
COURRIER DU 28.10.91
REMIS PAR JEAN VICTOR PAULET

INTER G
168-172, Bd de Verdun
F 92400 COURBEVOIE

CACHET :

Clichy le 13/12/91

NATURE : COQUES DE MONGONGO

ANALYSE : 08711/91-0177-CL

CELLULOSE BRUTE	57.0	%
CONSTITUANTS PARIETAUX		
NDF	79.4	%
ADF	79.3	%
LIGNINE	48.3	%

LA DETERMINATION CELLULOSE BRUTE (METHODE WEENDE) OU "INDICE D'INSOLUBLE" CORRESPOND PAR CONVENTION A LA TENEUR EN CELLULOSE, COURAMMENT UTILISEE EN ALIMENTATION HUMAINE ET ANIMALE POUR L'EVALUATION DE LA VALEUR ALIMENTAIRE DE L'ALIMENT.

PAR CONVENTION, ON ASSIMILE LA DIFFERENCE ENTRE LES INDICES NDF ET ADF (0.1 %) A LA TENEUR EN HEMICELLULOSE DU PRODUIT. DE MEME, LA DIFFERENCE ENTRE ADF ET LIGNINE (31 %) REPRESENTE LA TENEUR EN "CELLULOSE VRAIE" DE L'ALIMENT.

Michel BLANC
Chef de la Division

Paul ROYE
Adjoint au Chef de
la Division Agricole

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Céréales
Protéagineux
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Origine animale
Origine végétale
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Produits glucidiques
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- le Comité Technique du Marché International du Cacao en fèves de Paris
- la DGCCRF pour la délivrance de certificats d'analyses à l'exportation
- la FOSFA (full member)
- la NOFOTA (Nofota Laboratories)
- l'AOCS (referee chemist)
- le Conseil Oléicole International
- le Ministère de la Recherche et de la Technologie

ANNEX 1.C

MUNYELE - NYELE

MUNYELE-NYELE - RESULTS 1

Laboratoires Wolff analyses - expertises - recherches

DIVISION AGRICOLE

15, rue Charles Paradinas F 92110 CLICHY - Tél : (1) 47 30 04 40 - Télex : 610 867 F - Télécopieur : (1) 47 30 40 96

IDENTIFICATION :
COURRIER DU 08.01.92
V/REF.: GV/AV/22.002
REMIS PAR INTERG

INTER G

168-172. Bd de Verdun

F 92400 COURBEVOIE

OBJET :

Clichy le 24/01/92

NATURE : GRAINES DE MUNYELE-NYELE

ANALYSE : 10/01/92-0064-CL

EAU ET MATIERES VOLATILES (Norme ISO 665)	33.5	%
PROTEINES BRUTES 3e Directive CEE 72/199	7.8	%
HUILE SUR GRAINES BRUTES (Norme ISO 659 à l'hexane)	24.2	%
ACIDITE OLEIQUE (Norme ISO 729)	19.00	%

COMPOSITION DES ESTERS METHYLIQUES D'ACIDES GRAS (Norme ISO 5508-ISO 5509)

C 14	0.1	%
C 16	38.6	%
C 16 : 1	0.2	%
C 17	0.3	%
C 18	3.2	%
C 18 : 1	41.6	%
C 18 : 2	15.1	%
C 18 : 3	0.4	%
C 20	0.1	%
C 20 : 1	0.1	%
C 24	0.3	%

Michel BLANC
Chef de la Division

Paul ROYE
Adjoint au Chef de
la Division Agricole

DIVISION AGRICOLE
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Protéagineux
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Origine animale
Origine végétale
Aliments pour animaux
Matières premières
Additifs
Produits finis
Produits de mouture
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Gruaux
Produits glucidiques
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- l'AOCS (referee chemist)
- le Conseil Oléicole International
- le Ministère de la Recherche et de la Technologie

...ANTILLONS INFLAMMABLES OU PERISSABLES DETRUITS 15 JOURS APRES L ANALYSE

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IDENTIFICATION :
REFERENCE : E2
COURRIER DU 10.01.92
REMIS PAR JEAN-VICTOR PAULET

INTER G

168-172, Bd de Verdun

F 92400 COURBEVOIE

CACHET :

Clichy le 28/01/92

NATURE : NOYAUX

ANALYSE : 14/01/92 0055-CL

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EAU ET MATIERES VOLATILES (Norme ISO 665)	15.6	%
HUILE SUR GRAINES BRUTES (Norme ISO 659 à l'hexane)	25.0	%

Michel BLANC
Chef de la Division

Paul ROYE
Adjoint au Chef de
la Division Agricole

LES ECHANTILLONS SONT CONSERVES 3 MOIS EXCEPTIONS FAITES DES ECHANTILLONS INFLAMMABLES OU PERISSABLES DETRUITS 15 JOURS APRES L'ANALYSE

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CACHET :

Clichy le 28/01/92

NATURE : HUILE

ANALYSE : 14/01/92-0057-CL

EAU ET MATIERES VOLATILES (NORME ISO 662)	1.00	%
ACIDITE OLEIQUE (NORME ISO 660)	27.00	%
IMPURETES INSOLUBLES DANS L'HEXANE (NORME ISO 663)	0.03	%

Michel BLANC
Chef de la Division

Paul HOYE
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la Division Agricole

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- Café - Cacao

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- Origine animale
- Origine végétale

Aliments pour animaux
- Matières premières
- Additifs
- Produits finis

Produits de mouture
- Farines
- Semoules
- Gruaux

Produits glucidiques
- Sucres
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ACHET :

Clichy le 28/01/92

ATURE : PULPES

ANALYSE : 14/01/92-0054-CL

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Additifs
Produits finis

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- inistère de la Recherche et de la Technologie

EAU ET MATIERES VOLATILES (Norme ISO 665)	6.5	%
HUILE SUR GRAINES BRUTES (Norme ISO 659 à l'hexane)	33.7	%

Michel BLANC
Chef de la Division

Paul ROYE
Adjoint au Chef de
la Division Agricole

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REFERENCE : E3
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F 92400 COURBEVOIE

CACHET :

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NATURE : BOUES

ANALYSE : 14/01/92-0056-CL

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Ministère de la Recherche et de la Technologie

EAU ET MATIERES VOLATILES (Norme ISO 665)	2.8	%
HUILE SUR GRAINES BRUTES (Norme ISO 659 à l'hexane)	72.8	%

Michel BLANC
Chef de la Division

Paul ROYE
Adjoint au Chef de la Division Agricole

LES ECHANTILLONS SONT CONSERVES 3 MOIS EXCEPTIONS FAITES DES ECHANTILLONS INFLAMMABLES OU PERISSABLES DETRUITS 15 JOURS APRES L'ANALYSE

ANNEX 2

POWER SUPPLY OPTIONS

I - OPTION 1 - GENERATOR

An 80 Kva is envisaged to cover the power demand.

I.1 - Power conversion

1 HP = 0,736 W ; 1 Kv = 1,36 HP.

For required power, the yield would be 0,88 and the power factor 0,85 ; i.e. a ratio of absorbed power on transmitted power of :

0,88 x 0,85 = 0,748 (0,75)

Thus power called to the generator diesel motor is 109 HP.

I.2 - Kw cost price

Only the generator use is adopted as comparison with network supply costs :

I.2.1 - Depreciation

- Investment	US $ 35 000	
- Life time	20 000 hours	
- Hourly cost		US $ 1,75

I.2.2 - Consumption

- 190 g of fuel/hour, i.e. 0,22 l/Hp	
- Hourly consumption : 0,22 x 109 HP = 24 liters	
- Hourly cost : US $ 0,5 x 24 l	US $ 12
- 0,005 l of oil/HP	
- Hourly consumption : 0,005 x 109 HP = 0,55 liters	
- Hourly cost : US $ 3,5 x 0,55 l	US $ 1,92
	US $ 13,92

I.2.3 - Maintenance

- 20 % of investment amount, due to adopted life time that requires major overhaul after 10.000 operating hours.

I.2.4 - Overheads

- By an approach hypothesis : 12 % of 60 % of investment	
- 35 000 x 0,6 X 0,12 + 2.520 for 20.000 hours	
- Hourly cost =	US $ 0,13

I.2.5 - Kw production price

- Total cost = US $ 10,15.
  i.e. US $ 0,27/Kw

This option should be given up, since it is more expensive than electrical network connection, option adopted in the feasibility study (US $ 0,07/Kw).

II - OPTION 2 - ELECTRICITY + BOILER ADDITION

Oil plant in containers is equipped to use electrical power for motors and heat requirements which transfer is carried out by thermic fluid circulation.
Required mechanical power is 30 Kw and heat need also absorbs 30 Kw.

An ongoing study of hull boiler, to heat the thermic fluid outside the container was rencently started. This system would save 30 Kw of the demand for product treatment before pressure.

Investment related charges increase, while reversely, electricity consumption decrease.

II.1 - Investment charge increase

- Depreciation US $ 12.000/2.000 hours	US $ 0,6
- Maintenance : 5 % of investment	US $ 0,06
- Financial costs	US $ 0,04
	US $ 0,7

II.2 - Electricity consumption decrease

As mentionned in the pre-feasability study, yearly electricity consumption related charges are US $ 26,950.

Hull boiler addition allows a 30 Kw saving,

yearly electricity cost is down to. i.e. $26\ 950 \times \frac{30}{70}$ = US $ 11.550

Global yearly cost related to electrical consumption and to hull boiler additionnal investment is the following :

11.550 + (0,7 x 5.500) = US $ 15.400.

In view of these results, major savings may be envisaged with a hull boiler addition. However, this option was not adopted because, of dehulling cooking - toasting, which is hull consumer. A long as this problem is not solved it is impossible to know whether enough hull will be available for the oil plant.

In addition, if there is no hull availability problem, a hul transportation cost should be added to above mentionned cost. Due to the lack of information on supply sites and oil plant final location, this cost cannot be determined.

INTER G

Société anonyme au capital de 4 925 000 F R.C.S. Nanterre B [illegible]
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