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INDUSTRIAL RESEARCH CENTRE, TRIPOLI,

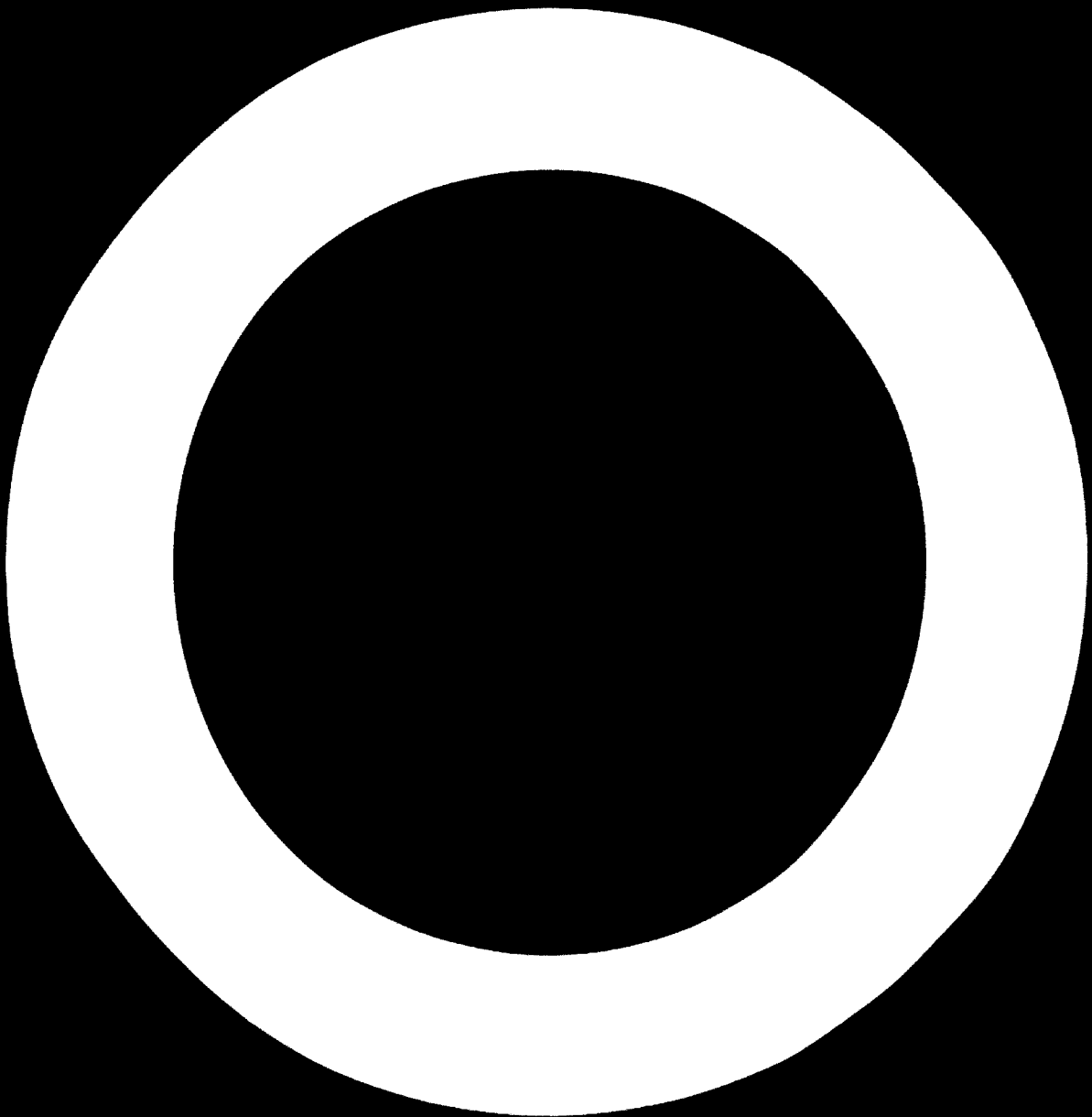
DP/LIB/69/512

LIBYAN ARAB REPUBLIC

Technical reports:
I. DOMESTIC MARKET ANALYSIS
II. EXPORT POTENTIALS
III. PESTICIDE MANUFACTURE .

Prepared for the Government
of the Libyan Arab Republic by the
United Nations Industrial Development Organization,
acting as agency for the
United Nations Development Programme

United Nations Industrial Development Organization



United Nations Development Programme

INDUSTRIAL RESEARCH CENTRE, TRIPOLI

(DP/LIB/79/518)

LIBYAN ARAB REPUBLIC

Technical report

I. Domestic market analysis

II. Export potentials

III. Pesticide manufacture

Prepared for the Government of the Libyan Arab Republic by the United Nations Industrial Development Organization, executing agency for the United Nations Development Programme

Parts I and II of this report are based on the work of Christopher Lalthy

Part III is based on the work of S.A. Qureshi

United Nations Industrial Development Organization

Vienna, 1979

EXPLANATORY NOTES

Use of a hyphen (-) between dates representing years signifies the full period involved, including the beginning and end years, e.g. 1971-1973.

A slash (/) between dates representing years indicates a crop year or financial year, e.g. 1971/72.

Reference to "tons" indicates metric tons, unless otherwise stated.

Reference to "gallons" indicates British imperial gallons, unless otherwise stated.

Reference to "dollars" ($) indicates United States dollars, unless otherwise stated.

Annual rates of growth or change refer to annual compound rates, unless otherwise stated.

In tables, apparent arithmetical discrepancies are due to rounding of the basic data.

The following exchange rates are used in the conversion of country currencies to United States dollars:

Country	Currency	Exchange rate per US dollar				
		1971	1972	1973	1974	1975
Austria	schilling (S)			19.30		
France	franc (F)		5.05	4.45	4.65	
Germany, Federal Republic of	mark (DM)		3.18	2.64	2.47	
Greece	drachma (Dr)	30.00	30.00			
Italy	lira (Lit)		582.00	600.00	667.00	
Libyan Arab Republic	Libyan dinar (LD)		0.325	0.296	0.296	0.296
Morocco	dirham (DH)	5.02				
Netherlands	guilder (f.)				2.60	
Spain	peseta (Ptas)			57.00	57.00	
Sweden	krona (SKr)		4.75			
Switzerland	franc (SwF)			3.20		
Tunisia	dinar (D)			0.417		
United Kingdom	pound sterling (£)		0.426		0.431	

The following abbreviations are used:

Economic and technical abbreviations

BHC	benzine hexochloride
b.p.	boiling point
BSS	British Standard Specification
BTN	British Tariff Nomenclature
Btu	British thermal units
c.c.	cubic centimetre
c.i.f.	cost, insurance, freight
cS	centistokes
D	diameter
EC	emulsifiable concentratee
f.o.b.	free on board
H	height
hp	horsepower
KOH	potaseium hydroxide
L	length
mol.wt	molecular weight
m.p.	melting point
p.s.i.g.	pounds per square inch gauge
SITC	Standard International Trade Classification
SP	soluble powder
SSU	Saybolt Universal Seconds
sp. gr.	specific gravity
V AC	volt, alternating current
v/v	volume/volume
WP	wettable powders
w/v	weight/volume

Organisations and governmental bodies

ARC	Agricultural Research Centre
ARD	Agrarian Reform Directorate
ASTM	American Society for Testing Materials

BPMC	Brega Petroleum Marketing Company
CAD	Council for Agricultural Development
CIPAC	Collaborative International Pesticides Analytical Council Ltd
CMAE	Committee of experts from the Ministries of Agriculture and of the Economy
FAO	Food and Agricultural Organization of the United Nations
G.E.F.Li.	Groupement d'étude français en Libye
IRC	Industrial Research Centre
NPC	National Pharmaceutical Company
WHO	World Health Organization

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Mention of firm names and products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO).

PREFACE

This report on the domestic and export market for pesticides in the Libyan Arab Republic and on pesticide manufacture is part of the ongoing project of the United Nations Development Programme (UNDP) entitled "Centre for Industrial Research" (DP/LIB/69/512). The project was established in 1969 and had the aim of providing technical and industrial services to existing and potential industrial enterprises, both public and private, and of assisting the Government in quality control, investment promotion and research programmes related to the utilization of local resources.

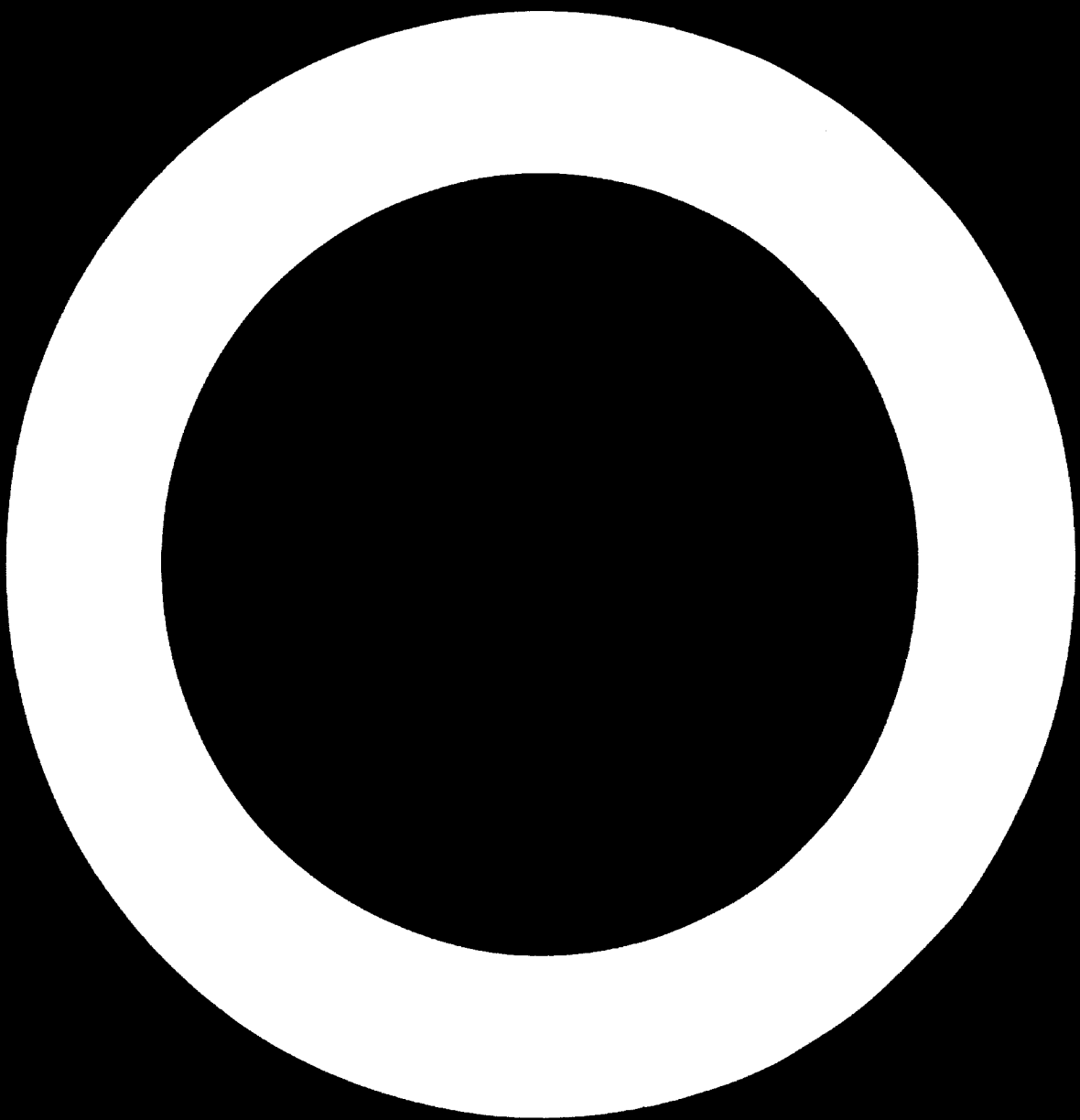
As an important part of the present government development plans, the Libyan Arab Republic is expanding agricultural production. To this end, considerable amounts of pesticides are being imported. In 1973, about 4,300 tons were brought in, and such imports are expected to rise.

In September 1973, a UNIDO expert, Preston L. Brandt, submitted, as part of the project, a pre-feasibility report "Pesticide manufacture in the Libyan Arab Republic", indicating that the manufacture of refined mineral oil (white oil), other emulsifiable concentrates and solutions, and wettable powders and dusts may be a very profitable industry for Libya. This would be particularly true if it proved possible to export either refined mineral oil or mineral white oil.

In order to establish firmly the plant size, which would depend upon the combined internal and external markets for its products, and to estimate accurately the economics of pesticide production in Libya, a three-phase study of the problem was undertaken: an analysis of the present and projected domestic market for pesticides; an examination of the potential export markets for pesticides produced in Libya; and an investigation of the assumptions made in the pre-feasibility study concerning certain process details, prices of raw materials and transportation costs.

The present report is therefore divided into three parts: I. Domestic market analysis; II. Export potentials; and III. Pesticide manufacture.

The domestic and export market analyses are the work of Christopher Maltby, and the study of techno-economic feasibility of pesticides production in Libya is that of S.A. Qureshi.



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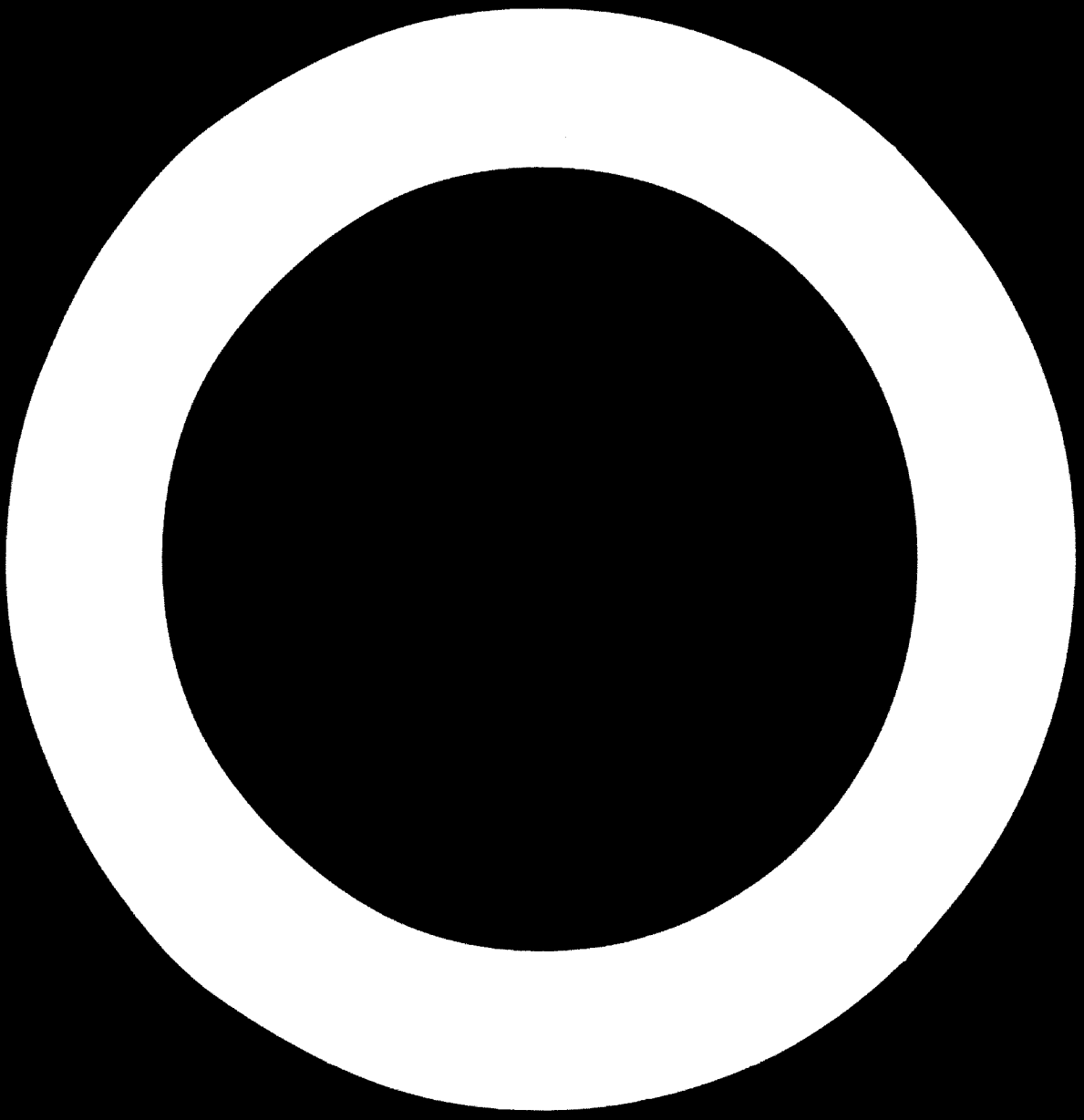
Part one. DOMESTIC MARKET ANALYSIS

by

Christopher Maltby, pesticides marketing expert



FINDINGS AND CONCLUSIONS

[illegible] of pesticides in the Libyan Arab Republic was discovered [illegible], and considerable time was spent in attempting to identify use [illegible], importers and the volume of each type imported. In the absence of [illegible] were compiled of the 1973 imports by product and [illegible] in each of the four important use sectors: agricultural crops, [illegible], public health and household. In the absence of definite figures, [illegible] were assumed to approximate the actual use in 1973, for the purpose of forecasting future use (table 1).

[illegible] No. [illegible].00) includes pesticides and disinfectants (table 2). [illegible] is payable on their importation. Estimates of 1973 pesticide imports [illegible], [illegible] tons, compared to the import statistics for products under this [illegible] item of 1,450 tons. Of this difference of 419 tons, 239 tons are shown in the statistics as imports from countries from which no pesticides are known to have been imported by any public authority or private merchant. Thus, either all, or a large part, of this difference of 419 tons is considered to be disinfectants. Part can be small individual imports of domestic aerosols or insecticides.

Duty-free entry into Libya of technical materials for pesticide formulation is proposed for negotiation with the appropriate authority prior to actual imports for the Libyan formulation plant.

Pesticides for agricultural use by family farms are limited in type and volume by safety considerations, extension facility, field tests, legislation and the prices farmers receive for perishable agricultural produce. Farmers utilise the generous pesticide subsidy payments to the extent of 20% of private farm use. The most agricultural output is produced by 165,000 farmers.

Pesticide use is limited economically to the irrigated crops and has increased 20% in total during the past five years.

Table 1. Estimated pesticide imports in 1973 and forecast use in Libya, 1975-1985
(Tons)

Formulated product	1973 Imports	Forecast use						
		1975	1976	1977	1978	1979	1980	1985
Mineral white oil	316	500	700	1 000	1 000	1 000	1 000	900
Insecticide EC-Crops	285	512	683	735	892	989	1 177	1 289
Livestock	39	61	68	74	80	110	121	174
Public Health	124	138	156	174	192	216	240	240
Household	1 450	1 629	1 710	1 796	1 885	1 979	2 078	2 653
Total EC	2 214	2 840	3 317	3 779	4 049	4 294	4 616	5 256
Aerosols (specified weight)	1 680	1 995	2 249	2 586	2 974	3 420	3 932	5 019
Insecticide/fungicide WP crops	561	605	672	698	775	781	895	1 023
Insecticide WP public health	51	92	104	116	128	144	160	160
Weed killers	182	227	311	392	433	473	582	614
Others suitable for local formulation	311	110	110	130	130	140	160	160
Total possible for local formulation	4 919	5 829	6 763	7 701	8 489	9 252	10 345	12 232
Others unsuitable for local formulation	14							

Table 7. Imports into Libya under tariff item No. 590.200 - insecticides, fungicides, disinfectants, and including sheep and cattle dressings and preparations equivalent to BTN heading 38.11 a/

Country of origin	1971 Quantity (kg)	1971 Value (LD)	1972 Quantity (kg)	1972 Value (LD)	1973 Quantity (kg)	1973 Value (LD)
Belgium	3 472	2 814	6 205	732	17 425	16 259
Cyprus	1 270	1 351	1 190	262	-	-
Czechoslovakia	86	17	-	-	-	-
Denmark	-	-	4 100	976	1 000	557
Egypt	21 660	1 290	-	-	-	-
France	99 848	13 980	21 019	10 424	213 196	208 126
Germany, Federal Republic of	252 002	147 512	173 707	96 802	671 341	256 247
Hong Kong	-	-	48 000	4 377	-	-
Italy	970 394	205 089	349 121	147 396	846 489	177 891
Japan	-	-	5 000	675	9 000	4 468
Jordan	-	-	-	-	400	558
Lebanon	15 698	6 785	7 525	1 102	2 870	1 357
Malta	-	-	-	-	1 256	509
Netherlands	1 155 090	261 742	1 527 487	330 568	1 518 907	373 334
Poland	-	-	-	-	20 160	4 499
Spain	200	91	100	18	55 305	11 662
Sweden	700	1 754	-	-	-	-
Switzerland	3 696	4 158	2 023	1 071	17 455	22 612
Tunisia	33 893	14 481	38 391	16 621	87 493	24 360
Turkey	13 851	2 796	-	-	7 500	2 856
United Kingdom	2 181 190	375 138	2 084 044	286 988	2 105 300	282 057
United States	33 348	8 912	18 548	3 326	46 384	19 030
Yugoslavia	-	-	-	-	30 075	3 081
Total	4 736 398	1 067 911	4 288 660	993 338	5 451 585	1 488 457

Source: Census and Statistics Department, Government of the Libyan Arab Republic.

a/ No exports or re-exports of item 590.200 are listed.

Two thirds of the imports are made by the General Company for Farm Equipment and Agricultural Necessities (which is commonly known as the Government Company), and the balance by the Projects of the Council for Agricultural Development (CAD) and private merchants. The private merchants have curtailed their pesticide activities. Imports are presently restricted to twenty products, but this number will soon be increased. Imports are dictated by safety considerations and local trial results.

Stock emulsions of mineral oil are estimated to be used at 20% of optimum but are forecast to rise to 1,000 tons in 1977/78. It is considered that preference in the future will be given to the use of acaricides with higher performance and higher toxicity than mineral oil.

Forecast use for crop pesticides in this report is based upon planned and projected irrigated crop areas, prepared by the Ministry of Planning and subdivided according to individual crops by the writer (in the absence of other data), on the basis of identified pests and diseases of economic importance.

There is clearly a strong case for local pesticide formulation in Libya, and specifically for insecticides and, separately, weed killers, liquid formulations, insecticide and fungicide, wettable powders (WPs) and mineral oil.

Pesticides for livestock are used by the Veterinary Department of the Ministry of Agriculture, which provides chemicals and facilities free of charge, and by the CAD projects, mainly for dipping sheep.

Pesticides for public health use are imported and supplied by the authorities. The trend is towards the use of low-toxicity pyrethroids.

Brega Petroleum Marketing Company (BPMC) now controls all imports of aerosols and liquid insecticides for the household market. It is already actively considering the formulation of domestic insecticides with locally available deodorized kerosene at their lubricating oil mixing plant adjacent to the As-Zawia refinery. The use of aerosol insecticides is increasing in Libya. The existence of a potential export market for such products may exist and should be investigated, particularly if the present and forecast Libyan consumption warrant local aerosol filling in Libya. The advantages of a local aerosol plant should therefore be assessed by a UNIDO expert. BPMC would be ideally suited to operate the pesticide formulating plant, because:

It is responsible for the import, export and marketing o all petroleum-based products;

Its lubricating oil mixing plant at Az-Zawia posesses some of the necessary facilities;

It is already considering the formulation of domestic liquid insecticide formulations at Az-Zawia and is responsible for marketing them in Libya;

It has the most direct access to the raw materials required for pesticide formulation and is well placed to develop a petrochemical complex in which consideration could be given to the basic manufacture of one or more technical pesticide materials, of which there is a world-wide shortage.

It should be understood that, under Libyan law, patents are granted for fifteen years from the date of application and may be renewed for a further five years, and that patents granted must be implemented within three years.

Letters have been drafted for the appropriate Government companies to write, asking the prices of technical pesticide materials from foreign manufacturers, so that the economic benefits of local formulation may be determined.

Local formulation of pesticides in Libya will make these products more readily available to the planned distribution channels, but care must be exercised as regards safety in formulation and use. Recommendations for packing pesticides are discussed in the section on packaging of pesticides.

The Annex outlines the estimated present and forecast pesticide use, and is proposed as the basis for planning a pesticide formulation plant in Libya.

RECOMMENDATIONS

Assuming that the work of the UNIDO pesticide manufacturing expert confirms the viability of a pesticide formulation plant in the Libyan Arab Republic, it is recommended that:

1. A pesticide formulation plant be established for insecticide liquids, insecticide and fungicide wettable powders and separately (perhaps at Benghazi) for weed-killers, at the Az-Zawia refinery, and operated by NOC, which already has a lubricating oil mixing plant there;

2. A plant to refine and formulate mineral oil stock emulsions be established in the insecticide and fungicide formulation plant at Az-Zawia, providing that a suitable feedstock is available;

3. The benefits of establishing an aerosol filling plant in Libya be examined by an expert, and if his findings and an initial assessment of the potential export market are positive, that a detailed export investigation be undertaken;

4. The proposals concerning packaging of pesticides, in the section on packaging of pesticides in part one, should be implemented in the pesticide formulation plant;

5. The basic manufacture of one or more technical pesticide materials for export be given serious consideration as a petrochemical complex is developed in the Libyan Arab Republic;

6. Technical pesticide materials and additives should be classified under duty-free tariff items prior to any actual importation into Libya for local formulation of pesticides;

7. Expert services should be sought:

   For the evaluation of tenders for the pesticide formulation plant;

   In the start-up of the formulation plant;

   For the establishment of a control laboratory at the formulation plant.

I. PRESENT PESTICIDE USE

At present, no pesticides are formulated or packaged in Libya.

Pesticide imports, by volume and value during the three years 1971-1973, are shown in table 3. These statistics are compiled from customs declarations and computerized. No breakdown by product type, chemical or package is possible. There are four main categories of pesticides use:

On crops
On livestock
In public health
For household purposes

In the absence of any use data, it was necessary to identify importers of each type of pesticide and attempt to establish or estimate the volume of their imports in at least one recent calender year. It was found that 1973 was the year for which most information was available.

The statistics indicate an over-all increase in total imports under the appropriate tariff item, which had been influenced by an increasing over-all use. No stock carry-over is normal each year. The actual use in 1973 is assumed to be similar in volume to the 1973 imports, as no excessive stock carry-over is known to exist, except as indicated below in the household sector. In these estimates it is assumed that all liquid pesticides have a specific gravity of 1, so that 1 litre will be equivalent to 1 kg.

On crops

The use of agricultural pesticides in Libya is limited to the irrigated areas. It appears impracticable to treat most rain-watered crops, the areas and yields of which vary each year according to the rainfall that occurs from October to March. The areas of the various crops grown under irrigation as well as cereals in rain-watered areas in 1973 are shown in annex I, table A-1.

There is some interplanting of crops under irrigation, such as barley with olives, and alfalfa with citrus, which make water requirements difficult to judge and the use of weed killers hazardous.

The Agrarian Reform Directorate (ARD) has implemented the policy of redistributing land into family-scale holdings of a normal maximum size of 30 hectares (ha), and has distributed 18,000 ha since 197[illegible]. ARD is implementing a major land reclamation programme for subsequent settlement as family farms. Primary agricultural production is therefore on a family scale and is in the hands of large numbers of farmers (165,324 in 1973).

A 1973 Survey of 73 farms by the Groupement d'Etude français en Libye (G.E.F.Li.) indicated that 14 of them had used a chemical. Trade sources report that the use of pesticides has increased a total of 10% over the past five years (an average of 4% per annum).

CAD, which is separate from the Ministry of Agriculture but which has ministerial status, is implementing a massive and important programme of land reclamation and irrigation. CAD controls four separate projects: at Kufra, Gebal Akhdar, Fezzan and Geffara. Each project is divided into three or more nearly autonomous areas, each of which is expected to operate within its financial budget and to accomplish its own targets.

In some cases, the areas within these projects will operate as single, large-scale farming units for cereal or animal fodder cultivation or livestock production. In others, the areas are destined for settlement by individual farmers.

The Agricultural Bank has granted a subsidy of 50% of the fixed selling price of pesticides to farmers since 1966, providing the farmer obtains the appropriate certificate from an agricultural extension officer before purchase.

In the past, pesticides were largely of Italian origin, as the trade names were well known. Until 1972 the Agricultural Bank bid for pesticide imports on behalf of the Ministry of Agriculture. At the same time, private merchants imported pesticides from abroad, primarily from Italy.

In 1972 an important government-owned company (the General Company for Farm Equipment and Agricultural Necessities usually referred to as the General Company) was given responsibility for pesticide imports, inter alia, from whom the Ministry of Agriculture drew their requirements and those for the General Marketing Company at Al-Hadaba, which farmed about 3,000 ha (mainly fruit). The General Company was responsible for the distribution of

pesticides through its 12 regional stores to co-operatives. It normally asks for bids for its annual requirements and, on occasion, purchases directly from local merchants. The General Company reports to the Ministry of Economy on finance and to the Ministry of Agriculture on technical matters. It is estimated that it now imports 65% of all pesticides brought into Libya. Since 1972 the pesticide activities of private merchants have decreased, and few (two of them were interviewed) now have any technical field staff to undertake field tests or visit farmers. Some continue to import pesticides and sell them to farmers who come to them and, in exchange for perhaps paying a slightly higher price than they would to a co-operative, receive some guidance on which pesticide to use and how to apply it. Some merchants have sold their stocks to the General Company. A third type of pesticide importer is the CAD Projects. Each area within any project apparently may import if it wishes, but in practice an area would probably seek supplies from the General Company, and only ask its head office for assistance in importing if it became necessary. At the time of writing, only the Kufra and Gebal Akhdar Projects have imported any substantial quantity; Geffara has taken only 3 tons and Fezzan nothing. The Gebal Akhdar Project has bought pesticides as a single unit, since it was established in 1965, and its three areas are reported to work closely with one another. As noted, projects are independent of the Ministry of Agriculture and are not obliged to accept its recommendations.

The first part of the General Company which now reports directly to the Ministry of Agriculture is the Technical Company for Pest Control, known as the Spray Company. It provides an advisory service to farmers at LD 0.500/ha for twelve visits annually and, if requested, a spraying service, supplying the chemical at the list price plus an application charge of LD 2,200 per 1,000 litres sprayed. It has 24 power sprayers and 3-man spray teams and operates in the Tripoli, Az-Zawia, Al-Khums, Misurata region, which, with Benghazi, are the two most important agricultural areas. The Spray Company seeks annual spray contracts for 20,000 ha and has already secured them for 2,000 ha. It has completed its first three months of operation and used about 9 tons of pesticides. It may import these materials, but has not yet done so.

The Spray Company was formed with a capital of LD 60,000, of which the Government and a private investor held equal shares. It is reported that the capital has been increased to LD 250,000, with about 14 private investors each buying an LD 5,000 share, with the Government maintaining more than a 50 per cent holding.

An agricultural extension service is provided to farmers by the Agricultural Moderia (Directorate) in each Mohafza (province), which is subordinate to the Mohafza administratively and to the Ministry of Agriculture functionally. The number of extension officers in all of the Moderia in 1974 was reported as 222, of which 155 were able to provide farmers with the pesticide certificate required to obtain the pesticide subsidy. The important Tripoli Agricultural Moderia reports having 18 extension officers and 8 branch offices. Thus, the farthest a farmer has to travel in the Tripoli Moderia to see an extension officer may be no more than 30 km. The distance is reported to be considerably farther in other Mohafza. Each of the eight branch offices of the Tripoli Agricultural Moderia keeps a power sprayer and team available for spraying farmer's crops.

The Ministry of Agriculture has a small extension service section that co-ordinates the extension activities of the Moderia throughout Libya.

The Plant Protection Section in the Ministry of Agriculture is composed of a few pesticide experts who provide expert guidance to the Moderia, to farming co-operatives and to individual farmers, and who undertake, whenever possible, the identification of pests and diseases and perform field trials and evaluate their results. This section maintains sprayers and spray teams to undertake demonstrations. In emergencies, these sprayers are available to undertake spraying on farms. Farmers therefore have the choice of finding an extension officer and obtaining a certificate from him and thus getting the benefit of the subsidy or even obtaining up to 10 kg of pesticides free of charge through the Moderia and also of having the spraying done for them. However, it is reported that farmers must normally wait a week or more for the sprayer to arrive. The other alternative open to a farmer whose crop is under attack by insects or fungus, is to go directly to the nearest pesticide dealer and purchase his requirements at the full price and apply them himself. This is, as will be shown later, what most farmers appear to do, perhaps because the loss of the subsidy on 10 to 20 kg of pesticides for a 10-ha holding is more than compensated for by the saving in time and travel costs.

No registration law for pesticides yet exists in Libya, but one has been proposed and is considered highly desirable since it will establish controls over labelling, stated composition data and precautions.

Meanwhile, late in 1973, legislation was adopted that required private importers of insecticides to obtain prior permission from the Ministry of Agriculture. Twenty different pesticides may be imported; for the most part, they are the same as the agricultural pesticides that have been registered at the Agricultural Bank as qualifying for payment of a subsidy, on presentation of the appropriate certificate of sale from either of the two registered suppliers, which are the General Company, which is government owned, and Ali A. Gamati, a private merchant. These subsidizable pesticides are:

White oil
Dimethoate 40 EC
Sevin (carbaryl) 50 WP
Malathion-50 EC
Dipterex-80 WP
Kelthane 18.5% EC
Tedion 8% EC
Metaldehyde 5%
Bird repellent
Protein Stanley bait No. 7
Maneb 70%-80% WP
Zineb 70%-80% WP
Micronized sulphur WP
Sulphur dust (not less than 90% particles 30-60μ)
Copper oxychloride (COC) 50% Cu WP
Nematocide (2,3-dichloropropene and 1,2-dichloropropane) products with agents for wetting and stickiness

This list, which was supplied by the Agricultural Bank, remained unchanged from the inception of the pesticide subsidy in 1974, when the bird repellent was added. It is planned to extend this list of subsidized agents to comprise 60 to 70 agents. For the time being, however, the list of importable pesticides is being held to 20, since the Ministry of Agriculture has been able to field test only that many. When further field tests have been completed, the list is expected to be increased to about 40.

It has been stated that many products were formerly imported, without Arabic labels, that had toxicities unsuitably high for small farmers and that were of doubtful composition. This situation led to misapplications and accidents. It has also been reported that there was little identification of pests, diseases, life cycles, generations, hosts etc., and that few field tests to determine optimal control measures had been performed. It was, inter alia, with these problems and their possible solutions in mind that the Agricultural Research Centre (ARC) was formed within the Ministry of Agriculture. This body seeks certain responsibilities as regards pesticides and directing a long-term programme. At present, the agreed-upon responsibilities of its Permanent Pesticide Committee, which are given in full in annex II, are broadly as follows:

Identification of pests and diseases of economic importance and the evolving of optimal control measures;

Emphasis on all aspects of safety and low mammalian toxicity;

Recommending legislation designed to secure the safe use of pesticides and the importation of only the least hazardous products.

It is clear that safety is of paramount importance, and that economics of production must give place to safety. It follows that chemicals with comparatively long residual effects, which are usually the most economic and which have the relatively highest mammalian toxicities, will be banned in Libya, except for application under the supervision of the comparatively few specialists. It follows also that pack sizes should be small (1 kg or less) for most pesticides for the many family farms. This also affects the economic use, since the cost per kilogram of small packs is more than in large (10- to 50-kg) ones. The advantage of 1-kg packs is that there will be little or no stock carry-over on the farm, where it could cause accidents.

The Pesticide Committee plans to classify pesticides in three categories, presumably by median lethal dose (50), usually oral: 1-50 mg/kg of body weight for Category I, 50 to 200 mg/kg for Category II, and more than 200 mg/kg for Category III, with due consideration of dermal toxicity and, particularly, in the arid Libyan climate, of the inhalation toxicity. Once this categorization has been completed, it is proposed to recommend legislation limiting the use of the most toxic chemicals (those falling within Categories I and II), and to purchase and use them under the supervision of a licenced operator (agricultural engineer) or government operator, for which the Spray Company qualifies. Some sources have reported that a law already existed which forbade a private merchant from supplying a pesticide to a farmer unless he had a signed certificate from an extension officer. However, the general view is that no such law has yet been enacted but will be in future, along the lines that the Pesticide Committee expects to recommend.

A recent ministerial declaration has urged farmers to form, operate and become members of co-operatives. It is reported by the Co-operative Section in the Ministry of Agriculture that: in 1973 there were 79 co-operatives, with 16,447 members; by July 1974 there were 130 co-operatives with 74,459 members.

Most co-operatives are situated in irrigated areas. The members hold 50% of the capital, and the Government the other 50%. They pay up to 35% of their profits to members if they are not used in the development of facilities.

The pesticide subsidy is payable only on the purchases of private farmers, not on those of government agencies, Ministries or the Projects. In May 1974, the pesticide subsidy was increased to 60% on purchases made by members of co-operatives and decreased to 40% for non-members. From January 1975, the co-operative member obtains a 60% subsidy, but the non-member receives none.

The normal cost build-up is as follows: c.i.f. purchase price plus 2% gives the delivered in-store cost, to which a maximum 12.5% mark-up may be added to produce the selling price to the farmer. The General Company's selling prices include an average of 5% on the delivered store cost, which leaves the co-operative about 7% maximum to cover its costs and yield a profit for its members or for increased funds for new facilities.

Another factor that affects the use of pesticides and that largely determines forecasts of their probable use is the way in which crops are marketed. At present, the Agricultural Bank purchases, at fixed prices, all of the wheat, barley and olive oil that are produced, and also pays a fixed price for groundnuts and almonds. The Ministry of Industry buys dates at a fixed price, and the Agricultural Crop Marketing Company at Al-Hadaba also buys in some fruit to market along with its own produce.

The organization at Al-Hadaba operates a tomato canning factory with an annual capacity of 1,200 tons and has contracted for fresh tomatoes at the price of LD 0.020/kg. At a yield of 35 tons/ha, growers would show a profit, but at this time a good yield is only 18 tons/ha. (A new fixed price of LD 0.050 is being negotiated.) The net result has been that the farmers deliver to the merchants at the markets large quantities of tomatoes and other perishable crops at the height of the season. Such gluts drive prices so low that the growers are unlikely to make a profit, and much of the produce is wasted. There appear to be no processing plants or cold-storage facilities to help absorb peak production.

The co-operatives are not yet involved in crop marketing and would find it costly to provide the needed facilities for processing, grading (which is increasingly important as consumers become more sophisticated and exacting), or for cold storage, unless government financing were to be arranged.

A shortage of spraying equipment is reported to be a major limiting factor in the use of pesticides, but it is also reported that many farmers who already use pesticides possess their own machines. In addition the Agricultural Mederia

have: 22 100-litre power sprayers, 500 50-litre hand sprayers, and [illegible] 18-litre and 10-litre knapsack sprayers, and the Ministry of Agriculture has [illegible] 500-litre power sprayers and is importing 50 more 500-litre and [illegible] power sprayers.

There has been no commercial use of weed killers exept at Geba Akhdir, where it is reported that 150,000 litres were purchased for LD 250,000 to spray 50,000 ha in 1973. The application was made by a Swedish contractor, and the source of the weed killer is reported as Amchem. It is considered probable that the cost included the application as well as the chemical itself, which was probably an ester of 2,4-D, formulated for aerial application, probably containing no more than 250 g acid equivalent per litre. Gramoxone, Hyvar X and Treflan have been imported but little used, as field trials of these agents have not been completed.

Insecticides appear to be used only as a curative measure, when insect populations are high, and not as a preventive. A variety of insecticides have been imported in the past including parathion, Ekatine, Zolone and Anthio, and recently Meta-Systox R, which has reported to be phytotoxic and which, to the writer's knowledge, had not been proved previously, when used as recommended. Field trials are desirable. As with all other pesticides, fungicides are generally economical only on irrigated crops in Libya. The only exception is fungicide seed dressing on rain-watered cereals. Quantities of dressed cereal seed have been imported from Tunisia.

There is a marked difference of opinion on the use of mineral oil in Libya. It is clear that a maximum of 300 tons was used in 1973. The last purchase was made in that year, and none was purchased for 1974, since the stock carry-over is reported to be sufficient. The latest prices known for Agrumol (from Sariaf, Italy, the composition of which is stated as: 80% vaseline oil, 20% emulsives and an index of unsulfonable residue greater than 95%) in September 1974, were $0.81 per litre in 18-litre tins and $0.87 per litre in 6-litre tins, c.i.f. Tripoli. These prices compare with the 1973 prices of $0.36 per litre c.i.f., when the posted price of Libyan oil was $8 per barrel, but which was $15 per barrel at this writing, indicating that the mineral oil price has risen proportionally with the posted prices for petroleum.

The advantages of mineral oil are its non-toxicity to man and predators and the inability of insects to develop a resistance to its physical action. Its disadvantages are its comparatively poor performance (compared to parathion, Guthion) and the risk of damaging trees and fruit if used when they are not at the dormant stage.

In Libya, mineral oil is used for scale control on olives, citrus and stone fruits. It should be applied almost entirely during winter and in the opinion of many, only on irrigated crops and not on rain-watered olives. (This opinion is clearly debatable.)

Mineral oil can be, and is, used in some countries as an additive at low rates to several insecticides and weed killers such as Atrazine, with the advantage that the active ingredient of the insecticide or weed killer can be reduced. A recommendation for the use of mineral oil can only be made following field trials to identify the precise application rate at which it performs without causing damage.

The choice of emulsifier is important because some have stronger activity in emulsifying oil with water than others, and because the higher the content of emulsifiers in the formulation, the greater the risk of phytoxicity.

Where sprayers with strong agitators are available, the 97% emulsifiable mineral oil is often used. This material contains a lower percentage of emulsifiers than the stock emulsion (white oil or citrus oil, which is usually 80% mineral oil and is pre-mixed with water). On addition of water in the spray tank, the stock emulsion (such as Agrumol) requires much less agitation than a 97% emulsifiable mineral oil. The smaller the sprayer, the less agitation is possible, with the consequent preference for an 80% stock emulsion, which can result in a greater risk of phytoxicity.

Only Agrumol and Siapi's mineral oils have been imported to Libya during the past two years.

BPMC has reported that the Ministry of Agriculture was erecting a plant to refine mineral oil. It also reports that, apart from kerosene, no solvents are available in Libya, and that it imported 50 tons of toluene and some light aromatic naphtha (LAN) but no xylene. The refinery at As-Sarir only separates out a multi-component hydrocarbon oil and has no plan to separate any specific solvents.

Table A-2 shows that the imports of formulated pesticides by the General Company were 234 tons in 1972, 1,168 tons in 1973 and 535 tons in 1974, at the time of writing. A total of 892 tons was identified by the writer during visits to the General Company, but subsequent reports to the Ministry of Agriculture listed an additional import of 275 tons, largely owing to an additional 113 tons of zineb-80. The higher import estimate is shown in table A-2.

Table A-3 in annex I lists the writer's estimates of the 1973 imports by private merchants and the CAD Projects. They total 502 tons, including 112 tons of sulphur, most of which is micronized. If the mill required for the wettable powders could grind it sufficiently fine, lump sulphur, imported lump sulphur or locally produced material, if available, could be micronized in it.

Table 3 shows that about 1,670 tons of pesticides and allied agents were imported by the General Company in 1973. Inspection of this table reveals that the installation of a plant to formulate pesticide ECs, insecticide and fungicide WPs and mineral oil, and a separate liquid mixing plant for weed killers is worthy of investigation.

An important consumer of pesticides is the Agricultural Crop Marketing Company at Al-Hadaba. During the period from October 1972 to September 1973, when it controlled 48 farms with a total area of 3,000 ha, it used the following pesticides in the volumes shown:

Product	Tons
Cupravit	8
Hamagon-DD	2
Ceresan	0.9
Anthracol	2.5
Sulphur WP	4
Ferrous sulphate	5
Tokel	7
Aldrin 40 WP	2
Dipterex-80	3.5
Lebaycid	6
Agrosol	120
Monit	5
Protein bait	2
Copper sulphate	4
Dayfolan	30
Treflan	1.5
Gramoxone	1
Total	204.4

It processed 120 tons of mineral oil, or one third of the total amount used in Libya in that year. In 1974, however, this organization controlled only 400 ha, since the other 2,200 ha had been allocated to individual farmers. It draws all of its pesticide requirements from the General Company.

Table 3. Imports of pesticides and allied products into Libya by the General Company and by private merchants and the ARD Projects in 1973 (Kilograms)

Formulation	General Company	Private merchants and ARD Projects	Total
WP insecticides	198 980	86 000	284 980
WP insecticides/fungicide	312 825	107 800	420 625
Dusts	32 000	-	32 000
Granules	30 000	3 000	33 000
Sulphur (mainly WP)	28 000	112 000	140 000
Weed killer liquid	17 300	155 000	172 300
Weed killer WP	10 015	-	10 015
Mineral oil 80%	300 080	16 000	316 080
Colloidal oil	75 000	6 000	81 000
Total true pesticides	1 004 200	485 800	1 490 000
Liquid fertilizer	66 000	-	66 000
Rodent bait	10 500	-	10 500
Bird repellent WP	28 000	10 000	38 000
Snail bait	45 000	6 000	51 000
Protein bait	12 000	-	12 000
Paradichlorobenzene	2 000	-	2 000
Total	1 167 700	501 800	1 669 500

Table 4 lists the pesticides on which a subsidy is payable by private farmers by the Agricultural Bank and the importers from whom they must be purchased to qualify for it. Purchases by government agencies are not subsidized, so in 1973 the 204 tons purchased by the Agricultural Crop Marketing Company at Al-Hadaba, the 51 tons purchased by the Ministries and the 225 tons purchased by the ARD Projects did not qualify for it (table A-3). When this total of 480 tons is subtracted from the total of 1,670 tons shown in table 3, 1,190 tons remain, which should represent materials which were used by private farmers and would thus qualify for the subsidy. Thus, although the subsidy is generous, it is not being used, as fully as might have been hoped, to promote the use of pesticides to increase agricultural production.

Table 4. Sales of pesticides to private farmers in Libya by the General Company and by private merchants that were subsidized a/ by the Agricultural Bank in 1972 b/ and 1973 c/
(Kilograms or litres)

Product	1972		1973	
	General Company sales	Private merchant sales	General Company sales	Private merchant sales
Dipterex 80	1 552	383	17 237	206
Sevin 50	1 648		2 683	
Lomocrunk 5	978		935	
Lomocrunk 2½		5		
Morkit 80 WP		315		10
Malathion	7 560	873	26 128	579
Dimethoate 40 EC	5 939	462	10 891	156
White oil	1 178	690	6 326	420
Tekel/Falcon	280		12 833	
Tedion 8		54		5
Cupravitam	3 025		4 059	
Vitam M (maneb)	1 616	348	3 072	10
Vitam A (sineb 70)	145		263	
Vitam Extra (sineb 80)		2 559	399	3 718
Micronised sulphur	8 747		142 865	
White sulphur		3 331		36
Copper sulphate			425	
Adhesive	1 413	363	925	249
Total	34 081	9 383	229 041	5 389

a/ The subsidy amounted to one half of the selling price.

b/ Total, LD 11,380.

c/ Total, LD 48,670.

At present, there is only one manufacturer of the weed killer Hyvar X (bromacil) WP, the patent for which is held by Dupont, an organization that normally is unwilling to sell technical materials. (The same holds true for Lebayeid, which is owned by Bayer.) Snail bait (metaldehyde 2.[illegible]%) and rodent bait (warfarin 0.05%) can be formulated with bran. All of these products offer possibilities for local formulation. Also, nitrogen-phosphorus-potassium (NPK: 11-8-6) could presumably be formulated locally.

Because of the considerable risk of contamination, weed killers must be mixed in a separate plant at some distance from an insecticide or fungicide plant. Consequently, if the Gebal Akhdar Project plans to continue the use of hormone weed killers, the installation of a weed-killer liquid mixing plant at Benghazi should be considered.

Optimum pesticide use in 1974 (table A-4), which has been calculated from the data on crop areas presented in table A-1 and the data on optimum pesticide application against specific pests (table A-5), which are reflected in the data on pesticide imports in that year shown in table 3, indicate the actual imports and optimum use of white oil (plus Folidol) and other true pesticides as follows:

	Actual imports (tons)	Optimum use (tons)
White oil plus Folidol	397	1 503
Other true pesticides	1 093	2 455
Total	1 490	3 958

It can be seen that imports of white oil, including a white oil-Folidol mixture, were 26% of optimum use. The use of white oil in 1973 is estimated to have been slightly more than 316 tons (table 3), which is about 20% of the estimated optimum use for scalicides.

On livestock

In 1973, the sheep and cattle populations of Libya were assumed to be about the same as they had been in the preceding year, namely 2.3 million sheep and 108,000 cattle (table 5). Their most important ectoparasites are the mites that cause sarcoptic mange in sheep, and ticks that infest both sheep and cattle. The extent and importance of these infestations and the damage they cause are not known, but most privately-owned sheep are dipped at least once annually, and those controlled by the Sheep Project four times

annually, except at the operation at Sirt, where the animals are said to be dipped six times annually, between the April shearing and the following September. The average commercial sheep flock numbers 300 to 400 head, but some of these flocks are nomadic and are rarely brought to the dipping sites. Cattle are normally sprayed once yearly.

Table 5. Present and projected numbers of sheep and cattle in Libya, 1972-1985
(Thousands)

Livestock	1972	1975	1976	1977	1978	1979	1980	1985
Sheep, privately owned	-	-	-	-	-	-	4 100	6 000
Sheep, government owned	-	-	-	-	-	-	500	700
Total	2 300	3 000	3 300	3 600	3 900	4 200	4 600	6 700
Local cattle	-	-	-	-	-	-	108	108
Improved cattle	-	-	-	-	-	-	162	187
Total	108	120	150	180	210	240	270	295

Source: 1972 figures from Production Yearbook, 1972, vol. 26 (Rome, FAO, 1973), p. 186 and 189; 1975-1979 figures are the consultant's estimates; 1980 and 1985 figures from Ministry of Planning.

The preparation normally used for both sheep and cattle is Gamatox Superfluid Concentrate EC, which has been used in Libya since 1968. It contains 20% (v/v) lindane. It is diluted 1:800 with water to control lice, flies and ticks and 1:1,000 for use against the mange mites. It is imported from the United Kingdom at a cost, in September 1974, of £13 per 160-oz gallon, c.i.f. Tripoli. While no resistance to this material has been identified, no comparative field trials have yet been undertaken.

The Veterinary Department of the Ministry of Agriculture provides the insecticids and the facilities for the movable dips and spray equipment free of charge, once a year, at various points in Libya, to which private owners bring their animals on a publicised date, to have them treated by Veterinary Department personnel. The Veterinary Department reports importing the following quantities of Super Gamatox (lindane 20% EC) from the United Kingdom:

1972	2,067 gallons
1973	2,772 gallons
1974	3,112 gallons

In late 1974 the National Pharmaceutical Company (NPC) took responsibility for such imports and brought in 9,000 litres of Nexadip (20% lindane) EC from the Federal Republic of Germany, at LD 0.743 litre c.i.f. Tripoli, which is nearly one third of the price of the British material.

Both of these preparations contain 20% lindane. In the former it is pure gamma isomer, but the latter also contains 6% alpha and beta isomers of benzine hexachloride (BHC), which are reported to accumulate in animal tissues. These two isomers have a higher mammalian toxicity than the gamma isomer (lindane), but Nexadip is reported to be safe, provided that the normal precautions associated with dipping are taken. The United States Food and Drug Administration Handbook No. 331 lists details of the current findings, hazards and precautions concerning the alpha and beta isomers of BHC.

Three of the CAD Projects, Kufra, Gebal Akhdar and Geffara, are reported to import their own animal dip and spray requirements, as do the three animal projects that report to the Ministry of Agriculture, namely, the Dairy Cattle Project, the Sheep Project and the Poultry Project.

From information obtained and estimates made, it is concluded that the best estimate of use and imports of lindane 20% EC in 1973 was:

	Gallons
Veterinary Department	6,000
Kufra Project	2,000
Gebal Akhdar Project	200
Geffara Project	20
Dairy Cattle Project	50
Sheep Project	300
Poultry Project	50

This total of 8,620 gallons is equivalent to 39,186 litres of 20% lindane EC, or 7,837 kg of active (100%) lindane.

These figures represent the estimated actual imports. Individual use figures may differ from these because of one department or project drawing supplies from another. It is doubtful that private merchants imported any significant quantity in 1973. No imports are known, and the authorities have reported that the product was difficult to obtain. Had it been otherwise, more would have been used.

In 1973, lindane 20% was at an average dilution rate of 1:1,000, and 5 litres of dip per sheep suggests an average of 3.5 dips per sheep, or slightly less, plus 1 or 2 sprays on some cattle (at 10-15 litres of spray

per animal) and on some camels. Bayer's Asuntol (coumaphos) has been tested, but is not used commercially in Libya as either a dip or spray.

No important animal ectoparasites other than ticks and mites are known to be treated in Libya. The Poultry Project used 5 kg each of DDT louse powder and Gamatox miticide powder (BHC) for lice and mites in 1973. The Dairy Cattle Project used 160 gallons of pyrethrin [illegible] in 1973 for the control of flies and mosquitoes in dairy buildings, but planned to change to Neo-Pybuthrin (see table A-6) in 1974.

In public health

During 1973 NPC imported pesticide requirements of the Ministry of Health. These imports and their reported use by the Ministry are shown in table A-6 in annex I.

The Health Moderia in each Mohafza normally draw their requirements from the Ministry of Health, but they appear to make purchases elsewhere when the stocks of the Ministry are exhausted.

The municipality of Tripoli normally draws its supplies from the Ministry of Health. The only other municipality that has a medical officer who controls public health spraying within its own area is Benghazi.

Other public health spraying is done by the Ministry, the individual Health Moderia, and the two largest municipalities, with their own ground power sprayers and spraying teams. The Ministry has imported a number of powered fogging machines and plans to import 40 more for distribution throughout the country. The Ministry is considering helicopter arial application, and a successful demonstration has already been given using Reslin, a bioresmethrin pyrethroid formulation.

In 1973, a change took place among the importers of public health insecticides. The total use (tons) of these insecticides in 1973 is considered to be more than the imports shown in table A-6 and is estimated to have been:

DDT 75% WP (WHO specifications)	18
Lindane-50 EC fog solution	10
Lindane-20 EC	30
Bromophos 40% (various liquid grades)	56
Bromophos WP (probably 25 WP)	30

Malathion-57 WDP (WHO specifications)	3
Malathion-50 EC	2
Pyrethrum (emulsifiable)	10
Aerosols gross weight, 15.589 tons, rounded to	16 tons

with a total estimated 1973 use of 175 tons, being 51 tons of wettable powders and 124 tons of liquid formulations. Libya is now regarded as free of malaria, and routine malaria barrier spraying on the southern boundaries is reported to have ceased in March 1973. Mosquitoes and sand flies are the major problems controlled by public health spraying.

A special situation exists in Tripoli in that the General Cleaning Company, which is part of the Tripoli Mohafza Health Moderia, was responsible for the spraying of slaughter-houses and rubbish tips. It reported drawing quarterly supplies from the Ministry of Health of Folidol M 50 (methyl parathion EC 600 g/litre) and a second insecticide labelled only "M.O.H. Libya", and using 3,000 litres of the former at a dilution rate of 1:200 parts water, and 2,500 litres of the latter at 1:150 parts water, annually.

During 1974 there has been a perceptible swing to the use of Neo-Pybuthrin liquid formulations (see table A-6).

Two private merchants were identified who continued to import insecticide formulations for public health use, for the account of the authorities, their imports are included in the use figures given above.

The Ministry of Health proposes to register public health insecticides and thus to control their use more precisely as well as to ensure that they are freely sold in the country of origin before they are imported into Libya. It wishes to prevent the use of organophosphate insecticides such as parathion and malathion. The Ministry of Health advises the Ministry of Agriculture on the human health hazards of pesticides for agriculture, but as yet they have not agreed on any classification.

For household purposes

Some troublesome domestic insects are flies, mosquitoes and, to a lesser extent, cockroaches and ants. The important use period is from April to September; most imports of formulations against them are imported during January and February. The two in most general use are aerosols and liquids for application by a small hand sprayer. Small volumes of both insecticide powders and fly-bait granules are used.

In the past, private merchants imported both aerosols and liquid insecticides, reselling them to wholesalers, who delivered them to retail shops. At the same time, BPMC imported Shelltox liquid (composition DDVP 0.6%, inerts 0.11% and petroleum hydrocarbons to 100%) from Shell and Flit from Esso.

In late 1973, legislation provided that, henceforth, BPMC would be the sole importer of liquid insecticides, since they were petroleum-based products. In fact, BPMC began to import them in March 1974, and private merchants continued to import household insecticides, making a payment of 7.5% of the c.i.f. value to BPMC. Some private merchants still continue on this basis. It is reported that an agreement exists enabling the Ministry of Agriculture to permit the separate import of insecticides for agricultural use.

The type, composition and package sizes of the more important aerosol and liquid insecticides imported by BPMC in 1974 are shown in table A-7. The 1974 imports of household insecticides have been estimated, and these figures are presented in table A-8. Shown in this table are the specified weights of the various packs, as shown on the containers and packing slips. These weights were used to compile the import statistics. Also shown are the net weights; with aerosols, the net weight differs from the specified weight. While the net weights are shown on some containers, in other cases these figures are estimates.

As for data on imports in 1973, although BPMC has indicated that it has figures, or at least estimates, for that year, none have been released. It was therefore necessary to estimate the 1973 sales and import figures for household pesticides by combining them with the 1973 figures for the other three classifications of true pesticides, namely those for crops, for livestock and for public health (table 1).

The 1974 sales forecast for domestic insecticides, as calculated by the Sales Department of BPMC, are presented in table 6. In this connexion, it is pertinent that, during that year, there was a perceptible trend towards aerosols from liquid preparations in a rapidly developing market. This development was largely owing to an embargo of the cheaper Flyol and Shelltox that had been imported previously, but which, in 1974 sold at wholesale prices of, respectively, LD 0.45 and LD 0.66 per 128-oz gallon, compared with the 1974 imports of the Montacatini liquid insecticide containing the more expensive pyrethroids, which had had a wholesale price of LD 1.02 per 128-oz gallon. BPMC estimated

that its sales, by the end of 1974, would be 1,500 tons of liquid insecticide, largely of 1973 stocks of Shelltox and Flyol, since there was consumer price resistance to the new Montacatini liquid.

Table 6. Forecast of 1974 sales of household insecticides in Libya

Product	Size (oz)	Number of packs	Specified weight	
			Oz	Kg
Low quality aerosol	12	1 000 000	12 000 000	340 100
Medium quality aerosol	12	200 000	2 400 000	68 000
Medium quality aerosol	18	800 000	14 400 000	408 100
High quality aerosol	8	150 000	1 200 000	4 000
High quality aerosol	16	350 000	5 600 000	158 700
High quality aerosol	18	50 000	900 000	25 500
Total aerosols		2 550 000	36 500 000	1 004 400
Liquid insecticides	16	75 000	1 200 000	34 000
	32	175 000	5 600 000	158 700
	128	500 000	64 000 000	1 814 000
Total liquid		750 000	70 800 000	2 006 700

Source: Brega Petroleum Marketing Company.

BPMC estimated that its aerosol sales by the end of 1974 would account for one half its 1974 imports.

In 1974, the private merchants continued to import aerosols but apparently not liquid insecticides. Because of their market knowledge, they can be expected to have sold a larger proportion of their imports than BPMC. BPMC sells through its petrol stations and to wholesalers. Private merchants who import are also usually wholesalers.

The estimates for imports and sales of household pesticides in 1973 and 1974 are shown in table 7.

The data presented in this table indicate a total of 3,050 tons specified weight of household insecticide imports in 1973. It must be emphasised that, this figure is the best estimate, in the absence of any actual figures, and

tends towards understatement, as it is conceivable that the actual figures for 1973 would be as much as 400 tons greater.

Table 7. Estimated imports and sales of household insecticides in Libya, 1973 and 1974
(Tons of specified weight)

	1973		1974	
	Imports	Sales	Imports	Sales
Liquids				
BPMC			1 551	
Private merchants			-	
Total liquid	1 450	1 400	1 551	1 500
Aerosols				
BPMC			1 497	750
Private merchants			1 133	900
Total aerosols	1 600	1 400	2 630	1 650
Total	3 050	2 800	4 181	3 150

BPMC expects to bring its lubricating oil plant at As-Zawia on stream in 1974. It is importing the appropriate mineral oils and additives as well as sheet metal for fabricating tin containers in which to pack the products.

In early September 1974, BPMC indicated that it proposed to mix liquid insecticides at As-Zawia for household use, utilising locally produced deodorized kerosene, and would reserve funds in its 1975 budget, then in preparation, for a mixing and packing plant.

BPMC is ideally placed to erect and operate such a plant and to market its production, since it already has a plant at As-Zawia, with services; is primarily responsible for the import, export and domestic marketing of petroleum-based products; and has already begun to market household insecticides in Libya.

BPMC has denied a report that it not only intends to produce liquid insecticides but was contemplating the production (filling) of aerosol insecticides and could be expected to request tenders for a suitable plant in the near future. Nevertheless, such a development is clearly a possibility for the future.

For the purpose of the present study, it was necessary to compare the cost of locally formulated products of the same composition as those now being imported, the cost of which is known. Nevertheless, alternative formulations should be considered for mixing in Libya.

Some important points for consideration in this connexion are:

The extent to which the market for liquids overlaps that for aerosols. There is a possibility that the real market for aerosols is for indoor use, while that for liquids is partly outdoor, and partly indoor especially among the lower income groups. Therefore, while safety is more important than economy in this context, there is a need for a non-toxic (mammalian) and therefore nonresidual, liquid insecticides for use indoors, similar to aerosol formulations and, separately, a liquid insecticide for outdoor use only, with a residual effect.

One of the best aerosols available in Libya is Bayer's Baygon (containing 2% aprocarb and 0.6% DDVP), since it is effective in controlling all domestic insects and provides a degree of residual effect. Approcarb, the important active ingredient, is still under Bayer patent, and this company may prefer not to sell the technical material. However, a liquid concentrate may be available. Bayer makes and sells in Italy, an aerosol also called Baygon that contains only DDVP at 0.6% as active ingredient.

The virtual banning of DDT and lindane for household use in Libya means that an alternative active ingredient must be chosen, if any persistence is expected. One possibility is diasinon, but the environmentalists may prefer a liquid containing 1% DDVP.

BPMC requests a definitive statement from the appropriate United Nations agency regarding the human health hazards and implications of use in household insecticide aerosols and liquid formulations of DDT, lindane, DDVP, bioallethrin and bioresmethrin at varying concentrations of active material. Manufacturers of aerosols tend to change the active ingredient composition yet maintain the same trade name or trade mark. The trend is towards inclusion of the less toxic but more expensive pyrethroids bioresmethrin and, to a lesser extent, bioallethrin, rather than pyrethrins.

Several reports suggest that up to 25% of the aerosols imported into Libya are re-exported to neighbouring countries in small lots. Market research is necessary to identify the extent and importance of any profitable export market for Libyan aerosol products. Libyan trade statistics show no exports or re-exports under tariff item No. 599.200 for insecticides, including aerosols

The active ingredient (100%) requirements for local formulations of household insecticides in a volume equal to 1973 imports would be, on the following assumptions:

If all liquids were of the Montacatini formulation (see table A-7, item 6):

217.5 kg bioallethrin
290 kg bioresmethrin
870 kg piperonyl butoxide

If the net weight of all aerosols were 63% of the specified weight, and if 66% by weight was of the composition shown in table A-7, item 1, and if 34% was composed of the active ingredients shown in table A-7, item 4:

3,991.7 kg DDVP
2,701.5 kg piperonyl butoxide
685.4 kg bioallethrin
68.5 kg bioresmethrin

for a net weight of 1,450 tons of liquid insecticide (at sp.gr. 1) and 1,008 tons aerosol formulations (at sp.gr. 1), totalling 2,458 tons net weight.

Duties on pesticides

Tariff item No. 599.200 is described in table 2. It comprises all pesticides, including aerosols, and also disinfectants. Goods classified under this tariff number enter Libya free of duty.

This tariff item appears to be based upon the former SITC No. 599.02, which has now become BTN 38.11. In most countries, this tariff refers only to pesticides that are ready formulated, and not to technical materials used for their subsequent formulation. Unless otherwise provided in the tariff, technical pesticide materials are normally classified according to the chemical group to which they appear to belong, rather than by their intended end-use.

For this reason, an anomaly has arisen in many countries wishing to encourage local pesticide formulation, where no tariff action has been taken, in that formulated pesticides enter free of duty; but a duty, sometimes substantial, is levied on technical materials and additives intended for subsequent formulation and end-pesticide use.

It is therefore proposed that, to avoid subsequent problems, action should be taken in advance of imports of technical materials, to have them classified under a duty-free item. At present, some technical materials might be classified under tariff items on which a duty is levied, particularly "chemical products and preparations not elsewhere specified".

The packaging of pesticides

The size of unit or consumer pack of pesticides is influenced by:

Safety. This consideration is particularly important where the majority of pesticide consumers farm small areas and would be unlikely to use all of a 1-kg unit at one time. A half-empty pack constitutes a hazard to less-informed members of the farmer's family and can result in accidents. A good rule to follow is that, the more toxic the product, the smaller the size of the pack.

Economic considerations and convenience. Normally, the larger the pack size, the lower the cost of packing and packaging materials per unit of weight or volume. Large-scale farmers or contractors who spray large areas object to spending time opening many small packs and prefer to use several large ones, normally 25- or 50-kg, for powder, and at least 50 litres for liquids and, if they have the handling equipment, up to 200-litre drums. The larger the pack, the less the storage space required and the lower the transport charges incurred per unit of weight or volume.

In Libya, however, priority must be given to safety, so 1-kg or 1-litre packs are proposed for general use. Some may support packing in 0.5 kg packs, but for most pesticide formulations in current use, 0.5 kg would be sufficient only for a single application on 0.25 ha or less. Thus, 1-kg packs are proposed for general agricultural crop use. The Projects or the Spray Company may make a case for 25-kg or 50-kg packs, but in this case care must be taken to ensure that they are not subsequently broken down in pesticide stores for repacking into unlabelled paper bags or tins, for use by the private farmers.

The majority of the animal dips and sprays are purchased and applied by authorities and the Projects. For this reason a 25-litre drum packing is proposed. Ideally, all treatment should be supervised by trained personnel, and perhaps the number of applications increased. If there are insufficient personnel to undertake this work and it is judged that farmers are competent to do their own dipping safely, consideration should be given to 1-litre packs for lindane 20 EC. Public health insecticides are purchased and applied exclusively by the authorities with their own equipment and personnel. Insecticides for this use are therefore proposed in 25-kg and 25-litre drums.

Household insecticides are of low toxicity, and their pack size should be based on a convenience and market requirements. The present 32-oz and 128-oz cans are suitable for liquids.

Aerosols constitute a health hazard, and there is a trend towards the smallest realistic size in some countries, which is judged to be 4 oz. However, 8 oz is satisfactory. In Libya, ideally the use of only 8-oz containers

at present might prove more economical than a range of sizes up to 18 oz. It is proposed that only two sizes, 8 oz and 12 oz, be marketed.

It is understood that the minimum annual market for which a completely integrated aerosol plant would be economic is 40-50 million units. Such a plant could manufacture the aerosol shell, caps and perhaps the valve, formulate the pesticide and pressure-fill the shells with pesticide and propellants. However, Libya's aerosol use is but a fraction of this figure, but it is proposed that UNIDO be asked whether the current and forecast market appears to justify detailed examination by a UNIDO expert of the economic benefits to be gained by formulating and filling aerosol insecticides in Libya, probably importing the containers and caps and certainly the valves initially. Pressure packs such as aerosols are normally of tin plate and sometimes of aluminium. Current aerosol use estimates and forecasts are discussed separately in the present report. Liquid pesticides should be packed as follows:

1-litre cans, if the material is corrosive or toxic (for example, Folidol oil, dimethoate, malathion, Lebaycid, DD and Kelthane) ideally in aluminium cans, but these would have to be imported. Lacquer-varnished tin-plate cans would be suitable and would be more convenient if local manufacture of them were to be undertaken in Libya in the future;

1-litre packs, if the material is non-corrosive and non-toxic (for example, Tedion) may be packed in tin-plate cans;

25 litre, and larger packs, if corrosive or toxic (see above, and lindane 20 EC) in epoxy (double epicoat) lined mild steel drums;

25-litre and larger packs, if non-corrosive and non-toxic (Tedion, Nexion and pyrethroids) in mild steel drums.

Hormone weed killer liquid formulations such as 2,4-D are corrosive but are frequently packed in mild steel drums because of their lower cost. They do not normally constitute a problem in this packing if used within two years.[1/] It is safer, however, but more costly, to pack these weed killers in epoxy-lined mild steel drums. Since 22 litres of mineral oil is the minimum hectare requirement, this size is proposed, in a mild steel drum, and in 1-litre tin-plate cans.

Pesticide powders should be packed in:

1-kg packs, if toxic (Ceresan and aldrin) in 400-gauge gusset-type polyethylene bags, heat sealed, in a labelled tin, with 24 tins to a corrugated board shipping carton;

1/ Disposable plastic containers are used for water-soluble weed killers of low toxicity in some countries, but the risk exists of their subsequent use for drinking water.

1-kg packs, if non-toxic (DDT, sulphur, Dipterex, Sevin, COC, zineb and maneb) in a 400-gauge, gusset-type, heat-sealed polyethylene bag in a labelled outer paper board carton (similar to Bayer's new pack for Dipterex), with 24 1-kg packs to a corrugated board shipping carton;

½-kg packs in a 250-gauge polyethylene bag appropriately closed in an outer fibreboard drum.

Labels should be firmly fixed to cans, tins and drums, and, if possible, printed on paper-board cartons. Ideally, pesticides should be classified according to their toxicity, and a colour selected for the labels of each of the three normal pesticide categories (see the section on present pesticide use on crops above). Normally red is used for category I pesticides, and a skull is prominently displayed on the label. Full directions and safety precautions must be printed on the label in Arabic.

Pesticides should be stored under cover and, ideally, in conditions where extremes of temperature can be avoided. Toxic chemicals should be kept in a separate store under lock and key, and a poison register maintained, showing incoming product, existing stocks and signatures obtained for all outgoing product.

A point worthy of consideration is the production and marketing of a crop composite pesticide pack, containing a sufficient quantity of all of the pesticides required for a single application to control the pests and diseases on a specific crop. The optimum pesticide applications for the major crops in Libya are set out in table A-7. A composite pack for one application on 0.5 ha of melons would contain: 1 kg sulphur, 1 kg Dipterex 80, 1.5 litres malathion 50 EC and 1.5 litre Kelthane 18.5 EC. Composite packs containing both powders and liquids are unsatisfactory, so the malathion EC would have to be changed to 1.5 kg malathion 50 W or 3 kg malathion 25 W, and the Kelthane EC to 1.5 kg Kelthane 18.5 WP.

Each product should be packed and labelled separately (as above) and the four products in the present example packaged in a corrugated board outer carton.

These composite packs can be made up for any crop, on any area basis or per 500, 1,000 or 2,000 litres of spray. This approach is valuable in helping farmers to appreciate the necessity of a spray schedule that includes the use of specific chemicals to control specific pests in a particular crop, and the

correct dosage. This can obviously promote increased production of high-value cash crops and takes a little pressure off the extension officers.

Once started, such a promotion programme must be sustained, otherwise large stocks of various pesticides can be left in what may be considered unusual pack sizes, which must then be repacked into more conventional sizes.

Soluble packs of wettable powder have been under test for five years in some countries, but their commercial use cannot yet be recommended.

II. FORECAST USE OF PESTICIDES

The forecasts of pesticide use in the four separate use sectors are estimates. Their bases have been accepted by some, but certainly not by all, interested and knowledgeable persons visited in each sector in Libya.

In the thriving and dynamic economic climate of Libya, these estimates may prove to be too conservative. Whenever applicable, particularly in the agricultural sector, these pesticide forecasts are qualified, and the assumptions made are considered in the appropriate sections of the present report and its annexes.

Forecasts are based on the continuous use of known and currently used pesticides. Clearly, as insect resistance develops to an insecticide, or if new and superior products become available in the future, the use pattern will change. However, it is unlikely that the volume of formulated products required will change dramatically within the context of the required capacity of the Libyan pesticide formulating plant. It is also possible that as the active materials change, adjustments in plant may be necessary, influenced for example by toxicity, corrosiveness, melting point or required particle size.

There could be a perceptible increase in the use of wettable powder formulations (particularly for fruit, where they are generally less phytotoxic than emulsifiable concentrates) over the figures forecast, as changes in use of active materials occur in the future. Equally, a major programme of arid spraying, particularly in the project areas, could result in a trend toward ultra-low volume (ULV) liquid formulations being required.

On crops

This forecast of pesticide use is based upon:

The 1975 Plan of the Ministry of Agriculture and the 1980 and 1985 projected irrigated crop areas drawn up by the Ministry of Planning, shown in annex I, table A-1;

The use of pesticides in irrigated areas only, except for seed dressings on rain-watered cereals (table A-1);

The estimates of optimum pesticide application on known pests and diseases, as shown in table A-5;

The optimum pesticide use forecast in irrigated crops, as shown in table A-4. However, it is rare for 100% of the optimum use to be actually achieved;

A substantial increase in pesticide extension activities. The current ratio of extension officers informed on pesticides is one for each 1,000 farmers. This ratio should ideally be narrowed to 1:100;

A major programme to organize marketing of agricultural produce, particularly perishable crops, through food-processing plants, cold-storage chains and markets. The Government may wish to assist in modulating the relative prices of agricultural produce and to encourage off-peak-season crop production;

A broadening of the Advisory Service on Pesticide Use and Application and of pesticide distribution channels so as to enable farmers to secure supplies more readily.

The optimum use of the forecasts given in table A-4 indicate the pesticides now used, which have been chosen in many cases becauee of their comparatively low toxicity and high degree of safety.

It is forecast that:

Insecticide and fungicide wettable powders will continue to be used at 45% of the optimum, but on the increased area to the end of 1975, will then rise to 5[illegible], and attain 55% in 1978 and 60% in 1980;

Insecticide emulsifiable concentrates will continue to be used at 40% of the optimum to the end of 1975, thereafter 50%, reaching 55% in 1978 and attain 60% in 1980;

Weed killer use will be 70% of optimum to the end of 1975, thereafter 80%, and rise to 90% in 1980;

Mineral oil use will rise, at most, to 25% of the optimum in 1977, if promoted. It is doubted if actual use will rise beyond 1,000 tons annually in Libya, owing to the better performance of more toxic acalicides, as has happened in other countries;

The use of rodent and snail baits will rise to 100 tons before 1985, and bird-repellent wettable powder to 60 tons.

The annual forecast by type of formulation is shown in table 8. It is proposed as the basis for planning the equipment and capacity of a pesticide formulating plant in Libya

Table 8. Forecast demand for pesticides in Libya, 1975-1985

(Tons)

	1975	1976	1977	1978	1979	1980	1985
Insecticide/fungicide-WP	605	672	698	775	781	895	1 023
Insecticide EC	512	683	735	892	989	1 177	1 289
Weed killer WP	49	47	47	48	48	51	60
Weed killer EC	178	264	345	385	425	531	554
Mineral oil	500	700	1 000	1 000	1 000	1 000	900
Rodent and snail baits	70	70	80	80	90	100	100
Bird repellent	40	40	50	50	50	60	60
Total	1 954	2 476	2 955	3 230	3 383	3 814	3 986

The list of products shown in table A-4 includes D-D, which is unsuitable fo for local formulation. Fenthion, the technical material for Lebaycid, is available only from Bayer, which holds its patents and may not wish to sell it, prefering to market its own formulations.

In 1971, two forecasts of the use of pesticides in Libya were made. The first was compiled by a committee of experts from the Ministries of Agriculture and of the Economy. This forecast was based on the use of these materials on 10% of the irrigated land in 1972, and in each year thereafter by their use on an additional 5% of the total irrigated area. Thus, their foreca forecast was that, by 1975, pesticides would be in use on 25% of the total irrigated land in the country. The second forecast was prepared by the Industrial Research Centre(IRC), using data provided by the Ministry of Agricultu and projected pesticide use to 1980, based on the use of pesticides on a percentage of the total area under crops. These two forecasts are compared in table A-9, where it can be seen they differ very considerably. It can be seen that these two earlier forecasts differ considerably, not only from those presented here, but from each other.

On livestock

The present and projected numbers of cattle and sheep in Libya are presented in table 5. These figures incorporate the writer's estimates of the build-up of these flocks and herds during the years 1975 through 1979 and the projections of the Ministry of Planning for the period from 1980 through 1985. For the purpose of this forecast, the following assumptions have been made:

The numbers of sheep and cattle forecast will be achieved;

All sheep will be dipped an average of four times annually during the years 1975 to 1978 and five times annually thereafter;

One half of the cattle will be sprayed an average of twice annually during 1975 to 1978 and, thereafter, 75% of the cattle will be sprayed three times annually;

Lindane 20% EC will continue to perform satisfactorily at a dilution rate of 1:1,000 parts water, allowing an average of 5 litres of dip per sheep per dipping, and 10 litres of spray per cow per spraying.

On this basis, the following volumes of lindane 20% EC use are forecast:

	Litres		Litres
1975	61 200	1979	110 400
1976	67 500	1980	121 075
1977	73 800	1985	174 137
1978	80 100		

which, as 20% w/v lindane, would require the following amount of lindane technical material in terms of active ingredient (100%):

	Kilograms		Kilograms
1975	12 240	1979	22 080
1976	13 500	1980	24 215
1977	14 760	1985	34 827
1978	16 020		

It is almost certain that ectoparasites will develop a resistance to lindane, as they have in other countries, and that an alternative material such a diasinon, coumaphos or dioxathion (Delnav) will be used. These newer materials are usually formulated in different concentrations but require the

same standard dilution rates with water; thus, the required volumes of the formulated dip emulsifiable concentrates would be similar to those indicated above, although the weights of active ingredients will vary with the technical material of choice and its biological activity.

In public health

Insecticide use for public health purposes is forecast to double by 1980 because of:

Increases in population, individual income, construction and land reclamation;

The continued increase in identification of public health hazards, and efforts to cope with them;

It is anticipated that the use of public health insecticides will remain nearly constant at the 1980 level.

It is probable that the ratio between wettable powders and liquids will continue to be 2:3, as at present. The trend is towards the use of less toxic insecticides (particularly bioresmethrin), but while the active materials may change, the volume of formulated products for further dilution in the spray tank is unlikely to change, unless there is a major change towards ULV aerial use.

On the basis of the above assumptions, the forecast use (tons) for public health purposes will be as follows:

Formulation	1975	1976	1977	1978	1979	1980	1985
Wettable powder	92	104	116	128	144	160	160
Liquids (EC oil-miscible)	138	156	174	192	216	240	240
Total	230	260	290	320	360	400	400

For household purposes

The imports of aerosol pesticides for household use in 1973 (1,600 tons) represent 0.71 kg per capita on the 2,250,000 population of Libya. The ... has noted that the average annual per capita consumption of them in the United States of America is 3.74 kg, and 2.72 kg in Europe.

The climatic conditions and high income in Libya both point to a marked increase in household aerosol use. It is therefore forecast that the annual increase will be 15% until 1980, when the market will probably become nearly saturated, with an annual increase of 5% thereafter. It is assumed that a high proportion of the population who do not yet use domestic insecticides will begin with the use of aerosols, particularly as they become available, although they are more expensive for the same volume than liquid insecticides. It is therefore forecast that the use of liquid insecticides will increase at 5% annually (population growth 3.7%) up to and including 1985. The forecasts are based on the estimated import figures for 1974 for liquid insecticides and 1,700 tons specified weight for aerosols, rather than the estimated sales figures, since it is assumed that a proportional stock will be maintained.

On these bases forecast requirements, as net weight in tons (rounded up to nearest whole ton) will be as shown in table 9.

Table 9. Forecast of requirements of aerosol and liquid insecticides for household use in Libya, 1975-1985

(Tons)

Aerosols	1975	1976	1977	1978	1979	1980	1985
Gross weight	(1 955)	(2 249)	(2 586)	(2 974)	(3 420)	(3 933)	(5 819)
Net weight[a]	1 232	1 417	1 630	1 874	2 155	2 478	3 667
Liquids	1 629	1 710	1 796	1 885	1 979	2 078	2 652
Total net weight	2,861	3,127	3,426	3,759	4,134	4,556	5,819

[a] The net weight of the aerosols is calculated as 63% of the gross (specified) weight of the formulations.

The per capita aerosol consumption, with an annual population increase of 3.7% would be:

0.81 kg at a population of 2,419,000 in 1975
1.36 kg at a population of 2,902,000 in 1980
1.44 kg at a population of 3,480,000 in 1985

If all aerosols were produced in a standard 12 oz size, the total number of units would be:

5,748,000 oz in 1975
11,560,000 oz in 1980
14,756,000 oz in 1985

As insect resistance developed to specific active materials, different ones would be substituted, but the volumes of the finished liquid or aerosol formulations are unlikely to be affected materially.

Annex I

PESTICIDE STATISTICS

A-1. Present, planned and projected crop areas in Libya

A-2. Pesticide imports by the General Company for Farm Equipment and Agricultural Necessities, 1972-1974

A-3. Estimated pesticide imports by private merchants and CAD Projects, 1973

A-4. Present and forecast optimum pesticide use in Libya

A-5. Optimum pesticide application to control identified pests and diseases of economic importance on irrigated crops in Libya

A-6. Public health pesticide use and imports for the Ministry of Health (MOH) and the army by the National Pharmaceutical Company (NPC), 1973 and 1974

A-7. Manufacturer, characteristics and cost of household insecticides imported into Libya in 1974

A-8. Estimated imports of household insecticides to Libya, 1974

A-9. 1971 forecasts of pesticide use in Libya by a committee of experts from the Ministries of Agriculture and of the Economy and by the Industrial Research Centre

A-10. Actual purchases of important pesticides by the Ministry of Agriculture, 1970-1974, forecast of 1974 purchases and existing stocks in August 1974

Table A-1. Present, planned and projected crop areas in Libya
(Thousand hectares)

A. Irrigated crop area

Crop	1973 Actual[a]	1975 Plan[b]	1975 Estimates[b]	1976 Estimates[c]	1977 Estimates[c]	1978 Estimates[c]	1979 Estimates[c]	1980 Projected[c]	1985 Projected[d]
Wheat	10.588							60	60
Barley	36.606	87.194	87.194	88	89	90	90	30	30
Maize, millet and sorghum	3.700	3.700	3.700	-	-	-	-	-	-
Beans (dry)	5.200								
Peas (dry)	0.330								
Chick peas (dry)	0.780	12.310	12.310	13	13.500	14	14.500	15	17
Green peas	0.400[e]								
Green beans	0.600[e]								
Groundnuts	5.500	10.600	9.6	10	10.5	11	11.5	12	19
Other industrial crops (tobacco)	0.100[e]		1	1.5	1.75	2	2.25	2.5	2.5
Winter potatoes	7.150		10	9	8	7	7	15 est. 7	19 est. 9
Summer potatoes	8.450		12	11	10	9	8	est. 8	est. 10
Summer tomatoes	12.148		18	18	18	18	18	21 est. 18	25 est. 21
Winter tomatoes	2.485		3	3	3	3	3	est. 3	est. 4
Garlic	0.388								
Onions (dry)	5.260	70.526	7	6.5	6	5.5	5	7.5	10
Green onions	3.380		4.5	4	3.5	3	2.5		
Carrots and other root vegetables	0.488[e]		0.500	0.600	0.700	0.800	0.900	1	1.5
Peppers	0.208[e]		0.500	0.600	0.700	0.800	0.900	1	1
Pumpkins	0.913		1	1	1	1	1	1	1
Watermelons	12.350		10	10	10	10	10	10	10
Sweet melons	2.430		2	2	2	2	2	2	2.5
Salads and cole vegetables	0.858[e]		1.026	1.5	2	2.5	3	5.5 est. 3	7.5 est. 4
Root vegetables	0.388[e]		1	1.3	1.6	1.9	2.1	est. 2.5	est. 3.5

Crop	1973 Actual a/	1975 Plan b/	1975 Estimates b/	1976 Estimates c/	1977 Estimates c/	1978 Estimates c/	1979 Estimates c/	1980 Projected d/	1985 Projected d/
Olives (20% x 220 trees/ha)	4.400*		10	11	12	14	16	est. 18	est. 19
Citrus (all x 400 trees/ha)	4.200*		10	11	12	14	16	est. 18	est. 19
Apricots, peaches and plums	0.500*		2	2	2	2	3	est. 3	est. 4
Apples, pears	0.100*	25.670	1.500	1.500	1.500	1.500	1.500	43 est. 1.500	46 est. 1.500
Almonds	0.350*		0.600	0.600	0.600	0.700	0.700	est. 0.800	est. 0.800
Figs	0.020*		0.070	0.100	0.100	0.100	0.200	est. 0.200	est. 0.200
Grapes	1.100*		1.500	1.500	1.500	1.500	1.500	est. 1.500	est. 1.500
Fodder crops (alfalfa)	-	25	25	40	60	70	80	92	97
Total irrigated crop area	130	235	235	248.7	270.95	285.3	303.55	318.5	349

B. Rain-watered crop area

Wheat	174.300	220		220	220	220	220	220	225
Barley	335.047	300		300	300	300	300	300	315
Total rain watered crop area	509.427	520		520	520	520	520	520	540

a/ The 1973 crop area is drawn from the Ministry of Agriculture statistics, except where marked with *, which indicates the consultant's estimate of area, based on Ministry of Agriculture production statistics.

b/ The 1975 Plan figures are drawn from the Ministry of Planning. The 1975 estimated figures are the consultant's estimates of area for individual crop, since these are necessary for making pesticide estimates, since different crops attract different pests, which are controlled by different pesticides.

c/ In the absence of crop area figures for each of the years 1976, 1977, 1978 and 1979, the consultant has made estimates for each crop by year, for the purpose of estimating pesticide use, and each column is marked with the appropriate year, followed by "est".

d/ The projected area figures bracketing various crops in the years 1980 and 1985 are drawn from the Ministry of Planning. The consultant has estimated the split of these bracketed areas between individual crops for the purpose of the pesticide estimates. These estimated figures are marked "est". The Ministry of Planning project years 1980 and 1985 figures for vegetables above represent a cropping intensity of 148.8% on 43,000 ha (64,000 ha) and 168.5% intensity on 46,000 ha (77,500 ha) in 1980 and 1985 respectively. Therefore the real irrigated surface area in 1980 is projected as 297,500 ha, and 317,500 ha in 1985.

Table A-2. Pesticide imports by General Company for Farm Equipment and Agricultural Necessities, 1972-1974

Manufacture	Trade name	Common name	Percentage of active ingredient and formulation	Pack size (unit)	Quality (Imported)	Lowest net price per unit
			1972			
Bayer	Dipterex	Trichlorfon	80 SP	1 kg	18 500 kg	DM 7.47/kg c.i.f. Benghazi
Bayer	Dipterex	Trichlorfon	95 SP	1 kg	500 kg	DM 9.10/kg c.i.f. Tripoli
Sariaf	Belgrano BHC	BHC	½% Lindane seed dressing	1 kg	1 500 kg	Lit 143/kg c.i.f. Tripoli
Sariaf	Gammisomero	BHC	50 WP	1 kg	2 800 kg	Lit 280/kg c.i.f. Tripoli
Sariaf	Lumacrusk 5	Metaldehyde	5 Bait	1 kg	2 800 kg	Lit 285/kg c.i.f. Tripoli
Sariaf	Morkit	Anthraquinone	80 WP	1 kg	1 008 kg	Lit 1 085/kg c.i.f. Tripoli
Sariaf	Polixane MT 50		50	1 kg	9 000 kg	Lit 788/kg c.i.f. Tripoli
Sariaf	Maladust	Malathion	1 Dust	1 kg	1 000 kg	Lit 216/kg c.i.f. Tripoli
Sariaf	Aldrin 40	Aldrin	40 WP	1 kg	500 kg	Lit 900/kg c.i.f. Tripoli
La Littorale	Triblecar MN	Anthraquinone	20% + Lindane 20% + Mancozeb 20%	1 kg and 200 g	11 000 kg	F 13.86/kg c.i.f. Tripoli
Degesch	Phosterin	Aluminium phosphide tablets		480 tablets per box	218 kg	DM 28/kg c.i.f. Tripoli
Sariaf	Agrumol	White oil	80 Vaseline oil	18 kg	36 432 kg	Lit 193/kg c.i.f. Tripoli
Sariaf	Malafos	Malathion	50 EC	1 kg	31 500 kg	Lit 770/kg c.i.f. Tripoli
Sariaf	Malafos	Malathion	50 EC	0.25 kg	3 050 kg	Lit 880/kg c.i.f. Tripoli
Sariaf	RL 40	Dimothoato	40 EC	1 kg	21 000 kg	Lit 1 421/kg c.i.f. Tripoli
Sariaf	Tekel	Tetradifon	6% + Dicofol 16 EC	1 kg	6 000 kg	Lit 1 900/kg c.i.f. Tripoli
Sariaf	Sariafos 50	Ethyl parathion	50 EC	1 l	1 000 kg	Lit 778/kg c.i.f. Tripoli
Sariaf	Apiren	Beta naphloxl acetic acid		0.25 kg	700 kg	Lit 1 300/kg c.i.f. Tripoli
Sariaf	Anticida	DDT 30% + ethyl	Parathion 20% EC	1 kg	500 kg	Lit 626/kg c.i.f. Tripoli
Bayer	Polidol E 605	Ethyl parathion	50 EC	1 l	2 400 l	DM 8.60/l c.i.f. Tripoli
Bayer	Polidol oil	Ethyl parathion	10% + White oil EC	1 l	5 240 l	DM 5.40/l c.i.f. Tripoli

Table A-2. (continued)

Manufacturer	Trade name	Common name	Percentage of active ingredient and formulation	Pack size (unit)	Quality (Imported)	Lowest net price per unit
			1972 (continued)			
Bayer	Metasystox	Oxydemeton-methyl	25 EC	1 l	125 l	DM 10.40/l c.i.f. Tripoli
Sariaf	Mecsar 50 liquido			1 kg	500 kg	Lit 1 028/kg c.i.f. Tripoli
Sariaf	Vitam M	Maneb	80 WP	1 kg	6 500 kg	Lit 915/kg c.i.f. Tripoli
Sariaf	Vitam A	Zineb	87% of 65 WP	1 kg	12 000 kg	Lit 580/kg c.i.f. Tripoli
Sariaf	Vitam Azzurro	Zineb	65 WP	1 kg	5 000 kg	Lit 590/kg c.i.f. Tripoli
Sariaf	Fitosir 90	Ziram	90 WP	1 kg	1 000 kg	Lit 495/kg c.i.f. Tripoli
Sariaf	Tioflor 80	Sulphur	80 Micronized sulphur	1 kg	3 000 kg	Lit 255/kg c.i.f. Tripoli
Sariaf	Cuprovitam	75% COC	50% copper and 25% sineb 65% WP	1 kg	4 500 kg	Lit 785/kg c.i.f. Tripoli
Sariaf	Idrosolfo Ramato	9.6% COC	50% copper and 28% sulphur WP	1 kg	2 300 kg	Lit 290/kg c.i.f. Tripoli
Sariaf	Zolfo Ventilato	Sulphur		1 kg	4 000 kg	Lit 225/kg c.i.f. Tripoli
Sariaf	Zolfo Polvere	Sulphur		1 kg	1 000 kg	Lit 225/l c.i.f. Tripoli
Sariaf	Idrosolfo	Sulphur bento-nite	33% Sulphur	1 kg	5 000 kg	Lit 176/kg c.i.f. Tripoli
Sariaf	Tioditan	45% Zineb (40% pure)	+ 20% Sulphur WP	1 kg	500 kg	Lit 396/kg c.i.f. Tripoli
Sariaf	Cuprosariaf	COC	50 WP	1 kg	500 kg	Lit 842/kg c.i.f. Tripoli
	Tabum 90 Ass	?		1 kg	200 kg	Lit 486/kg c.i.f. Tripoli
	Minadil	?		1 kg	1 000 kg	Lit 651/kg c.i.f. Tripoli
Plant protection	Gramoxone	Paraquat		5 l	1 120 l	£1.4965/l c.i.f. Tripoli
Sariaf	AU 45	Nitrogen and phosphate	Liquid fertilizer	1 kg	500 kg	Lit 263/KG c.i.f. Tripoli
Bayer	Bayfolan	NPK (11-8-6)	Liquid fertilizer	10 l	14 202 kg	DM 2.62/l c.i.f. Tripoli
Hachemie	Copper sulphate		98-100%	50 kg	2 000 kg	DM 1.75/kg c.i.f. Tripoli
Biosterfeld	Ferrous sulphate		Hepta hydrate 20% Fe	50 kg	5 000 kg	DM 0.29/kg c.i.f. Tripoli

Table A-2. (continued)

Manufacture	Trade name	Common name	Percentage of active ingredient and formulation	Pack size (unit)	Quality (Imported)	Lowest net price per unit
			1972 (continued)			
Biosterfeld	Zinc sulphate		22/23 % Zn	50 kg	5 000 kg	DM 0.58/kg c.i.f. Tripoli
Biosterfeld	Managanese sulphate		Min. 98% Monohydrate - 32 % Mn	50 kg	2 000 kg	DM 0.865/kg c.i.f. Tripoli
				Total 1972	233 395 kg	
			1973			
Servos-Greece	HCH	BHC (lindane)	2.6 Lindane dust	25 kg	25 000 kg	$138/ton c.i.f. Tripoli
Sariaf	Belgrano HBC	BHC (lindane)	½ Lindane dust	1 kg	5 000 kg	Lit 160/kg c.i.f. Tripoli
Bayer	Dipterex	Trichlorfen	80 WP	1 kg	30 000 kg	DM 7.89/kg c.i.f. Tripoli
Procida	Trichlorex	Trichlorfen		25 kg	5 000 kg	$1 595/ton c.i.f. Tripoli
Bayer	Morkit	Anthraquinone	80 WP	1 kg	28 000 kg	DM 7.02/kg c.i.f. Tripoli
Bayer	Nemacur	Phenamiphos	10 Granule	25 kg	20 000 kg	DM 5.50/kg c.i.f. Tripoli
Bayer	Mesurol	Methiocarb	4 Dust	0.5 kg	15 000 kg	DM 4.10/0.5 kg c.i.f. Tripoli
Bayer	Basamid G	Dazomet	Granule	20 kg	10 000 kg	DM 3.90/kg c.i.f. Tripoli
Saffa	-	Zinc phosphide	Rodent bait	0.25 kg	500 kg	Lit 1 225/kg c.i.f. Tripoli
Sariaf	Lomacrusk	Metaldehyde	2½ Granule	1 kg	30 000 kg	Lit 260/kg c.i.f. Tripoli
Sariaf	Topstop BG	Warfarin	0.05 Rodent bait	1 kg	10 000 kg	Lit 350/kg c.i.f. Tripoli
Sariaf	Maladust	Malathion	1 Dust	1 kg	2 000 kg	Lit 242/kg c.i.f. Tripoli
Sariaf	Agrumol	White oil	80 EC	22 l	300 080 kg	Lit 216.16/kg c.i.f. Tripoli
Sariaf	Malafos	Malathion	50 EC	1 kg	15 000 kg	$1.32/kg c.i.f. Tripoli
Procida	Cerathion	Malathion	50 EC	1.98 l	1 980 l	$1.01/l c.i.f. Tripoli
Sumitomo	Malathion	Malathion	50 EC	20 l	15 000 l	$1.03/l c.i.f. Tripoli
Cyanamid	Malathion	Malathion	50 EC	1 kg	20 000 kg	$1.20/kg c.i.f. Tripoli
Sariaf	Sarfon	Tetradifon	50 EC	1 kg	15 000 kg	$1.15/kg c.i.f. Tripoli
Sariaf	Falon	Tetradifon and dicofol	EC	1 kg	3 000 kg	$3.27/kg c.i.f. Tripoli
Siapa	KEL 20	Dicofol	18.5 EC	1 kg	6 000 kg	$1.50/kg c.i.f. Tripoli
Siapa	KEL 20	Dicofol	18.5 EC	5 kg	6 000 kg	$1.35/kg c.i.f. Tripoli
Procida	Systoate	Dimethoate	40 EC	2 l	2 000 l	$1.52/l c.i.f. Tripoli

Table A-2. (continued)

Manufacture	Trade name	Common name	Percentage of active ingredient and formulation	Pack size (unit)	Quality (Imported)	Lowest net price per unit
			1973 (continued)			
Celamerk	Roxion	Dimethoate	40 EC	1 kg	60 000 kg	$1.865/kg c&f Tripoli
Celamerk	Roxion	Dimethoate	40 EC	10 kg	40 000 kg	$1.650/kg c&f Tripoli
Procida	Paradichloro	Benzene		40 kg	2 000 kg	F 6/kg c.i.f. Tripoli
Bayer	Lebaycid	Fenthion	50 EC	20 l	15 000 l	DM 12.60/l c.i.f. Tripoli
Bayer	Folidol oil	Ethyl parathion	10% + white oil EC	20 l	75 000 l	DM 5.40/l c.i.f. Tripoli
Procida	Maneb		80 WP	1 kg	12 000 kg	$1.04 kg c.i.f. Tripoli
Bayer	Maneb	Maneb	80 WP	25 kg	10 000 kg	DM 4.40/kg c.i.f. Tripoli
Procida	Zineb	Zineb	80 WP	25 kg	151 000 kg	$0.62/kg c.i.f. Tripoli
Bayer	Lonocol	Zineb	75 WP	1 kg	36 000 kg	DM 5.39/kg c.i.f. Tripoli
Sariaf	Cuprovitam	75% COC (50% Cu) + 25% Zineb	65% WP	1 kg	10 000 kg	Lit 985/kg c.i.f. Tripoli
Sariaf	Tioflor	Sulphur	80 Micronized powder	1 kg	9 000 kg	Lit 285.60/kg c.i.f. Tripoli
Procida	Microlux	Sulphur	81 Micronized powder	20 kg	2 000 kg	$ 0.2706/kg c.i.f. Tripoli
Sandoz	Thiovit	Sulphur	Min. 81 Micronized powder	30 kg	15 000 kg	SwF 1.10/kg c.i.f. Tripoli
Bayer	Sulphur	Sulphur	95 Wettable sulphur	25 kg	6 000 kg	DM 1.71/kg c.i.f. Tripoli
Procida	Sulphur FOG	Sulphur	98.5 Dust	50 kg	2 000 kg	$163/ton c.i.f. Tripoli
Bayer	Cupravit	COC	85% OC (Cu 50%)	1 kg	20 000 kg	DM 9.00/kg c.i.f. Tripoli
Uniroyal	Vitavax	Thiram	20% DCNO + 40% thiram seed dressing	50 lb	29 825 kg	$4.45/kg c.i.f. Tripoli
La Quinolene	Quinolate V4X	50% Carboxine + 15% Copper oxyquinolate	WF	50 kg	3 000 kg	F 66.41/kg c.i.f. Tripoli
Bayer	Ester Combi		2.4-D/2,45T	25 l	1 000 l	DM 3.315/l c.i.f. Tripoli
Bayer	Tribunil Combi	Methabenthiazuron + 2,4-D	75 WP	25 kg	1 000 kg	DM 12.84/kg c.i.f. Tripoli
Elanco	Treflan	Trifluralin	48 w/v EC	1 US quart	15 300 kg	$7.95/kg c.i.f. Tripoli
Dupont	Hyvar X	Bromacil	80 WP	4 lb	10 015 kg	$11.74/kg c.i.f. Tripoli
FINO	Buminal	Protein bait		1 l	12 000 l	DM 2.25/l c.i.f. Tripoli
Bayer	Bayfolan	NPK 11-8-6	Liquid fertilizer	20 l	46 000 l	DM 2.40/l a/ c.i.f. Tripoli

Table A-2. (continued)

Manufacture	Trade name	Common name	Percentage of active ingredient and formulation	Pack size (unit)	Quality (Imported)	Lowest net price per unit
			1973 (continued)			
Otsuka (Japan)	Sampil No.3	NPK 8-3-3 + trace elements	Liquid fertilizer	0.5 kg	20 000 kg	$1.89/kg c.i.f. Tripoli
				Total 1973	1 167 700 kg	
			1974			
Sariaf	Aldrin	Aldrin	4 Granules	1 kg	5 000 kg	Lit 390/kg c.i.f. Tripoli
Sariaf	Aldrin	Aldrin	60 WP	1 kg	5 000 kg	Lit 2 235/kg c.i.f. Tripoli
Sariaf	Lumacrusk	Metaldehyde	5 Granules	1 kg	5 000 kg	Lit 445/kg c.i.f. Tripoli
Procida	HCH	BHC	2.6 Dust	25 kg	35 000 kg	$ 0.35/kg c.i.f. Tripoli
Bayer	Dipterex	Trichlorfon	80 SP	1 kg	30 000 kg	DM 7.89/kg c.i.f. Tripoli
Procida	Trichlorex	Trichlorfon	80 SP	1 kg	5 000 kg	F 8.80/kg c.i.f. Tripoli
Degesch	Phostoxin	Aluminium phosphide	Tablets	480 tablets per box	10 000 kg	DM 32.30/kg c.i.f. Tripoli
Bayer	Nemacur	Phenamiphos	10 Granule	25 kg	10 000 kg	DM 5.50/kg c.i.f. Tripoli
Bayer	Morkit	Anthraquinone	80 WP	25 kg	20 000 kg	DM 7.56/kg c.i.f. Tripoli
Bayer	Mesurol	Methiocarb	4 Dust	0.5 kg	5 000 kg	DM 8.20/kg c.i.f. Tripoli
Sariaf	Malafos	Malathion	50 EC	1 kg	10 000 kg	$2.12/kg c.i.f. Tripoli
Celamerk	Rogor	Dimethoate	40 EC	1 kg	40 000 kg	DM 5.40/kg c.i.f. Tripoli
Bayer	Tamaron	Methamidophos	60 EC	25 l	5 000 l	DM 21.25/l c.i.f. Tripoli
Bayer	Polidol oil	Ethyl parathion	10% + White oil EC	25 l	25 000 l	DM 5.40/l c.i.f. Tripoli
Bayer	Polimat		50 EC	1 l	20 000 l	DM 23.00/l c.i.f. Tripoli
Sariaf	Cuprovitam	75% COC (50% Cu) + 35% sineb	65 WP	1 kg	10 000 kg	Lit 1 325/kg c.i.f. Tripoli
Bayer	Cupravit	COC	50% Cu WP	1 kg	10 000 kg	DM 9.00/kg c.i.f. Tripoli
Bayer	Antracol	Mezineb	70% WP	1 kg	40 000 kg	DM 6.15/kg c.i.f. Tripoli
Bayer	Ceresan	Phenyl Mercuric acetate	1.5% seed dressing	1 kg	5 000 kg	DM 4.725/kg c.i.f. Tripoli

Table A-2. (continued)

Manufacture	Trade name	Common name	Percentage of active ingredient and formulation	Pack size (unit)	Quality (Imported)	Lowest net price per unit
			1974 (continued)			
Plant Protection	Gramoxone	Paraquat		1 l	5 004 l	£1.64/l c.i.f. Tripoli
Elanco	Treflan	Trifluraun	48% w/v EC	1 US quart	4 900 l	$ 7.95/kg c.i.f. Tripoli
Procida	Adhesol	Adhesive		1 l	5 000 l	$ 1.75/l c.i.f. Tripoli
Sariaf	Nuovo Bagnante	Adhesive		5 kg	5 000 kg	$ 1.43/kg c.i.f. Tripoli
FINO	Buminal	Protein bait		1 l	8 750 kg	DM 2.25/l
				Total 1974	534 650 kg	

Source: General Company for Farm Equipment and Agricultural Necessities.

a/ Rising to DM 4.6/l.

b/ The General Company ordered the following pesticides in September 1974 for delivery to Libya by the end of 1974:

Product	Quantity (kg or l)	Price c.i.f. Tripoli ($/kg)
Dipterex - 80 WP	35 000	3.60
Dimethoate - 40 EC	40 000	3.169
Malathion - 50 EC	60 000	1.95
Malathion 1% Dust	5 000	0.29
Kelthane - 18.5 EC	10 000	1.31
Aldrin 4% Dust	4 000	0.66
Aldrin 6% Dust	4 000	0.71
Micronized sulphur 100%	10 000	0.56
Sulphur - 80	10 000	0.47
Snail bait (5% Metaldehyde)	5 000	0.52
Cupravitam	10 000	2.59
Tekel	13 000	3.15
Total	211 000	

Table 1-3. Estimated pesticide imports by private merchants and CAD Projects, [illegible]
(Kilograms or litres)

Product	Tripoli, major private importers	All other private importers	Kufra Project	Gebel Akhdar Project	Gefara Project	Total
White oil	11 000	5 000	-	-	-	16 000
Lannate-25 WP	6 000	-	1 000	1 000	-	8 000
Dimethoate-40 EC	16 000	8 000	-	-	-	24 000
Malathion-50 EC	7 000	3 500	-	-	-	10 500
Guthion (?25 EC)	3 000	-	-	-	-	3 000
Aldrin-40 WP	1 200	600	1 000	-	-	2 800
Trichlorfon-80 WP	24 000	8 000	20 000	3 000	-	55 000
Meta-systox (?25 EC)	5 000	-	2 000	-	-	7 000
Metaldehyde 5%	3 000	2 000	1 000	-	-	6 000
BHC-50 WP	1 000	500	-	-	-	1 500
Anthraquinene-80 WP	3 000	2 000	3 000	2 000	-	10 000
Kelthane-18.5 EC	1 000	500	-	-	-	1 500
Folimat-50 EC	4 000	6 000	15 000	15 000	-	40 000
Copper oxychloride-50 WP	14 500	6 000	-	-	-	20 500
Maneb/Mezineb-80 WP	6 000	3 000	-	-	-	9 000
Benlate-50 WP	8 000	-		-	-	8 000

Table A-3. (continued)

Product	Tripoli, major private importers	All other private importers	Kufra Project	Gebal Akhdaer Project	Geffara Project	Total
Treflan EC	-	-	5 000	-	-	5 000
Micronized sulphur	?	?				112 000 a/
2, 4-D Weed killer EC (250 g (as ester)/litre)				150 000		150 000
Seed dressing (Vitavax)					3 000	3 000
Diayton 10 G			2 000	1 000		3 000
Polidol oil 10%	4 000	2 000				6 000
Total	117 700	47 100	50 000	172 000	3 000	501 800

a/ There is a discrepency between the amount imported by the General Company and the amount subsidized by the Agricultural Bank.

Table A-4. Present and forecast optimum pesticide use in Libya[a/]
(Tons)

Product	1973	1975	1976	1977	1978	1979	1980	1985
Wettable powders								
Dipterex-80/Sevin 50	190	345	392	473	514	540	606	670
Sevin-50	-	3	3	3	3	3	3	3
Aldrin-40	121	169	145	140	135	130	130	155
Total insecticide - WP	311	517	540	616	652	673	739	828
Aminolate V4X	87	98	98	98	98	98	98	101
Sulphur	101	91	93	94	95	96	97	100
Zineb/maneb-80	434	618	592	565	538	523	524	638
COC/zineb/eaneb-80	2	6	6	6	6	9	9	12
COC-50	5	12	13	14	17	19	22	23
Zineb-80	-	3	3	3	3	3	3	3
Total fungicide - WP	629	828	805	780	757	748	753	877
Atrazine-80	11	11	-	-	-	-	-	-
Linuron-50	31	44	42	40	38	37	37	46
Simazine-80	6	15	17	18	21	24	27	29
Total weed killer - WP	48	70	59	58	59	61	64	75
TOTAL WP	988	1 415	1 404	1 454	1 468	1 482	1 556	1 780
White oil	1 503	3 500	3 840	4 180	4 860	5 590	6 270	6 660
Emulsifiable concentrates								
Dimethoate-40	21	37	33	32	31	30	30	33
Malathion-50	134	210	235	275	297	318	344	379
Dimethoate-40/Lebaycid-50	166	390	427	465	540	621	697	740
Kelthane-18.5/Tedion-8	382	645	671	698	754	829	891	997
Total insecticide - EC	703	1 282	1 366	1 470	1 622	1 798	1 962	2 149
D-D 100%	693	1 200	1 170	1 140	1 110	1 230	1 230	1 530
Liquids								
2,4-D 25% ester	71	131	132	134	135	135	135	135
2,4-DB 30%	-	124	198	297	347	396	455	480
Total liquid weed killer	71	255	330	431	482	531	590	615
TOTAL ALL PESTICIDES	3 958	7 652	8 110	8 675	9 542	10 631	11 608	12 734

a/ This table is based on the optimum application of pesticides (table A-5) on the area of each crop (table A-1) estimated to be attacked by identified pests and diseases of economic importance. This table shows the author's estimates of optimal pesticide use in tons of formulated product.

Table A-5. Optimum pesticide application to control identified pests and diseases of economic importance on irrigated crops in Libya a/

Crop	Optimum percentage of irrigated cropped area for pesticide application	Number of applications per year	Past and present proposed pesticide treatment per 1,000 litres of water and per hectare
Wheat and barley	100	1	Loose and covered smut of barley and bunt of wheat: Quinolate 44% WP at 0.25 kg/100 kg seed at 90 kg seed/ha
	75	1	Weeds: 0.5 kg 2,4-D (as ester)/ha - viz. 2 litre 2,4-D 25% ester or 1 litre 2,4-D 50% ester/ha
	25	1	Aphis: 1 litre dimethoate-40 EC/ha
Alfalfa	100	2	Spodoptera litteralis (Spod. lit.): 2 kg Dipterex-80/Sevin-50 + 1 litre malathion-50 EC/ha
	75	1	Weeds: 2 kg 2,4-DB (as ester)/ha - viz. 6.6 litres 2,4-DB 30% ha
Maize, sorghum, millet	100	1	Agrostis Spp. (cutworms): 5 kg Aldrin-40 WP/ha
	100	2	Spod. lit.: 2 kg Dipterex-80/Sevin-50 + 1 litre malathion-50 EC/ha
	100	1	Weeds: 3 kg Atrazine-80 WP/ha
Olives	A difference of opinion exists. In the opinion of some, it is 50% of the total olive trees (irrigated and rain-watered) but in that of others, (including the author) it is 20% of all of the olive trees, which is the same as 100% of the irrigated olives	1	Olive bud scale: 50 kg white oil/1,000 litres at 5,000 litres/ha Dacus Spp. (olive fly): 1.5 litres dimethoate-40/Lebaycid-50 EC/1,000 litres
Almonds	20 (those irrigated at the coast)	2	Aphis: 1 litre dimethoate-40/2 litres malathion-50/1,000 litres at 1,500 litres/ha
Figs and dates (rain-watered and uncultivated)	Opinions differ as to whether any should be sprayed in view of the labour intensity (including the author's) or if 20% should be sprayed	1	Scale and hymenoptera: 15 kg white oil/1,000 litres at 1,500 litres/ha
Tobacco	100	2	Powdery mildew: 2 kg micronized sulphur-80 WP/ha

Table A-5. (continued)

Crop	Optimum percentage of irrigated cropped area for pesticide application	Number of applications per year	Past and present proposed pesticide treatment per 1,000 litres of water and per hectare
Tobacco (continued)	100	2	Spod. lit.: 2 kg Dipterex-80/Sevin-50 WP + 1 litre malathion-50 EC/ha
Groundnuts	50%, but there is considerable doubt as to its future in Libya because of its uneconomically high water requirement	2	
Peppers	80% (coast)	3	Mediterranean fruit fly: 1 litre dimethoate-40/Lebaycid-50/ha
Carrots and root vegetables	100	1	Weeds: 6 kg CIPC-40 LC or 1.5 kg linuron-50 WP/ha
Grapes	100	3	Powdery and downy mildew: 2 kg sulphur 80 WP + 3 kg zineb-80 WP/maneb-80 WP/ha
		2	Grape worm: 2 kg Sevin-50/ha
Peaches and apricots	50	2	Peach-leaf curl: 3 kg copper oxychloride (COC)-50 WP/zineb-80/maneb-80/ha
	100	3	Peach aphis, mites and Mediterranean fruit fly: 1 litre dimethoate-40/Lebaycid-50 + 3 kg Kelthane/Tedion-8/1,000 litres at 2,000 litres/ha
	100	1	Scale: 50 kg white oil/ha
	50	1	Nematodes: 300 litres D-D 100%/ha
Citrus	20	2	Phytoptera (blight): 3 kg COC-50 WP/ha
	100	3	Mediterranean fruit fly: 1 litre dimethoate-40/Lebaycid/1,000 litres at 5,000 litres/ha
	100	2	Mites: 3 kg Kelthane-18.5 EC/3 kg Tedion-8 EC/1,000 litres
	90	1	Scale: 20 kg white oil/1,000 litres at 5,000 litres/ha
	50	1	Weeds: 3 kg Simazine-80 WP/Krovar WP/ha
Apples and pears	30	2	Codling moth: 2 kg Sevin-50 WP/1,000 litres at 1,500 litres/ha
	30	2	Mediterranean fruit fly (pears) and aphis: 1 litre dimethoate-40/Lebaycid-50/1,000 litres at 1,500 litres/ha

Table A-5. (continued)

Crop	Optimum percentage of irrigated cropped area for pesticide application	Number of applications per year	Past and present proposed pesticide treatment per 1,000 litres of water and per hectare
Apples and pears (continued)	30	2	Apple scab: 2.5 zineb-80/1,000 litres at 1,500 litres/ha
All tomatoes and potatoes	100	4	Alternaria (early blight) and Phytoptera (late blight): 3 kg Zineb-80/maneb-80/ha
	50	1	Weeds: 2 kg Linuron-50 WP or 4 kg Patoran-50 WP/ha
Summer tomatoes and potatoes	100	1	Cutworm: 5 kg Aldrin-40 WP/ha
	100	2	Spod. lit. and Exigua Spp. (tomato worm): 2 kg Dipterex-80 WP/Sevin-80 WP + 1 litre malathion-50 EC/ha
	100	2	Spod. lit. and Exigua Spp. (tomato worm): 2 kg Dipterex-80 WP/Sevin-50 WP + 1 litre malathion-50 EC/ha
	10	1	Nematodes: 300 litres D-D 100%/ha
Melons, pumpkins and cucumbers	100	3	Powdery mildew: 2 kg sulphur 80 WP/ha
	100	2	Tomato worm: 2 kg Dipterex-80 WP/Sevin-50 WP + 1 litre malathion-50 EC/ha
	100	2	Mites and aphis: 3 kg Kelthane-18.5 EC/Tedion-8 EC + 2 litres malathion-50 EC/ha
Beans and peas	50	2	Downy mildew and Alternaria: 3 kg zineb-80/maneb-80/ha
	50	2	Spod. lit. and tomato worm: 2 kg Dipterex-80 WP/Sevin-50 WP + 1 litre malathion-50 EC/ha
	30	2	Mites and aphis: 3 kg Kelthane-18.5 EC/Tedion-8 EC + 2 litres malathion-50 EC/ha
Onions	50	3	Downy mildew: 3 kg zineb-80/maneb-80/ha
	50	2	Onion fly and thrips: 1 litre dimethoate-40 EC/2 litres malathion-50 EC/ha
Brassica	100	2	Tomato worm, minor and Spod.lit.: 2 kg Dipterex-80 Sevin-50 and 1 litre malathion-50 EC/ha
Rain-watered wheat and barley	100	1	Loose and covered smut of barley and bunt of wheat: Quinolate V4X WP at 0.25 kg 100 kg seed at 60 kg seed/ha

a/ Pesticide application is normally considered economic only on irrigated crop areas. The only major exception is fungicide dressing of seed for rain-watered cereal crops.

Table A-6. Public health pesticide use and imports for the Ministry of Health (MOH) and the army by the National Pharmaceutical Company (NPC), 1973 and 1974

Product	Source	Active ingredient, percentage and formulation	1973				1974			MOH forecast of 1975 use
			NPC imports (kg or l)	User	MOH use (kg or l)	c.i.f. price (LD)	NPC imports (kg or l)	User	c.i.f. price (LD)	
DDT 75	Procida	DDT-75 WP (WHO specifications)	16 600	MOH and Army	13 200	0.1995/kg	3,000	MOH	0.244	40 000
Lindane	Celamerk	Lindane-50 EC-Swing fog solution	12 000	MOH and Army	2 870	0.615/kg				7 500
Nexion	Celamerk	Bromophos-40 EC			1 900					15 000
Nexion	Celamerk	Bromophos-40 fog solution	36 000	MOH	10 050 kg	1.029/litre				8 000
Nexion	Celamerk	Bromophos-38.5 Refined grade			750 kg					1 000
Nexion	Celamerk	Bromophos-40 Deodorized roach spray	8 000	MOH		1.710/kg	3,000	MOH	2.1369/kg	
DDT 10	Procida	DDT-10 powder (?dust)-100-g tins	1 250	MOH	250 kg	0.090/tin	420	MOH and Army	0.092/tin	200
Lorexane		BHC-0.6 dusting powder-100-g bottles			2 171 kg					200
Alfacron		Malathion-57 water-dispersible powder (WDP) - WHO specifications			2 930					4 000
Chlordane		Chlordane-50 WDP - WHO specifications			-					500
Pybuthrin	Cooper	Pyrethrum EC water-miscible containing: 2.5% Pyrethrin, 10% piperonyl butoxide	10 000	MOH	4 180	1.495/kg	-		-	8 000
Neo-pybuthrin	Cooper	Bioallethrin 8%, bioresmethrin 4%, for dilution with kerosene	-	-	-	-	2,200	MOH and Army	9.336/litre	
Neo-pybuthrin	Cooper	Composition as above (EC) for dilution with water	-	-	-	-	2,000	MOH	9.3842/litre	
Lavender		Pyrethrin 0.25% piperonyl butoxide								

Table A-6. (continued)

Product	Source	Active ingredient, percentage and formulation	1973 NPC imports (kg or l)	1973 User	1973 MOH use (kg or l)	1973 c.i.f. price (LD)	1974 NPC imports (kg or l)	1974 User	1974 c.i.f. price (LD)	MOH forecast of 1975 use
Perfumed aerosol		0.8%, DDT 2%, petroleum distillate 16%			20 200 aerosols					70 000 aerosols
Pif-Paf aerosol	Cooper		54 080 x 11 oz	MOH and Army		0.232/11 oz	75 000 x 11 oz	MOH and Army	0.203/11 oz	
Lindane		Lindane-20 EC		Tripoli Health Moderia	16 320		8 680 litres	Tripoli Health Moderia		
Nexion		Bromophos WP (Probably 25 WP, conceivably 40 WP)		Tripoli Health Moderia	11 220					

Sources: National Pharmaceutical Company, Ministry of Health and Tripoli Health Moderia.

Table A-7. Manufacturer, characteristics and cost of household insecticides imported into Libya in 1974

Name	Manufacturer	Specified weight of size	Net weight	Formulation	Composition	Cost c.i.f. Tripoli in 1974
1. Killtox	Enna Nederlanse Aerosols	12 oz (340 g)	200 g (59%)	Aerosol	DDVP-0.6% - piperonyl butoxide 0.2% - SBP 34.2% - methylene chloride 10% - propellants 55%	f. 1.0.75 per aerosol
2. Daimentox	Enna Nederlanse Aerosols	8 oz (510 g)	300 g (59%)	Aerosol	DDVP-0.6% - piperonyl butoxide 0.3% - pyrethrins 0.2% - odourless kerosene 5% - methylene chloride 15% - SBP 34.3% - propellant (propane butane) 44.5%	f. 1.0.70 per aerosol
3. Pif-Paf	Cooper	8 oz (227 g)	156 g (69%)	Aerosol	Pyrethrins 0.175% - piperonyl butoxide 0.875% - 0.15% diazinon solvents and propellant to balance	£14.95 per case of 72 aerosols
4. Pif-Paf	Cooper	16 oz (454 g)	312 g (69%)	Aerosol	Bioallethrin 0.2% - Bioresmethrin 0.02% - piperonyl butoxide 0.4% - solvents and propellants to balance	£22.80 per case of 72 aerosols
5. Montacatini Montedison Aerosol	Montacatini	14 oz (397 g)	250 g (63%)		Extract of pyrethrum 0.65% - piperonyl butoxide 1.30% - perfuse/flavour 0.5% - Shellsol T 15.75% - Alfofrene 11/12 81.50%	Lit 420 per aerosol
6. Liquid insecticide	Montacatini	32 oz/tin	32 oz	Liquid	Bioallethrin 0.015% - bioresmethrin 0.02% - piperonyl butoxide 0.06%	Lit 650 per tin
7. Liquid insecticide	Montacatini	128 oz/tin	128 oz	Liquid	Bioallethrin 0.015% - bioresmethrin 0.02% - piperonyl butoxide 0.06%	Lit 1 500 per tin

Source: Brega Petroleum Marketing Company.

Table A-8. Estimated imports of household insecticides to Libya, 1974

Product	Weight specified on pack (oz)	Number of packs	Total weight specified on packs oz	Total weight specified on packs kg	Estimated net weight (kg)	Composition
Killtox	12	1 471 600	17 659 200	500 500	295 295 (59%)	See table A-7
Pif-Paf	8	657 000	5 256 000	148 900	102 741 (69%)	See table A-7
Pif-Paf	16	851 000	13 616 000	385 900	266 271 (69%)	See table A-7
Rentacatiel/Rentadiesm	14	90 000	1 260 000	35 700	22 491 (63%)	See table A-7
Dalmentox	18	834 000	15 012 000	425 500	251 045	See table A-7
Rententox-Holland	12	1 414 800	16 977 600	481 200	283 908	Not declared - unknown
Multitox	12	1 195 200	14 342 400	406 500	239 835	Not declared - unknown
Flytox	12	108 000	1 296 000	36 700	21 653 (58%)	Not declared - unknown
Insecto	12	72 000	864 000	24 400	14 396	Not declared - unknown
Killtox	12	216 000	2 592 000	73 400	43 306	Not declared - unknown
Raica	12	21 600	259 200	7 300	4 307	Not declared - unknown
Aerosol insectic	12	288 000	3 456 000	97 900	61 677 (63%)	Not declared - unknown
Raid	12	7 200	86 400	2 400	1 655 (69%)	Not declared - unknown
Deafly	12	11 520	138 240	3 900	2 691	Not declared - unknown
Total Aerosols		7 237 920	92 815 040	2 630 200	1 611 272	
Rentacatiel	32	140 000	4 480 000	126 900	126 900 (100%)	See table A-7
Rentacatiel	128	320 000	40 960 000	1 160 900	1 160 900 (100%)	See table A-7
Flyel	128	10 000	1 280 000	36 200	36 200 (100%)	Lindane 0.09%
Flyel	10	72 000	720 000	20 400	20 400 (100%)	Neopynamin 0.04%
Flyel	32	48 000	1 536 000	43 500	43 500 (100%)	Piperonyl butoxide 0.17%
Flyel	128	45 000	5 760 000	163 200	163 200 (100%)	Solvents to 100%
Total liquid			54 736 000	1 551 100	1 551 100	

Source: Brega Petroleum Marketing Company.

Table A-9. 1971 forecasts of pesticide use in Libya by a committee of experts from the Ministries of Agriculture and of the Economy (CMAE) and by the Industrial Research Centre (IRC)
(Tons)

Product	1972 CMAE	1972 IRC	1973 CMAE	1974 CMAE	1975 CMAE	1975 IRC	1978 IRC
White oil	599.2	414.1	898.8	1 198.4	1 398	1 204.7	2 932
Rogor-40 (dimethoate)	52.3	39.9	78.4	104.5	130.8	131.9	307 1
Malathion-50	40.8	40.5	61.2	81.6	102.2	105.4	234.6
Adhesive	10.8	13	16.2	21.6	27	38.6	94.6
Dipterex-80	26.1	31.5	39.1	52.2	61.5	68.2	129.2
Spider insecticide (Kelthane ?)	6.5	3.3	9.7	13	16.2	12.6	27.1
Snakeworm insecticide (nematocide ?)	15	15	22.5	30	37.5	37.5	113.3
Snail bait	15	15	22.5	30	37.5	37.5	113.3
Seed dressing	20	20	30	40	50	50	100
Poison bait	20	20	30	40	50	50	100
Emulsifiable/wettable sulphur	10.2	3.5	15.3	20.4	25.5	10.1	22.1
Maneb-80	12.5	11.1	18.7	25	31.2	30.7	69.7
Zineb-80/Fitosar (siram)	12.5	11	18.7	25	31.2	44	99
Sulphur dust/powder	87.5	24.8	131.2	175	218.7	29.2	33.8
Protein	-	8.1	-	-	-	29.4	63.6
Copper	12.5	12.5	18.7	25	31.2	31.2	130.9
Aldrin	0.7	-	1	1.4	1.7	-	-
Malathion 1% dust	8.6	-	12.9	17.2	21.5	-	-
Alprochim (?)	15.7	-	23.5	31.4	39.2	-	-
Total	965.9	683.3	1 457.5	1 931.8	2 314.4	1 911	4 570

Table A-10. Actual purchases of important pesticides by the Ministry of Agriculture, 1970-1974, forecast of 1974 purchases and existing stocks in August 1974
(Kilograms or litres)

Product	Actual purchases				1974		
	1970	1971	1972	1973	Actual purchase	Forecast	August stock
Diptrex-80	1 205	12 000			8 936	8 000	2 844
Aldrin-40 WP	262	6 250				5 000	2 200
Merkit/Triblecar	483	4 120	1 000/8 950		5 000	5 000	4 361/5 274
Sevin		5 000	10 000	5 000	5 000	5 000	5 743
Misurol/Lonocrank	197	1 000/8 300			10 720	16 000	5 667
Nemacur		2 000			1 000	1 000	2 714
Nemagon/DD/Nematox	2 280	999					1 892
Phostoxin	858			756	2 000	2 880	1 832
Gammexane (EEC)		25 000		25 000	-	-	-
White oil-80		79 535	100 000	8 765	40 000	40 000	35 847
Dimethoate-40 EC	8 727	2 800		1 000	5 000	5 000	4 064
Malathion-50 EC	2 970	12 000			5 000	5 000	3 442
Lebaycid-50 EC		1 000			4 295	4 000	3 919
Kelthane-18.5 EC	5 102	4 000			2 000	2 000	2 368
Polidol (? Oil 10%)					3 000	3 000	2 200

Table A-10. (continued)

Product	Actual purchases				1974		
	1970	1971	1972	1973	Actual purchase	Forecast	August stock
Tekel	200	2 932					1 600
Cupravit		2 000			5 000	5 000	3 423
Anthracol				500	3 000	3 000	2 093
Maneb	615	4 558		1 000	1 000	1 000	2 017
Zineb	1 020	6 000		1 000	1 000	1 000	1 270
Sulphur wettable	1 116	8 000		1 400	3 600	6 000	2 484
Vitavax				4 975			
2, 4-D		1 650		1 000			729
Hyvar						1 000	
Gramoxone						5 000	
Treflan					1 000	1 000	1 000
Protein bait	5 550		6 200	—	6 000	6 000	5 950
Wheat bran		(700 000)		300	300		(419 655)
Total	30 585	189 144 (+bran)	126 150	50 696	112 851	130 880	103 933 (+bran)

Annex II

PERMANENT PESTICIDE COMMITTEE

LIBYAN ARAB REPUBLIC
MINISTRY OF HEALTH

Decision of
Cabinet of Ministers to form a Permanent committee to Investigate and Study the Residual from the Use of Chemical Pesticides and Protection against any Residual Effects which may be harmful to the Health of Humans, Animals and Plants.

The Cabinet of Ministers referring to the

General Law of Health No. 69, Year 1958, also
Plant Protection Lax No. 27, Year 1958, and

according to the Memorandum presented to the Cabinet by both the Minister of Health and the Minister of Agriculture and Agrarian Reform,

Decided

Article 1) The Committee Members are as follows:

Dr. Abdul Gader Sherif, Director-General, Agricultural Research Centre, (Chairman);
Director-General of Social Health, Ministry of Health (Member);
Director-General of Pharmaceutical and Medical Equipment, Ministry of Health (Member);
Head of Section Pharmacy, Ministry of Health (Member);
Head of Section Laboratories, Ministry of Health (Member);
Dr. Mohamed Abu Raya, Head Plant Section, Faculty of Science (Member);
Dr. Mustafa Kamal, Head Section of Entomology, Faculty of Agriculture (Member);
Dr. Ali Khaled, Head Section of Plant Protection, Ministry of Agriculture (Member).

The Committee is entitled to any assistance in order to perform their duties, from any specialists in related fields of work.

Article 2) The duties of this Committee are as follows:

a) Survey and classify all chemical pesticides used in the Republic.

b) Evaluate the position of all types of these chemicals used for general purposes, and particularly for agricultural uses.

c) Specify the special recommendation for importing these pesticides and identify their fields of use.

d) Specify the conditions for proper storage of these pesticides, and method of application, with a view to maintain minimum damage or harm resulting from such storage or use.

e) Public awareness of the dangers in the use of such chemicals; specify the best methods of protection, emphasize dangers of mis-use; also, first-aid treatment which should be followed in the case of harm due to mis-use.

f) Specify quantities for dilution of chemicals and sprays; specify equipment suitable for spraying or dusting or fumigation; also take into consideration the residual effect as a result of such spraying or dusting treatment.

g) Recommend the proper legislation for results achieved from the purpose of forming such a Committee.

h) Revise all recommendations from international bodies and specialized committees, and scientific bureaux abroad, who are responsible for this field - whether in health, agriculture, or food industry - , for adaptation in Libya.

i) Other problems related generally with chemical pesticides and protection from hazards of use.

Article 3) Publish this Decision in the Public Gazette, to be applied from the date of issue, and executed by all Governmental Authorities, and their Agencies.

Major Abdulsalam Ahmed Jalloud

PRIME MINISTER.

Issued Tripoli : 23 Shaiban 1393

26 September 1973

Annex III

JOB DESCRIPTION

Post Title — **Pesticide Market Analysis** Expert

Purpose of project — To provide expert assistance to the Government of Libya in analysing present and future demands for pesticides in Libya as well as export potentials. Data from this study would serve as a basis for deciding whether to manufacture pesticides and/or pesticide formulations in Libya.

Duties — In co-operation with the Industrial Research Centre, the Ministry of Agriculture, the Ministry of Planning and other interested organizations, the expert will be expected to:

1. Review all data at hand with respect to present and past use of pesticides in Libya including their quantities, identities, type (s) of formulation, specifications and prices c.i.f. Tripoli. Where import duty is applicable, the amount of this duty shall also be identified.

2. Supplement, where necessary, such statistical data as is now at hand by contact with major users of pesticides in the various agricultural areas of Libya.

3. Check pesticide usage data by comparison with estimates based on acreage devoted to individual crops and normal treatment rates applied for control of known pests and determine the amount of pesticides entering the household and related markets, packaging both as aerosols and as solution for application with hand sprayers.

4. Review data of the Industrial Research Centre, projecting such usage to 1980, and compare with calculations based on projected agricultural areas and crops being compiled by the Ministry of Planning through 1985.

5. Establish optimum package types and sizes for distribution of the various pesticides in the Libyan market.

6. Estimate the export market (size and prices f.o.b. Tripoli) for mineral white oil(s) and/or refined mineral oils, particularly in the Mediterranean area among the countries with which Libya trades or may wish to trade.

7. Establish the quantities of such exports which may be shipped in bulk and the amount which will have to be shipped in drums or smaller containers.

Work has been completed on the first five items. The results are recorded in this report listed on the contents page.

Annex IV

AUTHORITIES AND ORGANIZATIONS VISITED

Visits were made in Libya to the following authorities and organizations (generally on 3 to 11 separate occasions) to secure data contained in this report:

Council for Agricultural Development
Geffara Project
Ministry of Agriculture - Plant Protection Section
- Agricultural Research Centre
- Statistics Department
- Section for Cooperatives
- Extension Services Section
- Horticulture Section
- Veterinary Department
- Dairy Cow Project
- Sheep Project
- Poultry Project

Agrarian Reform Directorate
Agricultural Crop Marketing Company, at Hadaba
Agricultural Bank
Ministry of Planning - Census and Statistics Department
Ministry of Planning - Agricultural Section
Ministry of Economy - Statistics and Foreign Trade Department
Treasury
Customs Department
Ministry of Health - Endemic Diseases Department
Ministry of Health - Supply and Toxicity Departments

Dr. Abdul Gader Sherif, Chairman, Permanent Pesticide Committee

Agriculture Moderia - Tripoli Mohafza

Health Moderia - Tripoli Mohafza

Municipality of Tripoli - Health Department

Municipality of Tripoli - Gardens Department

General Cleaning Company, Tripoli

General Company for Farm Equipment and Agricultural Necessities

Technical Company for Pest Control (Spray Company)

National Pharmaceutical Company

Brega Petroleum Marketing Company - Operations, Supply, Sales and Planning Departments

Chamber of Commerce

University of Tripoli - Entomology, Plant Pathology and Botany Departments

Az-Zawia Refinery

Mohamed A. Nashnush

Azzam M. Saied Shuiek

Ahmed S. Naami

Ali Mohamed Erkis

Ali A. Gamati

Nori E. Tarhoni

Muftah Nasr Sheria

Ali Khalil Gallel

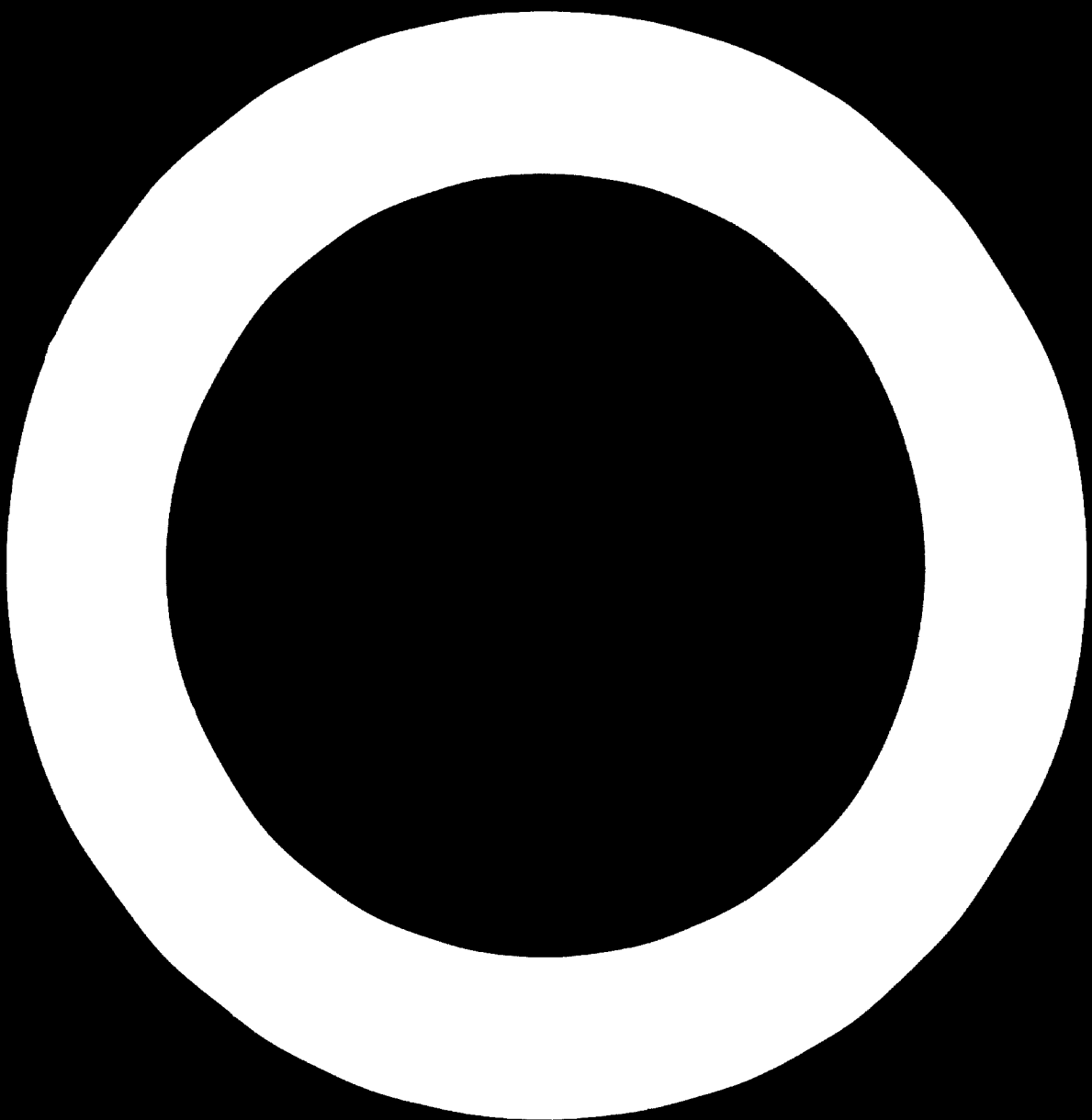
Khalik El Meki

Bidri

Part two. EXPORT POTENTIALS

by

Christopher Maltby, pesticides marketing expert



INTRODUCTION

An earlier study by a UNIDO expert indicated that the manufacture of mineral white oil, refined mineral oil and allied pesticidal materials might be profitable for the Libyan Arab Republic. The present report is an assessment of the potential export markets for such an operation. A separate study of the domestic market for such products forms the first part of the present volume.

The present report has been prepared solely on the basis of information obtained by correspondence and from statistics prepared by agencies of the United Nations. It contains the writer's best estimates of the export market for mineral white oil and refined mineral oil, using the information available to him in Tripoli. It concerns the last two items of the writer's job description (part one, annex III of the present volume).

The writer wishes to record that, in his opinion, the estimates that are given should not be used to justify the funding of a mineral oil plant in Libya that would be oriented to export markets unless and until detailed market investigations have been made within the foreign countries that would constitute the potential export market.

The writer worked with members of the Industrial Research Centre (IRC), Tripoli, from August through September 1974, in Tripoli, and with them visited government authorities and persons in other relevant organizations. None were able to provide information on export markets for Libyan mineral oils or on their use as insecticides in other countries.

When the writer offered to visit, accompanied by a member of the IRC staff, the countries that comprise the potential market for these materials, he was informed that the timing of such a mission was inappropriate. Consequently, the present report has the limitation of being a desk survey conducted in Tripoli.

SUMMARY

IRC has indicated that the countries to which Libya might wish to export refined mineral oils or white oils would include:

Algeria	Sudan
Egypt	Tunisia
Greece	Turkey
Rwanda	Yugoslavia

The writer recommended that these countries be visited to obtain the relevant information, since it was available in Tripoli. IRC decided that the timing was inappropriate for foreign travel, so the information was requested by mail. The following estimates of use in other countries are based on replies received and on information available in Tripoli.

In the preferred markets, above, estimated annual consumption, in tons, is:

Egypt	6,500	Tunisia	9
Greece	1,100	Turkey	3,000
Rwanda	17,800	Yugoslavia	137

No figures were available for Algeria or the Sudan. Consumption in other countries that may be of interest are, in tons:

France	2,500	Morocco	229
Hungary	356	Spain	5,000
Italy	5,000	Switzerland	385
Japan	11,000	United States	56,000

Refined mineral oil has been sold recently in a 200-litre drum packing at approximately $350 per ton c.i.f. the main European ports. The ready-formulated product has been sold at $370 to $380 per ton c.i.f. in 200-litre drums.

The writer was reluctant to make estimates based on the small amount of information that was available and wished to record that these estimates should not, in his opinion, be used to justify an export-oriented mineral oil refining plant. Before such a plant is built, it would be necessary to undertake a market investigation in the potential markets.

The export markets for these materials are of three kinds: first, there are those in which no oils are formulated and to which Libya may offer an emulsifiable refined mineral oil (white oil) packed in both 5- and 22-litre cans 200-litre drums, as was found to be the buyers' requirement during the market investigation. Tunisia may be an example of such a market.

Secondly, there are those that import both white oil and refined mineral oil for formualtion locally. Both materials may be offered, and probably the 200-litre drum will be found to be the most acceptable packing for them both. Greece, Turkey and perhaps Egypt, are examples. If large-volume sales could be negotiated to Egypt for delivery to Alexandria, clearly bulk shipment in 500- to 1,000-ton lots is a possibility. Another possible bulk market for refined mineral oil is Spain, where CAMPSA, the government petroleum products monopoly, is reported to control the formualtion and annual sales of 5,000 tons.

The third market would include countries where mineral oils are refined and formulated and which also export them. There will be some potential clients in those countries, and their willingness to import these materials will depend upon their cost. Refined mineral oil should be offered to these markets, as it is probable that most buyers will have their own formulating plants and be able to buy emulsifiers competitively. Most formulaters would probably prefer 200-litre drum packing to handling bulk. Such a potential market is Italy.

Libya thus has the choice of selling to countries at varying stages of development in the use of mineral oils. However, countries that use large volumes of them, already have, or will have, their own refining facilities. Egypt is a good example of the latter.

Therefore, most suitable markets for on-the-spot study, are proposed as:

Algeria	Italy	Spain
Egypt	Morocco	Tunisia
Greece	Rwanda	Turkey
Hungary		

Some smaller markets in Europe are listed in the statistics and include Austria and Switzerland. Cyprus and Nigeria also warrant study. Larger but more remote markets are Japan and the United States.

Requirements for product specifications may vary between countries, and these will have to be identified. In addition to those listed in this report, the IRC now has copies of the specifications of refined mineral oils of two major oil refining companies.

Meaningful freight estimates can be made only when the buyer's port of entry, the form of packing and the probable size of the shipments have been identified.

Tariffs for refined mineral oil and white oil need separate assessment in each potential market. The sources of both products require identification, and their prices, which are constantly rising, should be monitored.

Many pesticide distributors and formulaters buy on a pattern that includes purchasing several products from the same producer, such as buying white oil from a supplier from which they obtain other formulated products, or buying refined mineral oil from a producer who supplies him with solvents and some technical materials. Distributors and formulaters find their purchasing patterns tightened in conditions of short supply.

It is proposed that an expert undertake export market surveys in the priority countries listed above and to investigate the opportunities of marketing Libyan refined mineral oil and white oil. The job description for such an expert is presented in annex I. If he is to be able to perform his assignment properly, the expert will need to be provided with:

Specifications of the refined mineral oil and white oil that the Libyan plant is planned to produce for domestic use;

Price indications for both of these materials;

An outline of the packing capabilities of the Libyan plant.

He will need this information to obtain co-operation from potential export buyers.

RECOMMENDATION

Assuming that the current work of the UNIDO pesticide manufacturing expert[1/] confirms the viability of a refining plant for mineral oil and a pesticide formulation plant in the Libyan Arab Republic, it is recommended that an export market study be undertaken by a UNIDO expert in the countries listed, and in the manner indicated in annex I of part two.

1/ See part three of this volume.

FINDINGS ON MINERAL OILS AND WHITE OILS

The Industrial Research Centre (IRC) decided that an investigation on mineral oils and white oils for the export market should not be undertaken at that time. Therefore, the data presented were gathered by the author during his assignment at Tripoli.

The information included in table 1 lists the consumption of mineral oils in many countries. The 17,800-ton figure listed for Rwanda is of particular interest, but no further information has been obtained. The Canadian and Colombian tonnages may be additives to weed killers. If prices are competitive, export opportunities could exist for Libyan products in the 56,000-ton United States market and in the 11,000-ton Japanese market. The 2,200 tons shown for Turkey approximates the estimates obtained from other information sources.

Table 2, which presents statistics on pesticide imports and exports, provide a picture of the relative importance of the pesticide trade in some countries relatively near to Libya. The total value of the pesticide trade in each listed country can be estimated by using the approximate 1971 price of mineral oil ($240/ton or less).

The import and export statistics of some countries for various oils are given in annex II. These data should be treated with caution, since the identification of these oils is not sufficiently specific. The export statistics of the Federal Republic of Germany are particularly interesting because they may point to other potential export markets, including Nigeria. However, it is recommended that these statistics be treated with extreme caution, within the context of refined mineral oils and their emulsions (white oils) for agricultural pesticide use, unless and until the applicable code numbers have been checked against the precisely relevant designation in the country of origin.

Table 1. Consumption of mineral oils in selected countries, 1961-1971
(Units of 100 kg)

Country	1961-65	1969	1970	1971
Argentina	24 948			
Austria	2 199	5 459	4 803	
Canada	15 103	27 659	29 939	15 140
Central African Republic	43			
Colombia		13 000	14 000	15 000
Congo	50			
Cyprus	2 891	2 684	2 561	2 960
Egypt	6 222	52 080	36 040	32 041
El Salvador	345			
Finland	230	227	272	219
Germany, Federal Republic Republic of	8 792	7 778	4 372	1 932
Greece	8 664	4 500	4 000	1 840
Hungary		4 132	4 085	3 558
Iceland	13		3	2
India	4 245			
	16 600	35 000	45 000	45 000
Italy	82 825	107 015	110 041	
Ivory Coast	2 643			
Japan	67 835	102 350	105 235	110 000
Jordan	151	37	80	377
Kuwait		3	4	4
Lebanon		400	400	400
Libyan Arab Republic	98			
Luxembourg	11	3	3	3
Morocco	324			
New Zealand	4 920			
Paraguay	96			
Peru	3 208			
Poland	199	153	500	860
Republic of Korea	2 266	980	1 000	1 000
Rwanda		163 210	170 000	178 000
Saudi Arabia	171			

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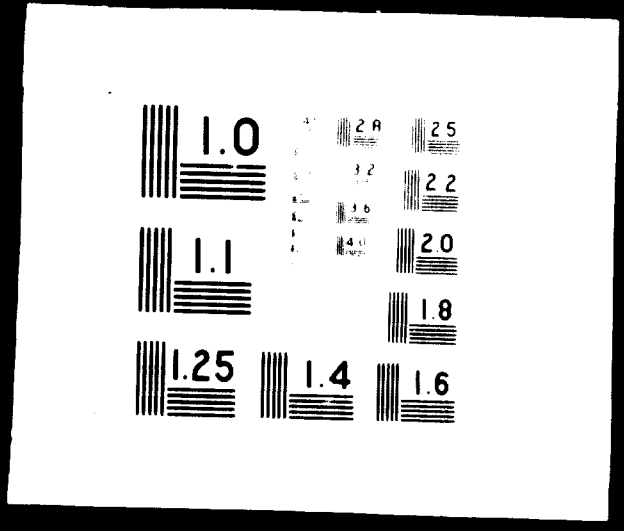


Table 1. (continued)

Country	1961-65	1969	1970	1971
Spain	62 067			
Switzerland	4 020	3 950	4 000	3 850
Syrian Arab Republic	184			
United States of America	708 664	461 053	545 315	565 983
Uruguay	1 054	1 300	1 250	1 300
Turkey		22 000	22 000	22 000

Source: Production Yearbook 1972, vol. 26 (Rome, FAO, 1973), p. 244.

Table 2. Value of pesticide imports and exports in selected countries, 1971
(Thousand dollars)

Country	Imports	Exports
Algeria	3 500	-
Cyprus	2 [illegible]48	-
Egypt	16 806	9
Ethiopia	400	-
France	45 5[illegible]9	51 385
Germany, Federal Republic of	21 981	151 449
Greece	8 310	19
Hungary	25 144	4 438
Iraq	1 900	-
Italy	21 8[illegible]3	1[illegible]00
Jordan	424	-
Kuwait	500	-
Lebanon	2 340	140
Malta	285	1
Morocco	4 000	100
Spain	11 963	851
Sudan	11 019	-
Switzerland	6 776	41 018
Syrian Arab Republic	601	-
Tunisia	955	18
Turkey	3 777	-
United Kingdom	16 61[illegible]	80 21[illegible]
Yugoslavia	9 032	16 673

Source: Trade Yearbook 1972, vol. 26 (Rome, FAO, 1973), pp. 471-472.

Table 3 presents statistics on citrus and olive production in some countries to which Libya may wish to export mineral oils. These data indicate the relative importance of Algeria, Egypt, Turkey and other countries as potential users of mineral oil for the control of scale insects on citrus and olive trees.

Table 4 shows citrus exports statistics of four North African countries, indicating their relative importance. Normally citrus for export is of high quality, achieved inter alia, by regular treatment with pesticides, including acaricides, which, if not used where scale are present, results in blemished fruit, which either do not attain export grade or sell at depressed prices.

Other estimates and information obtained by correspondance and verbally are summarized below by country.

Egypt

Various reports, which are not entirely consistent, indicate that between 7,000 and 9,000 tons of mineral oil are imported annually. Attempts are being made to refine an oil fraction suitable for the subsequent addition of an emulsifier. In addition, 10,000 tons of locally produced mineral oil, to which an emulsifier is added, are consumed annually.

In 1972, 6,500 tons of emulsifiable citrus oil were imported. A joint venture between a Spanish organization and a company in the public sector is planning to produce citrus oil at a new insecticide plant that is to be established at Alexandria.

Spray oils and spray oil emulsions are produced locally. Three pesticide formulation plants exist:

Misr Petroleum, at Alexandria, which produces emulsifiable concentrates, including some for aerosols;

Abu Za'abal, which produces mainly dusts and household insecticides;

Kafr el Zaiât, which has announced the production of a spray oil that has been developed in Egypt.

France

A member of a French oil company recently reported that annual consumption was 2,000-3,000 tons. Oils are separated, refined and formulated with emulsifiers (with the addition of as little as 0.5%), and local production satisfies demand. Other reports indicate that the majority of mineral oils used

Table 3. Production of citrus (1971) and olives (1970) in selected countries (Thousand tons)

Country[a/]	1971			1970
	Oranges and mandarins	Grapefruit	Lemons, limes and other citrus	Olives
1. Algeria	450	5	16	10
2. Tunisia	5	1	12	100
3. Egypt	680	-	0	8
4. Sudan	1	-	-	-
5. Turkey	520		128	81
6. Yugoslavia	1	-	-	8
7. Greece	480	-	140	900
8. Rwanda	-	-	-	-
9. Spain	2 250		80	2 042
10. France	6	-	-	3
11. Italy	1 774	1	775	2 124
12. Japan	3 000	-	120	-
13. Germany, Federal Republic of	-	-	-	-
14. Lebanon	-	-	65	20
15. Morocco	880	15	3	180
16. Austria	-	-	-	-
17. Syrian Arab Republic	6	-	4	83

Source: Production Yearbook 1971, vol. 25 (Rome, FAO, 1972).

a/ The countries numbered 1 to 8 were indicated by the Industrial Research Centre as those with which Libya may wish to trade. The writer has added numbers 9 to 17 as either their production of these crops is comparatively important, or because other data in this report are related to them.

Table 4. Citrus exports from four North African countries, 1972

Country	Oranges and tangerines		Lemons and limes	
	Tons	Thousand ($US)	Tons	Thousand ($US)
Algeria	302 000	41 000	500	3
Egypt	88 232	10 [illegible]	898	1[illegible]
Morocco	6[illegible]759	10[illegible]390	1 882	[illegible]26
Tunisia	10 000	1 000	2 000	200

Source: Trade Yearbook 1972, vol. 26 (Rome, FAO, 1973), pp. 20[illegible] and 30.

on crops in France are added to parathion and lindane (60% mineral oil) DNOC or DNBP (40% mineral oil) and other insecticides, winter washes for fruit trees, and insecticide formulations.

Federal Republic of Germany

Estimated 1973 consumption is 300-400 tons, with no expectation of any considerable growth in use.

Greece

In [illegible], consumption was estimated at:

Winter oils (all imported), 150 tons;

Summer oils, 950 tons. Emulsifiers were added locally to imported refined mineral oils.

Local production does not satisfy demand. Ready-formulated oils are imported from Italy. Refined mineral oils are imported from the western hemisphere and sell for $350/ton in 200-litre drums. The formulated product sells in Greece at up to $ 480/ton in 200-litre drums.

Italy

It is estimated that the annual use of refined mineral oils is 5,000 tons and that it will increase at 10% maximum annually for the next five years. Mineral oils are refined in Italy by many companies, of which the most important is Italian Shell. Local production satisfies demand.

The price for refined mineral oil is $350/ton ex stock in Italy. Importation is stated to be inconvenient, which may mean that, without a price incentive to import, it is considered more convenient to draw supplies ex local stock, thereby minimizing risk and finance charges.

The specifications of the refined mineral oil in Italy are:

Density at 20°C, 0.850-0.860

Viscosity at 100°F, 100-102 SSU

Unsulphonable residue (UR) 95-96%

Malta

Estimated 1973 consumption is 1.5 tons, imported from the Federal Republic of Germany and from Italy.

Spain

In 1973, consumption was estimated at:

Winter oils, 1,000 tons

Summer oils, 4,000 tons

A government company named CAMPSA controls the production and sale of [illegible] refined mineral oils, and local formulation satisfies demand. The refined mineral oils used are imported from the western hemisphere for local formulation.

In 1974, the grower price for summer oils was increased to 20 pesetas/kg, more than triple the 1973 price. For this reason it is anticipated that some growers will change to the use of specific insecticides for the control of citrus scale.

Tunisia

No emulsifiable white oils are produced locally; those used are imported. Direct contact is recommended with:

Sadok Alaya
Chef, Division de la defense des cultures
Megrine, Riadh

Turkey

The specifications of the base oils imported into Turkey for local formulation of insecticides are given in annex III. In 1973, consumption was estimated to [illegible],000 tons of summer oil, mainly containing 80% oil of various descriptions. Three brands are imported, and six are locally produced. Consumption of winter oil (mainly containing 60-80% oil plus DNOC and triethanolamine or DNOC and [illegible]sote) was estimated to be 1,000 tons. Two brands are imported, six are locally produced.

While local production of emulsifiable oil could satisfy demand, some is nevertheless imported, as are refined mineral oils, which originate in the western hemisphere. British Petroleum made its most recent import at $236/ton c.i.f., and Shell at $236/ton c.i.f.

Yugoslavia

No market is known to exist in this country, nor is any refined mineral [illegible] known to be produced there. A growing interest in white oils is reported, and no forecasts of their use have been made.

FINDINGS ON DNOC

Dinitro-ortho-cresol (DNOC) is used as a winter wash on fruit trees and, a a herbicide, is sometimes formulated with mineral oil. The 1971 FAO statistic show the tonnages used in five countries:

Czechoslovakia	80
Germany, Federal Republic of	396.8
Hungary	911.5
Lebanon	40
Turkey	25

Annex I

PROPOSED JOB DESCRIPTION

Post title:	Pesticide Export Market Analysis Expert
Duration:	Three months
Date required:	As soon as possible
Duty Station:	Travel as indicated below and report in Tripoli and Vienna
Purpose of project:	To provide expert assistance to the Government of Libya in analysing the present and future potential market for refined mineral oil and white oil made in Libya in the following countries: Egypt, Tunisia, Algeria, Morocco, Rwanda, Turkey, Greece, Spain, Italy and Hungary.
Duties:	The expert will be expected to visit the countries listed above, to:

1. Investigate the export opportunities for Libyan refined mineral oil and formulated white oil in the countries listed above.
2. Identify the more important volume buyers, their current sources of supply and purchase prices, purchasing pattern, annual volume and preferred packing.
3. Identify the specifications to which these materials should conform for sale to each country. Establish if a potential market exists or may develop for either product already formulated with a pesticide ingredient, and if so, the specification of the composite material, possible volume, and price that the buyer may be willing to pay.
4. Identify the tariff numbers, description and duty payable on both products, and composite products if applicable, of Libyan origin.

5. Identify the full cost structure from delivered local store in each country, to c.i.f. buyers port, and thence to f.o.b. Tripoli.

6. Forecast the future trend of use of both products in each country. Report any known plans for new plants or increase in capacity.

7. Prepare an export sales forecast for both products, for each country, for five years, by volume, pack and f.o.b. Tripoli price.

Qualifications: University degree in chemistry, chemical engineering or agriculture with experience in international marketing of pesticides.

Language: English; knowledge of Arabic and European languages an asset.

Background information: The Libyan Arab Republic is considering local formulation (mixing) of pesticides, and also the refining of mineral oil and its subsequent formulation in Libya for use as a scalicide. The Libyan market is forecast to rise to 1,000 tons per annum of 50% stock emulsion of emulsifiable refined mineral oil (white oil or citrus oil). In the previous study, desk research in Tripoli indicated a potential export market for refined mineral oil and stock emulsions to those countries with whom Libya may wish to trade, of upwards of 29,000 tons. In order to establish firmly the capacity of the mineral oil refining plant in Libya, a definitive export market investigation is necessa in the countries comprising the potential export market, so that a decision may be taken whether the Libyan plant shall be designed to serve either the Libyan domestic requirements, or Libyan domestic requirements plus the export market. If the latter, the annual tonnage which may realistically be exported.

Annex II

IMPORT AND EXPORT STATISTICS FOR WHITE OILS AND RELATED OILS IN SELECTED COUNTRIES

Austria

Code	Description	1973 Imports	
		Tons	Thousand S
27.10.31	White oil/vaseline oil, paraffin oil.	206.2	1 [illegible]

Source: Statistisches Zentralamt, Statistik des Aussenhandels Österreichs.

France

Code	Description	1972 imports		1973 exports	
		Tons	Thousand F	Tons	Thousand F
27.1079.0	White oils	7 433	9 130	10 757	9 350

Source: Statistique du Commerce Extérieur de la France.

Federal Republic of Germany

Code: 27.10.56 Description: White oil

1973 imports and exports	Tons	Thousand DM
Imports from:		
France	61.0	41
Belgium/Luxembourg	263.2	225
Netherlands	1 742.5	1 533
United States of America	99.7	111
Total imports	2 187.1	1 943
Exports to:		
France	296.4	335
Belgium/Luxembourg	103.6	131
Netherlands	180.8	188
Italy	57.6	84
United Kingdom	70.6	97
Denmark	240.8	209
Norway	294.3	275
Sweden	402.2	365
Switzerland	627.0	411
Austria	300.4	226
Portugal	229.2	165
Yugoslavia	137.1	162
Greece	162.6	136
Turkey	344.2	254
Sudan	184.3	151
Ghana	54.5	45
Nigeria	425.0	279
Kenya	214.0	184
Tanzania	41.7	40
Mozambique	82.1	67
South Africa	860.1	775
Chile	80.6	120
Cyprus	66.5	48
Saudi Arabia	140.5	79
Indonesia	55.3	86
Japan	68.3	193
Total exports	6 060.9	5 478

Source: Statistiches Bundesamt. Aussenhandel.

Greece

Code	Description	1971 imports		1972 imports	
		Tons	Thousand Dr	Tons	Thousand Dr
27.10.03.21	Mineral oil (paraffin oil)	926	6 218	833	6 676

Source: National Statistical Service. Foreign Trade of Greece.

Morocco

Code	Description	Country of origin	1971 imports	
			Tons	DH
27.10.31	Oil type water white	France	208.007	209 940
		Belgium/Luxembourg	7.2	6 300
		Netherlands	10,152	9 450
		Federal Republic of Germany	3.062	4 320
		United Kingdom	0.093	480
		United States of America	0.155	930
Total			228.669	231 420

Source: Service des Statistiques du Commerce Exterieur, Statistiques du Commerce extérieur du Maroc.

Spain

Code	Description	1973 imports	
		Tons	Thousand Ptas
27.10.61	vaseline and paraffin white oils	1 831	30 770

Source: Dirección General de Aduanas, Estadística del comercio exterior de España.

Sweden

Code	Description	1972 imports	
		Tons	Thousands SKr
[illegible]	White oil	1 [illegible]	1 903

Source: Statistiska Centralbyron.
Utrikeshandel.

Tunisia

Code	Description	Country of origin	1973 imports	
			Kg	D
27.10.19	Vaseline oil or paraffin oil	Federal Republic of Germany	189	63
		France	1 124	412
		Netherlands	8 175	1 189
	Total		9 484	1 664
27.12.00	Vaseline	Federal Republic of Germany	59 940	6 684
		France	647	310
		Netherlands	1 110	164
	Total		61 697	7 158

Source: Secrétariat d'Etat au Plan et à l'Economic Nationale, Statistiques du commerce extérieur de la Tunisie, Année 1973.

Annex III

SPECIFICATIONS OF BASE OILS IMPORTED INTO TURKEY FOR LOCAL FORMULATION OF PESTICIDES

Specification for mineral oil grade A (for summer oils)

Mineral oil grade A is a mixture of liquid hydrocarbons obtained from petroleum.

Appearance	A clear, colourless to pale amber, oily liquid
Specific gravity (15.5°/15.5°C)	0.84 to 0.92
Unsulphonated residue	Not less than 92% v/v
Viscosity (Redwood No. 1)	100 to 200 seconds at 70°F
Distillation range	The temperature at which 10% of the oil has distilled shall lie between 310° and 340°C.
	The temperature at which 50% of the oil has distilled shall lie between 350° and 375°C.
	The temperature at which 90% of the oil has distilled shall lie between 380° and 400°C.

Raw material specification for mineral oil grade B (for winter oils)

Mineral oil grade B is a mixture of liquid hydrocarbons obtained from petroleum.

Appearance	A pale straw to straw coloured transparent liquid with a characteristic odour
Specific gravity	0.86 to 0.93
Viscosity	100 to 200 seconds at 70°F
Unsulphonated residue	65.05 to 73% v/v

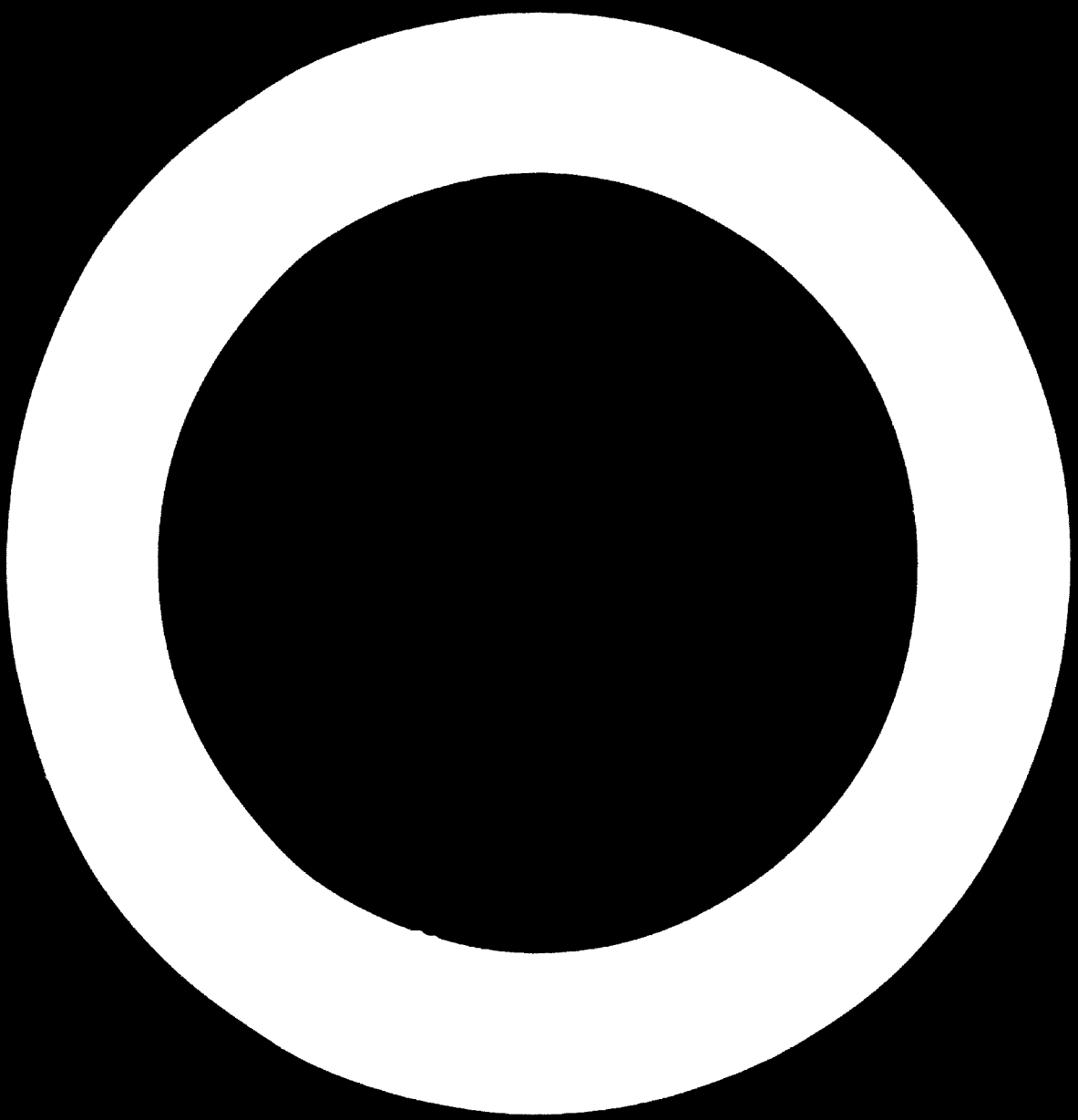
The above tests to be carried out in accordance with methods recommende in Ministry of Agriculture Technical Bulletin No. 1.

Volatility	The amount of isolated neutral oil distilling at an oil temperature of 35°C shall be not more than 5% of its volume when determined by the prescribed method DNC 5.

Part three. PESTICIDE MANUFACTURE

by

Shabbir A. Qureshi, pesticide manufacturing expert



[illegible]

This report [illegible] by the project "Industrial [illegible]" [illegible], [illegible] September [illegible], entitled "Pest[illegible] manufacture [illegible]", wherein [illegible] expert [illegible] manufacture [illegible], emulsifiable concentrates, wettable [illegible] may be [illegible] [illegible]ya; and a second, entitled "Domestic [illegible]", dated [illegible] which an estimate was made of present and forecast volume of pest[illegible] [illegible]ya over the years [illegible] – [illegible]. The latter report also [illegible] [illegible] of white [illegible] exports.

The purpose of [illegible] study [illegible] previous reports [illegible] [illegible]sh plant capacity [illegible] the manufacture of pest[illegible] [illegible] diagrams, if necessary; [illegible] [illegible]red as a feedstock [illegible] mineral-[illegible] [illegible] National Oil Corporation [illegible] and [illegible] [illegible] work out plant specifications, [illegible] [illegible]ty of the venture.

The duties of the expert are shown [illegible] description [illegible], [illegible] 1).

CONCLUSIONS AND RECOMMENDATIONS

Location

A desirable location for the plant would be adjacent to the As-Zawia Refinery, As-Zawia, where the infrastructure is available.

Unit capacities

In view of the present and predicted requirements of the different pesticide formulations (annex II), the capacities of the plants have been established as follows (tons/8-hour shift):

Refined mineral oil	5
Emulsifiable concentrates (including liquid insecticides)	10
Wettable powders	5
Aerosols	5

Investment and returns

The required investments and the probable returns on them (both in Libyan dinars) for four categories of pesticides are as follows:

Formulation	Investment (LD)	Returns (LD/year)
White oil	120 000	- 35 185
Emulsifiable concentrates	85 000	+253 531
Wettable powders	120 000	+ 7 063
Aerosols	100 000	- 65 500
Total	425 000	159 909

These four categories are considered separately below.

White oil and refined mineral oil

Cost of plant. A mineral oil refining plant with a capacity of 5 tons/8-hour shift will cost the equivalent of LD 120,000 in foreign exchange. The cost breakdown may be seen on page in the section on white oil. More complete data on white oil plants are given in annex V.

Cost of production. The cost of production of white oil comes to LD [illegible]/ton, as compared to LD 124/ton for imported material (table 1). If the designed plant capacity is fully utilized and the surplus over domestic requirements is exported to such countries as Egypt, Greece, Rwanda, Tunisia and Turkey, whose annual imports of white oil exceed 27,000 tons, the cost of production would be halved, that is, reduced to LD 110 to LD 120/ton.

Feedstock specifications. The standard feedstock required for the manufacture of white oils are certain base oils used for the production of lubricating oils. These base oils are not manufactured in Libya but would be imported (along with the additives) to feed the lube-oils blending plant at Az-Zawia. The c.i.f. values of the base oils vary between LD 75 and LD 90/ton. When refined, they will yield white oils at a cost of about LD 200 to LD 250/ton.

The As-Zawia refinery produces fuel oils, not lubricating base oils. In the pre-feasibility report, one of the two fuel oils, either the heavy gas oil or the fuel oil, is suggested as a feedstock for the refining plant. (There is no such oil as "heavy diesel oil".) When the physical properties and characteristics of fuel oils are compared with those of the standard white oil, it appears that none of them will meet the desired specifications on refining. However, this needs experimental verification.

It is considered that, prior to the selection of a suitable feedstock from the two above-mentioned fuel oils, both of them should be refined separately and then combined into 25%, 50% and 75% blends, in the manner described in the present report. The physical properties and characteristics of the refined oils thus obtained should be checked against those of the standard white oil.

In a similar manner, samples of the different base oils, namely HVI-160B and HVI-560, the principal components of the lube oils, should be obtained from the As-Zawia lube oils blending unit and refined. These refined oils may be compared with a standard oil for selecting the appropriate base oil to serve as feedstock. The final selection, however, will rest with clearance from the Department of Agriculture, after the usual field trials.

In the absence of these results, the likely choice of the feedstock would be:

(a) Base oils such as HVI-160B or HVI-650;

(b) A blend of heavy gas oil and fuel oil, presumably 50:50 ratio.

Table 1. Over-all profitability of producing three categories of insecticides[a/]
(Libyan dinars)

Formulation	Production (tons/year) (1975)	Total cost of raw material	Cost of raw material/ton	Processing cost/ton	Production cost/ton	Import cost/ton	Profit or loss/year
Emulsifiable concentrates							
White oil-80	500	65 935	131.87	62.3	194.17	193.8	- 185
Dimethoate-40	170	104 368	612	62.3	674.30	945 (1974)	+ 45 109
Tedion-8	129	47 292	367	62.3	429.3	334	- 12 255
Malathion-50	84	37 342	450	62.3	512.30	583	+ 5 964
Kelthane-18.5	129	40 406	311	62.3	373.30	392	+ 2 451
Lindane-20 Lindane-40	108	48 776	450	62.3	512.30	815 (1974)	+ 32 724
Liquid insecticide	1 629	52 282	32	62.3	109.6	236	+ 179 538
Weed killers	178	31 296	175.82	62.3	238.12	400	+ 28 315
		Profit = 294 601 LD/year					
		Loss = 47 440 LD/year					
		Net profit = 247 161 LD/year					
Wettable powders							
Dipterex-80	78	59 128	753	226	983	1 075 (1974)	+ 7 180
Sevin-50	79	30 514	386	226	676		
Aldrin-40	75	29 084	386	226	613	950	+ 28 200
DDT-75	27	5 191	192	226	418	200 (1973)	- 5 870
Zineb/maneb-80	281	139 066	495	226	721	640	- 22 800

Table 1.(continued)

Formulation	Production (tons/year) (1975)	Total cost of raw material	Cost of raw material/ton	Processing cost/ton	Production cost/ton	Import cost/ton	Profit or loss/year
Wettable powders (continued)							
Sulphur-80	41	1 073	26.2	226	252.2	141	- 4 448
Bromophos	60	17 294	287	226	577	600	+ 1 981
Anthraquinone-80	40	26 195	655	226	881	900 (1973)	+ 760
Weed killers (linuron)	49	23 084	468	226	758	800-900	+ 2 060
		Profit = 40 181 LD/year					
		Loss = 33 118 LD/year					
		Net profit = 7 063 LD/year					
Aerosols							
Pif-Paf (Cooper - UK)							
Bioallethrin							
Bioresmethrin	>1 500	875 520	583	154	735	690	- 65 500
Piperonyl butoxide							
Aromatic solvent							
Propellents (Freons 11 and 12)							
		Loss = LD 65 500 year					

a/ As of December 1974.

Emulsifiable concentrates and liquid insecticides, including weed killers

Cost of the plant. A batch-type plant with a capacity of 10 tons/8-hour shift would cost the equivalent of LD 85,000 in foreign exchange. A detailed cost breakdown is given on page in the section on emulsifiable concentrat (Also see annex VII.)

Product and import costs. The costs, in Libyan dinars, of producing [illegible] major pesticide formulations are compared in table , wher it can be seen that the costs of production of all emulsifiable concentrates listed, with the exceptions of white oil and Tedion-3, are lower than their respective import (c.i.f.) costs. It can also be seen that, out of the total yearly profit of LD 894,601 liquid insecticides alone contribute LD 178,538, or about 21% . It is of interest to compare those figures with those of the pre-feasibility study, which are summarized in table 2.

Table 2. Pre-feasibility report: plant capacities, costs and annual returns a/
(Sept. 1973)

Formulation	Plant capacity (tons/year)	Cost of plant (LD)	Production cost/ton (LD)	Annual profit (LD)
White oil (X)	10 000	80 000 ($272 675)	51.4	456 000
Emulsifiable concentrates (malathion)	500	35 800 ($121 600)	398.4	408 000
Wettable powders (sulphur)	300	44 500	70.7	26 100
		Total profit = LD 890 000 = $3 million		

a/ September 1973.

Composition of formulations. While the percentage contents of pesticidal chemicals in most formulations are known, those of the other (inert) ingredients, namely emulsifiers, stabilizers, solvents and any fillers present are not known precisely. If such formulations are to be manufactured in Libya, it will be necessary to negotiate with the present manufacturers in other countries for the acquisition, on a royalty basis, of the required information and technical know-how. Sources of such information are given in annex IV.

Wettable powders, including weed killers

Cost of the plant. A continuous-type plant to produce 5 tons of these materials per 8-hour shift would cost the equivalent of LD 120,000 in foreign exchange. The cost break-down of such a plant is given on page in the section on wettable powders. The cost of a similar plant to produce a wettable powder formulation of DDT is presented in annex IV (E). The costs of wettable powder plants are considered more generally in annex VIII.

Production costs. The costs of production per ton of some major wettable powder formulations are given below:

Formulation	Production (tons/year)	Cost/ton (LD)	c.i.f. value (LD)
Diptorex-80	78	983	1 075
Sevin-50	79	676	800 a/
Aldrin-40	75	163	950
DDT-75	27	418	200
Maneb/sineb	281	721	640
Sulphur-80	41	252.2	141
Bromophos-60	60	577	600
Anthraquinone-80	40	881	900
Weed killers	49	758	(800-900)
	730		

a/ Unverified.

The marginal profitability (LD 7,063) of production over importation is mainly due to low production rates.

Composition of formulations. As in the case of emulsifiable concentrates and liquid insecticides, the technical know-how for formulations would have to be acquired from the present manufacturers on a royalty basis. The addresses of the manufacturers of some important ingredients are given in annex IV.

Raw materials. All of the pesticidal chemicals and most of the inert ingredients for the formulations listed above would have to be imported. However, china clay, which is locally available in large quantitites could be used as a diluent or carrier.

Aerosols

Cost of the plant. A continuous-type plant to product 5 tons of aerosols per 8-hour shift could be expected to cost about LD 100,000. (See the section on aerosols later in this report (page).)

Production cost. The costs of production of such a plant can be calculated on the basis of the composition of Pif-Paf, a typical aerosol imported from the United Kingdom. It would cost LD 735/ton to formulate it in Libya, as against an import price of LD 690/ton, or a loss of LD 45, which would represent a loss of about LD 55,[illegible]/year at present rates of import.

Composition of formulations. The formulations for the aerosols can be obtained from the sources such as Cooper in the United Kingdom or Enna in the Netherlands. (See annex IV.)

Probable profitability of the project

In order to determine the cost of production of various pesticide formulations, it was necessary to obtain the latest information on the cost of the machinery and equipment, of the pesticidal chemicals and of the inert media such as emulsifiers, surfactants, clays and solvents.

Almost all of the well-known manufacturers all over the world were contacted through letters, followed by telegraphic reminders. Very little information was elicited, and was generally vague and off the point. The information supplied by UNIDO proved useful in completing the present work on schedule.

A standard format for evaluating the capital cost and the cost of production has been used for each group of pesticide formulations. The profitability has been calculated by subtracting the c.i.f. value from the cost of production, or vice-versa to indicate the gain or the loss, as shown in table 1.

Except for white oil and Tedion-8, production of all of the emulsifiable concentrates would be profitable. The net profit comes to about LD 220,000/year

In the case of wettable powders, the marginal profitability is the result of a low production rate and high processing cost. For example, the production cost for wettable sulphur is LD 252.2/ton against its c.i.f. value of LD 141/ton.

The formulation of aerosols is another area in which marginal losses can be anticipated. This point is well illustrated in the previous section, where the cost of producing the equivalent of an item (Pif-Paf) now purchased in the United Kingdom is compared with the present import cost.

The estimated over-all profitability, in Libyan dinars, of formulating four important categories of pesticides in Libya would be as follows:

Category	Profit	Loss
Aerosols		65 500
Emulsifiable concentrates	253 531	
Wettable powders	7 063	
White oil		35 185
	260 594	- 100 685 Net profit 159 909

This is considerably less than was indicated in the pre-feasibility study, which indicated that these operations would yield LD 890,000/year (table 2).

Implementation of the project

Since there is a reasonable expectation that it would be profitable, the project should be implemented as quickly as possible.

Feedstock for white oil. The implementation of the white oil project may be deferred till such time when the test reports on the recommended feedstocks, namely the fuel-oil blends, base-oils HVI-160B and HVI-560, are available and the final selection has been made. The test samples may be sent to the research laboratories of the following white oil processing concerns:

Shell, Brussels, Belgium
Shell, London, England
I.C.I., Haslemere, England
Sariaf, Faenza, Italy
Solplant, Milan, Italy
Afrasa, Valencia, Spain
Az-Zawia Refinery, Az-Zawia, Libya

Mode of implementation. In order to implement the whole project a Chemical Engineer In Charge, assisted by the following staff, be appointed for a period of 2 years:

Assistant Chemical Engineer (white oil)
Assistant Chemical Engineer (emulsifiable concentrates)

Assistant Chemical Engineer	(wettable powders)
Assistant Mechanical Engineer	(aerosols)
Chief Chemist	(quality control)
Draughtsman	(mechanical)

The Chemical Engineer In Charge, would guide and assist the manufacturers or suppliers of the plants from blue-print to installation and commissioning stage, in the following manner:

Draw up detailed drawings of the individual unit and prescribe their operation and equipment;

Prepare chemical plant layout and work details;

Prepare mechanical layout and work details;

Prepare electrical layout and work details;

Prepare utilities layout (steam, water, electric supply);

Prepare effluent disposal layout and work details;

Prepare building layout (factory, administration, laboratory, water supply, sanitation etc.);

Time scheduling.

Integration as a profit-making complex. If this project is to be an overall economic unit (that is, a profit-earning one), it should not be dismembered into units and installed separately on different locations. The chemical industry has seldom prospered as single units; in the form of a complex, it has invariably been profitable. For example, one unit's effluent can be the feedstock for another. Also, if one unit operates at a loss, the others will probably compensate for it.

Let us consider the case of a continuous white-oil plant whose output is very low and which does not utilize its by-products or wastes. Its output may never become competitive with the international prices. However, when its acid sludge is used to recover both the sulphuric acid and the emulsifying agents, such as sulphonic acids (mahogany acids), there is no apparent reason why such a small plant should not turn into a profit earning unit.

While there would be industrial wastes in the other units, such as emulsifiable concentrates, wettable powders and aerosols, the organization of a centralized quality-control laboratory, a workshop (mechanical and electrical), stores, transport both for men and materials, use of workers of one unit in another (for example, the emulsifiable concentrate workers could also operate the weed-killers unit) will have a cumulative effect to neutralize losses and build up profits.

Plant capacities

Brief review. In order to explore the feasibility of establishing pesticide formulation plants in the Libyan Arab Republic, two reports, namely the pre-feasibility report and the market analysis report, were prepared by UNIDO experts and submitted to the Libyan Government.

The pre-feasibility report submitted in September 1973, showed only the consolidated yearly import figures and the corresponding c.i.f. values of the pesticides under consideration. The volumes of neither the current and projected requirements of each of the presently imported formulations were analyzed nor were the chemical composition and the c.i.f. values of their components highlighted. The omission of this basic information makes it difficult to estimate the cost of production of the individual formulations. (Further information is presented in table 2.)

Some process outlines have been given for the manufacture of white oil, but nothing has been said about the emulsifiable concentrates, liquid insecticides or the wettable powders.

In the case of white oil, the domestic requirements have been set at 2,000 tons; another 8,000 tons have been ear marked for export. The sum of these figures determines the annual plant capacity. (It is interesting to note that the white oil imports did not exceed 316 tons in 1973.)

The pesticides market analysis report is included in this volume. It deals at length with the present and future requirements for certain formulations used on crops, in public health, on livestock and in the household sectors. The c.i.f. value of each of these formulations has been indicated. However, the composition and the c.i.f. values of the pesticidal chemical and inert media present in a formulation are not given.

In part II of this report, the market analysis expert has also discussed the possibility of exporting white oil to such countries as Algeria, Egypt, Greece, Rwanda, Sudan, Tunisia, Turkey and Yugoslavia, which currently import 27,000 tons annually from other sources. On the basis of these data the writer of the present report has prepared a statement showing the present and future requirements of the active ingredients of these formulations, their chemical names and physical properties, in detailed form in annex II and in condensed form in table 3 to establish the final capacities of the plants.

Table 3. Calculation of capacities of pesticide plants
(Tons)

Formulation	Present (1973) requirement	Future requirement			Recommended capacity
		1975	1980	1985	
White oil	316	500	1 000	900	5 tons/8 hours
Emulsifiable concentrates					
Insecticides and fungicides	765 (340)	1 012 (544.12)	2 538 (1 150)	2 603 (1 375)	10 tons/8 hours (including liquid insecticides)
Weed killers	150 (37.5)	168 (48.37)	531 (153)	554 (160)	Separate mixing unit 1 ton/hour
Liquid insecticides (household)	1 450 (117 kg)	1 629 (154 kg)	2 078 (197 kg)	2 653 (228 kg)	
Wettable powders and dusts					
Insecticides and fungicides	598 (435)	605 (292.1)	1 215 (698)	1 342 (890)	5 tons/8 hours
Weed killers	35 (28)	49 (27.8)	51 (34)	61 (38)	1 ton/hour (solid mixer)
Aerosols	1 600	1 955	3 932	5 019	5 tons/8 hours

Note: Figures in brackets indicate tons of pesticidal chemicals.

Plant capacities. Table 3 shows that the domestic demand for white oil, was 816 tons in 1973, rises to 1,000 tons in 1980 but falls to 900 tons in 1985. Also, with consideration for exports, the capacity of the plant has been set at 5 tons/8-hour shift. As both domestic requirements and exports increase, production can be stepped up accordingly, that is, from 5 tons per one-shift day to 15 tons per three-shift day. At full capacity, the plant will produce 4,500 tons of whits oil per year.

The requirements for emulsifiable concentrates (including liquid insecticides) is expected to rise from about 3,000 tons in 1975 to 5,256 tons in 1985. Since nine major insecticide formulations are to be manufactured with the same equipment, production must be stopped and the machinery cleaned after each production run to make ready for the next formulation. Because of this frequent cleaning and washing, the plant would operate on a six-month basis, that is, 150 days a year. The plant's capacity if fixed at 10 tons per 8-hour shift. As the demand for products rises, the plant may accordingly be run on a two- or three-shift basis.

The weed killers (EC and WP) will be manufactured in a totally separate section to prevent contamination of other formulations. The costs of construction and of production of this unit have been apportioned betwsen the EC and WP plants.

Since the deamnd for wettable powders is expeoted to rise from 605 tons in 1973 to 1,342 tons in 1985, the capacity of the production unit has been set at 5 tons per 8-hour shift. To meet the minimum requirement, the plant must be run on a single-shift basis; as demand increases, the plant will have to work on two- or three-shift basis. As with ECs, because of the need for frequent cleaning and preparation for the next formulation, the plant will function on a six-month basis.

The required production capacities for the various pesticide formulation plants over the ten-year period 1975-1985 are summarised in tabls 4.

Table 4. Required production capacities of projected pesticide formulation plants, 1975-1985

Formulation	Capacity (tons/8-hour shift)
White oil	5
Emulsifiable concentrates	10 a/
Wettable powders	5 a/
Aerosols	5

a/ Includes a separate unit for weed killers with a capacity of 1 ton/hour.

I. [illegible] AND REFINING [illegible]

[illegible] choice and specifications of feedstocks
[illegible] the manufacture of white oil

White oils[1/] are manufactured (figure I) from spindle and engine oils, which are vacuum-distillation products of paraffinic, mixed and naphthenic base crudes, the choice depending on their final use. Paraffinic crudes yield products low in density and viscosity, generally known as technical oils. They are used in textiles, cosmetics and as insecticide vehicles. The refined lubricating oils from naphthenic base crudes find their application in the pharmaceutical industry and in food-handling machinery. Basic data on some unit operations in a white-oil plant are presented in annex V.

In order to differentiate the two groups, some of their physical properties and characteristics are reproduced in table 5. Inspection of this table reveals that the medicinal oils are colourless and higher in density, flash-point and above all in the viscosity, than the technical oils.

Table 5. Specifications of white oils (Highly refined lube oils)

	Medicinal			Technical	
Physical property	Liquid paraffin	Light mineral oil	OB_n	WA_{20}	WA_{21}
Relative density	0.87-0.89	0.82-0.862	-	-	-
Flash point IP 34° C Min.	-	-	155	-	138
Colour IP 17B Max.	-	-	-	0.5	1
Viscosity cS 37.8° C (SSU)	64 (300)	37 (176)	13-16 (66-81)		24-30 (114-140)
60° C	-	-	-	16-21	-
Ultra-violet	0.05 Max.	-	0.4 Max.	-	-

1/ William A. Gruse and D. R. Stevens, Chemical Technology of Petroleum (New York, McGraw-Hill, 1960); Kenneth A. Kobe and J. J. McKetta, eds., Advances in Petroleum Chemistry and Refining, vol. IV (New York, Interscience Publishers (John Wiley and Sons, Inc.), 1961).

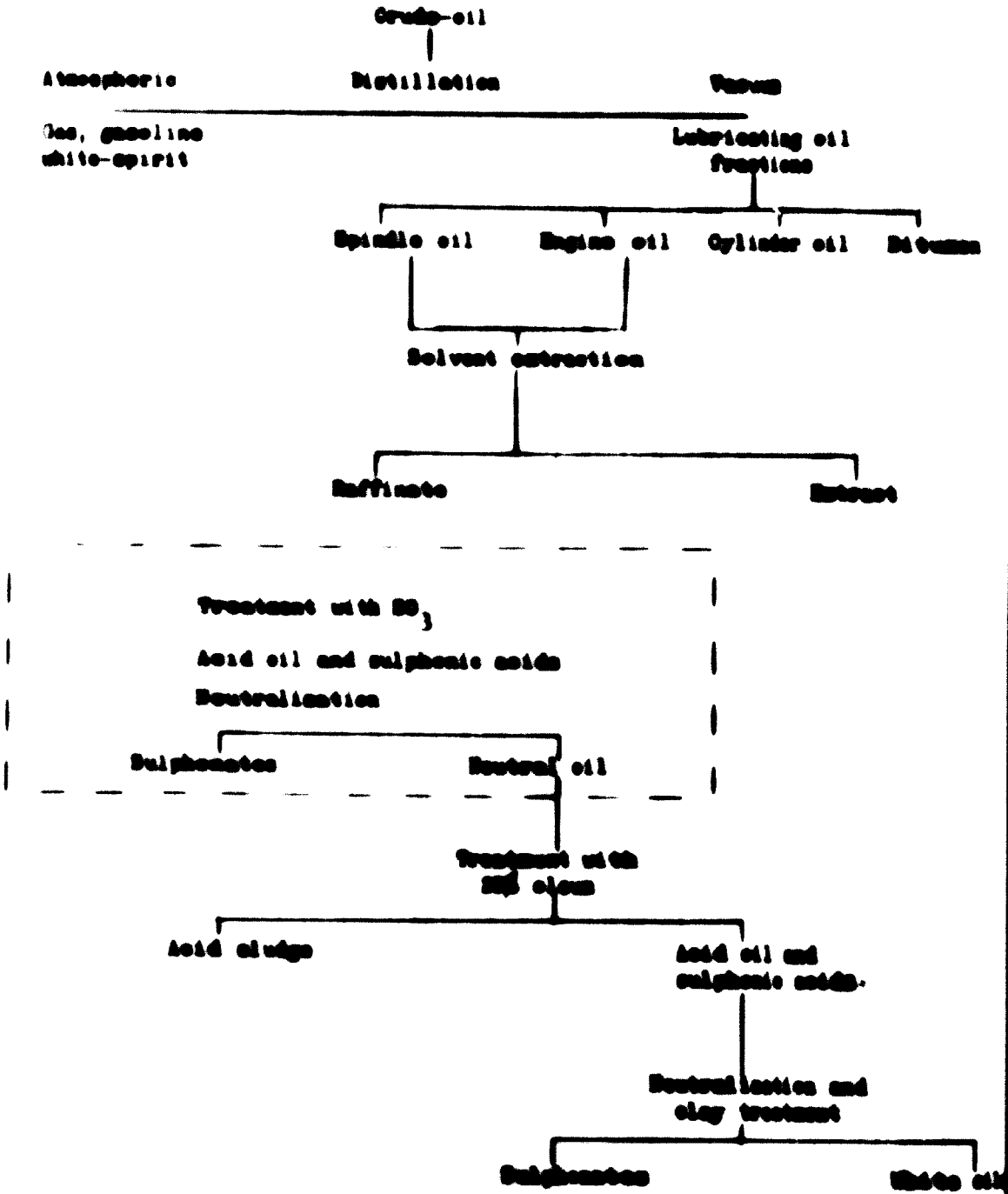


Figure 1. The process of the manufacture of white oils

There is a wide variety of technical oils, each meant to suit a [illegible] requirement. The specifications (BP) of technical or a white oil [illegible] British Petroleum (BP), are given in annex III. This particular [illegible] a minimum unsulphated residue of [illegible]%; a distillation range of [illegible]; viscosity [illegible] at [illegible] °C (55[illegible]); a relative [illegible] and a maximum pour-point of [illegible]. These properties [illegible] range covered by the white oil (BP) as shown in table [illegible].

Choice of feedstock from lube base oils. There is no present plan setting up a plant for the manufacture of lube base oils in the Libyan Arab public, but a blending plant[2/] has already been installed at Az-Zawiyah go on stream in 197[illegible]. This plant will blend imported base oils [illegible] ses to produce 30,000 tons/year of various lubricating oils, such [illegible] rs, gears, diesel engines and for industrial purposes.

The base oils used in the blending plant can provide a suitable [illegible] the refining plant. Table [illegible] shows the physical properties and [illegible] rics of the base oils. A close comparison of these properties with those the standard oil would narrow down the choice to base oils such as high viscosity HVI-160B and HVI-650 for use as feedstock.

Table [illegible]. Physical properties and characteristics of some base oils a/

Physical properties	HVI-60	HVI-160B	HVI-650	MVI-N	MVI-P-[illegible] 30
Viscosity (cSt) at 210°F	4.5-5	11.1-12.1	31.6-34.7	10.5-11.5	50-51
Pour point °C (max.)	-15	-6	-6	-21	-[illegible]
Colour ASTM (max.)	1.5	3.5	5.5	2	-
Acid m KOH/g (max.)	0.05	0.05	0.05	0.05	0.1
Ash (max.)	0.01	0.01	0.01	0.01	0.01
Flash-point °C (min.)	204	228	267	219	273

Source: Brega Petroleum Manufacturing Co., Tripoli.

a/ HVI = high viscosity index; MVI = medium viscosity index.

2/ Libyan Oil, Ministry of Petroleum, Tripoli; National Oil Corporation, Tripoli.

[illegible] two methods [illegible] range of [illegible] these oils be obtained from [illegible] and refined in the manner described in [illegible] report and [illegible] their physical properties and characteristics, [illegible] final selection.

[illegible] would be taken [illegible] that the c.i.s. values of these oils [illegible], [illegible]). Whether the refining of [illegible] base [illegible] white oil will prove economic remains to be s[illegible]

Manufacture of (lube) base oils. The National Oil Corporation reports that [illegible] of the refinery [illegible] as feedstock for the manufacture of base oils [illegible]. The process [illegible] may be roughly summed up in the following [illegible] operations:

- Vacuum distillation:
  - Spindle oil
  - Engine oil
  - Cylinder oil
  - Bitumen
- Solvent extraction of aromatics
- De-waxing
- Vacuum distillation

It added to the present set-up of the Az-Zawia refinery, such a unit would cost about LD 10 to LD 15 million. It would appear that such a costly addition to the existing installation at Az-Zawia, simply to cater the feedstock requirements of a 5-ton/8-hour shift white oil plant, would be advisable under no circumstances. If, however, it should become justifiable to establish a lube base oils manufacturing plant based on indigenous crudes, a suitable and cheaper feedstock for the white oil plant would be ensured.

Gas and fuel oils as substitutes. The Az-Zawia refinery will process (at atmospheric pressure) about 75,000 tons of Brega and Essider paraffinic crude per year, to produce a variety of fuel oils, namely liquefied petroleum gas (LPG) naphtha, kerosene oil, light gas oil (LGO), heavy gas oil (HGO) and fuel oil (FO). No bitumen is produced in this process.

Examination of the physical properties and characteristics of the three oils tabulated in table 7 reveals that the viscosity of LGO is 3, HGO is nearly 6 and that of fuel oil is 144. The first two oils have low viscosity values that render them unsuitable for the manufacture of white oil. Fuel oil, on the other hand, has a very high viscosity that might not be lowered to required specifications even after a drastic refining with 20% oleum. However, this possibility needs experimental verification.

Table 7. Specifications of light gas oil, heavy gas oil and fuel oil

Physical properties and characteristics	Light gas oil	Heavy gas oil	Fuel oil
Sp. gravity 15/15°C	0.[illegible]	0.851	0.91–0.9[illegible]
Flash point °C (min.)	102	142	[illegible]
Viscosity (cS) at 37.7°C (SSU)	3 (36)	5.07 (42.5)	[illegible] (50°C) ([illegible])
Sulphur wt. (max.)	0.12	0.3–0.4	0.[illegible]–1
Water, vol.% (max.)	–	–	1.0
Sediments, wt % (max.)	5	–	0.25
Initial boiling point, °C	225	273	—
Final boiling point, °C	298	359	—
Pour point, °C			43

Source: Az-Zawia refinery.

It is recommended that, in order to have the required physical properties and characteristics in the refined product, the heavy gas and the fuel oil be mixed into 25%, 50% and 75% blends refined according to the process described below and the physical properties of the samples determined. If the properties of the refined samples conform to those of the standard sample, it may be emulsified and sent to the Department of Agriculture for screening and clearance, to confirm its suitability for use as a spray oil (white oil EC). Should the experimental investigations so indicate, the heavy gas and fuel oil blend must be given preference over the base oils for use as feedstock. In the existing set-up of the Az-Zawia refinery, the heavy gas oil stream (which is being blended with light gas oil) can be tapped off separately if required for the manufacture of white oil. This procedure would require no change or alteration in the refinery set-up.

The process

In order to remove sulphur and aromatic compounds from heavy oils, the refining is generally carried out with 20% oleum, (fuming sulphuric acid), preceded by a mild treatment with the spent acid, which removes the moisture as well as the effects of the partial sulphonation of the oil (figure II).

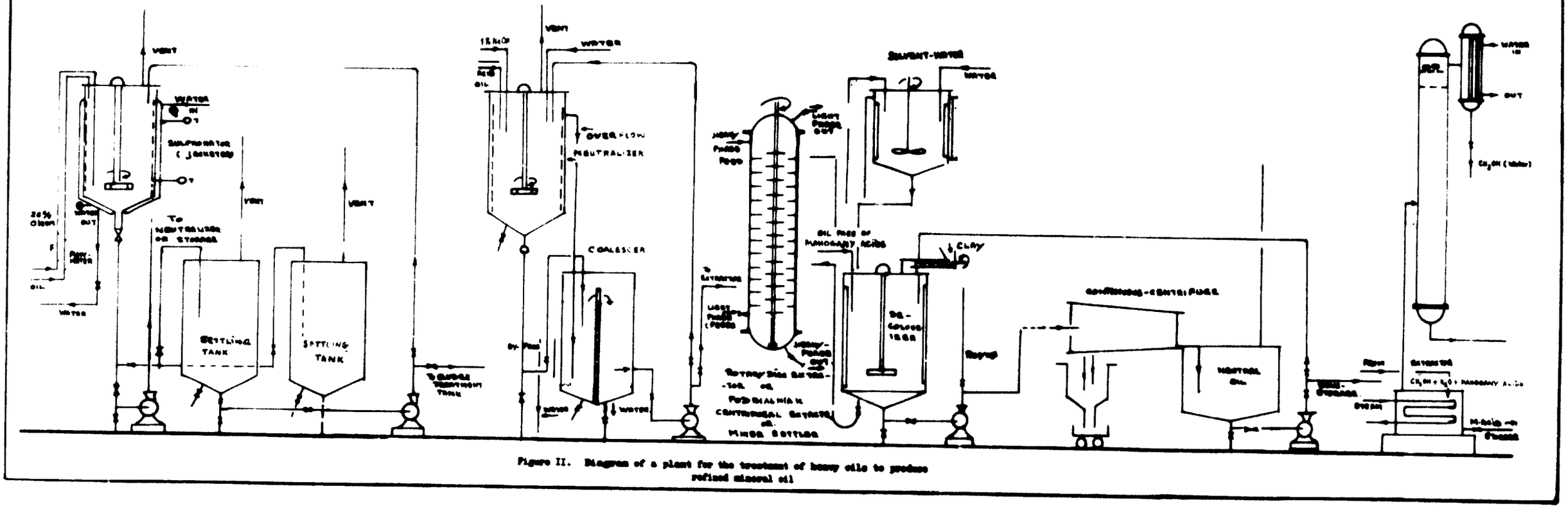
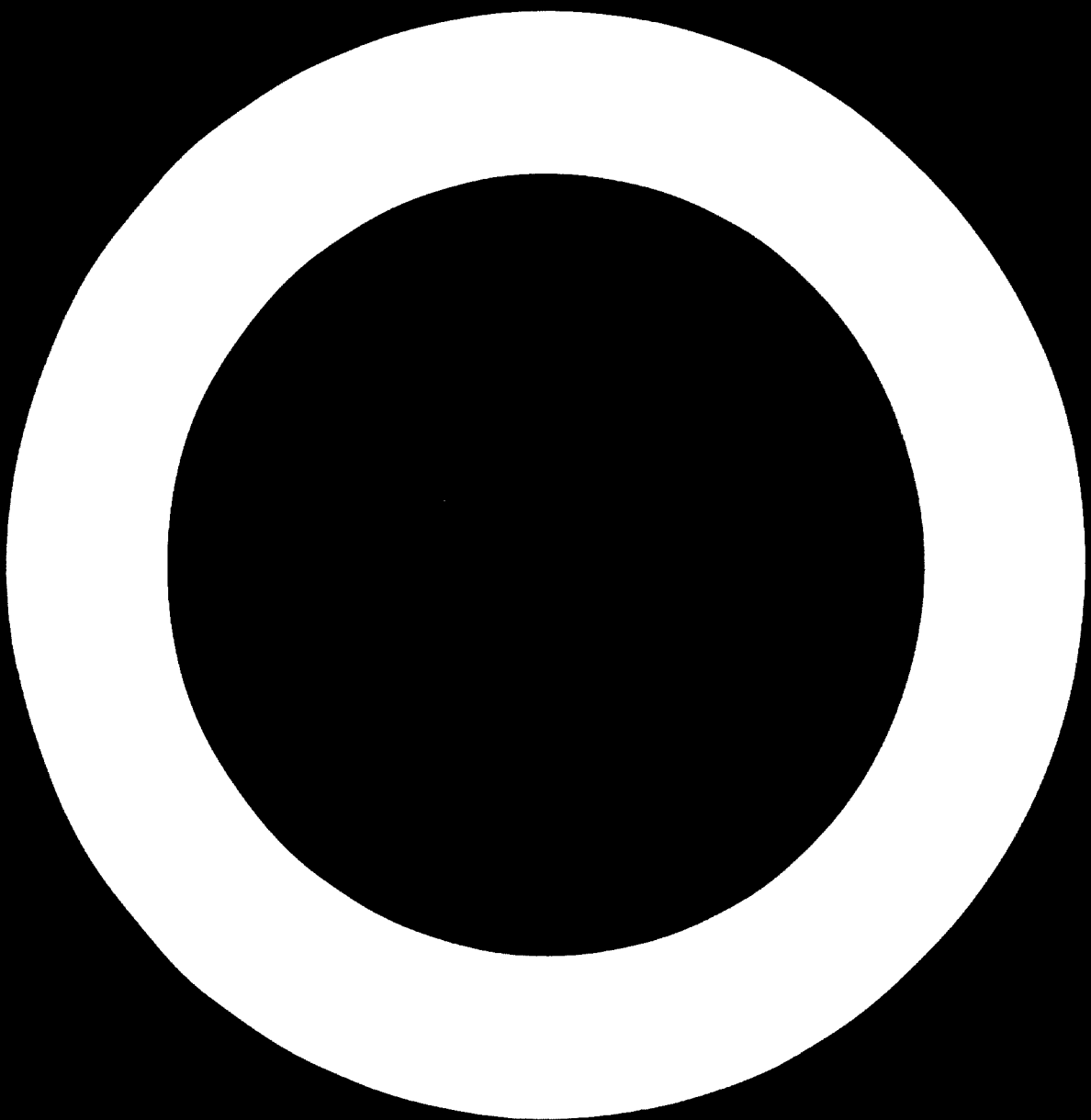


Figure II. Diagram of a plant for the treatment of heavy oils to produce refined mineral oil



[illegible]sulphonator is a high-silicon iron or carbon steel water-jacketed vessel, [illegible]ed with a turbo-agitator. The inner side of the vessel is reinforced by [illegible]rated stainless or carbon steel to protect the main vessel against [illegible]sive erosion.

Depending upon the amount of impurities present, the quantity of the acid [illegible] varies between 20% to 50% by weight of the oil used. The sulphonation [illegible] may vary from 15 to 30 minutes, once again depending on the quality of [illegible]il used. Heat is released owing to the oxidations of aromatics to [illegible]atic sulphonic acids and the dilution of the acid from 30% to about 70%. [illegible] recommended sulphonation temperature for lubricating oils of 100 SSU [illegible] cS) at 100°F viscosity, is 55° to 60°C. In case the feedstock has [illegible] SSU (= 325cS) at 100°F viscosity, the temperature is maintained at [illegible] to 60°C. When the acid treatment has been completed, the oil sludge is [illegible]charged into a settler, whence the oily layer is pumped back for further [illegible]atment with fresh oleum. The acid treatment may be repeated till the oil [illegible] colourless. The treated oil is pumped to the intermediate storage tank [illegible]-ton capacity) for interim storage. The over-all sulphonation and [illegible]tling operation should take no more than 1 to 1.5 hours.

The treated oil is pumped to the neutralizer, which is fitted with an [illegible]ator, at a rate of 1 ton/hour and is continuously neutralized with a 1% [illegible]stic soda solution. The acid-free oil is fed to a rotary disc contracter [illegible] any other continuous-type extractor, where it comes into contact with [illegible]H - H_2O solvent over a number of extraction stages. The oil, now free [illegible]mahogany acids, leaves the contracter in a direction opposite to that of [illegible] solvent.

The neutral oil overflows into the drying and decolourizing vessel, [illegible]ere the oil is mixed with 0.1% to 2% of the activated clay, both to remove [illegible]isture and to decolourize the oil. The oil-clay mixture is pumped to a [illegible]rizontal centrifuge for continuous filtration of the oil and removal of the [illegible]ay. The oil is collected in an intermediate storage tank either for direct [illegible]mping to the emulsifiable concentrate plant or to the bulk storage tank.

The methanol-water solution containing the mahogany acids is discharged [illegible] the fractionating column which separates the CH_3OH from sulphoric acids.

Sulphonic acids, when treated with $CaCO_3$ or Na_2CO_3, yield calcium or sodium sulphonates, which are important wetting agents. The methanol is returned to the methanol-water solution tank.

Disposal of wastes or by-products. The two important by-products of the process are sulphonic acids (mahogany acids) and sludge. The sulphonic acids are neutralized with caustic soda to yield soaps, which are useful emulsifying agents. The sludge acid is diluted to 30% acid strength. The sludge is thereby hydrolyzed, and most of the hydrocarbons (oil) are then separated as "liver" which is used as fuel. The diluted acid is brought into contact with flue gases to hasten its concentration from 30% to 90%. White oil sludge is also processed to recover water-soluble sulphonic acids ("green-acids"), which are powerful emulsifying agents.

Plant specifications

The detailed specifications of a white-oil plant with a capacity of 5 tons/8-hour shift are presented below. The basic data on some of the unit operations are presented in annex V.

I. Sulphonation:

A. Sulphonator (reactor)

1.	Number required	One
2.	Type	Water jacketed
3.	Nominal capacity	1.883 m^3
4.	Dimensions	D (diameter)= 1.25 m H (height) = 1.75 m
5.	Terminal process temperatures	Inlet = $77^{\circ}F$ Outlet = $90^{\circ}F$ Contents = $140^{\circ}F$
6.	Effective heat-transfer area	2 m^2
7.	Material	Plain carbon steel (with internal perforated lining) throughout
8.	Turbo-stirrer	5-10 hp (horsepower) motor with variable-speed gear etc., 220 V AC Peripherial speed at blade tip 600-700 ft/min

9.	Inlets and outlets	Inlets: D 5 cm, 4 required Outlet: D = 7.5 cm., 1 required Sample cock: 1 required Vent: D = 7.5 cm, 1 required
10.	Instrumentation	Level indicator Sight glass Temperature recorder Miscellaneous
11.	Pumps	(a) 1 hp (220 V AC) centrifugal steel pump H = 10 m (b) Water-circulation pump, 2 hp, H = 15, capcity 100 litres/min, inlet/outlet D = 5 cm.

B. Settling tanks

1.	Number required	Two
2.	Type	Vertical with conical bottoms and dished tops
3.	Nominal capacity	2 m^3
4.	Dimensions	D = 1.5 m , H = 2 m
5.	Material	Plain carbon steel or a better substitute
6.	Inlets and outlets (for each tank)	Inlets: D = 5 cm, 2 required Outlets: D = 5 cm, 1 required Sample cock: 1 required Air vent: 1 required
7.	Material	Plain carbon steel or mild steel
8.	Pump	Mild steel centrifugal pump 2 hp motor, 220 V AC
9.	Instrumentation	A level indicator and an overflow meter

C. Refined oil (acid) feed storage tank

1.	Number required	One
2.	Type	Horisontal, all welded

3.	Nominal capacity	10 m^3
4.	Contents	Refined mineral oil (0.1-0.2% H_2SO_4)
5.	Dimensions	D = 2 m H = 4 m
6.	Construction	All-welded mild steel with flanged and dished head. Head thickness $\frac{1}{4}$ in. (= 0.625 cm) and shell thickness 5/16 in. (= 0.775 cm)
7.	Inlets, outlets and connexions	Manhole: 45 cm; skimmer: 6.25 cm; drain: 5 cm; opening; 2.5 cm; gauge connexions: 4.2 cm; vent: 5 cm.; level indicator
8.	Pumps etc.	hp; 10 gal/min (= 35 l/min); head, 10 m (with flow-meter showing 15-50 l/ min flow/rates)

II. Neutralization and oil-water separator

A. Neutralizer

1.	Number required	One
2.	Nominal capacity	D = 1.0 m H = 1.5 m
3.	Type	Mild steel, reaction kettle with a turbo-agitator
4.	Connexions	Inlets: D = 5 cm, 2 required D = 5 cm, 2 required Hand hole: 12.5 x 20 cm, with peep hole; agitator opening: 5 cm.; overflow.
5.	Agitator	Type: 90-cm impeller with baffles (90 rev/min) Drive: 2 hp, 220 V single-phase, 60-cycles AC squirrel-cage induction, with type PB reduction, 12,000 rev/min

B. Oil separator

1.	Number required	One
2.	Nominal capacity	D = 1 m H = 1.5 m Partition wall 10 cm below the top, from the centre
3.	Type	Mild steel vertical cylinder with conical bottom
4.	Connexions	Inlet: D = 5 cm: 1 required Outlet: 5 cm, U-type over-flow-siphon for water, with one bottom outlet Outlet: 2.5 cm, 1 required
5.	Pump	Mild steel centrifugal pump, 1 hp, 220 V AC, H = 10 m

III. Extraction of mahogany acids

Any of the following continuous-type extractors may be used:

1. Rotary disc contractor (RDC)
2. Mixco (Oldhue-Rushton) extractor
3. Scheibel (York-Scheibel) columns (with alternately packed compartment for coalescing)
4. Treybal column (a unit of the mixer-settler type)

A. Specifications

1.	Number required	One
2.	Type	Any of the above
3.	Nominal capacity	1. Oil = 1.1138 tons/hour = 1.328 m^3 2. Solvent $\frac{0.5000}{1.6138}$ tons/hour = $\frac{0.576\ m^3}{1.904\ m^3}$ (Solvent 70% CH_3OH)
4.	Number of stages	6 to 8 (a) Motor: 3 to 5/hp, 220 V AC 60 cycles (b) Motors for inlet streams 1 hp with H = 10 m, 2 required
5.	Agitator	One

8.	Instrumentation	Usual Flow meters at inlets Oil: 25 l/min Solvent: 10 l/min

IV. Methanol bulk storage tank (outside) and methanol feed tank

A. Bulk storage tank (outside)

1.	Number required	One
2.	Nominal capacity	50 tons
3.	Type	Vertical, tank with covered top and a level indicator
4.	Dimensions	D = 4 m H = 6 m
5.	Material	Mild steel coated with: phenolic resins resins rubber (GR-S) epoxy resins Chlorimet or Hastealloy-C (too costly)
6.	Connexions, inlets and outlets	Inlet, D = 7.5 cm; 1 required Outlet, D = 5 cm; 2 required Air vent
7.	Pump	Stainless steel centrifugal pump with 2-hp motor, 220 V AC H = 15 m

B. Methanol feed tank

1.	Number required	One
2.	Nominal capacity	5 tons = 5.76 m^3 (70% methanol solution)
3.	Type	Horisontal
4.	Dimensions	D = 2 m H = 3 m
5.	Material	Same as for bulk storage tank
6.	Inlets and outlets	Inlet: D = 5 cm; 2 required Outlet: D = 5 cm; 2 required and 10-cm hole for a mixing unit (1-hp motor)
7.	Pump	0.5-hp centrifugal pump

V. Drying and bleaching

1. Number required	One
2. Type	Vertical, cylindrical vessel covered top and conical bottom
3. Nominal capacity and dimensions	D = 0.75 H = 1 m (0.5 m^3)
4. Connexions inlets and outlets	Inlets: D 5 cm; 2 required Outlets: One near top; D 5 cm 1 required one at bottom, D = 5 cm; 1 required
5. Agitator (mixer)	2 to 3 hp, 220 V AC, with variable-speed gear
6. Material	Mild steel
7. Feed hopper (for clay)	Screw conveyor with a feed-hopper (0.1 m^3) and a Star feeder; Motor for screw-conveyor - 0.5 hp

VI. Horisontal continuous centrifuge

1. Number required	One
2. Nominal capacity	Ton/h (solids, 0.2 tons/h)
3. Type	Continuous, horizontal
4. Over-all dimensions	Length: 1 m; width: 0.5 m; height: 0.7 m Slurry entrance: 5 cm
5. Drive motor	2 to 3 hp, 220 to 440 V, 3-phase 60 cycles AC, 1,750 rev/min
6. Material	Basket, screening and piping, stainless steel 304, Housing and base, cast iron

VII. Product - intermediate storage tank

1. Number required	One
2. Type	Vertical, covered top and conical bottom
3. Nominal capacity	0.5 m^3
4. Dimensions	D = 0.75 m, H = 1 m

5.	Inlets and outlets	Inlets: D = 5 cm, 2 required Outlets: D = 5 cm, 2 required Level indicator
6.	Pump	Mild steel centrifugal pump 2 hp; H = 15 m
7.	Material	Mild steel

Product (refined mineral oil) storage tank (2-weeks' capacity)

1.	Number required	One
2.	Nominal capacity	60 tons = 71.5 m^3
3.	Type	Vertical covered
4.	Dimension	D = 5 m; H = 5 m
5.	Inlets and outlets	Inlet: D = 5 cm; 1 required Outlet: D = 5 cm; 2 required Level indicator
6.	Pump	Mild steel centrifugal, 220 V AC 2 hp, h = 15 m

VII. Bulk-storage tanks (raw materials)

A. Heavy diesel oil (2 weeks' supply)

1.	Number required	One
2.	Type	Vertical, covered top and air-vent.
3.	Nominal capacity	84 tons (= 100 m^3)
4.	Dimensions	D = 5 m
5.	Connexions	D = 7.5 cm, 2 required D = 7.5 cm, 1 required
6.	Material	Mild steel throughout
7.	Pump	Mild steel centrifugal pump 2 hp, H = 10 m
8.	Steam-heating coils	One (bottom of the tank)

B. 20% oleum (3 months' supply)

1.	Number required	One
2.	Type	Vertical, covered. Air vent (special for 20% oleum)

3.	Nominal capacity	206 tons (= 111.5 m^3)
4.	Dimensions	D = 5 m; H = 5 m
5.	Inlet and outlets	Inlet: D = 7.5 cm; 1 required Outlet: D = 75 cm; 2 required
6.	Material	Plain carbon steel throughout
7.	Pump	Mild steel centrifugal pump 2 hp, H = 10 m

IX. Methanol and mahogany acids recovery unit
Methanol-water fractionating column

A. Column

1.	Number required	One
2.	Type	Bubble cap tower
3.	Nominal diameter	20 cm
4.	Number of plates	21
5.	Plates - specifications	6 bubble caps: D = 5 cm downput: D = 2.5 cm
6.	Plate spacing	45 cm
7.	Working pressure	Atmospheric
8.	Maximum working temperature	115°C (= 240°F)
9.	Material	Stainless steel

B. Still (pot-type)

1.	Number required	One
2.	Type	Unjacketed kettle with heating-coil
3.	Nominal capacity	350 l (= 100 US gal)
4.	Heating surface	2.69 m^2 (= 29 sq ft)

C. Solvent still condenser

1.	Number required	One
2.	Type	Tube and shell

. Cooling surface	3.75 m^2
. Material	Tubes: tube-sheet and bonnet, stainless steel 304; shell: plain carbon steel
. Operating pressure	5 lb/in^2

D. Solvent-still feed pump

1. Number required	Two
2. Meter capacity	35 l/min
3. Type	Single-stage centrifugal pump
4. Character of liquid	CH_3OH + H_2O + sulphonic acid mixture at 25°C
5. Inlet and outlet sizes	2.5 cm
6. Head	10 m
7. Motor	½ hp 220 V AC
8. Material	Cast iron (high silicon) or stainless steel 304

X. Methanol and mahogany acids storage tanks (from fractionating column).

Methanol intermediate storage tank. (See IV.3. Methanol feed tank above)

Mahogany acids storage tank.

1. Number required	One
2. Nominal capacity	10 m^3
3. Type	Horizontal with dished ends
4. Dimensions	D = 2 m; H = 3 m
5. Connexions, inlets and outlets	Inlets: D = 2.5 cm, 2 required Outlets: D = 2.3 cm, Manhole 45 cm Air vent Level indicator

6.	Material	Plain carbon steel (resin coated)
7.	Pump	1 hp, H = 10 m Cast iron (high silicon)

XI. Spray-cooling of water (with underground tank)

1.	Number required	One
2.	Type	Cascade trays (square)
3.	Number of trays	15
4.	Size of trays	1.5 x 0.3 m
5.	Distance between each tray	1 ft
6.	Inclination of trays	60°
7.	Spray nozzles	Vertical jets

Requirements of a refined mineral oil plant

A key component of the projected complex for the production of pesticides is a refined mineral oil plant with a capacity of 5 tons/day. The costs of the machinery and equipment for such a plant and the annual production costs are given below. Further data are given in annex VI.

Cost of machinery and equipment

Unit operations or equipment	Libyan dinars (approx.)
Sulphonator	7,500
Settling tanks	750
Turbo-mixers with coalescence tanks (3)	7,500
Extractor (mahogany acids) (stainless steel)	10,000
Continuous filter	5,000
Fractionating column with pot-still and condenser etc. (stainless steel)	10,000
Piping, ducts etc.	5,000
Valves, fittings and related items	2,500
Pumps, motors, switches etc.	7,500
Sludge-acid neutralization pit; acid brick-lined, with inlet and outlet pumps etc.	10,000
Storage tanks	
Bulk storage of raw materials	25,000
Partly finished products	5,000
Intermediate storage tanks	5,000
Miscellaneous	1,000
Electricity and instrumentation	5,000
Exhaust system	3,000
Safety equipment	1,000
Unforeseen	10,250
Total	120,000

Annual production cost

		Libyan dinars
1. Raw materials		
1.1	Heavy gas oil 1,995 tons/year at LD 27.9/ton	56,000
1.2	20% oleum 825 tons at LD 28/ton	23,100
1.3	Methanol (or furfural) 75 tons at LD 36/ton	2,700
1.4	Fuller's earth 30 tons at LD 30/ton	900
1.5	Caustic soda 12 tons at LD 46/ton	552
1.6	Limestone 1,200 tons at LD 2/ton	2,400
1.7	Packaging material (resin-coated drums) 500 at LD 3.44/drum	1,720
		87,382
2. Energy, fuel and water		
2.1	Electric power 100,800 kWh at LD 7.5/1,000 kWh	756
2.2	Water 10,000 m^3 at LD 20/1,000 m^3	200
2.3	Steam (10 p.s.i.g.) 600 tons at LD 1.2/ton	720
		1,676
3. Management, laboratory and labour		
3.1	Factory, stores, administration and laboratory	47,900
3.2	Contingencies (10% of 3.1)	4,790
3.3	Foreign specialist (1) at LD 500/month	6,000
		58,690
4. Depreciation and amortisation		
4.1	Depreciation of building and construction (4% of the cost a year - annex VI, A, 2)	1,148
4.2	Depreciation of machinery and equipment (10% of the cost a year - annex VI, A, 3)	19,305
4.3	Depreciation for transport vehicles (20% of the cost a year - annex VI, A, 4)	2,400

4.4	Depreciation for furniture and miscellaneous (10% - annex VI, A, 5)	400
4.5	Amortization of preliminary and promotional expenses	2,253
		25,506

5. Direct and general expenses

5.1	Maintenance expenses (4% of Capital expenditure - annex VI, A, 2-5)	9,410
5.2	Supplies (10% of 1. Raw materials and 2. Energy, fuel and water) (Note: take only 5%)	4,460
5.3	Sales and marketing expenses (10% of 1 to 4 of Production costs)	17,330
5.4	Research, development and training (5% of 1 to 4 of Production coste)	8,670
5.5	Contingencies (insurance, transport and othere) (5% of 1 to 4 of Production coste)	8,670
5.6	Royalty 2% on the total sales price	4,750
5.7	Charges on working capital (10% of Working capital - annex VI, A, 7)	1,080
		54,098
	Total production coet	227,352
		227,400 (approx.
	Profit at a rate of 5%	+11,370
	Total sales price	238,770
	Cost/ton	145.5

11. EMULSIFIABLE CONCENTRATES
(10 tons/8-hour shifts)

The process

The process for the manufacture of an emulsifiable concentrate (EC) is rather simple. When a pesticidal chemical is a solid (for example, dimethoate, tetradifon, Kelthane, lindane or DDT), it is first ground to about -30 +100 mesh B.S.S. in a hammer mill, discharged into an elevator through a vibrating chute or a screw conveyor, which lifts and delivers it to the feed hopper (figure III), whence it flows into the mixing vessel (jacketed) via a weight hopper.

A known amount of solvent is then pumped to the mixing vessel. If the solid chemical is only sparingly soluble in the ordinary solvent, a powerful solvent such as isopropanol or cyclohexanone may be used. The solution is then diluted with a relatively cheaper solvent such as benzene, toluene or xylene. Solubility may also be increased by steam heating the material.

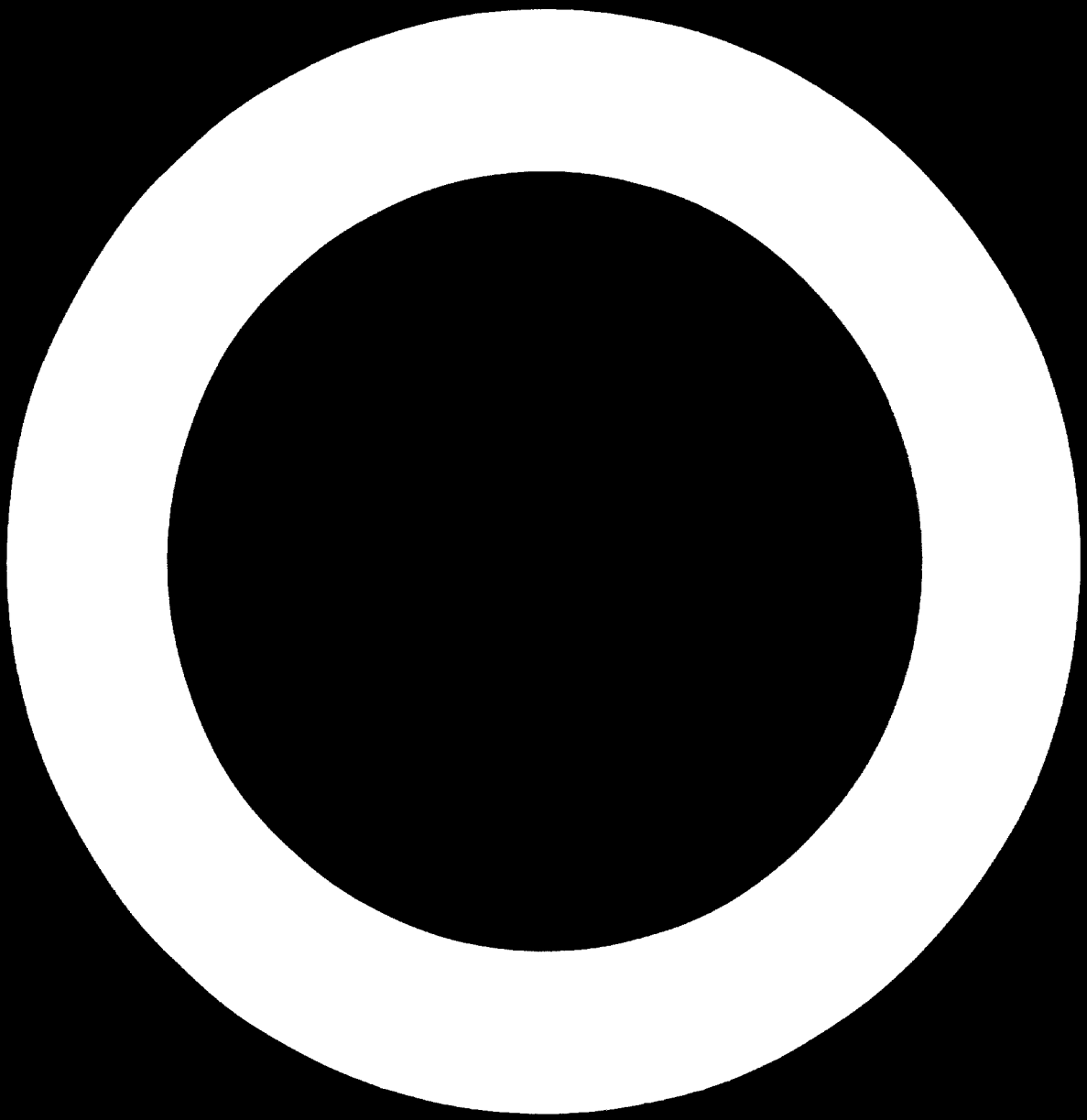
When the solution is ready, an emulsifier is added, and the whole mixture is vigorously stirred for about 5 to 15 minutes at a prescribed temperature.

The emulsifiable concentrate is then filtered and transferred to the service tank, whence it flows by gravity to the filling section.

The process may be divided into the following unit operations:

- Size-reduction (solid chemicals)
- Transportation
- Storage (feed bins) and weight hopper
- Mixing
- Filtration
- Storage (service tanks)
- Filling (automatic)
- Exhaust system

The specifications of a suitable plant for the production of emulsifiable concentrates, the cost of its machinery and equipment and its annual production costs are given below. Further data are presented in annex VII.



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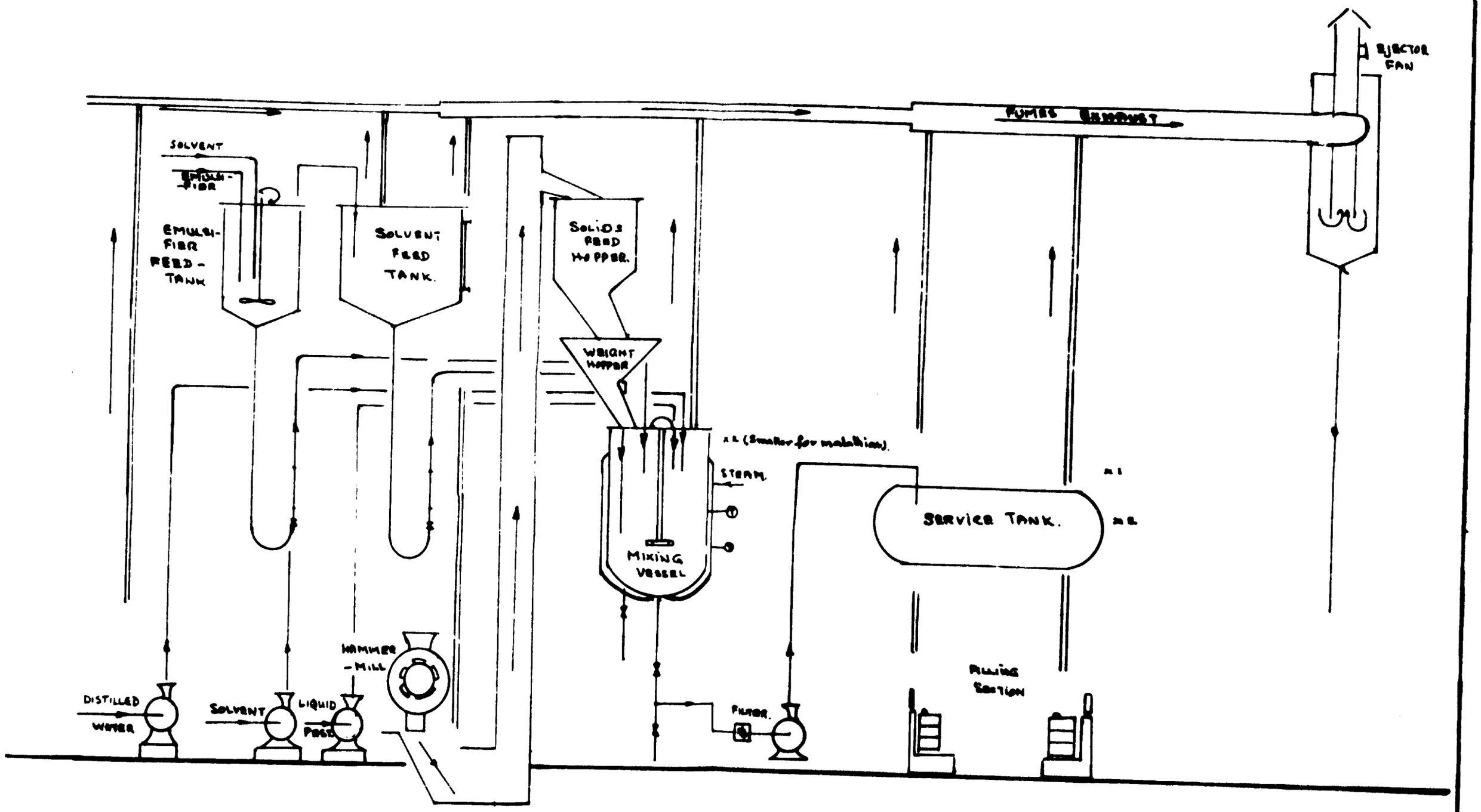
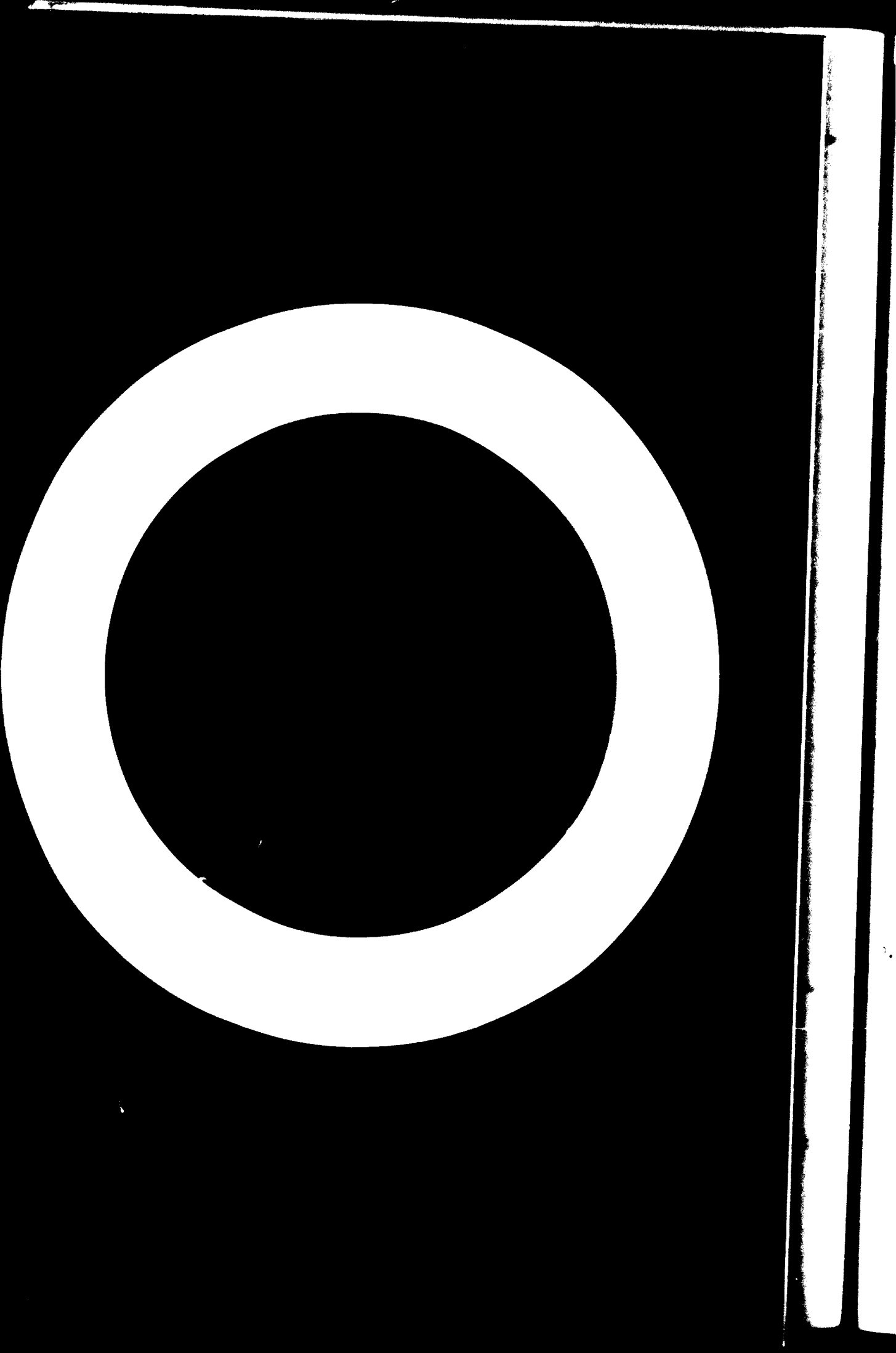


Figure III. Diagram of a plant to produce emulsifiable concentrates (5 tons/8-hour shift)



Separate mixing vessel for malathion. Although an odourless premium-grade malathion is available, it is advisable to have a separate mixing vessel, service tank and weighing equipment for this material, as it imparts its characteristic smell to any other EC prepared with the same equipment.

Plant specifications

1. Hammer mill
(for solid pesticides)

Number required	One
Type	Swing-hammer mill with internal classifier (non-clogging type)
Nominal capacity	1 to 2 tons/h of product (crystalline organic pesticide)
Feed size	2 mm to 1 cm
Product size (approx.)	-30 to +100 mesh B.S.S.
Material	Stainless steel 304 or other suitable material
Motor	2 to 3 hp, 220 V AC
Miscellaneous	A feed chute for the bucket conveyor

2. Bucket conveyor

Number required	One
Type and capacity	Centrifugal discharge 1 to 2 tons/h
Height	10 m
Material	Stainless steel (buckets only)
Motor	2 hp, 220 V AC with variable speed

3. Feed-storage bin and weight hopper

(a) Feed-storage bin

Number required	One
Type	Mass flow
Capacity	2 tons (bulk density 30 to 40 lb/ft^2)
Dimensions	2 x 1.5 x 1 m
Discharge	Star-feeder, collecting screw for uniform withdrawal
Material	Stainless steel or any other suitable material

4. Mixing vessel

4.1 general purpose

Number required	One
Type	Jacketed
Capacity	3 tons/h of EC Av. density 1.12 g/cc (= [illegible])
Dimension	D = 1.5 m; H = 2 m
Inlets	D = 3.75 cm; 2 required
	D = 5 cm; 2 numbers required
	D = 10 cm (solids); 1 required
	D = 10 cm (turbo-shaft); 1 required
	D = 2.5 cm (steam); 1 required
Outlets	D = 5 cm; 1 required
	D = 2.5 cm (jacket)
	Air-vent for gases or vapours from the vessel
Motors	(a) 5 to 10 hp, 220 V AC for turbo-agitator with variable-speed gear etc. Speed of the impellor tip 600 to 700 ft/min
	(b) 1-hp motor; 1 required
	(c) 2-hp motor; 2 required
	(d) 2-hp motor for pumping EC to the service tanks
Material	Stainless steel 304 (throughout)
Instruments	(a) Pressure gauge for steam (10 to 50 lb/in^2
	(b) Temperature indicator
	(c) Level indicator with light or alarm signal

4.2 Service tanks

Number required	Two
Type	Horizontal, dished ends
Capacity	10 tons each (for EC, density 1.12)
	D = 2 m; H = 3 m
Inlets and outlets	Inlets: D = 5 cm; 2 required
	Outlets: D = 5 cm; 2 required

	air-vent level indicator with light signal
Material	Stainless steel 304

. Malathion-50

.1 Mixing vessel

Number required	Two (one for weed-killer section)
Nominal capacity	1 ton = 0.893 m^3
Dimensions	D = 1 m; H = 1.5 m
Motor (turbo-agitator)	3 to 5 hp 220 V AC
Centrifugal pump	1 hp; 3 required

All the remaining features are the same as for the main turbo-mixer.

.2 Serive tank

Number required	One
Capacity	5 tons
Dimensions	D = 1.5 m; H = 2 m

All remaining features are the same as for the major service tanks.

. Weighing and filling section

For filling, weighing and automatic cut-off

(a) 45-gal drum (baked-resin lined)

(b) 5 to 10 gal polyethylene, blow-mouth drums

Number required	Two
Nominal capacity	(a) General-purpose: 25 to 50 tons/h (b) Malathion: 5 to 10 tons/h

Vapour and air exhaust system

1 Exhaust system

Number required	One
Type	Vapours exhaust coupled with water scrubber
Motor	Blower, 5,000 m^3/min 10 hp, 220 V AC Water scrubber - 1 hp
Material	Mild-steel with protective coating (or other suitable material)

Location	Dust arms (flexible) at all unit-operations where the dust and liquid fumes escape, especially the mixers and the filling points

Exhaust fans should be installed near the roof at regular intervals; for every 10 m^3 of plant volume, one exhaust fan with an 0.5 hp motor is to be provided. These exhaust fans are to be installed in the mixing and filling sections. There should be eight exhaust fans in the main EC block and four in the weed killer (EC and WP) sections.

9. Bulk storage tanks

9.1 White Oil EC (50 tons)

Number required	One
Type	Vertical, with covered top
Dimensions	D = 4 m; H = 5 m
Inlets and outlets	Inlets: D = 7.5 cm; 1 required
	Outlets: D = 7.5 cm; 2 required
	Air vents: D = 7.5 cm; 1 required
Material	Stainless steel 304 or mild steel (epoxy resin lined)

9.2 Xylenes

(Capacity required for 3 months = 90 tons)

Number required	One
Type	Verical, covered top but with air vent
Nominal capacity	100 m^3
Dimensions	D = 5 m; H = 6 m
Inlet and outlets	Inlet: D = 7.5 cm; 1 required
	Outlets: D = 5 cm; 2 required
Material	Mild steel
Pump	Mild steel centrifugal pump with 2 to 3 hp motor, H = 15 m

9.3 Kerosene oil

(Capacity required for 2 weeks storage)

Number required	One
Type	Vertical, with covered top but with air vent
Nominal capacity	67.5 tons = 88.5 m^3

Dimensions	D = 4 m; H = 7.5 m
Inlet and outlets	Inlet: 7.5 cm; 1 required
	Outlets: 5 cm; 2 required
Material	Mild steel
Pump	Mild steel centrifugal pump 2 to 3 hp, H = 15 m

7.4 Malathion feed tank

Number required	One
Type	Horizontal
Nominal capacity	10 tons; D = 2 m, H = 3 m
Inlets and outlets	(a) Inlets: D = 5 cm; 2 required
	(b) Inlet: D = 2.5 cm; 1 required
	(a) Outlets: D = 5 cm; 2 required
	(b) Air vent
Material	Stainless steel 304
	(a) Stainless steel centrifugal pump, 2 to 3 hp
	(b) Stainless steel centrifugal pump, 1 hp
	Important: pump Malathion from drums to the tank

Cost of machinery and equipment

Unit-operation or equipment	Libyan dinars (approx.)
Hammer mill	1,500
Bucket conveyor	1,000
Storage feed hopper and weight hopper	2,000
Mixing vessel stainless steel (3) (one for Malathion) (one for weed killers)	10,000
Service tanks stainless steel (3) (one for Malathion) (one for weed killers)	12,000
Weighing and filling (one for weed killers)	5,000
Bulk storage tanks	
(a) White oils(stainless steel)	7,500
(b) Xylenes	5,000

(c) Kerosene oil	5,500
(d) Malathion (stainless steel)	2,500
Piping:	
Valves, fittings etc.	1,000
Electrical installation	2,000
Instrumentation	5,000
Exhaust system	2,000
Unforeseen	5,000
	15,000
Total	85,000

Annual production cost

1. Raw materials

1.1 White oil-80

	Libyan dinars
(a) Refined mineral oil 400 tons (LD 160/ton)	64,000
(b) Stabilizer (casein) 2.22 tons (LD 483/ton)	1,074
(c) Emulsifier (Triton x 100) 1 ton at (LD 523/ton)	523
(d) Ammonia 0.9 3 tons at (LD 56 ton)	168
(e) Distilled water 84.4 tons at (LD 2/ton)	170
	65,935

1.2 Dimethoate-40

(a) Dimethoate (tech.) 72 tons (LD 1,280/ton)	92,200
(b) Emulsifier (?) 9 tons (LD 547/ton)	4,920
(c) Xylene 75.2 tons (LD 90/ton)	6,768
(d) Casein 0.85 ton (LD 483/ton)	412
(e) Distilled water 34 tons (LD 2/ton)	68
	104,368

	Libyan dinars
1.3 Tedion-8 (tetradifon)	
(a) Tetradifon (tech.) 10.04 tons (LD 3,275/ton)	32,880
(b) Emulsifier (Atlox) Atlas-ICI, USA 6.45 tons (LD 600/ton)	3,868
(c) Cyclohexanone and xylene 12.9 tons (LD 228/ton) (1:5) 70 tons (LD 90/ton)	9,240
(d) Casein 2.5 tons (LD 483/ton)	1,248
(e) Distilled water 28 tons (LD 2/ton)	56
	47,292
1.4 Malathion-50	
(a) Malathion (tech.) 42.5 tons (LD 751/ton)	31,920
(b) Emulsifier 4.2 tons (LD 600/ton)	2,520
(c) Xylene 37.8 tons (LD 90/ton)	3,402
	37,842
1.5 Kelthane-18,5	
(a) Kelthane (tech.) 23.8 tons (LD 1,275/ton)	30,400
(b) Emulsifier (P and H) 0.648 tons (LD 509/ton)	330
(c) Casein (or methyl-cellulose) 0.648 tons (LD 483/ton)	316
(d) Xylenes 104 tons (LD 90/ton)	9,360
	40,406
1.6 Lindane-20 and -50	
(a) Lindane (tech.) 25.29 tons (LD 1,645/ton)	41,600
(b) Emulsifier 2.16 tons (LD 600/ton)	1,296

(c) Casein 0.59 tons (LD 483/ton)		300
(d) (Benzene, toluene) xylene; 62 tons (LD 90/ton)		5,580
		48,776

1.7 Liquid insecticides

(a) Bioallethrin 244 kg at LD 37,815/ton		9,200
(b) Bioresmethrin 324 kg at LD 52,215/ton		16,918
(c) Piperonyl butoxide 896 kg at LD 7/kg		6,272
(d) Kerosene (deodorized) 1,620 tons (LD 17.64/ton)		28,600
		60,990

1.8 Weed killers (2,4-D and 2,4-DB)

(a) 2,4-D and 2,4-DB 53.26 tons		17,360
(b) Solvent oil or benzene 135.2 tons (LD 86/ton)		11,800
(c) Emulsifier 3.56 tons (LD 600/ton)		2,136
		31,296

1.9 Packaging material

55-gallon drums (= 7.35 ft^3) 16 gauge plate (baked resin coated) 1,000 at (c.i.f. LD 3.44 drum)		3,440
	Subtotal	40,345

2. Energy, fuel and water

2.1 Electric power (300 days) 170,000 kWh (LD 7.5/100 kW)		1,280
2.2 Water (300 days) 24,000 m^3 (LD 20/1,000 m^3)		480
2.3 Steam 750 tons (LD 1.2/ton)		900
	Subtotal	2,660

3. **Labour and administrative costs**

3.1 (A) **Factory**

Personnel	Number required	Monthly wage (LD)	Yearly wage including social charge (LD)	Total (LD)
Unskilled	4	70	950 x 4	3,800
Skilled	3	100	1,350 x 3	4,050
Highly skilled	1	120	1,600 x 1	1,600
Engineer (Chemical)	1	150	2,000 x 1	2,000
Chemist	1	150	2,000 x 1	2,000
				13,450

3.1 (B) **Commercial Department and stores**

Foreman	1	120	1,600 x 1	1,600
Helpers	2	70	950 x 2	1,900
Drivers	3	100	1,300 x 3	3,900
				7,400

3.1 (C) **Administration**

Clerks	2	120	1,600 x 2	3,200
Typists	2	120	1,600	3,200
Helpers	2	70	950 x 2	1,900
				8,300

3.2 **Contingencies** (10% of 3.1) 2,915

3.3 **Foreign Specialists (2)** at LD 500/month, for 6 months 6,000

Subtotal 37,865

4. **Depreciation**

4.1 Depreciation of buildings and construction (at 4% of the cost a year - annex VII, A, 1 and 2) 518

4.2 Depreciation of machinery and equipment (at 10% of the cost a year - annex VII, A, 3) 12,892

4.3 Depreciation for transport vehicles (20% of the cost a year - annex VII, A, 4)		2,340
4.4 Depreciation for furniture and equipment (20% of the cost a year - annex VII, A, 5)		1,000
4.5 Amortization of preliminary and promotional expenses (20% of 4.1 to 4.4)		3,550
		3,550
	Subtotal	20,300
5. Direct and general expenses		
5.1 Maintanance expenses (4% of 2 to 5 of Capital expenditure - annex VII, A)		5,943
5.2 Miscellaneous supplies (10% of 1 and 2 of Production cost) (LD 45,896, but take only LD 10,000)		10,000
5.3 Sales and marketing expenses (5% of 1-4 of Production costs)		25,846
5.4 Research, development and training (5% of 1-4 of Production costs)		25,846
5.5 Contingencies (Insurance, transport and others) (5% of 1-4 of Production costs)		35,846
5.6 Royalty (2% of annual sales)		12,800
5.7 Charges on working capital (10% of Working capital - annex VII, A, 1-4)		15,773
		15,773
	Subtotal	122,054
Total production cost		623,224 623,000 (approx.)
Average cost/ton (at 2,927 tons/year)		213
Processing cost/ton		182,659 / 2,927 = 62.3

III. WETTABLE POWDERS, GRANULES AND DUSTS

The process

The wettable powders[2] are generally prepared in high concentrations, namely 15% to 95%, with a dust carrier such as attapulgite or diatomaceous earth, which becomes wet and gives it a uniform suspension in water. In addition, 1% or 2% of a wetting agent is added to enhance their wettability and suspendibility in water. The particle size of wettable powders is usally smaller than 44μ or 325 mesh B.S.S. The requirements for an appropriate wettable powder plant are presented in annex VIII.

The dusts[3] contain low percentage of pesticidal chemical namely 1.0% to 10%, and the particle size ranges between 0.5 to 4μ. The common carrier and the diluent are shown in table 5.

The granules generally vary in size from 4 to 30 mesh, although such a wide range is seldom used but rather a narrow particle size range, namely 4/10, 10/30, 20/35, 20/40 and 30/60 mesh are used. In any case, 90% of the granules must pass through initial size and be retained by the second size. These granules are then sprayed, in a ribbon mixer, with either the molten pesticide chemical or its concentrated solution.

The process as illustrated in figure IV, shows a plant for the production of dusts, granules and wettable powders of different specifications. In case of dusts, both the carriers and the diluents are first crushed in a jaw crusher, followed by coarse grinding in a hammer mill and later dried in a rotary dryer, using flue gases. The dried material is discharged into the bucket elevator, which carries it over to a vibrating sieve to separate the different narrow particle size ranges namely +30, -30 + 60 and fines. The coarser particles, namely +30, are returned to the hammer mill, and granules of the regular size range are conveyed to the granules storage hopper. If the coarser granules are not required, they are fed to the ring-roll mill along with the fines for fine grinding, that is 325 B.S.S., and transported to dust storage hopper by means of an elevator (not shown in figure IV) for interim storage.

3/ Kirk-Othmer, Encyclopedia of Chemical Technology, vol. 11, (New York, Interscience Publishers (John Wiley and Sons, Inc.), 1960); Industrial Production and Formulation of Pesticides in Developing Countries (United Nations publication, Sales No. 72.II.B.5).

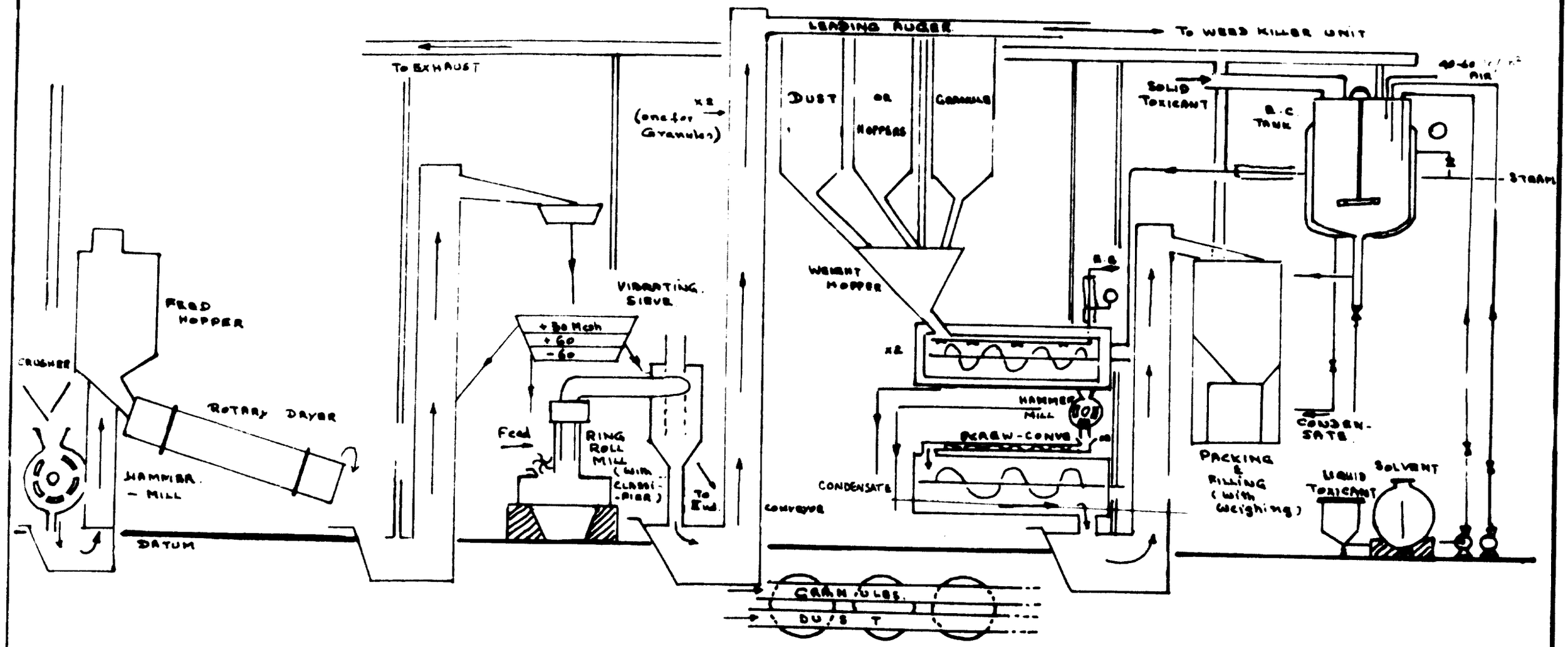


Figure IV. Diagram of a plant to produce wettable powders, granules and dusts (5 tons/8-hour shift)

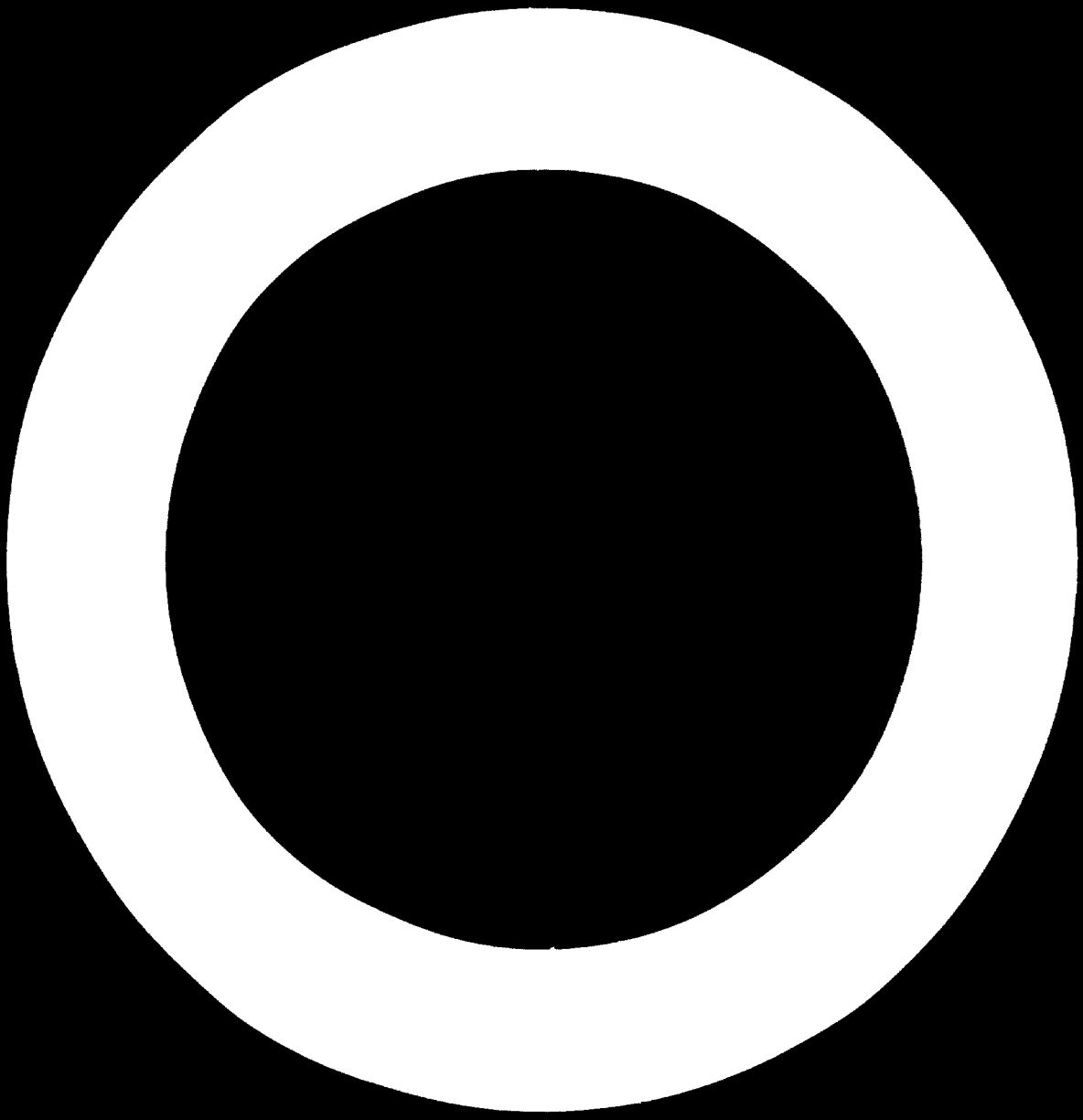


Table [illegible]. Sorptiveness of some minerals commonly used as pesticide carriers and diluents

	Sorption index
Carriers	
Silica	400
Diatomite (salt-water)	270
Vermiculite	250
Attapulgite	230
Diatomite (fresh-water)	200
Montmorillonite	190
Kaolinite	160
Diluents	
Pyrophillite	90
Bentonite	80
Pumice	78
Talc	73
Silica (natural)	64
Limestone	50
Gypsum	50

The material from the storage hoppers flows into the steam-heated ribbon-mixer via a weight hopper. The molten pesticide or its slurry is then sprayed over the dust at 20- to 40-p.s.i.g. pressure, using a gear pump. Owing to spraying, the dust particles which agglomerate are broken up in a high-speed single-rotor mixer. (This mixer is not used for granular formulations.) The mixed material flows into a bucket conveyor and is transferred to the storage bin for packaging and filling.

The pesticidal chemical melting or EC preparation kettle is steam jacketed and has inlets both for solid and liquid materials. Both the toxicants and the solvents can be pumped from the base tanks by means of centrifugal pumps. Compressed air is also used for pumping EC into the ribbon-mixers.

The process may be summarized in the following unit operations:

1. Crushing and intermediate size reduction
2. Drying

3. Size reduction (fine pulverizing)
4. Transportation and storage (of dusts and granules in feed hoppers)
5. Mixing (solids) and transportation of the products
6. Weighing and packaging
7. EC mixing vessel

Figure V shows a plant for the production of weed killers (both emulsifiable concentrates and wettable powders) that could be supplied with granules or dust for the wettable powder section.

Plant specifications

1. Crusher. For crushing clay, gypsum, limestone, bentonite and, if necessary, sulphur down to 1 to 2 inches, a Blake-type crusher may be used, with the following specifications:

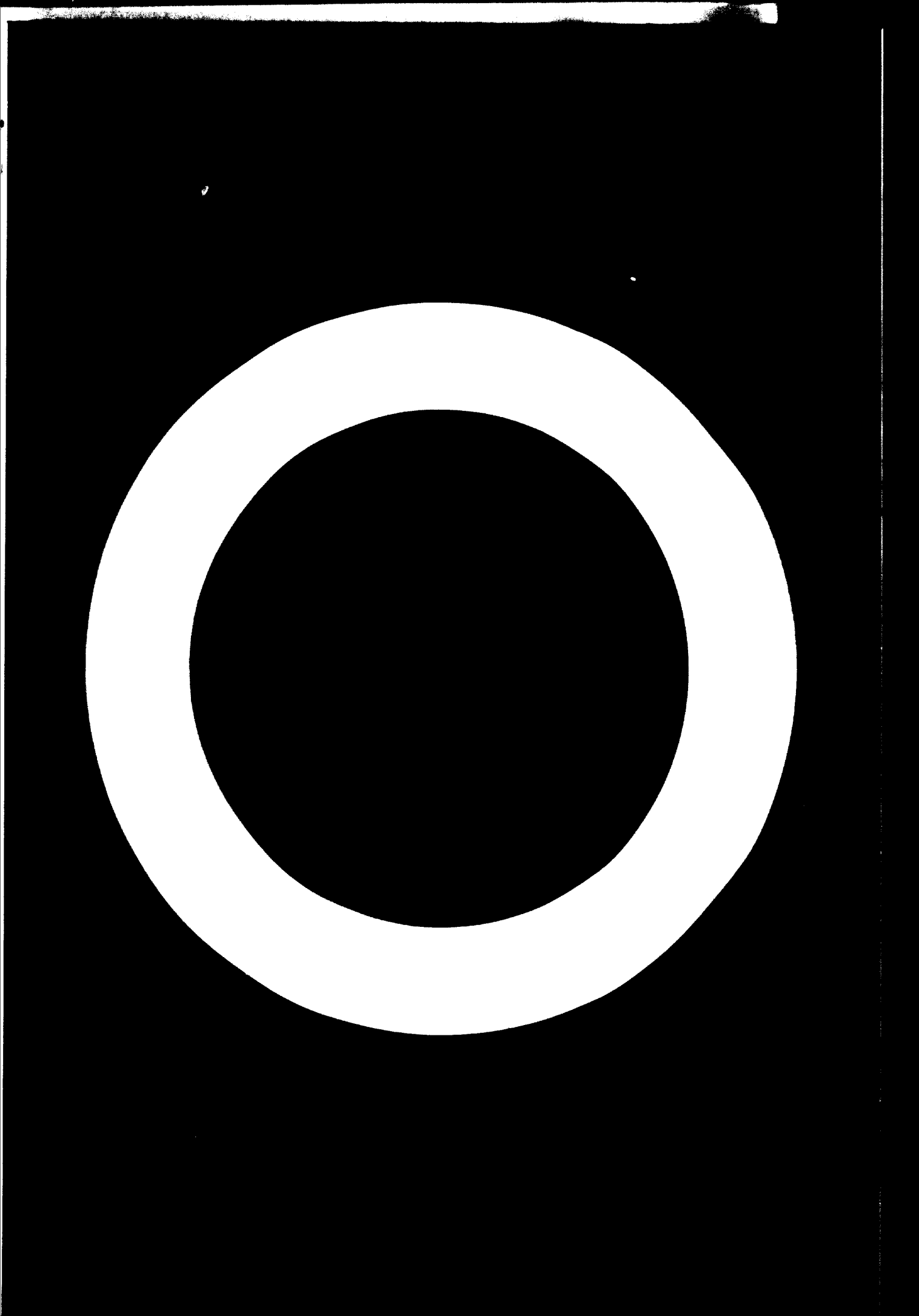
Number required	One
Type	Blake swing-jaw crusher
Crusher size	
Receiving opening	18 x 25 cm
Exit end	4.5 cm
Capacity at setting end	7 to 10 tons/h
Power required	15 hp (= 12 kWh)

2. Hammer mill (non-clogging swing-hammer mill, pulverize type)

Number required	One
Capacity	(a) 2 to 3 tons/h (product) (b) Feed size 3/4-1 in (c) Product size 10 + 100 mesh (with internal classifier)
Power required	6 to 8 hp
Material to be handled	Gypsum, limestone, bentonite kaolin and clays

3. Rotary drier (Raymond/Barlett or Snow and Co., USA)

Number required	One
Type	Countercurrent, direct heat, with cooler
Feed	Clay, gypsum, bentonite, diatomaceous earth



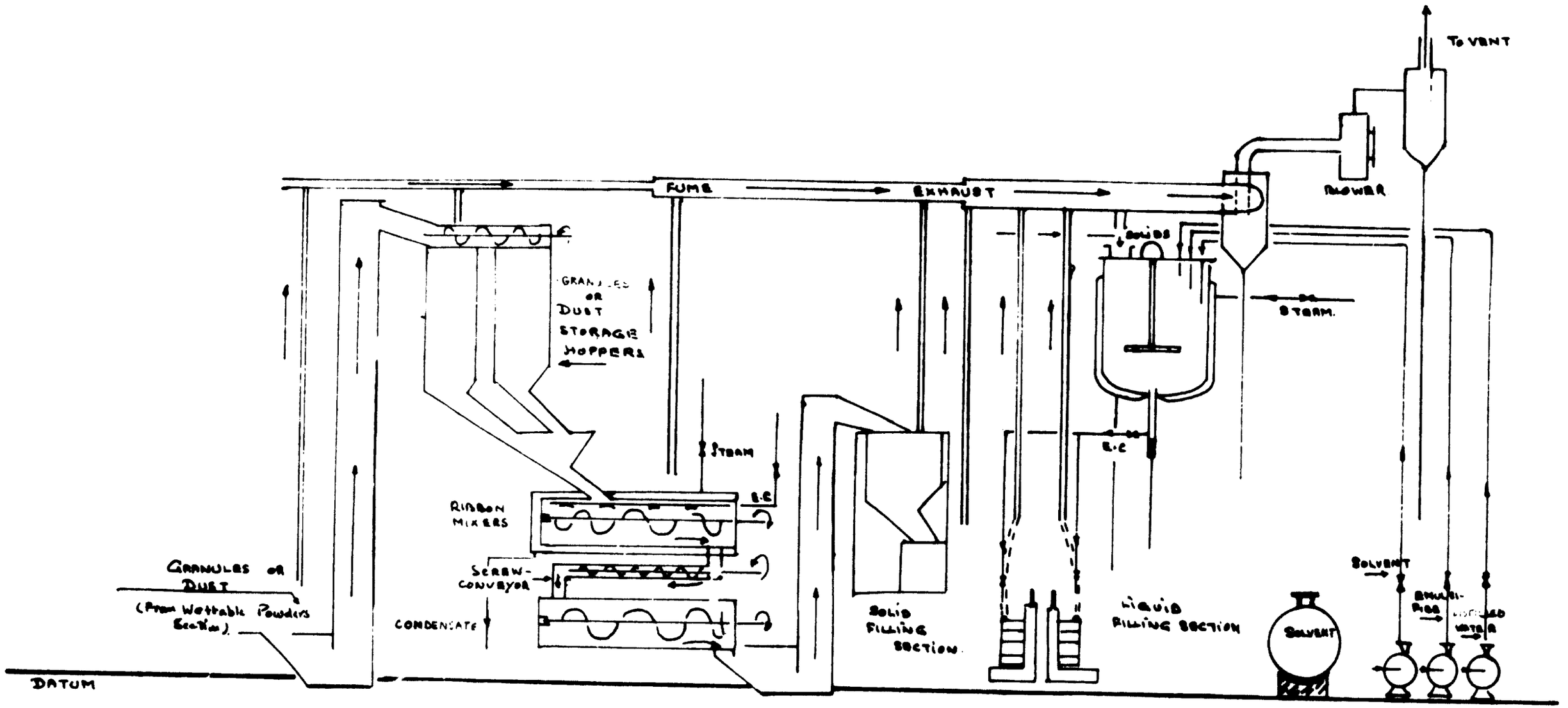
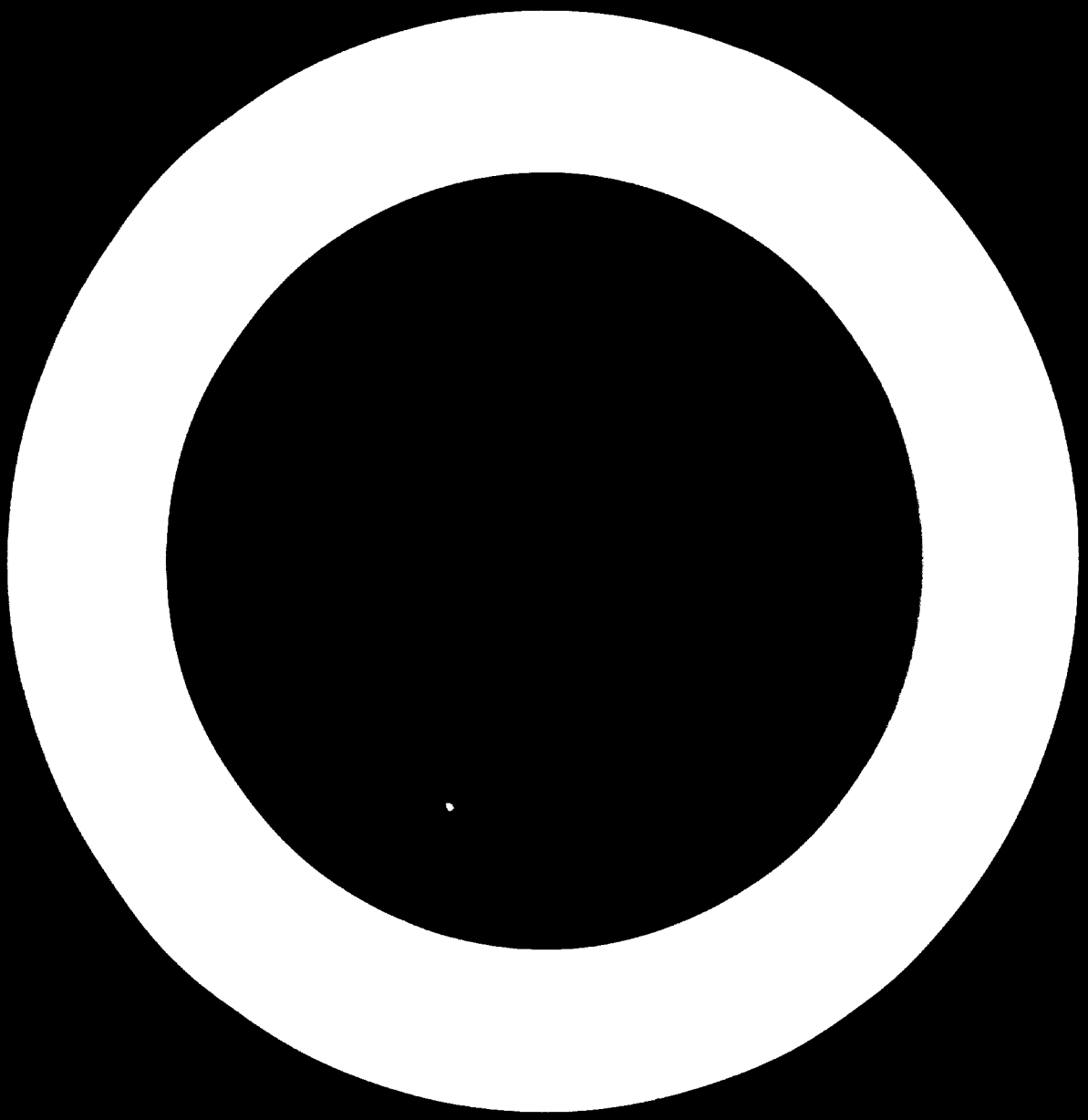


Figure V. Diagram of a plant to produce weed killers, both emulsifiable concentrates and wettable powders (2-5 tons/hour)



Size	-10, +100 mesh, free flowing D = 0.9 m; L = 6 m with: (a) Feeding device (b) Product cooler (c) Oil or gas burner (d) Flue gases offtake (e) Temperature required in the rotary drier = 100°C (f) Flight with right-angled tips (g) Feed guiding spiral flights (h) Speed: 6 rev/min (i) Driving motor (with variable-speed gear) 5 hp (= 3.73 kWh) (j) Drying rate (max.) 150 kg H_2O/h (from 5% to 0%)
Capacity	2-3 tons or less (required 1 ton/h)
Material	Plain carbon steel

4. Screw conveyor (horizontal) with variable-speed control

Number required	One
Type	Screw-type
Capacity	2 to 3 tons/h
Power required (with feed and discharge arrangements on both ends)	2 hp (= 1.5 kWh)

5. Bucket conveyor for materials (bulk-density 100 lb/ft^3)

Number required	One (for granules and dust)
Type	Centrifugal discharge, spaced buckets
Capacity	2 to 3 tons/h (or less), with variable-speed motor
Power (at head shaft)	2 hp (= 1.5 kWh) variable-speed motor
Height	8 m
Material (buckets)	Stainless steel

. Sieving or screening. The particle sizes between 10 and 100 mesh (that is, -8 +15, -16 +30, -20 +35, -20 +40 and -30 +60) are required for granular formulation. Genrally the size range -30 +60 is used.

Much smaller particle size is required for wettable powders and micronized dusts. Consequently, in addition to a -30 +60 screen, another screen to give particle size below 325 mesh (=μ 41) is also required. Although it may not be possible to have all of the above particle sizes separated in one operation, the machine should have at least the following set of screens, which are necessary for the present job, namely -30 +60, for granules, -200 +300 for dusts (and diluents) and finally -325 mesh for micronized sulphur etc. There are a number of screens, such as grizzly screens that require no power and little maintenance, but their use is limited to rough screening of dry materials of 2-in. size; they are not suitable for sticky materials. Screens of the revolving or trommel type are also meant for coarse screening - and there are mechanical screens, in which a to-and-fro motion is imparted to facilitate screening, but these are generally being replaced by mechanically vibrated screens.

Electrically vibrated screens are particularly useful in the chemical industry and can successfully handle the screening of 4- to 325-mesh particle size. Most of the screens operate at very high speeds (1,500 to 7,200 vibrations/min) supplied by an electromagnet.

One of such screens is Hum-Mur screen which is widely used in the chemical industry. Similar reciprocating screens find a wide application in the chemical industry, light metals and powdered foods, but they are not designed for handling heavy materials such as rock and gravel, so they may not be sufficiently durable for screening clays, limestones, talc and the like.

It is recommmended that electrically vibrated screens be used for the present job, as specified below:

Type	Electrically vibrated screen
Number required	One set
Capacity	(a) -30 +60 mesh, 2 to 3 tons/h
	(b) -200 +325 mesh, 2 to 3 tons/h
	(c) -325 mesh, 2 to 3 tons/h

7. <u>The Raymond ring-roll mill</u> (with classifier). While the function of a hammer mill is to provide material of particle size ranges between 10 and 100 mesh, the purpose of a ring-roll mill is to grind material below 325 mesh for the production of micronized powders (as with DDT and sulphur), and carriers as well as diluents for dust formulations.

Since the manufacturers of this mill have now made sulphur grinding possible by introducing inert gas and arrangements for the removal of excess heat, the use of a ring-roll mill with classifier that can pass 99.9% of the product through a 325 (44 μ) mesh is recommended for the present project.

Specifications

Type	Raymond No. 505/
	Ring-roll mill with classifier
	(limestone, clay and sulphur)
Capacity	2 to 3 tons/h
Power requirement	32.7 kWh/ton
	(= 82 kWh)

8. Bucket conveyors (3)
   1. One for granules
   2. One for dusts
   3. One for weed killers

Specifications

Number required	Three
Type	Centrifugal discharge, spaced buckets
Buckets	15 x 10 x 11.25 cm
Size	30 cm space
Height	10 to 12 m
Power requirement	2 hp for each of the 3 conveyors
Material (buckets)	Stainless steel

(Materials handled: attapulgite, bentonite, gypsum, kaolin, limestone, sulphur etc.)

9. Granules and dust storage bins. There will be six such bins: two for granules, two for dusts and powders and two for weed killers. Mass-flow bins are preferred to funnel-flow bins for the following reasons:

Mass-flow bins	Funnel-flow bins
1. Particles segregate but reunite on discharge	1. Particles segregate and remain segregated
2. Powders deaerate and do not flood when the system discharges	2. First portion is in the last out

3. Flow is uniform	3. Product can remain in a dead zone until a complete clean-out of the system
4. Density of flow is constant	4. Product tends to bridge or arch and this to rat-hole when discharging
5. Level indicators work reliably	5. Flow is erratic
6. No dead zones	6. Bins perform satisfactory with free-flowing materials
7. Bin can be designed to permit non-segregating storage	

The obvious choice is thus a mass-flow bin with the following specifications:

Number required	6 (2 each for granules and dusts, 2 for weed-killer section)
Capacity	10 tons each
Size	3 m x 1 m x 3 m
Discharge end	Star feeder
Material of construction	Mild steel

A continuous weighing and feeding device should be attached at the dicharge end to feed the ribbon-mixers at a rate of 1 to 2 tons/hour.

10. Types of solid-solid mixers. Some of the various types of solid-solid mixers used in industry are the following:

Tumblers with agglomerate breakers. These tumblers afford both mixing and size reduction. Examples are rod mills and pebble mills.

Stationary shell and trough. Here the container is stationary and the materials mixing is achieved by single or multiple inner rotating devices.

Ribbon mixers. In these mixers, the trough is satisfactory, while a rotor is fitted with helical mixing blades. The ribbon cross-section, its pitch, clearance between the trough and the ribbon blade and the breath of the blade are some features which determine the performance of these machines. They may be of the batch or continuous types, steam jacketed, and fitted with spraying devices. The application of such mixers covers a wide range, mainly from free-flowing to sticky materials requiring discharge aids.

Vertical-screw mixers. These machines are usually fitted in the conical section of tank or bin and are rotated to bring about mixing.

Muller mixers. These are of many types and are generally used in coarse mixing.

Twin-rotor mixers. In these machines, two shafts, fitted either with paddles or with screws, are encased in a trough. They may also be used for continuous mixing involving spraying and neat transfer.

Single-rotor mixers. These mixers have relatively high-speed rotors that not only bring about mixing but also size reduction or deagglomeration. They are also useful where small liquid injections are required.

Turbine mixers. These devices are suitable for free-flowing, semi-wet and liquid-solid mixing.

Selection of mixers. The steps of the process that involve spraying the inert carrier with either the slurry or the concentrated solution of the pesticidal chemical as a wetting agent, drying the moist product and finally breaking the agglomerates, will require the following combination of mixers:

For dusts and powders

A ribbon mixer, steam-jacketed and fitted with spray nozzles, in combination with a high-speed single-rotor (top speed, 6,000 to 9,000 rev/min);

For granules

One additional ribbon mixer as for granules.

. Specifications of a steam-jacketed/ribbon mixer. (for clay and sulphur, ulk density = 50 to 60 lb/ft^3)

Number required	Three (one for weed killer section)
Type	Continuous (ribbon mixer with spray nozzles
Material	Stainless steel 304
Working capacity	50 ft^3
Power requirement	10 to 20 hp, with variable-speed drives on all shafts (about 10 hp/ton)

Steam requirements

(a) Heat required to heat one ton of clay from 25°C to 115°C

$$= M \times \text{Sp. heat} \times t_2 - t_1$$

$$= \frac{1{,}000 \times 10^3 \times 0.224 \times 90}{252}$$

$$= 88 \times 10^3 \text{ Btu}$$

Steam requirements for one ton of clay at 25 lb/p.s.i.g. $= \frac{88 \times 10^3}{1,188} = 74.5$ lb

$= 33.6$ kg

Steam requirements for 5 tons $= 168$ kg

(b) Single high-speed rotary mixer

Number required	Two (one for weed-killer section
Type	Continuous (stainless steel 304)
Capacity	$= 50$ ft^2 ($\equiv$ 1 ton/h)
Power requirement	10 hp (with variable-speed drive)

(c) Weed killers (EC and WP)

Mixing vessel

Number required	One
Type	Steam jacketed
Size	D = 1 m; H = 1.5 m
Material	Stainless steel 304

Other features are same as those for the EC mixing vessel

12. Continuous bucket elevator

Same as in 5. Bucket conveyor for materials

13. Solid filling and packaging unit

Number required	One
Type	Mass-flow hoppers for free-flowing products, used with simultaneous filling and weighing scales (automatic)
Capacity	10 tons per 8-hour shift
Material	Plain carbon steel, or other suitable for insecticide formulations

14. Pesticidal chemicals mixing vessel and feed tanks

(a) Mixing vessel

Number required	One
Type	Steam jacketed
Capacity	2.14 m^3
	D = 1.25 m; H = 1.75 m

Turbo-agitator	with variable-speed drive
Power requirement	3 to 5 hp
Material	Stainless steel 304
Pump	Gear-type 50 to 60 lb/in^2

(b) Wetting agent feed tanks — D = 0.5 m; H = 1 m
Pump — 0.5 hp, H = 10 m

(c) Toxicant (liquid) feed tank — D = 1 m; H = 1.5 m
Pump — 1 hp, H = 10 m

(d) Horizontal solvent feed tank — D = 1.5 m; H = 3 m
Pump — 1 hp, H = 10 m

Cost of machinery and equipment

Unit operation or equipment	Libyan dinars (approx.)
Blake crusher	3,000
Hammer mill	1,500
Rotary drier	15,000
Screw conveyor	1,500
Sieving/screening unit	3,500
Raymond ring-roll mill with classifier (for clay, limestone and sulphur)	25,000
Bucket conveyor (3) (one for weed killers)	5,000
Bins (3) for powders, dusts and granules (one for weed killer section, with weight hopper)	5,000
(a) Ribbon mixers (3), stainless steel, steam jacketed (one for weed killer section)	10,000
(b) High-speed rotary mixer (2), stainless steel (one for weed killer section)	7,500
Mixing vessel, stainless steel	1,500
Packaging materials etc.	10,000
Piping, ducts etc.	8,000
Instruments	3,000
Electrical system	5,000
Exhaust system	5,000
Safety equipment	2,000
Unforeseen	14,500
Total	125,000

Annual production cost

	Libyan dinars
1. Raw materials	
1.1 Diptetrex-80	
Dipterex (tech.) 62.4 tons at LD 929/ton	57,969
Diatomite 14.05 tons at LD 26/ton	365
Wetting agent (sorbitan monostearate) 1.56 tons at LD 509/ton	794
	59,128
1.2 Sevin (tech.) 39.5 tons at LD 731/ton	28,800
Diatomite etc., 37.7 tons at LD 26/ton	980
Wetting agent 1.58 tons at LD 509/ton	803
	30,583
1.3 Aldrin-40	
Aldrin (tech.) 30 tons at LD 908/ton	27,200
Diatomite etc. 43.5 tons at LD 26/ton	1,110
Wetting agent 1.52 tons at LD 509/ton	774
	29,084
1.4 DDT 75 (WHO)	
DDT (tech.) 20.2 tons at LD 237/ton	4,780
Diatomite etc. 6.20 tons at LD 26/ton	161
Wetting agent 1.08 tons at LD 232/ton	250
	5,191
1.5 Zineb-80 and maneb	
Zineb (tech.) 244.8 tons at LD 600/ton	134,880
Diatomite etc. 50.5 tons at LD 26/ton	1,326
Wetting agent 5.62 tons at LD 509/ton	2,860
	139,066

1.6 Sulphur-80

Sulphur (tech.) 32.8 tons at LD 21/ton	690
Diatomite etc. 7.38 tons at LD 26/ton	192
Wetting agent 0.82 tons at LD 232/ton	191
	1,073

1.7 Bromophos-25

Bromophos (tech.) 15 tons at LD 1,060/ton	15,880
Diatomite etc. 43.8 tons at LD 26/ton	1,136
Wetting agent 1.2 tons at LD 232/ton	278
	17,294

1.8 Anthraquinone-80 (bird-repellant)

Anthraquinone (tech.) 32 tons at LD 800/ton	25,600
Diatomite etc. 7.2 tons at LD 26/ton	188
Wetting agent 0.80 tons at LD 509/ton	407
	26,195

1.9 Weed killers
Linuron, Simazine-80, Atrazine-60 and -50

Linuron (tech.) 27.8 tons at LD 800/ton	22,240
Diatomite 23.5 tons at LD 26/ton	612
Wetting agent 1 ton at LD 232/ton	232
	23,084

1.10 Solvents (miscellaneous)

Xylene (tech.) 20 tons at LD 90/ton	1,800
Benzene (tech.) 10 tons at LD 110/ton	1,100

Cyclohexane 3 tons at LD 300/ton		900
		3,800
1.11 Packaging materials (for 700 tons/year)		
55-gallon steel drums, removable head, 16-gauge plate (bulk density of this material is 60 lb/ft^3)		
750 at c.i.f. LD 3.44 drum		2,580
Sewn-valve bags with polyethylene internal sleeves, kraft paper, 12,000 bags		880
		3,460
	Subtotal	337,723

2. Energy, fuel and water

2.1 Electric power 123,000 kW/year LD 7.6/1,000 kW = LD 935		1,000
2.2 Water 20,000 m^3/year (estimate) at LD 20/1,000 m^3		400
2.3 Steam (low pressure)		
(10 p.s.i.g.) 234 tons at LD 1.2/ton		280
	Subtotal	1,680

3. Labour and administrative costs

3.1 (A) Factory

Personnel	Number required	Monthly wage (LD)	Yearly wage including social change (LD)	Total (LD)
Unskilled	4	70	950 x 4	3,800
Skilled	4	100	1,350 x 4	5,400
Highly skilled	1	120	1,600 x 1	1,600
Engineer	1	150	2,000 x 1	2,000
Manager	1	200	2,650 x 1	2,650
(Same staff will run weed-killer plant)				15,450

3.1 (B) Commercial department

Helpers	1	70	950 x 1	950
Drivers	3	100	1,300 x 3	3,900

Auto mechanic	1	120	1,600 x 1	1,600
Foreman	1	120	1,600 x 1	1,600
				3,000
3.1-(C) Administration				
Clerks	2	120	1,600 x 2	3,200
Typist	2	120	1,600 x 2	3,200
Helpers	2	70	950 x 2	1,900
				8,300
3.2 Contingencies (10% of 3.1)				3,275
3.3 Foreign specialists (2) at LD 500/month, for 6 months				6,000
			Subtotal	42,025
4. Depreciation				
4.1 Depreciation of building (4% of the cost a year)				513
4.2 Depreciation of machinery and equipment (10% of the cost a year)				18,090
4.3 Depreciation of transport vehicles (20% of the cost a year)				1,140
4.4 Depreciation of office furniture (20% of the cost a year)				1,400
4.5 Amortization of preliminary and promotional expenses (20% of 4.1 to 4.4)				4,230
			Subtotal	25,373
5. Direct and general expenses				
5.1 Maintenance expenses (4% of 2-5 of Capital expenditure)				7,949
5.2 Miscellaneous supplies (raw materials and energy)				5,000
5.3 Sales and marketing expenses (10% of 1-4 of Production costs) Take 5% only				20,352

5.4 Research, development and training (5% of 1-4 of Production costs)		20,352
5.5 Contingencies (Insurance, transport and others) (5% of 1-4 of Production costs)		20,352
5.6 Royalty (2% of sales)		10,500
5.7 Contingencies (10% of Working capital - annex VIII, 7.1)		11,993
	Subtotal	96,498
Total cost of production (Total of annex VIII, A, 1 to 7)		503,299
Sales price at 5% profit		528,711
Processing cost per ton	$\frac{165,576}{730} = 226$	

IV. AEROSOLS

Fundamental concepts[4]

An aerosol may be defined as a liquid or solid suspended in air or other gas. Such a suspension may be brought about in a number of ways. For example, if a spray pump blows the air at the tip of a capillary tube dipped in a solution or suspension of insecticides etc., it will send a stream of fine droplets of the liquid (and solids) into the air. At present, in place of compressed air, liquids, or rather liquefied gases, are now used to push the product out of the container in form of a fine spray. The liquefied gas used for this purpose is called a propellant.

The properties of a propellant are that it should have a vapour pressure in the range of 15 to 100 p.s.i.g. at $70^{\circ}F$; a low order of toxicity; be chemically inert, non-inflammable and free from colour and odour; have a good solvent power; and be available at a practical cost. Some of the halogenated products of methane series CCl_2F_2 (Freon 12) and many others have most of these properties.

The liquid container is in fact a vessel capable of withstanding internal pressure up to 100 p.s.i.g. (bursting pressure is 125 p.s.i.g.), with a special release valve at the top, connected with a plastic tube extending to the side of the bottom.

With reference to pesticidal sprays, the liquid within the container would be a mixture of pesticidal chemicals, a synergizer, a base oil, a co-solvent, propellents and a perfume to mask the odour of the total formulation.

The process

Although the details of the process could not be obtained, the principal unit operations involved may be summarized as follows:

Mixing vessel:

For mixing the pesticidal chemicals, synergizer, base oil, solvent and the propellents at $-21^{\circ}F$.

Filling unit

4/ H.R. Shepherd, Aerosols: Science and Technology (New York, John Wiley and Sons, 1960).

Sealing (the spray valves)

Packaging

A cost breakdown for a suitable plant for producing aerosols is presented in annex IX

Cost of machinery and equipment

Owing to the lack of recent information on the costs of machinery and equipment when this was written, only tentative estimates (maximum and minimum) of the probable cost of an aerosol plant with a capacity of [illegible] tons/8-hour shift are presented (table 9). The minimum figure (LD 100,000) has been used in the determination of production costs.

Table 9. Estimated cost of establishing a suitable aerosol insecticide plant
(Libyan dinars)

Items	Minimum	Maximum
Mixing unit	15 000	20 000
Injection or filling unit	15 000	20 000
Refrigeration unit	25 000	30 000
Pumps, motors etc.	5 000	10 000
Piping, ducts etc.	5 000	10 000
Insulation	10 000	15 000
Electricity lighting	10 000	15 000
Exhaust system	5 000	5 000
Unforeseen	10 000	20 000
Total	100 000	145 000

Cost of production of Pif-Paf aerosol

A number of aerosol insecticides are imported into Libya under various trade names. A typical one is Pif-Paf, which is manufactured by Cooper in the United Kingdom; it is used here as a basis for calculating production costs. This aerosol has a c.i.f. value of £22.80 (= LD 15.50) for a 72-unit package.

Its composition (per cent) is as follows:

Bioallethrin	0.2
Bioresmethrin	0.02
Piperonyl butoxide	0.4
Base oil + aromatic hydrocarbons	15.38
Propellants (Freons 11 and 12)	84.00
	100.00

The net weight of the container is 312 g. Each aerosol (container plus contents) weighs 16 oz (454 g).

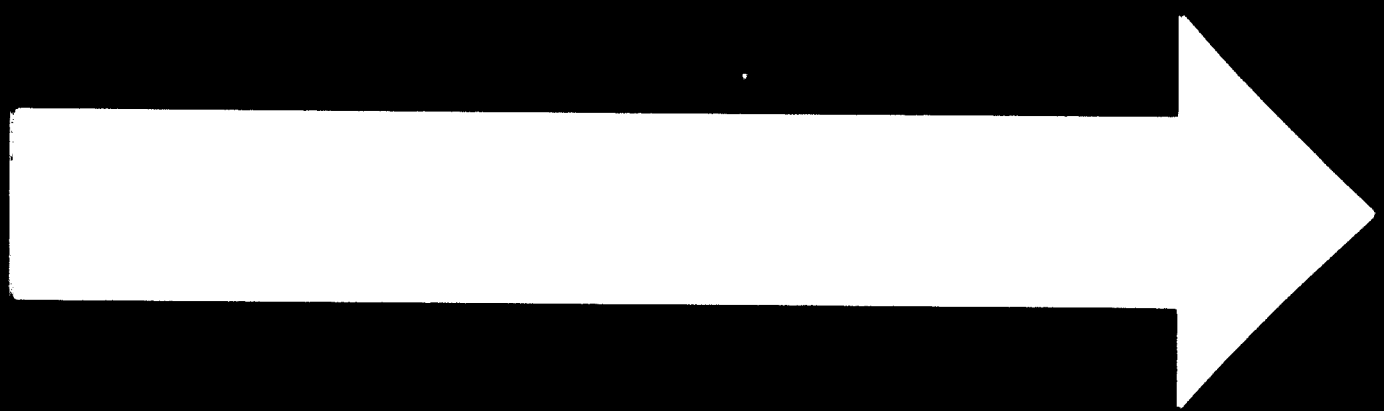
The cost of the contents of such an aerosol may be calculated in piasters (100 piasters = LD 1) as follows:

Cost (c.i.f.) per aerosol		21
Less cost of container		-7
Processing cost (15%)	$\frac{21 \times 15}{100}$	3.15
Freight per aerosol	$\frac{1,500 \times .5}{1,000}$	0.75

Thus, the cost of the contents of one aerosol is 14 piasters. On the basis of these data, the cost of the raw materials of one aerosol may be distributed over the formulation as shown below.

Items	Weight grams	Cost (piasters)
Bioallethrin at LD 37.70/kg	0.624	2.3500
Bioresmethrin at LD 52/kg	0.0624	0.3250
Piperonyl butoxide at LD 7/kg	1.248	0.7736
Solvents etc. at LD 90/ton	47.970	0.4320
Propellants (Freons 11 and 12)	261.996	10.0082
Total	311.9004	13.9888

= 312 g = 14 piasters



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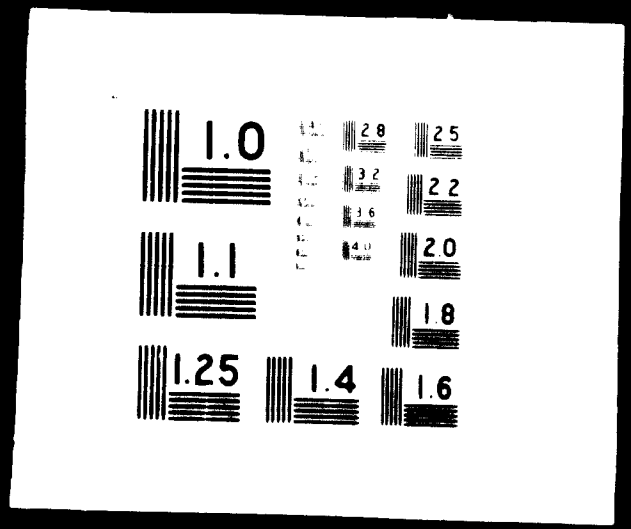

Annual production cost 5/

		Libyan dinars
1. Raw materials		
1.1	(See working capital for 3 months) Raw materials for 1 year	695,520
1.2	Packaging materials (16-oz containers) 5,200,000 at LD 25/1,000	130,000
1.3	Empty 1-ton cylinders for Freons 11 and 12 250 at LD 200/cylinder	50,000
	Subtotal	875,520
2. Energy, water and steam		
2.1	400,000 kWh/year at LD 7.5/1,000 kWh	3,000
2.2	Water 10,000 m^3/year at LD 20/1,000 m^3	200
2.3	Steam (10 p.s.i.g.) 500 tons at LD 1.2/ton (or compressed air)	600
	Subtotal	3,800
3. Management, laboratory and labour		
3.1	Factory, stores, laboratories etc.	27,156
3.2	Contingencies (10% of 3.1)	2,715
3.3	Foreign specialist at LD 500/per month	6,000
	Subtotal	35,871

5/ For fuller details see annex IX.

4. Depreciation and amortization (see annex IX)

4.1	Depreciation of building and construction (4% of the cost a year)	240
4.2	Depreciation of machinery and equipment (10% of the cost a year)	15,530
4.3	Depreciation of transport and vehicles (20% of the cost a year)	2,340
4.4	Depreciation of furniture and equipment (10% of the cost a year)	500
4.5	Amortization of preliminary and promotional expenses (20% of 4.1 to 4.4)	3,720
	Subtotal	22,330

5. Direct and general expenses

5.1	Maintenance expenses (4% of items 2 to 5 of Capital expenditure - annex IX)	17,000
5.2	Supplies (10% of 1. Raw materials plus 2. Energy, water and steam = LD 87,350 (Take LD 20,000)	20,000
5.3	Sales and marketing expenses (10% of 1 to 4 of Production cost) = 93,700 (Take LD 40,000)	40,000
5.4	Research, development and training (5% of 1 to 4 of Production cost)	20,000
5.5	Contingencies (insurance, transport and other) (5% of 1 to 4 of Production cost)	20,000
5.6	Royalty (2% on the total sales value)	22,000
5.7	Charges on working capital (10% of Working capital - annex IX, 7)	30,300
	Subtotal	169,300

Total cost of production (1 to 5)	1,106,050
Cost of production/ton	$\frac{1,106,050}{1,500} = 735$
Processing cost/ton	$\frac{230,530}{1,500} = 154$

c.i.f = LD 690/ton (= 3,205 aerosols)

V. LOCATION

Factors to be considered

A plant is said to be ideally located where it can give the highest return on the total investment. Factors that can help to determine an optimal plant location may be elaborated as follows.

Utilities. The basic requirements of any plant are water, electric power and steam. A plant located on a riverside will have both a water supply and a place for the disposal of chemically treated effluents. Plants situated on the sea need desalination units, which would no doubt add to the capital investment but this disadvantage would be offset in countries where fuel is available at low cost.

Electrical power is required to the plant, while steam is needed for power generation and for heat and mass-transfer operations in the process industries. The proposed site must therefore have all of these facilities.

Fuel. Fuel is required to produce the steam to run the turbine for power generation. Cheap fuel adds to the over-all economy of the process and lowers the costs of production and of transportation to local and foreign markets.

Raw materials. Ideally, a plant should be located near the source of its raw materials. For example, a cement plant is always located in the vicinity of a limestone quarry, a petrochemical complex near an oil refinery, a sugar plant in an area where sugar-cane is grown and a textile factory where the figres used are plentifully available.

Geographical features. The land selected should be available at reasonably low cost. Furthermore, it should be nearly level, and its load-bearing capacity in excess of 400 kg/m^2. It should be accessible to road, railway or water-borne carriers for the transport of both the raw materials and the finished goods.

Transportation. The means of transportation, public and/or private, for personnel, materials and products to and from the plant should be adequate.

Market. It is desirable that the site be near the market or the places where the finished goods are to be disposed of.

Legislation. Local laws concerning real estate, sanitary and safety codes, including the disposal of chemically treated effluents, may either exclude certain categories of plants or make the existing ones uneconomic to operate. Local taxes should be eased to attract industry.

Sources of information. The site should, as far as possible, be close to a place that could serve as a source of information on labour laws, power rates, research laboratories, new industrial sites and areas and future trends in the pesticide industry.

Appraisal of the Az-Zawia site

At Az-Zawia, most of the above requirements are met. The refinery there has surpluses of treated water, power and steam. Although no formal approach has thus far been made, the refinery direction would be willing to supply the requirements of the proposed pesticide complex if and when it were located near the refinery.

With the exception of heavy gas and fuel oils and clays, all of the other raw materials used in the manufacture of pesticide formulations are imported, unloaded at Tripoli harbour and transported over a distance of 40 km to Az-Zawia. This factor is not very favourable to the site, but since fuel is cheap and since the complex will use its own trucks and carriers for both the raw materials and the products, the over-all transportation expenditure would be greatly reduced.

In short, Az-Zawia has been developed to such an extent that it meets almost all of the prerequisites of a good plant location, namely almost level land, location near the national highway and a fast-spreading network of roads, favourable local laws and taxes and good means of transport for men and materials to and from the factory. Thus, in the light of the foregoing discussion, the best site for the proposed pesticides formulation complex would be in the vicinity of Az-Zawia Refinery.

Annex I

JOB DESCRIPTION

DP/LIB/69/512/11-09/E/03(05)

Post title: Pesticide Manufacturing Expert

Duration: Three months with possibility of extension

Date required: Two months after arrival of Pesticide Market Analysis Expert in Libya

Duty station: Tripoli, with travel within the country

Purpose of project: To provide expert assistance to the Government of Libya in the preparation of firm pre-investment design of manufacturing facilities for pesticides in Libya, preparation of estimated investment costs and profitability of the venture, and preparation of tenders for the construction of the facilities required.

Duties: In co-operation with the Industrial Research Centre, the Ministries of Agriculture and of Planning, and the National Oil Corporation, along with other interested organizations, the expert will be expected to:

1. Review all projected market requirements (domestic and export), which have been developed by a UNIDO expert working with the same organizations, and establish design capacities for a mineral oil refining plant (for ultimate mineral white oil production), and a plant or plants for the manufacture of pesticide formulations in the form of solutions, emulsifiable concentrates, wettable powders and dusts;
2. Review previously prepared pre-feasibility studies for adjusting capacities as necessary based on above, and modifying processing schemes as necessary to provide Libya with the least expensive plant(s) for pesticide manufacture;
3. Finalize specifications for a refinery stream required as a feedstock to the mineral oil treating plant, and establish with the National Oil Corporation means and costs for alterations if required;
4. Review projected investment costs of manufacture, and over-all profitabilities of the proposed plant or plants;
5. Prepare tender specifications for the construction of the facilities required.

Qualifications: Chemical engineer with extensive experience both in pesticide and petroleum manufacturing operations.

Language: English

Background: In a pre-feasibility study on the manufacture of pesticides in the Libyan Arab Republic it has been indicated that production of refined mineral oil(s) and formulation of several pesticides appear to be a very profitable operation both financially and as a support to Libya's growing agriculture. The pre-feasibility report included a number of assumptions on both domestic and export markets. Libya is planning to carry out the market analysis studies necessary to establish firm estimates of present and future demands for these products. Aside from the market volume, which will determine plant size(s), other assumptions dealing with certain process details, certain raw material prices, and freight rates also require confirmation.

Annex I

PRESENT AND PREDICTED REQUIREMENTS OF PESTICIDAL CHEMICALS IN THE LIBYAN ARAB REPUBLIC

Common name	Pesticidal chemical[a/]	Imports (tons) 1973 EC	Imports (tons) 1973 Active component	Forecast use (tons) 1975 EC	Forecast use (tons) 1975 Active component	Forecast use (tons) 1980 EC	Forecast use (tons) 1980 Active component	Forecast use (tons) 1985 EC	Forecast use (tons) 1985 Active component
Emulsifiable concentrates									
Crops									
White oil-80	Refined mineral oil (free of S and aromatics)	315.08	252.86	500	400	1,000	800	900	720
Dimethoate-40	$C_5H_{12}O_3NPS$; solid; m.p. 51°C; sp. gr. 1.35; soluble in all organic solvents	122.124	48.8	170	68	436	17.44	464.0	185.6
Tedion-8 (tetradifon)	$C_{12}H_6Cl_4O_2$; Mol. wt 356.1, solid m.p. 144°C	98.856	8.00	129	10.32	267	21.23	299	23.9
Malathion-50	$C_{10}H_{19}O_6PS_2$, sp. gr. 1.2315 at 25°C; m.p. 2.85°C; miscible in all organic solvents, less so in petrol	52.02	26.01	84	42	207	103.5	227	113.5
Kelthane-18.5	$C_{14}H_9Cl_5O$; m.p. 78.5-79.5°C, Sp.gr. 1.45 at 25°C, soluble in all organic compounds	12	2.22	129	23.8	267	49.4	299	55.3
		285	85	512	144.12	1,177	191.57	1,289	378.3
Weed killers									
2,4-D 25% ester	$C_8H_6Cl_2O_3$; mol. wt 263.1; liquid	150	37.5	91	22.77	121	30.22	122	30.5
2,4-DB 30% ester	$C_{10}H_{10}ClO_3$; mol. wt 249; sp.gr.-; m.p., 117-119°C	-	-	87	26.1	412	123.	432	29.6
		150	37.5	178	48.87	533	153.22	554	60.1
Livestock									
Lindane	$C_6H_6Cl_6$	33.[illegible]88	[illegible]	8[illegible]	[illegible]	[illegible]	[illegible]	[illegible]4	34.8
		33.[illegible]88	[illegible]	[illegible]	[illegible]		[illegible]	-	34.8

Table (continued)

Common name	Pesticidal chemical[a/]	Imports (tons) 1973 EC	Imports (tons) 1973 Active component	Forecast use (tons) 1975 EC	Forecast use (tons) 1975 Active component	1980 EC	1980 Active component	1985 EC	1985 Active component
Insecticides (continued)									
Sevin-50	$C_{12}H_{11}O_2N$; 201.2; solid m.p. 142°C; sp.gr. 1.232; b.p. decomp.	-	-	79	39.5	184	92	203	10 .5
Aldrin-40	$C_{12}H_8Cl_6$, solid; m.p. 130-150°C; soluble in acetone, xylene and benzene	2.8	1.12	75	30	78	31.2	93	37.2
		92.8	73.12	232	131.9	444	268.8	497	299.5
Fungicides									
Zineb-80	$C_4H_6N_2S_4Zn$, white solid; m.p. decomp.	189	152	141	112.8	160	128	196	156.8
Sulphur-80	m.p. 116°C	147	117.6	41	32.8	58	46.4	60	48
Quinolate-V4X		3	?	45	?	60	?	60	?
Maneb-80	$C_4H_6Mn\ N_2S_4$, yellow crystalline solid; sp.gr. 1.92; m.p. decomp.	19	15.2	140	112	158	126.4	194	155.2
Copper oxychloride (50% Cu)		48	24	6	3	15	7.5	16	8
		406	308.8	373	259.8	451	308.3	526	468.0
Weed killers									
Atrazine-80	Atrazine and simazine are chlorotriazines and high m.p. solids.	-	-	7	3.5	-	-	-	
Linuron-50	$C_4H_{10}Cl_2O_2$; white solid; m.p. 93.94°C	-	-	31	15.5	32	16	38	19
Simazine-80	$C_7H_{12}ClN_5$, Colourless solid; m.p. 225-227°C	-	-	11	8.8	23	18.4	24	19.2
		35	28.0	49	27.8	55	34.4	62	38.2

Table (continued)

Common name	Pesticidal chemical[a/]	Imports (tons) 1973 EC	Imports (tons) 1973 Active component	Forecast use (tons) 1975 EC	1975 Active component	1980 EC	1980 Active component	1985 EC	1985 Active component
Public health									
Bromophos-40	$C_8H_8O_3Cl_2BrPS$ crystals, m.p. 54, soluble in aromatic hydrocarbons	56	22.4	60	24	110	44	4	2
Lindane-20	$C_6H_6Cl_6$; mol. wt 290.8; solid	30	6	35	7	60	12	60	12
Lindane-50	$C_6H_6Cl_6$; mol. wt 290.8; solid	10	5	12	6	20	10	20	10
Pyrethrum (EC)	-	10	-	12	-	20	-	20	-
Aerosols	-	16	-	17	-	26	-	26	-
Malathion-50	-	2	1	2	1	4	2	4	2
Miscellaneous	-	285.611	-	505.19	-	115.4	-	1 226.22	-
		404.611	-	643.19	-	1 394.08	-	1 361.22	-
Household or limited insecticides	Bioallethrin, 0.015%; bioresmethrin, 0.02%; piperonyl butoxide, 0.08%; deodorized kerosene or any other solvent w/v to 100	1 450	Bioalleth-rin: 21; bioresme-thrin: 29; piperonyl butoxide, 87 - [illegible] kg	1 629	Bioalleth-rin, 21; bioresme-thrin, 29; piperonyl butoxide, 87 - 154.74 kg	2 078	Bioalleth-rin, 21; bioresme-thrin, 29; piperonyl butoxide, 87 - 197.35 kg	2 653	Bioalleth-rin, 21; bioresme-thrin, 29; piperonyl butoxide, 87 - 228.04 kg
		1 450	317 kg	1 629	154.74 kg		197.35 kg	2 653	228.04 kg
Wettable powders									
Crops									
Insecticides									
Dipterex-80 (Trichlorfon)	$C_4H_8Cl_3O_4P$; solid; m.p. 83.84; soluble in water, chloroform, ether and benzene	90	72	78	62.4	182	145.6	201	160.8

Table (continued)

Common name	Pesticidal chemical[a/]	Imports (tons) 1973 EC	Imports (tons) 1973 Active component	Forecast use (tons) 1975 EC	Forecast use (tons) 1975 Active component	Forecast use (tons) 1980 EC	Forecast use (tons) 1980 Active component	Forecast use (tons) 1985 EC	Forecast use (tons) 1985 Active component
Livestock	nil								
Public health									
Bromophos-25	$C_8H_8O_3Cl_2BrPS$; mol. wt 3.6, m.p. 59°C	30	7.5	60	15	102	25.5	102	25.5
DDT-75 (WHO)	$C_{14}H_9Cl_5$; m.p. 108.5; soluble in chlorinated solvents and xylene	18	13.50	27	20.2	50	37.5	50	37.5
Malathion-57 WDP (WHO)	-	2	1.14	5	2.85	8	4.56	8	4.56
		50	22.14	92	38.05	160	67.56	160	67.56
Household	nil								
Miscellaneous									
Anthraquinone-80 WP (bird repellent)	$C_{14}H_8O_2$; mol. wt 208.2	38	30.4	40	32	60	48	60	48
Metaldehyde-2.5% granules (snail bait)	Colourless crystals, sublimes at 110-120°C	10	0.250	55	2.7	70	3.5	70	3.5
Warfarin-0.05% (rodent bait)	$C_{19}H_{16}O_4$; Colourless; m.p. 154-161°C	10.50	0.0525	15	0.075	30	0.15	30	0.15
		48.5 (or 58.5)	30.45	110	34.775	160	51.65	160	51.65
Aerosols	Bioallethrin, 0.2%; bioresmethrin, 0.02%; piperonyl butoxide, 0.4%; solvents; propellants 11/12	1 600		1 955		3 932		5 019	

a/ Symbols: b.p. - boiling point; m.p. - melting point; mol. wt. - molecular weight; sp.gr. - specific gravity; w/v - weight by volume.

Annex III

FAO SPECIFICATIONS FOR SPRAY OIL

Pesticidal petroleum oil products for summer use (stock emulsion type)

Product specification

The following specification, dated 4/1.7[illegible], is laid down in the FAO Working Party on the Official Control of Pesticides, Section 3 (Specifications).[a/] It covers polyphase petroleum oil products for summer use, and excludes those that contain additional pesticides. BP Oleopron is an existing product that falls within this specification.

Active ingredient

The active ingredient shall be mineral oil. Minimum oil content: 60% v/v when determined by the method in CIPAC I,563.

Properties of the mineral oil

Unsulphonated residue. This is determined by CIPAC I, MT57 on the separated oil. A minimum of 92% v/v shall remain unsulphonated.

Distillation range. ASTM D1160 is the method used, but a gas-liquid chromatography method is under consideration; the former is a vacuum-distillation method, and the temperatures quoted below have been corrected to 760-mm pressure:

(a) Fractional distillation up to 320°C (608°F) maximum 10% by volume;

(b) Fractional distillation between 360°C and 410°C (680°F and 770°F) minimum 50% by volume;

(c) Fractional distillation up to 430°C (806°F) minimum 90% by volume.

Viscosity at 37.78°C (100°F). Determining methods are IP 71 and ASTM D445:

Minimum 10 cS	58 SSU
Maximum 13 cS	89.2 SSU

Relative density. This is determined at 15.5°C (60°F) in accordance with CIPAC I, MT 3.2:

Minimum 0.83

Maximum 0.88

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a/ (Rome, FAO, 1971).

Pour point. IP 15/67 and ASTM D97 are the methods employed.

Maximum 5°C (23°F)

Impurities

The specification refers only to phenols; methods of determination are under consideration.

Maximum -0.2% w/w

Physical properties

Stability of the undiluted product. (See CIPAC I, MT54 for method.) After storage at -5 ± 1°C (23 ± 2°F) for 48 hours, the product must show no obvious separation of the oil. After storage as above, followed by dilution by the manufacturer's recommended method and further standing for 2 hours at room temperature, the product must not show more than slight traces of oil separation.

Stability of the diluted product. Methods are under consideration. After dilution by the manufacturer's recommended method, and after standing for 2 hours at room temperature, the product must not show more than slight traces of oil separation.

Biological properties

Phytotoxicity. No test is yet specified to cover the phytotoxicity to crops. When a particular crop is not mentioned in the usage instructions of an individual formulation, purchasers are recommended to check the suitability with the supplier, always provided that such use is not restricted or forbidden.

Containers

Where necessary, these shall be lined, or their interior surfaces treated, so as to prevent corrosion of the container and/or deterioration of the contents. Containers shall comply with relevant national and international transport and safety regulations.

Annex IV

REQUISITES FOR A PHYSICO-CHEMICAL PROGRAM

A. Machines and equipment

I. White oil

Chemical Construction Corporation, New York, United States

Power Gas Corporation, London, England

Chemical and Thermal Engineering Ltd, Wilmslow, Cheshire, England

Reconstruction Developments Ltd, Manchester, England

II. Emulsifiable concentrates and wettable powders

Chemical and Thermal Engineering Ltd, Wilmslow, Cheshire, England

Montecatini Chemical Corporation of California, Union, N. J., United States

III. Aerosols

Aerosol Ltd, Switzerland

Adams Powell Equipment Ltd, Gateshead, England

Aerosol Machinery Co., Westbury, N. Y., United States

A. B. Aerosol Packing Company, Vallentuna, Sweden

B. Chemicals for emulsifiable concentrates

Chemicals	C.i.f. value (US$/ton) a/	Sources
Triton x-100 (Emulsifier for white oil)	5[illegible]	Rohm and Haas S.P.A. Milan, Italy
Zineb or maneb	1,275	Rohm and Haas S.P.A. Milan, Italy
AH-863	509	Rohm and Haas S.P.A. Milan, Italy (Also Montedison S.P.A. Milan, Italy)
Dimethoate (tech.)	1,280	Sariaf, Rome, Italy

[illegible]	C.i.f. value (LD/ton) a/	Sources
[illegible] (Tensio [illegible]) S-3 D-3	570	Savia?, Rome, Italy (Also Tensia S.a, Liege, Belgium)
Formulation (tech.)	3,275	
Emulsifier (Atlas)	600	Atlas-ICI, United States
Malathion 95% (tech.)	751	Cheminova, Lemvig, Denmark
Emulsifiers		
HOE-S 1955/Emulgen El.		Hoechst, Federal Republic of Germany
Atlox 855, 1955		Atlas Chemie, Joseph Stanley
Tween H 130 S		
Lebaycid (tech.)	1,275	Rohm and Haas, S.P.A. Milan, Italy
Emulsifier, AH-803	509	Rohm and Haas, S.P.A. Milan, Italy
Lindane (tech.)	1,350	Celamerk
Emulsifier (sorbitan monostearate)	232	
Liquid insecticides		
Bioallethrin	37,805	Cooper, England; Enna, Netherlands
		Enna, Netherlands
Bioresmethrin	52,215	Cooper, England
		Enna, Netherlands
Piperonyl butoxide	7,000	Cooper, England
		Enna, Netherlands
Kerosene oil (local)	17.64	BPMC, Tripoli, Libya
Weed killers	300	
2,4-D (tech.)		
Emulsifier		
2,4-DB (tech.)	259	
Emulsifier		

C. Chemicals for wettable powders

Formulation or Composition	C.i.f. value (LE/Ton) a/	Sources
Dipterex -30		
Dipterex	940	Bayer, Federal Republic of Germany
Wetting agent	42	Lobel Chemical Corp., New York, N.Y. United States
Filler: diatomite, kaolin	26	
Sevin-50		
Sevin	731	Air Products and Chemicals,
Emulsifier	509	Wayne, Pa.,
Filler	26	United States
Aldrin-40		
Aldrin	900	Sariaf, Faenze, Italy
Wetting agents	509	
Filler	26	
DDT-75		
DDT	237	Procida, Italy
Wetting agent	232	
Filler	26	
Zineb or Maneb		
Zineb or maneb (tech.)	1,060	Rohm and Haas S.P.A. Milan, Italy
Wetting agent (Unidentified)	509	Rohm and Haas S.P.A. Milan, Italy
Filler	26	(also Procida)
Sulphur-80		
Sulphur pure	21	

a/ Late 1974.

Wetting agent	232	
Filler	26	

Bromophos-25

Bromophos (tech.)	1,060	Celamerk
Wetting agent	232	
Filler	26	

Anthraquinone

Anthraquinone	500	Sariaf, Faenza, Italy, and Bayer, Federal Republic of Germany
Wetting agent	509	
Filler	26	

Weed killer

Linuron	800	
Wetting agent	232	
Filler	26	

D. Inert ingredients

Mineral - Oils

Kwizda - Vienna, Austria

Atlas - Erith, England

I.C.I. - Haslemere, England

Shell - London, England

Sariaf - Faenza, Italy

Aerosols - Amersfoort, Netherlands

Enna - Sexibierum, Netherlands

Bleaching earths

Rochdale - Manchester, England

Emulsifiers

Cehasel - Vienna, Austria

U.C.B. - Drogenbos, Belgium

Fraproduit - Asnières, France

Voreppe - Voreppe, France

Hoechst - Frankfurt, Federal Republic of Germany

I.C.I - Haslemere, England

Dow - Hounslow, England

Montedison - Milan, Italy

Aerosol - Amersfoort, Netherlands

Chem-Y - Bodegraven, Netherlands

Zmna - Sexbierum, Netherlands

Shell - The Hague, Netherlands

Tensia-Surface - Barcelona, Spain

Chromas - Zagreb, Yugoslavia

Radonja - Sisak, Yugoslavia

Propellents (for aerosols)

Cehasol - Vienna, Austria

Truff - Le Chesnay, France

Robel and Fiedler - Ettenheim, Federal Republic of Germany

I.C.I. - Haslemere, England

I.S.C. - Aronmouth, England

Montedison - Milan, Italy

Aerosols - Amersfoort, Netherlands

Lusear - Elst, Netherlands

Zmna - Sexbierum, Netherlands

E.I Dupont de Nemours and Co. (Freon Products Division) - Wilmington, Delaware, United States

Montecatini - Milan, Italy

E. Cost of machinery and equipment for a plant for formulating (air milling) DDT wettable powder

	US$
Ribbon mixer	46,000
Screw conveyor	13,000
Mills	15,000
Bag houses	13,000
Bucket elevator	3,500
Packaging	25,000
Air-mill	15,000

Air compressor	37,000
Metal paper sealer	14,500
Scales	6,500
Dust-collecting system	15,000
Electrical	32,000
Safety valves	8,000
Instrumentation	8,000
Cyclone	2,500
Piping and ducts	25,000
Laboratory equipment	20,000
Miscellaneous	6,000
Total	310,000 (= LD 100,000)

F. Cost of machinery and equipment for formulating liquid solutions

	$US
Solvent storage tanks (4) (5,000 gallons)	9,500
Sizing tanks (5,000 gallons)	8,000
Solution holding tanks (2) (5,000 gallons)	9,000
Filter press	3,500
Filling station	5,000
Pumps and motors	7,000
Electrical and lighting	11,500
Steel structure	3,000
Foundations	11,500
Piping	13,500
Instruments	5,500
Miscellaneous equipment	3,000
Total	95,000 (= LD 30,000)

Annex V

WHITE OIL: BASIC DATA ON SOME UNIT OPERATIONS

The process is of the batch type, up to and including sulphonation, but continuous thereafter. The plant will be comprised of the following unit operations:

A. Sulphonation
B. Settling and separation
C. Neutralization of acid
D. Extraction of mahogany acids
E. Drying and bleaching
F. Fractionation: recovery of methanol and mahogany acids
G. Water cooling tower

The following equation will form the basis to work out the plant specifications:

$$\text{Heavy gas oil} + 20\%\ \text{oleum} - (\text{refined mineral oil} + \text{sulphonic acid}) + \text{waste}$$

$$1.33 + 0.55 - \left(1 + 0.07\right) + \ldots$$

$$\text{or } 6.65 + 2.75 - \left(5 + 0.35\right) + \ldots$$

A. Sulphonation

Assume that complete sulphonation and the removal of sludge will take about 1 hour per batch of the mixture containing 1.33 tons (= 1.585 m^3) of oil and 0.55 tons (= 0.298 m^3) of 20% oleum. This operation will require a reaction vessel of diameter 1.25 m and height 1.75 m.

Since the sulphonation is exothermic, the sulphonation vessel will have a cooling jacket. Heat is given off by acid dilution and the oxidation of aromatics to aromatic acids, namely sulphonic acids, commonly known as mahogany acids. No figures are available for the heat of formation of sulphonic acids, but since SO_3 is being used for this purpose, it may be assumed that the heat of solution of SO_3 is approximately equal to the heat of formations of sulphonic acids.

Thus, the heat given out on the basis of 0.55 tons of 20% oleum will be the sum of :

Heat of reaction of SO_3 with aromatics

Heat of dilution of sulphuric acid from 80% to 70%

or $SO_3 = (\frac{20}{100} \times 0.55 \times 1,000) \times 504,000$ cal $= 554.4 \times 10^5$ cal/g

$= 220 \times 10^3$ Btu/h (heat of solution of SO_3 = 504 cal/g)

Heat of dilution of H_2SO_4

$= (0.44 \times 1,000) \times 25,600 = 112.64 \times 10^5$ cal

$= (44.7 \times 10^3$ Btu)

Total heat generated per batch per hour.

$= 667.04 \times 10^5$ cal/h

$(= 2.65 \times 10^5$ Btu/h)

Taking U = 100 Btu/h /ft^2 ($^\circ$F)

Water enters at 77°F and leaves at 95°F. Inside temp. = 140°F

Then $\triangle t_{a.m} = 53.5^\circ$F $\quad \triangle t_1 = 63^\circ$F

$\triangle t_2 = 45^\circ$F

$$A = \frac{265,000}{100 \times 53.5} = 49 \text{ ft}^2$$

$$= 4.6 \text{ m}^2$$

<u>The quantity of water required for cooling</u>

$$Q = M \times (t_2 - t_1) \times Cp$$

$$\text{or } M = \frac{Q}{(t_2 - t_1) \times CP} = \frac{265 \times 1,000}{18 \times 1}$$

$$= \underline{14,700 \text{ lb/h}}$$

$$= \underline{110 \text{ litres/min}}$$

Cooling surface = <u>4.6 m^2</u>

Requirements of cooling water = <u>6.6 m^2/h</u>

Materials balance (per batch)

	In	Out	
Oil	1.5 tons	Treated oil	= 1.125 tons
Oleum	0.645 tons	(Mahogany acids	= 0.0788)
		Sludge	= 1.020
Total	2.145 tons		2.145

Heat balance

	In	Out
Heat of reaction and Solution etc.	667.04×10^5	667.04×10^5 cal/hr
Total	667.04×10^5	667.04×10^5 cal/hr

B. Settling and separation

Oleum may be added in 2 or 3 lots at a predetermined rate. After each treatment, the contents are discharged into the settling tank, whence the treated oil is returned to the sulphonator for further refining with fresh (balance) acid.

The oil-acid mixture is finally discharged into a second settling tank. On settling, the oil is pumped to the treated oil intermediate storage tank for interim storage, and the remaining sludge-acid is reused for the next batch.

The intermediate storage tank (about 10 tons' capacity) will serve as a source of continuous feed for the remaining part of the process.

C. Neutralization of acid

A caustic soda solution (1%) is pumped at a rate of about 10 to 15 gal/min against an acid-flow rate of 15 to 20 litres/min into the neutralizer. The neutralized acid, along with aqueous sodium sulphate, will overflow into a separator/coalescer, whence it will flow directly into a rotary disc contractor for the removal of mahogany acids by a suitable solvent.

Materials balance over the neutralizer (tons/hr)

In		Out	
Acid-treated oil	= 1.1250	Acid-free oil	= 1.1138
Free acid max. % of treated oil		Na sulphate	= 0.0156
Na OH 1%	= 0.0090	Water	= 0.0040
Total	1.1340		1.1340

D. Extraction of mahogany acids

Contrary to batch-type extraction, where the two liquids are first brought into contact and then separated (represent one stage), in a continuous extractor, the liquids are not separated after the first mixing but allowed to remain in intimate contact with each other over a number of stages. The heavy phase is generally introduced from the top, while the lighter one enters from the bottom.

The HETS (height equivalent transfer stage), is affected and becomes smaller by increasing the diameter of the rotating discs or paddles, decreasing the diameter of stationery baffle openings, increased rotor speed and decreased height of each compartment, i.e. reducing the distance between the two stages.

There are a number of extractors which are extensively used in industry for different services:

Rotary disc contractor

Mixco (Oldhue-Rushton) extractor

Scheibel (York-Scheibel) columns (with alternately packed compartments for coalescence)

Treybal column (a mixer-settler type unit)

The neutral oil is stripped off the mahogany acids by means of a suitable water-miscible solvent such as methyl alcohol, ethyl alcohol, acetone or possibly furfural. Although the recommended of a methanol-water solution for the extraction of mahogany acid could not be confirmed, but it is taken here as the basis for working out the unit specifications.

The materials balance over the extractor may be written as follows:

Materials balance (tons/h)

In		Out	
Acid-free-oil	= 1.0358	Oil	= 1.0353
Mahogany acids	= 0.0780		
CH_3OH (70%)	= 0.500	CH_3OH + + Mahogany acids	= .5730
Total	1.6138		1.6138
CH_3OH	= 0.5 tons	CH_3OH	= 0.35
+ H_2O	= 0.5 tons	H_2O	= 0.15
			0.50

The liquid rates for oil and the solvent are about 20 litres/min and [illegible] min, respectively. If smaller units are available, one of the types mentioned above is recommended for the present task, otherwise a batch-type system such as a turbo-mixer and a coalescer combination may be used.

E. Drying and bleaching

After the oil had been stripped of mahogany acids, the oil flows out into the clay-treatment vessel where the clay removes the colouring matter and gives the oil a waterlike appearance.

The clay acid mixture is pumped to the continuous horizontal centrifuge which separates the clay. The oil flows into an intermediate tank for pumping to the bulk storage tank.

Materials balance

In		Out	
Oil	= 1.0358	Oil	= 1.035600
Activated clay 2%	= 0.0207	Clay	= 0.020700
		+ 1% oil	= 0.000207
	1.0565		1.056507

F. Fractionation: recovery of methanol and mahogany acids

The methanol-water-mahogany acid extract is fed to the fractionating column at a rate of 0.578 tons/h.

The heat load on the still is the sum of:

1. Heat required to heat up CH_3OH from 25° to 64.5°C
2. Heat required to vaporize 350 kg of CH_3OH (for CH_3OH, H vapour = 262.8 cal/g)
3. Heat taken up by water, 25° to 64.5°C
4. Heat taken up by mahogany acids, 25° to 64.5°C
5. Heat losses, 10% of 1 to 4

1. Heat required to heat up CH_3OH = (350×10^3) (.590) (39°C)
   79×10^5 cal = $(31.4 \times 10^3$h) Btu
2. Heat of vaporization = (kg) (heat of vaporization)
   = $350 \times 262.8 \times 10^3$cal
   = 915×10^5 cal/h = $(364 \times 10^3$ Btu/h)
3. Heat taken up by water = (wt) x (sp. heat) x (rise in temp.
   = 585×10^4 cal/h)
   $(23.2 \times 10^3$ Btu/h)
4. Heat taken up by mahogany acids = (78×10^3) (0.6 ?) (39)
   = 18.2×10^5 cal/h
   = $(72.3 \times 10^3$ Btu/h)
5. Heat losses (10% of 1-4) = 49.12×10^3 Btu/h

Total 1-5 = 540.32×10^3Btu/h

Heating surface:

Heating Surface = $\frac{\text{Heat load}}{U \times \Delta T_{lm}}$ Δt_1=163

= $\frac{540.32 \times 10^3}{150 \times 124}$ Δt_2=91

Inside temp. = 240°F

= 29 ft^2 ΔT_{lm} = 124

= 2.69 m^2

A 4-cm diameter pipe, about 21.4 m in length, will be required.

Steam requirements

Low-pressure steam at 10 p.s.i.g. 240°F, will be used
Steam enthalpy at 240°F = 1160.6 Btu/lb
Total required heat input = 540.32 x 10^3 Btu/h
∴ Steam requirements

per hour = $\frac{540.32 \times 10^3}{1160.6}$ = 467 lb/h
= 212 kg/h
= 1.698 tons/8 h
or 2 tons/8 h (approx.)

Number of theoretical plates

In a binary system such as methanol-water, the number of theoretical plates is about 7. Assume 33% plate efficiency (for bubble-cap), the number of plates required will be 21. Spacing between the plates, is 39.3 cm (15.7 in). Diameter of the column 20 cm. Bubble-cap size 5 cm. Pressure, 14.7 p.s.i.g.

Condensate surface requriements

U = 100 Btu/h (ft^2) $(^\circ F)$
G = 364 x 10^3 Btu/h
The water enters at 25°C and leaves at
35°C to give Δt_{lm}, 50°C or 90°F

The condensate surface = $\frac{Q}{U \times \Delta t_{lm}}$

= $\frac{364 \times 10^3}{100 \times 90}$ = 40.5 ft^2

= 3.75 m^2

C. Water cooling tower

The cooling water enters the sulphonator jacket at 77°F and leaves at 95°F at a rate of 110 litres/min. The hot water from the jacket is spray cooled over a cooling tower. The cooled water is collected in the base tank and returned to the sulphonation vessel.

Let the storage capacity of the pond	=	10 m^3
Initial temperature of the water	=	95°F
Final temperature of the water (after cooling)	=	77°F
Quantity of the water to be cooled	=	7 cu m/hr
Average wind velocity at Az-Zawia	=	3 miles/hr
	=	4.5 ft/sec.

Annex VI

REFINED MINERAL OIL: REQUIREMENTS OF THE PROPOSED PLANT

A. Capital expenditure (Libyan dinars)

1.	**Fixed capital**	
1.1	Land: 2 hectares (at LD 2/m^2)	40,000
1.2	Levelling (LD 0.5/m^2)	10,000
1.3	Contingencies (5% of 1.1 and 1.2)	2,500
	Subtotal	52,500
2.	**Building and construction**	
2.1	**Building**	
	(a) Gate house, 100 m^3 at LD 10/m^3	1,000
	(b) Concrete trays and foundations 110 at LD 15/m^3	1,650
	(c) Main building (including administration and stores) 73/m^3 at LD 15/m^3	11,055
2.2	**Roads and yards** (at LD 7.5/600 m^2	6,000
2.3	Fence with gates (approx.) 600 m (at LD 15/m)	9,000
	Subtotal	28,705
3.	**Machinery and equipment**	
3.1	Production equipment	120,000
3.2	Ancillary equipment	
	(a) Boiler-water preparation station	-
	(b) High-voltage distribution and transforming station; low-voltage distribution station	5,000
	(c) Repair and maintenance workshop equipment	2,000
	(d) Chemical laboratory equipment (quality control and testing)	2,000

(e)	Network within plant compound:	
	Electric voltage supply	2,500
	Water supply	3,000
	Sewerage	9,500
	Telephone installation	2,000
	Plant lighting	2,000
		23,000
3.3	Freight, insurance, dock clearance, including internal transport (15% of 3.1 and 3.2)	21,450
3.4	Design and technical works (5% of 3.1 and 3.2)	7,150
3.5	Erection and commissioning charges (15% of 3.1 and 3.2)	21,450
	Subtotal	193,050
4.	Transport vehicles	
4.1	20% oleum tanker (10-15 tons capacity) with air compressor, 25 ft^2, 5 hp pump (1)	4,500
4.2	Solvent tanker or simple truck for drums (1)	3,500
4.3	Pickup truck (1)	1,500
4.4	Personnel cars (2)	2,500
	Subtotal	12,000
5.	Office furniture and equipment	
5.1	Furniture	2,000
5.2	Equipment and miscellaneous	2,000
	Subtotal	4,000
6.	Preliminary and promotional expenses	
6.1	Legal matters	1,500
6.2	Advertising and publicity	2,000
6.3	Training	5,000
	Subtotal	8,500
7.	Working capital	
7.1	Raw materials	
(a)	Heavy gas oil 83 tons at LD 27.9/ton (2 weeks)	2,320

(b)	20% oleum 206 tons at LD 28/ton (3 months)	5,750
(c)	Solvent (methanol) 50 tons at LD 36/ton (3 months)	1,800
(d)	Fuller's earth 15 tons at LD 30/ton (6 months)	450
(e)	Caustic soda 6 tons at LD 46/ton (6 months)	276
(f)	Limestone 100 tons at LD 2/ton (1 month)	200
		10,796
7.2	Spare parts (10% of essential equipment)	22,000
7.3	Product - 2 weeks' production at production cost: 60 tons at (about) LD 160/ton	9,600
7.4	Wages and salaries (1 month)	4,890
7.5	Unforeseen expenses (10% of 7.1 to 7.4)	4,728
	Subtotal	41,218
	Total of 1 to 7 =	358,769
	Unit expenditure per ton of product =	219

B. Building, manpower and utilities requirements

1. Building and construction

Factory (for mineral oil only)

Size: 16 x 10 x 8 (approx.)

Walls = (16 x 10 x .3) x 2 = 96 m^3

+ (10 x 8 x .3) x 2 = 48 m^3

Roof = (16 x 10 x .15) = 24 m^3

Floor = (16 x 10 x .3) = 48 m^3

Unforeseen = 10 m^3

226 m^3

2. General, for laboratories and for all other component units

Walls =	(20 x 10 x .3)	x 4 =	240 m^3
	(10 x 7 x .3)	x 6 =	126 m^3
Roofs =	(20 x 10 x .15)	x 2 =	60 m^3
			426 m^3

3. Stores and sheds

For raw-materials in bags and drums etc. 20 x 5 x 5 m

Walls =	(20 x 5 x .3)	x 2 =	60 m^3
	(5 x 5 x .3)	x 2 =	15 m^3
Roof =	(20 x 5 x .1)	x 1 =	10 m^3
			85 m^3

Subtotal = 737 m^3

4. Concrete trays and foundations

Unit operations:	8 m^3 or 10 m^3 (approx.)	
Intermediate tanks:	3 m^3	
Bulk storage tanks:		
(i) Heavy gas		25 m^3
(ii) 20% oleum		25 m^3
(iii) Methanol		16 m^3
(iv) Refined mineral oil		16 m^3
		82 m^3
Pumps etc.		5 m^3
Unforseen		10 m^3
Total		110 m^3

5. Roads

Length	200 m
Breadth	2 m
Number required	2
Area	800 m^2

C. **Management, quality-control laboratory and labour costs** (Libyan dinars)

Number of personnel	Number	LD/month	LD/year	LD/year (plus social charges
1. Factory				
Unskilled	6	70	840	5,700
Skilled	6	100	1,200	8,100
Highly skilled	3	120	1,440	4,800
Engineer	1	150	1,800	2,000
Chemist	1	150	1,800	2,000
Manager	1	200	2,400	2,650
General manager	1	400	4,800	5,050
				30,300
2. Stores				
Foreman	1	120	1,440	1,600
Drivers	5	100	1,200	6,750
Helpers	2	70	840	1,900
				10,250
3. Administration				
Clerk	2	120	1,440	3,200
Typist	2	120	1,440	3,200
Helper	1	70	840	950
				7,350
			Subtotal	47,900

Power requirements (horsepower)

1.	Raw materials and finished product (pumps)	
	Heavy gas oil	2
	20% oleum	2
	Solvent (CH_3OH etc.)	2
	Refined mineral oil	2
2.	Intermediate storage tanks	4
3.	Unit operations and miscellaneous:	
	Sulphonator (turbo-mixer)	5-10
	Sulphonator (turbo-mixer)	2
	Water circulation pump	2
	pump	2
	Neutralizer (turbo-mixer)	2
	Neutralizer (turbo-mixer)	1
	Extractor	2-3
	Drying and bleaching	2
	Drying and bleaching	1
	Neutral - oil pump	2
4.	Unforeseen	10
		49 hp

Total of 1 to 4 = 31.8 = 32 kWh (approx.)

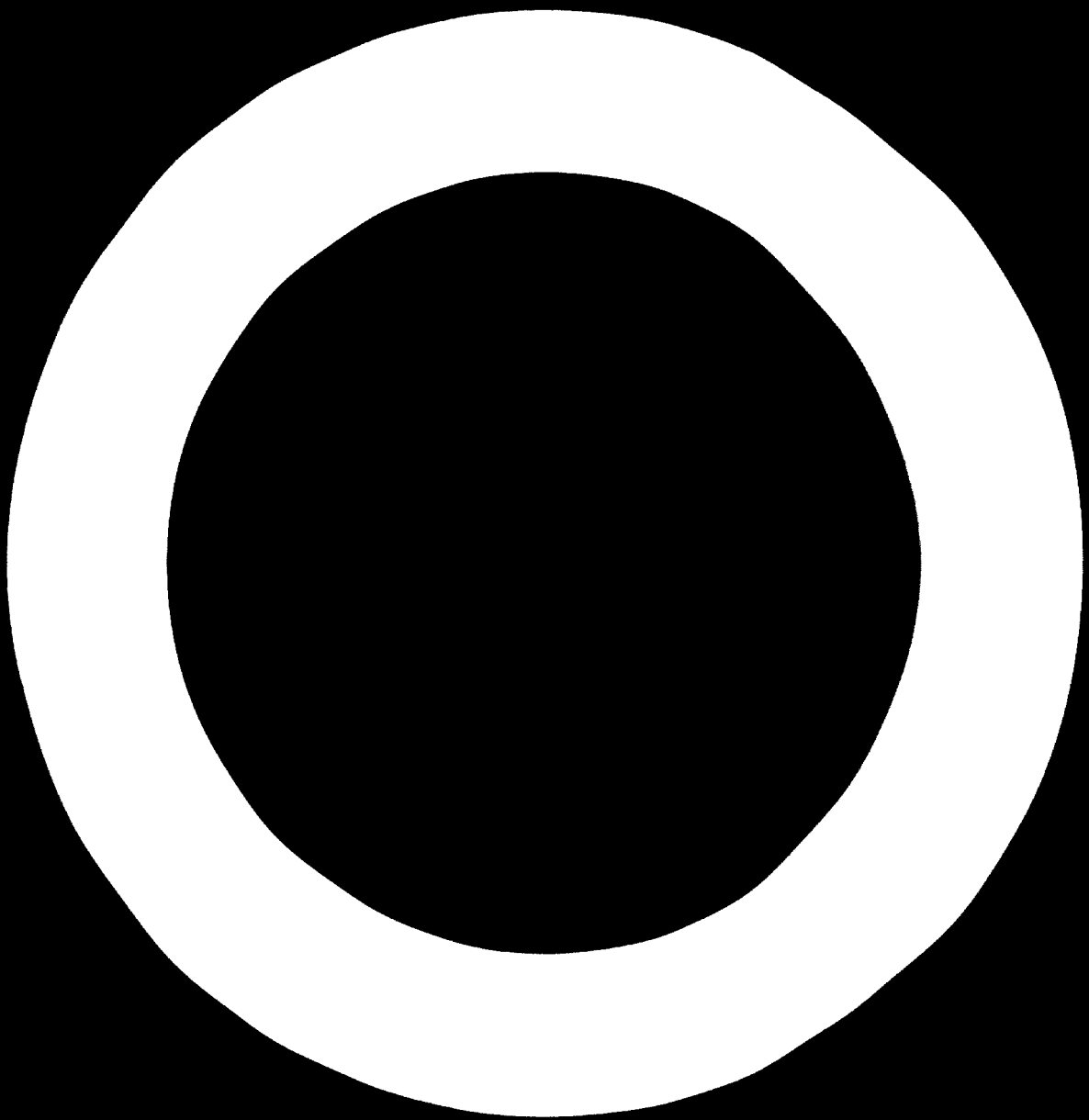
5. General lighting:	50 x 200 W
	10 kWh
Total	42 kWh
Requirements for 8 hours	336
Requirements for 1 year	100/800 kWh
Cost per year at a rate of LD 7.5/1,000 kWh	= $\frac{7.5 \times 100,800}{1,000}$
	= LD 756/year

6. **Steam requirements**

Steam requirements per 8 hours (10 p.s.i.g.)	2 tons
Steam requirements per year	600 tons
Steam cost per year (at LD 1.2/ton)	LD 720/year

7. **Water requirements** (m^3)

Sulphonator	
Initial	6.7
Replenishment at 2 m^3/day	600
	606 m^3/year
Fractionating column,	
for condensor	
incirculations	20
in losses (per year)	600
	620 m^3/year
General washing, scrubbing etc.	6,000 m^3/year
Unforeseen	1,000 m^3/year
Subtotal	8,226 m^3
	10,000 m^3 (approx.)
Annual cost at LD 20/1,000 m^3	LD 200/year



Annex VII

EMULSIFIABLE CONCENTRATES

A. Capital expenditure (Libyan dinars)

1.	**Fixed capital**	
1.1	Land	(None required. Installation is within white-oil premises)
1.2	Levelling LD 0.5 per m^2	2,000
2.	**Building and construction**	
2.1	Building:	
	(a) Gate house	-
	(b) Concrete trays and foundations 90 m^3 at LD 15/m^3	1,350
	(c) Main building, including administration, stores, sheds etc. 374 m^3 at LD 15/m^3	5,610
2.2	Roads (220 x 2) m^2 at LD 7.5/m^2	3,000
2.3	Fence with gate, 200 m long at LD 15/m	3,000
	Subtotal	12,960
3.	**Machinery and equipment**	
3.1	Production equipment (and weed killers EC)	75,000
3.2	Ancillary equipment	
	(a) Boiler-water preparation station	10,000
	(b) High-voltage distribution and transforming, and low-voltage distribution station (additional)	1,000
	(c) Repair and maintenance workshop equipment (additional to white-oil plant requirement)	1,000
	(d) Chemical laboratory (additional requirements)	1,500
	(i) Electricity - low-voltage supply to plant and stores etc.	1,500

(ii)	Water supply	1,500
(iii)	Sewerage	2,000
(iv)	Telephone installation	1,000
(v)	Plot lighting (additional)	1,000
3.3	Freight, insurance, dock clearance, internal transport (15% of 3.1 and 3.2)	14,325
3.4	Design and technical works (5% of 3.1 and 3.2)	4,775
3.5	Erection and commissioning charges (15% of 3.1 and 3.2)	14,325
	Subtotal	128,925
4.	Transport vehicles	
4.1	Diesel truck (solids carrier) 10-ton capacity (1)	2,500
4.2	Solvent tanker carrier 10 to 15 tons capacity (1)	3,000
4.3	Fork-lifts (2)	
	for bags	1,500
	for drums (40-gal) with tilting device	1,500
4.5	Station wagon (1)	2,000
4.6	Personnel car (1)	1,200
	Subtotal	11,700
5.	Office furniture and equipment	
5.1	Furniture	2,000
5.2	Equipment	3,000
	Subtotal	5,000
6.	Preliminary and promotional expenditure	
6.1	Legal matters	1,500
6.2	Advertising and publicity	2,000
6.3	Training	2,000
	Subtotal	5,500

7. Working capital

7.1 Raw materials:

(a) White oil-80

(i) Refined mineral oil 100 tons at LD 160/ton (3 months)	16,000
(ii) Casein 0.55 tons at LD 483/ton (3 months)	265
(iii) Triton-100 1 ton at LD 523/ton (1 year)	523
(iv) Ammonia S.G.0.9 1 tons at LD 56/ton (3 months)	56
(v) Distilled water 21.6 tons at LD 2/ton (3 months)	43.2

(b) Dimethodat-40

(i) Dimethoate (tech.) 18 tons at LD 1,280/ton (3 months)	23,040
(ii) Emulsifier (unidentified) 2.25 tons at LD 547/ton (3 months)	1,230
(iii) Solvent (xylene) 18.80 tons at LD 90/ton (3 months)	1,692
(iv) Casein 0.2125 tons at LD 483/ton	103
(v) Distilled water 8.27 tons at LD 2/ton (3 months)	17

(c) Tedion-8 (tetradifon)

(i) Tetradifon (tech) 2.5 tons at LD 3,275/ton (3 months)	8,220
(ii) Emulsifier, Atlox 1.612 tons at LD 600/ton	967
(iii) Solvent	
(a) 17.5 tons xylene at LD 90/ton	
(b) 3.225 cyclohexanone at LD 228/ton (3 months)	2,303

(iv)	Casein 0.645 tons at LD 483/ton (3 months)	312
(v)	Distilled water 7 tons at LD 2/ton (3 months)	14
(d)	**Malathion-50**	
(i)	Malathion (tech.) 10.5 tons at LD 751/ton (3 months)	7,980
(ii)	Emulsifier 1.05 tons at LD 600/ton (3 months)	630
(iii)	Solvent, xylene 9.45 tons at LD 90/ton (3 months)	8,505
(e)	**Kelthane-18.5**	
(i)	Kelthane (tech.) 5.94 tons at LD 1,275/ton (3 months)	7,570
(ii)	Emulsifier (Rohm and Haas) AH-863) 0.162 ton at LD 509/ton (3 months)	83
(iii)	Solvent (xylene) 26 tons at LD 90/ton (3 months)	2,340
(iv)	Stabilizer (casein or methyl-cellulose) 0.162 tons at LD 483/ton (3 months)	79
(f)	**Lindane-20 and 50**	
(i)	Lindane (tech.) 6.3 tons at LD 1,645/ton (3 months)	10,400
(ii)	Emulsifier (sorbitan mono- stearate ?) 0.54 tons at LD 232/ton (3 months)	125
(iii)	Solvent (benzene, xylene) 15.5 tons at LD 90/ton (3 months)	1,395
(g)	**Liquid insecticides**	
(i)	Bioallethrin 61 kg at LD 37,815/ton (3 months)	2,300

(ii)	Bioresmethrin 81 kg at LD 52,215/ton (3 months)	
(iii)	Piperonyl butoxide 244 kg at LD [illegible] (3 months)	1,708
(iv)	[illegible] 135 tons at LD 17.64/ton (1 month)	?,380
(h)	**Weed killers** 2,4-D and 2,4-DB	
(i)	2,4-D and 2,4-DB (tech.) 2,4-D, 5.69 tons at LD 418/ton 2,4-DB, 7.625 tons at LD 259/ton (3 months)	4,340
(ii)	Solvent oil or benzene 3.8 tons at LD 86/ton (3 months)	2,050
(iii)	Emulsifier ? 0.89 tons at LD 600/ton (3 months)	534
(i)	**Packaging material** 55 gallons (= 7.35 ft^3) 16-gauge plate (baked resin coated/ 500 drums at (about) LD 3.44/drum	1,720
7.2	**Spare parts:** (10% of essential equipment)	2,000
7.3	**Product** 2 weeks' production cost 100 tons at LD 200/ton	20,000
7.4	**Wages and salaries** (section C) (1 month)	2,263
7.5	Unforeseen (10% of raw materials)	14,339
	Total of 7.1 to 7.4	138,329.2
	Total capital expenditure 1 to 7	304,414.2
	Capital expenditure/ ton output (tons)	$\frac{304,414}{2,927}$ = 104 LD/ton

B. Building, manpower and utilities requirements

1. Building (approximate estimate of size and value)

Main plant building — 20 x 10 x 8 m

(a) Walls	(20 x 8 x 3) x 2	=	96 m^3
	(10 x 8 x 3) x 2	=	48 m^3
	Subtotal	=	144 m^3
(b) Roof and floor	(20 x 10 x 0.15)	=	30 m^3
	(20 x 10 x 0.3)	=	60 m^3
	Subtotal	=	90 m^3

Administration

Partly provided in white-oil plant project (Take additional 50 m^3)

Stores, sheds for raw materials and products

(a)	Solids: 65.665 = 70 tons	=	70 m^3
(b)	Liquids: malathion, emulsifier and cyclohexanone in drums	=	20 m^3
(c)	Gases: ammonia = 1-ton cylinders		

2. Concrete: trays and foundations

Storage tanks (outside):

(a)	White oil	16 m^3 (approx.)
(b)	Xylenes	25 m^3 (approx.)
(c)	Distilled water	15 m^3 (approx.)
(d)	Kerosene oil	16 m^3 (approx.)
(e)	Malathion	2 m^3 (approx.)
(f)	Unforeseen	8 m^3 (approx.)

Storage tanks, motors, unit operations etc.

(a)	Hammer mill	1 m^3
(b)	Bucket elevators	1 m^3
(c)	Supporting structure for feed-bin, mixing vessels, service tanks	10 m^3
(d)	Weighing and filling station - structure	4 m^3
(e)	Unforeseen	5 m^3

Total:

(a)	Building	374 m^3
(b)	Concrete trays	89.5 m^3
		463.5 m^3

3. **Road etc.**

200 x 2 m^2 — 400 m^2

C. **Staff requirements: wages and salaries**

Personnel	Number	LD/month	LD/year	LD/year (plus social charges)
Factory				
Unskilled	4	70	840	950 x 4 = 3,800
Skilled	3	100	1,200	1,350 x 3 = 4,050
Highly skilled	1	120	1,440	1,600 x 1 = 1,600
Engineer	1	150	1,800	2,000 x 1 = 2,000
				11,450
Commercial department				
Foreman (packing)	1	120		1,600 x 1 = 1,600
Helpers	2	70		950 x 2 = 1,900
Drivers	3	100		1,300 x 3 = 3,900
				7,400
Administration				
Clerks	2	120		1,600 x 2 = 3,200
Typist	2	120		1,600 x 2 = 3,200
Helper	2	70		950 x 2 = 1,900
				8,300
			Total	27,150/year

D. Power requirements (horsepower)

1. Size-reduction and transportation sections	
Hammer mill	5
(a) Star feeder to bucket elevator	1
(b) Bucket elevator	1
(c) Storage bin Discharge end	1
(d) Weight hopper	1
Subtotal	9
2. Mixing section	
Mixing vessel (No. 1)	5-10
Pump for liquid pesticidal chemical	2
Pump for liquid pesticidal solvent	2
Pump for liquid pesticidal emulsifier	1
Pump for liquid pesticidal EC to service tank	2
Mixing vessel (No. 2) (for malathion)	2-5
Pump for liquid pesticidal chemical	1
Pump for liquid pesticidal solvent	1
Pump for liquid pesticidal emulsifier	1
Pump for liquid pesticidal EC to service tank	1
Subtotal	35
3. Weighing and filling section	
Weighing and filling section with automatic shut-off	2-3
4. Vapour exhaust system	
(a) Exhaust fan or blower	10
(b) Water scrubber	1
(c) Exhaust fans (8 in EC section, 4 in weed-killer section)	4 2
Subtotal	17
5. Bulk storage tanks	
(a) White oil from service-tank or directly from mixing vessel to storage tank	2-3

(b)	Xylenes From storage tank to mixing vessel	2-3
(c)	Kerosene oil From storage tank to the mixing vessel	2-3
(d)	Malathion From storage to mixing vessel	2-3
(e)	Distilled water from storage tank to the mixing vessel	1-2
(f)	Emulsifier From storage to mixing vessel	1
(g)	Casein screw conveyor	0.5
(h)	Lighting: 50 x 200 V	10 kW
(i)	Unforeseen:	10
	Total 1-5	80.51 hp + 10 kWh

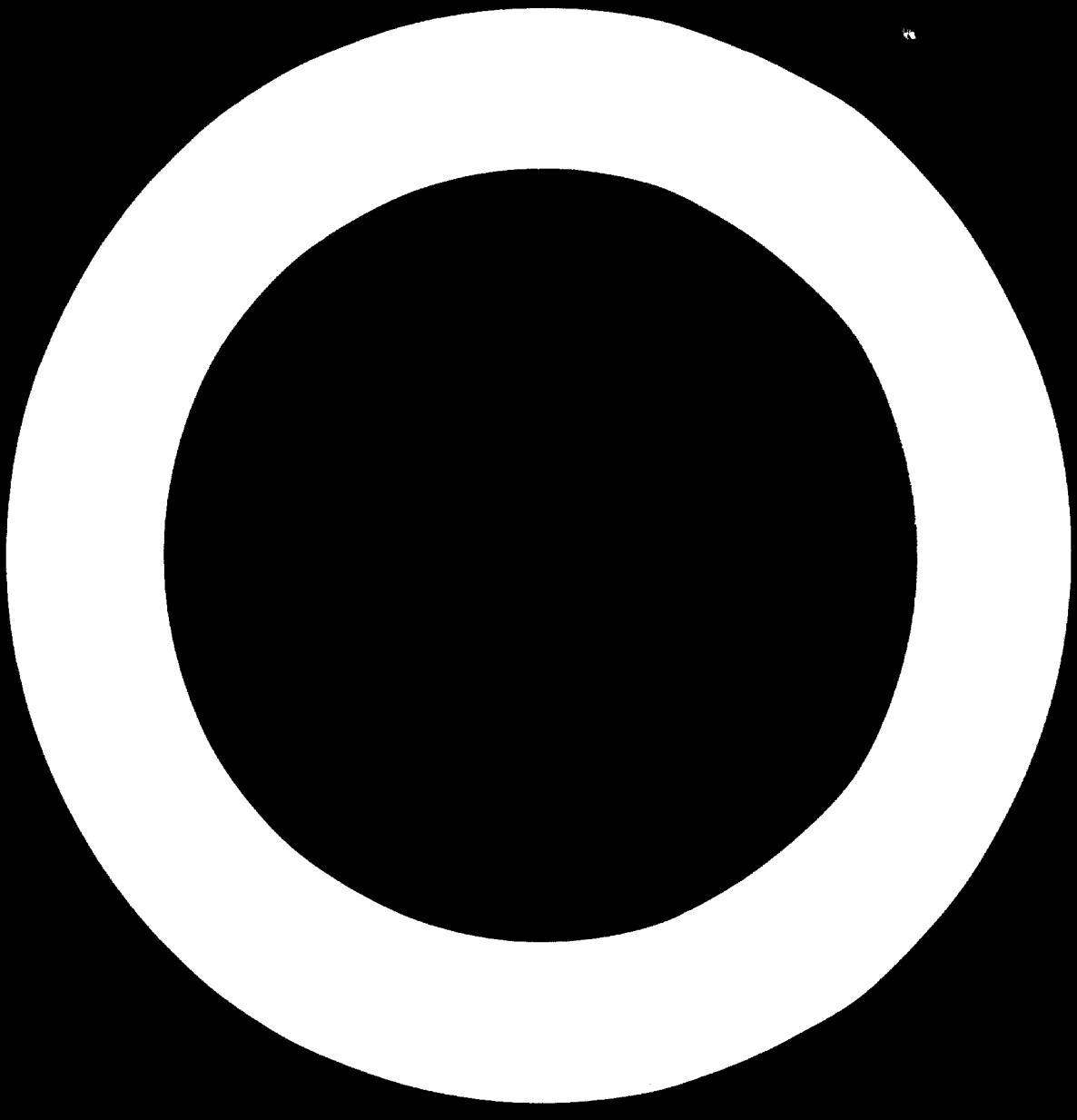
Cost at LD 7.5/1,000 kWh $\frac{(71 \times 8 \times 300) \times 7.5}{1,000}$ = LD 1,280/year

6. **Steam (low pressure) at 25 lb/in^2**

Maximum steam requirements per day (8 hours)	5 tons
per day (3 years)	5 x 150
	750 tons
Cost at a rate of LD 1.2/ton	LD 900/year

7. **Water requirements**

Per 8-hour shift	80 m^3
Per year	80 x 300
	24,000 m^3
Cost = $\frac{20 \times 24,000}{1,000}$	LD 480/year



Annex VIII

WETTABLE POWDERS

A. Capital expenditure (Libyan dinars)

1.	**Fixed capital**	
1.1	Land: 1 hectare (additional) at LD 2/m^2	20,000
1.2	Levelling: LD 0.5/m	2,000
	Subtotal	22,000
2.	**Building and construction**	
2.1	Building:	
	(a) Gate house	
	(b) Concrete trays and foundations 30 m^3 at LD 15/m^3	450
	(c) Main building including administration and stores etc. 312 m^3 at LD 15/m^3	4,680
2.2	Roads	-
2.3	Fence	-
	Subtotal	5,130
3.	**Machinery and equipment**	
3.1	Production equipment (including weed killers)	125,000
3.2	Ancillary equipment	
	(a) Boiler water preparation station	-
	(b) High-voltage distribution, transforming and low-voltage distributing station (in white oil installation)	-
	(c) Repair and maintenance workshop (additional)	1,000
	(d) Chemical laboratory	1,000
	(e) Network within the plant compound	
	(1) Electricity: low-voltage power supply to plant and stores (additional)	1,500
	(2) Water supply	1,500
	(3) Sewerage	2,000

(4)	Telephone	4,000
(5)	Plot lighting	1,000
	Subtotal	9,000
3.3	Freight, insurance, dock clearance, internal transport (15% of 3.1 and 3.2)	20,100
3.4	Design and technical works (5% of 3.1 and 3.2)	6,700
3.5	Erection and commissioning charges (15% of 3.1 and 3.2)	20,100
	Subtotal	180,900
4.	**Transport vehicles**	
4.1	Diesel truck (carrier for bags) 10 to 15 tons capacity (1)	2,500
4.2	Station wagon (1)	2,000
4.3	Personnel car (1)	1,200
	Subtotal	5,700
5.	**Office furniture**	
5.1	Furniture	3,000
5.2	Equipment	2,000
5.3	Miscellaneous	2,000
	Subtotal	7,000
6.	**Preliminary and promotional expenditure**	
6.1	Legal matters	1,500
6.2	Advertising and publicity	2,000
6.3	Training	2,000
	Subtotal	5,500
7.	**Working capital**	
7.1	(a) Dipterex-80	
	Dipterex (tech.) 31.4 tons at LD 930/ton (6 months)	29,200
	Diatomite or attapulgite 7.025 tons at LD 26/ton (6 months)	183

Wetting agent, 1.56 tons at LD 232/ton (1 year)	362
	29,745

(b) Sevin-50

Sevin (tech.) 19.71 tons at LD 731/ton (6 months)	14,400
Diatomite or attapulgite, 18.85 tons at LD 26/ton (6 months)	490
Wetting agent, 1.58 tons at LD 509/ton (1 year)	803
	15,693

(c) Aldrin-40

Aldrin (tech.) 15 tons at LD 908/ton (6 months)	13,600
Diatomite or attapulgite, 21.35 tons at LD 26/ton	555
Wetting agent, 1.52 tons at LD 509/ton	774
	14,929

(d) DDT-75 (WHO)

DDT, 5.05 tons at LD 237/ton (3 months)	1,195
Clay, 6.20 tons at LD 26/ton (1 year)	161
Wetting agent, 0.54 tons at LD 232/ton (1 year)	125
	1,481

(e) Zineb and Maneb-80

Zineb or maneb, 56.2 tons at LD 600/ton (3 months)	33,720
Diatomite or attapulgite, 25.5 tons at LD 26/ton (6 months)	663
Wetting agent, 2.81 tons at LD 509/ton (6 months)	1,430
	35,813

(f) Sulphur-80

Sulphur (tech.), 32.8 tons at LD 21/ton (1 year)	690

Diatomite, attapulgite or kaolinite, 7.38 tons at LD 26/ton (1 year)	192
Wetting agent, 0.82 tons at LD 232/ton (1 year)	191
	1,073

(g) Bromophos-25

Bromophos (tech.), 3.75 tons at LD 1,060/ton	3,970
Kaolin or attapulgite, 10.95 tons at LD 26/ton (3 months)	284
Wetting agent, 1.2 tons at LD 232/ton	278
	4,532

(h) Anthraquinone-80

Anthraquinone (tech.), 8 tons at LD 800/ton (3 months)	6,400
Attapulgite, 7.2 tons at LD 26/ton (1 year)	188
Wetting agent, 0.80 tons at LD 509/ton (1 year)	407
	6,995

(i) Weed killers (separate blending)

Linuron, simazine, atrazine
(50) (80) (80)

Linuron (tech.), 6.95 tons at LD 800/ton (3 months)	5,560
Attapulgite, 11.75 tons at LD 26/ton (6 months)	306
Wetting agent, 0.5 tons at LD 232/ton (6 months)	116
	5,982

(j) Solvents

Xylenes, 10 tons at LD 90/ton (6 months)	900
Benzene, 5 tons at LD 110/ton (6 months)	550
Cyclohexanone, 1 ton at LD 300/ton (3 months)	300
	1,750

(k) Packaging material

Mild steel drums, open top, 55 gallons each 500 at LD 3.44/drum (resin lined) (3 months)	1,720

Bags, cartons etc. (polyethylene lined) (3 months)	220
	1,940
Subtotal	119,933
7.2 Spare parts (10% of essential equipment)	2,500
7.3 Product: 2 weeks at production cost 50 tons at (about) LD 600 ton	30,000
7.4 Wages and salaries (1 month)	2,730
7.5 Unforeseen (10% of 7.1 to 7.4)	15,516
	170,679
Total 1 to 7	369,909
Capital expenditure per unit ton	$\frac{396,909}{730}$ =
	542/ton

B. Building, manpower and utilities requirements

1. Building and foundations

Main building (factory)	15 x 10 x 8 m
Walls	138 m^3
Roof	22 m^3
Floor	45 m^3
Administration:	
Partly	50 m^3
Stores, sheds raw materials	156 m^3
Finished product	- nil -
Subtotal	311 m^3

2. Concrete trays and foundations

Unit operations 26.5 m^3 - 30 m^3 (approx.)

3. Miscellaneous

Roads	- nil -
Unforeseen	50 m^3

C. Power requirements (horsepower)

1. Crushing and grinding section

Crusher	15	
Hammer - mill	6	
Dryer	5	
Screen conveyor	2	
Bucket conveyor	2	
Seiving (screening)	5	
Ring-roll mill	100	
Bucket conveyor	2	
Granules, dust storage bins	2	
Ribbon mixer	50 for 5 tons	Daily = 4 h
	50 for 5 tons	
Bucket conveyor	1	
Solid filling and packaging unit	3	
EC mixing vessel	5	
Miscellaneous	10	
	43 hp	
Power consumption per 8 h	(43 x 8) + 15 x 2 + 100 x 4	
	344 + 30 + 400	
	774 hp = 580 kWh	

2. Exhaust system

Horsepower required per hour	20
for 8 hours	160 = 120 kWh

3. Lighting

50 x 200 per hour = 10 kWh
for 8 hours = 80 kWh

Total of 1.2 and 3 = 780 kWh

Annex IX

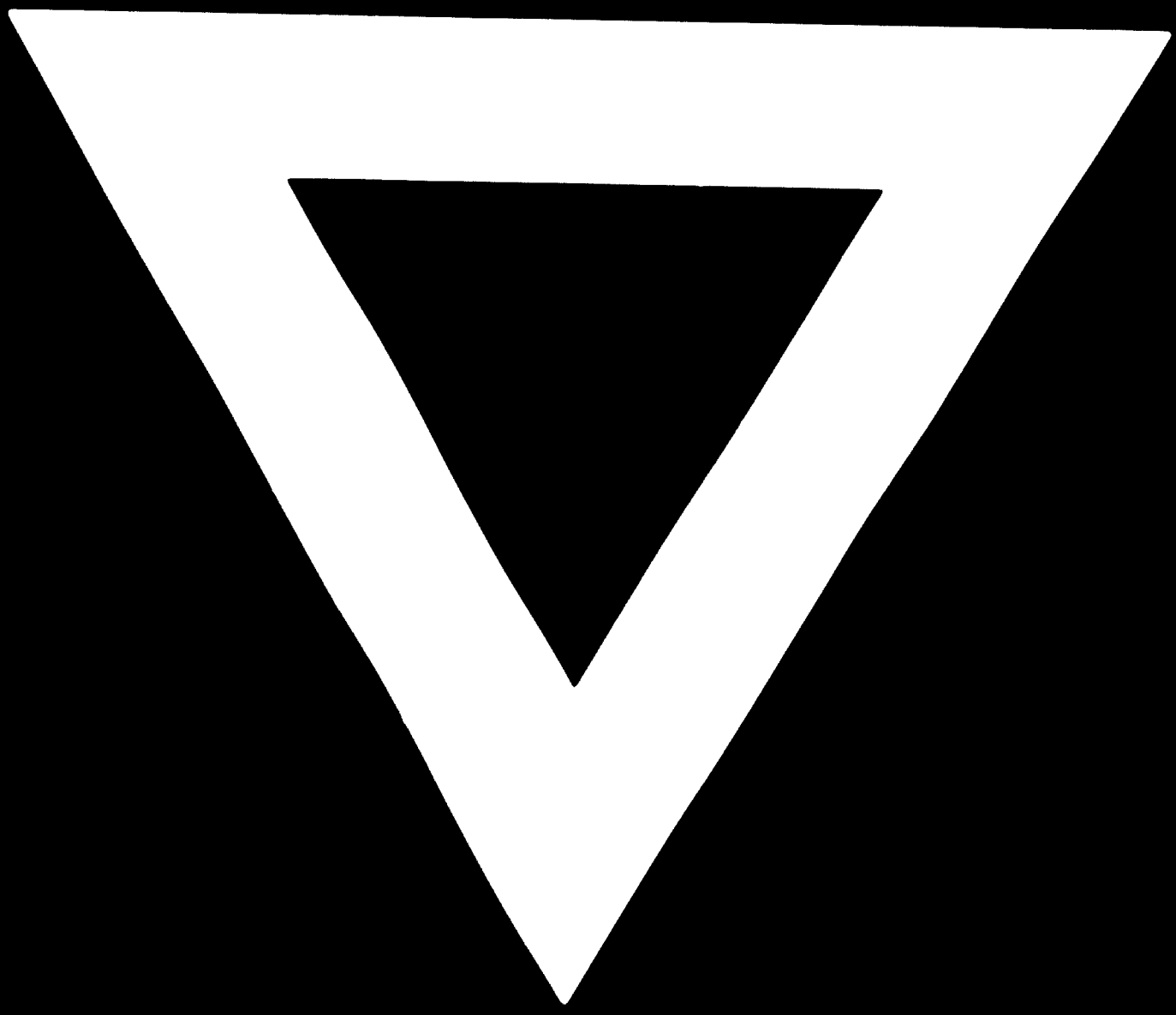
AEROSOLS

Capital expenditure (Libyan dinars)

1. Fixed capital		
1.1 Land		(None required. Installation is to be located within the premises of the white-oil plant.)
1.2 Levelling		2,000
	Subtotal	2,000
2. Building and construction		
2.1 Building		6,000
2.2 Roads		-
2.3 Fence		-
	Subtotal	6,000
3. Machinery and equipment		
3.1 Production equipment		
(a) Mixing unit		
(b) Injection/filling unit		
(c) Packaging tables etc.		
(d) Miscellaneous		100,000
3.2 Ancillary equipment		
(a) Boiler etc.		-
(b) High-voltage distribution etc.		-
(c) Repair and maintenance workshop (additional)		2,000
(d) Chemical laboratory		1,000
(e) Network within plant compound		-
(f) Electricity: low-voltage supply to plant and stores		3,000
(g) Water supply		1,500
(h) Sewerage		2,000

(i)	Telephone installation	1,000
(j)	Plot lighting (additional)	1,000
3.3	Freight, insurance, dock clearance, internal transport (15% of 3.1 and 3.2)	16,725
3.4	Design and technical works (5% of 3.1 and 3.2)	5,580
3.5	Erection and commissioning (15% of 3.1 and 3.2)	16,725
	Subtotal	150,530
4. Transport vehicles		
4.1	Diesel truck (10-ton capacity) (1)	2,500
4.2	Fork-lifts (2)	
(a)	for drums	1,500
(b)	For packages	1,500
4.3	Station wagon (1)	2,000
4.5	Personnel car (1	1,000
	Subtotal	8,500
5. Office furniture and equipment		
5.1	Furniture	2,000
5.2	Equipment	3,000
	Subtotal	5,000
6. Preliminary and preoperational expenditures		
6.1	Legal matters	1,500
6.2	Advertising and publicity	2,000
6.3	Training	2,500
	Subtotal	6,000
7. Working capital		
7.1	Raw materials	
(a)	Bioallethrin, 750 kg at LD 37.815/kg (3 months)	28,350
(b)	Bioresmthrin, 75 kg at LD 52.215/kg	3,900
(c)	Piperonyl butoxide, 1,500 kg at (about) LD 7/kg	10,500

(d)	Base oils (aromatics), 57 tons at LD 90/ton	5,130
(e)	Propellants (Freons 11 and 12) 315 tons at (about) LD 400/ton	126,000
(f)	Packaging (16-oz) 1,300,000 cans at LD 25/1,000	32,500
(g)	Empty 1-ton cylinders for Freon 11/[illegible] 250 cylinders at LD 200 (Cl_2 cylinders ?)	50,000
7.2	Spare parts (10% of essential equipment)	3,000
7.3	Product: 1 week's production (20 tons) at approx. LD 650/ton	13,000
7.4	Wages and salaries (as in emulsifiable concentrates (annex VII.C)) 1 month	3,000
7.5	Unforeseen (10% of 7.1 to 7.4)	27,500
	Subtotal	302,880
	Total 1 to 7	480,910
	Capital cost per ton	$\frac{480,910}{1,500} = 320.6$



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