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ASSISTANCE TO THE PESTICIDES INDUSTRY,

IS/SYR/72/819

SYRIAN ARAB REPUBLIC

TERMINAL REPORT .

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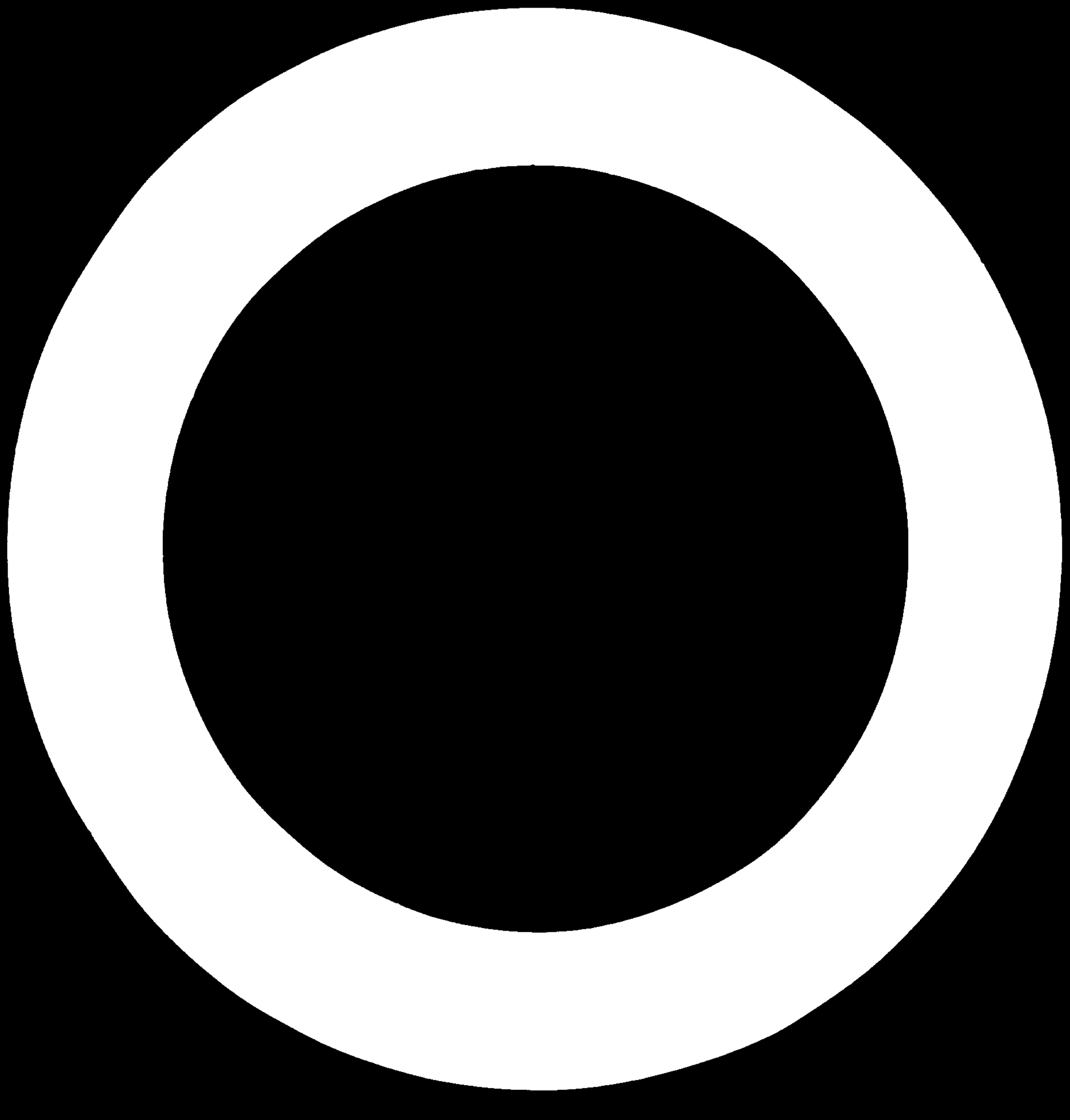
Prepared for
the Government of the Syrian Arab Republic by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization



United Nations Development Programme

ASSISTANCE TO THE PESTICIDES INDUSTRY

IS/SYR/[illegible]/819

SYRIAN ARAB REPUBLIC

Project findings and recommendations

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

Based on the work of Otto Zeiser, expert in the production of pesticides

United Nations Industrial Development Organization
Vienna, 1975

Explanatory notes

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

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.

A comma is used to distinguish thousands and millions.

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

The monetary unit of Syria is the pound (LS). During the period of the project, the value of the pound in relation to the United States dollar was $US 1 = LS 3.65.

The following abbreviations are used:

Technical abbreviations

atm	atmosphere
EBP	end boiling point
EC	emulsion concentrates
ha	hectare (10,000 m^2)
hp	horsepower
IBP	initial boiling point
kW	kilowatt
ULV	ultra low volume
WP	wettable powder

Organisations

CIPAC	Collaborative International Pesticides Analytical Council
FAO	Food and Agriculture Organisation of the United Nations
WHO	World Health Organisation

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SUMMARY

Agriculture is one of the most important economic activities of the Syrian Arab Republic. Each year, pests, diseases and weeds destroy crops with a value of more than LS 100 million.

This study gives a market analysis of the growing demand for pesticides. The description of the operation, personnel and surface requirements for a proposed formulation plant are presented in a layout. And economic aspects such as foreign exchange savings, investment and cash flow are analysed.

The consultant recommends that a formulation plant be constructed as soon as possible to be on-stream by 1978/79. In further recommendations he outlines the most important decisions that should be taken in establishing a pesticides industry.

INTRODUCTION

The purpose of the project "Assistance to the Pesticides Industry" (IS/SYR/72/819) was to provide expert assistance to the Government of the Syrian Arab Republic in assessing the feasibility of establishing a multipurpose pesticide formulation plant. Follow-up technical assistance by UNIDO is possible.

As stated in the job description, the expert, in consultation with the appropriate government agencies, was expected:

(a) To survey the current and short-term demand for export potential of pesticides;

(b) To recommend present and potential capacities, to describe the production processes with block-flow diagrams, and to give material and energy balances;

(c) To prepare a preliminary layout of the plant and to complete a detailed equipment list;

(d) To provide an organization chart, giving in detail the personnel required;

(e) To determine the technical inputs with emphasis on the raw material specifications;

(f) To assess the availability of know-how, patent rights and technical assistance needed;

(g) To indicate the most suitable site for the proposed plant, together with the site evaluation;

(h) To estimate the annual sales, annual operating expenditure and profits, and investment and cash flow;

(i) To prepare tender specifications for the formulation plant;

(j) To advise on future follow-up action, including the possibility of technical assistance.

The request of the Government, dated January 1969, was approved by the United Nations Development Programme (UNDP) in July 1969. A preliminary report was made by R. Krupicka (OA 220 SYR (16)) whose mission extended from 26 January to 17 April 1971. In October 1972, A Abboud, N. Chammas and Z. Katbali studied the feasibility of building a plant for pesticides. In June 1975, S. Haddad was asked by the Ministry of Industry to repeat this study.

The visit of the consultant was approved in March 1973 but was held in abeyance pending the completion of preparatory economic studies. He arrived in Damascus on 19 June 1975.

At present, in the Syrian Arab Republic, all pesticides are imported as formulated products at high cost. The objective of the study was to examine the possibility of formulation of imported raw active materials using as much as possible domestic resources for inert carriers, solvents and packing materials. The project could be feasible only if materials of high quality were found.

The establishment of a local pesticide formulation plant, providing for both agricultural and public health requirements and using domestic resources and the domestic labour force, would result in a reduction of foreign exchange requirements and of the cost of products.

The minimum economic capacities were considered to be 500 tons per annum (t/a) of liquid formulation and 1,000 t/a of powder formulation. The cost of equipment would be between LS 1-1.5 million, and land, buildings and civil work would cost approximately LS 1.0 million.

If the present study demonstrates good economic results, UNIDO assistance in equipping a demonstration plant may be requested.

Training possibilities exist for analytical control and establishing quality standards (through collaboration between a current UNIDO project and the Food and Agriculture Organization of the United Nations (FAO)).

This study was made under the supervision of the Ministry of Agriculture and Agrarian Reform. The consultant was assigned to the Research Centre at Douma and was assisted by M. Hamidi; A. Abboud was assigned as counterpart from the Ministry. The co-ordination of the interests of the Ministry of Petroleum and Mineral Resources and the Ministry of Industry was effected by the State Planning Commission with the help of T. Dagli.

I. IMPORTANT CROPS

The cultivated area, in 1973, amounted to a total of 5.9 million hectares (ha), 2.5 million ha fallow and 3.4 million ha cropped. Of this total area, 619,000 ha were irrigated and 2.8 million ha were dry-land. Co-operatives or publicly-owned cultivated land consisted of 600,000 ha, whereas privately-owned areas totalled 2.8 million ha.

Cultivated areas were concentrated as follows:

	Million ha
Hassakeh	1.58
Aleppo	1.26
Raqqa	0.67
Hama	0.50
Homs	0.43
Idleb	0.38
Damascus	0.26
Tartous	0.13

For this study 18 crops were selected (see annex III) covering a cultivated area of 2.4 million ha.

There were nearly 1 million people employed in agriculture, or more than 50% of the total work force. The contribution to GNP was around 23%. As agricultural products are the base for many other industries, harvest results are of the greatest importance for the whole country.

Agriculture depends on favourable climatic conditions, especially in the Syrian Arab Republic where only 18% of the cultivated area is irrigated, and abnormal weather from year to year affects crop yields. The yield figures for 1972 and 1973 are presented in table 1.

After the consecutive dry years 1955-1961, which resulted in nearly catastrophic consequences for the economy, all efforts were made to irrigate as much arable land as possible. The targets of the five-year plan, 1976-1980, are:

	1975 (thousand ha)	1980 (thousand ha)
Irrigated	576	1,024
Dry-land (250 mm rainfall)	2,032	2,872
Sub-total	2,608	3,896
Dry-land (250 mm rainfall) (not planned)	800	800
Total	3,408	4,696

Table 1. Harvest yields per crop in 1972 and 1973

Crops	Area (hundred ha)		Yield (t/ha)		Type of land
	1972	1973	1972	1973	
Wheat	1,354	1,476	1.3	0.4	Dry
Barley	593	914	1.2	0.1	Dry
Maize	12	12	1.3	1.3	Irrigated
Cotton	238	200	1.8	2.0	Irrigated
Sugar beets	10	3	26.0	20.0	Irrigated
Lentils	115	92	0.8	0.3	Dry
Potatoes	8	8	15.3	13.2	Irrigated
Olives	149	75	1.1	0.4	Dry
Grapes	67	74	3.1	2.0	Dry
Oranges	2	2	4.2	7.1	Irrigated
Tomatoes	22	21	14.5	13.0	Irrigated
Watermelons	57	40	8.1	2.5	Dry
Vetches	55	64	1.0	0.2	Dry

It is planned to have no fallow land in two climatic areas (with more than 250 mm rainfall). The total cropped area projected for 1980 should be 1.3 million ha greater than for 1975. This is an agrarian revolution; its targets for harvest yields are even more challenging than those for cropped areas, as given in table 2.

Table 2. Projected harvest yields for 1975 and 1980
(Thousand tons)

	1975	1980
Cereals	1,777	4,034
Legumes	121	365
Fodder crops	207	9,094
Cotton	388	488
Sugar beets	200	2,500
Oil seeds	249	437
Potatoes	117	458
Total	3,059	17,376

For some crops, in particular sugar beets, fodder crops, rice (to 27,000 ha) and maize, it is planned to augment the surface area drastically (annex III), while for cotton, wheat, fruit trees and vegetables, more intensive crop methods are planned. Such forecasted growth will require better irrigation, more fertilizer use and increase plant protection.

To meet the challenge of the five-year plan in utilizing more intensive cropping methods, plant protection will become an integral part of the new planning targets, for without increased use of pesticides the desired crop yields cannot be obtained.

II. USE OF PESTICIDES

Agriculture

Insects and diseases attacking crops

A variety of insects and diseases attack most cultivated crops (see annex IV), though the extent of infestation varies with climatic conditions and zones. Infested areas are usually small, only occasionally becoming epidemic.

In 1974, it was reported that infestation in the Syrian Arab Republic amounted to 5.3% for winter crops and 18% for summer crops. Heavier attacks have been observed among the following crops:

	Percentage
Cotton	30
Legumes	20
Chick peas	65
Tomatoes	25
Potatoes	25
Fodder crops	100

The most important pests are earias insulana, heliothis armigera, laphygma exigua, aphis fabae, dacus oleae, scale insects, carpocapsa pomonella, and red spider mites.

The most important diseases are plasmopara viticola and peronospora tabacina septoria.

Insects living on different crops pass from one cultivated area to another throughout the year. Plant protection is concentrated on a few crops: cotton, wheat and legumes (lentils, fodder crops etc.), olives, apples, sugar beets and tobacco. When a pest or disease is not kept under control, considerable damage is incurred and the entire harvest is threatened in an infested area.

Damage caused by insects and diseases

A United Nations report on growth prospects in the agricultural sector of the Syrian Arab Republic (1971) estimates that the response to the need for insecticides would result in a benefit cost ratio of 28:1; that is, for every LS 1 spent on insecticides, LS 28 would be earned on the saved crops. The low level of insecticide use as compared with the large number of infestations may be the reason for the high response noted in this case. R. Krupicka estimated losses of more than LS 200 million per annum owing to inadequate treatment with pesticides.

In the five-year planning report of the Plant Protection Department several examples of losses are given:

(a) Wheat. Zabrus tenebrioides caused a 50% reduction in yield by attacking the wheat in the first leaf stage.

The weed treatment campaign in 1971/72 realized a profit of LS 36 million;

(b) Cotton. Wilt caused a loss of 3.6% of the total harvest, whereas rhizoctonia effected a 10-90% loss in the infested area.

Early infestations of earias insulana caused up to 60% damage;

(c) Apples. In the Mediterranean area in 1972/73 scab destroyed the entire harvest.

Weed control made an improvement of 10%;

(d) Olives. Dacus oleae destroyed 90% of the harvest in Lattakia;

(e) Various. Ground-nuts cannot be grown without miticide treatment. In raising tobacco and sugar beets, it is possible to have good results only with intensive pesticide use. The tobacco foundation is at present one of the greatest pesticide users in the country.

The benefits of plant protection are respected in the fourth five-year plan. Higher crop yields are based on adequate pesticide use.

To make large quantities of pesticides available within a short time is the scope of this study.

Organisation of plant protection

Within the Government the responsibility for plant protection is delegated to the Ministry of Agriculture and Agrarian Reform. Both its directorates of agrarian affairs and the directorate of agricultural research have plant protection departments. The latter has research stations in Hama, Aleppo and Lattakia and research groups attached to Mohafazat inspectorates. Fourteen Mohafazat inspectorates for plant protection are under the Mohafazat directorates for agrarian affairs, with application groups in the most important areas.

Aside from the governmental organisation of plant protection, specialised groups within the tobacco corporation and sugar manufacturing corporation and trained service technicians from privately-owned companies are also interested in the promotion of the protection of plants.

The co-ordination of all state activities is handled by the plant protection section in the Ministry of Agriculture and Agrarian Reform.

A yearly forecast of needs is made in agreement with all groups.

All pesticides to be used are requested in July by TAMCO.

The quantities and qualities are specified in the tenders.

Importations are made in time for application.

Three large, privately owned companies and various smaller ones contribute one third of the volume of pesticides needed. With the importation of small quantities of different products by these companies, unplanned and unexpected pesticide needs are satisfied. These pesticides must be tested for three years in research stations. The privately-owned companies try to serve all farmers and tenants as much as possible.

The inspectorates for plant protection concentrates on large areas of key crops with modern methods of pesticide control. During periods of heavy infestation as many as 90 control teams consisting of a graduate engineer and an assistant with a car observe the areas. They control 3,000-4,000 ha every week and remain in close contact with the Ministry. In their reports to the Ministry they give the level of infestation, problems and results.

The Research Centre is enlarging its laboratory facilities. Although well-trained specialists in entomology, plant diseases and pesticide use are employed at present, there are still not enough qualified personnel.

Research is concentrated on individual crops. For example, at the Hama Research Station research is being conducted on potato growing and storage, thus making the researcher responsible for all potato-growing areas in the Syrian Arab Republic and for the plant protection in these areas. The results obtained have been good; up to 30 t/ha can be harvested. Soon potatoes will be available year around in good quality.

At the Douma Research Station, the most adaptive varieties of wheat were selected, resulting in a harvest of up to 7 t/ha. In growing maize the response activity of FAO is leading to favourable results.

Plant protection is always integrated into these programmes. The targets of the new five-year plan demand the enlargement and re-organisation of plant protection. A formulation plant could contribute to the attainment of the plant's objectives and should be included in the new organisation chart.

In the Syrian Arab Republic good organization exists for plant protection that provides specialists who are well-trained and research facilities that concentrate on single crops. As plant protection is well-integrated into the research programme, there is a good basis from which to increase the use and improve the quality of pesticides.

System of pesticide distribution

Importation of registered pesticides is possible only with the consent of the Ministry of Agriculture. Of the total amount of imported pesticides, excluding S-dust, TAFCO imports 60%. The Tobacco Foundation imports directly 500 t dithiocarbamates, or 10%. Private importers who are registered number 8. Only three of those registered import huge quantities; the remainder handle small amounts occasionally, usually for their own needs. The quantity purchased by private importers is 30% of the total. TAFCO gives small quantities directly at cost price to the Ministry and to state-owned farms.

The largest quantity of imports, which in 1975 was 2,300 t, is handled by the Agricultural Bank. Chemicals arrive at Lattakia where a warehouse with a capacity of 10,000 t and small analytical laboratory facilities are available. Chemical analysis is made at the Faculty of Pharmacy, University of Damascus.

From Lattakia, materials are sent to the storehouses at Aleppo (40,000-ton capacity), Deir-el-Zor (12,000-ton capacity), Damascus (10,000-ton capacity) or directly to one of the 50 warehouses throughout the country. Total warehouse capacity is 150,000-200,000 t, to be enlarged within the next few years. The transport and warehouse facilities are not always linked. Rain may cause damage.

The Agricultural Bank adds 25% to the import price. Prices offered by the Bank are fair; however, quality and services are not always sufficient. The local distribution of quantities is given in annex IX.

Private companies distribute through nearly 250 small dealers located throughout the country. The percentage that may be added to the net import price is 30%, distribution cost included, with the small dealer normally receiving 10% and the private company 20%. The importer is held liable for all accidents and failures connected with distribution and application. Prices offered by private firms are high, but services and quality seem good.

Distribution prices are regulated by the Government. The distribution network of the Agricultural Bank is still too small. It may be possible to include small dealers in the future. With more information about the benefits and proper uses of pesticides, combined with set prices, progress can be made towards improving the system of distribution. If new ways of distribution are found, the desired level of pesticide use could be attained sooner.

Types of pesticides used

More than 500,000 ha are treated with pesticides every year. The most commonly used form of pesticides is sulphur dust (approximately 3,000 t/a). Its application is widespread because it is easy to use, is not harmful and has positive side effects on many crops.

Dusting is the most widely used technique of application. In 1975, 5,500 tons of dust were used and it is expected that increasing quantities will be used for the next five years. How the dust is applied varies according to amount. Small quantities are spread by hand, while larger quantities are sprayed with power dusters. Attention should be paid to poisonous substances. Warning colours should be used.

To cover vast areas of 75,000-100,000 ha airplanes are used, thus making ultra low volume (ULV) application more important. Emulsion-concentrates (EC) are also used on a large scale.

At present, there are many different types of pesticides being used in the Syrian Arab Republic, with no preference for individual compounds. Both traditional compounds and the latest developments of the chemical industry are to be found. In the near future, with increased use and experimentation, only those compounds which prove most efficient will be selected and used.

Fungicides are traditional compounds. The tobacco-growing industry depends on the protection that dithiocarbamates provide and this accounts for the large quantities used. While dithiocarbamates play such an important role, at the same time different systemic fungicides are being introduced and will soon come into use. It is also planned that large quantities of fungicides will be designated for seed treatment. In fruit growing, especially in the growing of apples, fungicide treatment is most important, but the wettable powder (WP) formulations are still not receiving widespread use.

Weed control is concentrated on wheat and cotton. Various wheat pesticides such as 2, 4-D, MCPA and Banvel are used and will be sufficient for the near future. In cotton pre-planting, treatments with trifluralin are being introduced and will be used on a large scale soon. Weed control for other crops is still in its first stages. Different herbicides are used in small quantities. It is to be expected that the use of herbicides will grow rapidly.

Granular formulations are used against wire worms only on a small scale. Rodent control is made with zinc phosphide and nematocides are used only on a small scale.

Table 3 gives estimated consumption of pesticides in 1975 and table 4 indicates the aerial application plan for the period 1975-1980.

Table 3. Estimated consumption of pesticides, 1975

Crop	Insecticides		Fungicides	Herbicides
	EC/WP	Dust		
Wheat	20	300	100 (seed)	80
Chick-peas	25	30	-	-
Lentils	10	800	20	-
Legumes	40	100	-	-
Cotton	150	1,000	-	50
Tobacco	-	-	400	-
Potatoes	4	-	3	-
Tomatoes	6	20	3	-
Maize	6	-	-	-
Ground-nuts	7	-	1	-
Alfalfa	30	50	-	-
Apples	15	-	15	-
Olives	40	-	5	-
Grapes	8	-	5	-
Municipalities	15	-	-	-
Total	376	2,300	552	130
Unplanned estimate	100	250	150	50
Grand total	476	2,550	702	180

Unofficial source: A. Abboud (TAFCO tender 1975); 3,000 t sulphur dust are not included.

Table 4. Aerial application plan, 1975-1980
(Thousand ha)

Crop	1976	1977	1978	1979	1980
Wheat	[illegible]	25	30	35	50 to 200
Cotton	30	35	40	45	50
Peas	20	25	30	35	40
Sugar beets	10	12	15	17	20
Olives	20	25	30	35	40
	105	122	145	167	200

Source: A. Ali, Ministry of Agriculture.

Public health

In Damascus, 10 t of Actellic (50%) are used annually for public health purposes. Actellic is distributed with fogging machines. A small car equipped with two fogging guns circulates through the streets of Damascus. The fog is sprayed into the traffic, crowds of people and shops. M. Cabbani of the Public Health Department, Damascus, is of the opinion that this is the best way to combat insects in conjunction with the spraying of hiding and breeding places, channels, waste deposits etc. with small hand sprayers. Equally as important and often underestimated are the swallows who prove effective insect controllers.

During the dry season insect nuisance remains at tolerable levels. Especially in the cities more discipline in sanitation practices should be encouraged. In the other towns of the Syrian Arab Republic conditions are similar.

The over-all consumption remains below 20 t/a. (A. Abboud spoke of 80 t but this figure requires confirmation.)

Veterinary uses

Insecticides with low mammalian toxicity are used for the control of ectoparasites whose hosts are sheep, goats, cattle and poultry. Ectoparasites include ticks and lice. The diluted insecticides are used either by dipping or spraying.

At the moment nearly 50 t of different compounds, such as lindane and Dipterex, are used. The consumption remains limited and is not expected to exceed 100 t in the near future. This quantity does not effect over-all planning. Provision should be made for formulating locally small quantities of pesticides with low mammalian toxicity, which could be established as a separate department in the formulation plant. As a minimum precaution there should be a small filling station reserved for veterinary uses only.

Export market

The pesticide market (table 5) in the Arab and other countries is expanding rapidly.

Table 5. Imported pesticides in Arab and other countries (Thousand dollars)

	1965	1969	1973
Brunei	100	200	400
Iraq	700	1,200	2,000
Jordan	400	600	1,200
Kuwait	300	700	1,200
Lebanon	1,200	2,000	2,500
Syrian Arab Republic	500	800	2,400
	3,200	5,500	9,700

Source: FAO, Production Yearbook, 1973 (Rome, 1974).

These figures show a medium growth rate of 10 to 15% per annum. Sometimes, as in the Syrian Arab Republic, higher growth rates are realised. Iraq, for example, used the following amounts of emulsion concentrates:

	Tons
1971	400
1973	600
1976	980

Pesticides imported by Lebanon in 1973 amounted to:

	Tons
Chlorinated compounds	177
Phosphorous compounds	860
Carbamates	100
Acaricides	80
Sulphur	2,500
Copper compounds	40
Organic fungicides	290
Various	200

..

Many of these materials have been exported to neighbouring countries. Formulation equipment has been installed and export efforts have been strengthened. Iraq and Jordan are discussing formulation capacities.

Exporting pesticides is possible with a good knowledge of market conditions, with products of high quality and by establishing good relations with marketing organizations. For example, S-dust and solvent (xylene base) would readily find export markets. In the Syrian Arab Republic formulated pesticides may be marketed through a Syrian-based, privately owned company with outlets in the neighbouring countries. Through these channels, specific markets can be easily reached. Another possibility is to produce for large chemical companies, since the reputation of the factory would warrant the involvement of a large firm, and to export pesticides formulated according to company specifications.

The potential for export is high in the Syrian Arab Republic. It is limited, however, by the efforts of neighbouring countries to formulate for their own needs and by the necessity to have had a good working base previously.

Planning figures for the next years in the Syrian Arab Republic are optimistic. It will be possible to produce for export within a short time with second and third shifts.

Probable consumption of pesticides

As pesticide use is growing rapidly, radical changes are expected. In 1975, 648,000 ha were being treated with pesticides, whereas for 1980, 1,395,000 ha are expected to be treated. (See table 6.)

Table 6. Value of pesticide imports, quantities distributed and yearly use (Million LS)

Year	Effective	Year	Planned
1965	0.5	1976	51.0
1967	0.8	1977	81.0
1968	1.8	1978	95.0
1969	3.0	1979	118.0
1974	10.0	1980	140.0
1975	15.0		

Source: A. Abboud, estimates of the Ministry of Agriculture.

Table 6 (continued)

	Distributed quantities (Tons/annum)		
	1968 a/	[illegible]	[illegible]960
Insecticides			
Dust	[illegible]00	[illegible],450	4,5[illegible]
WP/EC	[illegible]	[illegible]	[illegible],504
Fungicides			
S-dust	[illegible],000	[illegible],000 b/	[illegible],0[illegible]
WP	[illegible]0	[illegible]0[illegible]	[illegible]
Seed treatment	-	[illegible]00	[illegible]
Herbicides	[illegible]0	[illegible]0	[illegible]

a/ Estimate of R. Krupicka (UNIDO preliminary report, 197[illegible]).

b/ Estimates of consultant.

Yearly variations in pesticide use

	Tons	Percentage
1969	716.9	100
1970	534.4	74
1971	1,190.8	166
1972	809.9	112
1973	640.3	86
1974	935.0	130

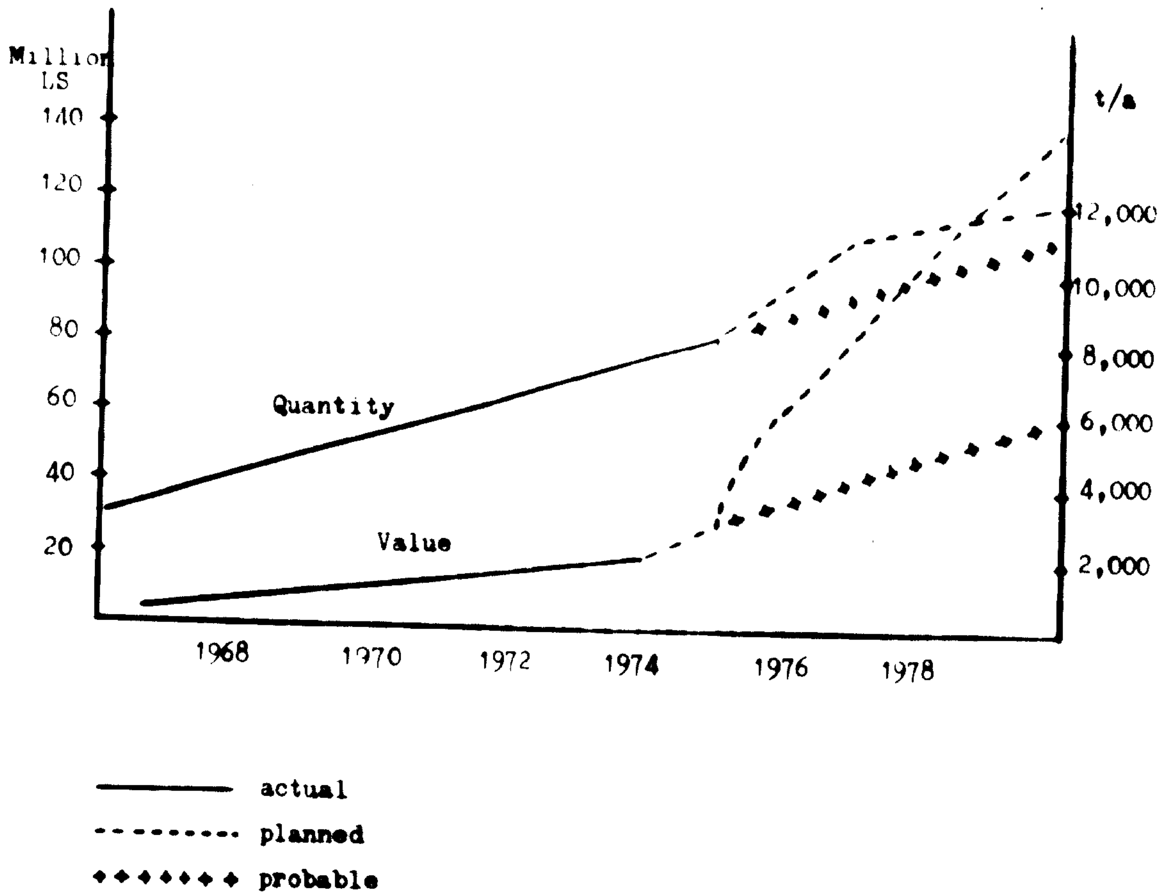
Source: K. Bahbouh, Agricultural Bank.

The planning figures of the fourth five-year plan are based on the necessity to augment cropped area from 2,799 million ha to 4,047 million ha and to augment crop yield per ha. To achieve these targets new crop rotation must be introduced and more equipment and trained personnel will be needed. Public health and veterinary uses will not influence planning as the amounts required for these purposes are minimal.

Exporting will influence the volume of production. A more detailed discussion will be given when considering the flexibility in layout for capacity expansion.

Sulphur dust will be produced by the Homs Oil Refinery. The dust-mill is under construction and will be on-stream in 1976. The ultrafine-mill is not

Development of medium pesticide use - quantities and values



the best equipped, but it could give good results if handled with care. The nominal capacity is 3 t/h. By using this mill, LS 1.5 million per annum in foreign currency can be spared. The export potential of sulphur dust is good. Sulphur is also the base for cottondust and may be used for other formulations in the future. The sulphur production in the refinery and the sulphur dust-mill are of great importance. They may be considered a foundation for pesticide formulation in the Syrian Arab Republic.

The formulated products that will be imported in the future include small quantities of specialities such as Al_3, P_2, Zn_3P, methyl bromide, as well as some products like Mancozeb, which, because there is only a small price difference between the price of the components and the formulated products, would not be profitable to formulate.

A fair estimate is that two thirds to three fourths of the total demand of pesticides would be formulated in the Syrian Arab Republic, which would amount to 5,800-7,000 t/a, if the targets could be reached. The plant could be on-stream at the end of 1978, if definite decisions for construction are taken immediately. Immediate follow-up action should be considered.

From year to year great variations in pesticide consumption are possible; thus the planning figures are medium values. Climatic conditions can affect consumption by more than 100%.

III. MATERIALS TO BE USED

The success of pesticide formulation depends on well-selected raw materials, efficient analytical control and standardization of important characteristics. The selection of raw materials should be based on the local experience.

Active materials

A few chemical companies produce pesticides. Specific compounds are available from only one company; however, materials used as mediums in formulating pesticides can be obtained from a greater number of producers.

It is preferable to contact directly well-known companies. They can readily provide information, technical advice, analytical methods and the guarantee of high quality.

Active materials must correspond to FAO specifications or to specifications given by the producer. Every shipment should be accompanied by an analytical certificate.

From the beginning, production should be concentrated on a limited number of active compounds. Only after resolving all problems concerning these compounds, should new formulations be considered. In annex V compounds to be used in the near future are indicated.

In co-operation with the counter part to the consultant, the following programme of production was selected:

Dusts: Cottondust, toxaphene-DDT-sulphur, endosulfan, trichlorfon

Emulsion concentrates: Phosphamidon, dimethoate, toxaphene-DDT-methyl parathion, Thiodan, Azodrin, malathion, leptofos

Wettable powders: Carbaryl, zineb

Herbicides: 2, 4-D, Banvel, Treflan

The final composition of these products must be elaborated on a pilot-plant scale in a laboratory. Suitable facilities exist at the site of the UNIDO Project, Industrial Research and Development, Masseh, for the training of an analytical chemist who has been requested for these investigations. The formulation could be supervised by the second counterpart from the Agricultural Research Station at Douma. Training is necessary. Later on, a specialist must be found to do this work, to allow the counterpart from the Research Station to concentrate on field application trials and to co-ordinate the interests of the Ministry of Agriculture and other parties. A team consisting of three men should be formed as soon as possible and should receive all needed assistance in obtaining results.

The composition of the selected compounds must be established before 1978 when the formulation plant is scheduled to start operation. The programme can cover more than 80% of quantities imported in 1975 and could correspond to about 70% of probable consumption by 1980. Immediate industrial production without field trials using pilot-plant quantities would prove unwise in the long run.

Difficulties arise when formulating pesticides such as phosphamidon and dimethoate, of which various components are available in the Syrian Arab Republic. Phosphamidon needs water soluble solvents (isopropyl alcohol, ethylene glycol, monoethyl ether). These solvents are not available domestically. Ciba-Geigy should be contacted for advice whether phosphamidon can be formulated under specific conditions with the locally available xylene. If this is not possible, other aphicides must be selected.

Dimethoate for low-volume application (1.5%) together with baits (3-4%) should be formulated with water soluble solvents, which are not available in the Syrian Arab Republic. A minimum of 30% of water soluble solvent (cyclohexanone) is considered indispensable. Before selecting the final mixtures of solvents, preparations should be tested in collaboration with producers (Cela-Merck, Basf, Montedison) most importantly for residues and phytotoxicity. If the locally available xylene cannot be used alone, concentrated solutions of dimethoate in cyclohexanon must be imported. The selection of surface-active agents remains critical.

Detailed information about emulsifier selection was given to M. Hamidi. Training is necessary.

Dusts need well-selected inert carriers, preferably those available locally that even after improper storage retain fluidity and that in the rainy season remain stable. Test methods will be given to M. Hamidi.

Inert carriers

These inert carriers for dusts and wettable powders available locally include limestone (chalk, marble), clay (kaolinitic, montmorienitic), phosphate rock and gypsum.

Minimum or maximum qualities are:

SiO_2	max 0.2-0.5%
Fe_2O_3	1-2%
H_2O chalk	1%
clay	6%

Free of coarse grain about 1-2 mm

Limestone is available in abundance. Aleppo is built on limestone. Near Sednaya are 99.2-99.5% deposits. SiO_2 is below 0.2%; Fe_2O_3 is 0.5%.

The water content of limestone varies. Chalk is compacted and contains not more than 3% water, even in the wet season. Crystallized limestone (al-Adra) contains more water because it is porous.

Attention must be given to free alkali.

Drying operation with air 300° C with Ultra Rotor combined with grinding, is indispensable.

Limestone cannot be used for phosphorus compounds.

Gypsum, available in large quantities, could be used for the formulation of dusts. Owing to the sensitivity of gypsum to humidity, precautions should be taken in storing. Attention must also be given to the drying operation to ensure against dehydration.

Various deposits of clay are known to exist in the Syrian Arab Republic.

At Zabedani Gdieda, Kfier and Skaf the content of free SiO_2 is very high. The deposits are small with contaminations of sandy silt. A typical analysis, made in 1969 in Germany, is given in annex XIII.

Tias, 100 km east of Homs and 60 km west of Palmyra, has not yet been exploited. The analysis in annex XIII shows a high content of quarts. Smaller quantities of 500-1,000 t/a may be obtained with a lower quarts content, if care is taken. Different samples should be analysed to see that quarts content and water are low enough.

At the Euphrates Basin sources of green kaolinite are known. No samples had been taken until recently. An official request for a geological survey (S. Atwer, Ministry for Engineering and Industry; see annex I) is necessary.

Clay from Bylun near Aleppo will be upgraded for deep-well drilling. Samples must be taken and analysed. The iron content is around 3%. Tests on the clay are necessary.

If deposits in the Euphrates Basin or Bylun are not clean enough, upgrading is necessary, which involves wet operations at high costs. This upgrading is not feasible for small quantities that will be used in pesticides. For these purposes, clean qualities could be imported from neighbouring countries or France.

Solvents

As most pesticidal chemicals are insoluble in water, it is necessary to use some form of organic solvent for the preparation of liquid formulations. Two types of solvents are used: non-polar petroleum distillate solvents and polar, partly water soluble solvents, which include ketones, esters and glycols. The petroleum distillate solvents are available on the local market but they are at the moment not pure enough. Within the next year white spirit will be available at a price of LS 350 per ton.

The white spirit mixture to be produced at the Homs Refinery in 1976 has a composition as follows:

Specific gravity	0.775
Flash point	37°C min
IBP	150°C min
EBP	210°C max
Sulphur	0.1% max
Aromatics	13%

From the Homs Refinery the following sample was obtained of a technical xylene/toluene mixture:

Specific gravity 60/60	0.800-0.840
IBP	100 ° C
EBP	180° C
Sulphur	0.007% max
Aromatics	90%
Water	0.2%

Both these solvents could be further improved by combining characteristics of IBP 150-180, EBP 180-200 and aromatics minimum 70%. Testing is necessary in any case to find out the distillation range, volatility (confronting with technical xylene), density, flash point and colour/odour. With all active compounds practical solvency tests are essential.

Surface-active agents

Emulsifiers are surface-active agents, reducing interfacial tension between immiscible liquids. Water insoluble pesticides could form stable emulsions if a selected emulsifier is added and then diluted with water.

The selection of an emulsifier needs some training. It must be done systematically and laboratory trials are indispensable. On the world market paired emulsifiers are available and it is not difficult to find out the best combination, producers being the best sources for advice. Samples of emulsifiers can be obtained easily. For example, Farbwerke Hoechst in the Federal Republic of Germany, Tensia, UCB in Belgium and Koppe in Italy could be contacted.

In the formulation of powders dispersants, such as the commonly used calciumlignosulphonate, are needed. Wetting agents are also needed.

It is difficult to give a full outline of materials to be used.

The best way to obtain good results is through laboratory testing.

The exact dose of surfactant is of fundamental importance.

Emulsifiers are not available in the Syrian Arab Republic and must be imported.

Packing materials

Packing materials of different qualities are available in the Syrian Arab Republic. Care must be taken to select stable materials for the packaging of poisonous products. Transport, unfavourable storage conditions and handling by farmers who often are not accustomed to pesticide use are all factors to consider in the selection. On the other hand, it is not necessary to use expensive packing materials.

Packaging of powders

Powders in amounts of 1 kg, 10 kg and 25 kg require packaging. For 1 kg, paper boxes are still the best containers. These boxes must be strong; 10 kg may be packed in a cardboard box and piled up to 4 m for transport under difficult conditions. Less poisonous pesticides can be packed in plastic bags. Zineb, dusts, sulphur etc. can be packed in this way and transported in cardboard boxes.

Bags of good quality for packing 10 and 25 kg are available. They are made of polypropylene on the outside and the inner bag is made of polyethylene. In Damascus, Kamal El-Khatib is a producer. The price ranges between LS 0.[illegible] and LS [illegible], depending on quality and size. Trials are necessary to select the best bag combination. Storage tests will also be needed (analytical control), and transport trials should be made.

Liquid packing

Cans for packing [illegible] and [illegible] kg of liquid are readily available. The quality is still not up to standard. A stable tin must be selected, and production must be carefully supervised; otherwise poison may escape during transport. A producer is Homs Refinery. Leak-proofing methods are necessary.

Glass bottles of 1 kg can be used if each bottle is protected by packing it in a small cardboard box. A well-protected glass bottle, notwithstanding certain criticism, is still one of the best containers for pesticides. The bottle design must be carefully selected, to obtain a form stable enough; e.g. laboratory chemicals are transported in good stable glass bottles.

If aluminium bottles are used, they must be imported. Salcon, Genova, produces them. Pilfer-proof caps are needed.

IV. CAPACITY PLANNING

Capacity needed, 1976-1980

Capacities needed are determined by the fourth five-year plan and depend on development of agriculture and plant protection. More equipment, better service and a better distribution network will be needed for a higher level of pesticide use, thus requiring the concerted action of available specialists and means.

The targets for the use of pesticides may not be reached before 1980. The amount of consumed pesticides especially will remain lower than planned. Estimated capacities are based on the assumption that two thirds to three fourths of the total pesticide market can be covered by the formulation plant. Seasonal variations must be considered and heeded (annex X). Capacities will have to be based on the maximum consumption, taking into account:

(a) Long transport for active materials and delays in deliveries;

(b) Unforeseen interruptions, e.g. lack of spare parts;

(c) Year-to-year variations of climatic conditions, causing great differences in consumption;

(d) Heavy infestations needing immediate action.

Sometimes it will be necessary to stop formulation because warehouses will be full. Eight production lines may be indicated:

Inert carrier upgrading

Powder formulation

Dust

Wettable powder (insecticides, fungicides)

Powder filling

Liquid formulation (emulsion concentrates)

Liquid filling

Herbicide solutions

Herbicide filling

Veterinary products

The formulation capacity for the next few years may be envisaged as follows:

	1976-1978 (tons)	1978-1980 (tons)	1980-1982 (tons)
Dust	2,500	3,000	3,600
WP	400	500	600
Powder total	2,900	3,500	4,200
EC	200	500	1,000 (?)
Herbicides	180	400	900 (?)
Seed-treatment	-	180	200
Total	3,280	4,580	6,300

Monthly production programme

Monthly variations in the use of pesticides are given in annex X. Estimates of deliveries for 1980 are based on the assumption that two months, which should be accepted as average delivery time, would suffice to distribute materials. This may be too short a time for some products handled in large quantities; other products must arrive within a week.

Respective values are given in figure I. The greatest consumption is from January to April. The production programme must therefore be based on compensated capacities. Peaks of unreasonably high delivery per month should be eliminated, and provision should be made for two months maintenance and vacation time. A month is calculated as an average of 20 working days, taking into account holidays and unprogrammed interruptions. The remaining maximum capacities for 1980 then are:

	Tons/month	Tons/day
Powder formulation	460	24
EC	150	7.5
Herbicides	150	7.5
Seed-treatment	100	5
	860	44.0

Table . Monthly pesticide delivery and production programme, 1980

	Total	11/12	1/2	3/4	5/6	7/8	9/10
Pesticide delivery							
EC	1,000	50	300	300	300	50	
Dust	3,600		1,600	2,000			
WP insecticide	300		100	100	50	50	
WP fungicide	300	60	100	100	40		
Herbicide	900	400	500				
Seed-treatment	200				200		
Total	6,300	510	2,600	2,500	590	100	
Production programme							
Dust	3,600	720	720	720		720	720
WP insecticide	300	200		100			
WP fungicide	300		200	100			
Powder, total	4,200	920	920	920		720	720
EC	1,000	300	300	300	100		
Seed-treatment	200				200		
Herbicides	900	300	300				300
Grand total	6,300	1,520	1,520	1,220	300	720	1,020

Source: Consultant's own estimates.

Balance and values of materials

Formulation processes are simple unit operations. Losses of materials remain low: 0.5% in formulation and 0.5% in packing. In the hot summer solvent losses may become higher than 1%. Powder formulation needs active materials, sulphur, two types of inert carrier and dispersants. The following quantities are estimated for 1980.

Table 8. Materials for powder formulation and emulsion concentrates (tons)

	Total	Active material	Sulphur	Carrier 1	Carrier 2	Dispersant
Powder formulation						
Dust 60%	2,100	120	210		1,770	
Cotton dust	1,500	450	600	450		
WP insecticide 50%	300	150		129		21
WP fungicide 75%	400	225			54	21
	4,200	945	810	579	1,824	42

Table 8. (continued)

	Total	Active material	Solvent 1	Solvent 2	Emulsifier
Emulsion concentrates					
Phosalone	[illegible]00	[illegible]0	[illegible]		
Volatile, non-persistent	[illegible]00	40	[illegible]		
Dimethoate	400	[illegible]0	[illegible]	[illegible]00	[illegible]
Aphicides	[illegible]0	[illegible]0			
Different	1[illegible]0	[illegible]0	[illegible]		[illegible]
	[illegible],000	3[illegible]0	[illegible]0	[illegible]00	[illegible]0
Herbicides a/					
Water solution	150	[illegible]0	[illegible]0 water 10 alkali		
Solvent solution	450	[illegible]	288		[illegible]
	900	225	288 ([illegible]0 water) (40 alkali)		[illegible]

a/ The assumption is that all herbicides used are solutions; half the quantity in water solution and half as emulsion concentrate.

The total volume of production is [illegible],[illegible]00 t; of this, 4,000 t ([illegible]3%) are available locally.

Value of locally available raw materials

	Quantity (tons)	Price (LS/t)	Value (LS 1,000)
Inert carrier	2,400	40	96
Sulphur	800	250	200
Solvent	800	350	280
	4,000	640	576

The importation of 1,600 t of active materials is estimated roughly to cost LS 31 million.

Value of imported raw materials

Quantity (tons)	Value (LS/kg)	Total (million LS)
500	5	2.7
400	10	4
200	20	4
100	30	3
350	50	17.5
1,550	115	31.2

A quantity of 100 t special solvent, 42 t dispersant and 87 t emulsifier must be calculated at a medium price of LS 5/kg and a total value of LS 1.2 million.

Value of raw materials for production
(million LS)

Imported materials	32.4
Locally available	0.6
Packing materials	3.0
	36.0

The same products imported to the Syrian Arab Republic would have (at 1974/75 prices) a total value of LS 44 million.

Volume, 1980

Pesticides	Quantity (tons)	Price (LS/t)	Value (million LS)
Cottondust	1,500	2,140	3.2
Dust	2,100	2,540	5.3
Insecticide WP	300	9,000	2.7
Fungicide	200	8,000	1.6
Phosvel	200	12,000	2.4
Diff	350	8,500	3.0
Dimethoate	400	12,400	5.0
Phosphourcomp	50	5,000	0.3
Systemic fungicides	100	40,000	4.0
Banvel G	450	6,000	2.7
Treflan	450	20,000	9.0
Plantvax	200	25,000	5.0
	6,300		44.2

The highest costs are incurred by the use of specific cotton herbicides (Treflan, Cobex, Cotoran), systemic fungicides (Benlate, Topsin etc.), seed-treatment (Vitavax, Plantvax), and specific low-residue insecticides.

At the 1974/75 consumption level, the yearly production programme would be:

	Quantity (tons)	Import value (million LS)	Raw material (million LS) a/
Dust	2,000	4.4	3.5
WP	190	1.8	1.2
EC	260	2.5	1.8
Herbicides	100	0.7	0.4
	2,550	9.4	6.9

a/ Consultant's own estimates.

Raw materials amounting to 750 t would be used with a medium value of LS 9 per kg. Treatment programmes are still based on simple, persistent pesticides. In other countries, the use of materials like BHC, DDT and Endrin is forbidden. Consumption is decreasing; prices remain relatively stable. The change to new compounds, as indicated in the treatment programmes of the plant protection section, Ministry of Agriculture and Agrarian Reform, evidently costs more. The medium cost price of raw materials is rising from LS 9 to LS 19 per kg.

The formulation plant can contribute to minimizing a rise in costs. This could be one of the most important indirect contributions of independent formulation.

Formulation capacity

The formulation capacity must be based on the maximum daily output needed. In figure I, the medium values of compensated capacities are given on the basis of which each production line must be considered.

Powder formulation

The daily capacity needed in 1980 will be 24 t/day, and a daily maximum of three products. Three grinding units (Ultra Rotor III) are needed; two will be sufficient at the start, and a third could be installed later if needed.

Two double-ribbon blenders should be added after the Ultra Rotors are installed to give time enough for analytical control. Filling operation is capacity limited to 300-400 kg outlet with two or three workers.

	Tons	
Filling, blending	2	50'
Silo	2	
(Grinding		1 h 30)
2 blenders	4	3 h (analytical control)
2 siloe	4	4 times 3 h

Total blender and silo capacity is 12 t.

Powder filling

Eight filling stations with hand-filling are needed. Most powders are filled into 10 and 25 kg bags. If possible, the use of fibre drums for cotton-

[illegible] should be eliminated because it is expensive (better transportation and warehousing are needed). Vissomatic semi-automatic equipment is used for filling powder into small bags. Bags can be closed with a heat-sealing device.

Poisonous materials should be packed into carton boxes ([illegible] litres volume [illegible]). Transport should be in cardboard boxes.

Inert carrier upgrading

The maximum of 180 t/month inert carrier should be used, or [illegible]0-[illegible] t/day and [illegible].5-[illegible] t/h. At present it is not clear whether inert carrier will be available that is clean and fine enough. Even if the standard quality is available, the rainy season always presents unforeseen problems. Storage capacity should be high to limit difficulties with wet inert material.

It is unreasonable to store more than 700-1,000 t. Maximum consumption is during March and April, which is still the rainy season.

Bulk storage	700-1,000 t/1,500 m^2
Mechanical transport	2-3 t/h
Pluristadio 180 mill	2-3 t/h depending on corn size and humidity
Silo storage	2 times 100 m^3 with pneumatic handling

Pneumatic weighing and transport system to Ultra Rotor

Inert carrier upgrading must still be tested. It is sometimes better to grind arriving inert carrier directly with pesticides. It may also be necessary to upgrade the inert material with more sophisticated methods such as drying and milling at 250° C. It is important to find out the best way through small-scale testing. Analytical control is indispensable.

Liquid formulation and filling

Two solution vessels with 6 m^3 capacity are needed to formulate 7.5 t/day. One vessel is used solely for dimethoate, a blue, slightly smelling compound; the second vessel serves for different products.

One to two operations a day are possible:

Solvent storage	2 times 100 m^3 (white spirit, xylene)
2 solution vessels	6 m^3
4 storage tanks	7 m^3
2 filling stations for cans	
1 filling station for bottles	

Herbicide formulation and filling

Two solution vessels with 6 m^3 capacity are needed to prepare 7.5 t/day. One vessel is reserved for water solutions of 2, 4-D and Banvel; it should be constructed with AISI 316 stainless steel. The other vessel can be constructed with Carbonsteel.

A small tank of 10 m^3 is needed to store caustic soda for ethanolamin. The second vessel is used to produce emulsion concentrates. Two storage tanks of 7 m^3 are needed for finished products. Care must be taken to separate categorically herbicides from other productions: 30 m distance in the direction of the main wind, with trees planted between, may be enough to eliminate cross contamination.

V. PRODUCTION PROCESSES

Formulation is the physical preparation of raw active materials with surface active agents and inert materials, to obtain good application results. The choice of active material and type of formulation depends on field trials.

It is important to decide whether dust, wettable powder, emulsion concentrate, stock emulsions or granules should be used. Depending on this decision, the details of formulation such as finess and emulsion stability must be worked out on a laboratory scale.

Production processes are simple physical operations such as mixing, grinding, dissolving and absorbing. No chemical change in active material should occur. The production equipment is only for a few specific operations.

It is crucial to obtain, even under difficult conditions, constant results as given in product specifications. Small variations in composition, e.g. 0.2-0.5% of surface active agent, can completely change the physical state of the product. More than 0.2% of water can decompose active material in emulsion concentrates and cause containers to corrode. The material flow in formulation is straight throughout:

Storage of raw material
Formulation (mixing, grinding, dissolving)
Storage of formulated product
Packing (powder, liquids)
Storage of finished products

Block flow diagrams for formulation are given in annex XII.

Storage facilities

Storage is of fundamental importance. Its main function is to provide all needed materials in time. Good quality storage depends on the chemical and physical conditions of the material, quantities used and transportation facilities.

Inert carrier. Inert carrier arrives in bulk loads and may be wet and not pure enough. It is stored in open heaps 2-3 m high. If it is pure enough, it is passed directly to silos of 100 m^3 capacity with pneumatic handling devices, e.g. if inert carrier is imported in 50 kg multiwall paper bags it will be stored in piles 4 m high and later transported pneumatically to the silo.

If upgrading is necessary, inert carrier passes through a mill with hot-air drying. If the moisture content is too high, a rotary-drying kiln is necessary. Such a kiln is uneconomical for small quantities. A specific study is necessary for wet upgrading (ceramic industries, Hama).

Solvents. These arrive in bulk loads; 100 m^3 storage tanks are considered the minimum. Special solvent arrives in barrels and is stored with active materials or in a shed (flash point often below 20° C). Solvents are inflammable; precautions must be taken.

Active materials. These products are transported in drums and sometimes in paper bags. They should be handled carefully; floors must be cleaned frequently. Handling should be with a fork-lift truck.

Inert carrier upgrading

Limestone. Limestone is available in good quantities. Drying may sometimes be necessary to guarantee product stability. Limestone cannot be used for unstab'e phosphorous and chlorinated compounds.

Clays. These will always be too humid and must be dried. At the moment no good exploited deposits are available. The baylun-clay near Tell Hassar may be good enough. Tests are indispensable. Wet upgrading may be necessary. The economical maximum should be to pre-grind, sieve (1-2 mm) grind (0.1 mm) and dry. Otherwise, kaolin or talc should be imported from neighbouring countries. The Pluristadio 50 mill of Guseo is the best available equipment for semi-industrial trials. This mill can also be used to produce wettable sulphur or other explosive mixtures. Results can be easily transferred to industrial equipment like Pluristadio 180 with capacities of 2-3 t/h.

Powder formulation

Dusts will be used in amounts of 2,000-3,000 t/a, the greatest part still being cottondust. Stability tests with different carriers must be carried out, as indicated under analytical control. Fineness must be controlled frequently; volume, weight and flowability depend on it. Attention must always be paid to obtain homogeneous products. Sieving before grinding is always necessary. For coarse-grain inert material mixing does not give good enough homogeneity. Mixing after grinding is indispensable.

[illegible] mill of Altenburger Maschinenfabrik is very flexible. Mesh-size can be regulated by air input (up to 30 m^3/minute) and by the distance of working plates. An air mill would also be suitable. Grinding operation is regulated automatically in order to have constant power input. The finely ground product is separated in the filter cyclone specifically for this mill.

The product is transported pneumatically to the mixing units. At the beginning every mill has two after-mixers, to give time for analytical control.

Wettable powder formulation is the same process, but 5-7% dispersants and wetting agents are added; 99% must be finer than 40 micron; sometimes it is necessary to have 99% finer than 20 micron. Preparatory work done on a small scale should be the reference for all results obtained on a larger scale.

Analytical control of every batch is indispensable.

Packing powders

The greatest problems are caused by the changing volume and weight in the storage silo and flowability. Storage conditions must be controlled; the injection of compressed air can help to overcome these problems. The composition of inert carrier influences flowability; e.g. 10-20% talc facilitates the flow.

The filling operation must be from a small silo at a constant level. The level is regulated by Roto-bin, a rotating paddle device. Extraction from the silo can be with a rotating valve or a semi-spherical valve and vibrating channel. Bag-filling is done by hand with a semi-spherical valve (Alpine).

Each working place must be ventilated 10 m^3/minute with 250-300 mm H_2O under pressure through a filter bag. Protective clothing is necessary. Working clothes must be changed at least once a day; showers should be available for each worker.

Bags should be palletised and protected with shrinking film. Small bags can be filled with a Vissomatic filling device, which is a vertical screw filler controlled with a balance.

Poisonous products should be packed in paper boxes; 10-12 bags or boxes may be packed in cardboard boxes, labelled and sealed.

Liquid formulation

Emulsion concentrates are solutions of active material and emulsifiers in solvents. They must:

(a) Be of exact concentration;

(b) Be spontaneously emulsifiable with water;

(c) Keep in storage for at least two years, between 0°-50° C;

(d) Give stable emulsions in different concentrations with different water hardness and temperatures;

(e) Be easily mixed with other pesticides;

(f) Have proper wetting properties.

The above-indicated requirements should be checked for every operation; sometimes corrections are unavoidable (see FAO specifications). The single components are dosed, as determined in the laboratory, and mixed.

Some products must be melted to a liquid. The maximum temperature must not exceed 60° C. Above this temperature fire and explosions are possible. Good ventilation even in open-air constructions is important.

Workers must have protective clothing (gloves, goggles, plastic aprons). The heating coils in the solution vessel should not be warmed up before filling with solvents.

The cool finished product should be stored until it is controlled analytically. High toxic materials should be filled into bottles with caution. Semi-automatic filling machinery (OCME) helps to cut down the number of workers needed for this operation. All operations should be done under a safety hood. Bottles should be closed with a double cap. A plastic cap is recommended for use inside the aluminium cap.

The bottles must be packed in cardboard boxes. If glass bottles are used, each bottle must be separately packed in a small cardboard box. Cans should be stable enough for bad transport conditions. Packing in cardboard can be useful. The filling operation is done with a pneumatic filling station (OCME). The tap must be hermetically sealed (Trisure etc.).

Herbicide formulation

As it is assumed that all herbicides are in liquid formulation, the same principles apply.

Water solutions should be neutralized to pH 9-10; this would probably be the only chemical reaction carried out.

Amine salt formulation in good mixtures with other active compounds will give the same effect. As salts are not volatile, the action will be slower and the danger for neighbouring sensible cultures will be lower.

Neutralization should be carried out with cooling to control temperature. The cool product is pumped to storage and filled only after analytical control.

VI. SURFACE REQUIREMENTS

The following facilities are needed for pesticide formulation:

(a) Raw material storage space for inert carrier, active material, solvents, emulsifier and packing material;

(b) Formulation area for inert carrier upgrading, powder formulation, emulsion concentrates and herbicides;

(c) Auxiliary facilities such as a laboratory with semi-industrial production room, an office, a workshop, and space for personnel services, a power centre and waste disposal;

(d) Expansion reserve area;

(e) Transportation facilities such as roads and railway connexions.

The dimensions of each department depend on:

(a) Disposition of quantities;

(b) Volume and type of packaging of materials;

(c) Work organization;

(d) Capacity of machinery;

(e) Security distances.

Raw material storage

Inert carrier arrives in bulk loads of 20 tons and can be stored 2-3 m high in open boxes in a storehouse (see ceramic factory, Hama). Inert carrier is moved with a small caterpillar. Delivery trucks enter directly into the store. Transportation to upgrading is done mechanically with an elevator and belt. Amounts of 700-1,000 t can be stored in 800 m^2. The total area necessary will be 1,500 m^2.

Active materials arrive by train or truck in 10 to 20 ton lots. The material should be palletised to international standard size pallets of 100 x 120 cm. The weight of the load for a pile of 3 or 4 pallets can be 1,000 kg/m^2. Maximum loads are considered to be 1,800-2,000 kg/m^2.

Each pallet weighs 400-800 kg; 3-4 pallets make up a pile; 3-4 piles form a file; and 4 files make a block for a truck load. Between blocks of the same material there should be a distance of 50 cm for emergency purposes.

The assumption is that 285 t of active material are needed for dust formulation (50% of yearly consumption), 375 t for WP formulation (100% of yearly consumption) and 100 t of sulphur (15% of yearly consumption) should be stored at maximum. This makes a total of 760 t of active material for powder formulation.

If the plant is working at full capacity, the planned capacity should be nearly twice that required for 1980.

The warehouse space could be used to better advantage. The active material needed for emulsion concentrates should be stored for one year's requirements together with emulsifier, making a total of 410 t. For a 1,200 kg/m² load, [illegible]0 m² will be needed. An 800 m² surface is needed to store packing material (part of the packing material can be stored near the facility for liquid formulation).

Requirements for storage of raw material are:

	m^2
Inert carrier	1,500
Powder formulation	1,500
Liquid formulation	700
Packing material	800
Herbicides	600
Expansion reserve	900
	6,000

The store-rooms should be 7 m high to have good ventilation. Floors must be easy to clean. Walls should be covered with washable paint up to a height of 5 m and be constructed of heavy cement stones.

Four blocks of 28 x 54 m should be built with a distance between of 18 m and an 8 m road. The blocks for liquid and powder formulation may be 10 m apart.

Formulation area

Formulation should be separated into isolated departments to facilitate good housekeeping. Contamination of insecticides with herbicides can cause great damage. For safety a distance of a minimum of 20 m is required in handling toxic materials and for minimising fire hazards. Each department is divided into a formulation area, and place for intermediate storage and packaging.

For inert carrier upgrading one Guseo Pluristadio mill with a 4 m³ silo is needed in a building 14 x 28 m and 11 m high. This space will be sufficient for both upgrading and expansion of carriers. On the outside of the building, two silos 100 m³ should be erected, and space should be left for the construction of two more silos later.

The transport and pre-mixing unit should be placed under a shed between the silos and millhouse no. 1. Part of the raw material may be handled with a small elevator leading to the mixing units.

Millhouse no. 2, which is used for powder formulation, [illegible] contain two complete milling and blending lines. In the near future, [illegible] to erect two other mills. This should easily be possible. The dimensions are 28 x 28 m and [illegible] high. The millhouse is divided into two parts for formulation and packaging. The packing department contains four mixing units with [illegible] and eight filling stations.

For liquid formulation two solution vessels of [illegible] m^3 and four finished product tanks of 7 m^3 are needed. Outside the building at a distance [illegible] there should be a solvent tank of 100 m^3.

The building should be 14 x 28 m and 7 m high.

All tanks are constructed within large cement tubs, so that if a tank leaks, the product remains within this tub and the pollution of the surrounding area will be prevented. These tubs must be cleaned frequently. The water is cleaned or better burned at temperatures about 1,200° C.

For herbicide formulation a building 14 x 28 m and 7 m high is required in order to easily expand capacities. If it later becomes feasible, the 2 and 4-D esterification facility can be constructed within this area.

Warehouses

Finished products are handled with pallets. The maximum load for bags, cardboard boxes and cans is 1,400 kg/m^2. For fertilizer, it is possible to load without pallets up to 3 t/m^2. This cannot be done with pesticides.

Leaking containers contaminate other boxes. Such boxes cannot be handled.

Storehouse surface should be filled to a maximum of 50% to leave enough room for transport and to keep different products separated. Capacity compensation makes it necessary to store finished products until they can be delivered. From September to January 2,650 t of finished products may accumulate. In addition to the stock of 600 t (10% of yearly consumption), remaining products and the unplanned storage of finished imported products, more than one half of the yearly output must be stored; for 3,200 t 4,500 m^2 storehouse room is necessary.

As Agricultural Bank deposits (storage areas) are enlarged from year to year, future increased pesticide demand can be handled by these distribution centres. These deposits should be better adapted for chemical handling; they should be higher, better ventilated, use pallets, and have better floors for easy cleaning.

About 80% of yearly output will be delivered from February to April. Transport facilities can be a limiting factor if not adequate.

The forwarding department is of great importance. A daily delivery (store) room should be provided for. It can be a shed 14 m wide with a loading ramp for 5 trucks and 10 railway cars.

Transport should be done as much as possible by rail, because it is less dangerous and more economical. The position of the ramp depends on the railway line. A second rail will serve for incoming materials and should have a ramp for not less than 10 cars.

Auxiliaries

The laboratory is divided into an analytical lab under the director, and a formulation lab under the plant manager. These activities should always remain close. The minimum space required is:

	m^2
Analytical laboratory	
General	30
Weighing	10
Precision instruments	20
Storage samples and chemical	20
Formulation general	
Small-scale formulation	150
Offices	40
Different	30
	180 + 150

The laboratory should be located as near as possible to the factory. It may be in the office building or between the workshop and millhouse no. 1, and contain small-scale formulation units.

The office building with all social services should have more than 1,000 m^2. A bathroom with showers for every worker, a small laundry and a separate dining room must be available.

The office rooms can be divided with prefabricated parts to make small offices for 1 to 3 persons. The single departments should remain together: director, administration application group, plant management and warehouses.

The workshop with power centre is one of the most important units. Minimum space requirements are 800 m^2, near millhouse no. 1.

The power needed will be 400-500 kW, 220 or 380 V. The yearly consumption of electricity will be ca. 0.5 million kWh. The price of electrical energy will be LS 0.07-0.10 per kWh. To warm up and dissolve active material and emulsifier, 500,000 kcal/h at 60° C are needed; 60° C must remain the maximum temperature for security purposes. Compressed air (9 ata) must be attainable with minimum capacity of 10 m^3/min.

Waste disposal should be in a far corner of the factory. Everything must be burned at temperatures above 1,200° C, with precaution in order not to pollute the surroundings.

VII. PERSONNEL REQUIREMENTS

The performance of the plant depends on selecting qualified specialists, on their training and motivation, and on payment of reasonable salaries. Personnel should be selected carefully, according to the main functions, which will be:

(a) Selection of active material and type of formulation;

(b) Acquisition of raw materials;

(c) Formulation;

(d) Quality control;

(e) Storage and transport;

(f) Organization and co-ordination of all functions.

The organization chart is given in annex XVI.

Job descriptions

Director

It is the responsibility of the director to co-ordinate and control all activities. He must be a person with high leadership ability and have a good understanding of all technical problems and a profound knowledge of plant protection necessities. He should be a graduate agronomist or chemist and have an agronomist as vice-director. For planning and plant supervision, he should have an assistant. The secretariat can service all departments. Correspondence should remain centralized. All personnel questions should be handled by the director, except for the payroll (often considered the most important) and other administrative functions, which would be delegated to an independent administrator.

The plant must provide, within the limits of current planning but sometimes also in excess of it, enough pesticides of specific quality. Plant activity must be co-ordinated between the plant protection department of the Ministry of Agriculture and Agrarian Reform and the Agricultural Bank. It is fundamental that the formulation plant be geared to changing plant protection needs; developement must follow practical demand.

Application group

The plant must have an independent application development group. This group should be in continuous contact with farmers, the Research Centre and the inspectorates of Mohafazat, in order to keep informed about all problems arising.

It should observe results of new formulations with different active ingredients or inert carriers. Agricultural engineers equipped with cars and other appropriate accessories should be in the field all year. Each team would be expected to carry out at least 15-20 experiments a year in different areas on different crops.

Plant manager

The main responsibilities would be:

(a) To develop formulations based to a maximum degree on national resources and corresponding to application standards. This is the main activity of the formulation lab, first on a laboratory scale and later on a semi-industrial and industrial scale;

(b) To work with selected equipment on an industrial scale. He must organise and guide, with the help of an assistant, 80 workers. As precautions are necessary with poisonous and explosive materials, he must give safety regulations for every work area and function;

(c) To prepare monthly work plans and to control daily manwork, materials moved and machine output;

(d) To supervise workshop for maintenance and repair of equipment. Small modification of equipment may become necessary;

(e) To purchase pesticides, within the framework of planning figures in co-operation with other parties interested in importing pesticides;

(f) To oversee storage of raw materials with all precaution for good housekeeping. A man with industrial experience is required for such high responsibility for men and equipment. He should be a chemical engineer and have at least two years practical experience with pharmaceuticals, detergents or other activities in the field of applied chemistry.

Analytical lab

This lab should be run by a graduate chemist or pharmacist. It is indispensable to establish quality standards according to FAO and CIPAC. UNIDO can provide training and assistance. Annex XV outlines the analytical programme.

It is the task of the analytical lab to control arriving materials and production without interrupting production processes. Sampling is one of the most important operations. Simple control methods with approximate results in time are better than to accomplish 0.1% exact results too late.

Training programme

Three men must be selected for the first training. It is indispensable that these three men collaborate harmoniously from the beginning. They must [illegible] train six to nine men to form the nucleus of industrial activity. The three men should be:

(a) An expert to co-ordinate a development programme between the Industrial Development Center and the Ministry of Agriculture, to help in sampling raw active materials needed for tests and to make the necessary field trials. He should receive training in all aspects of pesticide formulation and application;

(b) An analytical chemist should receive with the help of UNIDO training in quality control. As M. Parkany of the Industrial Development Center has many years of analytical experience with pesticides, he can help during his mission to implement the programme;

(c) The future plant manager could be trained in Egypt; a request should be made through UNIDO or through the Co-operation among Developing Countries (CDC) programme.

These three men will also be active in the Industrial Development Center, Mazzeh. Their first task should be the reproduction of the composition of the 20 most important products on a semi-industrial scale by utilizing local diluents selected by the quality control group.

Table [illegible]. Personnel requirements - yearly payroll

		LS/month	LS/year
Direction			
Director	1	2,000	24,000
Assistant	1	1,000	12,000
Chief secretary	1	800	9,600
Secretary	2	600	14,400
	5		60,000
Application group			
Vice-director	1	1,500	18,000
Assistant	5	800	48,000
Helper	5	600	36,000
Secretary	1	400	4,800
	12		106,800
Plant site			
Manager	1	1,500	18,000
Assistant	1	800	9,600
Disposition	1	800	9,600
Purchase	1	800	9,600
Storehouse	1	800	9,600
Workshop	1	800	9,600
	6		66,000

Table 9. (continued)

		LS/month	LS/year
Laboratory			
Analyst	1	1,000	12,000
Assistant	2	800	19,200
Formulation assistant	1	1,000	12,000
	5		43,200
Distribution			
Warehouse	2	1,200	28,800
Forwarding	1	1,000	12,000
	3		40,800
Administration	7		70,800
Labour (60 direct, productive; 30 indirect, contributing)			
Skilled	14	600	100,800
Qualified	26	500	156,000
helper	50	400	240,000
	90		496,800
Minus 40% social indirect contribution and unexpected expenses are			316,000
Total personnel	128		

VIII. SPECIFIC MACHINERY

Part of the equipment will be constructed in the Syrian Arab Republic or is available. Tank and other storage facilities, transportation and energy equipment can easily be locally furnished. For milling, pneumatic transportation and semi-automatic filling, specific equipment must be imported. As pesticide formulation is a relatively small activity world-wide, only few companies are specialized enough to guarantee good results. In annex XVIII only well-known and reliable companies are given.

IX. SELECTION OF PLANT SITE

The selection of the plant site depends on: shortest way for raw material; availability of technical infrastructure; and shortest distribution way.

Active raw materials are arriving at Lattakia. Solvents and sulphur are available at Homs. Limestone is available all over the country in high purity. Clay deposits must still be tested and will be available near Homs, Lattakia and Aleppo, or must be imported.

The distribution network is shown in annex IX. The greatest consumption is in the north of the country.

The plant site could be between Homs and Aleppo. If the plant can be joined with the fertilizer complex at Homs, the following advantages would result:

(a) Existing facilities for energy, workshop etc. would diminish investment;

(b) Good conditions for road and railway connexions;

(c) Skilled and trained work force available. The plant would be on-stream within a shorter time, diminishing relative costs;

(d) Organization and administration within an existing complex would be easier;

(e) Financing could be easier.

The plant should be located at Homs. Another possibility would be the area of Aleppo.

X. LAYOUT

Annex XIV gives the layout of the formulation plant. Space requirements must be calculated generously because a great expansion is expected in the next 10 years. An area of 200 x 400 m must be available.

For security the distance between buildings must be 20 m; roads can be 8-12 m and the remaining area planted with trees.

A large area should be reserved for liquid and powder formulation.

The distance between store and working area should normally be 20 m, with a storehouse area that is never larger than 1,500 m^2.

Well-insolated roof should be used, but they should not be made of concrete; eternit or similar materials are better. The buildings should be 7 m high and the millhouses 11 m high.

All internal tranportation must be on one level. The position of the loading ramp for railway and truck depends on the railway line. It is essential:

(a) To separate store, working and forwarding areas;

(b) To have straight production lines on a single level with security distances;

(c) To separate herbicides, especially from fertilizer and other pesticides;

(d) To leave enough room for washing;

(e) To make good housekeeping possible;

(f) To burn all residues, including water, at temperatures of about 1,200°C;

(g) To clean ventilated air with at least one set of filter bags;

(h) To respect the main wind direction.

XI. ECONOMIC ASPECTS

The volume and value of pesticide consumption is growing in Arab countries at a rate of 10-15% yearly. Locally it is expected that the growth rate will be even higher.

All major European pesticide producers are represented, and the latest scientific pesticide methods are applied. Similar projects are on-stream or will be erected in the next few years in neighbouring countries. Small privately owned companies will be active locally.

The project will have every chance of economic success. The production would be distributed by the Agricultural Bank at a fair price on recommendation of the Ministry of Agriculture.

As production volume is planned by the plant protection department of the Ministry within the limits of climatic variations, the total production will be consumed.

Management must still be trained. A skilled work force is available at relatively low cost.

Foreign assistance will be required. UNIDO and the Industrial Research and Development Center, Messah, are ready to help with training programmes on request.

Raw active materials must also be imported in the future; the value would be around 70% of turnover (distribution cost not included); 10% would be packing material and inert materials locally available; 12% would represent production cost and 8% profit.

A rough estimate of investment needed would be:

Terrain and buildings	Total m^2	Cost in LS per m^2	Total LS
Land	80,000	3	240,000
Storehouse	10,000	360	3,600,000
Production	2,000	600	1,200,000
Office	1,000	1,000	1,000,000
Workshop, power	500	800	400,000
			6,200,000

Civic work	Total m^2	Total LS
Roads	10,000	500,000
Canalization		500,000
Energy distribution		400,000
Railway connexion		400,000
Different		300,000
		2,100,000
Equipment		
Mills, storage, transport		2,000,000
Auxiliaries		600,000
Laboratory, semi-industrial pilot equipment		500,000
		3,100,000
Construction 50%		4,700,000

Investment cost will be between LS 12.8 and LS 14 million.

Pre-investment and start-up costs will be around LS 500,000.

Cash flow is given in annex XVII.

Annual operating costs and profits are given in table 10.

Table 10. Costs and profits (million LS)

Item	1974/75	1980	1985
Value of total imported material	9.4	44.0	100
Imported raw material	6.3	32.4	73.0
Locally available material	0.6	1.6	7.3
Personnel	0.7	1.1	1.4
Interest on material	0.1	0.8	1.6
Investment	0.5	0.8	0.9
Depreciation of equipment	0.3	0.4	0.6
Buildings	0.3	0.4	0.4
Other costs	0.6	1.0	2.0
	9.4	40.5	87.2
Profit million LS	0	3.5	12.8
Per cent of turnover		7.9	12.8

Interest is calculated at 12%. The assumption is that imported finished products are paid for by farmers within 8 months and own formulation within [illegible] months. Only the difference of 4% is calculated. Interest on investment is [illegible]% with a depreciation time of 10 years for equipment and [illegible]0 years for buildings.

The project is economically feasible. A saving of LS 10 million foreign exchange can be made yearly. It is a valuable contribution to agriculture development.

XII. RECOMMENDATIONS

Within the goals of the fourth five-year plan and if agricultural production is intensified as envisaged, it is expected that the consumption of pesticides will grow rapidly from LS 15 million in 1975 to LS 40 million by 1980. Imports of more than LS 100 million are planned in the 1980s; 25% of foreign exchange could be saved with a local formulation plant. If the decision is made now to build the formulation plant, it could be on-stream by 1978.

The following steps are recommended:

1. That the formulation plant be established as soon as possible. The plant should have a 6,300 t per year capacity. In the Syrian Arab Republic 4,000 t solvent and inert carrier are available. An investment of LS 12 million is needed. The maximum daily output would be 24 t powder and 24 t liquid formulation. The production could be distributed together with fertilisers by 50 Agricultural Bank distribution centres.

2. That the formulation plant be combined with the fertiliser plant at Homs where the chemo-technical infrastructure is available. This would save about LS 2 million.

3. That an agronomist be responsible for the direction and be assisted by three chemists and five agronomists. The production programme of the formulation plant should consist of 20 different pesticides to be formulated with local diluents. However, pesticide formulation depends on changing conditions in agriculture. Pests become resistant to pesticides; hence new application methods must be used and new products developed.

4. That the Industrial Research and Development Center, Massch, carry out the necessary material tests on a laboratory and semi-industrial scale. Co-ordination between the Ministry of Agriculture and the Research Center at Douma would be necessary.

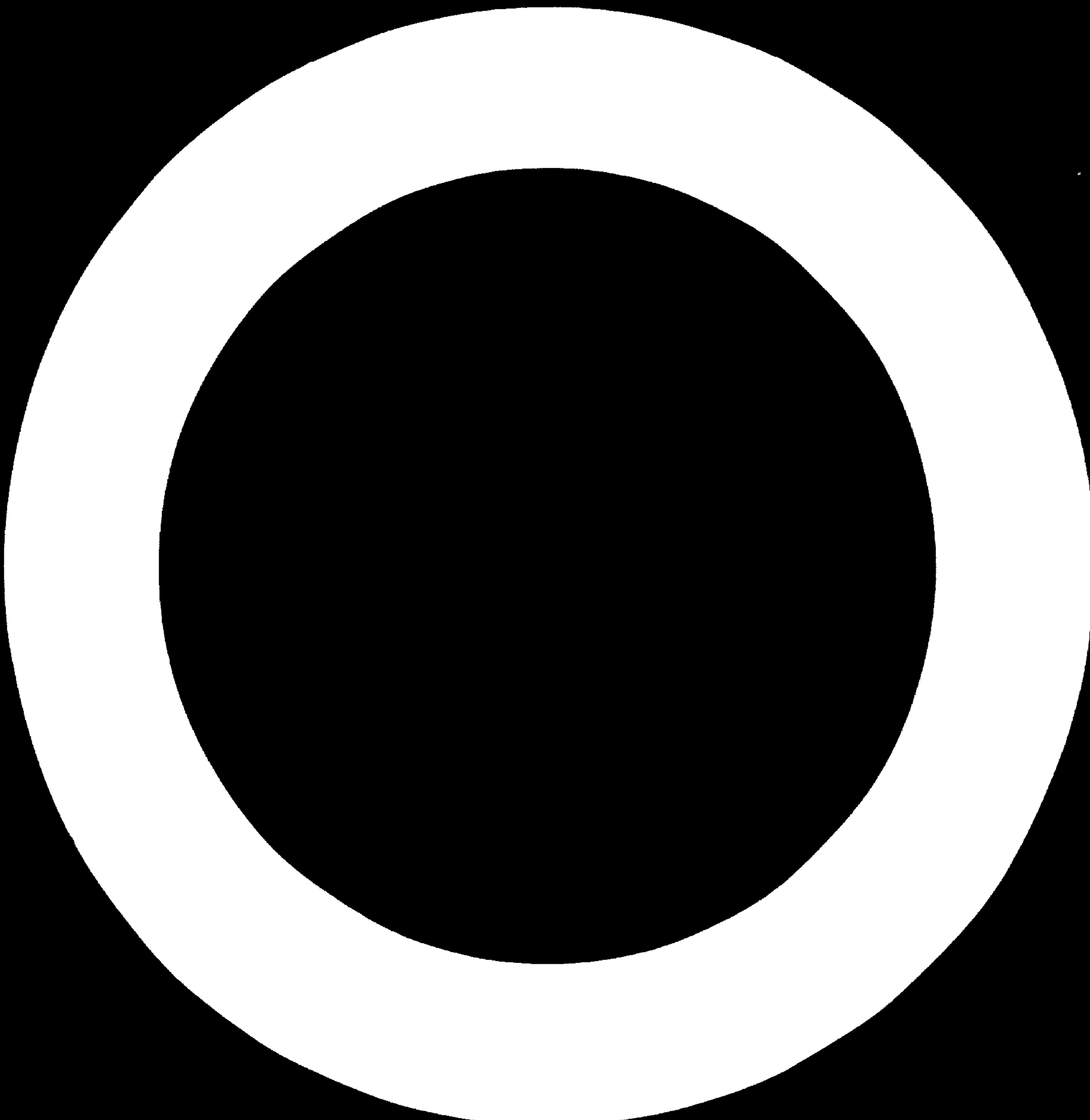
5. That field tests should be carried out with [illegible]. [illegible] this, it would be necessary to train three specialists:

(a) A graduate chemical engineer, to be trained in formulation [illegible] a laboratory and industrial scale. (Training [illegible] Egypt);

(b) A graduate analytical chemist, to be trained [illegible] UNIDO;

(c) A graduate agronomist, who should receive a rounded training in all aspects of formulation.

6. That the growing use of pesticides should have more and better analytical control on all levels. At least one central analytical laboratory should be erected.



Annex I

PERSONS AND INSTITUTIONS CONTACTED

United Nations personnel

H. R. Danisman	Deputy Resident Representative, Syrian Arab [illegible]
A. S. Salem	Senior Field Adviser, Beirut
Y. Kassab	Senior Programme Assistant, UNDP
M. Shaaban	Project Manager, Industrial Research and Development Center, [illegible]
Z. Sawaf	Director, Industrial Research Center
M. Parkany	Expert in analytical quality control, UNIDO
A. Soghaier	Senior Agricultural Adviser, Food and Agriculture Organization

Ministry of Agriculture and Agrarian Reform

M. Sabbagh	Director, Plant Protection Section
A. Abboud	First counterpart in pesticide use
Z. Jafi	Plant protection
A. Dib	Agriculture Director, Raqqa
A. Mosa Ali	Agriculture Director, Aleppo
G. Cher Dek	Agriculture Director, Lattakia

Directorate Agricultural Research, Douma

R. Abdel Kader	Director
W. Malek	Vice Director
K. Suad	Plant Protection Group
M. Hamidi	Second counterpart in pesticide use
M. Khoury	Research Director, Aleppo

State Planning Commission

B. Al Holou	Vice Minister
M. Saidi	Director, Agricultural Planning
T. Daughly	Co-ordination, UNDP

Ministry of Petroleum and Mineral Resources

Z. Kassabelli	Petroleum refinery
N. Samman	Mineral resources planning

E. Ka[illegible]	Head, Industrial Section
F. Al[illegible]	Director, refinery, Homs
T. Bi[illegible]	Chemical engineer

Ministry for Engineering and Industry

V. Dik	Director General, state-owned companies
S. At[illegible]	Geological survey
F. Katt[illegible]	Director, Pharmaceutical Corp.

Porcelain factory, Hama

A. Jammal	Director

University of Damascus

M. Dekkak	Dekan Pharmaceutical Faculty

Agriculture Bank, Damascus

K. Bahbouh	Head, Agriculture Department
M. Serag el Din	Agriculture Department

Municipality of Damascus

H. Masselmi	Public Health Department

Annex II

CHECK-LIST FOR A FEASIBILITY STUDY OF A LOCAL PESTICIDE FORMULATION PLANT
(Working programme of 8 weeks)

Probable pesticide use, 1980-1985 (2 weeks)

Important crops: cropped area 1974/75-1980-1985; economic pests and diseases; treatment programme for every crop; theoretical and probable monthly pesticide use, 1980-1985

Plant protection organization

Distribution system (Agricultural Bank)

Imported pesticides 1974/75 quantity and value

Visit of characteristic areas (4 days): application techniques and capacity; practical impressions about development; first idea for plant site location

Public health: consumption in municipalities, household uses

Animal health

National natural resources (2 weeks)

Solvents (refinery programme)

Emulsifier (detergent industry)

Inert carriers: clay (ceramics industry, deposits); sulphur, marble (deposits, industry); phosphates (deposits and industry), gypsum (deposits)

Packing materials: glass, paper, plastics, cans, cartons

Plant site locations/personnel (1 week)

Collaboration with existing plants

UNDP project quality control and chemical pilot plant

Personnel training: responsible manager; plant manager/formulation, analytical control, product development, field trials

Export market potential: situation in Lebanon, Jordan, Iraq

Planning (2 weeks): production processes; capacity production lines; equipment; technical information; block flow diagram; material specifications and balance; material flow; space requirements; organization chart

Economic aspects (1 week)

Sales volume

Operation cost

Investment, financial

Cash flow

Follow-up action

UNDP existing and future projects

Egypt, Kafr El-Zayat

Annex III

IMPORTANT CROPS, AREA DEVELOPMENT
(Thousand ha)

Field crops	1956	1963	1972	1973
Cotton	272	292	238	200
Sugar beets	3	4	10	8
Tobacco	7	7	15	17
Ground-nuts		10	13	12
Lentils	85	75	115	92
Potatoes	2	4	8	8
	369	392	399	337
Cereals				
Wheat	1,537	1,559	1,354	1,476
Maize	10	7	12	12
Rice	(6)			(2)
Barley	636	804	593	914
	2,183	2,370	1,959	2,402
Fruit				
Olives	105	111	149	175
Grapes	72	70	67	74
Citrus	-	2	3	3
Apples	4	7	10	14
Apricots	8	9	11	10
Others	42	41	49	47
	231	240	289	323
Vegetables				
Tomatoes	11	23	22	21
Melons			86	57
Legumes			129	158
Onions	3	5	9	9
Others			14	14
			260	259

Source: Statistical Abstracts, 1974.

Annex IV

IMPORTANT PLANT PESTS AND DISEASES

Field crops

Cotton

- *Earias insulana*
- *Heliothis armigera*
- *Prodenia litura*
- *Tetranychus telarius*
- *Agrotis ipsilon*
- *Laphygma exigua*

Sugar beets

- *Cassida* spp.
- *Aphis fabae*
- *Chaetocnema tibialis*
- *Erysiphe polygoni*
- *Cercospora beticola*
- *Laphygma exigua*

Tobacco

- *Thrips tabaci*
- *Aphis fabae*
- White fly
- *Laphygma* spp.
- *Erysiphe cichoriacearum*
- *Peronospora tabacina*
- *Pseudomonas tabaci*

Potatoes

- *Phytophthora* spp.
- *Erwinia atroseptica*
- *Laphygma exigua*

Lentils

- *Laphygma* spp.
- *Heliothis* spp.

Cereals

Wheat

- *Eurygaster integriceps*
- *Syringopais temperatella*
- *Oscinella frit*
- *Ustilago tritici*
- *Tilletia* spp.
- *Septoria nodorum*

Maize

- *Heliothis zea*
- *Aphis* spp.
- *Laphygma* spp.

Fruit

Olives

- Euphyllura olivina
- Prays oleellus
- Dacus oleae
- Phloeotribus oleae
- Parlatoria oleae
- Clinodiplosis oleisuga
- Cycloconium oleaginum
- Pseudomonas savastanoi
- Ascochyta spp.
- Agrotis spp.

Grapes

- Theresimina ampelophaga
- Polychrosis botrana
- Pseudococcus citri
- Uncinula necator
- Plasmopara viticola
- Aonidiella spp.

Citrus

- Aonidiella aurantii
- Chrysomphalus aonidium
- Ceratitis capitata
- Aphis spp.
- Phytophthora citrophthora
- Dialeurodes citri
- Various diseases

Apples

- Winter spray
- Aphis pomi
- Zeuzera pyrina
- Carpocapsa pomonella
- Tetranychus spp.
- Ptosima spp.
- Podospharea leucotricha
- Venturia inaequalis
- Septoria spp.
- Stephanitis pyri

Stone fruit

- Rynchytes auratus
- Cladosporium carpophilum
- Clastreosporium carpophilum
- Taphrina deformans
- Cimbex quadrimaculada
- Capnodis spp.
- Different fruit worms

Others

- Scolytus rugulosus
- Idiocerus stali
- Thaumetopoea pityocampa

Vegetables

Tomatoes

Heliothis armigera	Alternaria solani
Gryllotalpa spp.	Phytophthora infestans
Agrotis ipsilon	Rhizoctonia solani
Laphygma exigua	

Melons

Diabrotica spp.	Aphis spp.
Myiopardalis pardalina	Erysiphe cichoriacearum
Dacus ciliatus	Pseudomonas lacrymans

Legumes

Agromyza phaseoli	Ascochyta pisi
Bruchus spp.	Laphygma spp.
Macrosiphum spp.	Heliothis spp.
Tetranychus spp.	

Onions

Thrips tabaci	Peronospora destructor
Hylemyia antiqua	Botrytis allii
Liriomyza spp.	Stemphylium botrysum

Others

Laphygma spp.	Gryllotalpa gryllotalpa
Nezara viridula	Aphis spp.
Calliptamus spp.	Agrotis ipsilon
Field mouse	

Important weeds in all crops

Amaranthus spp.	Johnson grass	Anchusa spp.
Setaria spp.	Cyperus spp.	Diplotoxis
Echinochloa spp.	Cynodon dactylon	Siphalarus syriaca
Portulaca spp.	Sorghum halepense	

Annex V

FAO PESTICIDES QUESTIONNAIRE
(October 1974)

Active material imported in tons

Insecticides	1971	1972	1973	1975	1976	1977
Phosphamidon	2	3	[illegible]	5	5	15
Dimethoate 40	8	12	14	50	60	75
Trichlorfion 80		5				
Parathion		100				
Others		15				
Leptofos 30		20	5	60	80	100
Azodrin				10	15	20
	10	155	24	125	160	210
Cottondust	200	700	200	1,000	700	500
Toxaphene-DDT				50	70	150
Endosulfan				50	100	200
Carbaryl				20	50	100
	200	700	200	1,120	920	950
Fungicides						
Copper oxychloride		5		15	15	15
Maneb	160	160	160	150	150	150
Zineb	120	120	120	90	120	130
Vitavax				2	10	30
Plantvax				2	5	5
Dodine		3				
Benlate			3	5	15	15
	280	288	283	264	315	345
Herbicides						
2, 4-D	15	45	45	150	200	250
Vensar				5	5	10
Treflan	4			50	50	50
Cobex				9	15	30
	19	45	45	214	270	340

Annex VI

IMPORTED PESTICIDES, 1974/75

Insecticides	Tons	US dollar per ton	Thousand dollars
Dust			
Cottondust 3/10/40	1,600	585	936
Endosulfan 5	100	700	70
Toxaphene-DDT-S 10/5/40	200	592	119
Trichlorfon 8	100	719	72
WP			
Heptachlor 40	26	1,650	43
Aldrin 40	33	2,160	71
Trichlorfon 85	30	5,050	150
EC			
Rogor 40	50	2,570	64
		3,380	85
Phosvel 30	20	3,767	75
Dimecron	7	7,000	49
Malathion 57	15	1,640	25
Parathion 50	6	3,000	18
Toxaphene-DDT-methyl parathion	120	3,720	330
Endrin 20	50	1,880	94
Fungicides			
WP			
Sulphur	100	535	53
Maneb 80	255	2,900	740
Zineb 80	95	2,450	230
Dodine	5	5,150	26
Saprol	1	4,700	5
Benlate	2	13,630	27
Topsin	1	7,980	8

Herbicides	Tons	US dollar per ton	Thousand dollars
2, 4-D 80 acid	25	2,900	73
2, 4-D 260	80	1,500	120
Dicamba 2?			
Various			
Zinc phosphide	10	1,230	12
Aluminium phosphide	3	14,800	45
			3,540 =
			LS 13 million

Note: $1 = LS 3.65.

Source: Unofficial import list (A. Abboud).

Annex VIII

PLANNING PLANT PROTECTION, 1975–1980
(Climatic area I + II in thousand ha)

	Crop 1975	Area 1980	Infested and treated: Insects 1975	Insects 1980	Diseases 1975	Diseases 1980	Weed 1975	Weed 1980	Seed-treatment 1975	Seed-treatment 1980
Field crops										
Cotton	195	200	100	120	-	-	49	170	10	20
Sugar beets	11	80	4	8	3	6	1	40	2	8
Tobacco	21	25	4	4	8	10	-	-	20	24
Lentils	167	186	30	36	-	-	-	-	-	-
Potatoes	11	10	2	2	2	2	2	11	4	22
Fodder crops	305	1,200	100	120	-	-	-	-	28	300
Total	971	1,714	240	290	13	18	52	221	64	374
Cereals										
Wheat	900	1,261	35	42	-	-	100	230	500	1,261
Maize	20	64	1	1	-	-	2	23	4	64
Barley	220	392	5	6	-	-	11	99	23	198
Total	1,246	1,717	41	49	-	-	113	352	527	1,523
Fruit										
Olives	100	100	20	100	5	25				
Grapes	82	82	2	10	10	50				
Citrus	4	4	2	4	-	50				
Apples	18	18	6	18	6	18				
Total	204	204	30	132	21	143				
Vegetables										
Tomatoes	21	22	9	11	5	6	2	9	-	-
Cucumbers	57	62	15	18	5	6	-	-	6	21
Legumes	100	121	57	68	16	32	3	16	10	47
Total	178	205	81	97	26	44	5	25	16	68

Annex VIII

PESTICIDE USE, 1973-1980

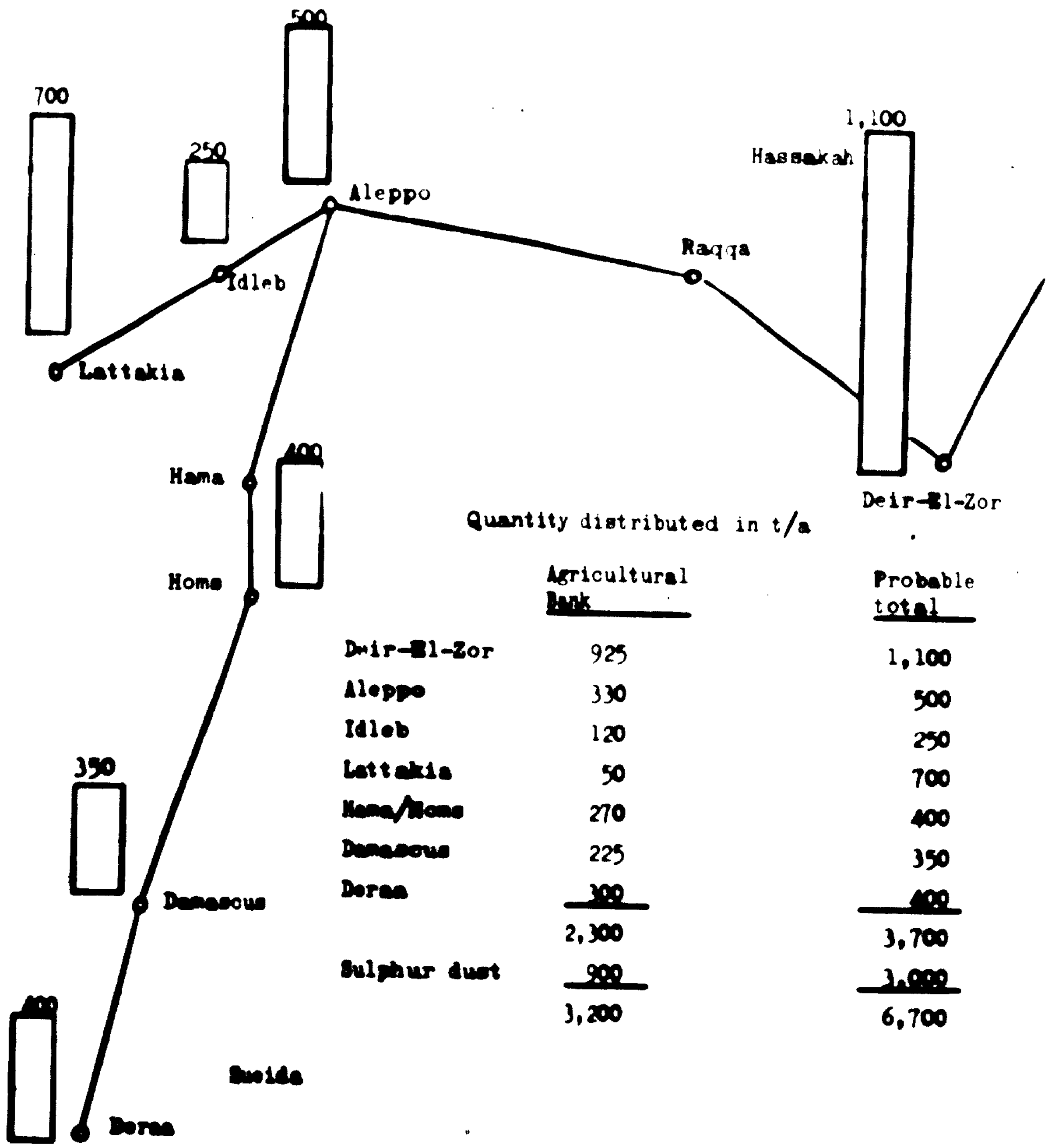
	1973	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80
Insecticides							
WP }	550	446	256	295	332	342	394
EC }			600	750	950	1,000	1,110
Dust	1,600	2,250	4,160	4,243	4,356	4,435	4,516
Fungicides							
Sulphur dust	3,000 a/	3,000 a/	3,000 a/	3,000 a/	3,000 a/	3,052	3,052
WP	135	602	486	600	660	708	775
Herbicides							
EC + solutions	100	100	205	500	974	1,404	1,732
Seed-treatment							
	60	100	100	151	175	241	287
	5,445	6,778	8,898	9,637	10,447	11,260	11,866
Yearly augmentation		1,333	2,120	739	810	813	606

Source: Fourth five-year plan, Ministry of Agriculture and Agrarian Reform.

a/ Raw estimates.

Annex IX

DISTRIBUTION NETWORK, 1974/75



Quantity distributed in t/a

	Agricultural Bank	Probable total
Deir-El-Zor	925	1,100
Aleppo	330	500
Idleb	120	250
Lattakia	50	700
Hama/Homs	270	400
Damascus	225	350
Deraa	300	400
	2,300	3,700
Sulphur dust	900	3,000
	3,200	6,700

Annex I

MONTHLY VARIATIONS IN PESTICIDE USE
(Tons)

	1975 estimated	1980 planned	1980 probable formulation	1/2	3/4	5/6	7/8	9/10
Insecticides								
EC	480	1,110	1,000	50	300	300	300	50
WP	46	384	300		100	100	50	50
Dust	2,450	4,516	3,600		1,600	2,000		
Fungicides								
WP	600	775	700	60	300	300	40	
Herbicides	100	1,732	900	400	500			
Seed-treatment	100	287	200					
	3,776	8,804	6,700	510	2,000	2,700	390	100
S-dust	3,000	3,002						
	6,776	11,806						

Source: Consultant's own estimates based on discussions with J. Safr.

Annex XI

PRICE LIST OF THE AGRICULTURAL BANK, 1975
(LS/kg)

Insecticides	Price
Toxaphene	4.25
Torbidan 40/20/5	4.25
Sevin 85	9.00
Sevin/S 15/15	2.15
Cottondust	2.80
Gusathion	12.00
Malathion	7.30
Aldrin	7.10
Trichlorfon 8	3.60
Trichlorfon 85	18.85
Roxion 40	8.37
Perfecthion	7.38
Rogor 40	16.20
Dimethoate 40	12.90
Winter oil	3.75
Summer oil	3.85
Dimecron	29.75
Anthio	22.00
Supracide	58.45
Methyl parathion	5.75
Ethyl parathion	5.00
Phosvel	15.35
Gardona	16.00
Pirimor	61.00
Monocrotophos	44.35
Endosulfan 35	15.90
Endrin	9.65

Acaricides	
Tedion	6.50
Acaridol	18.00
Pinedin	10.00

Fungicides	Price
Sulphur dust	0.86
Sulphur WP	2.25
Cuprosan	6.45
Copper oxychloride	10.50
Karathane	9.05
Benlate	75.00
Topsin	37.50
Dithane	10.50
Dodine 75	25.65
Saprol	28.60
Dilancol	20.00

Nematocides	
Nemafos	18.60
Mocap	5.05

Herbicides	
Cotoran	25.50
Treflan	29.55
U 46 fl.	5.53
Banvel G	7.10
Herbasol 2, 4-D	15.50
2, 4-D ester	4.60

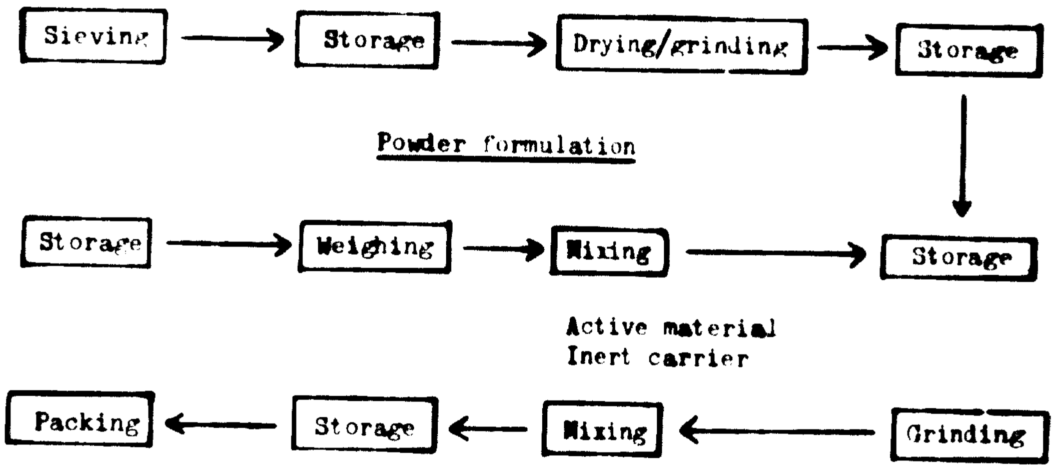
Source: K. Dahbuh, Agricultural Bank.

Annex XII

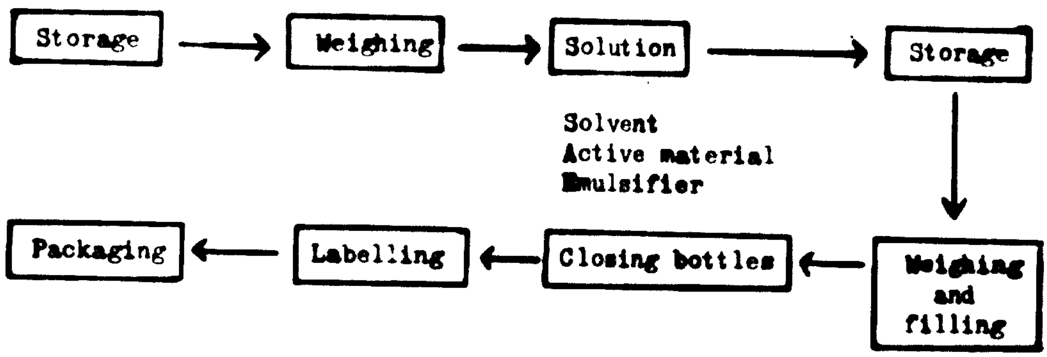
BLOCK FLOW DIAGRAMS

Inert carrier upgrading

Powder formulation



Emulsion concentrates



Annex XIII

ANALYSES OF KAOLINS FROM ZABEDANI AND TIAS
(Percentage)

Zabedani kaolin
(price: LS 35-50 per m^3)

Constituent	Deposit		
	Gdieda	Kfier	Skaf
$Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$	28.8	60.2	43.6
$K_2O \cdot Al_2O_3 \cdot 6SiO_2$	8.3	10.8	7.7
$Na_2O \cdot Al_2O_3 \cdot 6SiO_2$	0.5	1.3	0.6
$CaCO_3$	1.9	3.3	1.4
Fe_2O_3	2.9	1.2	2.3
TiO_2	1.7	2.4	2.9
SiO_2	54.8	21.7	42.5

Source: Deutsche geologische Gesellschaft, 1968.

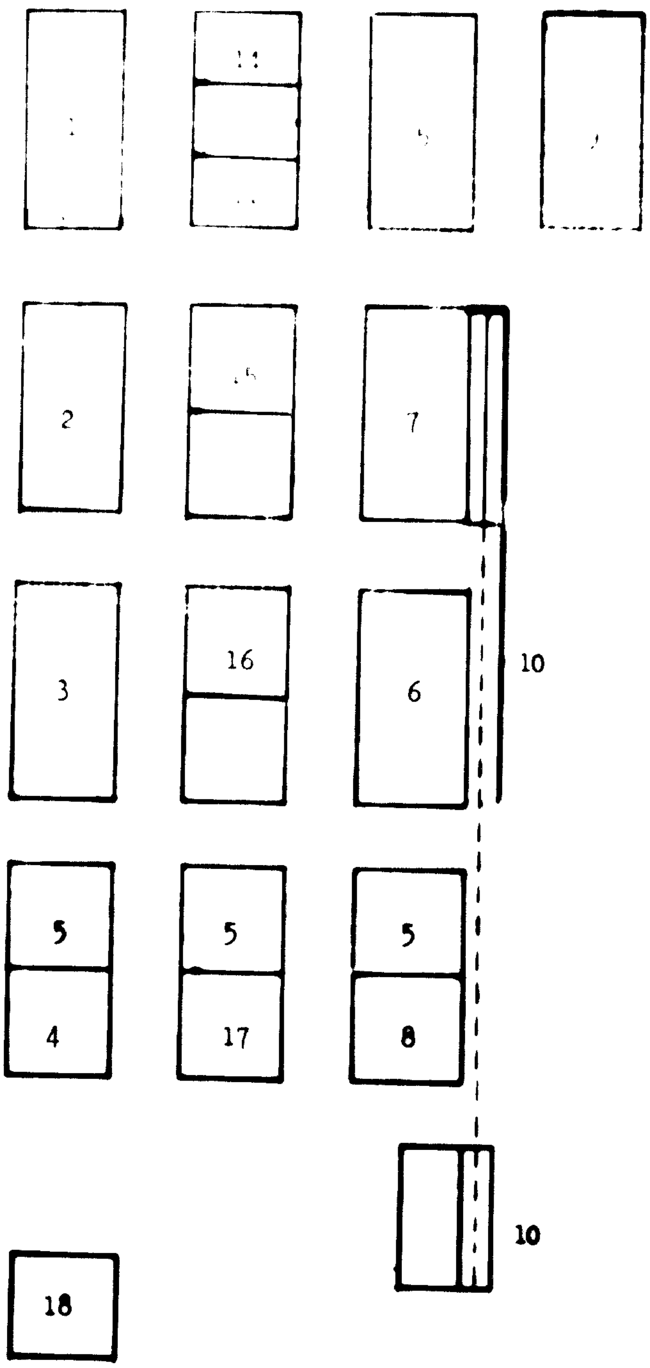
Tias kaolin

Constituent	Content	Constituent	Content
Kaolinite	40	SiO_2	47.0
Illite	14-20	Fe_2O_3	4.0
White mica	5-10	FeO	0.3
Montmorrillonite	4-6	Al_2O_3	22.2
Quartz	12	CaO	5.3
Calcite	8	MgO	2.0
Water, free	8		
Water, combined	6.8		

Source: Geological survey by S. Atwer, Ministry for Engineering and Industry.

<u>Annex XIV</u>

PLANT LAYOUT



100 x 100 m

1. Inert carrier
2. Powder storehouse
3. Liquid storehouse
4. Herbicide storehouse
5. Expansion area

6-8. Finished products

9. Office building
10. Loading ramp
11. Inert carrier upgrading
14. Workshop energy
15. Powder formulation
16. Liquid formulation
17. Herbicide
18. Waste burning

Annex XV

PESTICIDES ANALYTICAL CONTROL

Interested parties

Research station, Douma: residue analysis; Faculty of Pharmacy, Damascus University: residue analysis; toxicology; import control; formulation plant; UNDP/FAO: quality standards and control of all productions

Formulation plant

(1) Production programme: dusts; wettable powders; emulsion concentrates; water solution (herbicides)

(2) Analytical programme: quality standards for finished products; raw active material; inert carriers; solvents

(3) Methods according to CIPAC/FAO

Physical properties

Common methods: dry/wet sieving; flash point; pH meter; microscope (particle size); distillation

Impurities

Water; acidity alkalinity; Fe_2O_3, SiO_2

Active material methods

Potentiographic method (total chlorine, nitrogen); spectrophotometer (visible, ultraviolet); gaschromatograph; thin layer chromatography

Active material to be analysed

Chlorinated compounds: DDT, BHC, endosulfan, toxaphene, heptachlor, aldrin

Phosphorous compounds: Malathion, dimethoate, phosvel, trichlorfon, azodrin, phosphamidon, methyl parathion

Others: Sevin, zineb, 2, 4-D, Banvel, Treflan

Problems

(1) Inert carriers: particle size (after grinding); humidity; SiO_2 Fe_2O_3

(2) Dust preparation: mixing inert carriers with active materials, cottondust 3/10/40, DDT toxaphene S 10/5/40, endosulphan 5, trichlorfon 8

Analysis: particle size, extract active material

Followed immediately by storage 54° C 2 weeks, 1 month, 3 months, 6 months, storage under pressure (WHO specifications)

Field application

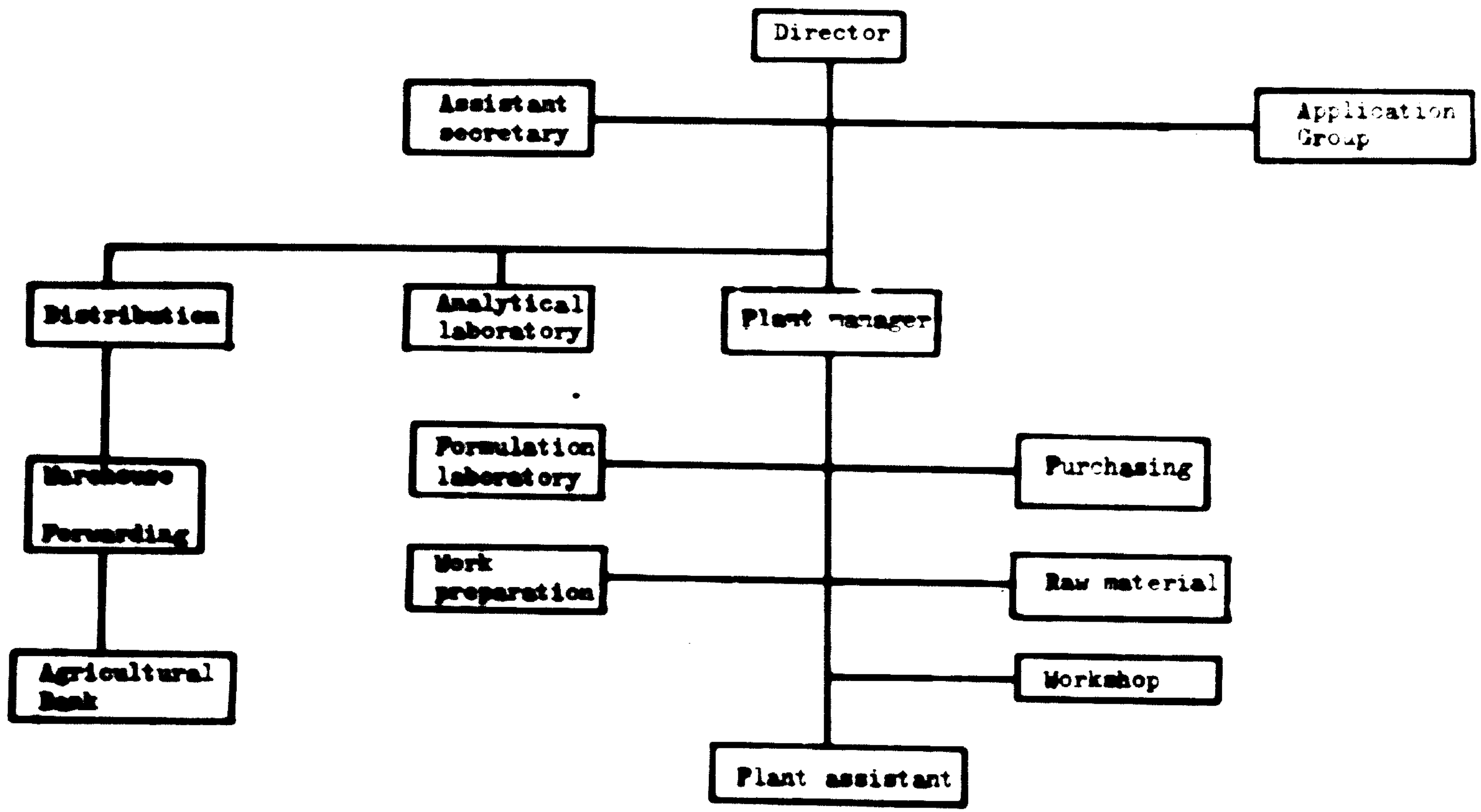
(3) Solvent: distillation analysis (Engler); volatility (confronting with xylene); solubility test with active material 50%

Cold storage test

Emulsifier testing

Annex XVI

ORGANIZATION CHART



Annex XVII

CASH FLOW
(million LS)

Source of funds	1980	1985
Financial resources	not cleared	
Sales revenue (equivalent to import value)	44	100
Uses of funds		
Land, buildings	8.5	8.5
Machinery, equipment	4.3	5.5
Total fixed capital	12.8	14.0
Stock of materials	3.2	7.3
Stock finished products	14.0	25.0
Total net working capital	17.2	32.3
Start-up expenses	1.0	
Personnel expenditure	1.1	1.4
Materials	36.0	80.0
Other costs	1.0	2.0
Total production cost	38.1	83.4
Interest on loans	1.6	2.5
Repayment of loans (equivalent to depreciation)	0.8	1.0
Total debt service	2.4	3.5
Profit	3.5	12.8

Annex XVIII

TENDER SPECIFICATIONS AND MAJOR EQUIPMENT LIST

Construction of pesticides formulation plant with 6,300 t/a initial capacity, including buildings and civic work on a plant site of 6 ha.

The following production programme is planned:

	t/a
Inert carrier upgrading	2,400
Powder formulation	4,200
Emulsion concentrates (including seed-treatment solution)	1,200
Herbicide solution	900

The plant site is near an existing chemical complex with all technical infrastructure. The formulation plant must be on-stream within two years after definite order is given with full capacity (test run one month). The necessary machinery must be installed and all information and instructions given to local personnel.

The following buildings must be erected:

	m^2
Storehouse room 7 m high	10,000
Production room 11 m high	2,000
Office, laboratory and workshop	1,500

Civic work includes 10,000 m^2 roads, water supply, canalisation, waste-water treatment, waste furnace, power supply and transportation facilities

In the following list of major equipment the type and size of specific machinery and the constructor's name are given. The cost of complex constructions in the Syrian Arab Republic are calculated at LS 10/kg and the cost of construction steel for silos at LS 5/kg. Installation cost may vary.

List of major equipment

Inert carrier upgrading

(1) Jaw crusher with rotating sieves, 100 hp; installed near inert deposit; Syrian construction

(2) Pre-crushing sieve mill with micro-pulverizer 3 t/h; Micropul (Federal Republic of Germany), 25 hp

(3) Z conveyor-elevator, 20 m long, 5 m high, 3 t/h, 2 hp

(4) Hammermill with vertical shaft, pluristadio 180, Guseo, Italy, 100 hp; with pre-grinding silo 2 m^3; cyclone, filter bag; air preheating 300° C; 3 t/h capacity; 150 kg/h water evaporation; control panel

(5) Air-lift transport 3/h, 0.7 hp

(6) Two silos 50 m^3 with pneumatic handling, bridge breaking; 2 independent weighing units, 1,000 kg; 2 independent transport systems to pre-grinding blenders

(7) Construction cost of mechanical and electrical installation, transport, auxiliary material

Powder formulation

(1) Two double-ribbon blenders, 4 m^3, 15 hp, with 4 m^3 silo attached, screw conveyor

(2) One vertical-shaft mill, pluristadio 180, 100 hp, Guseo, Italy, with cyclone, filter bags, control panel

(3) One vertical-shaft mill, Ultra Rotor III, Altenburger Maschinen (Federal Republic of Germany), with filter cyclone, control panel

(4) Four double-ribbon blenders, 4 m^3, 15 hp, with special 4 m^3 silo attached

(5) Eight semi-spherical valves 250 mm; Alpine Werk Augsburg (Federal Republic of Germany)

(6) Six air filters 6 m^2 with centrifugal fans 10 m^3/min, 150 mm H_2O under pressure, ventilation hoods, vent pipeline

(7) One filling station for small bags, semi-automatic, with vertical screw, Vissomatic, Pierre Boulart, Paris

(8) Eight constant-level hoppers 250 l, with discharge valve, semi-automatic weighing system for 5-25 kg bags

Liquid formulation

(1) Two storage tanks 50 m^3 for solvents with valves, pipeline installation

(2) Two centrifugal pumps 300 l/min, 10 m pressure head, 4 hp

(3) One flow meter for solvent, with de-aerator

(4) Two solution vessels with paddle agitator, 6 m^3, 60 rpm, 5 hp, valves, filter, vent

(5) Four storage tanks 7 m^3 with valves

(6) One filling station for small bottles, pneumatic, semi-automatic with closing equipment, transportation belt

(7) One filling station for cans 5-20 l, pneumatic weighing system

(8) One cardboard carton handling

Herbicide formulation

(1) Two solution vessels with paddle agitator, 6 m^3, 60 rpm, 5 hp, valves, filter, vent

(2) Two storage tanks 7 m^3 with valves

(3) One storage tank for alkali 10 m^3 complete with valves, pump, pipeline

(4) One balance, 500 kg

(5) One filling station for cans; pneumatic weighing system

(6) One filling station for drums 50-200 l

Auxiliaries

Transportation:

(1) Three fork-lift trucks 1,500 kg; 5 m lifting

(2) 2,000 standard pallets 100 x 120

(3) Six electrical transpallets

(4) Four loading ramps, variable levels

(5) Six transpallets

(6) 200 pallet boxes

Power station:

(1) One furnace 600,000 kcal, boiler, burner, pump, with installation in office, including warm-water bath for 12 drums

(2) Furnace for waste burning

(3) Water treatment waste water

(4) One air compressor 8 atm; 60 hp

(5) Electricity distribution

<u>Laboratory</u>

(1) General equipment

(2) Spectrophotometer

(3) Potentiograph

(4) Gaschromatograph

(5) Laboratory blender 3 l type Lödige

(6) Laboratory sieve mill, type Alpine Perplex

(7) Laboratory air jet mill, type Micronette M 50, Gumeo, Italy

(8) Microscope

(9) Balance type Sauter Toppan

(10) Torsion balance, Krüss, Hamburg

(11) Thermostat, refrigerator

(12) Water bath

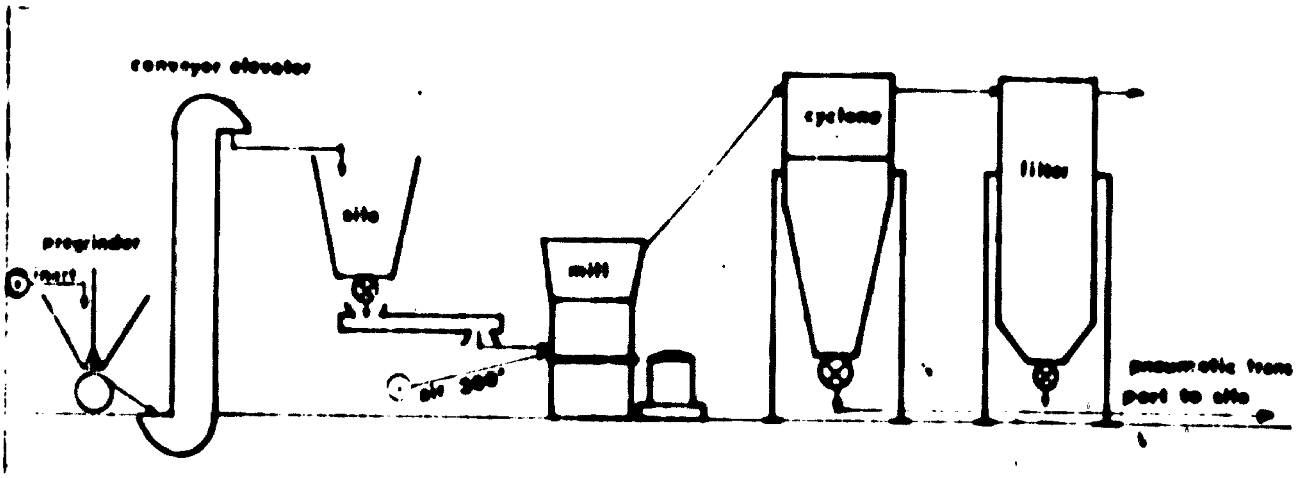
(13) Five laboratory agitator type Heidolph

(14) Two solution vessels 300 l, with agitator for semi-industrial production

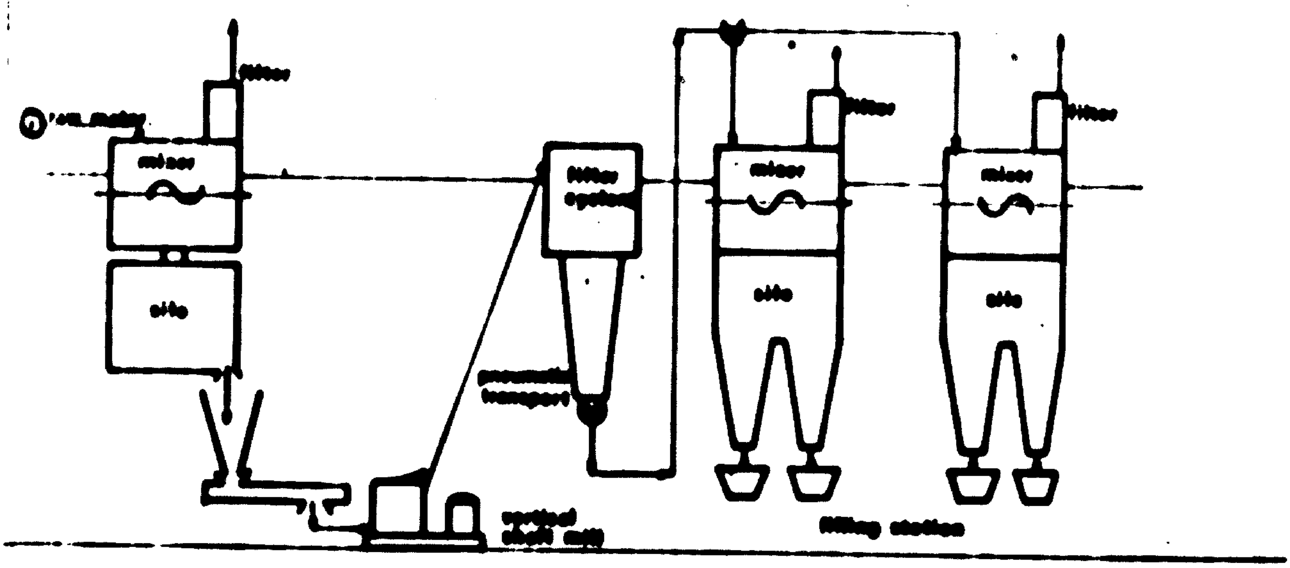
(15) One pluristadio mill gr 80, Gumeo, Italy, with heating, cooling and inert gas for semi-industrial production, complete with mixer 500 l type Nauta; cyclone, filter and control panel

Annex XIX

(1) POWDER FORMULATION



Inert carrier upgrading

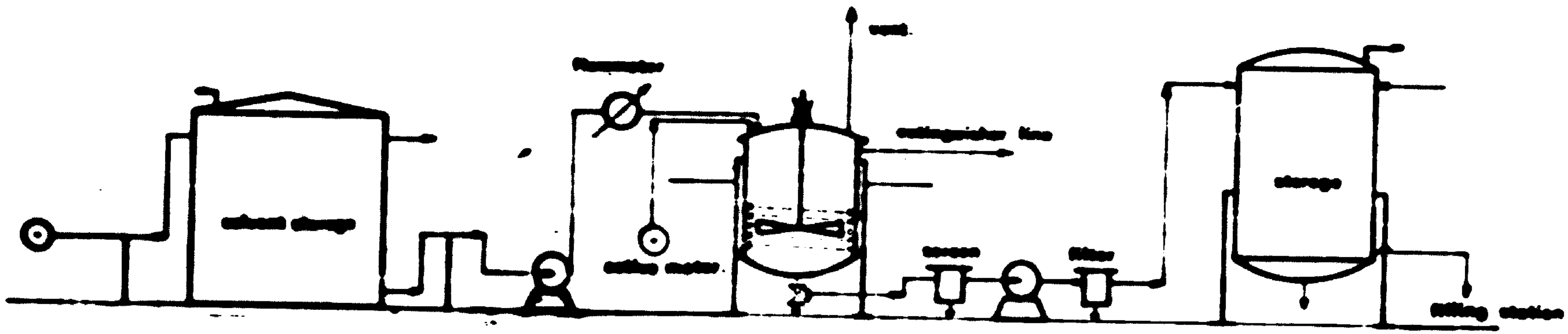


Dust mill

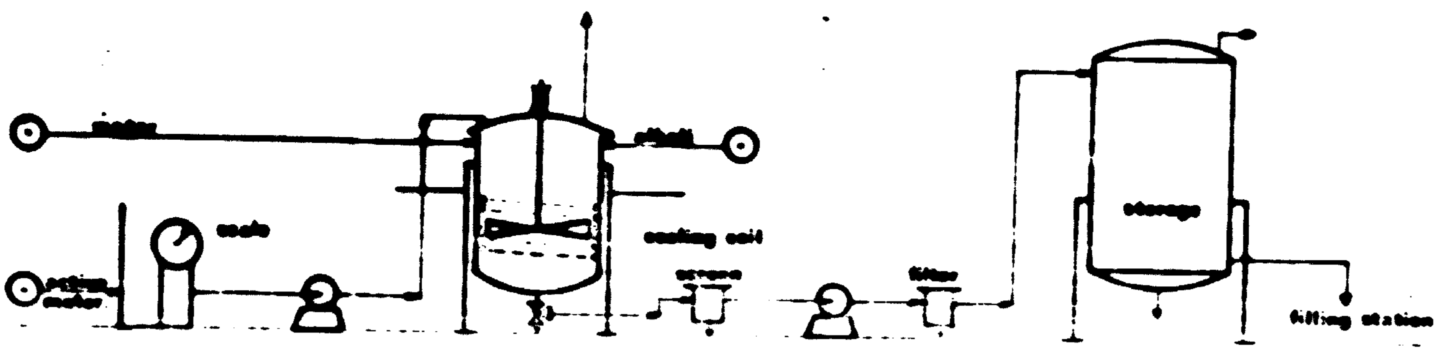
Annex XIX

(2) LIQUID FORMULATION

Emulsion concentrates



Herbicide solution



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