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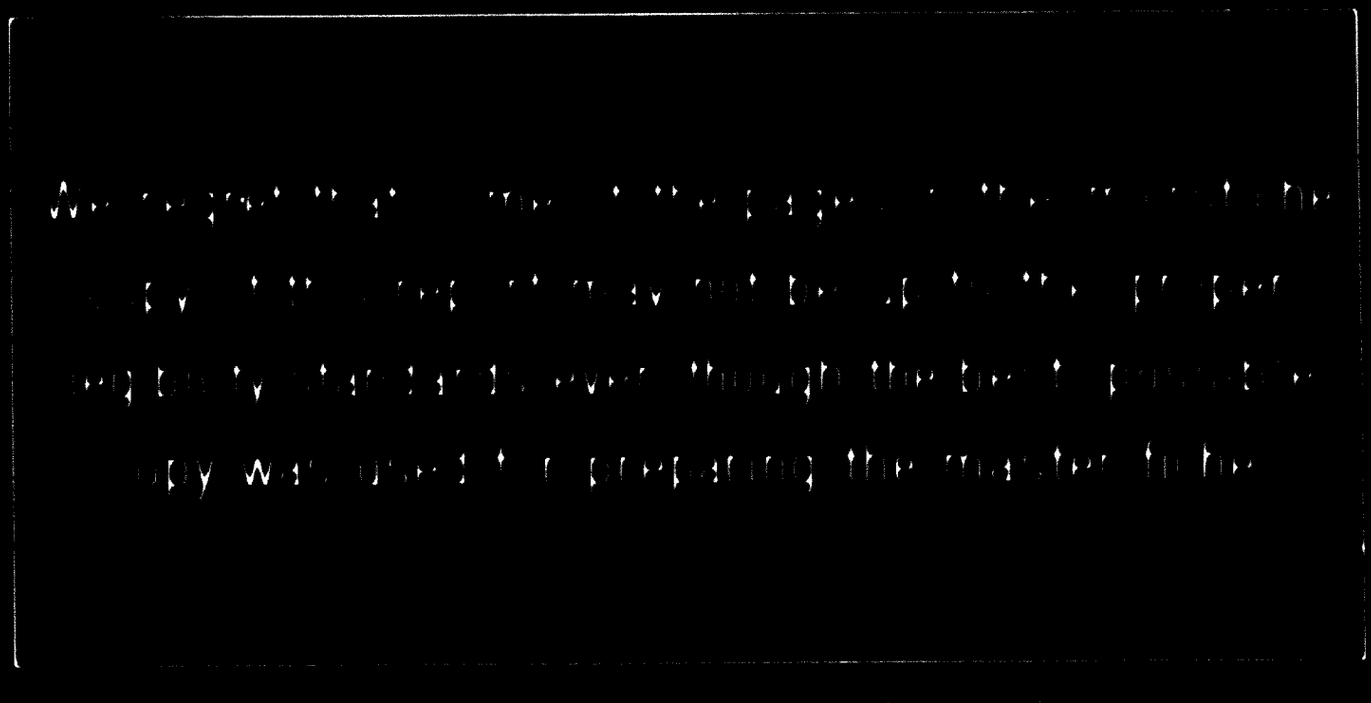
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org



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(R) EVALUATION SURVEY OF THE VEGETABLE OIL INDUSTRY[1/]

THE SUDAN.
UF/INT/78/052.

Terminal report prepared for the
Government of the Sudan

by
H. B. W. Patterson

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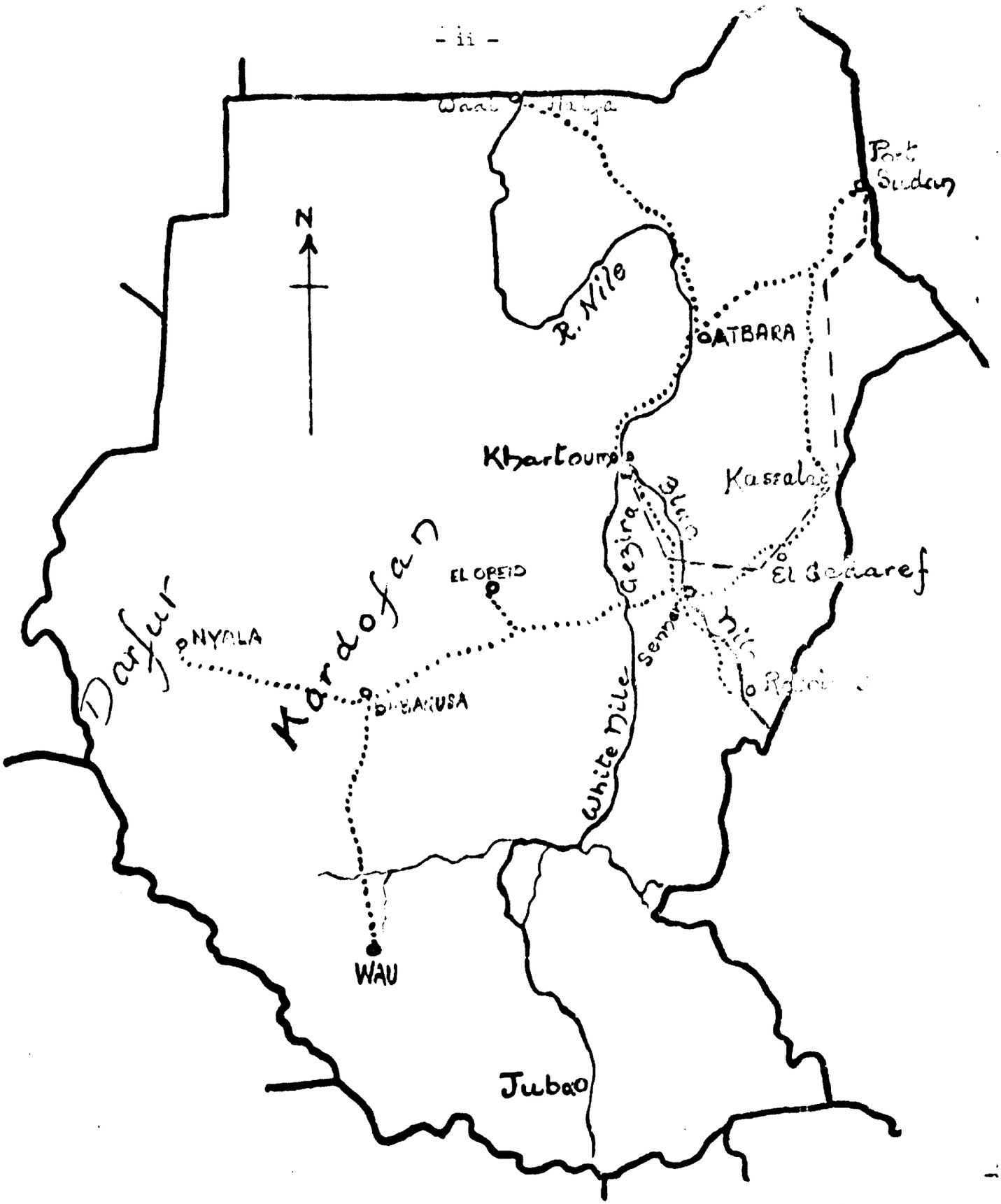

1cm = 100Km

1 inch = 158miles

..... Railway

— — New Highway (-partly completed)

The Sudan

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Conversion factors

Many local weights and measures exist. For example the Ministry of Agriculture officially lists seven different values in kg. for "sack" according to the crop being handled. Unless otherwise stated the usual metric units are used in this report and, therefore, only a limited number of factors need be listed.

Weight

1 Metric tonne (here abbrev. to mt) = 100 kg = 2.204.62 pounds
= 2,225,8 rottles

1 Rottle = 0.9905 pounds
= 0.4493 kgs

Length

1 Km = 0.62 miles; 1 mile = 1.61 Km

Area

1 sq. Km = 100 hectars = 238.1 Feddans = 247 acres
1 Feddan = 0.420 hectars = 1.0379 acres

Currency (January 1979)

1 Sudanese Pound (Ls) = 100 Piastres (pt)

1 Sudanese Pound closely approximates to US$ 2.00

1 Sudanese Pould closely approxmates £ 1.00.

1 US$ closely approximates 0.5 Ls

Summary

The planned steady increase in areas under cultivation for all seed crops is described in detail with respect to groundnut, sesame and cotton. This has the two-fold object of maintaining and even increasing the present vegetable oil tonnage available for human consumption within the country and at the same time of strengthening Sudan's traditional position as a net exporter of oil and oil cakes. The per capita consumption of vegetable oils and animal fats taken together under the headings of visible and unvisible fats (the latter via meat, milk, seeds) appears to be superior to many neighbouring countries but nevertheless there is a market demand for more cooking oil. Additional crops, notably sunflower and soya bean are being investigated as pilot projects but not at high priority. Water is the major factor in selecting areas for agricultural development since there is an agreement with Egypt as to how much may be taken from the Nile and this amount has almost been reached. Rain-fed areas, especially in the south, offer most of the long-term opportunities. This situation serves to emphasize the Sudan's most urgent current need which is improved transport. In this, Africa's largest country, the main cultivation areas are remote from the sea.

It is clear that there exists in the country ample capacity for processing oilseeds and this will cover likely crop increases for several years to come. Particular attention has been paid to exploiting the existing possibilities of exporting those vegetable oils which command the highest price (e.g. groundnut oil) on the world market whilst maximising the use of cheaper but technically satisfactory oils and fats for home use (e.g. tallow and coconut oil for soap-making, cotton oil for cooking).

Recommendations

1. Bringing existing crops to existing factories is the most urgent need of the vegetable oil industry. The improvement to railway track and rotting stock which this implies, benefits the remainder of industry. If the intended increase in crop size is achieved, the demand on transport will increase accordingly.

2. Repair and occasional replacement of existing machinery such as screw presses in oil mills should be preferred to construction of new mills.

3. Since the Sudan's two largest oil mills and only solvent-extraction plants are already situated at Port Sudan with the export of oil and cake meal as their main concern, the Ministry of Industry should investigate the opportunities for exporting vegetable ghee (refined hydrogenated vegetable oil blends) to Middle Eastern and African countries where it is in demand. If, as appears likely, the prospects are good, a hydrogenation unit plus refinery at Port Sudan would be a logical development in Sudan's efforts to create the added value arising from the processing of existing edible oil.

4. Brief courses on the technology of oil milling and refiningof about three weeks' duration should be instituted for the benefit of mill managers and their managerial assistants. Instruction should pay special attention to feasible standards of technical efficiency in Sudanese mills and refineries and the procedures for checking these so as to avoid waste. Public and private sectors should co-operate in this.

1. Introduction

1.1 Purpose of the mission

The purpose of this UNIDO mission (6 January 1979 - 31 January 1979) was toevaluate the present state of the vegetable oil industry in the Sudan, to identify improvements in the existing operations, and in particular to assess whether by-products from its own processes, or those of associated industries, were being exploited to the greatest advantage. Current plans for the future expansion of the vegetable oil industry, including the export as well as the domestic market, were to be related to the necessary infrastructure, both in human and physical resources. Sincere thanks are here accorded to those in the Government service and private industry who made their knowledge and time available to the mission. A list of visits made is at Appendix I.

1.2 Situation in Sudan

Sudan is now beginning its second six year plan (1978 - 1983) of development which entails the progressive enlargement of the existing oilseed crop growing areas, for example in the large irrigated triangluar area the Gezira (island) to the south of Khartoum between the Blue and White Nile and bounded roughly on the south by the railway running westwards from Sennar; also, in the regions around El Gedaref and North Kordofan (see map). It will be noted that the first two areas are served by rail and the new Khartoum - Port Sudan Highway due for completion in 1980, which is already operating from Khartoum to El Gedaref. However, because they are rainfed areas, the long-term potential of Kordofan and Darfur may be greater than dry areas further north. Both public and private sectors now exist in the vegetable oil industry and UNDP already provides some continuing technical advice on a range of specific items within industry through its industrial field adviser stationed in the country.

1.3 Sudanese intentions

Since there is a lively world demand for the products of the vegetable oil industry (crude oil, cooking oils and fats, oilseed cake and meal) the Sudanese plan aims at the acquisition of foreign currency by increased exports of several of these as well as an increasing per capita consumption at home. Along with increases in production such a plan must rationalize the use of vegetable oil resources within inevitable technical constraints so as to achieve the greatest economic advantage from day to day world prices.

2. Vegetable oil crops

2.1 Location

Groundnut and sesame are the purpose grown oil crops. The provinces of Blue Nile, Kassala, Dafur and Kordofan contribute the vast majority, the first two depending on irrigation and the last two on rain. Table 1 and 2 relate to the whole country.

2.2 Production and disposal of groundnuts (m.t.)

Table 1

Year	Area '000 Feddans	Production in Shell	Yield Kg/Fd (a)	Deduct Seed Kg/Fd (b)	Waste	Human Food Direct	To local crushing Decorticated Equivalent (c)	To export In shell	Decort.
1971	913	338	370	30	20	34	24	14	107
1972	1512	388	257	33	23	37	44	18	97
1973	1643	567	345	35	34	40	102	9	130
1974	1724	544	316	36	33	42	112	5	126
1975	1790	930	520	41	56	46	251	1	205
1976	1877	997	531	43	60	49	204	16	290
1977	1970	1070	543	45	64	53	388	18	142
							Estimated total incl. export		
1978	2066	1147	555	48	69	57	569		
1979	2167	1230	568	50	74	61	611		
1980	2274	1320	580	52	79	65	658		
1981	2385	1415	593	55	85	70	707		
1983*	2900	1568	541	110*	94	86	695		

(a) In the USA yields equivalent to 940 Kg/Fd are common but 500 Kg/Fd represents a good yield for most world conditions.

(b) For 1971-1974 the amount retained for seed is taken directly from Dept. of Agricultural Economics, Current Agricultural Statistics, Vol. 1, No. 2 (June 1976) Table 27. Later figures based on those supplied by Ministry of Industry (January 1979) in which 22 Kg/Fd is applied to area of following year's planting.

(c) Proportion of shell or nut varies from 30 % (rain fed) to 38 % (irrigated); 34 % shell represents a weighted average for current crops.

* A more conservative yield estimate from a different expert source in Ministry of Agriculture.

2.2 [illegible] and disposal of groundnut oil, cake and meal

The location, capacity and efficiency of oil mills is described in Chapter 3. Here the overall productive effect is considered.[1]

Table 2
(thousands of m.t.)

Year	Decorticated	Crude oil	Oil Yield %	Oil consumed in Sudan	Oil exported	Cake/meal produced	Cake/meal consumed in Sudan	Cake/meal exported
1971	[illegible]	11	45	11	-	12	12	-
1972	44	20	45	20	-	22	22	-
1973	102	46	45	46	-	51	51	-
1974	112	50	45	50	-	56	56	-
1975	251	113	45	102	11	126	100	26
1976	204	92	45	91	1	102	60	42
1977	388	175	45	147	28	194	126	68
1978	NA							
1983[2]	695	313	45	110	203	348		

[1] Current Agricultural Statistics (Dept. Agricultur) Vol.1, No. 2, June 1976

[2] Estimate by individual expert in Ministry of Agriculture

2.3 Production and disposal of sesame seed (thousands m.t.)

Table 3

Year	Area '000 Fed.	Production Undecorticated (a)	Yield Kg/Fd (b)	Deduct up to 2 % seed (c)	Waste about 5 % (d)	Human Food shown as undecorticated (e)	To local crushing undecorticated (f)	To export undecorticated (g)
1971	1857	297	160	5	11	22	179	86
1972	1922	296	154	7	11	21	174	87
1973	2846	340	119	5	12	23	192	105
1974	2167	240	111	5	8	17	135	108
1975	2180	230	106	6	77	13	109	57
1976	2258	248	110	5	12	17	146	104
1977	2340	270	115	5	13	19	159	109
1978	2424	292	120	5	14	20	172	
1979	2511	316	126	5	15	22	187	
1980	2601	342	131	5	17	24	200	
1981	2695	371	138	6	18	26	219	
1983[1]	2700	378	140	8	11	30	329	

(b) The yields are about the same as the average in India (118 kg/Fd) but well short of 200-390 kg/Fd common in several other countries.

(f) In the Sudan the white variety of seed contains 35-40 % hulls; this variety is the one preferred for the preparation of confectionery; the red variety is often somewhat richer in oil and has less hulls. Some of the locally crushed seed may later be exported as oil and cake. (f) = (a)-(c)-(d)-(e)-(g) approx. (e) = 0.35(a-c);(d) = 0.05(a-c). approx.

(g) International Trade Statistics shown here rather than Ministry of Agriculture figure from which there is some variations.

[1] From a different export source in Ministry of Agriculture.

2.3.1 Production and disposal of sesame oil, and cake (thousands m.t.)

Table 4

Year	Seed Crushed	Crude Oil	Oil Yield %	Oil Consumed	Oil Exported	Cake Produced	Cake Consumed in Sudan	Cake Exported (a)
1971	179	86	48	86	(27 t)	89	13	11
1972	174	84	48	83	(533 t)	87	72	18
1973	192	92	48	87	(222 t)	96	84	18
1974	138	66	48	65	(1.3 t)	67	53	4
1975	108	52	48	51	(294 t)	54	49	30
1976	153	70	48	69	2.4	73	28	45
1977	159	76	48	76	(201 t)	80	55	25
1978								
1979								
1980								
1981								
1983	329	158	48	86	72	165		

Undercorticated seed exported (white, red and mixed) is shown in Table 3.

(a) These figures are from International Trade Statistics and not Ministry of Agriculture

1/ From a different export source in Ministry of Agriculture

2.4 Production of castor beans (thousands m.t.)

Castor has been cultivated in the Kassala province under irrigated conditions for many years. The 1970 season, produced some 23,000 mt from 45.000 Fd. at an average yield of 511 Kg/Fd. This represents the biggest annual production although a few years have shown yields up to 636 Kg/Fd. About double this yield under good conditions (Brazil, California) is attainable. At present the crop is running at about 16000 m.t. and yields of only 350 Kg/Fd. This crop is unlikely to be extended; it is virtually all exported and fetches over Ls. 3 million.

2.5 Experimental production of soya beans in the Gezira

Recent experiments on irrigated land in the Gezira by the Agricultural Research Corporation have resulted in a yield of about 1000 Kg/Fd soya-beans, which is well inside the normal range of yields in USA. However, the types tested did not grow tall enough in the Gezira for mechanical harvesting. Since the Sudan cannot hope to compete with the USA as a world source of soyabeans, and since in soya bean the protein : oil ratio is some 35 : 18, there appears no obvious reason why the Sudan should invest in this crop. However, it is claimed that being of rapid growth soya bean has a better chance than other crops of being cultivated between two

cotton crops on the same land. Further, some of the areas being considered for soya bean cultivation are on the periphery of the present cultivated area and therefore, no other current crop would be affected. Finally, and perhaps most telling, it is said the crop could be used to fatten cattle awaiting slaughter for export. An area of about 40,000 Fd is being considered but a suitable variety of soya bean yet to be selected.

3. By-product vegetable oil crops

3.1 Cottonseed

Over three quarters of the cotton is grown in the Blue Nile province in irrigated conditions (the Gezira is easily the most important sector) whilst Kassala and Kordofan come next in importance among the remaining provinces. Concerning variety it is sufficient here to say that the so called "black" variety is distinguished by the great ease with which the cotton fibre separates for the seed rendering delinting superfluous. With no lint present to act as an oil absorbant the loss of oil in that direction is eliminated. However, if dehulling is attempted, the lack of even a little lint to help float the cracked hull from the meat by winnowing makes this inefficient, especially since a stronger air current may remove too many of the meats' particles. Only a linted number of mills have delinting facilities and this keeps down the price of white cotton seed to around Ls 38/ton, whereas the miller is prepared to pay Ls 60/ton for black seed.[1] The proportion of white cotton seed is increasing and it is arguable that linters being such a pure source of cellulose more than pay for their removal by a 2-cut delinting as in the USA and elsewhere - See Appendix 2.

Each year the Government decides in advance what proportion of the cotton seed oil produced is to be diverted from domestic edible use to the production of laundry soap. Cotton seed is allocated in proportion to the nominal capacity of the mills, with the exception that white cotton seed is first allocated to satisfy the delinting capacity of those mills which posses it and the remainder then shared along with the black seed. Commencing during 1974 the Government have imposed a ban on the export of cotton seed so as to obtain the added value of crushing, etc.

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[1] See definitions in Appendix 2.

3.2 Production and disposal of cotton seed (thousands m.t.)

Table 5

Year	Area '000 Feddans	Production Black plus White seed (a)	Yield Kg/Fd (b)	Seed deduct % (c)	Waste (d)	For local crushing (e)	Export (f)
1971	1210	470	389	18	24	362	55
1972	1219	441	362	17	22	354	25
1973	1193	358	304	18	18	297	16
1974	1194	431	370	18	22-	388	5
1975	1195	418	350	15	21	378	Nil
1976	1125	392	348	15	20	357	Nil
1977	NA	NA					Nil
1978							Nil
1979							
1980							
1981							
1983 1/	1490	598	401	20	30	548	

(a) From Current Agricultral Statistics - 1976
(b) Yields vary widely around the world, but 450 Kg/Fd and upwards is good.
(f) Note export ceases during 1974. Figures are from International Trade Statistics.

1/ From another export source in Ministry of Agriculture.

Table 6

3.2.1 Production and disposal of cottonseed oil cake (thousands m.t.)

Year	Seed Crushed (a)	Semi-refined oil prod. (b)	Semi-refined oil consumed in Sudan (c)	Semi-refined oil used for soap in Sudan (d)	Semi-refined oil exported (e)	Cake produced (f)	Cake consumed in Sudan (g)	Cake exported (h)
1971	362	58	20	15	23	282	92	190
1972	354	57	5	15	37	276	132	145-
1973	297	48	6	20	21	232	220	12
1974	388	62	37	25	(5 t)	303	198	105
1975	378	60	20	30	11-	295	258+	36+
1976	357	57	39	18	-	278	189	89
1977					(176 t)			61
1978								
1979								
1980								
1981								
1983 1/	548	88				427		

(a) From Current Agricultural Statistics - 1976
(b) The total raw oil recovery is 22 % (of seed weight) which contains 16 % edible oil, 4% soapstock and 2 % solid wastes according to Current Agricultural Statistics, Vol. 1, No. 2, June 1976, but it is common to estimate the oil content of the black seed as 23 %.
(f) Production of oil cake is 78 % weight of seed crushed in the same Current Ag. Stats. (1976), but some estimates round this off to 80 %.

1/ From another export source in Min. of Agriculture.

4. Vegetable oil potential production

The Sudan Yearbook of Agricultural Statistics (1974) indicates that 16,985,000 Fd were cultivated the previous year and these amounted to only 8.5 % of total cultivable land. The area actually cultivated depends on water available and since there is more rain in the South it is here the greatest expansion appears possible. The Gezira project now cultivates 2.1 million Fd of 5 m Fd lying between the Blue and White Nile. This cannot be increased to any great extent without endangering the amount of water agreed as the Egyptian share. The limits intensification of cultivation (vertical development) as well as cultivating more of the existing land (horizontal development) in the Gezira.

4.1 Cotton

Cotton does well under irrigation in this area, but it is primarily grown for its fibre. In spite of the increasing world use of synthetic fibres cotton, especially the high grade Egyptian and Sudanese production, is confidently expected to find a ready market for the foreseeable future and the oil is expected to rise steadily in price.[1/] Cotton then, remains even today, the most attractive crop to the farmer in the traditional cotton growing areas.

4.2 Sunflower

Apparently there is not enough time to grow a crop such as sunflower between two cotton crops on the same land and there is no incentive to replace groundnut with sunflower in other areas.

4.3 Groundnut

This is the dominant oil bearing crop and its future development is assured as indicated in Table 1. A major problem in January 1979 is moving much of the crop; in Darfur particularly, 60,000 - 100,000 mt are estimated to be rotting for lack of transport (See Sec. 5.1).

4.4 Sesame

North Karofan which produces the biggest crop of the various provinces has one of the poorest yields - ca. 75 Kg/Fd against average ca. 100 Kg/Fd. Although a large amount of this crop is grown in rainfed areas and probably suffers on that account, the introduction of better yielding varieties might improve the situation and this is appreciated by the Ministry of Agriculture.

1/ World Bank, Agricultural Sector Review, 1978.

4.5 Soyabean

It has already been stated in para. 2.5 that an economic case would have to be made for the introduction of this crop at the expense of some other. On the Nile, immediately to the north of Khartoum however, there is also understood to be spare land available (in addition to some in the Gezira) and here also experimental cultivation is being considered with foreign financial and technical aid.

4.6 Conclusion

In conclusion, therefore, the growth rate of 7 - 8 per cent per annum proposed for the three most important oil bearing crops of groundnut, sesame and cotton during the second six year plan appear to represent the maximum which is practical in relation to the present infrastructure of transport and management and the rate at which these can be improved.

5. Infra-structure

5.1 Transport

In order that a satisfactory rate of progress may be maintained towards realizing the large potential availability of oil bearing crops in the Sudan, the most important item in the physical infra-structure is transport. The rich and developing area of the Gezira can look forward in 1980 to the completion of the new high way to Port Sudan which already connects it to the industrial area of Khartoum (see map). The railway section Khartoum - Port Sudan via Atbara is over-burdened and receives priority for maintenance. This is understandable as the industries in the Khartoum area have to pay a heavy road freight of ca. Ls 65/ton which may drop by merely 10 to 15 per cent when the better conditions of the completed new highway are provided. The present rail rate of Ls 15/ton may be artificially low, but it is obvious that even if this is increased to pay for improved maintenance, all industry will benefit by a better connection between the capital and the main part of the country. As regards the vegetable oil industry, it may be mentioned that there is a heavy concentration of oil mills around Khartoum because it has always been on the perimeter of the main cotton growing area to its south. The importance of the rail link to the south-west is emphasized as Kordofan and Darfur are already individually next in importance to the Gezira as producers of groundnut and the most important

as producers of sesame. Encouraged by favourable prices for groundnuts the population in these south-west areas, including many who have been semi-nomadic, have taken to raising greater crops, with the unhappy result that in the Darfur area where some 200,000 tons have lately been harvested, about 100,000 tons are awaiting transport on a railway which currently provides only an erratic service and is currently quite unequal to its task. The railway is 3' 6" gauge throughout its length but different weights of rail track occur as follows - from Port Sudan to Khartoum the rail weights 90 lbs/yard; from Khartoum to a point a little south of El Obeid, 75 lbs/yard; from there southwards to Nyala and Wau, 50 lbs/yard; all track is mounted on sleepers, not laid on hard core but the ground itself and stretches of track, especially in the south, are badly in need of maintenance. Only light engines can operate on the light 50 lbs track and this leads to congestion at the change over point. About 50 per cent of the railways mixed collection of German, Japanese and American diesel locomotives are in workshop being maintained. The World Bank was stated by the Ministry of Industry to have been giving support to the Sudanese Railway and to be producing the latest in their series of reports on the system later in 1979. Clearly the railway system is the first priority for industrial development in the Sudan.

Although it may be time there is substantial inofficial trade in groundnuts and soap from the Sudan to neighbouring central African countries using animal transport, it remains true that much economic advantage to the Sudan will be lost if crops from the rain-fed areas to the south cannot be processed. The fact that the surplus has appeared confirms the real potential of these areas when they have an incentive.

5.2 Management and maintenance

Management must provide themselves with information to see that the efficiency of the plant is not falling away and if it is, the information should be such as to indicate quite quickly in nearly all cases where the trouble lies. Equally this applies to mechanical maintenance. A UNIDO supplied maintenance engineer quotes how he has taken it as normal in his own country that before opening a new set of ball bearings a

fitter should wash and dry his hands so as not to convey the least grit to the new bearings. He discovered during his assignment that a fitter would lay the ball bearings on the floor prior to installing them. Instances are now noted, and not only in the vegetable oil industry, where when tendering for the supply of a plant such as a combined oil mill, refinery, hardening and packing unit the supplier proposes to train a limited number of Sudanese personnel (management and engineering) and to establish a service depot in the Sudan as well as to commission the plants supplied by him. Contacts of this kind can obviously raise the standard of local maintenance, but only if the local management and maintenance staff have the incentive to keep up the monotonous routine inspection of plant performance records as well as visual daily checks on the quality of the material in process and the behaviour of machines. In simple terms the attitude to the job is placed next to transport in importance but as a non-physical item of the infra-structure. It would seem that this second item will be more difficult to improve than the railway.

6. The domestic market for oils, fats and associated products

6.1 Types of oils and fats consumed

Traditionally the Sudanese use oil for cooking and are fortunate in ejoying a much higher invisible fat (meat, milk) diet than many other developing countries. Table 7 which is an excerpt from FAO Food Balance sheets - 1974, makes this clear.

Although a hydrogenated vegetable oil/soft oil blend is marketed as a cooking fat "samn nabati", or "vegetable ghee", and is thus equivalent to the widely known "vanaspati" of the Middle East, India and elsewhere, this product is not in such demand as in those other areas. The greater part of the groundnut oil and sesame oil are consumed in the raw state, merely being filtered. With cottonseed oil full refining is necessary for edible purposes, both to lighten the colour by removal of the black phenolic pigment gossypol, and to reduce the free fatty acid and to give a bland taste. At Appendix 3 are set out the costs of producing groundnut oil (crude and refined), sesame oil (crude), refined cotton seed oil and laundry.

Table 7[1/]

International Comparison of Private Consumption Expenditures (PCE), Consumption Levels and Income Elasticities of Demand for Food Fats and Oils

	PCE per caput 1970 US$	Visible fats consumption Kg/cap/annum				Invisible Fats	Total Food Fats	Population ('000) 1974	Income Elasticity of Demand	
		Vegetable Oils	Animal Fats	Butter	Total Kg/cap/ann.				Total Fats and Oils	Vegetable Oils
Sudan	72	6.1	0.4	0.9	7.4[2/]	14.0	21.4	15.786	0.77	0.7
India	73	3.9	0.3	0.8	5.0	5.6	10.6	538,986	0.92	1.0
Iraq	161	5.3	0.9	0.7	6.9	7.0	13.9	9,695	0.70	0.7
Iran	235	5.8	1.1	1.4	8.3	5.9	14.2	28,372	0.77	0.8

1/ Excerpt from "Commodity Policy Study on Oilseeds, Edible Oils, Oilcakes and Meals Pakistan" AG : DP/PAK/73/047 - Terminal Report. FAO 1975.

2/ The Nutrition Division of the Ministry of Health, Khartoum, informed the mission that four recent surveys (1974-1979) carried out by the division on visible fat consumption showed consumptions Kg/cap/annum of 16, 14, 15 and 11.

6.2 Allocation of oils; their present and future use

A peculiarity of the situation in the Sudan is that although cotton seed oil is a useful component in a soap corn position along with tallow, palm or hydrogenated oil to increase the firmness of the tablet and coconut or palm kernel oil to promote solubility and hence quick lathering, it is far from ideal as the sole fat or dominant fat component. The mere fact that it is available on the spot has led to the soap makers being allocated at times half the domestic production of semi-refined cotton seed oil (i.e. 30,000 mt) for laundry soap manufacture, which is in the region of 50,000 mt per annum at 58 per cent fatty matter, i.e. 1 ton of oil when saponified is taken to yield 1.5 tons soap. The latest (January 1973) allocation is soap 70 per cent, edible use 30 per cent. Toilet soap at 2.600 mt/annum is made from imported tallow and coconut oil. The domestic consumption of laundry soap is, therefore, close to 3 Kg/cap/annum for a population of an estimated 16 million and toilet soap 0.16 Kg/cap/annum. A negligible amount of soap is imported but because of the low cost of soap in the Sudan it is understood a lot is smuggled abroad. The low cost is, and has been, related to the Government policy of keeping the cost of cottonseed oil allocated to soap-making to a low figure, currently Ls. 336 per ton as against Ls 413 when used for edible purposes. It is foreseen that the demand for laundry soap is likely to reach 6 Kg/cap/annum unless the production and use of soapless detergent grows sufficiently rapidly to depress this as it already has in developed countries (U.K. laundry soap consumption = 0.4 Kg/cap/annum). The only manufacturer with capacity to produce pure sulphonic acid and hence to sulpherate hydrocarbon or glyceride bases has up to now produced and sold only some 1.500 mt/annum of soapless detergents, but he now has a blowing capacity of 3 tons/hr, thus in 300 days an output of 16,000 tons would be feasible (75 % utilization), and this together with the product of one other manufacturer who merely dry mixes and packs ingredients, would be quite capable of levelling off the laundry soap demand in a very few years as long as the price remained competitive and the means of distribution effective. The low overhead costs of the traditional manufacturers of soap are likely to ensure that their disappearance will be slow.

Evidently any plans to import tallow for soap making so as to release the more valuable vegetable oil for sale on the world market must be viewed in the long term against the levelling off and indeed decline of the laundry soap trade. At the same time the cost of importation of suitable hydrocarbon from Arab controlled oil fields to be sulphonated in Sudan must be compared without delay with soap making costs and this is not difficult since both processes are now underway in Khartoum.

Already a low foaming soap cum soapless detergent powder mix has been put onto the non-distributive market (e.g. army and other public bodies) since these are in a position to wash laundry by machine but for the population who seemingly will continue to prefer a bar or tablet of soap to a powder. This raises the question as to whether a filled soap plus detergent bar might prove a commercial succes in African countries when it has not gained popularity in more sophisticated markets where domestic washing machines are common place. Finally the bio-degradable standard of the synthetic detergent should be checked so as not to create a pollution problem.

6.3 Edible fats: retail prices

The current situation of the edible oils and fats domestic market is that, as indicated in Appendix 3, the cost of groundnut and sesame oil very from one part of the country to another and, depending on the harvest, are scarce or easy to find. Butter is expensive in Khartoum at Ls 2.5 to 4.0 per kg. At controlled prices for oils, on the cost of the 16 kg tin ex-factory the whole-saler gets 5 per cent and the retailer 10 per cent; thus (retail price in brackets), groundnut Ls 10.50 (Ls 12.08), cottonseed oil (deod.) Ls 6.705 (Ls 7.71), sesame Ls 12.50 (Ls 14.38). Bought in small amounts local ghee is 75 piastres per half kg; cooking oil 40 piastres per 0.5 kg.

These commodities are available in the co-operative shops on a rather irregular basis, and if found with private dealers are likely to cost somewhat more. Sudan is decidedly a net exporter of vegetable oil, yet the World Food Programme finds it desirable to import edible hydrogenated marine oil from Norway for free distribution in certain areas to needy cases. Again large crops of groundnuts in the south have to be stored in unusual buildings, temporarily at least, since

60,000 - 1000,000 tons cannot be moved on a railway which is reported in such poor shape that during August 1978 only four goods trains reached Nyala where much of the crop was stored and where much still remains (Sec. 5.1).

6.4 Oil cake

Finally, oil cake has been both used at home and exported on the large scale for many years. Table 8 shows the trend for oils, soap and cake over recent years and what is the target for the end of the current six year plan (1983).

6.5 Soap retail prices

The detail of the derivation of the ex-factory cost of laundry soap is given at Appendix 3 and amounts to 36 piastres per kg. A carton containing 45 tables of 180 grams each has a cost of Ls 2.88 or 6.4 piastres per tablet, to which must be added a wholesale and retail margin of at least (5 + 10 %) bringing a minimum retail price to almost 7.5 piastres. For some toilet soap 20 piastres a tablet is asked; for the premium local brand (Lux) a 140 g tablet costs 27 piastres. Imported toilet soap costs more again. The present level of demand is laundry soap approximately 50,000 mt/annum, Soapless detergents 1700 mt/annum; toilet soap approximately 2.700 mt/annum, and these should increase by about fifty per cent by the end of the current six year plan, 1983.

6.6 Domestic consumption trends

Table 8[1/]

Domestic consumption of vegetable oils for food, oil cake for feed and soap (thousands m.t.)

Edible oils	1971	1972	1973	1974	1975	1976	1983
Groundnut	11	20	46	50	102	91	110
Sesame	86	84	87	65	51	68	86
Cotton	20	5	6	37	20	29	88*
Total:	116	108	139	152	173	188	284
Kg per cap.	8.3	7.7	9.6	10.2	11.3	11.7	14.8
Oil cakes							
Groundnut	12	22	51	56	100	136	(348)*
Sesame	74	72	84	53	49	60	(165)*
Cottonseed	92	132	220	198	258	189	(427)*
Total:	178	226	356	307	407	385	(840)*
Soap							
Laundry kg/cap	2.0					2.7	ca.4
Toilet kg/cap	0.13					0.16	ca.0.21

*Total production estimate. For local consumption of cotton seed oil in 1983 the total production is taken as being used domestically for food and none for soap. For 1976 the figure 29,000 mt represents 50 per cent of the total production, the other 50 per cent being regarded as converted to soap. As regards cake in 1983 the estimated 840.000 mt covers domestic use and export.

At present (January 1979) groundnut cake costs Ls 70 - 80 per ton ex-mill. Sesame cake is fed to cattle only in the White Nile region. There is a variation in cake prices from region to region depending upon transport costs.

1/ Based primarily on Current Agricultural Statistics 1976 and some data from private and Government specialists.

7. The export of vegetable oil industry products to the international hard currency market and elsewhere

7.1 Current export position

The Sudan has been established in the international oils and fats market for many years. Appendix 4 gives the recent position of seed, oil and cake, 1971 - 1977, and Tables 1 - 6 allow exports to be compared with production and domestic use over a similar period with projections as far as production is concerned to the end of the present six year plan (1983). The Sudan Oil Seeds Corporation (58 % public ownership) controls exports of oil seeds and determines minimum internal prices as well, although it does not conduct internal trade. The export of oilseeds represents about one third of the country's export earnings. The quality requirements and trading practices of the international market are obviously familiar to the Corporation. Since 1974/75 no export of cottonseed or its oil has been allowed, but only cake and even this to a rather diminishing extent. With the exception of the production of two oil mills at Port Sudan, which largely serve the export trade, the export of groundnut and sesame oil ceased in December 1978. For groundnut in shell and decorticated export is permitted in Grade 1 (the best); groundnut cake is also exported. White sesame seed maybe exported, but all red seed is crushed in the Sudan, the oil being retained in the Sudan (except for two mills at Port Sudan), whilst it is permitted to export the cake.

7.2 Export opportunities

It should be evident that Sudan will maximise foreign earnings by selling the biggest amount of the higher priced materials which can be spared, e.g. groundnut products and to the extent that industrial processing can be performed, there is the opportunity to earn more by the added value. This implies that more is earned by the additional processing than the cost of processing as performed in the Sudanese context. Before any capital investment is made this point must always be thoroughly explored; it is closely allied to the question of infrastructure (Chapter 5).

7.3 Edible v. soap

From information available to the mission before arrival in the Sudan it was clear that the very high proportion of cottonseed oil used in the production of household soap represented a technical and economic oddity (Sec. 6.1.1). This had also been appreciated by the Ministry of Industry, and the feasibility of employing imported tallow and coconut oil to replace cottonseed oil in household soap was being studied. The cottonseed oil thus released (ca. 35,000 m.t. p.a.) could be exported, or better, used to replace groundnut oil in the domestic market so that the latter, because of its higher international price, could be used to maximise foreign earnings. In the context of cheap domestic cotton seed oil even locally made, hydrogenated cottonseed oil has been used to "firm up" the fat composition for soap making by those who had the facility. The following differential as estimated by the Ministry will make clear the immediate advantage to be gained. This also is highly likely to persist indefinitely. The calculation by the Ministry at current (January 1979) prices runs as follows.

1. Sudan uses (say) 30,000 mt semi-refined cotton seed oil per annum at Ls 336.50/mt for soap making (no glycerine credit). This is an internal cost, or charge to the soap maker, but without the 5 per cent Development Tax and the Ls 15/mt Excise Duty the charge would only be Ls 306.205/mt to which we would then have to add Ls 9.00/mt as a deodorizing charge = Ls 315.205/mt before tax.

2. A tallow plus coconut blend can substitute for cottonseed oil and produce a superior soap. Their costs c.i.f. Port Sudan are: Tallow = US$ 600/mt; Coconut = US$ 950/mt both in bulk. Cost of one ton 80 : 20 : tallow : cooonut blend = US$ 670.

3. By diverting 30,000 mt semi-refined cotton seed oil to edible use 30,000 mt groundnut oil are released for export valued c.i.f. Rotterdam at US$ 1090/mt.
   Gain per ton 1090 - 670 = US$ 420
   Gain 30,000 mt = US$ 12,600,000.

4. From this gain we must deduct certain expenses
   (Transport in Sudan Ls 15/mt = US$ 37.5)
   (a) Transport in Sudan 30,000 mt = US$ 1,125,000
   (b) Ocean freight 30,000 mt = US$ 900,000 (at US$30/mt)
   (c) Insurance, commissions etc.
   at 3 % cif price = US$ 32.7/mt
   for 30,000 mt = 981,000
   Total (a), (b) and (c) = US$ 3,006,000

5. Gain (3) - Expenses (4) = US$ 9,594,000.

6. A policy decision has also to be taken to amend the low soap prices to fall in line with the cost of the new fat charge of US$ 670/mt at Port Sudan to which is added 52 per cent as clearance (customs etc.) expenses, making it US$ 1018.4/mt or Ls 407.36/mt (taking Ls 1 = US$ 2.5).
   Further transport of the tallow and coconut fats must be considered as taking place by rail and road for which an average (50/50) would be $\frac{\text{Ls } 15 + \text{Ls } 50}{2}$ = Ls 32.5/mt.
   - but this can be recovered, it is believed, by selling drums used (5 to the ton) at point of delivery, usually in Khartoum.

If the Ministry decides to split the imported tallow and coconut oil at Port Sudan and export the glycerine, the capital investment of the necessary plant would be made on the prospect of a pay back in 2.5 years by which time the basic advantage of importing cheaper tallow and coconut is virtually certain to remain and persist.

Since the soapmakers are concentrated mainly in the Khartoum area where the cottonseed oil is most readily available, it is necessary to allow for the above cost of transporting the corresponding groundnut oil from its place of origin to Port Sudan, and the cost of bringing tallow plus coconut oil from Port Sudan to the soap makers. The Ministry was warned that any more to split the tallow and coconut oil and transport the free fatty acid so obtained as the soap making material entailed the serious risk of the free fatty acid attacking the metal of any container unless the latter were specially protected, say by expoxy resin. Traces of iron act as oxidation catalysts and promote discolouration of the soap.

7.4 Vegetable ghee (Samu nabaati (Arabic) Vanaspati (Urdu))

Since the Arab countries of the Middle East are among the most important of Sudan's customers for edible oil it would appear likely that these should be customers also for vegetable ghee. The vegetable oil is already passing through Port Sudan or being extracted there, hence a hydrogenation unit sited in Port Sudan would be the most advantageously placed of any in the Sudan to serve such an export market just as the solvent plants there supply vegetable oil for export.

7.5 Soap

The Sudan is a net exporter of soap although the trade is not large as yet. Besides the 120 per cent c.i.f. value import tax, there is an import duty of Ls 65 per ton on toilet soap and Ls 7 per ton on household soap and detergents. The import/export statement for 1976 will make the position clear:

Imports 1976	
Household soap 1.03 tons Toilet soap 47.47 tons	Ls 14,922
Export 1976	
Household soap 584.8 t at Ls 260/t Toilet soap 70 tons at Ls 429/t	Ls 181,943
Favourable balance of trade:	Ls 167,021

Since indigenous vegetable oil is more suited to be sold as food and as most soapmakers are near the centre of this large country, it does not appear that Sudan is likely to develop a flourishing soap export business. Evenso, there was a shapp increase between 1974 and 1976 to the levels quoted above.

8. Present operational state of the vegetable oil industry and plans for its expansion

8.1 Location of oil mills, crushing capacity and utilisation (1977/78)

Table 9

These mills crush groundnuts and sesame seed.

Province	Number of mills	Nominal capacity '000 mt/ann.	Capacity utilised '000 mt/ann.	Oil Produced '000 mt (197)	Utilisation %
Gezira	7	55	21	9	39
Red Sea	7	293	152	67	52
Kassala	2	4	2	(697 mt)	46
White Nile	10	51	6	2	13,4
Blue Nile	8	43	2	(741 mt)	4,4
N. Kordofan	23	108	54	22	50
Khartoum	6	5[illegible]	37	16	73
N. Darfur	2	5	(585 mt)	(240 mt)	22
S. Darfur	10	39	16	7	45
Rounded Totals:	75	648	290[1/]	124	44.8

1/ This figure may be appreciably less than the total national crush for the same period, simply because several cotton seed crushers (Table 10) buy some decorticated groundnut and undecorticated sesame to be crushed in their own mills which would otherwise stand idle for a time.

Table 10

These mills crush cotton seed; most are not equipped with delinters, hence "white" (American type) or lint bearing seed is preferentially supplied to those which have delinters and the surplus then shared along with "black" (Egyptian type), a virtually non-lint bearing variety.

Province	Number of mills	
Khartoum	19	Omdurman. Khartoum North.
Gezira	1	Wad Meddani
Blue Nile	2	Rabak. El Diwain
N. Kordofan	2	El Obeid. El Rahad
Kassala	1	New Wadi Hal fa

Together, the above mills have a nominal cottonseed processing capacity of 555,000 mt/annum of which some 263,000 mt or 47.5 per cent were taken up in 1977/78. At this level some 40,000 of semi-refined cottonseed oil are produced, 30,000 mt going for soap making and 10,000 mt for edible use after refining. For detailed explanation of the disadvan-

tages of failure to delint cottonseed see Appendix 2. The village mill powered by animals has disappeared from the Sudan; "apart from a few near El Gedaref in the east". Only two pre-press/solvent extraction plants exist; these are at Port Sudan and operate largely for the benefit of the export trade. They are included in the Red Sea Province of Table 9. One (El Sheikh) has a capacity of 400 mt/day groundnuts and the other (Walliab) 250 mt/day. Both plants pre-press down to approx 15 per cent oil in cake; the first has a solvent extraction capacity of 250 tons cake/day and the second 160 tons cake/day. Both state they operate at 1 per cent oil in meal although their respective guarentees were 0.4 per cent and 0.5 per cent. The first claims a solvent loss of 3 Kg hexane/ton input and the second 6 Kg. Steam usage in both cases is 320 kg/ton input. The meal is pelletized and sold by both c.i.f. Rotterdam US$ 225/ton. In addition El Sheikh has a capacity for 100 tons mts/day expelling only. There is a 100 mt/day crushing mill at Wad Meddan. The mills are thus a mixed collection of screw presses of different ages and origins (British, German, French etc.)

8.2 Efficiency of crushed oil production

At best those on cotton which might have to crush a 3 : 1 mixture of black : white seed would yield from a 22.5 per cent oil in seed some 17 per cent refined oil and 80 per cent of cake containing some 5.5 per cent oil. Ministry of Agriculture are less optimistic (Sec. 3.2.1 (b)) as regards cotton but work on a 45 per cent (from ca. 47 per cent) crude oil yield for groundnut (Table 2), and 46 per cent (from ca 50 per cent) crude oil for sesame (Table 4).

8.3 Future oil mill construction

For some three years early in the 1970's when optimistic forecasts of the rate of development of oilseeds crops were widely accepted permission was granted to build more oil mills and these are listed below. Now, although the need is seen not to be so urgent, the Government feels unable to rescind licences once granted and hence has merely restrained the rate of new building by slowing the rate at which land is authorised for the purpose.

Table 11

Oil mills under consideration - use groundnuts and sesame seeds for milling

Province	No of oil mills proposed	Maximum proposed capacity ton/annum
Blue Nile	11	92,725
Gezira	31	318,730
Khartoum	7	87.100
Nile	3	8,650
Southern Sudan	4	34,130
Southern Kordofan	2	10,200
Red Sea	6	71,350
North Kordofan	15	104,980
North Darfor	2	8,700
Southern Darfor	10	68,900
Kassala	6	143,200
White Nile	9	29,400
	106	978,065

Table 12

Oil mills which have refineries

Name of oil mill	Type of refining C = continuous; B = batch
1. Bitar Company	C
2. Sudanese Oil Corporation	C
3. African Oil Corporation	C
4. Sudan Soap Factory	C + B
5. Taitel	C + B
6. Malik Industrial Company	C + B
7. Kamair	C
8. El Sheikh Mustafa El Amein	C + B
9. Marhab	C + B
10. New Halfa	C + B
11. Sunosi	C
12. Bahri El hadeitha	C
13. Port Sudan Vegetable	C + B
14. El Madih	C
15. El Nafoum	C
16. Oil and Soap New Company	C + B
17. El Gezera	B
18. El Safa	B
19. El Nifaidi	C + B
20. El Hiderbi	B
21. El Nakhilat	B
22. El Hamed	B
23. El Fadel	B
24. El Sheikh Mohammed Ali	B
25. El Barbari	B
26. El Toum AbdAllah	B
27. Rabak	B
28. El dibait	B
29. Awad Mohammed Ali	B (under construction)

Many continuous refining lines are of the Sharples type. As far as is known the input capacity for crude oil is at least equal to the output of the mill it serves (see Table 9 and 10 for output of oils).

8.4 Soap manufacturing capacity

There are eight soap factories classed as "modern" with a combined output of 9 tons/hour. These include some Mazzoni plants. These are equivalent to a possible output of some 45,000 tons/annum. Six additional factories (or extensions) to be commissioned add a further capacity of about 40,000 tons/annum. The number of traditional soap makers is estimated to contribute a possible 60,000 tons/annum. These bring the total to 145.000 tons/annum capacity which is evidently about 36 per cent employed and would cope with demand far beyond the termination of the current six year plan. Even if a radical change in soap compositions and costs closes some of the traditional manufacturers in the next year or two ample capacity will remain.

9. Management and process control

9.1 Management

The organization of factory management appears to be on the same pattern in the larger establishments such as the nationalized Oil Corporation in North Khartoum, The Gezira Oil Company, Wad Meddani and the Soap and Allied Industries (Sudan) Ltd. in North Khartoum, as would be the case for comparable establishments in Europe. A number of staff are likely to have studied and possibly obtained operational experience in Europe. Factory managers, departmental managers, qualified works engineers and chemists were encountered. With some notable exceptions the process knowledge appears circumscribed by the particular requirements of the plant in which the individual operates. Here and there, such as in a soap packing room or hydrogen generating room, tolerably tidy conditions would be met but most places were untidy or dirty or both. Expert knowledge is not required to detect this, it is agressively obvious; improvement will come when management see it as their responsibility and they are supported in their efforts by the interest of higher authority which is publicised and made evident to operatives by their visits to the factory floor. It will take longer to improve attitudes to work than to build new factories.

9.2 Quality control and efficiency measurement

Some simple tests are performed and acted upon such as the estimation of the free alkalinity of the finished soap (or its absence), or the free fatty acid of an oil about to be neutralized or which has been deodorized. Commonly oil will not be weighed into the refinery but measured by volume from a particular store tank which may be sufficiently filled to serve the refinery for several days. Whilst the theory of quality checks and simple mass balances between inputs and outputs from each process stage may be understood the practice seems to fall short of the standard whereby management can identify within narrow limits where discrepancies are arising and what may be their cause. Such a control is a routine chore and will be taken seriously to the extent that management makes use of it.

9.3 Maintenance - general

This is a major problem for the Sudanese in which they are not alone. It underlines the difficulties experienced by the Sudanese railway which in turn frustrate the enjoyment of the full potential benefits of agriculture and place burdens of delay and cost on industry. At least the problem is openly recognized and has been the subject of a detailed analysis by the Sudanese Management Development and Productivity Centre[1/] The study proceeded via (a) distribution of a questionnaire and analysis of replies; (b) personal interviews with a cross section of managers and supervisors; and (c) discussions held with those taking part in courses conducted by the Centre for a group of industries.

9.4 Maintenance organization

The most interesting facts to emerge from the whole study were briefly as follow.

(a) 98 per cent of the companies examined had their won maintenance section and in manufacturing and light engineering organizations this accounted for 22 per cent of those employed (an adequate proportion);

(b) Some form of planned maintenance was followed by the great majority;

1/ "Maintenance Problems in Industry" by industrial engineering specialists of the Management Development and Productivity Centre, Khartoum, October 1977.

(c) Poor records made it difficult or impossible to estimate frequency and cost of maintenance but about 12 per cent of production costs appear to arise from plant maintenance.

(d) Technical standard of competence of maintenance personnel was inadequate (see also 9.5 below) and the country suffered from a "brain drain" of good maintenance personnel to some surrounding Arabic speaking countries. Only a quarter of engineering personnel depended upon training abroad.

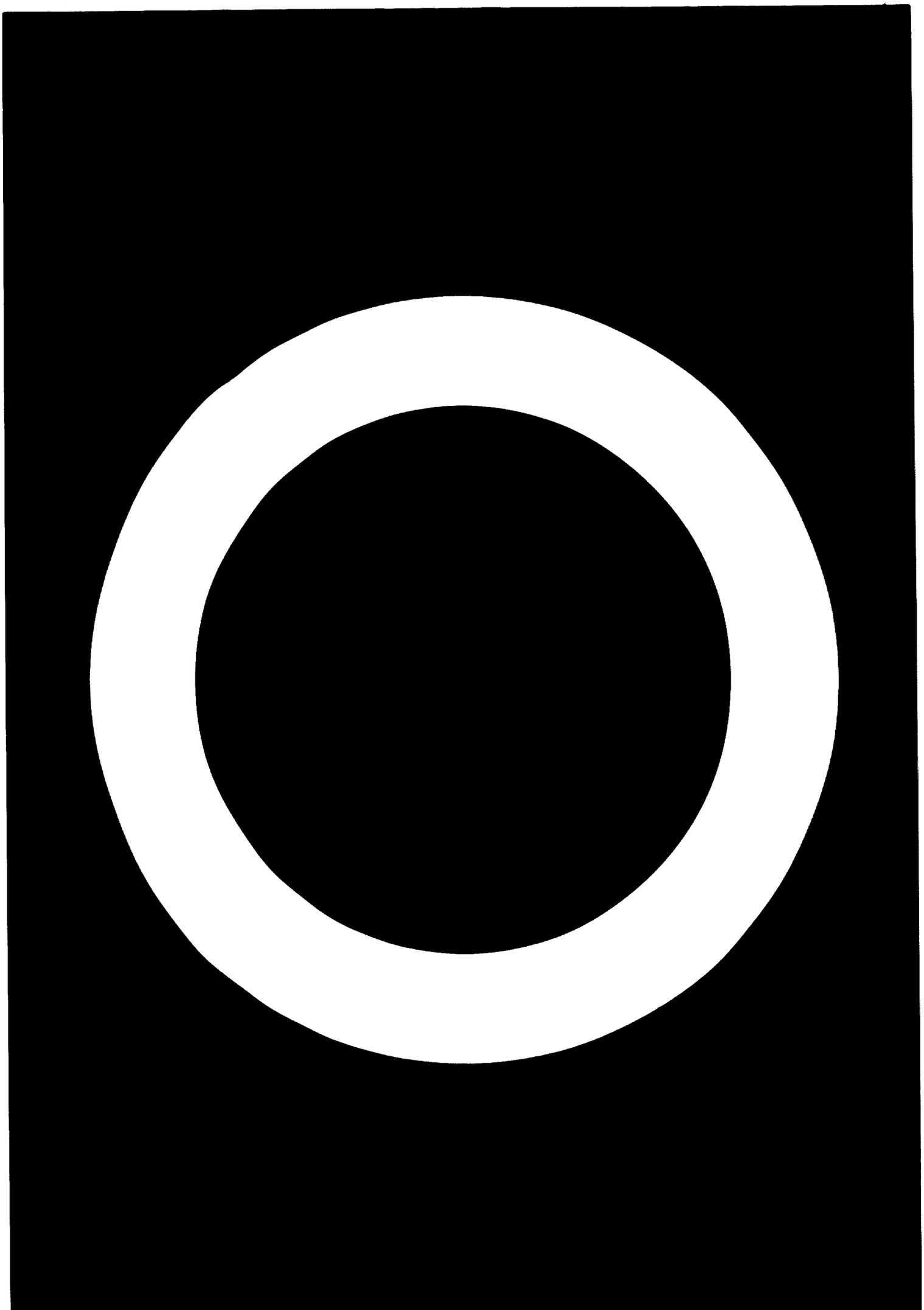
9.5 Aggravating factors

Various factors aggravate difficulties experienced by the Sudanese but it may be remarked that certain of these operate in developed countries to a varying extent. A considerable variety in type of machine installed for the same class of work has arisen either because the firm started in a small way with second hand equipment and added different new machines as it grew, or Government might direct that machines were to be purchased from certain foreign countries as the result of bilateral agreements. Engineering personnel were thus called upon to become familiar with wide range of equipment; a larger stock of spares becomes necessary and this increases expense; there is a reduced interchangability; the variety of tools lubricants and paper work increases; about 72 per cent spares have to be imported directly.

Although minimum and maximum stock control was understood, it was not practised.

9.6 Conclusion

It seems that now the nature of the difficulties is being recognised efforts to correct the situation over a period of time could be effective. Management have a most important part to play in maintaining an insistence that where some form of repair is feasible, it must be done. At least within a company standardisation will help and to the extent that imports are controlled Government can show understanding to industry whilst themselves promoting greater standardisation in areas under their own control wherever this is feasible.



Appendix 1

Contacts

Mr. G. Ibrahim (Managing Director)	Soap and Allied Ind. (Sudan) Ltd.
Dr. El Rasheed	Soap and Allied Ind. (Sudan) Ltd.
Mr. B. M. Bukhari (Man. Director)	Oil Corporation (Public)
Mr. W. Shanouda	Oil Corporation (Public)
Mr. M. M. Satti (Man. Director)	Satti Company (Soap and Edible Oils)
Mr. E. I. Satti	
Mr. M. A. Hamo, Exec. Director	Ministry of Industries
Mr. A. G. Suleiman	Ministry of Industries (Gen. Man. Ind. Control)
Mr. Osman El Amin	Ministry of Industries (Food Technologist)
Mr. E. Sidig	Ministry of Industry (Cost Accountant)
Mr. H.A.H. Mohammed	Ministry of Industry (Chem. Engineer)
Mr. M. A. Ahmed	Ministry of Agriculture
Mr. A. El Sheik	El Sheik Oil Mills
Mr. K. Ibrahim	Waliab Oil Mills
Mr. A. A. Mohamed	Oil Corporation (Public)
Mr. K. I. Ahmed	Oil Corporation (Public)
Mr. A. H. N. El Galil	Oil Corporation (Public)
	Secretary to the Egyptian-Sudanese Committe making feasibility studies for integrated agro-industrial complexes of which Mr. Bihari is a chairman.
Mr. Sayed Elhag	Sudan Oilseeds Company
Mr. Milad Soleiman	Gezira Board (PRO)
Mr. Hussein Omer Kisha	Gezira Board (Dep. Man. Dir. Agro-Ind.)
Mr. Stephen Szivos	UNIDO-SIDFA rep. in Egypt and Sudan
Mr. George Zaki Boutros	Regional Manager, Sudan Railways, Khartoum
Dr. Ali Karrar Osman	Nutrition Division, Ministry of Health

Appendix 2

1. Typical Analysis of Main Oilseeds grown in the Sudan (Wellcome Laboratory, Ministry of Health)

Type	% oil	% protein	% carbohydrate	% fibres
Groundnut	45	27	17	3
Sesame	50	20	16	5
Black Cotton-seed	23	22	28	21
Soyabean 1/	18	35	20	22

A ten years (1963-1973) average of seed cotton (Ministry of Agriculture, Food and Natural Resources, 1974, p. 24) gives:

Lint	34.20 %
Scarto and linters	0.49 %
Seed	64.36 %
Waste	0.95 %
	100.00 %

1/ Experimentally grown in Gezira and too short to be harvested mechanically.

2. Definitions

Seed cotton - seed cotton is the cotton as picked.

Cotton seed - Ginning reduces the fibre attached to the seed from ca. 34% to ca. 14 % for most varieties of cotton in Sudan.

Delinted seed - The so called "black" seed (Egyptian variety) in the Sudan parts so easily with all its fibre that virtually none is left on the seed; the "white" seed (American variety) on the other hand like most varieties elsewhere retains ca. 14 % fibre after ginning. This, when given one "cut" during delinting, is reduced to 7 % and when given two "cuts" is reduced to 3 - 4 %, which is comparable to the best practice anywhere. The short lengths of fibre removed by these cuts are known as "linters".

Clean whole seed - when all extraneous fibre (lint) is removed by hand e.g. in the test laboratory, a "clean whole seed" remains. Because of the dry climate in the Sudan. This clean whole seed only contains about 4.5 % moisture as against the 10 - 12% common in several other countries. Black seed, of its nature, approximates already to clean whole seed, and shows 23 % oil content as it is, i.e. on a wet (4.5 % moisture) basis. White seed is tested (for moisture then oil) whilst still carrying its 14 % linters, the whole containing some 5 - 6 % moisture, and it is therefore, not surprising that white seed is reported as containing only 18 - 19 % oil. The best international practice is to dry clean whole seed to constant weight and then report the oil content on a dry basis.

Appendix 2
(contd.)

Washed oil or semi-refined oil

Crude oil as expelled whose free fatty acid content has been reduced to about 0.3 % by alkaline neutralisation, washing and drying.

Examples	Composition		
(a) Seed cotton	34 lint 66 seed	or	51.5 lint 100 seed
(b) Cotton seed	14 lint 86 seed	or	16.3 lint 100 seed
(c) Delinted seed	4 lint 96 seed	or	4.2 lint 100 seed

(d) Crushing undelinted seed as at (b) above which contains say 5 % moisture and 19 % oil. For simplicity assume moisture distributes itself evenly and is ignored.

116.3 **Parts crude oil** 11

Cotton seed 105.3 **Parts cake**

parts washed oil + soapstock 10.6 + 0.4

parts oil in cake 8

97.3 **parts hulls, linters etc.**

$$\text{Oil in cake} = \frac{(19-11)}{(97.3+8)} = \frac{8}{105.3} = 7.6\ \%$$

Oil lost to direct human consumption. $= \frac{8}{19} = 42\ \%$

(e) Crushing well delinted seed as at (c) above which, say, contains 5 % moisture, as before, and now $19 \times \frac{116.3}{104.2} = 21.2\ \%$ oil, because of the delinting of the non-oil bearing linters. Again for simplicity assume the 5 % moisture distributes itself evenly and is ignored.

104.2 **cottonseed** **Parts crude oil** 16.7 87.5 **Parts cake**

Pats washed oil + soapstock 16.00 + .67

Parts oil in cake 4.5

83 **Parts hulls, linters, etc.**

$$\text{Oil in cake } \frac{(21.2-16.7)}{83+4.5} = \frac{4.5}{87.5} = 5.1$$

Oil lost to direct human consumption $\frac{5.1}{21.2} = 24\ \%$

Appendix 2
(contd.)

(f) Pre-pressing and solvent extraction of delinted, dehulled seed. This corresponds closely as it happens to Sudanese black seed. 100 parts clean whole seed contain 23.0 crude oil
44.0 fat free meal
33.0 hulls

After dehulling 23.0 crude oil
44.0 fat free meal } "meats"

After solvent (hexane) extraction, in which the meal is left with only 1 per cent of its own weight as oil, is obtained

22.55 crude oil

oil 0.45
fat free meal 44.00 } meal

$$\text{oil in meal} = \frac{0.45 \times 100}{44.45} = 1.01\ \%$$

$$\text{Efficiency of crude oil recovery} = \frac{22.55 \times 100}{23.00} = 98.04\ \%$$

In practice, to assist the mechanics of pressing, an amount of the separated hulls equal to about 10 per cent of the weight of meal is added back to the dehulled meats. Although this then increases the weight of non oily material being extracted, the pressing so compacts the cake that the bulk is decreased compared with material which merely had hulls but no oil removed; hence a slightly better yield is obtained. The above idealised example (f) serves to illustrate how much more valuable oil is recovered for human consumption by a solvent plant. At the same time a market must exist for meal and hulls which enables a profit to be earned whilst still selling the oil at a competitive price. Hulls may be re-incorporated in meal up to the limitation imposed by regulations fixing the maximum permissible fibre content, another aspect of which is the expected protein and oil content.

3. Refining losses

At the beginning of the harvest the FFA of the crude cottonseed oil is about one per cent and towards the end of the season it may reach 2 per cent, but fortunately very rarely any more since in the Sudan dry storage is no problem. The removal of sediment from the crude oil by setting, straining or filtration will help to reduce losses of good oil when neutralization and washing is performed to produce the semi-refined or washed cotton seed oil of commerce. This latter normally has an FFA below 0.3 per cent.

Appendix 3

Groundnuts oil:

A. For local consumption:

1. Groundnut oil is the main oil used for edible purposes
2. The bigger portion of this oil is being consumed without refining ..... filtered only;
3. Prices of oil are controlled by supply and demand;
4. Costs differ from one site to another owing to the variations of groundnuts prices;
5. Costs obtained from an Omderman oil miller recently are as follows:

	Cost unit is one ton of oil	Ls
	cost of nuts = 2.380 x 220 =	523.600
	cost of processing = 2.380 x 20 =	47.600
	cost of processed products =	571.200
minus	revenue of cake 1.356 x 80 =	108.480
	cost of oil =	462.720
	cost of tins 61.7 x .940 =	=58.000
	Cost of packed production	520.720

N.B.: 2.38 mt nuts costing Ls 220 are required to produce a ton of edible oil clothedin 61.7 tins of nominal 16 kg content.

Sales revenue 61.7 x 10.500			647.850
Minus	cost of oil	520.720	
	development tax	30.130	
	exise duty	15.000	
	Total		565.850
	Profit		82.000

B. Refined oil:	Ls
crude oil = 1.070 x 462.720 =	495.110
refining cost 1.070 x 45 =	48.150
cost tins 61.7 x .940 =	58.000
cost of production	601.260
Sales revenue = 61.7 x 12.5	771.500
Minus: development tax 36.025	
exise duty 15.000	
cost of prod. 601.260	652.285
Net profit	119.215

Appendix 3
(contd.)

Cost of production of one ton of packed sesame oil

	Ls
Cost of seed 2.200 x 280 Ls =	616.000
Cost of processing 2.200 x 25 Ls =	55.000
Cost of tins 61.7 x 1.300 Ls =	80.210
Total cost of production	751.210
Profit 10 per cent	75.120
Price of output before taxes	826.330
Revenue from cake 1.180 x 90 Ls	106.200
Price of one ton of packed oil before tax	720.130
Development tax 5 per cent	36.005
Exise duty	15.000
Price per ton ex factory	771.135
Price per tin of 16.2 kg (: 61.7)	12.500

- Sesame oil is consumed directly without refining, merely being filtered.

Cost of production of crude, semi-refined (washed) and fully refined cottonseed oil

Cost unit - one ton of refined oil

1. Crushing process	Ls
Cost of seed = 5.880 x 57.750	339.685
Seed transportation = 5.880 x 4.500	26.470
Cost of crushing = 5.880 x 12	70.585
Cost of cake and crude oil	436.740
Profit allowed 10 per cent	43.675
Prices before tax	480.415
Minus cake revenue 4.7 tons x 45	211.500
Price of crude oil	268.915
Cost of neutralization and bleaching	33.900
Profile on semi-refined oil of 10 %	3.390
Price of semi-refined or washed oil before taxes	306.205
Development tax 5 %	15.310
Exise duty 15 Ls à ton	15.000
Price ex-mills	336.515

Appendix 3
(contd.)

Cost of edible oil		Ls
Price before tax		306.205
Deodorization cost	9.000	
Tins = 61.7 x .94 =	58.000	
Total addition at cost =	67.000	
Profit 10 %	6.700	73.700
Price before taxes		379.905
Exise duty		18.995
		15.000
Price after tax à packed ton		413.900
Price per tin of 16.2 kg		6.705

Percentage of refined oil is 17 per cent of the inputs of seed. Refining loss ranges between 5 - 7.5 % of the crude oil.

Cost of laundry soap

The costing sheet is unified for all factories and it is based on the fact that - according to the applied specifications - one ton of fatty materials should produce 1.5 tons of soap.

Cost unit is one ton of packed soap

	Ls
Semi-refined c/seed oil = 0.600 x 336.515 =	201.910
Tallow or coconut oil = 0.060 x 450 =	27.000
Cost of processing inclusive	54.360
Cost of packaging cartons 123.5 x .15 =	18.520
Cost of production	301.790
Profit 10 per cent	30.180
Price before taxes	331.970
Development tax	16.600
Exise duty	7.000
Price à ton	355.570
Price per carton : 123.5	2.880

Each carton contains 45 pieces of 0.180 kilograms.

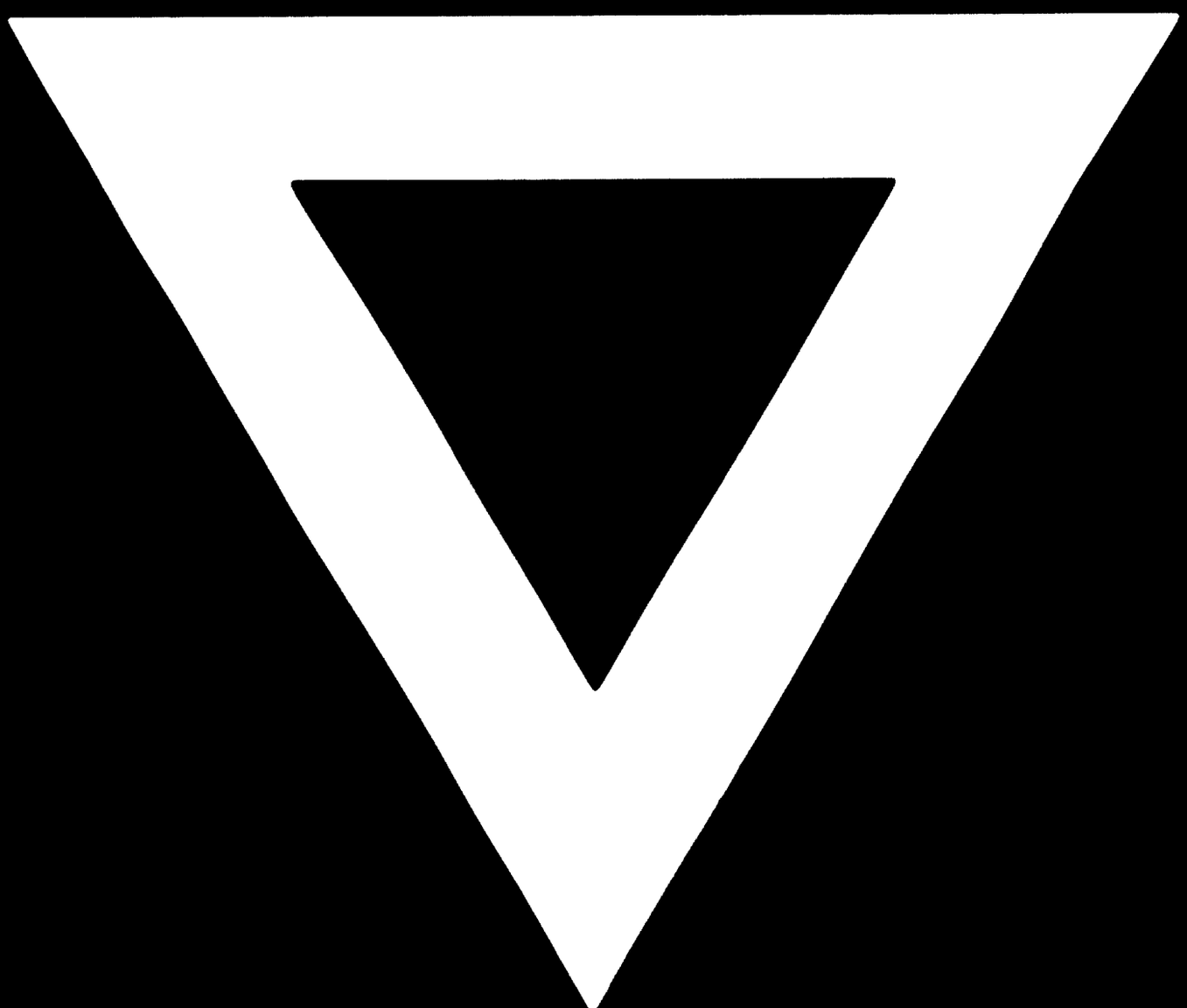
Tallow or coconut oil is used to improve the titre degree of the mixture of fatty materials.

Appendix 4

Obtained from international trade statistics - The export of oilseeds, oil and oil cakes (metric tons) 1971-1977

Type	1971	1972	1973	1974	1975	1976	1977
Groundnut in shells	14,408	18,189	8,635	5,487	795	16,388	18,492
Decorticated groundnut	106,920	96,618	130,117	124,557	205,141	290,011	142.014
Groundnut oil	-	-	1,568	5,659	6,840	1,076	27,765
Groundnut cake	24,388	50,315	31,622	21,501	31,778	41,794	67,726
White sesame	11,762	4,133	6,989	1,493	17,616	20,354	2,437
Red sesame	3,586	498	197	-	-	-	-
Mixed sesame	70,912	81,891	97,769	106,359	39,087	83,160	106,909
Sesame oil	27	523	222	1,321	294	2,365	201
Sesame cake	10,647	17,945	17,501	3,613	30,213	45,077	25,383
Black cotton-seed	3,444	-	-	-	-	-	-
White cotton-seed	52,662	24,730	15,917	4,752	-	-	-
Cotton-seed oil	34,333	30,983	10,633	-	10,523	-	176
Cotton-seed cake	153,711	149,854	90,571	55,799	14,504	39,494	60,538

B-90



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