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A MODEL CONCEPT

FOR THE UTILIZATION OF BALANITES AEGYPTIACA FRUITS FOR THE PRODUCTION OF VEGETABLE OIL AND ANIMAL FEED READY FOR IMPLEMENTATION IN THE SUDAN*

US/GLO/84/233

Prepared by the

Industrial Research and Consultancy Centre**

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Acknowledgments

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1] EXECUTIVE SUMMARY

1. The Project: [Chapter II]

1.1. Project Name: The Commercial Utilization of Balanites aegyptiaca.

1.2. Project Promotor: UNIDO - VIENNA

1.3. Project Orientation:

The project is both market and raw materials oriented in that it utilizes indigenous raw materials and satisfies demand locally thus substituting imports of raw materials.

2. Market & Plant Capacity: [Chapter III]

2.1. Demand:

Oil	80000	Ton /Year
Cake	314431	Ton/Year

2.2. Projected Sales:

Oil:	1310.4 Ton/Year
Cake:	3295 Ton/Year

2.3. Production Programme:

Year 1	60% of full capacity
Year 2	75% of full capacity
Year 3	85% of full capacity
Year 4	90% of full capacity
Year 5 Onwards	100% of full capacity

2.4. Plant Pressing Capacity 3360 Ton Kernel/Annum

2.5. Market Potential:

a] There is a good potential for Lalobe Oil for direct consumption and soap making.

b] There is a good potential for Lalobe Cake

3. Materials & Inputs [Chapter IV]

The basic raw materials for the plant is the Balanites aegyptiaca fruit locally known as Lalobe. According to the survey done by IRCC the amount of fruit yielded annually within accessible distance from the proposed factory is 201 thousand tons while the annual requirements of the plant are about 36 thousand ton which means that the plant is going to buy its requirements easily.

4. Location And Site [Chapter V]

4.1. The plant is proposed be located in Abu Gubeiha Town in the Eastern District of Southern Kordofan Province. The town is acquiring importance as a commercial centre for the surrounding rural areas.

4.2. Underground water is available, so that the plant can have its own supply. The chemical analysis indicated that the ground water of Abu Guweiha is fit for human and industrial uses.

4.3. The town is expected to be supplied with electricity from an electric generator in the very near future. However, the plant must have its stand-by generator.

4.4. The highway under construction is expected to finish in two years time. This will facilitate transportation of the raw materials and finished products.

5. Project Engineering [Chapter VI]

5.1. The fact that the Balanites oil, based on most favourable data, constitutes only 5% of the whole fruit, calls for

maximum possible utilization of other constituents of the fruit to improve viability of the project.

5.2. The presence of a high percentage of hard shells [over 12%] in the cake makes it less acceptable in the market. Therefore the efficiency of separation of shells from kernels must be significantly improved. In a similar type of industry, viz the palm oil industry, the percentage of shells remaining with kernels after separation is not more than 2%. This piece of information was furnished by an official from the Palm Oil Research Institute of Malaysia who visited IRCC early this month [June 1989].

5.3. The high percentage of shells not only causes wear to the expeller screw, but also decreases the amount of oil expelled from the kernels.

5.4. The main feature in the processing of high-oil content seeds [e.g. groundnuts and sesame] in Sudan, is that they are seldom singly pressed in small mills where the various adjustments necessary for best yield and the skillful handling cannot be ascertained. Therefore considering the Lalobe kernel as a high-oil-content seed [average 46%) the double-pressing method is proposed.

5.5. Buildings & Civil Works:

Total Area	12,000 m²
Total Built Area	2,141,m²
Total Cost of Buildings	Ls. 2,138,750
Type of buildings:	Steel Structure & Concrete

6. Financial Evaluation [Chapter VII]

6.1. Total Initial Investment

Year	1989	1990	Total
Fixed Investment Cost:			
Land, Site Prep., Developt.	140,000	-	140,000
Buildings & Civil works	1,119,000	1,000,000	2,119,000
Auxiliary & Service	480,000	480,000	960,000
Incorp. F.A.	1,056,000	50,000	1,106,000
Plant & M/c	6,438,000	-	6,438,000
Total Fixed Investment Cost	**9,233,000**	**1,530,000**	**10,763,000**
Preproduction Exp.	522,000	-	552,000
Net W.C.	-	879,000	879,000
Total Initial Investment	**9,785,000**	**2,409,000**	**12,194,000**
Of it Foreign, in %	**31.8**	**-**	**25.5**

6.2. Project Financing:

Sources of Finances: Equity and Grants.

6.3. Production Costs: [at full Capacity e.g. 1995]

	Ls.
Factory Costs	10,882,270
Administrative Overheads	172,400
Sales & Distribution	-
Operating Costs	11,054,670
Financial Costs	-
Depreciation	651,575
Total Production Costs	**11,706,245**

Of it Foreign,%	1.33
Of it Variable, %	90.436
Total Labour	198,400

6.4. Financial Evaluation:

Net Present Value at 15%	=	3719.65
Internal Rate of Return		20.07%
Return on Equity 1		16.75%
Return on Equity 2		19.62%
Pay-back period-about		3 years
Commercial Profitability		33.36%

7. Conclusions:

7.1 Major Advantages of the Project:

1.1. The project will utilize indigenous raw materials hence contributing positively in G.D.P.

1.2. The project will contribute in the development of a rural area.

1.3. The project will create employment opportunities and generate income for the inhabitants of that area.

1.4. The project will satisfy the need for oils and cakes.

1.5. The project will introduce a new technology which could be followed by countries having the same raw materials.

7.2. Major Drawbacks of the Project:

7.2.1. The inability to utilize the by -products increases the cost of production of oil and cake.

7.2.2. The hull separation ratio is rather low compared to similar industries.

II. PROJECT BACKGROUND & HISTORY

The project under consideration was registered as an in-house research project by the Industrial Research and Consultancy Centre [IRCC] on 15th of June 1977 as a continuation of the work done in Bulgaria by one of the team members.

In October 1978 Mr. Szivos of the UNIDO visited the IRCC and was enlightened about the project. On his return he took a sample of the fruits of Balanites aegyptiaca tree to UNIDO Headquarters.

Afterwards UNIDO nominated the Sudan, represented by IRCC as a home office, to carry out a comprehensive study on the possibility of industrial utilization of the Balanites aegyptiaca fruit.

In February 1979 UNIDO sent Mr. G.D. Brown of the Research and Productivity Council, Fredricton, Canada, to carry out, in cooperation with IRCC, a survey of the areas densely populated by the Balanites tree to quantify the fruit yield and survey its market. At the end of this phase a report was prepared by Mr. Brown covering the results of the survey as well as the results of the chemical and biological analyses of the fruit (1).

In September 1979 UNIDO informed the IRCC that the findings of Phase one are promising and would like IRCC to commence following phase [Phase Two] of the project.

In November 1979 Mr. H. Koenig of UNIDO visited IRCC and negotiated carrying out of phase two of the project [Product and Process Development]. As a result IRCC was requested to prepare a proposal to carry out the work.

In January 1980 the proposal was accepted by UNIDO and a contract was signed in March 1980. The aim of the project and contract was to set-

up a "Model Scheme for the Utilization of Balanites aegyptiaca Fruits in the Project Area for the Production of Edible Oil and Pharmaceutical Raw Materials", thereby laying the basis for the definition of the scope and requirements of the following phase of the project. At the end of this phase [Phase Two] of the project a review in view of the industrial utilization of Balanites aegyptiaca fruits for the production of a variety of human food and animal feed products as well as steroid compounds was prepared (2).

It has been found, as a result, that the Balanites fruit forms a potential for the production of edible oil, cake and other by-products. For that reason, it was recommended that a techno-economic feasibility study should be made. The aim of the techno-economic feasibility study was to fill the gap between the laboratory and the factory.

In April 1984 the Ministry of Finance and Economic Planning [Sudan] was informed by UNIDO Office [Khartoum] that UNIDO would like to have an indication of the interest of the Sudanese Government in the project, and expressed its interest that implementation will be made with IRCC on Contract basis.

Consequently UNIDO decided to carry out the project titled " Elaboration of a Commercial Balanites aegyptiaca Utilization Model" and signed the contract No. 86/108 in December 1986. The aim of this contract was:

[Phase One] :- to conduct a survey of potential harvests, determine harvest time, and nominate a specific area for setting up a model utilization schemes and;

[Phase Two] :- to specify the required equipment and elaborate on relevant engineering designs as well as final economic and cost calculations. The model scheme will then be completed ready for implementation.

In June 1988 the IRCC submitted the Draft Final Report for Phase One of the Project "Survey and Assessment", which was accepted by UNIDO. The present report covers the work under Phase Two of the Project: Engineering Designs, Cost/Price Calculations and Economic Evaluation.

III] MARKET ANALYSIS

3.1. INTRODUCTION:

From the results of the products and process development work on Balanites aegyptiaca [Lalobe], UNIDO and IRCC concluded that the Lalobe fruits can be processed for edible oil, food,feed,drugs and pharmaceutical products according to the requirements.

However, at this phase the study is confined to the utilization of Lalobe fruits as an industrial raw material for the production of edible oil and animal feed. This comes in line with the Sudan Government's declared policy to utilize the idle capacities in the oil mills by increasing the production of oil seeds. The objective in the basic scenario of the Four Year Salvation,Recovery, and Development Programme [FYP], is to increase the per capita consumption of edible oil towards the 1990/91 to reach the levels attained in the seventies. This will be possible as a consequence of an increase in the output of oil seeds.

3.2. OIL SEEDS PRODUCTION [OUTPUT]:

Table [1] shows the oil seeds production for the period 1980/81-1986/87. The oil seeds which are produced in Sudan for commercial use are:

Table [1]

OIL SEEDS PRODUCTION

FOR THE PERIOD 1980/81-1986/88[in '00^ MT]

Year	Sesame	Cotton Seed	Groundnuts
1980/81	221	120	707
1981/82	242	151	721
1982/83	163	203	497
1983/84	206	213	413
1984/85	130	741	378
1985/86	131	278	274
1986/87	301	363	454
Average	199	296	492

3.2.3. Sesame:-

Sudan is ranked third in sesame world production reaching 9-12% of world sesame production.. Sudan's share in sesame export markets is about 25%.

Sesame is mainly geared towards the export market and its contribution in the oil and cake domestic market is not significant.

Sesame production during the 1985/86 season was only about 131 thousand m.t. although the area under cultivation was higher by 35% than before. This is because the productivity per feddan witnessed a sharp decrease due to the pests attack in the main growing areas.

3.2.1. Cotton Seed:-

The cotton seeds produced are consumed locally and it is assigned totally for the production of oils and cakes for local consumption, it is not permitted to export cotton seeds nor its products e.g. oil and cake.
The cotton seed prices and quotes are fixed by the government for the oil mills which are liscenced to produce cotton seed oil and cake. The availability of cotton seed oil and cake is the main determining factor for the surplus in groundnuts and sesame oils for export.

3.2.2. Groundnuts:-

Sudan is the fourth world producer and is ranked as the second world exporter of groundnuts. Sudan production constitutes 36% of the world production of groundnuts.
Groundnuts production showed a decrease of about 28% from 378 thousand metric tons in the 1984/85 season to 274 thousand metric tons in 1985/86. The decline was entirely due to a sharp reduction in the area under cultivation. The 1986/87 production increased due to the increase in area under cultivation. However, the production of groundnuts dropped sharply if compared to the level of the late seventies and early eightees and this was mainly attributed to the wide fluctuation in groundnuts prices which encouraged many producers to shift to other c :h crops.

Table [2]

EXPORTS OF OIL SEEDS & OIL SEEDS PRODUCTS

1980 - 1986

		Oil Seeds		Oil Seeds Products	
	Year	Sesame	Groundnuts	Oil	Cake
	1980	57194	22093	42517	177681
	1981	58731	94349	22286	108640
	1982	60766	88990	21533	84950
	1983	66109	18037	10690	110125
	1984	82301	22453	12905	110557
*	1985	17541	13260	-	10235
*	1986	29051	1090	-	41521

SOURCE: Bank of Sudan Twenty Seventh Annual Report 1986.

Table [3]

PROJECTION OF OIL SEEDS PRODUCTION

1987/88 - 1990/91

[in '000 MT]

Year	Sesame	Cotton Seed	Groundnuts
1987/88	268	340	382
1988/89	275	378	436
1989/90	284	402	513
1990/91	302	440	620

SOURCE: Extracts from the Four Year Salvation. Recovery and Development Programme.

The production during 1986/87 touched the peak level of 301 thousand tons due to the good rainy season & availability of agricultural inputs.

To encourage the exports and improve the level of capacity utilization in oil mills, new types of oil seeds have been introduced such as Soya Bean and Sunflower.

3.3. VEGETABLEOIL INDUSTRY:

3.3.1. Present Local consumption:-

It is not easy to find any reliable figures about the consumption of edible oil in the Sudan. Any published figures are only estimates and that is because:

a] There is a considerable number of camel driven treadmills [Assarat] scattered all over Kordofan and Darfur Provinces & constitute the main supplier of edible oil in these areas. The production of these treadmills is unknown and is not reflected any where in the edible oil production statistics in Sudan.

b] The imports of oil through different sources was not reflected in Foreign Trade Statistics e.g. Chief & Stearin oils.

c] The vegetable oil supplied through international aid organizations is not reflected in the Foreign Trade Statistics e.g. in 1984/85 Sudan received about 35.000 tons of edible oil from two sources only which are USAID and Save the Children Organization.

Table [4]

VEGETABLE OIL PRODUCTION, LOCAL CONSUMPTION AND EXPORTS 1980/81-1985/86

Year	Production	Export	Local Consumption
1980/81	69.2	22.3	46.9
1981/82	75.8	18.2	58.6
1982/83	73.8	9.2	64.0
1983/84	70.4	11.9	64.5
1984/85	81.6	-	81.6
1985/86	NA	-	NA
Average	74.16	12.32	63.12

SOURCE: BANK OF SUDAN ANNUAL REPORTS.

This means that the official figures are not reflecting the total consumption of edible oil in Sudan. Table[4] shows the local production, export and local consumption for the period 1980/81-1985/86. The highest total consumption in this table reached 81600 MT. in 1984/85. The per-capita consumption is approximately 3.70 Kg taking

Sudan population as 22 million. This figure seems to be low if compared to the figures estimated by international organizations and Sudan Government.

3.3.2. Per Capita consumption:-

The per capita consumption of edible oil in the Sudan ranges between 5.3 and 14.5 Kg as per estimates of International Organizations and Government authorities. Some of these estimates are:

a] Food & Agriculture Organization [FAO] Estimates :In 1981: the FAO experts estimated the per capita consumption of edible oil in Sudan at 14.5 Kg resultig in a total annual consumption of about 275.000 tons.

b] Arab Organization for Agricultural Development Estimates :
In 1985, this organization estimated the per capita consumption at 7.35 Kg reaching a total annual consumption of about 162 thousand tons taking Sudan population as 22 million people.

c] Arab Union for Food Industries Estimate.
The Union estimates Sudan annual consum-

ption of edible oil as follows:-

1985	:	309,000 Tons
1990	:	371,000 Tons
1995	:	433,000 Tons
2000	:	495,000 Tons

Accordingly, the per capita consumption in 1985 was estimated as 14.05 Kg.

d] The Four Year Salvation, Recovery & Development Programme [FYP] Estimate:

The proposed [FYP] is an ambitious economic plan which is now under scrutiny to furnish for its presentation to the Parliament [constituent Assembly]. The programme is a result of intensive work in which data is piled like never before in the history of Sudan.

The Programme estimates the per capita consumption of edible oil as shown below . The programme assumes that the per capita consumption of edible oil in Sudan has dropped in the Eighties compared to the consumption of the Seventies. This was due to the drop in the oil seeds production. The [FYP] is planning to increase the per capita consumption of edible oil by increasing the production of oil seeds .

This is reflected in the following estimates for the period of the programme 1987/88-1990/91.

Year	Per Capita Consumption [In Kg.]
1988/87	5.30
1987/88	6.50
1988/89	7.50
1989/90	8.00
1990/91	9.00

However, we will depend, to a great extent, on the results of [FYP] to make our demand projections.

3.3.3. The Total Consumption of Vegetable Oil in Sudan:-

If we take the above mentioned estimates as a measure of per capita consumption, we find that the least estimate is the [FYP]'s estimate. To be on the safe side we take the programme's estimate as a measure of the per capita consumption of edible oil. From Table [5], we find that:

a] Sudan population is estimated to be 24 million in the year 1986/87.

b] The rate of increase in population is 2.8% p.a. and it is considered as the main factor in increasing the total consumption of vegetable oil. e.g. the total consumption of Sudan in 1986/87 was estimated to be 127,820 tons of

edible oil. To get 1987/88 figure we simply multiply the 1986/87 figure by 2.8%, to get 131,399 which is more or less, the same figure shown in Table[5]. The Table shows in detail a projection of supply and requirements for vegetable oil.

3.3.4. **The Local Production:-**

a] **Production Capacities of Oil Mills:** Table [6] shows the designed capacities of oil mills in the Sudan which reaches about 2.8 million tons and the capacity of the already installed mills is about 2.2 million tons.

Table [5]

PROJECTION OF SUPPLY & REQUIREMENTS

OF VEGETABLE OIL

1986/87-1991/92

Year	Production	Imports	Total Resources & Uses	Consumption	Exports
1986/87	120.234	7.586	127.820	127.820	0.000
1987/88	159.478	0.000	159.478	131 403	28.076
1988/89	180.900	0.000	180.900	142.727	38.173
1989/90	180.900	0.000	180.900	142.727	38.173
1990/91	233.362	0.000	233.362	150.830	82.532
1991/92	263.746	0.000	263.746	155.053	105.693

SOURCE: Four Year Salvation, Recovery and Development Programme.

Table [6]

DESIGNED CAPACITIES OF OIL MILLS IN SUDAN [1987]

Type of Mills	No.	Production Capacities
Cotton Seed	64	969.625
Sesame & Groundnuts	140	1,262.600
Under Construction	66	542.000
Total		2,974,225

SOURCE: Ministry of Industry

The extraction of oil according to these capacities will be:

Oil Seed		000'Tons p.a.
Sesame & G.N.[1.262,.600x0.48]	=	606,048
Cotton Seed [969,625 x 0.18]	=	174,533
Total		780,581

On the other hand, even if we take the most ambitious per capita consumption rate [i.e. 14.5 Kg.p.a.] and the assumptions in points 3.3.3 a & 3.3.3 b of this Chapter for the year 1990/91 the total consumption of vegetable oil will not be more than 400 thousand tons per annum. This represents only abut 51.2% of the crushing capacity of the installed factories. If we take the more realistic figure of [FYP] in 1990/91., the total consumption of edible oil [155,053 tons p.a] will be about 20% of the total quantity of oil extracted by the installed oil mills.

b] Availability of Raw Materials:-

The main raw materials for the installed oil mills are Sesame,Cotton Seed and Groundnuts. Refering to Table [3] which shows a projection of oil seeds production during the programme period [1987/88-1990/91] and assuming that all the production of oil seeds in 1990/91 is crushed, this will cover about 61% of the installed capacity of oil mills.

However, the actual capacity of oil mills at present is

about 26% of installed capacity. This reflects a very low ratio of capacity utilization. To improve that, the following recommendations were presented in FYP.

a] Increase in oil seeds production through increasing total cultivated area.

b] Availability of spare parts.

c] Promotion of edible oil exports.

d] Encouraging the production of hydorgenated oils.

e] Local production of necessary inputs for vegetable oil production.

f] Stop liscencing new vegetable oil mills until the attainable capacity is fully utilized.

3.4. SOAP MAKING INDUSTRY:-

Another area where vegetable oil is consumed in considerable quantities is soap making industry. Sudan had witnessed acute problems in the availability of soap for the last five years. The industry used to depend mainly in the production of soap on local vegetable oils. In the late Seventies the oil mills were stopped completely from supplying soap factories with local vegetable oils and all the quantities of locally produced oil were directed towards direct consumption. Since then the soap industry depended mainly on the import of raw materials e.g. tallow. The shortage in the supply of soap was mainly caused by the shortage in hard currency to import the in-

puts for soap.

3.4.1. Potential Demand for Soap:-

The FYP estimate for soap consumption in 1986/87 is 80,000 tons p.a. for laundry soap and 9.000 tons p.a. for toilet soap. Taking Sudan population in that year as 24 million, the per capita consumption of soap in that year is 3.33 Kg and 0.375 Kg for laundry and toilet Soap respectively. Taking the population rate as the main factor affecting soap consumption , the soap consumption during the programme period will be as follows:

Year	laundry	Toilet	Total
1986/87	80.000	9.000	89,000
1987/88	82.240	9.252	91,492
1988/89	84.543	9.511	94,054
1989/90	86.910	9.777	96,687
1990/91	89.343	10.051	99,394

If we take other factors, such as social changes, the per capita consumption will be more than this.

3.4.2. Local Production of Soap:-

The installed capacities of operating soap factories is about 400 thousand tons.

Table [7] shows the designed and actual capacities of soap factories in the Sudan. From this table it is observed that :

a] The actual working capacities of these factories is about 10%. This is mainly due to the unavailability of raw materials.

b] There is a gap between demand and supply of about 50 thousand tons. This means that the local production of soap covers about 50% of the total demand.

3.4.2. Vegetable Oil Requirements for Soap Making:-

Since the late Seventies the soap factories were importing tallow for production of soap. Before that cotton seed oil was being used. If oil is available locally it could constitute up to 80% of raw materials required for laundry soap making. Accordingly, the requirements of oil for soap industry could be as follows:

a] Assume that the existing factories are working at full capacity.

Particulars	Designed Capacity Tons p.a.	Oil Req. Tons/a
Laundry Soap	390,600	210,924
Toilet Soap	9,000	1,500
Total	**399,600**	**222,424**

b] Assume that the factories will operate to cover the FYP soap requirements.

Year	L.Soap Req. Tons.	T.Soap Req. Tons.	T.Oil Req. Tons
1986/87	42666	1500	44166
1987/88	43861	1542	45403
1988/89	45089	1585	46674
1989/90	46351	1630	47981
1990/91	47649	1675	49324

Table [7]

DESIGNED & ACTUAL CAPACITIES OF SOAP FACTORIES

Particulars	No.	Designed Tons	Actual Tons	%
Modern Laundry Soap	20	244,800	30,000	12
Toilet Soap	6	46,800	9,000	20
Traditional Laundry Soap	19	108,000	1,800	1.7
Total	67	399,600	40,800	10

SOURCE: Economic Conference 1986

However, the Ministry of Industry estimates that the annual requirements for tallow for soap industry at present is 40 thousand tons. The CIF cost per ton in 1988 was about US$ 420. To meet the local demand for soap, the tallow imports bill will be around US$ 16.8 million. At least 80% of this amount will be saved if we find a local substitute for tallow, e.g. Lalobe oil, without affecting the quantities of vegetable oil assigned for direct consumption.

After the acute shortage in soap due to hard currency problems, the Ministry of Industry has decided to supply the local soap factories with 39,000 tons of cotton seed oil. This will have negative effect on the balance of trade since this will lead to consuming sesame and groundnut oil instead of cotton seed oil, hence reducing the export of these high price special oils.

3.5. THE CAKE MARKET:-

The cake is the main by-product in any oil industry. It is used as an animal feed stuff either by direct consumption or by mixing with some other materials to produce different feeds for different animals. Consequently, the supply of cake is a function of oil production and the demand for it is a function of the livestock population.

3.5.1. Demand for Cake:(i) Local Market

As stated earlier the demand for cake is derived from the livestock population. Sudan is considered as one of the richest developing countries in livestock. The 1983/84 estimates [TAble (8)] shows that the livestock population in the Sudan is about 57 million heads out of which 21 million cattle, 20 million sheep, 14 million goats and about 2 million camels.

The animals in Sudan depend in their feeding mainly on natural pastures and water resources. This is reflected in the continuous movement of the nomadic tribes in their quest for good pastures.

Many factors have emerged in the past few decades that highlighted the need for changing the animal husbandry style and feeding patterns. Some of these factors are:

a] Drought and Desertification.

b] Expansion in Agriculture.

c] Fires.

d] Mal-Nutrition.

e] Export Markets.

However, the effect of these changes will not result in an immediate drastic change in the demand for cake.
As for the existing demand for cake, Table [9] shows the local consumption of cake for the period 1981-1985. The average annual local consumption is 326,000 metric tons out of which 69% is cotton seed cake, 15% sesame cake and 16% groundnuts cake. The cotton seed cake is mainly for local consumption. The end users are animal fodder factories, farms and household animals. There is no breakdown for these quantities by end users.

(ii) Export Market:-

The Sudanese cake has a good potential in the international cake market specially after solving the aflatoxins problem. Table [9] shows the export of cake for the period 1981-1985. The main exported cake is the groundnuts cake . This is because the cotton seed cake is for local consumption and the sesame cake production is low compared to the others.
Table [10] shows the international trade of groundnuts cake and Sudan share of the international market. It is observed that the Sudan share of the market has come down from about 15% to 7% which was mainly due to the problem of aflatoxins. After solving this problem Sudan could

increase its share of the international groundnuts cake market leaving the local market for other types of cake e.g. Lalobe Cake.

3.5.2. Local Production:

No information is available concerning the local production of cake. However, we assume that the local production in a certain year is equivalent to the sum of local consumption and exports in that year.

Table [9] shows the estimated production for the period 1981-1985. The average annual production is about 411,000 metric tons out of which 55% is cotton seed cake, 32% groundnuts cake and 23% sesame cake.

3.5.3. Potential Demand:

The fact that there are cake exports and no cake imports shows that there is a surplus in the local market. As mentioned earlier in this chapter, there is a good potential for export. The potential for the local market depends entirely on the socio-economic changes and the animal feeding patterns.

At present, the officials at the Ministry of Agriculture and Natural Resources assume the following:

(i) Only cattle and sheep are cake consumers; when 25% of the total no. of cattle and 6% of the total number of sheep consume cake.

(ii) The average annual consumption of cake/cow is 476 Kg /annum.

(iii) The average annual consumption of cake/sheep is 120 Kg /annum.

Applying these assumptions we find that the average annual consumption of cake is about 394,000 tons per annum [250,000 tons for cattle and 144000 tons for sheep] which seems to be reasonable compared to the actual average consumption of 316,000 metric tons/annum. If the percentage is only increased to50% for cattle and 10% for sheep the quantity required will double.

Table [8]

ESTIMATED ANIMAL POPULATION

1983-1984

[in '000 Heads]

Animal / Region	Cattle	Sheep	goat	Camels	Total
Northern	79	587	509	198	1,373
Eastern	930	2,232	1,707	786	5,655
Khartoum	88	366	536	17	1,007
Central	4,061	5,543	2,986	310	12,900
Kordofan	3,291	4,063	2,966	101	10,421
Darfur	4,985	3,252	2,880	436	11,553
Southern	7,609	3,926	2,499	50	14,084
Total	21,043	19,969	14,083	1,898	56,993
Rate of Growth	2.6% p.a.	3.3%p.a.	2.7% p.a.	1.2%p.a.	

SOURCE: Ministry of Agriculture & Natural Resources.

Table [9]

PRODUCTION, LOCAL CONSUMPTION &

EXPORTS OF CAKE

[1] Local Consumption

	81	82	83	84	85
Cotton Seed	149,325	187,275	251,625	288,750	247,500
Sesame	66,252	59,324	25,679	48,618	16,863
G.N.	62,985	71,002	51,193	54,206	50,068
Total	**278,562**	**317,601**	**328,497**	**391,574**	**314,431**

SOURCE: Faisal Islamic Bank-Periodical 5,1986

[2] Exports

	81	82	83	84	85
Cotton Seed	1,189	198	-	-	892
Sesame	25,515	12,257	6,354	7,494	2,372
G.N.	81,936	72,458	103,771	100,395	6,971
Total	**108,640**	**84,913**	**110,125**	**107,889**	**10,235**

SOURCE: Bank of Sudan Annual Reports.

[3] Local Production:*

	81	82	83	84	85
Cotton Seed	150,514	187,476	251,625	288,750	248,392
Sesame	91,767	71,581	32,033	56,112	19,235
G.N.	144,921	143,460	154,964	154,601	57,039
Total	**387,202**	**402,517**	**438,622**	**499,463**	**324,666**

* Derived by the Consultant from Tables [1] and [3]

Table [10]

INTERNATIONAL TRADE ON GROUNDNUTS

CAKE

Year	International Trade M.T.	Sudan Exports M.T.	%
Oct.-Sept.80/81	860,600	127,746	14.84
1981/82	666,000	80,764	12.12
1982/83	720,700	86,367	12.00
1983/84	725,500	50,654	7.00

SOURCE: Oil World, June6,1984, Section 4.

3.6. MARKET DEMAND FOR LALOBE PRODUCTS:

In the light of what have been mentioned, we can assess the market demand for Lalobe oil. The two main uses of Lalobe Oil could be:

4.6.1. Direct Houshold Consumption of Lalobe Edible Oil:

The vegetable oils which are used in Sudan for domestic consumption are sesame, groundnuts and cotton seed oils. The consumer preference in using these oils differs from one area to another. Traditionally people used to prefer sesame and groundnuts oils respectively.

In the 1960's the cotton seed oil started to have a share of the market encouraged by the government to induce the export of other oil seeds.

In a questionnaire conducted by IRCC, people in Kordofan Region rank sesame oil first, Lalobe Oil second, groundnuts oil third,and cotton seed oil fourth. This means that the Lalobe oil could have a good market share in the existing market. For consumption in other parts of the Sudan the market potential needs a market test in different areas and consumers would need time to get used to it as had happened in the case of cotton seed oil. To make an estimate for the potential demand for Lalobe oil, we have to investigate the demand for vegetable oil in Kordofan and the market share of Lalobe oil. The demand projection will depend on the following assumptions presented in FYP:

a] Kordofan Region Population in 1983 was estimated to be 3,247,000.

b] The population rate of growth in Kordofan is 3.7%.

c] The per capita consumption of vegetable oil will be as mentioned earlier in this chapter.

Accordingly, the estimated demand for vegetable oil in Kordofan for direct consumption during the Programmes period could be as follows:

Table [11]

Projected Total Consumption

Year	Population 000 People	Per Capita Cons. Kg.	Total Oil Consumption Tons
1986/87	3756	5,30	19.907
1987/88	3895	6.50	25.317
1988/89	4039	7.50	30.293
1989/90	4189	8.00	33.512
1990/91	4344	9.00	39.096

However, we have to be careful in estimating the demand for lalobe oil as edible oil consumption.

Any market potential depends to a great extent on the quality of the oil and the selling price. A market penetration strategy by the Lalobe Oil for domestic uses will release other locally produced vegetable oils and oil seeds and gear them towards export markets to contribute in solving the Balance of Payment problems.

3.6.2. **Lalobe Oil Requirements for soap Industry:**

The soap industry is the best potential market for Lalobe Oil utilization. The main reasons for that are:

a] Taking the present demand for soap, the quantity of vegetable oil required for soap making is at least 40,000 tons per anuum.This quantity could increase to more than 200,000 tons if the idle capacity of the soap factories is to be utilized.

b] There is an accute shortage in the supply of laundry soap. The existing factories are working at 10% of their capacities and this is mainly due to the unavailability of raw materials.The main raw material being used now is imported tallow which is not flowing smoothly due to hard currency problems.

c] The experiments have shown that Lalobe Oil could be used in soap production and could constitute more than 80% of the material inputs. This could contribute in solving the raw materials problem and saving in hard currency.

3.6.3. Lalobe Cake:

The results of the pilot experiment carried out by IRCC in 1981, showed that the feeding of Lalobe Kernel Cake did not stimulate any digestive disturbance of the experimented animals.

So, the potential for marketing the cake locally is there. This potential could be further improved if used as an ingredient of animal feed.

IV] RAW MATERIALS AVAILABILITY

" LALOBE "

1.1. Raw Materials Specifications:

The plant is meant to process Balanites aegyptiaca fruit, known locally as Lalobe fruit, it is a green fruit ripening in yellowish 2.5-4 cm. long and 1.5 cm. in diameter, shortly stalked, with a thin hard skin over a yellow-brown sticky flesh in which is embedded a large hard pointed stone.

In average the constituents of the fruit by weight are:

Epicarp [peel]	17%
Mesocarp [soft fruit wall]	33%
Endocarp [hard wodden shell]	40%
Kernel	10%

The oil content of the kernel is 46% of its weight.

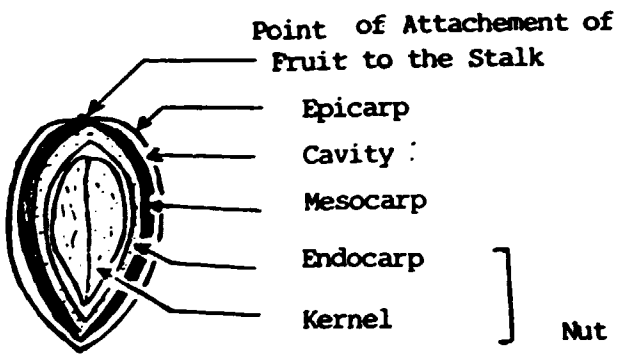


Fig.[1] Longitudinal Section of the Ripe Fruit

The epicarp is thin, brittle and easy to remove by hand. The mesocarp is gummy, rich in sugars and steroidal saponins. Because of its gummy nature the mesocarp adheres firmly to the nut, but it can easily be leached out with water. The endocarp [wooden shell] is tough and very hard; embedded in it is the oily kernel [Fig.1]. However during current study it was found that 1.1-8.8% of the fruit has its kernel eaten up by insects.

1.2. Wild Resources of the Balanites Tree:

The Balanites tree grows wildly on the savana dark cracking soil between rain falls of 500 to 1000 mm and on sandy soil where the rain fall exceeds 250 mm. In Sudan, the major occurence of the Balanites tree is in Darfur, Kordofan and to a less extent in the Blue Nile and Kassala Provinces. The Balanites tree is also found in other parts of Africa and Asia.

1.3. Availability of the Balanites Fruit for Abu Gubeiha Pilot Plant:

The town of Abu Gubeiha, Southern Kordofan which was selected for the establishment of the plant is surrounded by villages of dense Balanites tree growings. The survey conducted by IRCC team revealed that the annual yield of the Balanites tree in the villages arround Abu Gubeiha is in the region of 201 thousand tons of fruit [Table12].The plant normal

feasible capacity is 36 thousand of fruit. This means that the plant is expected to acquire the necessary tonnage of raw materials quiet easily being the only plant.

Table [12]

ANNUAL FRUIT YIELD AT COLLECTION CENTRES

Centre	Distance from Abu Gubeiha Km	Annual Fruit Ton
Abu Gubeiha	1-5	26888
Sisban	42	21600
Kabous	44	20000
Um-Hashima	24	25501
El Khazan	23	21247
Tagmala	42	4940
Um Berembita	112	25039
Abaseya	119	1683
Abu Kershola	130	30771
Abu Gureis	68	16300

THE PLANT PRODUCTION CAPACITY

Although the market study carried out by IRCC has not come up with an exact figure for the demand for Lalobe oil and cake it has shown that the people of Kordofan Region ranked Lalobe oil as the second best. The present total demand for edible oil at Kordofan region is about 30000 tons per annum for the year 1988/89. This demand is far from being met due to the shortage of oil seeds. Lalobe oil could also be diverted to meet part of the country soap industry demand which is presently estimated at 40000 ton per annum.

Hence the potential demand for Lalobe oil is great. Lalobe fruit is found in abundance as shown previously. However as a start the study team has decided to commission the lalobe industry by a small plant capable of processing 170 ton of lalobe fruit per day [16 ton kernel] which would yield about 1000 tons of lalobe oil per annum. Future expansion of the Lalobe industry will be decided upon on the light of the financial and technical performance of the plant under study. However, in the first years the factory will not operate at full capacity partly because of technological reasons [new technology] and partly due to organizational reasons beside the labour learning process. The estimated attainable production capacity in the first five years is as shown on the following table:

Table [13]

ANNUAL PRODUCTION CAPACITY

Year	% Of Full Capacity	Attainable Tonnage Kernel Day
1	60	9.6
2	75	12.0
3	85	13.6
4	90	14.4
5	100	16.0

- RAW MATERIALS REQUIREMENT

Based on the plant production capacity and the assumption that about 5% is the wasted raw materials the lalobe fruit annual requirements are illustrated in the following table.

Table [14]

Annual Lalobe Fruit Requirement

Year	Crushing Capacity Ton/ Annum	Required Whole Fruit	Waste	total Fruit Requirement/Annum
1	2016	20160	1061	21221
2	2520	25200	1326	26526
3	2856	28560	1503	30063
4	3024	30240	1592	31832
5	3360	33600	1768	35368

V. LOCATION & SITE

1. Location:

1.1. Geographical Location:

During the team's first field survey [April 1987]described earlier(3) the team observed that Abu Gubeiha Town,in the Eastern District of Southern Kordofan Province called "Tegali", lies in the centre of an area densely inhabited by the Balanites aegyptiaca "Hejlij" Tree.

Tegali District has an area of 50253 Km^2[about one third of the area of Southern Kordofan Province]. (4) It lies in the south eastern corner of Kordofan Region (Map 1).
The latitudinal extension of the district is between 9^{o} 36' N and 12^{o} 18' N. Longitudinally, it extends from about 30^{o} E to 33^{o}E.

The area is hilly and high. The relief factor there makes all the Nuba Mountains [of which Tegali District forms the eastern part] anomalous in the isohyetal of the Sudan.

1.2. Climate(5)

Tegali District is classified as "semi arid". Mean annual rainfall over the district varies from about 500 mm in the north to 800 mm or more in the south [Fig. 2 & 3]. Relative humidity is at maximum in July-September when mean monthly values are 60-70%. The atmosphere has clouds all the year round , but in winter the coverage is normally less than $\frac{1}{8}$ of the sky. In summer the normal coverage is 5/8 or more, the peak of which is in the period of July-August.

Map [1] LOCATION OF TEGALI DISTRICT

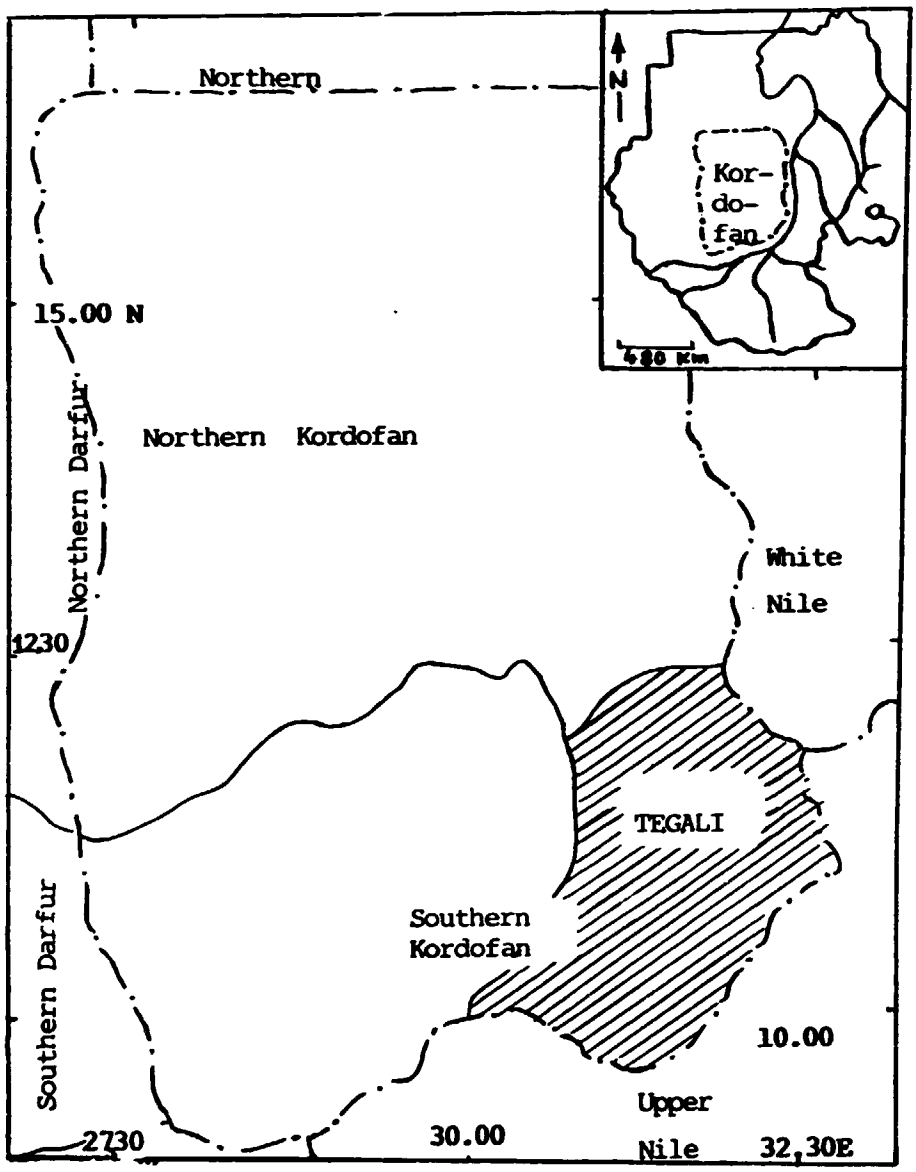


Fig [2] Mean Monthly Rainfall

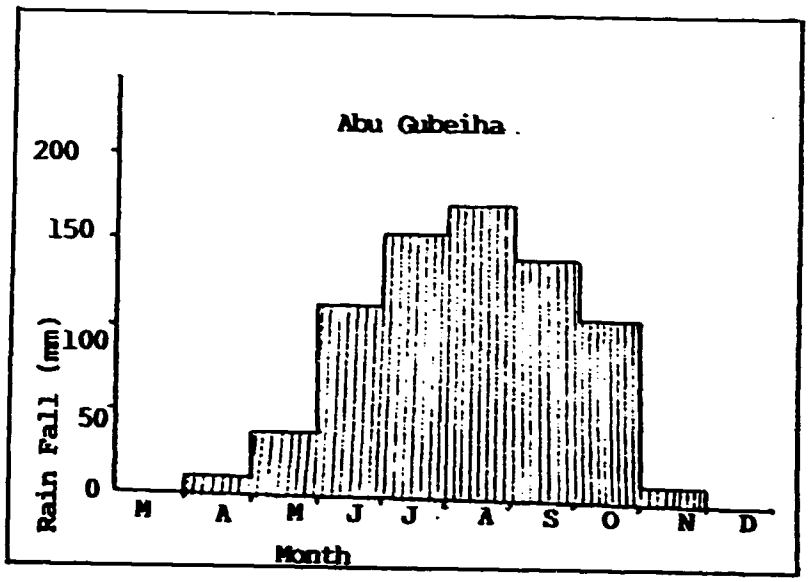
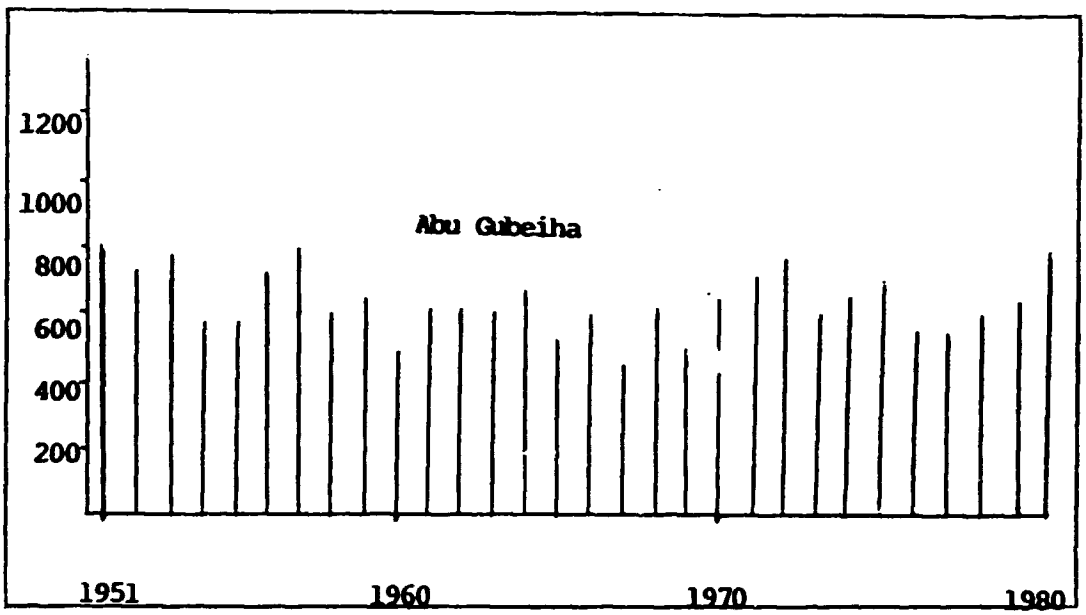


Fig [3] Annual Rainfall [1951-1980]



The north easterly winds prevail from November to April after which period the moist south westerlies dominate at mean velocity of 6-7 mph.

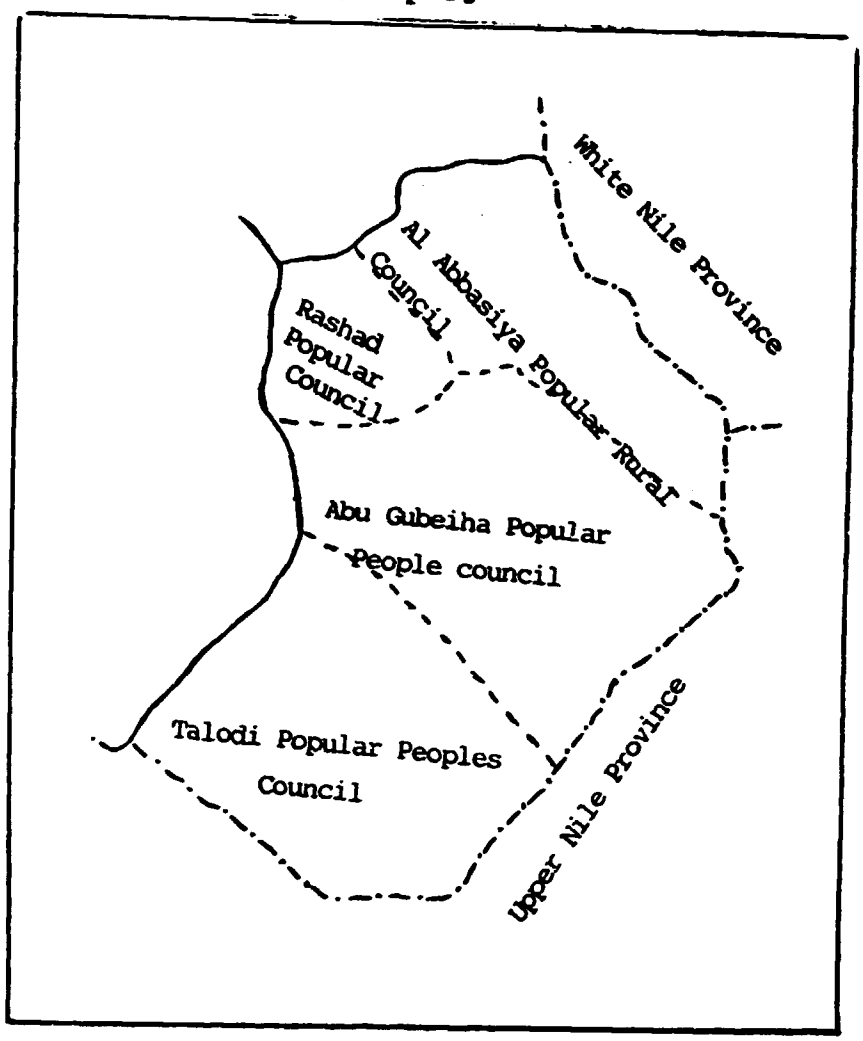
Temperature records gauged at Rashad [Districts Headquarter] show the daily average mean max. for the whole year as 32.9°C and the mean minimum for the 12 months is 20.3°C. At the same station, the mean monthly temperature for January is 24.7°C when the mean maximum is 31.5°C and the mean minimum is 17.9°C. The highest January temperature ever recorded within the period 1951-1980 was 40°C in 1967. On the other hand the lowest ever recorded January temperature was 9.0°C in 1974. May is perhaps the hottest month in Rashad when the mean maximum is 36.0°C. In this month conditions of lower than 21°C have never been recorded within the whole period of 1951-1980.

1.3. Occupation And Mode of Living

In Tegali pastoral nomads and the Sedentary agriculturists co-exist. For a long time in history, the area was not open to the outside world and thus the native lived in isolation. Recently however, the whole of the Nuba Region has witnessed some rapid changes towards modernization. Now the subsistence economy inherited and passed to generations is quickly giving place to cash economy with new techniques, tools and larger forms. Of paramount importance, however, are the new aspirations and attitudes in which profit maximization overwhelms other interests of environmental conservation.

The district is adminstered by four Popular people Councils Viz: Abu Gubeiha, Rashad, Talodi and El Abbasiya Popular People Councils [See Map 3] with the exception

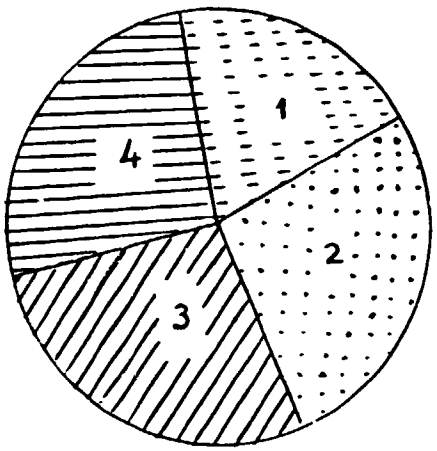
[Map 3]



of the northern part [El Abbasiya Popular People Council], the district is sparsely populated by the Standards of Kordofan Region. It accomodated only 16.5% of Kordofan Fegion Population [1983] and about 27% of Southern Kordofan Province Population. The district population by Popular People Councils and mode of living is shown in Fig.[4].

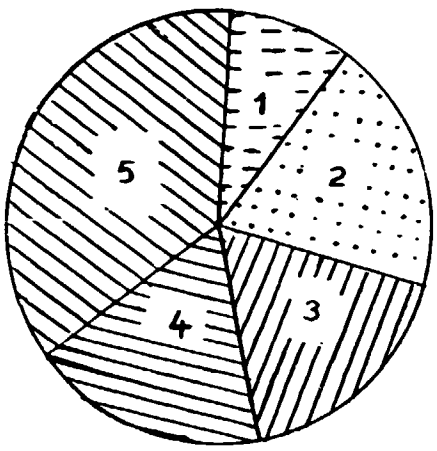
Fig.[4] DISTRICT POPULATION BY POPULAR PEOPLE COUNCIL AND MODE OF LIVING 1983

[A] Settled Rural



1. Abu Gubeiha P.P. Council
2. Rashad „ „
3. Talodi „ „
4. El Abbasiya „ „

[B] Urban



1. Rashad Town
2. El Abbasiya
3. Abu Kershola
4. Talodi
5. Abu Gubeiha

Source: Data 1983 National Census

2. Site:

2.1. Geographical:

Abu Gubeiha Town lies at latitude $11^{o}25'$ N and longitude $31^{o}\ 15'$. It is situated in a clay flat area. The highway under construction [See Map 4] passes by the town and is going to facilitate a lot the transportation of crops in the area.

There are only two factories at Abu Gubeiha Town, an oil mill and a ginning factory located at the South East and South West of the town respectively. However, a new industrial area has been planned to occupy the land lying south east of the town. Until now no factory has been established in the new industrial area but it is expected that some will be established in the very near future.

2.2. Water Resources of Abu Gubeiha:

In 1974 onwards the Rural Water Corporation [RWC] drilled about five production wells and more than five piezometers near the wells along Khor Tandik [See Map 4] from Melemm El kur in the north to Abu Gubeiha town in the south. The water levels ranged from 12 to 15 fact below ground level. The discharge of the wells ranged from 800 gallons per hour to over 1000 g.p.h. The wells drilled by RWC did not penetrate the weathered Basement Complex. If, however, the weathered Basement Complex is tapped, discharge of the wells could be improved. The chemical analysis indicated that Abu Gubeiha ground water [See Table 15] is fit for human, animal and industrial uses.

M A P NO. 4

THE EASTERN DISTRICT

SOUTHERN KORDOFAN PROVINCE

(TEGALI)

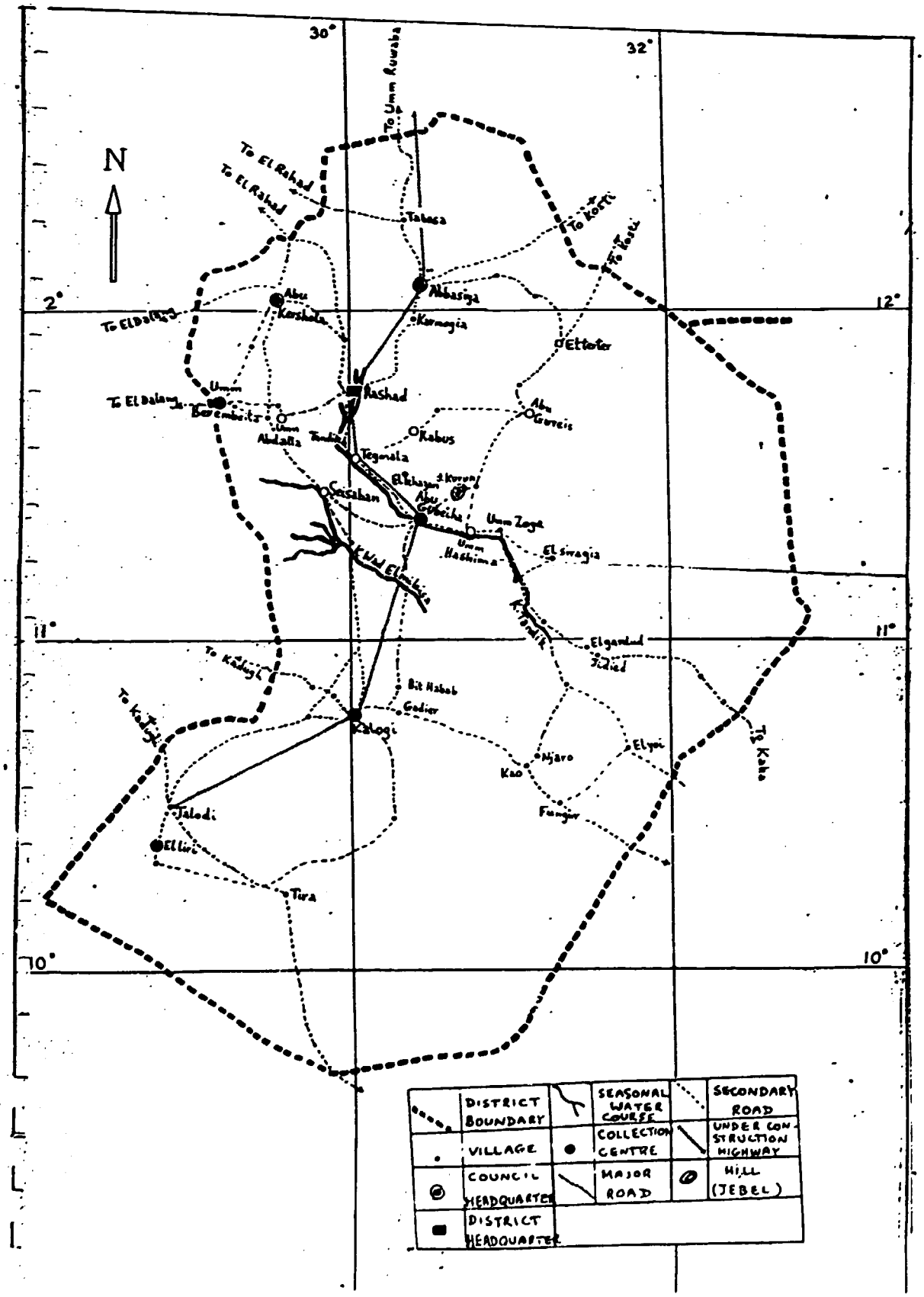


Table [15]

Characteristics of 3 Wells Drilled by Rural Water Corporation(RWC) at Abu Gubeiha Area

	Well No. 6350	6351	6352
EC	350 ma/cm	430ms/cm	350 ms/cm
pH	8.0	8.0	8.0
T.D.S.	240 ppm	280 ppm	220 ppm
Total hardness($CaCo_3$)	170 ppm	170 ppm	165 ppm
T.Alkalinity ($CaCo_3$)	200 ppm	320 ppm	250 ppm
Ex.Alkalinity(Na_2Co_3)	(...)	160 ppm	90 ppm
Ca	50 ppm	30 ppm	45 ppm
Mg	10 ppm	20 ppm	30 ppm
Na	30 ppm	65ppm	45 ppm
NO_3	0.9 ppm	Nil ppm	Nil ppm
NO_2	0.012ppm	Nil ppm	0.012 ppm
SO_4	15 ppm	20 ppm	10 ppm
Cl	5 ppm	Nil ppm	10 ppm
F	0.3 ppm	0.4 ppm	(...)
K	5 ppm	5 ppm	5 ppm
Depth	89 ft	80 ft	70 ft
S.W.L.	12 ft	14 ft	15 ft
Yield	1074 gal/h	800 gal/h	916 gal/h

EC - Electrical Conductivity
T.D.S.-Total Dissolved Solids
S.W.L.-Static Water Level

2.2. Electricity:

It is planned that Abu Gubeiha be supplied with electric power from an electric generator. Installation of the grid is expected to finish very soon. However the proposed Lalobe processing factory must have its own standby electric generator.

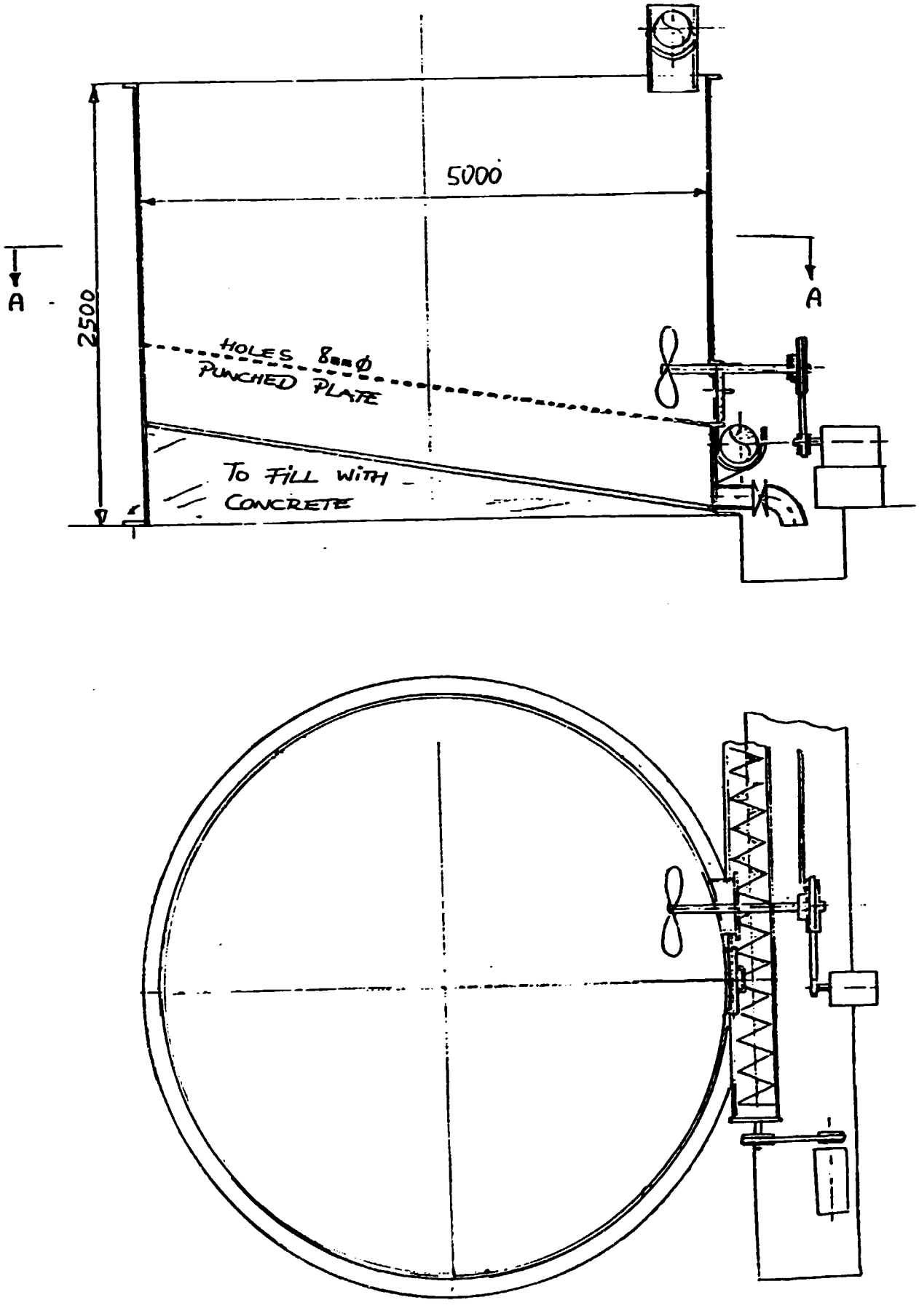
VI] PROJECT ENGINEERING

PROCESS DESCRIPTION & SPECIFICATION OF MACHINERY

Starting up with decentralized collecting stations where the pickers bring in the Lalobe on standardized trailors of 10 ton capacity which can be made locally all having the same weight and containing the same volume of fruits. Standardizing of the trailors will be very helpful to facilitate accounting with the fruit-pickers.

From these collecting points the Lalobe will be transported by trucks, tractors to central collecting stations close to or at the oil mill. After arrival at the oil mill the Lalobe-transports are weighed and then discharged into the fruit storage, from there it will be moved by carts to a hopper which feeds via screw conveyor the mesocarp separation tanks. The tanks are equipped with a bottom valve for the pulp-outlet, an agitator driven by a diesel or animals, a sieve-plate with holes 8mm in dia and an outlet opening for the nuts.[see drwg.]

After removal of the mesocarp [8 hours] under continuous stirring the pulp-water-mixture is emptied by the bottom valve into a collecting channel from where it is pumped to a holding tank,from there the mixture is fed to decanter separators for separation of pulp. Nearly all the water can be recycled [loss appr. 2%] and can be stored in a tank for further use. The pulp is pumped to a tank for further discharge for feeding.The nuts are fed via screw-conveyor to a drying-unit,consisting of a vibrating screen and a cascade-dryer heated with steam. A magnet for iron separation is fixed over the conveying belt feeding the nuts to the nut cracker impact-Dehyller].The mixture of hulls and kernals is discharged at the cracker bottom and fed to the hull-separator [double sifter with air classifier] [See attached plates and drawings.] .



SECTION A-A.

The separated hulls are fed to a flat storage from where they can be conveyed to the steamboiler for burning.

The Lalobe kernel is accepted as a "high-oil-content seed", with an average oil content of 46%. In a previous report[6],reviewing most of the oil seeds, it was found that groundnut is the most closely related oil seed to the Lalobe kernel.

The main feature in the processing of high oil content seeds in Sudan [groundnut and sesame] is that they are seldom single-pressed in small mills, where the various adjustments necessary for best yield and the skillful handling cannot be ascertained.

In previous experiments[6]both high-pressure single pressing and double pressing have been tried on 3 tons of Lalobe kernels. As a result of these experiments it has been concluded that the ideal method found was high-pressure single-pressing of the whole kernels giving 11.2% residual oil in the cake, while two double pressing gave 12.1 and 13.4% residual oil in the cake.

Recently however, [Jan.1989] a double-pressing trial using only one sack of Lalobe kernel [about 62 Kg.] was done on an Indian expeller [Steelchem Expeller] Model: Supermax Four in Abu Gubeiha Oil Mill, adopting the same conditions used by the mill for pressing ground-nuts, gave a residual oil content 9%. This result is better than that obtained earlier by the high pressure single-press mentioned above.The facts that the trial was done on only one sack [due to lack of raw material], and that the expeller is a relatively old one make us expect that the residual oil content could go as for fown as 5.6%.

From the foregoing discussion and results we propose that the Lalobe kernels be pressed by the double pressing method.The proposed oil mill

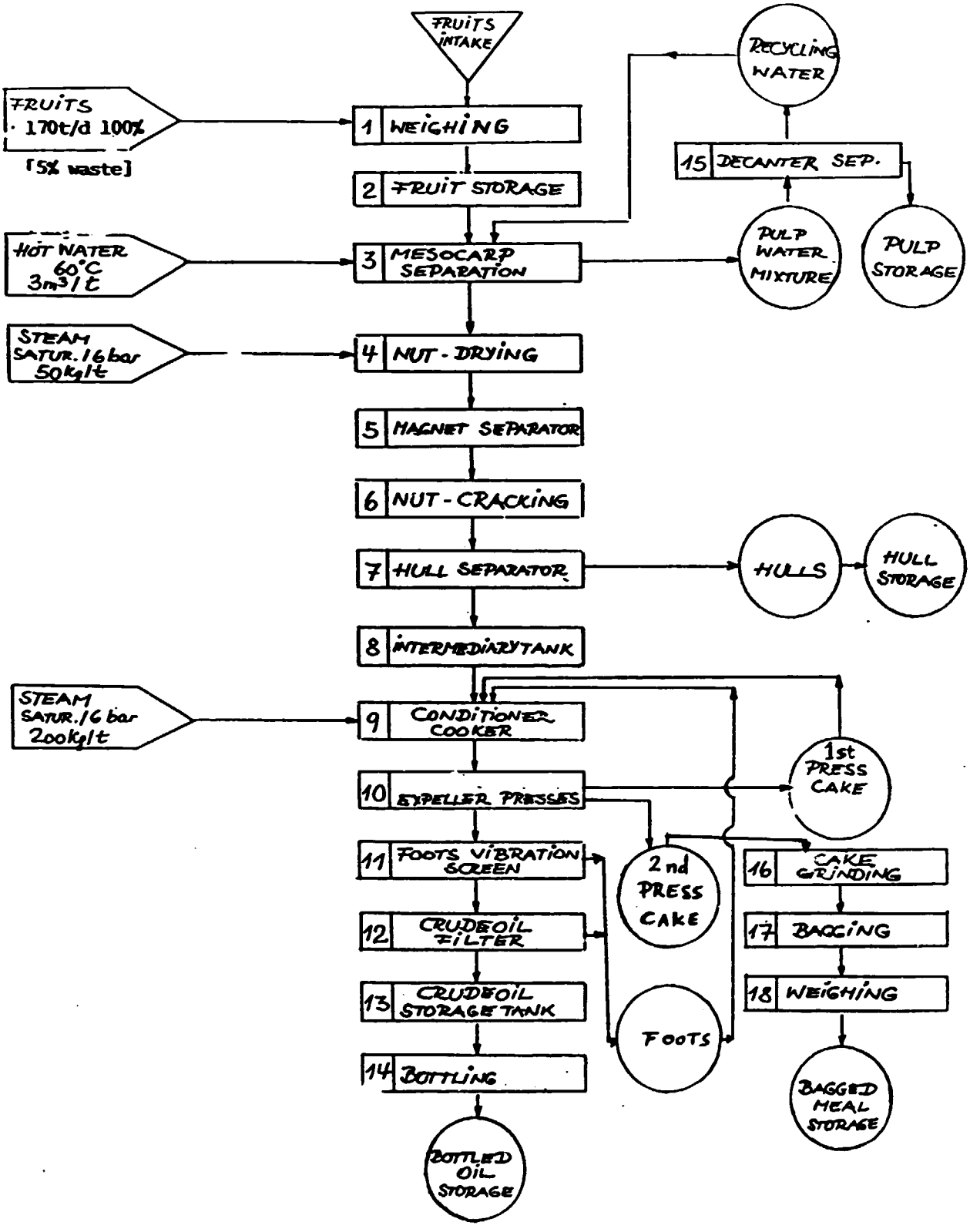
could be equipped with 3 eight-ton/day expellers. The first two expellers make the first press and the third one makes the second pressing of the cake coming out of the first two expellers. This leaves us with an overall mill capacity of 16 tons of Lalobe kernels per day . The following flow diagram shows the process of Lalobe oil and cake production.

The kernel fraction is conveyed to an intermediary tank from where it is fed to the conditioner-cooker. The conditioned kernel-fraction is fed now to the high-pressure-expeller-presses [3x8t/d]. From this step of the process we get our final products, crude oil and the press cake. The crude oil containing solids from the press-cake(foots) is screened by a foots-vibrator-screen [all particles bigger than 0.4mm are removed].The crude oil then is pumped through a cloth-filter or a self cleaning Niagara-filter to be polished.

The finished crude oil is stored in a storage tank from where it is pumped to the bottling plant or sold in bulk.

The press cake is stored in a flat storage from where it is sold as it is as a feed stuff. All the presscake leaving the factory has to be weighed exactly for proper calculation.

Flow Diagram



SPECIFICATION OF ITEMS MENTIONED IN FLOW-DIAGRAM

Item 1.] Weighing Machines :

2 weighing machines (capacity 1 ton).

Item 2.] Flatstorage for Fruits:

Since the Lalobe fruits can only be harvested from December to end of February (3 month) the fruits must be stored in a quantity to have enough raw material for the processing all over the year.(210 working days)The layer of fruits in a flat storage may not exceed 5 sacks. (ca 150 cm.) Therefore appr. 4 m^2 are required for storage of 5 ton of fruits. A lot of Lalobe can be stored outside of the factory but to ensure the operation of the oil mill a quantity of fruits for 15 days of operation should always be available . Therefore approx. 2000 m^2 of flat ground is to be prepared for storage. This will be enough storage capacity for appr. 2,500 t of fruits . From here the Lalobe can be supplied by carts to a hopper from where it is fed to the next processing step via screw conveyor. (5 kwh).

Item 3.] Mesocarp Separation:

The mescoarp can be removed by leaching the whole fruits in hot water ($60^{o}C$) for 12 hours under constant agitation. For 200 t of fruits 10 tanks will be required (40 m^2 each) (5 m dia, 2 m high) containing 10 m^3 of Lalobe and 30 m^3 of water. If the tanks are emptied the water could be recycled.(loss appr. 2%) using 2 decanter-separators

(20 KWH each) to separate the pulp from the water.

From a pulp channel under the leaching vessels the pulp-water mixture will be pumped to a storage tank for 80 m^3 (pump-5KWh) from here it will be pumped by another pump (pump 5 KWh) to the decanters. The recycled water can be stored for reuse in a tank with 60 m^3.

To cover the loss of 2% of water a fresh water tank containing 50 m^3 should be installed.

The clean but wet nuts will be removed from the separation tank by the built in agitator through the outlet door into a screw conveyor (5KWh) for further processing.

Item 4.] Nutdryer:

After removal of the mesocarp the remaining quantity of 85 t of nuts must be dried. This will be done in two steps. In the first step, a vibration screen, the surplus water between the nuts will be removed. In the second step, a cascade dryer steam heated air is blown in counter current to the down streaming nuts [fan 15 KWh] 50 kg of saturated steam with 6 bar will be required to dry the nuts to a satisfactory degree for grinding.

Item 5.] Magnet:

Above a belt conveyor feeding the nuts to the cracker a magnet should be installed to prevent mill-damage by iron parts.

Item 6.] Nut Cracker:

In this process step a hammer mill or an impact mill or breaker rolls will be used to crack the hulls of the nuts and to remove the oil bearing kernels [mill 15 Kwh]. If the kernels are used for the production of oil it will be an advance if they are broken because it is increasing the oil-yield.

Item 7.] Hull Separator;

For separation of hulls from kernels a combination of a sifter can be used [10 KWh]. Appr. 40% of the total amount of 53% of hulls will be separated (12% hulls remaining in the kernel fraction). The hulls are conveyed to a flat-store for appr. 200 t of hulls 10m x 20m/storage hight 2 m.)

Item 8.] Intermediary Tank:

The kernel-fraction is fed to a tank with a capacity of appr. 35 m^3 [3 m in dia and 5 m high].This tank serves as a buffering tank for the mechanical extraction.

Item 9.] Conditioning [Heating Kettles]

Since the kettles are supplied together with the press 2 units will be available [1 for every press].
The conditioning is done in 5 stages. During a treatment with heat and open steam a certain temperature [appr.100^{o}C] and moisture content [appr. 9% is introduced into the kernels to achieve a maximum oil-yield during the extraction.

Item 10.] High Pressure-Expeller Pressing:

3 presses with a capacity of 8t/day each will be required to extract the oil from the conditioned kernel-fraction by high pressure in single operation. The remaining oil-content in meat after pressing will be appr. 9%.

Item 11.] Foots Vibration Screen:

The crude oil from the press still contains fine particles of kernel-meat. These particles called foots are removed from the oil by this screen and fed back to the conditioner. [5 KWh].

Item 12.] Crude Oil Filter:

The crude oil already cleaned mechanically has to pass this filter unit to take out all visual impurities. [Cloth-filter or a self cleaning Niagara-filter] and get a clear product ready for sale.

Item 13.] Crude Oil Storage Tank:

[2x6 tons] The tanks have a storage capacity for the crude oil can be sold in bulk or pumped to the bottling plant.

Item 14.] Bottling Plant:

For the retail market the oil could be bottled.
Plastic jerrycans containing 18 litres would be the most common size.
For the beginning it will be more economical to buy the containers. Later on they can be produced locally by a blow moulding machine.

Press Cake Storage:

The other product coming from the high-pressure press is the press cake. The store for press cake should be able to keep the production of 7 days which will be appr. 240 tons. [size: 15m x 20m, storage height 1m].

Building for Administration:

This building contains all offices for the staff, laborartory, social rooms, canteen and workshops for repair and maintenance as well as store for spare parts.

Steam Boiler and electric Generator:

Every oil mill needs for operation steam and electricity. Therefore a steam boiler for 1 ton of steam/hour with a pressure of 6 bar has to be installed to cover the steam supply for the production, the burner has to be designed to burn solid fuels as the hulls of Lalobe or fire wood.
[for the start-up,till hulls from the process are available.]
The electric generator set consisting of two units with an installed capacity of 450 KVA and driven by Diesel-engines should be split into two units, one for normal operation and one for emergency.

III.3.]Maintenance & Spare Parts

For a manufacturing plant proper maintenance and the availability of spare parts are the guarantee for satisfactory and economic operation.
Since appr. 60% of the plant can be supplied locally in

Sudan only special equipment as the expeller presses, steam boiler and electric generator should be supplied from abroad but priority should be given to suppliers with agencies in Sudan to facilitate the supply of spare parts.

If in times to come more factories are in the Lalobe business a mobile workshop could be purchased for maintenance of the Lalobe plants with special equipment and experienced fitting hands.

III.4] Figures of Demand, Yields And Investment Costs

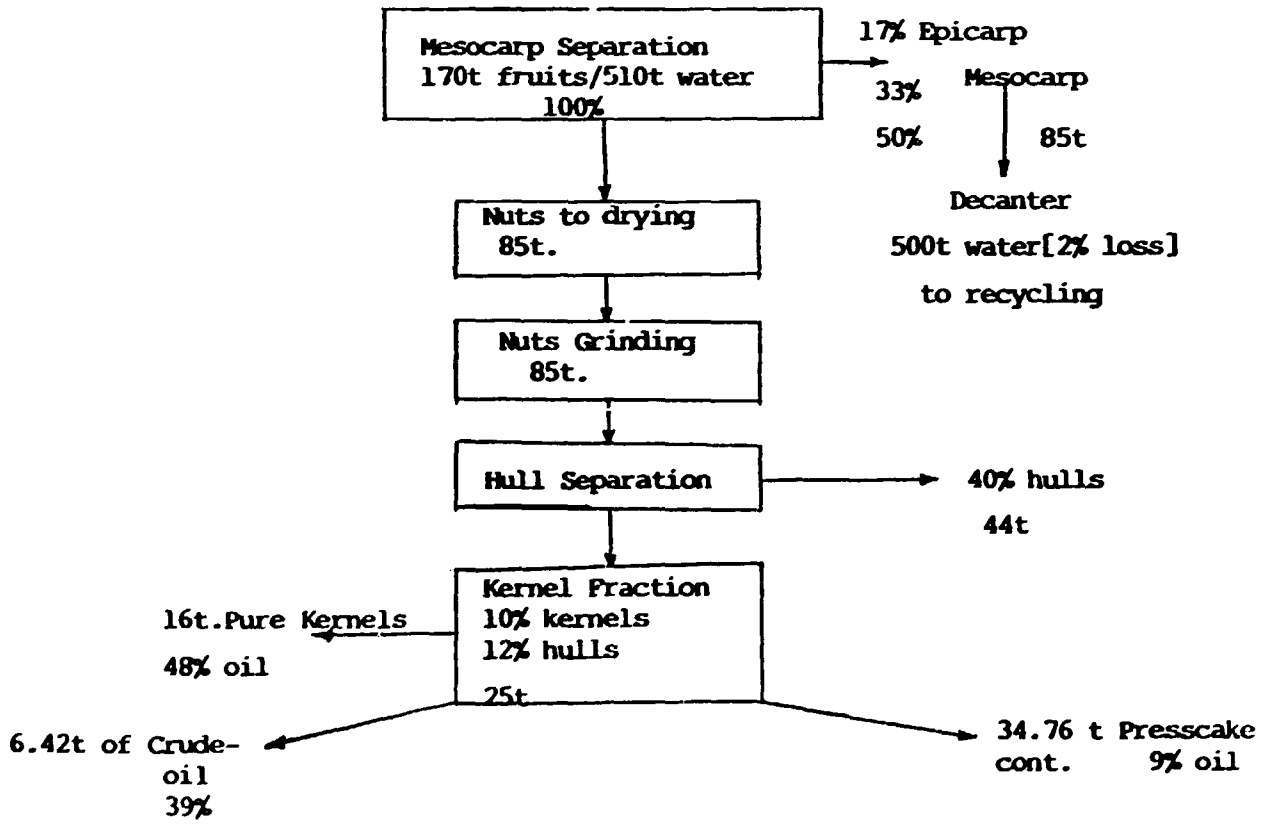
Since the plant is designed for a pressing capacity of 3x8 t/day of kernel meat we will need a daily throughput of 170 t of Lalobe fruits. The average daily losses are estimated as 10 ton. The plant will be operated 210 days/year and has following energy demand:

	Kg/t Lalobe	Throughput t/y	Demand/Y in Kg
Steam	250	33,600	8,400.000
	KWh/t Lalobe	throughput t/y	demand/Y in KWh
Electricity	45	33,600	1,512,000
	m^3 /t Lalobe	Throughput t/y	demand/Y in m^3
Water	1,5	33,600	50,.400

Raw Material - Yields in % & T/Year

	Whole Fruit	Waste	Good Frut	Kernel	Oils	Cake Kernel	Husk Cake	Pulp
100%	35700	2100	33600	3360	1310.4	2049	3295	11781

PRODUCT BALANCE OF LALOBE PLANT



LIST OF MACHINES & EQUIPMENT

		Qty.
1	Weigh Machine	2
2	Mesocarp Separation 10 tanks a 40m³	10
3	2 Decanter Separators	2
4	Pulp/Water Mixture Tanks	2
5	Recycled Water Tanks	1
6	Fresh WAter Tanks	1
7	Nut Dryer	1
8	Magnet Separator	1
9	Nut Cracking,Dehulling Hull Separation	1
10	Expeller Presses 3x8t/day	3
11	Crude Oil Vibration Screen and Filtration	1
12	Steam Boiler lt/h/6 bar	1
13	Electric Generator 450 KWh (2sets)	2
14	Tanks and Storage Crude Oil	3
15	Electric Installations Switchboards	
16	Conveying Equipment	lset
17	Pipes and Insulation	
18	Laboratory Equipment	

PROPOSED BUILDINGS OF LALOBE OIL FACTORY AT ABU GUBEIHA

The factory is to be constructed at a site of total area 12000 square meters including flat storage area. The layout of buildings follows the sequance of production steps for as much as is required. The specific areas alloted to the different activities were based on industries. Activities that could be sheltered under one truss were grouped together for better management and reduction of construction costs.

Main sheds are to be constructed using steel trusses on reinforced concrete bases, red bricks in cement mortor walls and corrugated zinc roofing . Floors vary from levelled ground to red bricks to plain concrets slabs . Three types of truss of different unit cost are shown in the cost estimate bill to allow for and variation mentioned and area variation and variation in walls height & finishing.

The administration building is a wall -bearing structure of ground floor only with zinc roofing & false ceiling, moderate standard finishing and sanitation facilities.

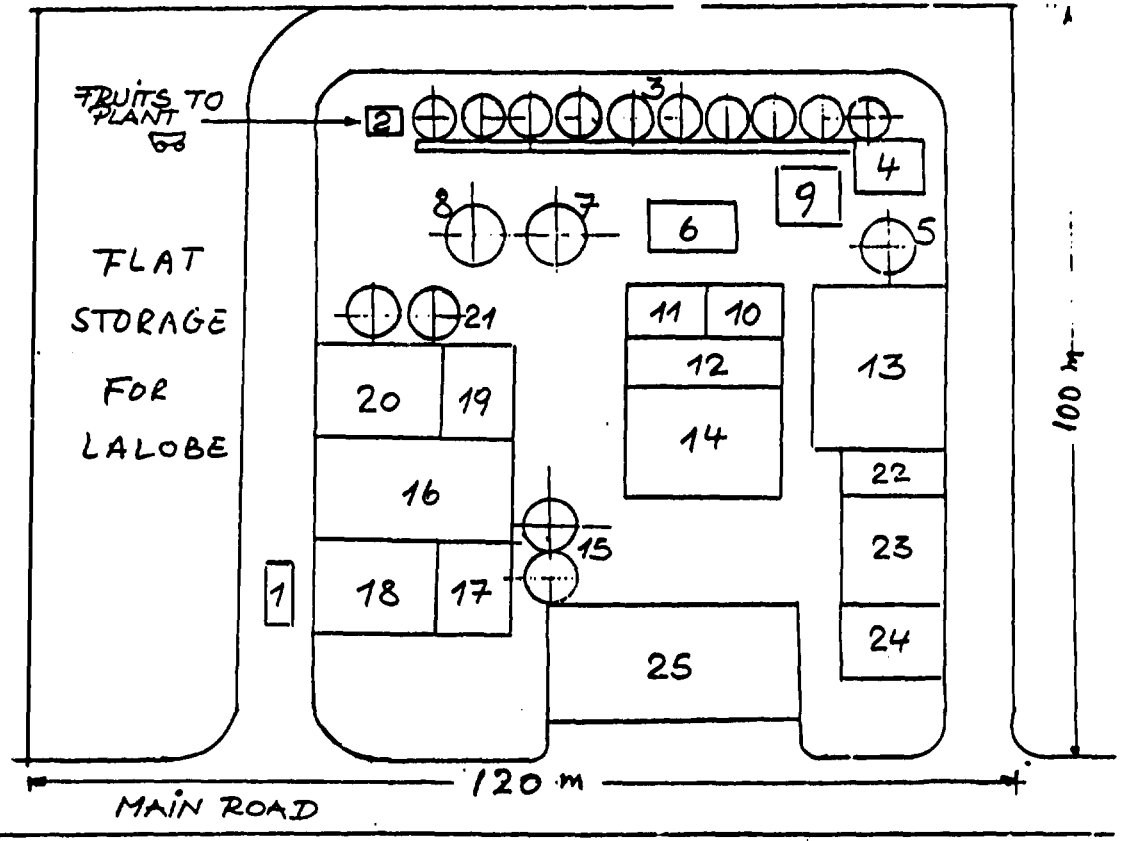
Reinforced concrete bases are provided for all tanks. The cost of the tanks themselves is not included in the civil buildings bill.

Pits of suitable size are provided for pulb collection and nuts collection.Pits have plain concrete in floor and brick in cement mortor for walls.

A raised flat storage area of 2000 sq. meters is provided with brick wall in mud mortor at edges and necessary filling material.

For water supply a borehole is needed plus an elevated steel tank and piping connections. A system of septic tanks and disposal pits is proposed for sewage treatment.

Fencing consists of parbed wires and steel angles on a short wall with the necessary gates.



1.) WEIGHBRIDGE
2.) FEEDER HOPPER
3.) MESOCARP SEPARATING
4.) PULP COLLECTOR PIT
5.) PULP TANK
6.) DECANTER SEPARATOR
7.) RECYCLING WATER TANK
8.) FRESHWATER TANK
9.) COLLECTING PIT FOR NUTS
10.) NUT DRYER
11.) NUT CRACKER
12.) HULL SEPARATOR
13.) HULL STORAGE
14.) HIGH PRESSURE PRESSING CRUDEOIL FILTRATION
15.) CRUDEOIL TANKS
16.) PRESSCAKE STORAGE
17.) BOTTLING PLANT
18.) STORAGE FOR BOTTLED OIL
19.) CAKE GRINDING / BAGGING
20.) BAG STORAGE
21.) PULP STORAGE TANKS
22.) BOILER HOUSE
23.) ELECTRIC GENERATOR
24.) FUEL STORAGE
25.) ADMINISTRATION, LABORATORY, WORKSHOP, SOCIAL ROOMS

PROPOSED LALOBE FACTORY AT ABU GUGEIHA

DESCRIPTION AND COST ESTIMATE FOR REQUIRED CIVIL WORKS

	No.	Activity Or Process	Area For M^2	Type of Building			Estimated Cost		Remarks
				Floor	Walls	Roof	Per M_2	Total	
	1	Weighing Area	50	R.C.Base	-	-	250	12,500	
*	2&3	Mesocarp Seperation Tanks 10x40m^3 Bases	200	R.C. Base	-	-	200	40,000	For Feeds Hopper 10 Tanks Each 40M^3
	4	Pulp Collector Pit	72	P.C.	1½ Brick	None	250	18,000	Pit Dipth 1m.
	5	Pulp Tank Base	20	R.C.Base			250	5.000	
	6	Decanter Seperator	25	R.C.Base			250	6,250	
	7	Recycling Tank 60m^3	16	R.C.Base			250	4,000	
	8	Fresh Water Tank 50m^3	15	R.C.Base			200	3,000	
	9.	Collection Pit for Nuts	124	P.C.	Red Brick	None	250	31,000	124 tons
10,11,& 12		Preperation Shed	600	P.C.	1m Brick	Truss	800	480,000	9m^2 R.C.
	13	Hull Storage	200	Levelled Ground	2m Bricks	Truss	800	160,000	

PROPOSED LALOBE FACTORY AT ABU GUGEIHA

DESCRIPTION AND COST ESTIMATE FOR REQUIRED CIVIL WORKS

No.	Activity Or Process	Area For M^2	Type of Building			Estimated Cost		Remarks
			Floor	Walls	Roof	Per M_2	Total	
14	Cake Section	300	Brick	-	Truss	800	240,000	Type 1
14,15,16,17,18	Production Shed	300	200 p.c.+100R.C.	Brick	Truss	900	270,000	Window frames Gates Type 1
19	Pulp Storage Tank	15	R.C. Base			200	3,000	
20	Boiler House	20	R.C.Fondation	Wire Mesh	Zinc	60	12,000	Type 11
21	Generator Room	20	R.C. Foundation	Wire Mesh	Zinc	600	12,000	Type 111
22	Fuel Storage	24	P.C.	Bricks	Zinc	750	18,000	Type 111
23	Administration	140	Tiles	Bricks	Zinc Ceiling	900	126,000	
24	Water supply System	-	Brick/Tiles	-	Zinc		500,000	
25	Drainage System	-		-			75,000	
26	Flat Storage Area	2000				25	50,000	
27	General Site Treatment						20,000	
28	Fencing	440				120	53,000	
							2138,750	

VII] FINANCIAL EVALUATION

The financial appraisal is a tool to help the investor to take a decision on the project proposal under study. To facilitate this decision, both investment and production costs have to be arranged clearly, keeping in mind that the profitability of the project will depend on the size and structure of investment and production costs and their timing. In the early chapters of this study the proposed capacity of this project has been discussed . To calculate the required investment and the cost of production the following assumptions have been made.

1. Production Capacity & Programme:

The production capacity is assumed to be 16 m.t. of Kernel /day.Due to operational problems envisaged during the early stages of the project the production programme is assumed to be as follows:-

Year	Capacity Utilization
1	60% of designed capacity
2	75% of designed capacity
3	85% of designed capacity
4	90% of designed capacity
5 Onward	100% of designed capacity

2. Timing of Expenditures & Costs:

The project is assumed to be implimented in two years. The timing of capital expenditures and costs is expected to be as shown below:

2.1. **Land & Site Preperation:**

All costs are assumed to be incurred in the first year of implementation.

2.2. **Buildings and Civil Works:**

52.8% of the cost is assumed to be incurred in the first year and the balance in the second year.

2.3. **Machinery & Equipment:**

All costs are assumed to be incurred in the first year. Machinery supplier credit terms have not yet been negotiated.

2.4. **Vehicles & Transport Facilities:**

1st. year: One vehicle and 4 tractors and trailers.

2nd. year: 4 tractors and trailers.

Then one tractor in each of the following 4 years.

2.5. **Furniture:**

All costs are assumed to be incurred in the second year.

2.6. **Preproduction Capital Expenditure:**

This is assumed to be 5% of fixed assets to be incurred in the first year.

2.7. **Working Capital:**

This is assumed to be incurred in the second year of construction.

3. <u>Sources of Finance:</u>

The cost of the project is assumed to be 100% financed by equity and grants.

4. **Depreciation:**

The depreciation rates are based on the schedules provided by the Sudanese Tax Department which are as follows:

4.1.	Buildings and Civil works	2.5% p.a.
4.2.	Machinery and Equipment	5% p.a.
4.3.	Vehicles	20% p.a.
4.4.	Furniture	20% p.a.

4.5. Preproduction Capital Expenditure is assumed to be amortized over 5 years.

5. **Exchange Rate:**

The official rate is used in calculating the cost of imported capital goods.

US$ 1.00 = Ls. 4.50

6. **Discount Rate:**

The discount rate is assumed to be 15% p.a., based on the rate charged by the Industrial Bank of Sudan.

7. **Expected Life:**

The project expected life time is 15 years.

8. **Credit Policy:**

The credit policy is assumed to be as follows:

Accounts receivable	30 days
Accounts payable	30 days.

9. **Stocks & Cash in Hand:**

Inventory and materials	60 days
Energy e.g. fuel & lubricants	60 days
Spares	90 days

Finished products	15 days
Cash in hand	30 days

10. Corporate Tax:

According to the Investment Act 1980, all industrial projects are exempted from business profit tax in the first 5 years of operation. From the 6th. year onwards the following tax charges are applied:

The First	5,000	25%
Next	20,000	35%
Next	75,000	45%
Next	900,000	50%
Over	1,000,000	60%

For the purpose of this study the business profit tax is assumed to be 50% starting the 6th. year.

11. Finished Products Selling Price:

The selling price of edible oil is based on the prevailing market price of groundnut oil while the cake selling price is taken at 50% of groundnut cake market price. The cake being new to the market and it contains a high portion of husk .

Edible Oil = Ls. 7960 per ton,

Cake = Ls. 1000 per ton.

12] MACHINERY AND EQUIPMENT COSTS

A] Imported Machinery:

Description	Qty	FOB Cost US$	Freight 8% US$	C&F US$
1. Decanter Separator	2	166,000	13,280	179,280
2. Nut Dryer	1	22,000	1,760	23,760
3. Magnet Seperator	1	2,000	160	2,160
4. Nut Cracking,Dehulling	-	-	-	-
and Hull Seperator	1	130,000	10,400	140,400
5. Expellers	3	-	-	32,100
6. Filter Press	1	-	-	4,150
7. Electric Generators	2	140,000	11,200	151,200
8. Pipes and Insulation		25,000	2,000	27,000
9. Laboratory Equipment		10,000	800	10,800
10. Electric Installations		20,000	1,600	21,600
Total C&F				**592,450**

			Ls.
Total C&F in Ls.	**592,450x4.5**	=	**2,666,025**
Marine Insurance @	1%		26,660
Total CIF			**2,692,685**
Quay dues,handling, clearance etc. 5%			134,634
Defence 10%			269,269
Additional Tax			403,903
.Cost of Machinery at Port Sudan			**3,500,491**
Inland Transport 7%			245,034
Cost of Machinery at Site [Abu Gubeiha]			**3,745,525**

B] Local M/C

Sr.	Description	Qty	Price[Khartoum] Ls.
1.	Mesocarp Removal Tanks	10	800,000
2.	Tanks for Oil	3	13,590
3.	Pulp Water Mixture Tanks	2	450,000
4.	Recycled Water Tank	1	225,000
5.	Fresh Water Tank	1	300,000
6.	Conveying Equipment 110m.	1 Set	893,750
7.	Conveying Equipment 10m.	1 Set	81.250
8.	Bucket Elevator	1 Set	50,000
9.	Weigh Machines	2	40,000
	Total Local M/c.Cost		**2,853,590**
	Transportation cost 4%		**114,144**
			2,967,734

C] **Total Cost of Machinery & Equipment at Site:**

	Ls.
Imported	3,745,525
Local	2,967,734
Total	**6,713,259**
Erection @ 12% of Total Cost	805,591
Total Cost of Erected M/C	**7,518,850**

13] Labour Requirements:

A. Direct Labour:

Department	Skilled Labour	Unskilled Labour	No.of Shifts Per Day
- Fruit Storage	1	3	1
- Mesocarp Dept.	1	-	2
- Nut Drying	1	-	2
- Nut Cracking	1	-	2
- Husk Separation	2	4	2
- Expellers Room	1	1	3
- Filtering	1	-	3
- Cake room	-	4	1
- Boiler House	1	1	3

Assumptions:

- Skilled worker average monthly pay Ls. 500
- Unskilled worker average monthly pay Ls. 300
- Number of working days 210 days per year.
- Variablity of direct labour cost 80%
- **Total Annual Costs = Ls. 112000**

B. Indirect Labour:

	No.
Plant Manager	1
Foreman	1
Clerks/Sales men	4
Maintenance Crew	4
Car Drivers	2
Messengers & Guards	5

Assumptions:

- Plant manager monthly pay is Ls. 2000
- Other wages range Ls. 300-500
- Number of working days 300 days per year

Total Annual Costs Ls. 86400

BALANITES AEGYPTICA STUDY
MAY 1989

2 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 4.5000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: 000,LS

Total initial investment during construction phase

fixed assets:	11315.00	27.521 % foreign
current assets:	879.00	0.000 % foreign
total assets:	12194.00	25.537 % foreign

Source of funds during construction phase

equity & grants:	12468.00	0.000 % foreign
foreign loans :	0.00	
local loans :	0.00	
total funds :	12468.00	0.000 % foreign

Cashflow from operations

Year:	1	4	6
operating costs:	6819.69	9996.33	11054.67
depreciation :	633.57	651.57	481.17
interest :	0.00	0.00	0.00
production costs	7453.27	10647.91	11535.84
thereof foreign	2.09 %	1.46 %	1.35 %
total sales :	9464.15	14198.02	15774.78
gross income :	2010.89	3550.12	4238.94
net income :	2010.89	3550.12	2119.47
cash balance :	1987.81	4092.68	2300.65
net cashflow :	1987.81	4092.68	2300.65

Net Present Value at: 15.00 % = 3719.65
Internal Rate of Return: 20.07 %
Return on equity1: 16.75 %
Return on equity2: 19.62 %

Index of Schedules produced by COMFAR

Total Initial Investment in 000.LS

Year	1989	1990
Fixed investment costs		
Land, site preparation, development	140.000	0.000
Buildings and civil works	1117.000	1000.000
Auxiliary and service facilities	480.000	480.000
Incorporated fixed assets	1056.000	50.000
Plant machinery and equipment	6438.000	0.000
Total fixed investment costs	9233.000	1530.000
Pre-production capital expenditures.	552.000	0.000
Net working capital	0.000	879.000
Total initial investment costs	9785.000	2409.000
Of it foreign, in %	31.824	0.000

CONFAR 2.1 - IND. RESEARCH AND CONSULTANCY CENTRE, [illegible]

Total Current Investment in 000,LS

Year	1991	1992	1993	1994	1995
Fixed investment costs					
Land, site preparation, development	0.000	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000	0.000
Auxiliary and service facilities	120.000	120.000	120.000	120.000	0.000
Incorporated fixed assets	0.000	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	0.000	0.000	0.000	0.000
Total fixed investment costs	120.000	120.000	120.000	120.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000	0.000
Working capital	536.647	327.054	217.372	109.018	217.704
Total current investment costs	656.647	447.054	337.372	229.018	217.704
Of it foreign, %	0.000	0.000	0.000	0.000	0.000

BALANITES AEGYPTICA STUDY ---

CONFAR 2.1 - IND. RESEARCH AND CONSULTANCY CENTRE,

Total Current Investment in 000,LS

Year	1996
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	0.000
Auxiliary and service facilities	0.000
Incorporated fixed assets	300.000
Plant, machinery and equipment	0.000
Total fixed investment costs	300.000
Preproduction capitals expenditures.	0.000
Working capital	0.000
Total current investment costs	300.000
Of it foreign, %	0.000

Total Production Costs in 000,LS

Year	1991	1992	1993	1994	1995
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	5941.521	7428.791	8417.282	8913.039	9903.040
Other raw materials	0.000	0.000	0.000	0.000	0.000
Utilities	0.000	0.000	0.000	0.000	0.000
Energy	188.950	236.298	267.740	283.510	315.000
Labour, direct	76.157	89.614	98.557	103.043	112.000
Repair, maintenance	146.753	183.487	207.903	220.147	244.600
Spares	156.360	156.360	156.360	156.360	156.360
Factory overheads	151.270	151.270	151.270	151.270	151.270
Factory costs	6661.051	8245.819	9299.112	9827.369	10882.270
Administrative overheads	158.639	163.805	167.239	168.961	172.400
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	633.575	639.575	645.575	651.575	651.575
Financial costs	0.000	0.000	0.000	0.000	0.000
Total production costs	7453.266	9049.200	10111.930	10647.910	11706.250
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	2.089	1.721	1.540	1.462	1.330
Of it variable,%	85.220	87.760	88.987	89.485	90.436
Total labour	162.557	176.014	184.957	189.443	198.400

Total Production Costs in 000,LS

Year	1996	1997-2001	2002- 5
% of nom. capacity (single product).	0.000	0.000	0.000
Raw material 1	9903.040	9903.040	9903.040
Other raw materials	0.000	0.000	0.000
Utilities	0.000	0.000	0.000
Energy	315.000	315.000	315.000
Labour, direct	112.000	112.000	112.000
Repair, maintenance	244.600	244.600	244.600
Spares	156.360	156.360	156.360
Factory overheads	151.270	151.270	151.270
Factory costs	10882.270	10882.270	10882.270
Administrative overheads	172.400	172.400	172.400
Indir. costs, sales and distribution	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000
Depreciation	481.175	541.175	481.175
Financial costs	0.000	0.000	0.000
Total production costs	11535.840	11595.840	11535.840
Costs per unit (single product)	0.000	0.000	0.000
Of it foreign, %	1.350	1.343	1.350
Of it variable,%	91.772	91.297	91.772
Total labour	198.400	198.400	198.400

CONFAR 2.1 - IND. RESEARCH AND CONSULTANCY CENTRE, KHARTO

Net Working Capital in 000,LS

Year			1991	1992	1993	1994	1995
Coverage	adc	coto					
Current assets &							
Accounts receivable	30	12.0	568.707	700.802	788.863	833.028	921.222
Inventory and materials	60	6.0	990.254	1238.132	1402.080	1485.506	1650.507
Energy	60	6.0	31.498	39.383	44.623	47.252	52.500
Spares	90	4.0	39.090	39.090	39.090	39.090	39.090
Work in progress	0	---	0.000	0.000	0.000	0.000	0.000
Finished products	15	24.0	284.154	350.401	394.431	416.514	460.611
Cash in hand	30	12.0	57.432	62.045	65.111	66.648	69.719
Total current assets			1970.735	2429.853	2734.998	2888.038	3193.650
Current liabilities and							
Accounts payable	30	12.0	555.088	687.152	774.926	818.947	906.856
Net working capital			1415.647	1742.701	1960.072	2069.090	2286.794
Increase in working capital			536.647	327.054	217.371	109.018	217.704
Net working capital, local			1415.647	1742.701	1960.073	2069.090	2286.794
Net working capital, foreign			0.000	0.000	0.000	0.000	0.000

Note: adc = minimum days of coverage ; coto = coefficient of turnover .

BALANITES AEGYPTICA STUDY ---

CONFAR 2.1 - IND. RESEARCH AND CONSULTANCY CENTRE, KHARTO

Net Working Capital in 000,LS

Year			1976-2005
Coverage	adc	coto	
Current assets &			
Accounts receivable	30	12.0	921.222
Inventory and materials	60	6.0	1650.507
Energy	60	6.0	52.500
Spares	90	4.0	39.090
Work in progress	0	---	0.000
Finished products	15	24.0	460.611
Cash in hand	30	12.0	69.719
Total current assets			3193.650
Current liabilities and			
Accounts payable	30	12.0	906.856
Net working capital			2286.794
Increase in working capital			0.000
Net working capital, local			2286.794
Net working capital, foreign			0.000

Note: adc = minimum days of coverage ; coto = coefficient of turnover .

Source of Finance, construction in 000,LS

Year	1989	1990
Equity, ordinary ..	10059.000	2409.000
Equity, preference.	0.000	0.000
Subsidies, grants .	0.000	0.000
Loan A, foreign .	0.000	0.000
Loan B, foreign..	0.000	0.000
Loan C, foreign .	0.000	0.000
Loan A, local....	0.000	0.000
Loan B, local....	0.000	0.000
Loan C, local....	0.000	0.000
Total loan	0.000	0.000
Current liabilities	0.000	0.000
Bank overdraft	0.000	0.000
Total funds	10059.000	2409.000

Source of Finance, production in 000.L5

Year	1991	1992	1993	1994	1995
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	0.000	0.000	0.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000
Loan A, local....	0.000	0.000	0.000	0.000	0.000
Loan B, local....	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000
Total loan	0.000	0.000	0.000	0.000	0.000
Current liabilities	555.088	132.064	87.774	44.021	87.908
Bank overdraft	0.000	0.000	0.000	0.000	0.000
Total funds	555.088	132.064	87.774	44.021	87.908

Cashflow Tables, construction in 000,LS

Year	1989	1990
Total cash inflow	10059.000	2409.000
Financial resources	10059.000	2409.000
Sales, net of tax	0.000	0.000
Total cash outflow	9785.000	2409.000
Total assets	9785.000	2409.000
Operating costs	0.000	0.000
Cost of finance	0.000	0.000
Repayment	0.000	0.000
Corporate tax	0.000	0.000
Dividends paid	0.000	0.000
Surplus (deficit)	274.000	0.000
Cumulated cash balance	274.000	274.000
Inflow, local	10059.000	2409.000
Outflow, local	6671.000	2409.000
Surplus (deficit)	3388.000	0.000
Inflow, foreign	0.000	0.000
Outflow, foreign	3114.000	0.000
Surplus (deficit)	-3114.000	0.000
Net cashflow	-9785.000	-2409.000
Cumulated net cashflow	-9785.000	-12194.000

Cashflow tables, production in 000,LS

Year	1991	1992	1993	1994	1995	1996
Total cash inflow . .	10019.240	11932.740	13495.620	14242.050	15862.690	15774.780
Financial resources .	555.688	132.064	87.774	44.021	87.908	0.000
Sales, net of tax . .	9464.152	11800.680	13407.850	14198.020	15774.780	15774.780
Total cash outflow . .	8031.425	8988.743	9891.496	10149.370	11360.280	13474.140
Total assets	1211.735	579.118	425.146	153.039	305.612	300.000
Operating costs . . .	6819.690	8409.625	9466.351	9996.331	11054.670	11054.670
Cost of finance . . .	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	2119.470
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	1987.815	2944.001	3604.127	4092.676	4502.412	2300.640
Cumulated cash balance	2261.815	5205.816	8809.943	12902.620	17405.030	19705.680
Inflow, local	10019.240	11932.740	13495.620	14242.050	15862.690	15774.780
Outflow, local	8031.425	8988.743	9891.496	10149.370	11360.280	13474.140
Surplus (deficit) .	1987.815	2944.001	3604.127	4092.676	4502.412	2300.640
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	0.000	0.000	0.000	0.000	0.000	0.000
Net cashflow	1987.815	2944.000	3604.127	4092.676	4502.412	2300.640
Cumulated net cashflow	-10206.180	-7262.184	-3658.057	434.619	4937.031	7237.676

Cashflow tables, production in 000,LS

Year	1997	1998	1999	2000	2001	2002
Total cash inflow . .	15774.780	15774.780	15774.780	15774.780	15774.780	15774.780
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax . .	15774.780	15774.780	15774.780	15774.780	15774.780	15774.780
Total cash outflow . .	13144.140	13144.140	13144.140	13144.140	13144.140	13174.140
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs . . .	11054.670	11054.670	11054.670	11054.670	11054.670	11054.670
Cost of finance . . .	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax . . .	2089.470	2089.470	2089.470	2089.470	2089.470	2119.470
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	2630.646	2630.646	2630.646	2630.646	2630.646	2600.646
Cumulated cash balance	22336.320	24966.960	27597.610	30228.250	32858.900	35459.540
Inflow, local	15774.780	15774.780	15774.780	15774.780	15774.780	15774.780
Outflow, local	13144.140	13144.140	13144.140	13144.140	13144.140	13174.140
Surplus (deficit) .	2630.646	2630.646	2630.646	2630.646	2630.646	2600.646
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	0.000	0.000	0.000	0.000	0.000	0.000
Net cashflow	2630.646	2630.646	2630.646	2630.646	2630.646	2600.646
Cumulated net cashflow	9868.322	12498.970	15129.610	17760.260	20390.900	22991.550

Cashflow tables, production in 000,LS

Year	2003	2004	2005
Total cash inflow . .	15774.780	15774.780	15774.780
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	15774.780	15774.780	15774.780
Total cash outflow . .	13174.140	13174.140	13174.140
Total assets	0.000	0.000	0.000
Operating costs . . .	11054.670	11054.670	11054.670
Cost of finance . . .	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax . . .	2119.470	2119.470	2119.470
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	2600.646	2600.646	2600.646
Cumulated cash balance	38060.190	40660.830	43261.480
Inflow, local	15774.780	15774.780	15774.780
Outflow, local	13174.140	13174.140	13174.140
Surplus (deficit) .	2600.646	2600.646	2600.646
Inflow, foreign . . .	0.000	0.000	0.000
Outflow, foreign . . .	0.000	0.000	0.000
Surplus (deficit) .	0.000	0.000	0.000
Net cashflow	2600.646	2600.646	2600.646
Cumulated net cashflow	25592.190	28192.840	30793.480

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	1145.23 at	15.00 %
Internal Rate of Return (IRRE1) ..	16.75 %	

b) Net Worth versus Net cash return:

Net present value	3445.65 at	15.00 %
Internal Rate of Return (IRRE2) ..	19.62 %	

c) Internal Rate of Return on total investment:

Net present value	3719.65 at	15.00 %
Internal Rate of Return (IRR) ..	20.07 %	

Net Worth = Equity paid plus reserves

Net Income Statement in 000.LS

Year	1991	1992	1993	1994	1995
Total sales, incl. sales tax	9464.152	11800.680	13407.850	14198.020	15774.780
Less: variable costs, incl. sales tax.	6351.661	7941.595	8998.321	9528.300	10586.640
Variable margin	3112.492	3859.084	4409.527	4669.725	5188.145
As I of total sales	32.887	32.702	32.888	32.890	32.889
Non-variable costs, incl. depreciation	1101.605	1107.605	1113.605	1119.605	1119.605
Operational margin	2010.887	2751.479	3295.922	3550.119	4068.539
As I of total sales	21.247	23.316	24.582	25.004	25.791
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	2010.887	2751.479	3295.922	3550.119	4068.539
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	2010.887	2751.479	3295.922	3550.119	4068.539
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	2010.887	2751.479	3295.922	3550.119	4068.539
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	2010.887	2751.479	3295.922	3550.119	4068.539
Accumulated undistributed profit	2010.887	4762.366	8058.288	11608.410	15676.950
Gross profit, I of total sales	21.247	23.316	24.582	25.004	25.791
Net profit, I of total sales	21.247	23.316	24.582	25.004	25.791
ROE, Net profit, I of equity	16.128	22.068	26.435	28.474	32.632
ROI, Net profit+interest, I of invest.	15.648	20.691	24.172	25.830	29.141

Net Income Statement in 000.LS

Year	1996	1997	1998	1999	2000
Total sales, incl. sales tax	15774.780	15774.780	15774.780	15774.780	15774.780
Less: variable costs, incl. sales tax.	10586.640	10586.640	10586.640	10586.640	10586.640
Variable margin	5188.145	5188.145	5188.145	5188.145	5188.145
As % of total sales	32.889	32.889	32.889	32.889	32.889
Non-variable costs, incl. depreciation	949.205	1009.205	1009.205	1009.205	1009.205
Operational margin	4238.939	4178.939	4178.939	4178.939	4178.939
As % of total sales	26.872	26.491	26.491	26.491	26.491
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	4238.939	4178.939	4178.939	4178.939	4178.939
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	4238.939	4178.939	4178.939	4178.939	4178.939
Tax	2119.470	2089.470	2089.470	2089.470	2089.470
Net profit	2119.470	2089.470	2089.470	2089.470	2089.470
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	2119.470	2089.470	2089.470	2089.470	2089.470
Accumulated undistributed profit	17796.420	19885.890	21975.360	24064.820	26154.290
Gross profit, % of total sales	26.872	26.491	26.491	26.491	26.491
Net profit, % of total sales	13.436	13.246	13.246	13.246	13.246
ROE, Net profit, % of equity	16.999	16.759	16.759	16.759	16.759
ROI, Net profit+interest, % of invest.	14.861	14.651	14.651	14.651	14.651

Net Income Statement in 000,LS

Year	2001	2002	2003	2004	2005
Total sales, incl. sales tax	15774.780	15774.780	15774.780	15774.780	15774.780
Less: variable costs, incl. sales tax.	10586.640	10586.640	10586.640	10586.640	10586.640
Variable margin	5188.145	5188.145	5188.145	5188.145	5188.145
As % of total sales	32.889	32.889	32.889	32.889	32.889
Non-variable costs, incl. depreciation	1009.205	949.205	949.205	949.205	949.205
Operational margin	4178.939	4238.939	4238.939	4238.939	4238.939
As % of total sales	26.491	26.872	26.872	26.872	26.872
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	4178.939	4238.939	4238.939	4238.939	4238.939
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	4178.939	4238.939	4238.939	4238.939	4238.939
Tax	2089.470	2119.470	2119.470	2119.470	2119.470
Net profit	2089.470	2119.470	2119.470	2119.470	2119.470
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	2089.470	2119.470	2119.470	2119.470	2119.470
Accumulated undistributed profit	28243.760	30363.230	32482.700	34602.170	36721.640
Gross profit, % of total sales	26.491	26.872	26.872	26.872	26.872
Net profit, % of total sales	13.246	13.436	13.436	13.436	13.436
ROE, Net profit, % of equity	16.759	16.999	16.999	16.999	16.999
ROI, Net profit+interest, % of invest.	14.651	14.861	14.861	14.861	14.861

Projected Balance Sheets. construction in 000,LS

Year	1989	1990
Total assets	10059.000	12468.000
Fixed assets, net of depreciation	0.000	9785.000
Construction in progress	9785.000	1530.000
Current assets	0.000	879.000
Cash, bank	0.000	0.000
Cash surplus, finance available	274.000	274.000
Loss carried forward	0.000	0.000
Loss	0.000	0.000
Total liabilities	10059.000	12468.000
Equity capital	10059.000	12468.000
Reserves, retained profit	0.000	0.000
Profit	0.000	0.000
Long and medium term debt	0.000	0.000
Current liabilities	0.000	0.000
Bank overdraft, finance required.	0.000	0.000
Total debt	0.000	0.000
Equity, % of liabilities	100.000	100.000

CONFAR 2.1 - IND. RESEARCH AND CONSULTANCY CENTRE, KHARTOUM

Projected Balance Sheets, Production in 000,LS

Year	1991	1992	1993	1994	1995
Total assets	15033.970	17917.520	21301.210	24895.360	29051.880
Fixed assets, net of depreciation	10681.420	10161.850	9636.274	9104.699	8453.124
Construction in progress	120.000	120.000	120.000	0.000	0.000
Current assets	1913.303	2367.808	2669.868	2821.389	3123.936
Cash, bank	57.432	62.045	65.111	66.648	69.719
Cash surplus, finance available	2261.814	5205.817	8809.942	12902.620	17405.030
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	15033.970	17917.520	21301.210	24895.360	29051.860
Equity capital	12468.600	12468.000	12468.000	12468.000	12468.000
Reserves, retained profit	0.000	2010.887	4762.366	8050.288	11600.410
Profit	2010.887	2751.479	3295.922	3550.119	4068.539
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	555.088	687.152	774.926	818.947	906.856
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	555.088	687.152	774.926	818.947	906.856
Equity, % of liabilities	82.932	69.586	58.532	50.082	42.916

BALANITES AEGYPTICA STUDY --- h

CONFAR 2.1 - IND. RESEARCH AND CONSULTANCY CENTRE, KHARTOUM

Projected Balance Sheets, Production in 000,LS

Year	1996	1997	1998	1999	2000
Total assets	31171.270	33260.740	35350.210	37439.680	39529.150
Fixed assets, net of depreciation	7971.949	7730.774	7189.600	6648.425	6107.250
Construction in progress	300.000	0.000	0.000	0.000	0.000
Current assets	3123.930	3123.930	3123.930	3123.930	3123.930
Cash, bank	69.719	69.719	69.719	69.719	69.719
Cash surplus, finance available	19705.670	22336.320	24966.960	27597.610	30228.250
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	31171.270	33260.740	35350.210	37439.680	39529.150
Equity capital	12468.000	12468.000	12468.000	12468.000	12468.000
Reserves, retained profit	15676.950	17796.420	19885.890	21975.360	24064.820
Profit	2119.470	2089.470	2089.470	2089.470	2089.470
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	906.856	906.856	906.856	906.856	906.856
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	906.856	906.856	906.856	906.856	906.856
Equity, % of liabilities	39.998	37.486	35.270	33.302	31.541

BALANITES AEGYPTICA STUDY ---

Projected Balance Sheets. Production in 000,LS

Year	2001	2002	2003	2004	2005
Total assets	41618.620	43738.090	45857.550	47977.020	50096.490
Fixed assets, net of depreciation	5566.075	5084.900	4603.726	4122.551	3641.376
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	3123.930	3123.930	3123.930	3123.930	3123.930
Cash, bank	69.719	69.719	69.719	69.719	69.719
Cash surplus, finance available	32858.890	35459.540	38060.180	40660.820	43261.470
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	41618.620	43738.090	45857.550	47977.020	50096.490
Equity capital	12468.000	12468.000	12468.000	12468.000	12468.000
Reserves, retained profit	26154.290	28243.760	30363.230	32482.700	34602.170
Profit	2089.470	2119.470	2119.470	2119.470	2119.470
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	906.856	906.856	906.856	906.856	906.856
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	906.856	906.856	906.856	906.856	906.856
Equity, % of liabilities	29.958	28.506	27.189	25.987	24.888

ANNEX 1

BY - PRODUCTS

1. Molasses:

In our previous report[7] we proposed that the mesocarp be utilized for production of liquid sugar. The proposal was based on that the mesocarp, which comprises about 33% of the whole fruit, contains about 56% of its weight reducing sugars.

Recently however, a new proposal on the same track of liquid sugar production was formulated. The new proposal is that the mesocarp extract be screened, centrifuged, concentrated by a double or triple effect evaporator and the concentrated juice sold to the existing two local factories which produce ethanol from cane sugar molasses.

Some contacts, in this context, were made with the officials of one of the two factories at Khartoum North, namely "Molasses Products Factories". They showed great interest in the matter and would like to buy Lalobe "Molasses" should it be supplied in properties that meet their requirements.

On the other hand fermentation experiments done at the Industrial Research & Consultancy Centre [IRCC] gave encouraging results. Samples of mesocarp extracts about 20°C B each were fermented with and without addition of nutrients. The best result was obtained from samples without nutrients" i.e. the control probe". After 80 hrs fermentation the ethanol yield was 75% [7.1% by wt. of the fermented mash in the control experiment], whereas samples containing nutrients gave lower yield [68.1 and 73.4%]. These results show that the presence of saponins in the mesocarp extract does not have a significant effect on the fermentation process.

The above mentioned factory buys cane sugar molasses from the local

sugar factories at a price of about 720 Sudanese Pounds per ton excluding transportation costs. Bearing in mind that the Lalobe fruit mesocarp contains 56% of its weight fermentable sugars[glucose and fructose] and that the mesocarp comprises about 33% of the weight of the whole fruit, we find that the quantity of Lalobe fruit processed by annually [33600 tons] contains about 6200 tons of fermentable sugar, which could fetch a price of about 7790000 Sudanese Pounds,thus adding more to the viability of the project.

Production of Lalobe "molasses" is not only on the same track of liquid sugar production but it has the advantage over the latter in being an easier process. If, however, production of liquid sugar is to be considered later, this would envolve only some additional steps to the process e.g. juice clarification, removal of saponins and other constituents.

2. Epicarp:

The epicarp of the fruit consititutes @ 17% of the weight of the whole fruit, being composed mainly of fibrous material. For maximum utilization of the fruit consitituents the only one constituent left for us is the epicarp.

When ruminants feed on the Lalobe fruit they ingest the whole fruit, eat the epicarp and mesocarp and discard the nut. Therefore the most appealing idea for utilization of the epicarp would, so far, be to incorporate it into a compound animal feed as a fibre component. This requires that the epicarp be removed prior to extraction of the mesocarp with water as described in our last report(7).

For this last variant to be applied either the concentrated mesocarp extract or the pulp could be used as a binding material for the

epicarp [fibre source] and the cake [protein source]. At the same time it serves as an energy source because it contains a considerable amount of carbohydrates. Moreover it helps the pelleting of the resultant compound feed stuff. This variant requires use of a cake breaker, a mixing machine for the three components and a pelleting machine.
As far as the saponims are concerned, they could be recovered either after fermentation of the " molasses" [see Annex 1] or in the course of liquid sugar production proposed in our last report(7).

3. Shell:

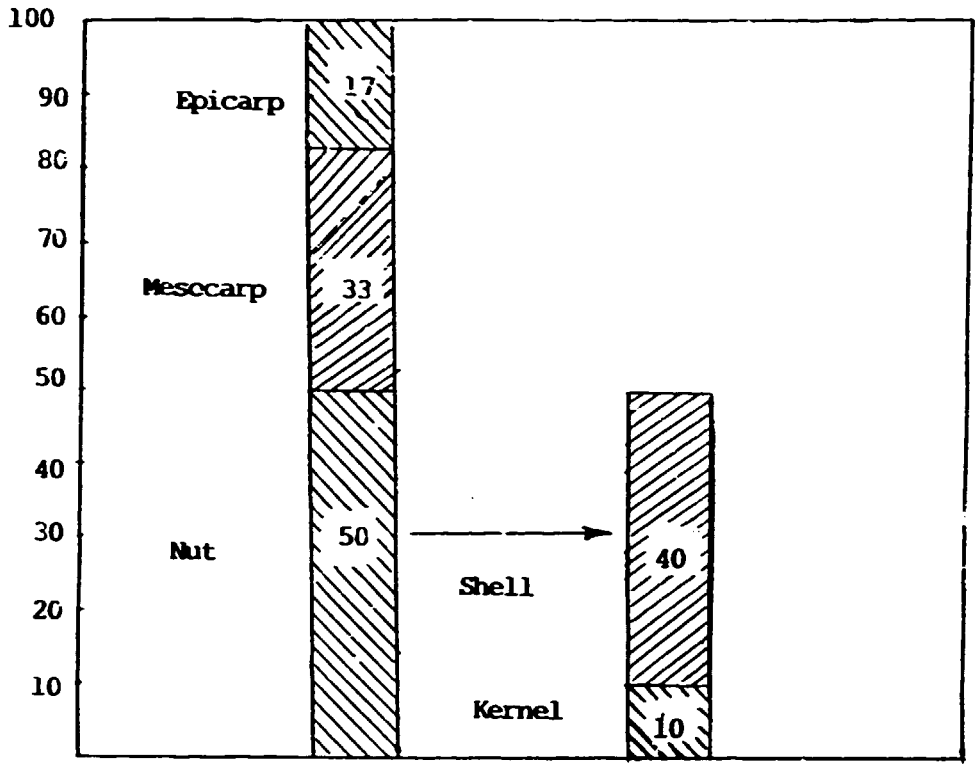
In modern mills there is a great number of machines in operations.Each machine requires an individual electric motor. Therefore it is necessary to equip each mill with a power station including a steam source and sometimes an installation to convert steam into electrical power. A complete power plant is not just a technical need but an ecomomic one as well.

To produce the required electrical power in rural areas two solutions are possible:

1. Make no changes in the steam production system in the mill[i.e.keep the steam pressure relatively low] and produce electrical power with a diesel generator.
2. Improve the boiler works to produce enough pressure to drive a turpogenerator.

The second solution is used in modern similar oil mills, viz palm oil mills. Electrical production has a number of advantages since the Lalobe Oil extraction generates waste materials [Shells] of no food

Fig [5] Composition of Lalobe Fruit



value which could be used as fuel with an N.H.V. of @ 4000 Kcal. The following is an attempt to see if the quantity of Lalobe fruit shell could produce all the required oil mill energy making with reference to the palm oil industry[8].. Fig [5] shows composition of the Lalobe fruit.

The shells from 1 ton of Lalobe fruit provide a potential heat supply of:

400 Kg of Shells of 4000 Kcal = 1,600,000 Kcal

If the mean efficiency of the boilers is taken as 70%, this brings us to:

1,600,000 x 0.70 = 1,120,000 Kcal.

The useful heat provided by the shells is capable of producing

1,120,000 ÷ 620 = 1,806 Kg. of steam. For a small size oil mill processing 7t/h of whole fruit of power requirements are:-

1. Steam at 6 bars: for 1 ton of fruit, mesocarp removal requires @ 400 Kg.
2. Steam at 6 bars: Nut drying requires 50 Kg/t; processing [cooking] requires 200 Kg. It i.e. a total of 250 Kg/t. at 6 bar.
3. Electricity: the electrical power requirement for the mill is 450 Kwh.

The stem pressure required for processing is low, which allows for the use of the exhaust pressure from a turbine or a reciprocating steam engine.

To remain within a relatively unsophisticated equipment range, the pressure upsteam of the turbines could be set at 18-20 bars. This permits the use of medium pressure boilers of 20-22 bars.

Taking steam consumption as 27 Kg/kW , we can draw up the balance of energy demands in a 7t/h oil mill, and arrive at the following.

1. Potential steam production of 1806 x7 = 12.642 tons
2. Generate 450 KWH, we need 27 x450= 12,150 tons of steam at 20 bars.
3. For mesocarp removal, nut drying, and processing we

need (400 + 250) x 7 = 4.550 tons of steam at 6 bars.

The balance is therefore positive . Wastes can supply 12.642 tons of steam at 20 bars, whereas the turbine requires 12.150 tons to produce the necessary power, and it returns 12.150 tons of steam at 6 bars whereas mesocarp removal, nut drying, and processing require only 4.550 tons.

The above calculations show that we have enough fuel to produce the electrical power required by the plant and meet processing demands.

Some manufacturers produce boilers that burn vegetable waste similar to the shells of the Lalobe fruit viz.The oil-palm fruit shells. Among such manufacturers are:

1. Babcok — England
2. Frazer & Frazer — England
3. Wickers Hoskins — Australia
4. Duray — Belgium

Boilers that burn both solid agricultural waste and oil for standby & make-up purposes [in case of difficiency of solid fuel] are also used in industry.

Tubrine manufacturers that have really penetrated the palm oil mill market are:

1. KKK — Germany
2. Worthington — France , and
3. Manubat — France

There are,nonetheless, reciprocating steam engines still in use in palm oil mills [used to drive AC generators rather than belt transmission shafts]. The advantage of these engines is that they

are more efficient than turbines, they do not require superheated steam, and they can run with less pronounced pressure differentials. They are mainly used in small palm oil mills < 10 tons/h as they are the only means of balancing fuel supply. Of the manufacturers of steam engine used in the palm oil industry we mention: Spieling in Germany.

The power plant is usually completed by diesel emergency generators. These emergency units make it possible to start up the mill and run the extraction section in case of turbogenerator troubles. the emergency units and turbogenerators can be coupled together.This however, means a large control and distribution station requiring personel well trained.

ANNEX 2

1. Quantification of Possible Harvest

.1. Description & Habitat of Hejlij Tree (Lalobe Tree)

.1.1. Description:

A tree usually 20-25 feet high, with long, wide, deep vertical fissures, in which the yellow of the new bark can be seen; scales long, thick prominant and ragged. Slash pale yellow. Young branches green, smooth with cream - coloured lenticels, becoming denser from the tip downward until the grey colour of the older bark is reached. Thorn stout, green straight up to 5 cm long, in axils of the leaves. Leaves consisting of two leaflets on a short petiole, leaflets obovate to orbiculate - rhomboid, grey green in colour, usually 2.5 - 5cm long by 1.2 - 2.5 cm broad, sometimes (var. memberanaceae van tiegh.) considerably larger. Flowers in spikes, sometimes shortened to round clusters, in the leaf axils; yellowish green, 1 - 1.2 cm in diameter, with 5 small decidious sepals, 5 petals, 10 stamens, and a disc surrounding the ovary. Fruit green ripening yellowish 2.5 - 4 cm long and 1.5 cm in diameter, shortly stalked, with a thin hard skin over a yellow-brown sticky flesh, in which is embedded a large hard pointed stone.

.1.2. Distribution and Habitat:

This species is a widely distributed tree, being absent only from the wettest parts (rainfall over1100 mm), though in dry areas it is confined to water - receiving sites such as

wadis, khors and river banks. It is very characteristic of the dark cracking clays where it occurs and on the none - water - receiving sites under rainfall of 500 mm and upwards. Here it is commonly associated with Acacia Seyal and usually found scattered sporadically among it, but also often forms pure stands. They are not generally cut while trees are cut for fire wood or cultivations purposes, the Hejlij tree is left because of its hard timber and the benifits of its fruits are not fully identified. In the flood regions of the Upper Nile Province, however, it appears to be rather more tolerant of flooding than Acacia Seyal (Talh) and thus found rather lower down contours.

On sandy soil it is more sporadic and tend to occur as scattered trees only, but it occurs throughout the sands of Kordufan and Darfur where rainfall exceeds about 250mm. It becomes more prominant near towns and villages where other vegetation has been destroyed.

It also occurs on hard surfaced sandy clays and is particularly common on the detritus slopes of the foot of rocky hills. Also it is found on the fringe of the ironstone in the so-called "goke" region. In fact there are few types of soils from which it is absent. In wadis it occurs on the Red Sea Coast, up to the Northern frontier of the Sudan. Hejlij in the area under study is characteristic to black cracking clays, Gardud Dahara soils, along side khors and rivers. Sometimes it is mixed with talh, arad, umbaddad etc.

Outside Sudan it is found in Northern and West Africa, Palestine, Saudi Arabia, Kenya, and Uganda.

1.1.3. Hejlij Utilization Rate:

Trees that do not offer a source of income are not attractive to the local citizens. For example the Gum Arabic tree has possessed an economical importance because it enable its owner to gain more than fifty pounds per tree every year.

Nowadays all people there became aware of the benifit of this tree, and for this reason it has become one of the very tightly protected species. The Hejlij fruit known locally as Lalobe up till now has very little economic value. Since the present UNIDO Project Commercial Utilization of Balanites aegyptiaca has stressed and confirmed the possible use of the Lalobe fruit as an edible oil seed plus other commercial uses local citizens and officials have shown great interest for the project and their readiness to offer every possible help to make it a success.

1.1.4. Factors Affecting the Hejlij Tree & Lalobe Fruit:

A. Pests:

A_1 Borers:- Observation made on the types of pest that infest the Lalobe fruit revealed remarkable rate of attack by certain type of borers.

Survey of borers attack was carried and revealed that the rate of attack was very slight in most of the investigated areas. Severe attack was observed in minor areas (e.g. Et-Tartur).Illustration of percentage of attacks were shown in Table (1). With few exeptions all investigated areas showed slight fruit damage caused by borers ranging from 1.1 to 8.8 % Table (1).

A_2 Hoppers: Has minor effects on leaves flower and green fruit.

B. Farming Practices: It was observed that new ferming is being set on the expense of the Balanites aegyptiaca forests.

C. Irresponsible Man-Made Fire:

This phenomenon which is seldomly repeated within the area causes real damage and harms to the preservation process and causes slight effects to the matured trees.

Table (1)

Percentage of Fruit Damage Caused by Borers

	Investiaged Areas	Percentage Of Damaged Fruits	Degree of Fruit Damage
1	Abu Kershola	7.70 %	slight
2	Um Berembeita	1.10%	"
3	Kabus	7.20%	"
4	Rashad Town	5.80%	"
5	Tegmala	5.26%	"
6	Abu Hasheema	5.80%	"
7	Nilat Abu Gureis	4.7%	"
8	Suk Abu Gureis	8.86%	"
9	Ballula Area	2.49%	"
10	Et-Tartar Area	39.89% (40%)	severe

1.2. Methodology & Field Work:

1.2.1. Surveyed Area:-

All materials of this report were based on the information gathered during the Field Survey,(8th. of December 1987-6th. of January 1988) and also upon the light of the findings of the first field study.

Ir the present study the survey covered around 10% of the Eastern zone of Southern Kordofan (E.Sk) with an area of about thirteen thousand kilometres.

The concerned area consists of the following towns and villages: (See Map).

- Abbasiya.
- Rashad
- Um Rerembeita
- Abu Kershola
- Et-Tartur
- Ballula

and - Abu Gubeiha

1.2.2. Sampling and Survey Plans:

The sampling and the survey plan was based on questionnaires filled by the appropriate informants, and also based on reports given by the IRCI teams who visited the area, due to practical limitation aerial photographs planometric maps, detailed geographical maps could not be made for the area because of budget shortage. Certain agencies have started some work on the area which would

yield better coverage for the whole area.

- To estimate the total number of Balanites aegyptiaca, (Hejlij), production trees strip sampling method was used, with continuous strips which include a series of rectangular shaped sample units.
  In addition tc enumeration the following important observations were also made:
    - Rate of Fruiting
    - Rate of attack by borers
    - Other damaging factors that affects the Hejlij tree (Balanites aegyptiaca).
- Twenty two regeneration sub-sample plots were laid out, enumerated, and their regeneration were categorized into the following :-
    - Juveniles
    - Sapling
    - Seedling

Results obtained were used for further analysis.

- To quantity the Lalobe fruit harvest during the main harvest season two methods were adopted:
    a) Manual Fruit Felling
    b) Collectors Estimate

a- Manual Fruit Felling:

This method was based on felling all the fruit in each tree manually using all techniques of felling collection, packing, weighing.

The felling was performed at twenty selected locations, where twenty representative trees of different size crown were chosen (e.g. narrow, medium and wide crowned ones).

b- Collectors Estimate Method:

In this method Lalobe fruits local collectors from different localities were interviewed in their opinions on the average Lalobe fruit yield per tree. This estimates given by the informants were recorded and kept for comparison with the results of the manual fruit felling method. It was observed that the collectors estimate was on the higher side due to their bias to wide crown trees and also due to their enthusiasm towards the proposed project.

- Results obtained during the field study, were tabulated in a practical manner and analyised statistically to calculate the following statistical parameters:
  - arithmetic mean ($\bar{x}$)
  - standard deviation (s)
  - coefficient of variation (c)
  - absolute mean deviation (d)

The arithmetic mean obtained is not expected to be a very good representative to the actual mean due to presence of extreme values. In order obtain

results closer to reality the absolute mean deviation method was calculated to represent the scatter of the results.

1.3. Collected Data

1.3.1. Estimated Average Number of Hejlij Tree Per Feddan:

Enumeration for the Hejlij adult trees was conducted in one hundered and twenty nine continuous strips in different localities.

Data tabulated in Table (2) showed average number of adult trees that range from zero to 35 trees per feddan or zero to 83 trees per hectar.

The calulated overall arithmetic mean for the two sets of values were 8.4 trees per feddan and 20.3 trees per hectar.

The standard deviation of values was determined as ± 7.5 per feddan.

Due to appearance of rather high variability, the absolute mean deviation method was adopted to minimize the rate of variability Table (3)

1.3.2.

Manual Fruit Felling are shown on Table (4), Fruit harvest figures for trees with different types of crowns are detailed.

The total fruit weight obtained from twenty different crowned trees was 2390.5 kilograms.

The weight of fruit harvest per tree ranged between 26 kilograms for a narrow crowned tree and 325 kilogram for a wide deep crowned one.

- The overall mean ($\bar{x}$)of fruit harvest (yield was calculated as 119.53 Kg. per tree, while the standard deviation was $\pm$ 91.8.
- Due to the high variability shown on the data observed the method of absolute mean deviation was conducted (Table 3) in order to improve the accuracy of the statistics.

1.3.3. Fruit Collector's Estimates:

Data tabulated in Table (4) is a summary of estimates of different crowned trees given by Lalobe fruit collectors - (questionnare).

Estimates of fruit yield per tree has ranged between 42.5 Kg. for a narrow crowned tree and 325 kilogram for a wide deep crowned trees.

The percentage, of the none fruiting trees was observed to represent 10% of the total numbers of the mature enumerated ones.

1.3.4. Enumeration of Regeneration:
(Immature Trees)

The Hejlij regeneration was enumerated and tabulated in categories of seedling, sapling and junveniles, Table (7).

The regeneration shows absence in certain areas while it is dense in other. A full explanation is found in the complete work to be published later by Bayomi.

Table (2)

Enumeration of Heilij Trees

(Average)

n	Surveyed Area	Average No.of Trees Per Feddan ($\bar{x}$)	Average No. of Trees Per Hectar ($\bar{x}_2$)
	Abbasia Area:		
1	Bideria Forest	26.00	61.91
2	Karmogia Forest	15.5	30.91
3	Auregia	1.5	3.57
4	Nigeria	0.57	1.36
	Abbasia Town:		
5	(a) From Centre - Eastward	3.38	8.05
6	(b) From Centre - Southward	2.38	5.67
7	(c) From Centre - Westward	1.12	2.67
8	Fallata Reserved Forest	9.39	22.39
	Ballula Area:		
9	One long Strip Crossing Ballulas	2.35	5.60
10	Ballula - Wakara (Road)	4.00	9.52
11	Mabruka - Aradeiba (Route)	000	000
12	Nilat Wakera	5.00	11.91
13	Um Kuk	0.50	1.19
14	Khor Eldigel	4.90	11.67
15	Um Sabur	3.90	9.29
16	Khor Elbagar	5.50	13.10
	Et. Tartur		
17	A.Gures - El-Turta Rout	1.83	4.36
18	Centre Et-Tartar towards South	3.40	8.10
19	Centre Et-Tarta toward J.Kaylan	1.00	2.38

* n = Number of Observation

n	Surveyed Area	Average No. of Trees Per Feddan ($\bar{x}$)	Average No. of Trees Per Hectar ($\bar{x}_2$)
20	From Et-Tartur to Fullat Haj Eltayib (To Ballula)	6.10	14.52
21	Fullat H. Eltayib to Ed-Dabba	0.46	1.10
22	Ed-Dabba - Reba	000	000
23	Reba - Abu Galib	000	000
24	Abu Galib Elzaraf	000	000
25	Elzaraf - Elarad	000	000
26	Abu Gubeiha - Elbiteira	3.80	9.05
27	Elbiteira - Uvo	0.50	1.19
28	Uvo - Abu Gures	000	000
	Abu Gures		
29	Abu Gures En-Vila	10.90	29.95
30	Abu Gures Um Duraba-Suk	2.56	6.10
31	Abu Gures North Direction	000	000
32	Abu Gures Id ed-Dum	4.40	10.48
33	Abu Gubeiha - Um Haseema	12.18	29.00
34	Wad Abid	9.64	22.95
35	Daleibat Um Haseema	5.80	13.81
36	Daleibat Um Haseema	4.70	11.19
	Um Hasheema		
37	- Um Fashog	4.70	11.19
38	- Rout Elsragia	12.90	30.71
39	- "	6.20	14.76
40	Strips in all direction of A.H.	13.70	32.62
41	Um Hasheem West Direction	13.40	31.91
42	Um Fashog - Elzireiga	2.90	6.90
43	El Zireiga - Elzileb	2.04	4.86
44	Abu Hasheem South Direction	27.30	65.00

n	Surveyed Area	Average No. of Trees Per Feddan ($\bar{x}$)	Average No. of Trees Per Hectar ($\bar{x}_2$)
	Kabus		
45	Southward dirction	20.35	48.45
46	" "	6.90	6.90
47	Westward direction	16.74	39.80
48	" "	9.65	22.98
49	" "	12.20	29.05
50	Northward direction	14.90	35.48
	Abu Gubeiaha		
	A.G- Malum Elkur		
51	A.G- Tayba	12.50	29.76
52	Tayba - Malum Elkur	11.30	26.91
	Strips from M.Elkur v.		
53	(a)	8.90	21.19
54	(b)	17.70	40.88
	Abu Gubeiha - Seisaban		
55	- Gabrona route	2.48	5.90
56	Gabrona east	7.87	18.74
57	Gabrona west	8.00	19.05
58	Gabrona north	2.00	4.76
59	Other strip in Gabrona	8.30	19.76
60	Gabrona - Seisaban route	5.10	14.52
61	Seisaban - Butri	5.60	12.57
62	Seisaban Butri	4.80	11.43
63	Seisaban - East - Tagmala	5.28	12.57
64	11 Sample	19.00	45.24
65	111 Sample	000	Zero
66	1V Sample	11.20	26.67

n	Surveyed Area	Average No. Of Trees Per Feddan ($\bar{x}_1$)	Average No. Of Trees Per Hectar ($\bar{x}_2$)
	Tagmala		
67	1 Strips Northward	13.70	32.62
68	11 Strips Northward	3.36	8.00
69	111 Prom Barno North	5.45	12.98
70	1V From Barno	7.35	17.50
71	V West Tagmala	8.78	20.91
72	V1 East Tagmala	5.89	14.02
73	V11 South Tagmala	5.30	12.62
74	V111 S.E. Tagmala	9.28	22.09
75	1X Gubba - Dibeker	12.29	29.26
76	2nd. Sample	33.70	80.24
77	3rd. Sample	11.60	27.62
78	Kunjara - El Khazan	12.75	30.35
79	Ban Gadeed - Dibeker	17.20	40.95
	Abu Gubeiha		
80	- Elsahal	19.30	45.95
81	- J.Elumda	16.24	38.67
82	Sample	9.10	21.67
83	Sample	5.29	12.60
84	Sample	6.50	15.48
85	Sample	6.00	14.29
86	W. Abid Route:	17.40	41.43
87	Sample	10.40	24.76
88	Sample	19.50	45.43
89	Sample	21.25	50.60
90	Sample	7.29	17.36
91	Eastward Strip 1	6.70	15.96
92	Eastward Strip 11	5.81	13.83
93	Eastward Strip 111	3.18	7.57

n	Surveyed Area	Average No. Of Trees Per Feddan ($\bar{x}_1$)	Average No. Of Trees Per Hectar ($\bar{x}_2$)
94	Areed West 1	11.40	27.14
75	" " 11	0.70	1.67
96	Areed South 111 S	10.90	25.95
97	Areed Fagagh En-Nom	12.80	30.48
98	P.En Nom - Elsirajia	3.00	7.14
99	El Sirajia - Abu Hasheem	13.00	30.95
100	Tayba - Kareems	16.9	40.24
101	Tayba - Kareema	9.56	22.76
102	Kareem - Ban Gadeed	4.17	9.93
103	Ban Gadeed Dibeker	17.20	40.95
104	Rashad Town	2.88	6.86
	Um Barembeita		
105	Route Rashad U.Baremeita	4.67	11.12
106	Ambeir - Strip Crossing	35	83.33
107	Ambeir - Hijer U.B.Route	7.82	18.62
108	H.U.B. - U.Barembeita	1.50	3.57
	Um Barembeita Town		
109	a- Forest Haj Wad Elamin	10.4	24.76
110	b- Forest Kadbar	9.25	22.02
111	Hijer Moro	16.29	38.79
112	Elkoz	12.6	30.00
113	(Route U.Barembeita -) (Khor Elmalbak)	3.8	9.05
114	Khor Elmalaba	0.65	1.55
115	Matgolil Forest	32.4	77.14
116	Elharmal Forest	7.3	17.38
117	Route Sample	11.25	26.79
118	Route Sample	10.20	24.29
119	Eloga Scheme	4.20	10.00
120	Eloga Scheme	5.25	12.50

n	Surveyed Area	Average No. Of Trees Per Feddan ($\bar{x}_1$)	Average No. Of Trees per Hectar ($\bar{x}_2$)
121	Rideena East	5.00	11.91
122	Elafna Forest	6.36	15.14
123	Hillat Ibrahim	Zero	Zero
124	Abukershola North	Zero	Zero
125	Abu Kershola - G.Et.tes	Zero	Zero
126	G.Eltes - Elfarsha	2.41	5.74
127	El Parsha - Gibeilat	34.00	80.95
128	El Parsha - East	Zero	Zero
129	El Parsha South	15.30	36.43
		$Ex = 1086.94$	

- No. of Observation (n) = 129
- $E(x_1) = 1086.94$
- Overall mean ($\bar{x}$) = $\frac{Ex_1}{n}$ = 8.4 trees/feddan
- Standard deviation (SD) = $\pm$ 7.5
- Overall mean ($\bar{x}$) = $\frac{Ex_2}{n}$ = 20.3 trees/hectar
- Standard deviation = $\pm$ 17.

Table (3)

Enumerations of Hejlij Tree

(Scatter)

n	Surveyed Areas	Average No. Trees Per Feddan $\bar{x}$	Deviations $d = x - \bar{x}$	ldl
1	Abbassia	26.00	17.60	17.60
2	Area	15.50	7.10	7.10
3		1.50	-6.90	6.90
4		0.57	-7.83	7.83
5	Abbassia Town	3.38	-5.02	5.02
6		2.38	-6.02	6.02
7		1.12	-1.28	7.28
8		9.34	0.94	0.94
9	Ballula Area	2.35	-6.05	6.05
		4.00	-4.40	4.40
10		0.00	-8.40	8.40
11		5.00	-3.40	3.40
12		0.50	-7.90	7.90
13		4.90	-3.50	3.50
14		3.90	-4.50	4.50
15		5.50	-2.90	2.90
16		1.83	-6.57	6.57
17	Et-Tartur	1.83	-6.57	6.57
18		3.40	-5.00	5.00
19		1.00	-7.40	7.40
20		6.10	-2.30	2.30
21		0.46	7.94	7.94
22		0.00	8.40	8.40
23		0.00	8.40	8.40
24		0.00	8.40	8.40
25		0.00	8.40	8.40
26		3.80	-4.60	4.60
27		0.50	-7.90	7.90
28		0.00	-8.40	8.40

n	Surveyed Areas	Average No. of Trees Per Feddan $\bar{x}$	Deviations $d = x - \bar{x}$	ldl
29	Abu Gureis	10.90	2.50	2.50
30		2.50	-5.90	5.90
31		0.00	-8.40	8.40
32		4.40	-4.00	4.00
33		12-18	1.24	3.78
34		9.64	2.60	1.24
35		5.80	3.70	2.60
36		4.70	-3.70	3.70
37	Um Hasheema	4.70	-3.70	3.70
38		12.90	4.50	4.50
39		6.20	-2.20	2.20
40		13.70	5.30	5.30
41		12.40	5.00	5.00
42		2.90	-5.50	5.50
43		2.04	-6.36	6.36
44	Kabus	27.30	18.90	18.90
45		20.35	11.95	11.95
46		5.90	-2.50	2.50
47		16.74	8.34	8.34
48		9.65	1.25	1.25
49		12.20	3.80	3.80
50		14.90	6.50	6.50
51	Abu Gubeiha Seisaban	12.50	4.10	4.10
52		11.30	2.90	2.90
53		8.90	0.50	0.50
54		17.70	9.30	9.30
55		2.84	-5.56	5.56
56		7.87	-0.53	0.53
57		8.00	-0.40	0.40
58		2.00	-6.40	6.40

n	Surveyed Areas	Average No. of Trees Per Feddan $\bar{x}$	Deviations $d = x - \bar{x}$	|d|
59		8.30	-0.10	0.10
60		6.10	-2.30	2.30
61		5.60	-2.80	2.80
62		4.80	-3.60	3.60
63		5.28	-3.12	3.12
64		19.00	10.60	10.60
65		0.00	-8.40	8.40
66		11.20	2.80	2.80
67	Tagmala	13.70	5.30	5.30
68		3.36	-5.04	5.04
69		5.45	-2.95	2.95
70		7.35	-1.05	1.05
71		8.78	0.38	0.38
72		5.89	2.51	2.51
73		5.30	-3.10	3.10
74		9.28	0.88	0.88
75		12.29	3.89	3.89
76		33.70	25.30	25.30
77		11.60	3.20	3.20
78		12.75	4.35	4.35
79		17.20	8.80	8.80
80	Abu Gubeiha	19.30	10.90	10.90
81		16.24	7.84	7.84
82		9.10	0.70	0.70
83		5.29	-3.11	-3.11
84		6.50	1.90	1.90
85		6.00	-2.40	2.40
86		17.40	9.00	9.00
87		10.40	2.00	2.00
88		19.50	11.10	11.10
89		21.25	12.85	12.85

n	Surveyed Areas	Average No.of Trees Per Feddan $\bar{x}$	Deviations $d = x - \bar{x}$	ldl
90		7.29	1.11	1.11
91		6.70	-1.70	1.70
92		5.81	2.49	2.49
93		3.18	-5.22	5.22
94		11.40	3.00	3.00
95		0.70	-7.70	7.70
96		10.90	2.50	2.50
97		12.80	4.40	4.40
98		3.00	-5.40	5.40
99		13.00	4.60	4.60
100		16.90	8.50	8.50
101		9.56	1.16	1.16
102		4.17	-4.23	4.23
103		17.20	9.80	9.80
104		2.88	-5.62	5.62
105	Um Berembeita	4.67	3.83	3.83
106		35.00	26.60	26.60
107		7.82	-0.58	0.58
108		1.50	-6.90	6.90
109		10.40	2.00	2.00
110		9.25	0.85	0.85
111		16.29	7.89	7.89
112		12.60	4.20	4.20
113		3.80	4.60	4.60
114		0.65	7.75	7.75
115		32.40	24.00	24.00
116		7.30	-1.10	1.10
117		11.25	2.85	2.85
118		10.20	1.80	1.80
119		4.20	-4.20	4.20
120		5.25	-3.15	3.15

n	Surveyed	Average No. of Trees Per Feddan $\bar{x}$	Deviations $d = x - \bar{x}$	ldl
121		5.00	-3.40	3.40
122		6.36	-2.04	2.04
123		0.00	-8.40	8.40
124		0.00	-8.40	8.40
125		0.00	-8.40	8.40
126		2.41	-5.99	5.99
127		34.00	25.60	25.60
128		0.00	-8.40	8.40
129		15.30	6.90	6.90

Number of observations (n = 129)

E ldl = 742.59

Overall mean deviations $(\bar{d}) = \frac{Eldl}{n} = \frac{742.59}{129}$

Overall deviation mean $\bar{d} = 5.76$

Sd. For the new overall deviation mean is as follows : $\bar{d} = \pm 3.21$

Ta (4)

(Manual Fruit Felling Method)

(Averages)

No.	Size of Crown	Site(Location)	Fruit Harvest Weight/tree (Kg)
1	Wide	(U.Berembeita along side (Khor U.B.	325.00
2	Wide	Inside a house Rashad	273.00
3	"	Arak Forest A.Kershola	231.00
4	"	Khor Eloga A.Kershola	222.00
5	"	Abu Gures "Nila"	183.00
6	Medium	(Family house)Rashad	160.00
7	"	Arak Forest	154.00
8	"	" "	142.00
9	"	- (Esharak Forest (U.Barembeita	138.00
10	"	- Family house tree Rashad	108.00
11	"	- Kabus Forest	106.00
12	Narrow	- Nital Sulaiman	85.50
13	"	Arak F.U.Barembeita	65.00
14	"	Nilat Sulaiman	44.53
15	"	Higer Yasin	35.00
16	"	Esh.Sharak	35.00
17	"	(Esh.Sharak Forest (U.Barembeita	28.00
18	"	Higer Yassin	27.00
19	"	Higer Yassin	26.00
20	"	Higer Yassin	2.50
			Ex = 2390.53

* n = 20 * Ex = 2390.53 * $\bar{x}$ = 119.53 Kg./tree

* Sd = ± 91.8 * CV = ± 77%

n= Number of Observations

Table (5)

Manual Fruit Felling Method
(Scatter)

No.	Size of	Share of Crown Size in Total Population %		Fruit Harvest (x) Weight/ tree Kg.	Deviation l d l d=x − $\bar{x}$	l d l
1	Wide		1	325.00	205.47	42217.9
2	"	20%	2	273.00	153.47	23553.0
3	"		3	231.00	111.47	12425.5
4	"		4	222.00	102.47	10500.1
5	"	$\bar{x}$. = 246.6 Kg wc.	5	182.00	62.47	3902.50
6	Medium		1	160.00	40.47	1637. 8
7	"		2	154.00	34.47	1188. 1
8	"	50%	3	142.00	22.47	504. 9
9			4	138.00	18.47	341.14
10		M= 128.0 Kg	5	108.00	11.53	132.94
11	"	$\bar{x}$ = 143.Kg m.c	6	106.00	13.53	183.06
12	Narrow			85.50	34.03	1158.04
13	"			65.00	54.53	2973.52
14	"			44.53	75.00	5625.00
15	"			35.00	84.53	7145.32
16	"	30%		35.00	84.53	7145.32
17	"			28.00	91.53	8377.74
18	"			27.00	92.53	8561.80
19	"			26.00	93.53	8747.86
20	"	$\bar{x}$ = 38.6 Kg		2.50	117.03	13696.02
		M = 128.0 Kg			1503.53	1160017.7

Number of Observation (n = 20)

E l d l = 1503.53

Overall mean deviation $\bar{d}$ l = 1503.53/20 = 75.18 kg

E ldl^2 = 160017.78

Standard Deviation Sd= $\frac{160017.78}{20}$ = ± 89.45

CV = $\frac{Sd}{\bar{d}}$ x 100 = $\frac{89.45}{75.18}$ x 100 = ± 118.98 %

Table (6)

(Estimates of Fruit Collector's)

(Average)

No.	Size of Crown	Harvest In (Kgs)Tree	No.	Size of Crown	Harvest in (Kgs)Tree
1	Wide	325.00	25	Wide	130.00
2	"	292.50	26	"	130.00
3	"	260.00	27	"	130.00
4		260.00	28	Narrow	97.50
5		260.00	29	"	81.25
6		260.00	30	"	65.00
7		260.00	31	"	65.00
8		260.00	32	"	65.00
9		260.00	33	"	65.00
10		227.50	34	"	65.00
11	Medium	195.00	35	"	65.00
12	"	195.00	36	"	65.00
13	"	195.00	37	"	58.50
14	"	195.00	38	"	48.75
15	"	195.00	39	"	48.75
16	"	195.00	40	"	47.50
17	"	195.00		Ex=	6402.25
18	"	195.00			=======
19	"	195.00		Ex = 6402.25 Kg	
20	"	170.00		n= / trees = 40	
21	"	162.50		$\bar{x}$ harvest / tree = 160.1	
22	"	162.50		Sd = $\pm$ 81.0	
23	"	130.00		Cv = $\pm$ 50.6%	
24	"	130.00			

* n = No. of Observations

Table (7)

Enumeration of Regeneration of Hejlij Trees

n	Forest	Regeneration (No) Seedings	Saplings	Joveniles	(X_1) Total No. Feddan	(X_2) Total No. Hectar
1	Abbassia	28	17	7	52	124
2	Abu Gubeiha	51	18	12	81	193
3	Rashad	25	8	3	36	86
4	Khor Eldigel) Wakara)	38	11	7	56	133
5	Elsiragia	00	1	3	4	10
6	Abu Hasheema	49	12	8	69	164
7	Areed	00	00	00	00	00
8	Elsahal	00	00	00	00	00
9	Elmasukaba	92	10	8	110	262
10	El Khazan	292	32	21	345	821
11	Tegmala	21	11	3	36	86
12	Abu Gures) "Nila")	00	00	00	00	00
13	Ballula	57	17	8	82	195
14	Elarak)	182	27	19	209	498
15	Elarak)	241	23	8	272	648
16	Matgolil)	200	32	13	245	583
17	Matolil)	123	21	8	245	583
18	Matolil)	192	29	17	238	567
19	El Farsha	15	14	9	38	90
20	Kadbar	00	00	00	00	00
21	Wad Elamin	00	00	00	00	00
22	Elkoz	00	00	00	00	00

Ex_1 = 2025 Ex_2 =4822

	Per Feddan	Per Hectar
* E(x)	Ex_1 = 2025 Trees	Ex_2=4822 tree
* Overall mean ($\bar{x}$)	92 trees	219 trees
* Standard Deviation(Sd)	± 105	± 249
* C.V.%	± 114%	

1.5. Summary

1.5.1. Number of Mature Trees Per Feddan:

The results obtained for estimating the population of Hejlij trees, which are shown on table (1), reveal a pronounced abundance of Hejlij tree in the Eastern zone of Southern Kordofan. This is confirmed by the high values indicated by an average number of (8 trees per feddan or (83) per hectar for the surveyed area. This average of 8.5 trees per feddan represent all mature trees including fruiting and none fruiting ones.

Observation made during the survey estimated that the number of mature none fruiting tree represents 10% of the total population.

However in the absence of aerial photography for the whole zone which has an area of a round 50 thousands square kilometers (11,965,239) it is not recommended to infer this findings i.e. 8.5 tree per feddan over the whole area. Considering the scatter of the collected data an average of 5.4 tree per feddan seems to be more realistic.

1.5.2. Yield Per Tree.

Result of manual fruit felling illustrated in Table (4) give a yield of 119.52 kg per tree arithmatic mean with a standard deviation of 91.8 . To improve

this estimate the variability of the trees by crown size was taken into consideration. Trees of wide crown represent 20 percent of the total number of trees, trees of medium crown are 50 percent while trees of narrow crown are 30 percent. When considering this factor into the calculation the average yield would be 128 Kg per tree. Fruit collectors estimate is 160 Kg per tree. This latter was observed to be biased towards wide crown trees and because the collectors are very enthusiastic about the proposed project. Hence it is recommended to consider the average yield per tree to be 128 Kg.

Quantification of Possible Yield at Plant Location

A. Plant Location:

After studying the possible location in terms of density of the Balanites aegyptiaca and the situation with regard to infra-structure i.e. roads, water, power and modes of communication and labour the town of Abu Gubeiha was selected as the most suitable site for the pilot plant.

B. Lalobe Fruit Collection Centres:

Ten different villages are chosen as centres of collection. The criterion for selecting these centres were as follows:

1. A high density of Balanites aegyptiaca trees.
2. Availability of minimum required local services.
3. Ease of road transport to plant site.
4. Availability of labour for collecting the lalobe fruit i.e. people are not occupied by other more rewarding business.
5. Distance from Abu Gubeiha.

C. Quantification of Possible Yield at Collection Centres:

The ten collection centres studied are shown on table (8). To estimate the average number of Hejlij tree per feddan at each centre the same sampling and enumeration techniques discussed earlier were adopted. For the estimation of the area covered by the Balanites aegyptiaca forest at each centre the vegetation map drawn by Harrison and Jackson was consulted. The annual yield per tree has been

arrived at earlier in this Chapter. Hence the quantity of fruit at each centre is computed - see Table (3). However not all the fruit at the area could be practically collected and made available for the proposed project. Animal grazing, inaccessability at forests, borers, wood cutters shall decrease the quantities available for the proposed factory. Time is also needed to organize aggressive Lalobe fruit collectors groups. For these reasons it estimated that only about 40% of the computed yield could be practically collected and made available for the proposed factory during its early years.

Table (8).

Collection Centres

Centre	Distance From Abu Gubeiha In Km.	Quantity of Balanites aegyptiaca	Transportation Cost to Abu - Gubeiha /ton in Ls.
Abu Gubeiha	1-15	26888	34.00
Sisaban	47	21600	51.00
Kabous	44	20000	85.00
Umm Hashima	24	25501	51.00
El Khazan	23	21247	42.50
Tagmala	42	4940	51.00
Umm Berembita	112	25039	68.00
Abaseya	119	1683	136.00
Abukershola	130	30771	119.00
A.	68	16300	60
Total		200,969	

ANNEX 3

2- Collection, Purchasing, Storage & Transport Systems

2-1 Collection & Purchasing

2.1.1. Forests Ownership & Utilization:

All the forests in Sudan are owned by the Government. The Government has vested all powers in dealing with forest resources to the Forest Department . The 4 year Salvation Recovery & Development Programme (FYP) has proposed a " National Resources Management Programme " which states the following:

a) Establishment of a" National Foresty Commission" which will replace the existing Foresty Administration to permit greater adaptation to the changing role of forestry.

b) The development of an integral national " Land Use Policy".

c) Conservation of the existing forest areas through enhanced regulation of forest clearance activities for mechanized agricultural schemes.

d) Increasing wood fuel supplies through tree planting and other afforestation programs.

e) The promotion of forestry development strategies for agricultural production & enviromental protection.

These points were confirmed by the recommendations of " Kordofan Rehabilitation & Development Workshop Jan 1987" and it was further recommended that " a comprehensive survey is to be undertaken to assess the current and potential natural resources in the

region for present and future utilization."

This shows that the Central & Regional Governments encourage the utilization of forest products. At present the people in the area under study are permitted to utilize forest products such as Lalobe fruit free of charge with the exception of a negligable levy tax on wood commercial use. The main role of the Forest Department is to protect the forests from unauthorized wood cutters and nomads. In areas where there are no Forest Department Offices, the tribal chiefs are delegated the authority to supervise the forests.

2.1.2. The Present Collection System:

The main economic activity in Southern Kordofan is rainfed agriculture. This activity extends from June to October. For the rest of the year people seldom have any other economic activity except that some of them are engaged in fruit collection. Fortunately, Lalobe starts fruiting in November and extends up till February. This could help in generating an additional income for the locals if the fruit is to be utilized commercially.

At present, the Lalobe collection practices are not organized due to the negligible demand for the fruit which is reflected in a low economic value, resulting in a marginal collection activity. The main collectors are children women and nomads who collect small quantities in their leisure time and consider it as a marginal source of income. The collection process is not done by any devices or

measures and depends mainly on the personal convenience of the collector . So,measures like quantity, quality, time for collection, packing and delivery are not planned for, and hence it is unwise to depend on the present system for the supply of large quantities.

The collecters usually collect the falling Lalobe and sometimes climb the trees to shake the branches for falling the fruits. The collected quantities are packed in sacks (a sack weight is approximately 70 Kg.), or smaller local packing material and they transport it by means of animals or on shoulder to the nearest market. The quantities collected are usually limited by the following factors:

a) Fruit collection is not the main occupation of these collectors and they usually collect the quantities enough to help them in obtaining enough money to purchase the necessary domestic goods e.g. sugar, salt, tea..etc.

b) The collector is limited by the transportation factor. They are usually living in remote areas and the thick forests hinder vehicles from reaching these areas. Even if the collection area is not far from the main road, the collector usually would not have enough money to pay for transportation.

c) The demand for and the prices of Lalobe do not encourage the local traders to organize and finance the collection activities.

So, the collection activity is solely vested on the individual collector who is limited by the aforementioned factors.

2.1.3. The Present Purchasing System:

There is no established purchasing system for Lalobe. The quantities traded are very small and the Lalobe trade is not considered as an important economic activity.

The collectors usually transport the collected quantities to the nearby markets. Usually, there are few people who are trading in Lalobe. The collectors sell their fruits to the local retailors. Some of these retailors sell directly to the consumers, mainly children, and others store it and sell it later to the wholesalers who come from major towns such as Khartoum, Kosti, Al-Obeid and Abu Gebieha.

The price from the collector to the retailor are arrived at through bargaining. The retailors refrain from buying bulk quantities due to:

a) Storage problems; b) Duration of storing the product and c) Uncertainity of selling the product.

The price from the local retailor to the wholesaler is determined by the forces of supply and demand and bargaining is also the key determinant of the final price. The prices are usually very low e.g. in 1987/88 season, the price per sack of Lalobe (approx.70 Kg) from the retailor to the wholesaler ranged between £s.9 and £s 15

(US$ 2-4) while an empty sack was sold for about £s.4

With such a weak trade activity people who deal in Lalobe never thought of designing special storage facilities for Lalobe.

2.1.4. The Proposed Collection & Purchasing System:

The commercial utilization of Lalobe will definitely affect the demand for the fruit.

The collection activity will definitely be more intensive if the prices of Lalobe reach a level that could induce more people to be involved in the collection activity.

To make an equilibrium between an affordable price by the user (manfacturer) and an equitable direct return to the collectors, the collection and purchasing practices must be organized. With the present malpractices in trade and the absence of consumer protection, it will be quite dangerous to depend on an unorganized raw materials supply. As experienced in the marketing of other commercial forest products, the traders will tend to monopolize Lalobe trade exerting pressure through fixing the prices and playing with the supply to get inflated prices. At the same time the collector will not benefit from the project, as the middlemen will offer low prices to the collector in order to maximise their profits. In that way, the collector might be dicouraged from collecting the required quantities. This experience has resulted in the formation of Public Sector Companies to organize the trade

in such products e.g. Gum Arabic Company and Oil Seeds Company.

The new collection & purchasing system should consider the following factors:

a) The maximum benefit of this project should go to the fruit collector, offering him an additional source of income that will encourage him to be more involved in the collection activity.

b) The system should be designed to ensure the continuous flow of raw materials through shortening the supply lines by discouraging brokers & middlemen to monopolize the Lalòbe trade.

c) The development of more advanced collection systems and extending service facilities to the collectors.

d) The storage & transportation should be extended & controlled by the project management and to encourage & justify dealing in commercial quantities.

The proposed collection and purchasing system is derived from the experience of the " Gum Arabic Company." which struggled for about twenty years to come out with the present system.

The main similarities between Lalobe & Gum Arabic trade are : a) that both of them are forest products; b) that there is an overlap in the growing area.

This means that if we introduce a system similar to the Gum Arabic Co. System, it will be accepted by the people in the area and could work smoothly.

The main steps inorganizing the collection and purchasing system are:

(i) Formation of an organization that looks after collection, purchasing, storage and transport of Lalobe and be responsible for the mgt. of these activities.

(ii) To reserve certain areas where dense Lalobe forests are located. This will give an opportunity to protect these forests and a guarantee that fruit collectors will do their jobs without interference from individuals, tribes or local forest authorities. This is also in line with government policy.

(iii) Assign certain collection centres near the main collection areas and provide them with the following:

a) Building of Storage Facilities.

b) Centre for Extension of Service Facilities to Collectors e.g. Water Supply, Medical Care, Collection Tools, Packing Materials etc.

(iv) Appoint an Agent in each Collection Centre. This agent should work either on commission basis or on the fixed price basis (having two prices: from the collector to the agent & from the agent to the project),

At later stages more than one price could be fixed according to quality and place of delivery.

(v) Fix Lalobe selling price before the collection season. This will ensure that:

a) A reasonable price is fixed to jusdfy the commercial utilization of the product.

b) The fruit collector will be the direct beneficiary from the collection activity and that the price is high enough to make more people involved in the collection activity.

c) The collector will be aware of the selling price.

d) El mination of black market activities, middlemen, brokers & unfair trade practices.

e) Control of the pricing policy for the raw materials & finished products.

(vi) Arrange for transport facilities from the centres to the central processing area.

2.1.5. Proposed Fruit Collection Method:

As stated earilier, the mature Balanites aegyptiaca " Hejlij" tree is a tall tree. It starts fruiting at an age of 7-10 years. At this age and under normal growing conditions it attains a height of 6-8 metres. It reaches maturity at an age of 20-25 years attaining a height of up to 10 metres..

The Lalobe fruits do not ripen all at one time, but the season extends from mid - November until February. The ripe fruits detach from the stalks mainly during the night. Detachment of the fruits is also effected by the winds, or by inducing the ripe ones to detach from the stalks and fall to the ground by shaking the branchlets either by hand or using a hook. The latter should be relied on in order to collect fruits for commercial purposes. Care must be taken that the shaking should not be vigorous to the extent that causes green fruits to detach from the tree.

Some of the trees are climbable, in particular the old ones because they have their thick branches bare of thorny branchlets, thus allowing fruit collectors to stand on them and shake the branchlets by hands and/or hooks. If, however, there are small branches on top of the trunk,that prevent climbing

they have to be cleared off by using axes.

- It is recommended that the fruit collectors move in twos, the first collector to climb the trees and shake the branchlets, and the second to collect the fallen fruits. If the ground under the tree is bare and solid the epicarp of some fruits might break due to impact against the ground. To prevent or minimize further breakage of the epicarp, the ripe fruits are better collected in " Raikas " (Shallow wide round containers made of bamboo, singular - Raika). After collecting the maximum amount that could be carried on shoulder (25-35 Kg) this would be transported on shoulder to a drying place. The drying place should have a clean ground covered by pieces of mats, fenced either by iron net work or sticks - to prevent grazing animals from eating the fruits,and preferably guarded by one man. Each lot of fruits that arrive to the drying place should be left for 2 - 3 days under direct sun to dry before packing into jute sacks and transporting to the intermediate store by animal driven carts (2.5 - 3 tons load each).

2.2. Storage

2.2.1. Intermediate Storage:

The intermediate store could be a mere open yard with a cemented ground and brick walls in the markets of the villages chosen as stations for intermediate storage. The Lalobe sacks could be stacked one on top of the other to a height reachable to porters when loading the factory trucks with sacks. This type of an intermediate store is found in Northern Sudan where they are used to store dates. However, in the case of the Lalobe fruit intermediate storage, one sack might not stay for more than one week in the intermediate store before it is transported to the central store in the factory by factory trucks.

2.2.2. The Central Store:

The central store in the factory could be a rectangular shed with a cemented floor. The walls (maximum height about one metre) should be of bricks, because wood though usually cheaper than other materials, is less durable, more inflammable and is more exposed to infestation by pests. On top of the brick walls could be fixed an iron network that reachs up to the roof thus allowing natural aeration of the fruits. The roof could be made of corrugated zink which is widely used in Sudan. Inside this store the Lalobe sacks should be stacked in a way that ensures good aeration. Such a store is constructed in

in a modern factory at Khartoum North, that used to produce an alcoholic beverage from dates in the past before banning this type of industry by the Sudanese Government in 1983.

It is desirable that the total capacity of the central store should be sufficient to accommodate all the Lalobe fruits that arrive at the factory at the peak of the season. Storage requirements could be calculated from graphs showing receipts of fruits and processing. Processing goes on for a long time (7 months), but the period during which Lalobe fruits are received at the central store is short (60 days). Processing may be slow in starting, so that it may be that at the peak receipt time, about 20 days after the season opens, storage must be found for about (19,000) tons of fruits. Care must be taken not to store the fruits during the rainy season (May - September) because the fruit mesocarp absorbs moisture leading to inevitable sticking and lumping of the fruits together. This problem of course is not encountered when nuts are stored.

Without going into too many details, the following remarks may be made:

1. It is to be expected that the fruits will arrive at the factory at a lower rate at the beginning of the harvest season than at the end, whatever the duration of the season may be.

2. It is expected that the production will go at a lower rate in the beginning due to the lower efficiency at the start of operations. Once the factory is working at full capacity the production rate will soon become steady.

The details of the storage requirements will be discussed in the next phases of the contract (i.e. Design and Technoeconomic Feasibility Study).

2.3. Transportation

The need for rural transportation have received comparatively little attention in the country. All the investment in this sector is mostly by private sector and the role of the government in that part of the country is negligiable. This inadequate growth of this basic infrastructure has been an important factor in the state of imbalance in the country.

Traditionally, the dominant modes of transportation in the area are:

2.3.1. Human Porterage:

Head - Shoulder - and back loading, or human porterage, is still the most common method of load-carrying in Kordofan District.Human porterage, however, is not the best modes of transport; the movement is slow the loads are limited and can only be moved short distances.Head loads are usually limited to about 40% of body weight (25-35Kg). This mode of transportation seems not to work in case of mass collection.

Even for small capacity of 20 tons per day we need more than 5000 porters. With simple calculation, that will be expensive and the control is more expensive.

2.3.2. Pedal Vehicles:

Bicycles are used as means of personal transport extensively in the area but their utilization as cargo carrier

is rather limited. Bicycle loads can be increased by different modifications, e.g. attaching trailer, tricycle, but their use is rather uncommon in developing countries. This needs a growth of a bicycle industry in the area to meet the needs of the project. It will be rather impractical to think about that at this stage since the assembly of spare parts for bicycles require hard currency to import them at the present economic situation. It is advisable to use means of transportation using indigenous raw materials and parts.

2.3.3. Animal Transport:

Animal used for transport purposes include donkies, horses, camels and oxens. Power output varies, but in all cases is much greater than that generated by human beings. Thus greater loads can be moved though speeds are slow. To make use of this characterstic we can increase the payload and keep the speed static. In addition we have to make use of the indiginous raw materials. This could be achieved by developing locally made animal carts. This could be made of wood and driven by donkies or oxens. We only need wheel rims and tyres. The rail could have a maximum payload of one ton and moves at 3-4½ Km/h. This will remarkably increase the quantities to be carried to intermediate stores. The advantage of the animal cart is that it could be used in all weather, roads, different services and it has more manoverrability in the forest.

This could be used in trasnporting Lalobe from the forest to the intermediate stores. Their movement should be scheduled in such a way to cover the collection areas where the collectors are working in a particular time. There should be small collection and packing points in the forest where the cart will load from. The small collection centre should also be as camp for the collectors where they could live, cook and keep their tools and belongings.

2.3.4. Motorized Vehicles:

The only long distance transport mode used in the area is motorized vehicles. Although motor vehicles have long been known in the Sudan, but their impact in that area has only recently began to be felt. This has largely been due to the absence of any serious building programme until recent years.

However, in this chapter, we will consider the role of motorized vehicles in transporting the Lalobe from intermmediate storage to the central storage.

The vehicles operating in the area all light trucks the payload of which ranges between 6 to 8 tons and that is mainly due to the physical features of the area. Most of these trucks come from Central and Western Sudan bringing consumer goods such as sugar, salt, tea, flour and taking fruits and wood products.

I- Quantity of Lalobe to be Transported:

The optimum crushing capacity for this project will be determined at the feasibility study stage.Provisionally, the crushing capacity is thought to be 10 tons of kernels/ day.

This is based on the following:

a) Forest reservation needs a lengthy procedure. Starting with a low capacity will enhance the administrative problems and results in quicker decisions.

b) A provision is made for the response of the collectors at the beginning of the project.

c) Less cost of stores buildings.

d) Less investment in transportation facilities.

e) Disposal of waste will be easier and does not result in environmental problems.

f) Less effort will be required to market the finished products.

g) Better control on the project and less administration costs.

If we assume that the number of working days per annum is 210 days, t) total annual requirements of Lalobe kernel will be 2100 tons, which needs 21,000 tons of Lalobe whole fruit. So, the required quantity of Lalobe to be trnaported from intermediate stations to the Central Station is 21,000 tons.

II. Possible Harvest at Intermediate Station:

Table (8) Chapter (1) shows the proposed intermediate Centres, their distance from the Central Station, the possible harvest at each station and the transportation cost per ton.

However, due to practical limitation we may assume that the collectable quantity of Lalobe fruit in the first year is 40% of the possible harvest. To determine the intermediate stations which could supply the central station with the required quantity of Lalobe, i.e.21,000 tons per annum, the following table should be considered:

Table (9)

Proposed Main Intermediate Stations

Station	Distance From Abu.Gubeiha Km.	Collectable Qty M.Tons	Transportation Cost/ Ton Ls.
Abu Gubeiha	1-15	10,755	34.00
Seisaban	47	8,640	51.00
Kabus	44	9,600	85.00
Umm Hashima	24	10,200	51.00
El Khezan	23	8,499	42.50
Tegmala	42	3,176	51.00
Umm Berembita	112	10,016	68.00
Abbasiya	119	673	136.00
Abu Kershola	130	12,308	119.00
Abu Gureis	68	6,520	60.00
Total		80,387	

The two major factors affecting the selection of a station are: the collectable quantity, the distance and the transportation cost. So, the proposed,intermediate stations to supply the required quantity of Lalobe to the Central Station are:

Intermediate Station:	Qty(tons)
Abu Gubeiha Area	10,755
Umm Hashima Area	10,200
El- Khazan Area	8,499
Total	29,454

III. Transportation Cost:

Let us assume that the supply of Lalobe from each station will be as follows:

Abu Gubeiha Area	8000
Umm Hashima Area	8000
El- Khazan Area	5000
Total	21000

There are two alternatives to calculate the transportation cost and these are:

a) Transporation Cost: Hiring Vehicles:

According to Table (10) the cost of transporting the required quantities will be as follows:

Table (10)

Transportation Cost on Rental Basis

Station	Quantity Ton	Cost/Ton Ls.	Total Cost Ls.
Abu Gubeiha	8,000	34.00	272,000
Umm Hashima	8,000	51.00	408,000
El-Khazan	5,000	42.50	212,500
Total	21,000		892,500

b) Transportation Cost : Project Own Fleet:

In case of using vehicles owned by the project, the following assumptions should be considered:

i) The payload of vehicles to be purchased is 8 tons.

ii) The selling price per vehicle is Ls.300,000 (Three Hundred Thousand Sudanese Pounds).

iii) The estimated life of the vehicle is 10 yrs.

iv) The vehicle daily milage is 250 Km.

v) The number of operating days of a vehicle per annum is 210 days (excluding the rainy season).

vi) An interest in capital is estimated at 15%.

vii) Fuel, oil and lubricants, tyre wear, crew wages and other operating expenses have been based on a study made by the Transport and Communication Section, Ministry of Finance and Economic Planning 1985 after updating it.

Accordingly, the vehicle operating cost will be as follows:

Vehicle Oparating Cost

1. Fixed Costs:

Crew	18,508
Depreciation	30,000
Interest	30,000
Overheads	2,032
Other Fixed Cost (Liscences, Insurance) etc.	1,700
	82,240

2. Running Cost:

Fuel	15,120	
Oils & Lubricants	5,520	
Tyre Wear	10,000	
Repair & Maintenance	10,000	40,640
Total Operating Cost		122,880

The operating cost of a vehicle per kilometer will be found using the following formula :

$$\frac{\text{Vehicle Annual Operating Cost}}{\text{No of Km/day x No. of Working Days/ Annum}}$$

$$= \frac{122,880}{250 \times 210}$$

$$= \text{Ls. } 2.34$$

This figure varies depending on the vehicle usage.

The following table shows the cost/ kilometer in different situations using an 8 ton payload vehicle:

Table (11)

Vehicle Operating Cost/Kilometer

Meleage/Annum			Operating Cost			Ls/Km
Working	Km/Day	Total	Fixed	Variable	Total	
30	250	7,500	66,376	5,805	72,181	9.62
60	250	15,000	69,02o	11,610	80,630	5.37
90	250	22,500	71,664	17,415	89,079	3.96
120	250	30,000	74,308	23,220	97,528	3.25
150	250	37,500	76,952	29,025	105,977	2.83
180	250	45,000	79,596	34,830	114,426	2.54
210	250	52,500	82,240	40,640	122,880	2.34

To find the cost of transporting one ton from the intermediate stations to the central station using the above rates we find the following:

Table (12)

Transportation Cost Per Ton

Working Days	A.Gubeiha Area Ls.	Umm Hashima Area Ls.	El Khazan Ls.
30	18.04	28.86	27.66
60	10.07	16.11	15.43
90	7.43	11.88	11.39
120	6.09	9.75	9.34
150	5.31	8.49	8.14
180	4.76	7.62	7.30
210	4.39	7.02	6.72

The table shows that the longer we extend the working days the less becomes the transportation cost and this is a well known economic principle. Unfortunately, the Lalobe fruiting season duration being two month only acts as a constraint against extending the transport working days. It extends from Mid - November till the end of February of each year.

Another constraint for extending the transport working days is the rainy season. The rainy season extends from May up - till end of September in an area with heavy rainfall and unpassable track roads. The area is almost completely isolated during the rainy season. This is why we assumed earlier that the working days are 210 (7 month only).

So, the maximum time to extend the duration of transportation is six month (from November to May). The two - month season could be extended by building stores that could accomodate the appropriate stocks to keep the vehicles occupied for 6 month. Taking an 8 ton payload vehicle, doing four return trips a day for six month period will transport a total of 5160 tons. To transport the 21,000 tons we need four 8 ton payload vehicles to be purchased which will cost £s.1.2. million.
The cost of transporting this quantity will be as shown in the following table :

Table (13)

Transportation Cost Using Own Vehicles

Intermediate Station	Quantity Ton	Transp.Cost £s./ton	Total Transp. Cost Ls.
Abu Gubeiha Area	8,000	4.76	38,080
Umm Hashima Area	8,000	7.62	60,960
El-Khazan Area	5,000	7.30	36,500
			135,540

So, the annual savings on the transportation cost in this second alternative over the first alternative is £s. 756,960. The savings for two years will purchase about five vehicles. The only additional costs are building extra sheded stores to keep the Lalobe stored for longer periods in addition to the administrative expenses.

Which Alternative to Select ?

From the above discussion it is obvious that the second alternative is more attractive economically. It's success depends entirely on availing funds for the initial investment on vehicles. However the vehicle cost could be remarkably reduced if they are imported and exempted from custom duties and other local taxes.

2.4. Organization of Purchasing, Storage, & Transportation Activities:

A project like the one under study needs to be well managed and controlled by defining our objectives and tackling the problem in a scientific approach that could reach the target. The administration and control of the operations through well calculated costs and benefit analysis. Part of the control system is the organization of the main activities that is : Collection, purchasing, storage and transport.

2.4.1. Collection:

The collectors will be divided into groups, depending on the intensity of work load will be assigned a location in the forest and that location will be considered as a field collection centre and camping place.

A group leader should be assigned to look after the collection activities, the drying, the collection centre, the packing and the loading of Lalobe. He should also keep record of productivity per worker, total quantity collected, quantity delivered to intermediate stores and the expenses of the camp. This is in addition to his role as a group leader in organizing the living aspects at the camp.

2.4.2. Field - Intermediate Store Transport:

If the cart system is adopted then, the cart driver has a number of responsibilities:

- He transports Lalobe from the field to the intermediate stores.
- He transports tools, empty sacks, personnel,food stuffs water etc. from the intermediate station to the field station.
- He keeps record of the quantities delivered with both the field team leader and the intermediate store keeper/agent.

2.4.3. Purchasing:

An agent should be appointed in each location and be appointed on profit or commission basis. The agent will be responsible for :

- Receiving and inspecting the quantities comming from the field.
- Properly storing the received quantities in the stores allocated by the project management and excercising an inventory control system that facilitates the appropriate supply of raw materials.
- Keeping record and administer the stors and transport activities.
- Supplying the field camps with the required materials.

2.4.4. Intermediate Store Central Store Transportation:

The administration of the proposed transport fleet will be entrusted with a supervisor who will also be responsible

For the field intermediate store transport. His main responsibilities will be :

- Working in laison with the central store management to see the required quantities and the collection points.
- Scheduling and proper routing for the vehicles from collection centres (intermediate stores) to the central stores.
- Keeping a record of the quantities of Lalobe received and delivered.
- Looking after the supply of vehicles with the required fuel, oil,lubricants and petty cash expenses.
- Looking after the maintenance of the vehicle and secure the supply of spare parts.

2.4.5. <u>The Project Management Team:</u>

A project manager is to be assigned at the top of the organization pyranid who will deligate part of the authority to the following personnel:

- A Project Engineer: to be responsible for the technical part of the project.
- A Transport Officer : to be directly responsible for the management of fleet of trucks and look after the op eration of the field transport through reports and spot checking.

- Collection & Welfare Officer: to be responsible for the collection, packing, delivery of Lalobe in addition to looking after the welfare of the collectors camps.
- Project Stores Supervisor: to be responsible for the maintenance of store keeping and control of raw materials and supplies for the project. His role is to keep a constant flow of raw materials from the field via the intermediate stores to the central stores to keep the process running for all its working days and keep the fleet at a maximum utilization point.
- Project Management Accountant:

  A qualified Management Accountant should be appointed to keep record of all the operations and assign costs to different operations.

  It seems that the personnel cost will be too high compared to the size of the project. The personnel cost should not be assigned to the operations and should be allocated to the project management because under normal conditions such personnel will be assigned to a larger project.

ANNEX 4

3. Nomination of Location For Setting Up The Model Scheme

3.1. Raw Materials:

During the team first field survey (April 1987) which was described in the Progress Report May 1987, the team observed that Abu Gubeiha lies at the centre of Lalobe growing area. Although we limited our present survey to areas North of Abu Gubeiha town, for the purpose of this study, Lalobe forests extend south and east of Abu Gubeiha to the Southern Region and the White Nile. The surveyed area is selected due to the following factors:-

a) It lies within the vicinity of the Central Station (Abu Gubeiha), so transportation cost will be minimized.

b) It lies on the main road from Central Sudan to the area where the road traffic is more intense and this will facilitate transportation of raw materials and distribution of finished goods.

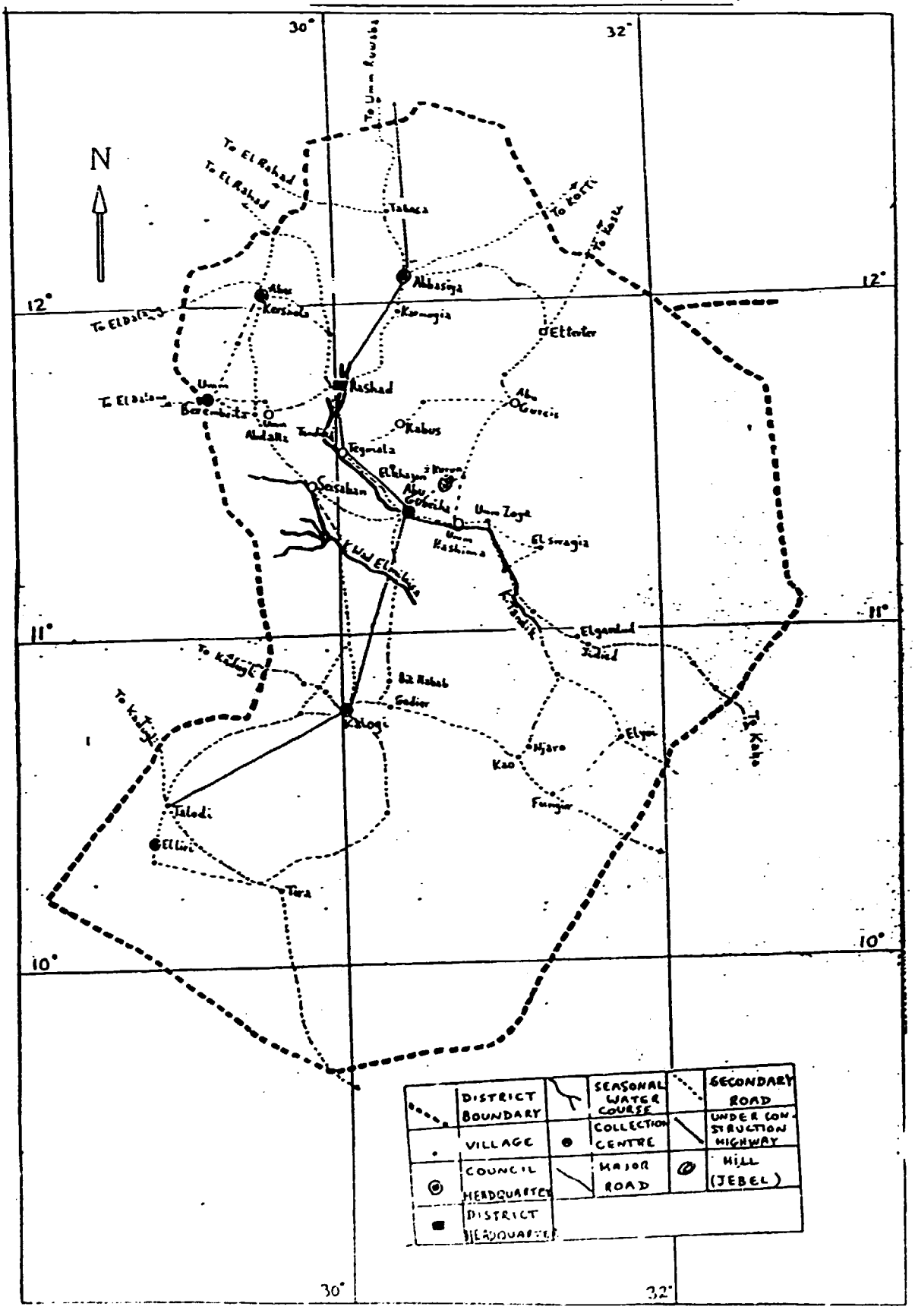
c) The collectable quantity will meet raw materials requirements for the proposed project.

d) The area is more secure and densily inhabited the thing that sccures a permanent supply of manual labour.

MAP No. 1

THE EASTERN DISTRICT

SOUTHERN KORDOFAN PROVINCE (TEGALI)



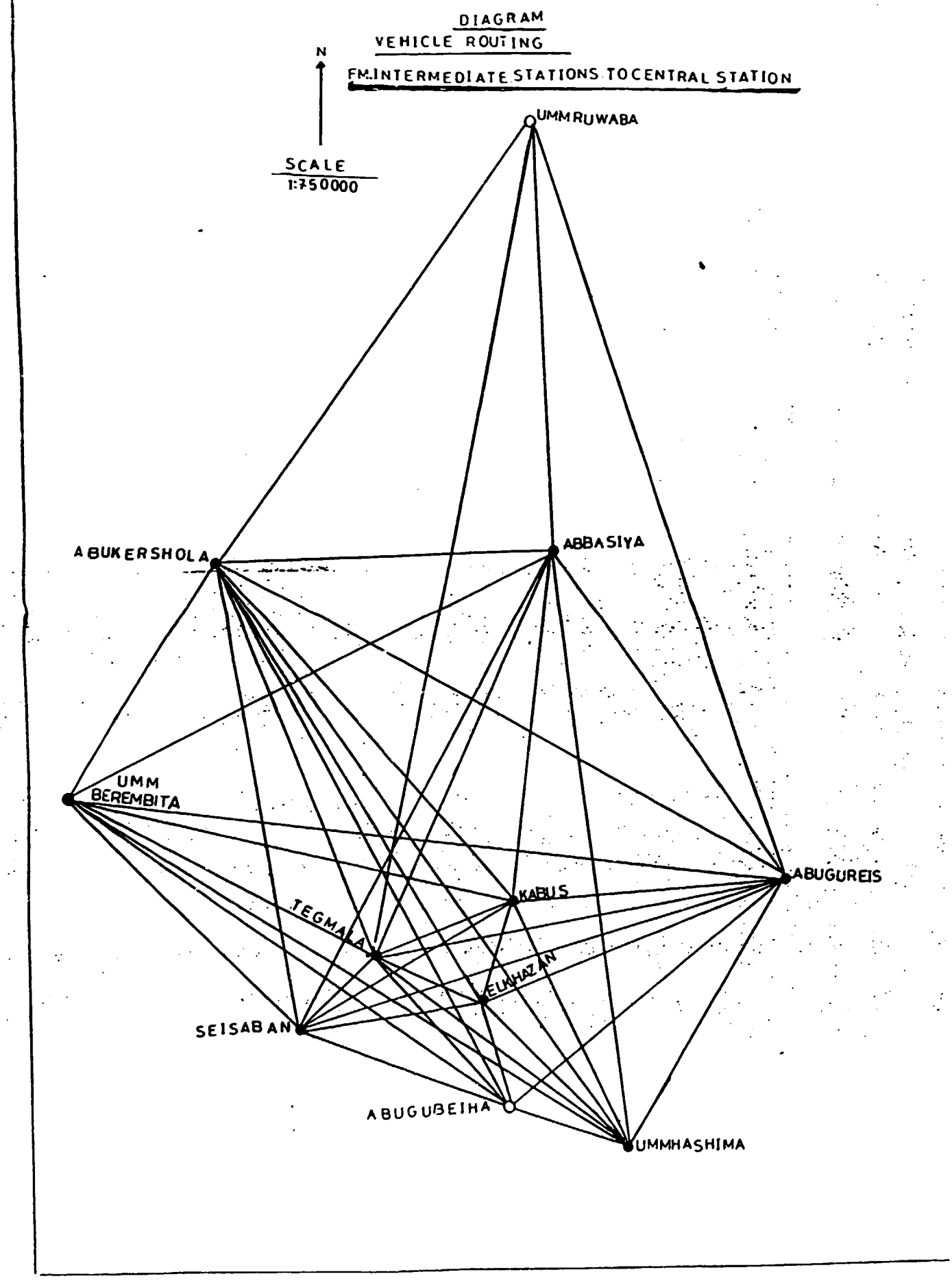


DIAGRAM
VEHICLE ROUTING
FM.INTERMEDIATE STATIONS TOCENTRAL STATION
N
SCALE
1:750000
UMM RUWABA
ABUKERSHOLA
ABBASIYA
UMM
BEREMBITA
ABUGUREIS
KABUS
TEGMALA
ELKHAZAN
SEISABAN
ABUGUBEIHA
UMMHASHIMA

The central location is selected near the Lalobe growing area because the cost of transporting raw materials is about ten times the cost of transporting the finished products. This is illustrated by the following transportation comparison.

- The comparing is between two locations, one within the vicinity of raw materials (Abu Gubeiha) and the other is far from raw materials but characterised by being a main market, good transportation system and better services & a quite a number of already established oil mills.
- The vehicle routing method is used to find the total travelled distance from intermediate stations for both locations (Table (14) and Table (15).

The result was as follows:-

	KM
From Intermediate Stations to Ummruwaba	606
From Intermediate Stations to Abu Gubeiha	453
Kilometers Saved	153
% Saving in Transport Cost	25.2%

This ratio increases with the increase in distance from raw materials area. The selection of the location in Abu Gubeiha which lies at the centre of Lalobe growing area, will have the following advantages:

- Saving in Transportation Cost.
- The Project can make use of the other unsurveyed areas east and south of Abu Gubeiha in case of establishing a mass producing unit.

Table(14) Vehicles Routing : Intermediate Stores-Abu Gubeiha

a) Mileage Matrix:

Distance from Abu Gubeiha In Km	24 Ummhashima	75 AbuGureis	119 Abbasiya	130 A.Kershula	112 UmBerimbita	47 Sisaban	42 Tagmala	44 Kabus
75 Abu Gureis	68	-	-	-	-	-	-	-
119 Abbasiya	125	86	-	-	-	-	-	-
130 Abu Kershula	157	180	54	-	-	-	-	-
112 Um Berimbita	140	155	120	48	-	-	-	-
47 Sisaban	11	109	117	98	70	-	-	-
424 Tagmala	66	88	95	92	76	22	-	-
44 Kabus	60	66	75	96	101	53	34	-
23 El-Khazan	44	77	99	111	99	42	23	24

Table (14)

b) Points Saved Matrix:

Location	Um,Hashim	A.Gureis	Abbasya	A.Kershole	Umberimbita	Sisaban	Tagmala	Kabus
Abu Gureis	31	-	-	-	-	-	-	-
Abbasiya	18	108	-	-	-	-	-	-
A.Kershula	-3	65	195	-	-	-	-	-
Um Berimbita	-4	32	111	194	-	-	-	-
Sisaban	0	13	49	79	89	-	-	-
Tagmala	0	29	66	80	-8	61	-	-
Kabus	8	53	88	68	55	38	52	-
El Khazan	3	21	43	42	36	28	24	43

- Optimum Route: Abu Gubeiha to El-Khazan to Kabour to Tagmala to Sisaban to Um Berimbtia to Abu Kershola to Abbasiya to Abu Gureis to Umm Hashima to Abu Gubeiha.
- Mileage : 453 Kilometer
- Point Save: 779

Table (15)

Vehicle Routing: Intermediate Stores-Ummruawaba

a) Mileage Matrix:

		Abbasiya 88	A.Gurais 195	U.Hashim 217	A.Gubeiha 206	El Khazan 185	Kabours 102	Tagmala 177	Sisaban 199	U.Berimbeta 167
195	A.Gurais	86	-	-	-	-	-	-	-	-
217	Um Hashim	125	68	-	-	-	-	-	-	-
206	A. Gubeiha	119	75	24	-	-	-	-	-	-
185	El Khazan	99	77	44	23	-	-	-	-	-
162	Kabour	75	60	60	44	24	-	-	-	-
177	Tagmala	95	88	66	42	23	34	-	-	-
199	Sisaban	117	109	71	47	42	53	22	-	-
167	Umm Brembita	120	155	140	112	99	101	76	70	-
119	A.Kershula	54	140	157	130	111	96	92	98	48

Table(15)

b) Points Saved Matrix:

	Abbasiya	A.Gurais	U.Hashim	A.Gubeiha	E. Khazan	Kabous	Tagmala	Sisabàn	U.Brembita
A.Gurais	197	-	-	-	-	-	-	-	-
U.Hasim	180	344	-	-	-	-	-	-	-
A.Gubeiha	175	326	399	-	-	-	-	-	-
El-Khazan	174	303	358	368	-	-	-	-	-
Kabous	175	297	319	324	323	-	-	-	-
Tagmala	170	284	328	341	339	305	-	-	-
Sisaban	170	285	345	358	342	308	354	-	-
U. Bermbita	135	207	244	261	253	228	268	296	-
A. Kershula	153	174	174	195	193	185	204	220	238

- Optimum Route: Umm Ruwaba to Abbasiya to Abu Gureis to Umm Hashima to Abu Gubeiha to El Khazan to Kabour to Tagmala to Sisaban to Umm Berembita to Abu Kurshola to Umm Ruwaba.
- Points Saved: 2824
- Mileage : 606 Kilometer

- The project will create employment opportunities for local population.
- There is a potential market for finished products, specially oil, because people used to consume it and hence we avoid an additional transportation cost of oil for human use.

3.2. Finished Products:

The area is also considered as a potential market for finished Lalobe products, the main reasons for that are:-

a) Abu Gubeiha is considered as the main market for Eastern Kordofan Region and supplied the whole area with consumer goods and a distribution centre for agricultural and forest products.

b) The area is linked by road transport to the other parts of Sudan and to the villages and towns of South Kordofan.

c) The people in the area are already used to the Lalobe products, specially oil.

d) There is an oil mill in Abu Gubeiha suitable for processing Lalobe and its owner has shown his willing to cooperate.

e) The owner of the oil mill has been granted a liscence to establish a soap factory at Abu Gubieha and he is enthusiatic about using Lalobe oil as a raw material for soap making.

3.3. Nomination of the Central Oil Mill:

The fact that there is an oil mill at Abu Gubeiha adds more weight to our proposal of Abu Gubeiha to be the Central Station for processing the Lalobe fruit.

The oil mill processes sesame seeds and peanuts. At the moment it has 3 expellers: One Buharat expeller of 6 tons/day capacity ; one Rumex expeller of 5 tons/day; one new chinese (200 A-3) expeller of 9-10 tons of peanut/day; and another new similar chinese expeller which is not yet installed.

The mill also has 2 "Andoria" diesel engines for electric power generation, one to operate the mill and the other one a standby engine. It also has oil storage tanks and an oil filter. Besides these facilities the oil gets its own water supply from a well at the premises. It also has plenty of space for addition of new pieces of equipment that are necessary for preparation of the Lalobe fruit to get the kernels for pressing.

Since the oil mill processes peanuts for oil production this means that it would be suitable for processing the Lalobe kernel owing to the resemblance between the Lalobe and the peanut kernels (see UNIDO/IO.494, April 1983 Balanites aegyptiaca ", An Unutilized Raw Material Potential Ready for Agro - Industrial Exploitation TF/INT/77/021).

In addition to all this, the owner of the oil mill is very much interested in this project and is willing to cooperate with the IRCC for implementation of the Project.

3.4. Transportation:

The lack of railway and river transport services in South Kordofan has encouraged consideration of an alternative transport mode and an increased emphasis is being placed on road transport. The demand for road transport is emanating particularly from high value and perishable commodities. The lack of an adequate system from the production centres to the main consumption areas has been a major hinderance to the economic and social development of potentially rich areas.

In the last decade road transport played an important role in moving passengers and freight compared to other transport modes. The liscinced road vehicles in the Sudan has increased in number and size and efficiently contributed in combating famine through transportation of food stuffs to the affected areas. The share of road transport in total freight traffic hauled was increasing over years from 25% in 1969/70 to about 80% at present.

However, the road transport in South Kordofan area is still at an early stage of development. The whole road network is made up of earth tracks of varying quality, most of them are impassable during the rainy season. A very large number of potentially productive areas can be reached only on foot or on animals. In spite of the lack of all seasons roads of good quality, the motor traffic has steadily increased in the area. The physical features of the area do not encourage using heavy trucks the thing that

adversely affected the transportation cost.

The whole area is underlain by basement complex rocks of different types and is considered as a natural extension of the Nuba Mountains, where linear hills are distributed over the majority of the area. In addition a number of deep Khores (brookes) are extended over the area. The mean annual rainfall over the area varies from about 500 mm in the North to about 800 mm in the South. The rainy season is in summer and extends from May to end of September. The daily average temperature for the whole year reaches a maximum mean of 32°C and a minimum mean 20.3°C. This means that:

a) The roads are unpassable during the rainy season and vehicles could operate for seven months only.

b) The vehicles are running under severe climatic conditions on mountains and rocky roads.

c) The only trucks which could operate in the area are light trucks (payload 6-8 tons).

In recent years increasing recognition has been shown for the need for evolving an appropriate strategy for the development of road transport by constructing all weather roads that will serve fertile agriculture and forest rich areas of Kordofan Region. Moreover, the road projects will serve the central trade markets in the region and provide direct access to the area. The two main proposed roads which will link the area with the rest of Sudan are:

i) Kosti - Umm-Ruwaba - El Obeid Road:

The construction and maintenance of this all weather road from Kosti to El-Obeid via Ummruwaba will connect western Sudan with the main national network to transport the surplus of the agricultural and forest production of western Sudan for the markets for distribution internally or for export.

This road will connect Kordofan to the National Capital via Kosti - Khartoum road.

It will connect Kordofan to Southern part of Blue Nile Province via Kosti Sennar - Damazine road.

It will connect Kordofan to the Central & Eastern Region via Kosti - Sennar - Wad Medani - Port Sudan road. This is in addition to the steamer services from Kosti - to the Southern Region.

The road is financed by US AID and work has already started on it and completion date is supposed to be in 1992.

ii) Ummruwaba - Kalogi Road:

This road will connect the Lalobe growing area with the main proposed road at Ummruwaba and also connecting it to the railway line.

This road is also financed by US AID and tenders for its construction has already been announced. The completion date is targeted to be in 1992.

This road passes through the main Lalobe growing areas and it extends from Umruwaba - Abbasiya - Rashad - Abu - Gubeiha - Talodi - Kalogi to meet with a road project passing through the Western side of Nuba Mountains to Kadogli-Delenj - El Obeid.

The construction of these roads will help in linking the areas with the national network all over the year and will permit the usage of heavy trucks with greater pay loads. No plans for feeder roads are revealed or foreseen in the near future so the transport between collection areas and main centre will still be over unconstructed earth roads.

3.5. Water Resources

3.5.1. Sources:

Water for industrial purposes can be obtained from one of two general sources: the plants own source or a municipal supply. If the demands for water are large, it is more economical for the industry to supply its own water. Such a supply may be obtained from drilled wells, rivers, lakes dammed streams or other impounded supplies. Before a company enters upon any project, it must ensure itself of a sufficient supply of water for all industrial, sanitary, and fire demands, both present and future. If wells are to be relied on, geologists and practical well drillers should be consulted.

In relation of water supply to plant or factory location the major items requiring consideration are (3) :

i- Availability of surface and underground water and seasonal fluctuation in quality, quantity, and temperature.

ii- Data to show, statistically, the influence of prevailing meteorological conditions on the availability of the water supply under consideration.

iii- Chemical comprosition and physical characteristics of the water supply, including sufficient data to show the average, maximum, and minimum conditions.

iv- Quality of supply as revealed by microscopic and bacteriological analyses.

v- Existing or predicted influence of industrial or domestic waste contamination.

vi- Estimated requirements for various needs of the proposed plant, such as water for processing, cooling, steam generation, sanitary uses, and fire protection.

vii- Evaluation of future requirements for the various services so as to provide for expansion.

viii- Design of heat exchange equipment, recycling of cooling water, and provision of a cooling tower to provide for the conservation of the total volume of water required.

ix- Influence of the present rate of water consumption and the predicted results of industrial expansion in the area upon the continued availability of the supply and effect upon quality and temperature.

x- Effect of contamination on surface and underground water, resulting from various activities in the area.

3.5.2. Water Requirement For Industry

3.5.2.1 Quantity:

The quantity of water required in industrial production varies greatly from commodity to commodity. The average

water intake per unit output is also affected by the extent to which water is reused. Plants which are equipped with facilities permitting water re-use may lessen considerably their water requirements. Water use figures are usually presented as the number of gallons or cubic metres or litres required to produce a given unit or quantity of the material, e.g. the quantity of water required per one litre of edible oil is estimated as 22 litres, while that required per ton of beet to produce beet sugar is 20400 litres including beets flumming and washing.

3.5.2.2. Water Quality Indicators:

The most important quality indicators for the water used in the food-processing industry are: composition of the suspended matter, solids, total hardness and its components, total alkalinity with its components, ability to oxidize, concentration of hydrogen ion (pH), the composition of the gases dissolved in the water and the microbiological state of the water.

Water hardness is one of the most important water quality indicators regardless of the purpose for which the water is used. Total hardness is the sum of the concentrations of cations of calcium (calcium hardness) and magnesium (magnesium hardness) expressed in milligram equivalent per litre (meq/l) or gram-equivalent per cubic metre. According to the grade of total hardness an approximate classification of water has been established as follows:

Total Hardness (meq/l)	Classification
0 -- 1.5	Very Soft
1.5 - 3.0	Soft
3.0 - 6.0	Average Soft
6.0 - 12.0	Hard
Over 12.0	Very Hard

Alkalinity is usually imparted by the bicarbonate and hydroxide components of a natural or treated water supply expressed meq/l. It is determined by titration with a standard solution of a strong acid, using phenolphthalein as the indicator. This amount of the acid enables the measurement of that alkalinity fraction contributed by the hydroxide and half of the carbonate present in the water.

Titration with a standard mineral acid solution indicated by methyl orange determines the total alkalinity of the water. The results obtained from the phenolphthalein and total alkalinity determinations offer a means for the stoichiometric classification of the three principal forms of alkalinity of many supplies:

a) Carbonate alkalinity is present if the phenolphthalein alkalinity is greater than zero but less than the total alkalinity.

b) Hydroxide alkalinity is present if the phenolphthalein alkalinity is more than half the total alkalinity.

c) Bicarbonate alkalinity is present if the phenolphthalein alkalinity is less than

half the total alkalinity.

3.5.3. Water Quality for Technological & Other Use In Individual Branches of the Food Processing Industry (4)

Each particular branch of the industry imposes specific water quality requirements. The food-processing industry usually uses water that meets the waterworks standards of potable water. In places where it is not possible to utilize water-works either surface or underground natural water must be used, but it must be subjected to sanitary checks and treatment before entering the production process. Water treatments include the following operations: clarification and decolorization; elimination of corrossive gases, iron, oil, calcium and magnesium salts; and disinfection by means of various reagents and nonreagent methods.

3.5.3.1. Water For The Canning & Sugar Industries (See Annex)

The bulk of water in the canning industry is used for technological purposes (preparation of sauces, syrups, brines), the remainder for washing the vessels, etc. This water must meet all the standards for potable water. Table (16) gives the standards for the water to be used in the canning and sugar industries.

Table (16)

Characteristics of the water used in the canning and sugar industries:

Quality Indicator	Unit	Canning	Sugar
Dry Residue	mg/l	500	300-500
CaO	mg/l	120	200
MgO	mg/l	30	-
$FeO_3 + Al_2O_3$	mg/l	0	Traces
Chlorides	mg/l	30	50
Sulphates	mg/l	36	60
Nitrates	mg/l	Traces	Traces
Nitrites	mg/l	-	0
Alkalinity	mg/l	2.5-4.5	60
Oxidizability	mg/l	0	0
Hardness	mej/l	6-7	Up to 7.5

3.5.3.2 Water for Thermo-Power Station Equipment:

In a thermo-power plant that is an integral part of a food-processing concern, water is used for feeding boilers, cooling condensers of steam turbines and heating.

The impurities contained in raw water causes a whole series of undesirable processes in the installation: boiler scale formation on tubing and heating surfaces, deposits inside steam engines, turbines and pre-heaters, corrosion of boiler plating, steam ducts, heat exchangers, etc.

3.5.3.3. Water For Steam-Boiler System:

Boiler scale is a source of many difficulties in thermo-power plants. It has a far smaller coefficient of thermal conductivity than steel, and therefore the heat transmission is greatly reduced. The growing thickness of boiler scale on the steel plating causes loss of heat in the boiler system. Because of this the fuel consumption increases in order to maintain the required steam temperature.

One of the main reasons for the formation of sediments in boilers is the increase in concentration of disolved substances as the boiler water evaporates. In this process the substances that reach the state of saturation first are the first to form as a sediment.

As recommended by the Vereinigung der Grosskessel-besitzer in Bund Deutscher Tecknik (VGB), Federal Republic of Germany, the qualities of the feed and boiler water must not exceed the values given in tables (17) and (18).

Table (17)

Quality Standards for Boiler Feed-Water (VGB)

Quality Indicator	Feed-Water for Boiler with Single Phase Circulation	Feed-Water for Boiler with Forced Water Circulation			
		20 atm.	40 atm.	60 atm.	80 atm.& More
General Conditions	Pure and Colourless				
Oxygen (mg/L)	Up to 0-03				
Hardness (meg/L)	In traces	0.02	0.01	0.01	In traces
Iron (Mg/L)	Up to 0.02	If possible up to 0.05			Up to 0.03
Copper(Mg/L)	Up to 0.005	Up to 0.01			Up to 0.005
Total CO_2(Mg/L)	Up to 1	If possible Up to 20			Up to 1
pH at 20°C	7-9.5	7-9.5			7-9.5
Silicic acid (Mg/L)	Permanently running up to 0.02	If there is no desludging, in permanent running maximum 0.3			
Oil (Mg/L)	Up to 0.3	If possible up to 10.6			Up to 0.5

Table (18)

Quality Standards for Boiler Water (VGB)

Pressure in Atm.Gauge	20	40	64	80	125	160
P-Value (Meg/L)	Up to 10	To 6	To 3	To 1	To 0.3	To 0.1
Silicic	Compute from p-value					
Acid (Mg/L)	By Formula(70 + 7.0)		To 10	To 4	To 1.2	To 0.4
Phosphates (Mg/l)	Up to 25	To 10	To 10	To 3	To 3	To 3
Specific Electro-	To 8,000	To 5,000	To 2.500	To 1.500	To 250	To 50
Conductivity	D= 0.4 °Be'	D= 0.25 °Be'				
ms/cm.						

3.5.3.4. Water For Cooling Purposes:

The food - processing and other industries use water-cooled heat exchangers, condensers and reactors. The temperature of the water in such cases in usually low, ranging within the limits of 50-60°C.

Cooling is effected by water flowing through the system. This water, after becoming hot, can be discharged into the sewer or recooled and recycled. The former procedure uses an open (flow-through) cooling system and the latter a closed (recycled) one.

In the second case water is recycled into the cooling towers or into the spray towers where it is cooled to the initial temperature and then returned into the cooling cycle.

The water utilized for cooling must not leave any deposits in the piping and apparatus. Scale deposition on the walls greatly decreases cooling water efficiency by reducing the rate of heat transfer. The cooling water must not contain any coarse inorganic particles (sand) that could remain in the system. The softer suspended matter (clays) as a rule does not settle, but its particle get trapped by the scale deposits and subsequently drop with them as an amorphous deposit on the heating surfaces and thus prevent good heat transfer.

Live organisms (bacteria and fungi) can develop in water that contains a large amount of organic matter when it is used for cooling in condensers at temperatures of 10-40°C.

Deposition of scale and other solid sendiments rarely occurs in cooling system with wall temperature between 30-40°C.

3.5.3.5. Water For Fire Fighting:

When designing and erecting food-processing plants, provisions must be made for supplying water for fighting fires. Usually water for this purpose is taken from the already existing water supply system. A certain number of fire-prevention pumps is set up at the very pumping station that supplies a particular factory with water. This is called a " high pressure fire - combating water system."

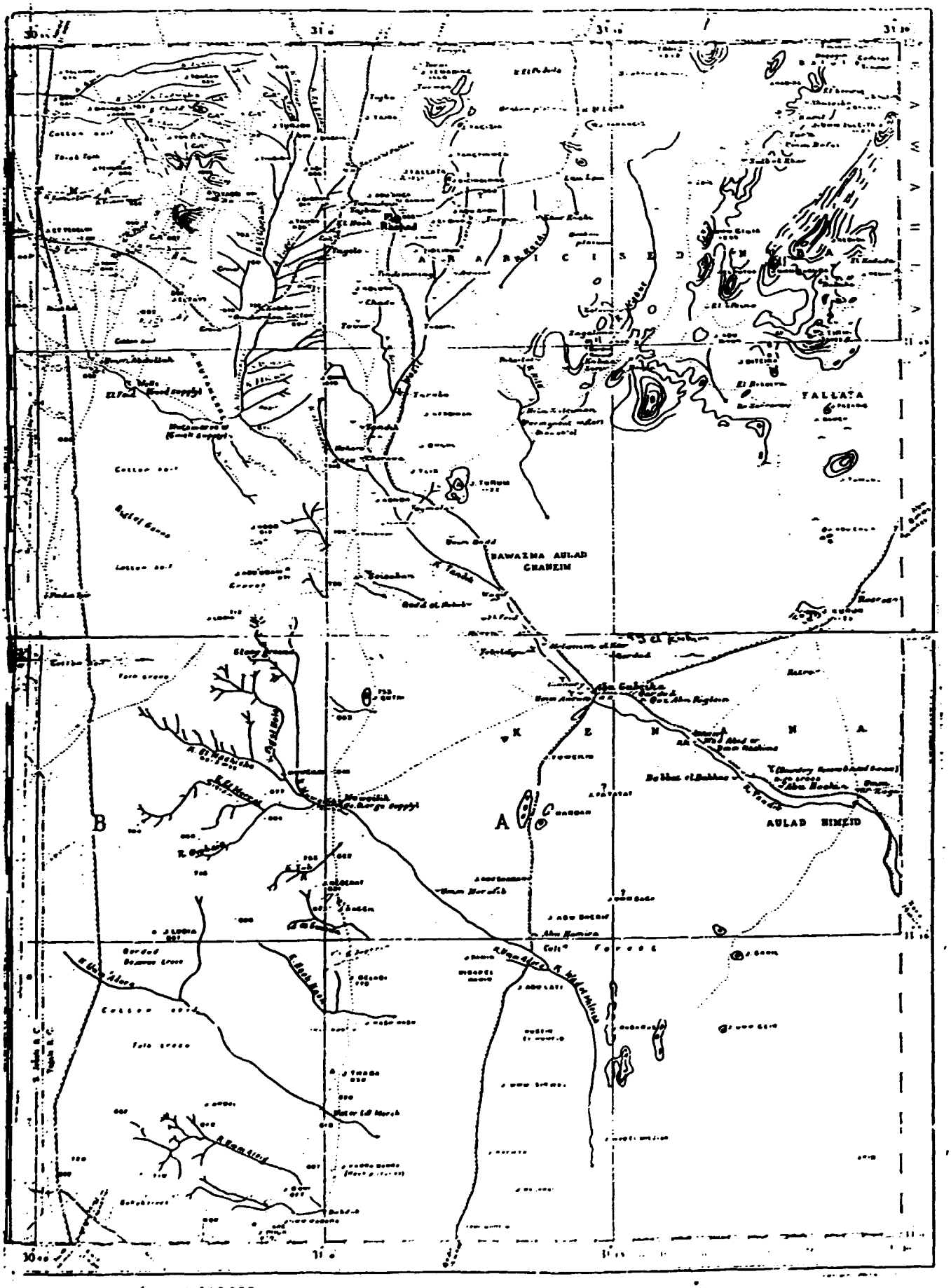
3.5.4. Water Resources of the Eastern District of Southern Kordofan(5)

The Nuba Mountains area (Southern Kordofan Province) is dominated by solid rock masses of the Basement Complex separated by clay plains which are dissected by seasonal water courses (Khors) that drain the highlands. This geological, pedological and topographic set-up limits the chances of obtaining sizeable ground-water supplies. The Basement Complex is basically of solid materials and unless highly weathered, fractured, jointed or crushed can not provide a storage and transmission facility for water.

The thick clay overburden does not allow the infiltration of water to the underlying weathered Basement Complex zones due to the impermeability of these clays. Such weathered zones when contain water, are thought to be in direct contact with the exposed hill masses through highly cracked and jointed tracts and faults. In such plains the sandy Khor beds are the only sources of water supply.

The undulating hilly and steep-sloping topography drains the rain water so quickly that little time is available for the infiltration of such waters were conditions are favourable.

Considering the water resource development activities in the Eastern District of Southern Kordofan Province (Map No. 2) within the above mentioned context we find that:-



Scale 1:250,000

1- Rural Water Corporation Khartoum (RWC) drilled 52 wells in the area with about 32% failure (17 dry wells).

2- UNICEF drilled 48 boreholes to be equipped with hand-pumps with 50% success rate (24 dry wells).

3- Rural Water Corporation (RWC) also excavated 24 Hafeers (shallow wide surface-wells) early in this century but Hafeers tend to silt-up.

4- The majority of the population depend on hand-dug large diameter wells with very low yields and high polution hazards.

5- In some areas springs issue from the mountains and supply water for varying lengths of time.

3.5.4.2. Abu Gubeiha Area:

Abu Gubeiha Area is dominated by vast clay flats with scattered inselberges. It is mainly drained through Khor Tandik and Khor Wad Elmileisa (See Map No.2). Khor Tandik holds ample supplies of water in its sandy bed. The quartzite ridge that forms the small hill at Abu Gubeiha acts as an underground dam that blocks sizeable amounts of water in the Khor bed upsteam.

The underground water resource of Khor Tandik alluvium has been and is being heavily exploited for fruit gardens,

where millions of mango and citrus trees are grown, as well as for domestic use. The development is mainly through hand-dug open wells of large diameter.
The aquifer at Abu Gubeiha is composed of both the Khor alluvium and the underlying weathered Basement Complex in hydraulic connection.

In 1974 onwards Rural Water Corporation drilled about five production wells and more than five piezometers near the wells along Khor Tandik from Helemm Elkur in the North to Abu Gubeiha town in the South. The profiles of the wells showed succession of silt, sands, gravels and boulders varying in thickness from about 30 feet in the north to around 90 feet at Abu Gubeiha. The water levels ranged from 12 to 15 feet below ground level.
The discharge of the wells ranged rom 800 gallons per hour to over 1000 g.p.h. The wells drilled by RWC did not penetrate the weathered Basement Complex. If, however, the weathered Basement is tapped, discharge of the wells could be improved.
The chemical, analysis indicate that Abu Gubeiha ground water is alkaline and moderately hard with pH values 8.0 total hardness,(as $CaCo_3$) between 105 and 170 ppm. The electrical conductivity values range between 350 and 480 µmho: total dissolved solids (TDS) of 220-360 ppm. (See Table 19).

The water is thus chemically fit for human, animal and industrial uses, however, high nitrate values have been recorded due possibly to organic contamination through the grat number of open unprotected wells and defecation practices inside the Khor in dry seasons. High iron content was also recorded in one sample.

Haggaz and co-workers (U.of Khartoum) commented on the ground water of Abu Gubeiha as being dominantly Sodium bicarbonate water with the sodium absorption ratio (SAR) being between 1 and 15, whence the suitability of Abu Gubeiha water for irrigation.

Downstream of the quartzite ridge (South of Abu Gubeiha), a well drilled at Umm Hashima gave low yield while drilling further downstream at Umm Zoga failed alltogether. The area is, however, suitable for hand-pump installation since these pumps can be sustained by very low yields. The area south of Abu Gubeiha obtains its water supplies from the sandy bed of Khor Wad Elmileisa particularly at El Muweilih village. East of Abu Gubeiha water is found in the coarse soil around Jebel Kurun especially at the North East side of the hill.(See Map No.2).

To conclude, large scalewater development in the area is only possible along major water course after proper geophysical and hydrogeological surveys. Handpumps,however, can safely be utilized for domestic supply.

Table (19)

Characteristics of 3 Wells Drilled by Rural Water Corporation(RWC) at Abu Gubeiha Area

	Well No. 6350	6351	6352
EC	350 ma/cm	420ms/cm	350 ms/cm
pH	8.0	8.0	8.0
T.D.S.	240 ppm	280 ppm	220 ppm
Total hardness($CaCo_3$)	170 ppm	170 ppm	165 ppm
T.Alkalinity ($CaCo_3$)	200 ppm	320 ppm	250 ppm
Ex.Alkalinity(Na_2Co^3)	(...)	160 ppm	90 ppm
Ca	50 ppm	30 ppm	45 ppm
Mg	10 ppm	20 ppm	30 ppm
Na	30 ppm	65ppm	45 ppm
NO_3	0.9 ppm	Nil ppm	Nil ppm
NO_2	0.012ppm	Nil ppm	0.012 ppm
SO_4	15 ppm	20 ppm	10 ppm
Cl	5 ppm	Nil ppm	10 ppm
F	0.3 ppm	0.4 ppm	(...)
K	5 ppm	5 ppm	5 ppm
Depth	89 ft	80 ft	70 ft
S.W.L.	12 ft	14 ft	15 ft
Yield	1074 gal/h	800 gal/h	916 gal/h

EC - Electrical Conductivity

T.D.S.-Total Dissolved Solids

S.W.L.-Static Water Level

ANNEX 5

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