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RESEARCH INTO THE CHEMICAL INDUSTRY AND FERTILIZERS IN WEST AFRICA.

The formulation of data in regard to planning.

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CONTENTS

CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

DIAGRAMS

RESEARCH INTO THE CHEMICAL INDUSTRY AND FERTILIZERS IN WEST AFRICA

FORMULATION OF DATA IN REGARD TO PLANNING

I. GENERAL REMARKS

I.1 Introduction

This particular study is a follow-up of recommendations made at the Bamako Conference (from 5 to 15 October 1964), and its aim is to indicate the favourable prospects for industrial development in West Africa.[1/]

Attention was drawn from the very outset (at the first Niamey Conference in 1962) to the need for establishing co-operation between the various countries in a given zone, in order to enable them to set up basic industries designed, for instance, for the manufacture of metallurgical products and fertilizers.

The United Nations Economic Commission for Africa also sent a mission to West Africa from 17 August to 1 November 1963, which produced two reports.[2/3/]

These reports were examined by the sixth session held at Addis Ababa from 19 February to 3 March 1964 as well as by the Bamako Conference. They emphasized the interest attaching to the chemical industry as a starting point for industrialization. The manufacture of fertilizers would, in particular, make it possible to sustain the effort made in the field of agriculture towards increasing the yields of crops, raising the living standard of the people and freeing manpower for industrial development, and at the same time economizing foreign currency.

1/ See E/CN.14/INR/77 - Co-ordinated industrial development in West Africa: suggestions for further action - 21 July 1964.

2/ See E/CN.14/INR/25 - Preliminary report of the West African Industrial Co-ordination Mission - 2 December 1963.

3/ See E/CN.14/246 - Report of the West African Industrial Co-ordination Mission - 30 January 1964.

I.2 Aims and objects

As the economic framework has already been defined in previous reports, the inventory of the main industrial sources has made it possible to put forward a few suggestions regarding the possibilities of setting up factories for the production of chemicals and fertilizers in West Africa.

On this basis, a new report was written[1] defining the following points:

- what are the chemical products capable of being manufactured in West Africa, their quantities and prices?
- what are the favourable sites for production, having regard to available raw materials and areas of consumption?

As there was only a short time limit for this study, it was not possible to consider the data for more than a few industries, which were thought to have a preliminary value. The authors (Institut Batelle, Frankfurt-on-Main, Germany) themselves stressed the need for following up and completing the results of their report.

Under bilateral aid, M. Jacques Dépardieu, the officer in charge of studies at the SEDES, prepared a provisional report which dealt mainly with the present situation, from documents available in Paris for eight French-speaking countries in the West African sub-region.[2]

The present study, strictly speaking, is in two parts:

- the main part
- the annex

The object of the main part is to determine the conditions for setting up and exploiting chemical factories which seem to have a favourable chance of success. It includes proposals and recommendations.

1/ E/CN.14/INR/73 - Chemical Products and Basic Fertilizers - 21 July 1964.

2/ E/CN.65.3321: J. Dépardieu - L'industrie chimique en Afrique de l'ouest (provisional text)

In the annex, a detailed examination is made of the situation as far as each country is concerned, in order to bring out the following points:

- first, the resources that may be used for the chemical industry (raw materials, energy, water, transport, etc.)
- secondly, the position of the local market, bearing in mind the existing industries. Statistics have been given for basic products, fertilizers and other chemical products in an endeavour to anticipate the needs that will have to be met for the years 1965, 1970, 1975 and 1980.

In the annex, use is made, among other things of the indications given in the provisional report and the report of the Institut Batelle, although certain figures are corrected and amplified in the light of the latest facts collected on the spot by a travelling mission, as well as from documents available to the ECA.

As part of the bilateral aid programme, the present study has been discussed with the Société d'Etudes pour le Développement Economique et Social (SEDES) in Paris, with the Institut Français du Pétrole at Rueil-Malmaison (Haute Seine) and the Société d'Aide Technique et de Coopération (SATEC) in Paris.

I.3 Countries concerned

There is no question of going back on the geographical delimitation of West Africa, as previously defined in studies conducted by the ECA. In principle, West Africa includes the fifteen following countries: the Ivory Coast, Dahomey, Gambia, Ghana, Guinea, Portuguese Guinea, the Upper Volta, Liberia, Mali, Mauritania, the Niger, Nigeria, Senegal, Sierra Leone and Togo.

This region is bound on the north by the Sahara, on the west and south by the Atlantic Ocean, on the east by Cameroon and Chad. The assumption is made, as a result of certain statistics, that trade is possible between these two neighbouring countries, whereas the inadequacy of

transport links by road limits access towards North Africa.

The chief means of communication between the countries named above, as far as heavy merchandise is concerned, is obviously traffic by sea, and this gives rise to three very important consequences:

- the countries in the interior are handicapped when compared with their neighbours on the coast, and the result is an appreciable population exodus towards already over-populated areas;
- any industry which exceeds the limits of the national boundaries, must of necessity be established near a port or be linked to it by railroad;
- the problem of transport plays a vital role in the marketing of products.

The present report includes all the West African countries with the exception of portuguese Guinea.

II. FACTORS GOVERNING THE ESTABLISHMENT OF A CHEMICAL INDUSTRY

The setting up of a processing industry and particularly a chemical industry, should take account, among other things, of the following factors:

- the availability on the spot of raw materials, electrical or thermal energy and water;
- possible markets in the sphere of influence, limited by foreign competition;
- transport possibilities for supplies of raw materials and shipment of finished products;
- availability of manpower;
- the economic prospects of production.

II.1 Raw materials

In the course of the examination of the situation as it affects each country (see Annex), a detailed analysis was made of the problems concerning raw materials.

Here, one would like simply to recall, with the aid of Table 1, the availability of raw materials for chemical industries in each of the countries of the sub-region, and add a few supplementary observations about the situation as it affects the whole of the sub-region.

From Table 1 it will be clearly seen that the best conditions for the development of the chemical industry are found in Nigeria, Ghana and Senegal.

Some raw materials and fuels, like natural gas (Nigeria) and phosphates (Senegal, Togo) which are already being exploited, can immediately be processed into more finished products. Others, including naphta, are already available in certain countries, but will be available in greater quantities when the installations envisaged are in operation. However, the production of naphta, which is designed for the manufacture of various petrochemical products, runs the risk of still being inadequate for the needs of countries which have refineries of only minor importance. It may however be possible to remedy the shortages, by using the larger refineries in the sub-region.

TABLE 1

Available Raw Materials for the Chemical Industries

Countries	Coal	Natural gas	Crude oil	Petroleum products	Salt	Gypsum	Lime-stone	Phos-phates	Ba-xite
First region									
Nigeria	+	+	+	+	.	.	+	.	.
The Niger	.	.	.	.	.	.	+	.	.
Dahomey	.	.	.	.	.	.	+	.	.
Togo	.	.	.	.	(+)	.	.	+	.
Second region									
Ghana	.	.	.	+	+(+)	.	+	.	+
The Ivory Coast	.	.	.	+	.	.	.	.	.
The Upper Volta	.	.	.	.	.	.	(+)	.	.
Third region									
Guinea	.	.	.	(+)	(+)	.	+	.	+
Sierra Leone	.	.	.	(+)	.	.	.	.	+
Liberia	.	.	.	(+)	.	.	.	.	.
Fourth region									
Gambia	.	.	.	.	.	.	.	.	.
Senegal	.	.	.	+	+	.	+	+	.
Mauritania	.	.	.	.	+	+	+	(+)	.
Mali	.	.	.	.	+	.	+	(+)	.

Key to conventional signs:
. nothing, negligible
+ in course of operation
(+) at the project stage

The situation regarding other raw materials, particularly lime and salt, is not clear. There is no precise information about high-content lime such as could be used for making chemical products, or extracted and worked near the coastal region.

The available quantitites of salt seem to offer more chances of success than those of lime. The extension of the salt mines of Senegal and the completion of projects envisaged in Ghana, Togo and Guinea, would seem likely to provide a solution to the problem of the supply of salt.

It is to be hoped in this connexion that these countries will place the first priority on the implementation of their plans for salt exploitation, not only in the interests of the chemical industry, but also to meet the needs of the people of the sub-region.

Among the raw materials to be imported should be mentioned sulphur, benzene, ethylic alcohol and coke.

Because of the great quantities necessary, the first of these will have by far the largest demand in the sub-region. The indications that it exists in the form of pyrites, hold out very little promise up to now. Because of the lack of convertible currency, which will be seriously affected by the tendency to a rise in world prices, and the increasing demands of the sub-region, it is of the highest importance that the countries in which the presence of sulphur or pyrite deposits are indicated, should embark upon more intensive prospecting.

Mention should again be made of the possibilites of using gypsum and anhydrite.

Factories for the production of sulphuric acid, treating calcium sulphate as gypsum or anhydrite, are at present being used in the United Kingdom, Poland, Austria and Turkey. This warrants the possibility that prospecting should be extended to gypsum and anhydrite, as well as sulphur or pyrites. In the absence of the last two raw materials, gypsum or anhydrite would supply the answer to the problem arising from the small quantities of sulphur in the world. In this connexion, it is worth noticing that any good economic return from a process based on gypsum, would depend on the demand for the cement obtained in the process.

Benzene and ethylic alcohol are important items under the heading of "imports". Already there exist (and conditions are ripe for their manufacture on the spot), oil refineries for benzene and sugar refineries for making molasses for ethylic alcohol. It may therefore be assumed that the necessity to import these two products will arise only in the initial years.

As far as coke is concerned, production prospects locally are not favourable. Coal from Nigeria is not capable of being converted into coke. Here also, until it is possible to convert local coal into coke, it will be necessary to rely on imports to cover the need which cannot be met by charcoal or natural gas.

II.2 Electrical energy

A large number of chemical industries examined in this dissertation, are heavy consumers of electricity. They are as follows: viscose rayon, salt electrolysis, calcium carbide, polyethylene, ammonia, PCV, etc.

In other words, the sine qua non of any possible local manufacture, depends upon the availability of electrical energy, cheap and in abundant quantity.

There is unfortunately only one country namely Ghana, which now satisfies these conditions, Reference may be made in this connexion to Table 2 which indicates the hydro-electric potential, existing tariffs and tariffs envisaged for the industry in the future.

This situation will change for the better when hydro-electric power stations now under construction, or those to be built in future, come into operation. This possibility must be taken into account when envisaging probable sites in the sub-region for factories, for the manufacture of chemical products consuming a great deal of electricity.

TABLE 2

Hydro-electric potential and electricity tariffs for the industry

Countries	Hydro-electric potential 10^9 kWh	Tariffs $/1,000 kWh	Index x/
Nigeria	17,0	13,0	4,9
Ghana	9,0	2,65	1,0
The Upper Volta	-	80 1/	30,2
Mali	13,0	61,0	23,0
The Ivory Coast	20,0	14,6 2/	5,5
Guinea	25,0	35,0 15,0 3/	13,2
Senegal	16,0	20,0	7,6
The Niger	-	76,0	28,6
Sierra Leone	10,0	65,0 4/	24,5
Dahomey	3,0	68,0 4,0 5/	25,6
Togo	2,0	48,0 1/	16,1
Liberia	25,0	9,0 1/	3,4
Mauritania	-	108,-	40,7
Gambia	-	34,0 6/	12,8

Source: "The Situation, Trends and Prospects of Electric Power Supply in Africa" (E/CN.14/EP/3. Part I).

x/ Index for Ghana equals 1.

1/ Tariff envisaged for the future.

2/ Tariff in force in the region of Conakry.

3/ Tariff estimated for the future.

4/ Tariff in 1960.

5/ Tariff estimated in the future for electricity from Ghana.

6/ Tariff in 1963.

II.3 Markets

The study of the market which is of supreme importance for the setting up of a chemical industry, has been very carefully undertaken in the Annex, for each product in each country of the sub-region. The increase in consumption has been envisaged on the basis of the tendencies observed in the course of the past years, and in the development of consumption in other countries with a similar or slightly higher standard of living. In these estimates, consideration has been given to the existing enterprises which supply the local markets whether:

- by processing raw materials: soaps, plastic material, industrial gases (oxygen and acetylene), etc.;
- or, by making up and packing semi-finished products: drugs, paints, pesticides, detergents, etc.

However the national markets are at present insufficient for anything like the establishment of a "heavy" chemical industry, which does not begin to yield economic returns until a certain level of production has been reached. This disadvantage comes particularly to the fore in the study of markets.

Actually, if it is not possible to install a factory which will produce chemical products to feed a single country, regional agreements can be concluded, with a view to making it a joint venture. In such a case, it will be necessary to determine two essential factors:

- the point at which the enterprise will begin to yield economic returns,
- the sphere of influence.

The point at which economic returns begin, means in effect the minimum production level for which a given product can be sold at the normal market price. It has been observed that unit capacities are constantly increasing, in an attempt to reduce the cost price. This is true of ammonia where the capacity of a unit (that is to say of a reactor) is at present 1,000 tons per day, whereas larger units are under construction

and are being studied. This is also true of units of ethylene which have now reached the stage of 200,000 tons per year or more.

This idea is based on the fact that investments do not vary in a straight line in accordance with capacity, but in response to a power factor which is generally between .60 and .85; hence the interest in building large-capacity units which cost proportionately less than low-or medium-capacity units. The same observation may be made with regard to manpower, general factory overheads and general expenses for maintaining the head office, which are proportionately less expensive for large capacity units.

From this arises, at any rate where basic products are concerned, the idea of a minimum economic capacity, which compels one to build increasingly larger units if they are to be competitive.

The sphere of influence of industrial plant, is defined as the area which is in fact accessible by road, railway, or boat, without leading to prohibitive transport costs.

The study of the consumption level, that is to say the maximum production tonnage which can be marketed at the normal price in this sphere of influence of the particular factory under consideration, makes it possible to evaluate the necessary capacity of the factory.

On the other hand, any serious determination of spheres of influence can only be undertaken after a preliminary study of transport conditions.

II.4 The transport problem in West Africa

A mere examination of the map of the sub-region would lead one to the conclusion that most of the transport facilities derive from the coastal ports moving into the hinterland with very little parallel communication by sea.

As one goes from north to south, and west to east, one meets with the following links:

II.4.1 Railways

Distances are calculated from the terminus which is underlined (in round figures):

- Mauritania: the Port-Etienne line to Port-Gouraud and Tozadit (650 km) serves a dessert area (a mining railway).
- Senegal: The Dakar line to Bamako and Koulikoro(1,200 km approximately) links the coast to the west of Mali. It branches out from Thiès towards Lunguéré (307 km) and towards Saint-Louis (253 km) passing through Taiba on the way; it links up again with Kaolack and Lundiane (215 km) from Guinguinéo.
- Guinea: the Conakry line to Kankan (570 km approximately) with a branch line going to Fria (140 km).
- Sierra Leone: the Pepel lines to the Marampa mines (93 km) and the Freetown line to Pendembu (365 km) with a branch line going to Makani (253 km) from Banya.
- Liberia: the Monrovia mining lines to Mano-River (147 km) and Bong-Range (80 km) as well as the Buchanan line to Mount Nimba.
- Ivory Coast: the Abidjan line to Ouagadougou (1,150 km) which serves the southwest of the Upper Volta.
- Ghana: the Accra - Kumasi line (250 km) and Sekondi-Takoradi to Kumasi (220 km) with branch lines going to Kade (200 km) and Abousso (220 km)
- Togo: the Lomé line to Blitta (276 km) with a branch line for Palimé (119 km) from Takoin and a link with Anécho (44 km).
- Dahomey: the Cotonou line to Parakou (438 km) with a branch line for Segborone (57 km) from Pahou and a link with Pobé (108 km).
- Nigeria: the Lagos line to N'Guru (1,350 km) with branch lines going to Koura-Namoda (1,070 km) from Zaria, towards Baro (920 km) from Minna and in the direction of Idawgaw (65 km from d'Ife). There are two inter-connexions with the Port-Harcourt line to Maiduguri (1,456 km): one joins Kaduna (902 km from Lagos) to Kafanchan (737 km from Port Harcourt) through a 179 km link; the

other passes by way of Jos, situated 920 km from Port Harcourt and approximately 1,175 km from Lagos.

At present only two railway lines cross the frontiers.

In future a third should link Maiduguri in Nigeria with Fort Lamy in Chad (250 km).

However a 45 km line between Anécho in Togo and Ouidah in Dahomey along the coast would be sufficient to inter-connect the two networks (gauge: 1 metre).

On the other hand, a link between Pobé and Idawgaw (45 km approximately), would effect a junction between the networks of Dahomey and Nigeria; but there are differences in the size of gauge (1 m and 1.07 m).

The average cost of railway transport is estimated at US$ 0.02 per ton/km for goods carried in full wagons.

II.4.2 Main routes

What follows is a mere enumeration of the routes linking the ports or towns served by railways crossing the frontiers:

- Mauritania: it is linked to the Sahara and Morocco towards the north by the road from Nouakchott to Fort-Gouraud (700 km), Tindouf (1,600 km) and Agadir (over 2,000 km).
  The link towards the southern part from Nouakchott to Rosso (200 km) and Saint-Louis in Senegal.
- Portuguese Guinea is linked to Senegal by a 400 km route between Bissau and Tombacounda (situated 464 km by rail from Dakar) passing through Farim, Volda and Valingara.
- Guinea is linked with Senegal partly by roads and partly by tracks which extend for instance from Kindia (150 km by rail from Conakry) to Tambacounda (600 km) passing through Gaoual or Mamou (300 km by rail from Conakry) to Tambacounda (590 km) by way of Labé.
- Guinea is linked with Mali by road from Kankan to Bamako (360 km) passing through Siguiri.

- Mali is linked to the Upper Volta by the 540 km road from Bamako to Bobo-Dioulasso (800 km by rail from Abidjan in the Ivory Coast) through Bougouni and Sikasso.

  The same route (through a change in direction to Sikasso) makes it possible to effect a link over a distance of 500 km between Bamako and Ouangolodougou (situated 600 km from Abidjan) in the Ivory Coast.
- Guinea and Sierra Leone are linked by two routes: Conakry to Freetown (340 km) and Kankan to Pendenbu (400 km).
- Guinea is also linked with Liberia by road from Kankan to Monrovia (700 km), which appears to be the only link which can be used between these two countries, passing through Beyla and Nzérékoré.
- Liberia is linked with the Ivory Coast by road from Monrovia to Abidjan (1,200 km) passing through Nzérékoré, Man, Daloa, Banaflé and Toumadi.
- The Upper Volta is linked with Ghana by road from Ouagadougou to Kumasi (750 km) passing through Navrongo, Tamale, Salaga and Mampong.
  It is also linked with Togo by road from Ouagadougou to Blitta (760 km) passing through Tenkodogo, Sansané and Sokodé.

  It is also linked with Dahomey by the 820 km road from Ouagadougou to Tchaourou (380 km by rail from Cotonou) passing through Fada N'Gourna, Pama, Natitingou and Djougou.

  Finally it is linked with the Niger by road from Ouagadougou to Niamey (530 km) passing through Fada N'Gourna, Natiacouli and Kanchari.
- The Niger is linked with Dahomey by road from Niamey to Parakou (610 km) passing through Doso, Gaya and Kandi. It is also linked to Nigeria by the 760 km road from Niamey to Gussau (1,200 km by rail from Lagos) passing through Bimi N'kouni and Sokoto. Another route links Zinder with Kano (situated 1,020 by rail from Lagos).

-- Nigeria is linked with Chad by road from Maiduguri to Fort Lamy (250 km). It is also linked with Cameroon by road from Enugu (243 km by rail from Port Harcourt) to Douala (600 km). Finally it should be mentioned that the coastal road continues, thus doubling the railway (which ends) between:

Accra in Ghana and Lomé in Togo (193 km);
Lomé in Togo and Porto-Novo in Dahomey (186 km);
Porto-Novo in Dahomey and Lagos in Nigeria (144 km).

To some extent, roads make up for the lack of railway, but the distances to be covered are considerable, and some areas in Mali (Ségou, Mopti, Timtuctou, Gao) and in Niger (Tahoua, Agadès) are indeed isolated from the coastal area.

The average cost of transport by road is estimated at US$ 0.035 per ton/km.

II.4.3 Waterways

It is certain that the main rivers and their tributaries serve as a traditional means of penetration and transport, and this might be interesting where heavy goods are concerned. Unfortunately the rapids and the lack of water during the day season make this possibility somewhat fortuitous. At most it may be pointed out that certain portions of the Senegal, Gambia, Volta and particularly Niger rivers are used permanently, while others can serve as occasional substitutes.

II.4.4 Coastal service

Transport by sea is still one of the main links between the countries on the coast, although the rates now charged are very high (US$ 10-12 per ton between two neighbouring ports).

It is however certain that a heavy chemical industry might create a fruitful trend of regular trade, in which certain raw materials would be the outgoing freight (salts, phosphates, etc) and certain finished products the in-coming freight (nitrogenous fertilizers for example).

In these circumstances, it is legitimate to assume that prices would easily drop by half, in particular, where contracts for organized regular links are faithfully honoured.

On the other hand, the installation of such an industry would automatically lead to an improvement in harbour equipment, and this is not by any means a negligible point.

II.5 Spheres of influence

There are great differences between the countries grouped together in the sub-region:

- the extent of the national territory and the internal network link;
- the size of the population and its local distribution;
- the degree of industrialization as compared with the agricultural sector;
- the ordinary medium of expression, currency, and protective customs tariffs, etc.

Certain obstacles to the development of trading relations are tending to disappear, and bilateral agreements already exist between various countries.[1/] But differences in language, currency and customs regulations are regarded as of secondary importance in this particular study, as it is assumed that any enterprise agreed upon in common, will automatically lead to the conclusion of certain necessary economic agreements.

However, unless a "common market" is achieved for the whole of the sub-region, with its own protective customs tariffs, it seems a dream to think of setting up a single factory which will supply the market for the majority of the products. Even if the effect of

1/ See Annex III of the report E/CN.14/246 - Report of the West African Industrial Co-ordination Mission - 30 January 1964.

size makes it possible to sell at lower prices, transport costs become prohibitive in the long run, and there is the risk of being unable to stand up against international competition for heavy goods that are relatively cheap such as (fertilizers). There is no reason why consumer prices should be increased, or freedom of choice severely limited.

Consequently, it becomes necessary to determine spheres of influence for each factory, bearing in mind transport facilities, when fixing production capacities and estimating the probable economic returns.

In order to determine spheres of influence when a new industry is to be established, it is important to group countries that are now linked by convenient means of transport. An examination of the map, and the brief inventory given above would lead to the selection of four regions:

1st region: this would comprise Nigeria, the Niger, Dahomey and Togo, the railways of that country serving as the main penetration route towards the Niger with a possible link towards Chad.

The coastal road and the railways from Togo and Dahomey would supply links between those countries. Togo and Dahomey have secondary internal link roads whereas the hinterland of the Niger is linked with Nigeria, Dahomey and the Upper Volta.

The main ports are Lagos, Port Harcourt and Cotonou, with Lomé as a secondary port.

2nd region: This would comprise Ghana, the Ivory Coast and the Upper Volta, with the main railway line from Abidjan to Ouagadougou and the railway lines in Ghana; there are a fairly large number of road links between the various frontiers (only the main ones have been given), and these make it possible to link up with the hinterland. The Upper Volta is also linked with the Niger, Togo and Dahomey.

The main ports are Abidjan, Sekondi-Takoradi and Tema.

3rd region: it should be recognized that Guinea, Sierra Leone and Liberia are not strictly speaking an economic unit. These countries are at present cut off from one another, since link roads are few and far

between and sometimes impracticable. The hinterland of Guinea is linked with Mali instead.

It is more logical to consider these countries as separate units where communications are carried out exclusively by sea. In this respect, they can be joined indifferently to other regions.

4th region: this would comprise Gambia, Senegal, Mauritania, Portuguese Guinea and Mali. The inhabited areas are fairly well linked with the railway from Dakar to Bamako, which to some extent was their backbone, with the port of Dakar as the main external outlet. The ports of Saint-Louis and Bathurst may serve as secondary outlets. Mali provides an internal link with Guinea, the Upper Volta and the Niger.

The pattern sketched out above makes it possible for one to get a clear picture of the markets open to the sphere of influence, in any enterprise set up in one or other of the countries mentioned. It would indeed be unlikely that an article manufactured in Senegal would be sold automatically in Nigeria (except under a special agreement) whereas on the other hand it would be wrong for the Upper Volta to search elsewhere for an article which it could obtain reasonably in the Ivory Coast.

It is not certain that the regions above defined would provide a sufficient market to make an industrial concern a paying economic proposition. In this case, it would be possible to group two or several regions in the same zone (including the isolated countries) but it must however be noted that a link up in this case would be achieved by way of the sea, and would have to cope with external competition.

With a view to presenting the points most in their favour and offering possibilities for comparing the economic situations in the regions mentioned above, population estimates are also given below as well as the gross domestic product for each of the regions considered.

II.6 Population

The estimates for population have been calculated for each country from the results of the latest population census, bearing in mind the rate

of population growth in the country considered.

The proposed figures are only orders of magnitude owing to the fact that there is an almost general lack of complete recent censuses. Nevertheless, it is probable that the margin of error is low, and does not influence either the classification of the countries, nor the value of the indices calculated "per head of population".

TABLE 3

Population estimates for the West African countries

Countries	Population 1,000 inhabitants					Rate of annual growth in %
	1960	1965	1970	1975	1980	
Nigeria	50.000	58.000	67.500	79.500	91.000	3.0
The Niger	2.823	3.270	3.625	4.085	4.675	2.6
Dahomey	2.150	2.355	2.600	2.935	3.355	2.8
Togo	1.440	1.640	1.820	2.060	2.370	2.5
Total for the First Region	56.413	65.265	75.545	87.580	101.400	2.9
Ghana	6.777	7.740	8.975	10.400	12.130	2.9
The Ivory Coast	3.431	3.834	4.235	4.740	5.385	2.2
The Upper Volta	4.300	4.782	5.195	5.735	6.415	2.0
Total for the Second Region	14.508	16.356	18.405	20.875	23.930	2.6
Guinea	3.072	3.480	3.880	4.325	5.030	2.5
Sierra Leone	2.450	2.710	3.000	3.310	3.660	2.0
Liberia	980	1.050	1.110	1.170	1.240	1.2
Total for the Third Region	6.502	7.240	7.990	8.805	9.930	2.1
Gambia	284	324	370	425	490	2.8
Senegal	3.110	3.475	3.765	4.145	4.630	2.1
Mauritania	694	740	765	820	890	1.3
Mali	4.100	4.580	5.060	5.680	6.485	2.3
Total for the Fourth Region	8.188	9.119	9.960	11.070	12.495	2.1
General total	85.611	97.980	111.900	128.390	147.755	2.8

Source: Provisional Report on World Population Prospects as Assessed in 1963, ST/SOA/SER.R/7; ECA Demographic Section, 3 March 1966.

II.7. Gross Domestic Product

The gross domestic product per head of population, which is the aggregate most frequently available, is the most synthetic economic indicator possible, although the very different structure of the economies under consideration forbids one to make an exclusive use of it.

TABLE 4

Estimates of the gross domestic product for the West African Countries

Countries	Gross domestic product (millions of dollars)					Rate of annual increase in the %
	1960	1965	1970	1975	1980	
Nigeria	3,396	4,272	5,576	7,285	10,060	5.5
The Niger	203	296	404	550	708	6.4
Dahomey	155	163	198	241	344	4.0
Togo	120	143	184	237	332	5.2
Total for the First Region	3.874	4,874	6,362	8,313	11,444	5.5
Ghana	1,338	1,565	1,997	2,550	3,487	5.0
The Ivory Coast	589	953	1,360	1,945	2,446	7.4
The Upper Volta	179	224	311	432	662	6.8
Total for the Second Region	2,106	2,742	3,668	4,927	6,595	5.9
Guinea	207	252	324	418	562	5.2
Sierra Leone	187	228	304	405	593	5.9
Liberia	173	263	376	537	726	7.4
Total for the Third Region	567	743	1,004	1,360	1,881	6.2
Gambia	20	23	29	38	54	5.1
Senegal	591	700	893	1,140	1,560	5.0
Mauritania	79	142	205	296	340	7.6
Mali	276	327	407	507	657	4.5
Total for the Fourth Region	966	1,192	1,534	1,981	2,611	5.1
General Total	7,513	9,551	12,568	16,581	22,531	5.7

TABLE 5

Estimate of gross domestic product per head of population for the West African countries

Countries	Gross domestic product per head of population					Rate of annual investment in %
	1960	1965	1970	1975	1980	
Nigeria	67,9	73,7	82,6	92,8	110,5	2,6
The Niger	71,9	90,5	111,4	134,6	151,4	3.8
Dahomey	72,1	69,2	76,2	82,1	102,5	1.2
Togo	83,3	87,2	101,1	115,0	140,1	2,6
Total for the First Region	68,9	74,7	84,2	94,9	112,9	2,6
Ghana	197,4	202,2	222,5	245,2	287,5	2,0
The Ivory Coast	171,6	248,6	321,1	410,3	454,2	5.0
The Upper Volta	41,6	46,8	59,9	75,3	103,2	4.7
Total for the Second Region	145,2	167,6	199,3	236,0	275,6	3.3
Guinea	67,4	72,4	83,5	96,6	111,7	2.6
Sierra Leone	76,3	84,1	101,3	122,4	162,0	3.8
Liberia	176,5	250,5	338,7	459,0	585,5	6,2
Total for the Third Region	87,2	102,6	125,7	154,5	189,4	4.0
Gambia	70,4	71,0	78,4	89,4	110,2	2.3
Senegal	190,0	201,4	237,2	275,0	336,9	2.9
Mauritania	113,8	191,9	267,9	361,0	382,0	6.2
Mali	67,3	71,4	80,4	89,3	101,3	2,1
Total for the Forth Region	118,0	130,7	154,0	179,0	209,0	2.9
General Total	88,0	97,5	112,3	129,1	152,5	2.9

We note that the domestic product per head of population is very low: 88 in 1960, 97.5 in 1965 and will be 152.5 dollars, on the average, in 1980. It is worth recalling that the United Nations Organization fixed the level of annual revenue, below which a country is considered as insufficiently developed, at 200 dollars per head of population.

The leading group is to be found among the more industrialized countries: Ghana, the Ivory Coast and Senegal. There is no doubt that industry raises the wealth of a country very considerably; nevertheless, it must not be forgotten that the influence of industry affects only a portion of the population, and more often than not, a minority of that population. A gross domestic product which has attained only a moderate height, may therefore conceal enormous disparities in the standard of living of the various classes of the population. The position of Liberia, for instance, is explained only in terms of the importance of the mining sector on the one hand, and the American rubber plantations on the other; the position of these large enterprises explains the fact that half the gross national revenue is collected by foreign agents. Liberia's average revenue is therefore appreciably reduced. The same situation exists in Mauritania.

II.8. Manpower

Modern chemical plant calls for the use of the latest advances in technique, particularly in the field of metallurgy, mechanics and regulation. Consequently, the staff using and upkeeping these units is a very specialized kind of labour needing great experience.

The problems of staff training: engineers, foremen of works, operators, chemists, are therefore extremely important and the expenses in connection with the costs of training are high.

It is therefore absolutely necessary if an industry is to be set up in a country, to visualize a programme which will facilitate the training of staff as this is the only way in the long run to achieve,

maintain and ensure the development and technical level necessary for the industry.

Competition among the various teaching establishments in the industrialized countries is useful at the outset, in training engineers and technicians to be capable on their return, of personally solving the precise problems that face any new activity in their country.

The necessary establishments to ensure that natives of the country are able to use their acquired knowledge, should however be set up on the spot, and as early as possible, in order to ensure better productivity for the investments which must follow.

II.9 Economic returns of production

After studying the market in the sphere of influence, investigating raw materials, motive agents, manpower, transport and other factors, it is possible to arrive at an estimate of the technical process, the capacities of and possible sites for the factory. The most favourable sites - can only be determined after a preliminary calculation of the investment costs and the production costs for all the sites chosen.

Only such an analysis can serve as a basis for serious recommendations for projects that can, in any sense be profitable.

In the present study, consideration has been given only to those projects which can guarantee an economic return for production.

It is accepted that any projects should satisfy the following economic criteria:

(1) The selling prices should not exceed the price of the importation of equivalent merchandize. In certain cases these prices may be modified by subsidies, tax relief, deferred amortization, etc., but the protectionist tariffs applied to encourage local industries can only have a deleterious effect on consumers by forcing them to pay higher prices for national products than for imported ones. The aim of customs tariffs must be to protect new industries against dumping, but this protection cannot be applied indefinitely

to enterprises that are ineffective. Such measures are open to discussion. Nevertheless they can be justified by the need for accelerating the industrialization process. For instance, they make it possible for an industry below the normal capacity required for economic returns, to take off in exceptional circumstances. However, there is a condition which must be rigorously adhered to, namely, the certainty that the future increase in demand will enable a quick return to normal conditions of operation.

(2) Profits from the enterprises should be sufficient to provide the necessary resources for:

- reimbursing capital in a reasonable space of time, bearing in mind the changes in technique,
- ensuring not only the upkeep of the installations, but also the development of their production capacities, and the technical improvement in the factories by the establishment of new units.

In order to make a comparison between the various products and cost prices of manufactured products, a standard method of calculation has been adopted taking into account the special characteristics of the various production units and the economic factors peculiar to each country.

The calculations made in this document actually rest upon a certain number of basic assumptions, the most important of which are the following:

- It has been presumed that the construction cost of a factory for chemical products on the coast, should not vary substantially from one country to another, because none of the countries of the sub-region is in a position to produce equipment goods (machines, materials, supplies, etc.).

- The calculations of the various cost prices of the different chemical products, are based on the nominal unit capacity.

- It has been assumed that the prices of raw materials for fuel and imported goods are approximately the same in all the countries on the coast. Prices may be slightly different from one country to another. But in view of the fact that the differences are relatively minimal, they can be ignored, and consideration given to the average prices for all the countries on the coast. It will be noted in this respect that raw materials, fuel and imported goods are billed at their CIF prices. This means, in other words that they are exempt from customs duties and other rates and charges.

- It has also been presumed that labour costs are the same throughout the sub-region, inasmuch as minor differences in salaries and wages in the various countries do not lead to any substantial differences in expenditure.

- Without running any risk, this may be assumed in regard to the chemical industries, seeing that the capital and equipment costs are relatively high compared with staff expenditure.

The calculation of labour costs has been based on four main categories of staff, bearing in mind the factors that make up the average expenditure:

-administrative and technical staff, directors, engineers, in part foreign experts: 1,000 dollars per month

- specialized staff (electricians, mechanics, etc.)
200 dollars per month

- office staff (accountants, stenographers, etc.)
120 dollars per month

- unskilled and semi-skilled labour
80 dollars per month.

Because of the social charges, staff expenditure increases by 20 per cent on the average.

The capital expenditure included in these calculations is based on investment costs indicated for each installation. On this basis, the following evaluations were made:

10 per cent depreciation on machines and equipment
5 per cent depreciation on buildings
3 per cent maintenance on capital invested
3.5 per cent interest on capital invested

Five per cent contingent expenses were added to the cost in order to cover utilities not included separately in the calculations, (steam, water, etc.) and ensure a reserve on possible price differentials.

In estimating the production costs of finished products, expenses in connexion with the production of (workshop price) intermediary products were included en bloc in the cost of the raw materials.

An evaluation has also been made of the selling prices for each product, in each location, taking into consideration the 40 per cent tax on profits.

In certain cases, the estimated selling prices may be reduced or the economic factory returns increased because taxes may have been reduced or waived in order to encourage local industries, particularly in the take-off period of the factory.

A comparison of the estimated production costs and selling prices with the estimated CIF prices given in this report, make it possible to examine the possible distribution of products in the sub-region.

The calculation of production costs is followed by an economic analysis of the economic returns, likely to accrue from the initial units proposed for each country.

The calculations for increased capacities in the following stages have not been shown, because the principle was adopted that increased capacity leads to greater economy.

In making an economic analysis of possible economic returns, the following economic factors have been stressed:

1. Capacity:
2. Investment: fixed investment =
   working capital =
   total =
3. Selling price per ton:
4. Cost price per ton:
5. Profit after payment of taxes per ton = selling price - cost price:
6. Profit after payment of taxes:
7. Amortization = 0.085 x fixed investment
8. "Net cash flow" = profit after payment of taxes + amortization
9. "Pay-out time" = $\frac{\text{fixed investment}}{\text{"net cash flow"}}$
10. Added value = annual production x (salaries + capital costs + contingencies + indirect expenditure, general expenditure + profits before the payment of taxes)
11. Gross annual value = annual production x selling price
12. "Rate of return on sales" = $\frac{\text{profits after payment of taxes}}{\text{gross annual value}}$
13. "Rate of return on investment" = $\frac{\text{profit after payment of taxes}}{\text{total investment}}$
14. "Turnover ratio" = $\frac{\text{gross annual value}}{\text{fixed investment}}$

III. FAVOURABLE PROSPECTS FOR THE ESTABLISHMENT OF A FEW CHEMICAL FACTORIES IN WEST AFRICA

III.1 Pharmaceutical Industries

III.1.1 Health problems in West Africa

The problems of public health in West Africa are unlimited. The fact that the native inhabitants are spread over vast territories, the low population density per square mile, nomadic tendencies and inadequate financial resources are so many obstacles to any effective intervention by fixed or mobile medical teams.

In spite of inadequate hospital accommodation, the imperfect state of hygiene in the towns and villages, and the lack of qualified medical and para-medical staff, substantial results have been recorded in the course of the last few years in practically all the countries of West Africa.

Preventive medicine on a massive scale has also become more widespread as a result of the coordination of case-finding campaigns and campaigns for the eradication of serious endemic diseases.

The Organization for the control of endemic diseases which began on a fairly modest scale in 1932, has developed as a result of the unification of control methods and the stimulation of progress in research.

All governments are perfectly aware of the need for their countries to enjoy the best possible health. They are well aware of the fact that social enterprises are also economic, hence they are doing all in their power to place at the disposal of their nationals, the necessary staff and medical installations, as well as vital pharmaceutical products. What is more, the struggle in the cause of public health directs the energies of Africans, who are too often divided in other spheres, to a common goal.

Much has been achieved in Africa in the field of public health, but much still remains to be done.

It must not be forgotten that infantile mortality reached enormous proportions, and it was only because of a prolific birth rate that a population figure which is generally low could be maintained, and that tropical diseases are still the main causes of mortality.

Although the so-called pestilential diseases (small pox, plague cholera, yellow fever, typhus and remittent fever) are very definitely on the decline in Africa, south of the Sahara, malaria continues and will for some time yet continue to be the number one problem in most of the countries situated in tropical and inter-tropical zones.

The terrible havoc caused by tuberculosis, which was one of the worst scourges of mankind, has been reduced.

Leprosy is still very widespread and is responsible even now for far too many victims. No doubt it will require a great deal of effort, but intensive case-finding and treatment campaigns are being waged against it.

In addition, tropical Africa has to combat other contagious diseases such as yaws, bilharziasis, filariosis and trypanosomeasis.

Yaws is also very widespread, but is being fairly well tackled. Since the discovery of the trachoma virus by T'Ang and his collaborators, trachoma too can be dealt with successfully. The eradication of bilharziasis is primarily a matter of active mass health education, while filariosis is essentially a disease for treatment by chemical therapy.

The virulent effects of trypanosomiasis, which are propagated by the tse-tse fly, are being progressively diminished, thanks to the vigorous steps being taken in mass prospecting, treatment and rural hygiene.

Mention can only be made of venereal diseases, another social scourge, which appears to be gaining ground. This requires to be tackled extensively and systematically, and that is costly. The ignorance of the inhabitants in the matter of hygiene is a considerable handicap to mass campaigns.

Apart from other diseases which are to be found everywhere in the world, this is the broad picture of the diseases which the health services in West Africa have to deal with.

III.1.2 Classification of pharmaceutical preparations

(a) In its report of a technical meeting held in Europe (Warsaw, 29 May - 2 June 1961)[1/] the World Health Organization published the following definitions for pharmaceutical preparations, drawn up by a study group:

1/ World Health Organization, Technical Report series No.249 (1961)

1. A drug (or pharmaceutical preparation) is any substance or mixture of substances manufactured, sold, offered for sale or represented for use in:

- the diagnosis, treatment, mitigation or prevention of disease, abnormal physical state or the symptoms thereof in man or animal;
- restoring, correcting or modifying organic functions in man or animal.

2. A pharmaceutical speciality is a simple or compound drug ready for use and placed on the market under a special name or in a characteristic form.

(b) The suggested pharmacological classification of pharmaceutical preparations as a basis for restriction of sale,[1/] distinguishes the following groups:

Preparations acting on the alimentary system: antacids, anti-spasmodics, gastrointestinal sedatives, laxatives and purgatives

Preparations acting on the cardiovascular system: preparations acting on the heart, vasodilators, vasoconstrictors, anti-hypertensives, anticoagulants.

Preparations acting on the nervous system: addictive analgesics, antipyretic analgesics, specific analgesics, barbiturates, non-barbiturate hypnotics, tranquillizers, anti-emetic preparations, anti-convulsants, preparations for the treatment of parkinsonism, muscle relaxants, stimulants.

Preparations acting on the genito-urinary system: sex hormones, diuretics, preparations acting on the uterus.

Preparations acting systematically on infections, antibiotics, sulfonamides, anti-tuberculosis, anthelmintics, vaccines and sera.

1/ World Health Organization, Technical Report Series No 249 (1961)

Preparations affecting metabolism and nutrition: insulin, oral hypoglycaemics, erythropoietic preparations, vitamins, corticosteroids, anabolic drugs, thyroid and antithyroid preparations, antimitotic preparations.

Preparations affecting allergic reactions: antihistamines, preparations for protein desensitization.

Topical preparations (not previously specified). Acting on the eye, acting on the ear, acting on the skin (sedatives and antipruritics), antiseptics and disinfectants.

(c) The revised[1/] model classification for international trade makes a distinction in section 4 x 5 between chemical products; and in division 54 between medicinal and pharmaceutical products, in which are to be found the following groups and sub-groups:

541.1	Vitamins and provitamins
541.3	Penicillin, streptomycine, tyrocidine and other antibiotics
541.4	Opium alkaloids, cocaine, cafeine, quinine and other vegetable alkaloids, their salts and other bye-products
541.5	Hormones
541.6(1)	Heterosides and their bye-products
541.6(2)	Glands and other organs for opotherapic purposes and their extracts
541.6(3)	Bacteriological products, serums, vaccines
541.7	Drugs
541.9	Pharmaceutical articles
541.9(1)	Bandages, etc. saturated or covered over with pharmaceutical substances or packed for retail.
541.9(1)	Other pharmaceutical preparations and articles.

1/ United Nations, Statistical Papers, Series M No. 34

III.1.3. Economic importance of pharmaceutical industry in Africa

Ever since man appeared on the earth and became subject to various diseases and infirmities, he has always as a matter of course sought the means of restoring waning health, preventing the commonest pathological affections and eradicating or mitigating pain.

Modern science has provided, among other things, the powerful weapons of modern pharmacopaeia to control disease or prevent it.

It has been observed that the inhabitants of Africa are increasingly shunning the "witch doctor", and systematically turning towards proved medical science and highly prized therapeutic remedies which have been produced in modern countries. Retorts, stills, mortars and pestles have been consigned to oblivion. The dispenser in Africa, as in Europe, does not mix juleps any more, he sells patented products.

The increase in the consumption of pharmaceutical products is very clear and is attributable to the intensified control of serious endemics in the hinterland, as well as to the slow rise in the number of prescriptions delivered by medical practitioners in urban centres. As the health map of the African States takes shape, and mobile teams penetrate further into the remoter areas, the volume of drugs distributed increases substantially.

Finally, the improved standard of life in certain territories adds whole lists of consultants to the number of private and public health establishments. At least in the towns, the people tend to consult the doctor as in the most highly developed countries, and the list of drugs prescribed tends to become increasingly diversified.

To a very large extent, the present rate of pharmaceutical consumption is met by imports from abroad.

A comparison of the statistical data of exports reveals the constantly growing increase in consumption and the economic importance of the pharmaceutical industry.

Imports of medicinal and pharmaceutical products in Africa have gone up between 1952 and 1960 from 47,743 to 105,806 million dollars.

TABLE 6

Imports and exports of chemical products and medical and pharmaceutical products per region, 1952 and 1960

(value expressed in thousands of dollars, quantities in metric tons)

	Imports			
	1952		1960	
	Quantities	Value	Quantities	Value
North Africa				
Chemical products total	943.970	140.671	1.247.181	189.284
Medical and pharmaceutical products	8.962	28.130	13.051	57.025
West Africa				
Chemical products total	85.873	49.900	244.221	108.122
Medical and Pharmaceutical products	1.870	12.256	3.271	31.791
Central Africa				
Chemical products total	48.785	19.529	249.914	55.841
Medical and pharmaceutical products	1.424	4.668	1.145	10.245
East Africa				
Chemical products total	42.811	13.861	84.997	28.268
Medical and pharmaceutical products		2.689		6.745
Africa[1]				
Chemical products total[2]	1.121.439	223.961	1.826.313	381.515
Medical and pharmaceutical products total.	12.256	47.743	17.467	105.806

Sources: Industrial development in Africa, UN, New York: 1963
National Statistical Publications

1/ Excluding South Africa
2/ Total imports of chemical products for Africa according to the United Nations Monthly Statistical Bulletin amounted to 540 billion dollars in 1960.

The Monthly Statistical Bulletin does not take account of the imports from countries outside Africa, whereas the data supplied by national statistical publications cover inter-African trade. This explains why the import figures per region and per country are higher than the figures relating to the continent as a whole.

From table 6, it becomes clear that of all chemical products the medical and pharmaceutical ones require the largest amount of convertible currency in all the African regions.

If one takes the average value for the period 1952 - 1960, the imports of chemical and allied products are distributed as follows:

Medical and pharmaceutical products	23.2 %
Fertilizer	16.2%
Perfumes, cosmetics, soaps, washing and cleaning compounds and detergents	11.6%
Mineral chemistry products	9.8%
Pigments, paints and varnish and allied products	7.8%
Explosives	5.1%

It should be emphasized that, in each region the medical and pharmaceutical products head the list of imported chemical products

North Africa	25.2%
West Africa	28.2%
Central Africa	18.8%
East Africa	23.0%

It must be explained that North Africa includes the Sudan and Morocco and the countries separating them; West Africa includes all the countries situated west of the Sudan and north-west of the Congo river; Central Africa, is made up of Ethiopia, Somalia and what was formerly British East Africa; East Africa embraces all the rest with the exception of the Republic of South Africa. Portuguese Guinea, West Africa and Spanish Guinea the High Commission territories Somalia and the French

Coast of the Somalia have been excluded, either because of the paucity of their market or the absence of satisfactory data.

The evolutionary trends in the consumption and production of pharmaceutical products in some of the industrialized countries have been described in the East African Report[1/].

III.1.4 Consumption of pharmaceutical products in West Africa

Before making a more detailed examination of the market for pharmaceutical products in West Africa, its recent development, present state and future prospects, we should like without further delay to indicate the degree of importance implicit in that market, and this can be done by giving a single figure, namely, 42 million dollars, which was the extent of pharmaceutical consumption in 1964.

The pharmaceutical products sector has been in full tide of expansion for the past few years. In 1964, about 36 million dollars worth of drugs were imported. Table 7 gives some idea of the evolutionary process.

1/ E/CN.14/INR/91 Prospects of the pharmaceutical industry in East Africa.

TABLE 7

Imports of medical and pharmaceutical products for West Africa

(Value expressed in thousands of dollars)

Country	1960	1961	1962	1963	1964
Nigeria	12,983	14,374	12,987	14,233	14,287
Niger	19	248	621	511	699
Dahomey	300 x/	395	447	1,753	908
Togo	512	560	807	779	791
Total 1st. region	13,814	15,577	14,862	17,276	16,685
Ghana	6,869	7,271	7,293	8,420	5,660
Ivory Coast	1,580	2,107	3,538	2,661	3,882
Upper Volta	261	424	776	537	590 x/
Total 2nd region	8,710	9,802	11,607	11,618	10,132
Guinea	487	1,484	1,970	2,120 x/	2,470 x/
Sierra Leone	1,069	1,667	1,213	1,384	1,721
Liberia	883	1,177	1,454	1,006	1,100 x/
Total 3rd region	2,439	4,328	4,637	4,518	5,291
Gambia	234	302	331	420	324
Senegal	2,800	3,029	1,993	1,834	2,261
Mauritania	18 x/	28	40	72	93
Mali	200 x/	828	893	1,017	1,330
Total 4th region	3,252	4,187	3,257	3,393	4,008
General total	28,215	33,894	34,363	36,805	36,096

x/ Estimations.

At present, the bulk of pharmaceutical products imported meets substantially the same needs as in Europe with an extra amount of drugs for the control of purely tropical diseases.

It must be pointed out that the item which sets the tone, representing generally 70 to 75 per cent of imports in tons relates to special pharmaceutical products. Codex drugs or drugs approved but not packed represent 15 per cent. The 10 to 15 per cent that remain are made up of serums or vaccines (not given free as is often the case) and especially cotton wadding, bandages, dressings, medical kit, etc.

The multitudinous variety of pharmaceutical products makes it impossible at any rate as far as this survey is concerned, to embark upon an analysis in volume per product of the market, which really represents an infinite number of micro-markets, each one characterized by a specific therapeutic feature, superimposed one upon the other. Whereas in Europe wholesale dealers regularly keep a stock of 18,000 out of 43,000 special approved products, in African countries 7,000 to 10,000 special products are the usual stocks held, and of these 600 products represent 40 per cent of the turnover. Half the total turnover is generally made up of three main groups: antibiotics, corticoids and vitamin B.

III.1.5. Local Industry

For a long time, only administrative bodies, namely, the pharmacies that supplied the products, produced certain drugs, tints, pommades, solutions, injectable ampoules, etc., packed for the needs of medical care. But then it was a question of transactions on a handicraft basis, quite irrespective of any commercial considerations.

In the dispensaries, the pharmacists agreed to pack certain articles imported in bulk, as well as compound drugs prepared on the spot.

This is how the pharmaceutical industry appeared in its embryonic stages.

A new step forward has just been taken in the establishment of companies with more extensive activities. Indeed the manufacture, among

other things, of injectable solutions has been undertaken by them and the main consumer is the medical assistance which finds most of these preparations available on the spot.

Within the past three or four years a considerable change has taken place in the local pharmacies, tending to the establishment of a unit which can supply the market without being tied so closely to foreign laboratories. For example, they cannot boast a very vast record of achievement, but agreements are about to be entered into, if not already concluded, with large European laboratories with a view to "finishing" certain products on the spot.

The activities of these laboratories is sometimes entirely concerned with the packing of products in the form of powder, pastilles, suppositories and ampoules, etc.

In connexion with this activity, a growing increase in the imports of glassware for laboratory use is observable.

In Nigeria, 14 enterprises, among which the three largest at Vom, Kano and Apapa manufacture certain packed products in the form of syrup, tablets, pommade or glass ampoules, vitamins, sufonamides, aspirin, anti-malaria, tablets etc.

The installation of a "Pharmaceutical Manufacturing Laboratory" is being envisaged, and this will make it possible to supply hospitals and dispensaries far more substantially than before. The ultimate extension of this laboratory is also being considered, so that the bulk of drugs the country needs may be produced locally as quickly as possible.

In Ghana, six workshops (the two largest at Bolgatanga and Abankwakrom) manufacture drugs from herbs (medicinal plants) and some of the country's medicinal products.

There is an Hungarian project for the manufacture in Ghana of 1 million ampoules and 100 million tablets a year of different kinds of special pharmaceutical products.

In Mali, a decree passed in November 1963 has approved a convention between the Government of the Republic of Mali and the Tranduy Company S.A. in Geneva for the building of a laboratory to pack and verify pharmaceutical products in Bamako.

About 50 different kinds of special products have already been elaborated in the Ivory Coast, by a small concern which formulates pharmaceutical products.

The African Pharmaceutical Laboratory (APL), which has signed agreements in the Ivory Coast with the major French laboratories, is hoping to manufacture over 200 special products, which are very much in demand in Africa.

The Farbe Werke Hoechst, which established the company in Abidjan known as the Société Hoechst Pharmafrique, is thinking of extending its influence from the capital of the Ivory Coast throughout all the French-speaking African States.

From 1964, the Valdafrique establishments have been supplying Senegal and neighbouring countries with gum. It would appear that the project to set up a factory for pharmaceutical products which was foreshadowed in July 1964 by President Senghor, will soon become a reality and local patients will find relief and healing, thanks to drugs produced on the spot.

There is one enterprise in Liberia which manufactures certain antiseptics. There is a project to produce about 70 different kinds of special pharmaceutical products and transform semi- inished imported products so as to produce about 100 finished products.

Vaccines and sera. This concerns products which apply equally to the treatment of human ailments as to veterinary purposes. Vaccines are already being prepared in West African States. The African States are also very much interested in the preparation of veterinary vaccines on the spot.

In Nigeria, two workshops produce sera and vaccines. The one at Vom produces vaccines and sera for cattle, the other at Yaba produces preparations against yellow fever and smallpox.

In Mali, a laboratory set up in 1964 produced vaccines against bovine fever, contagious bovine pleuro-pneumonia, blackleg, anthrax, rinderpest, and pasteurellosis.

The Veterinary Research Laboratory in Dakar has a potential vaccine production of over 12 million doses a year.

The Department of Public Hygiene in Guinea is equipped with a laboratory for dealing with bacteria and parasites. Agreements have been concluded with the Federal Republic of Germany for the establishment of a laboratory designed to produce vaccines or sera against animal diseases.

A laboratory is under construction at Niamey for the animal husbandry department, which hopes to produce vaccines for the treatment of rinderpest, anthrax, blackleg, bovine pasteurellosis pleuro-pneumonia, rabies, fowl pox and other fowl diseases.

In Dahomey, five laboratories produce sera and vaccines. They are situated at Cotonou, Savalou, Parakou, Kandi and Natitingou.

It is difficult to evaluate the total production of the local pharmaceutical industry. The estimates claim that in 1964 it was in the neighbourhood of US$ 6 million.

III.16. Prospects for the Development of the Market

As regards the development of the market for pharmaceutical products in West Africa during the years to come, the forecasts are very optimistic. The change in social habits and economic circumstances, which has for the past seven or eight years brought about a considerable and steady increase in demand in this sector, continues. It should contribute to the expansion of a market which is being patronized increasingly, not only by the privileged classes but also by the population as a whole. The rapid development of the market will be influenced by the social policy adopted by the local governments. The State intervenes by establishing pharmacies under government control, with a view to distributing products cheaply to a large mass of customers.

Each year the number of people who seek admission to the various forms of social security increases, and every year a rise in the number of those affiliated to medical-social aid is observable.

Control campaigns of the serious endemic diseases are being organized or developed, and should normally create new needs in drugs (a campaign undertaken as part of the OCCGE for instance against river blindness).

In addition, as was to be expected, the consumption of pharmaceutical products is actually in proportion to the rate of population growth and the income of the consumer.

Bearing in mind all these factors, a forecast has been made in the annex of future demand for medical and pharmaceutical products by the West African States, and the results of these investigations are shown in Tables 8, 9 and 10.

TABLE 6

Demand for Pharmaceutical Products in 1964 and estimates for 1965, 1970, 1975 and 1980 (expressed in '000s US$)

Country	1964	1965	1970	1975	1980
Nigeria	16.000	17.600	28.300	45.600	73.500
Niger	699	770	1.200	2.000	3.200
Dahomey	908	1.000	1.600	2.600	4.300
Togo	791	870	1.400	2.300	3.600
Total First Region	18.398	20.240	32.500	52.500	84.600
Ghana	9.100	9.800	14.400	21.200	31.100
Ivory Coast	3.862	4.170	6.100	9.000	13.200
Upper Volta	590	660	1.200	2.000	3.500
Total Second Region	13.552	14.630	21.700	32.200	47.800
Guinea	2.470	2.670	3.900	5.800	8.500
Sierra Leone	1.721	1.860	2.700	4.000	5.900
Liberia	1.100	1.200	1.600	2.100	2.900
Total Third Region	5.291	5.730	8.200	11.900	17.300
Gambia	324	350	500	700	1.000
Senegal	2.700	2.920	4.300	6.300	9.300
Mauritania	93	104	180	320	570
Mali	1.330	1.460	2.360	3.800	6.100
Total Fourth Region	4.447	4.834	7.340	11.120	16.970
General Total	41.688	45.434	69.740	107.720	166.670

The consumption of medical and pharmaceutical products will rise from US$41,688 in 1964 to US$166,670 in 1980, that is almost 4 times. The average rate of increase for the whole of the sub-region will be the same for the three periods covered by 1965-1970, 1970-1975 and 1975-1980 (9 per cent per year). In certain countries, particularly

in those whose level of consumption per head of population was low, in particular the Upper Volta and Mauritania, the annual rate of increases is higher (12 per cent per annum). On the other hand, the rate for countries with a relatively high per capita consumption (Liberia and Gambia) is fairly small (6 and 7 per cent per annum).

The consumption of medical and pharmaceutical products by the various countries can better be evaluated by using a level of consumption per head of population (see Table 8).

TABLE 9

Demand for Pharmaceutical Products per head of Population: estimates for 1965, 1970, 1975 and 1980

(in US$)

Country	1965	1970	1975	1980
Nigeria	0.30	0.42	0.58	0.81
Niger	0.24	0.33	0.49	0.68
Dahomey	0.42	0.62	0.89	1.28
Togo	0.53	0.77	1.12	1.52
Total First Region	0.31	0.43	0.60	0.83
Ghana	1.27	1.60	2.04	2.56
Ivory Coast	1.09	1.44	1.90	2.45
Upper Volta	0.14	0.23	0.35	0.55
Total Second Region	0.89	1.18	1.54	2.00
Guinea	0.77	1.01	1.34	1.69
Sierra Leone	0.69	0.90	1.21	1.61
Liberia	1.14	1.44	1.79	2.34
Total Third Region	0.79	1.03	1.35	1.74
Gambia	1.08	1.35	1.65	2.04
Senegal	0.84	1.14	1.52	2.01
Mauritania	0.14	0.24	0.39	0.64
Mali	0.32	0.47	0.67	0.94
Total Fourth Region	0.53	0.74	1.00	1.36
General Total	0.46	0.62	0.84	1.13

Table 9 provides a general picture of the situation which makes it possible to compare the level of consumption, and indicates the objectives likely to be attained in consumption, as well as the limits to be placed upon a policy of expansion.

Table 10 gives a forecast for the consumption of pharmaceutical products in tons.

TABLE 10

Demand for Pharmaceutical Products in 1964 and estimates for 1965, 1970, 1975 and 1980

(Quantities in tons)

Country	1964	1965	1970	1975	1980
Nigeria	5.000	5.500	8.900	14.300	23.000
Niger	172	190	300	500	800
Dahomey	266	290	500	800	1.200
Togo	204	220	400	600	900
Total First Region	5.642	6.200	10.100	16.200	25.900
Ghana	6.180	6.550	8.750	11.700	15.700
Ivory Coast	1.091	1.180	1.700	2.500	3.700
Upper Volta	200	220	400	700	1.200
Total Second Region	7.471	7.950	10.850	14.900	20.600
Guinea	1.330	1.410	1.900	2.500	3.400
Sierra Leone	500	540	800	1.200	1.700
Liberia	350	370	500	700	900
Total Third Region	2.180	2.320	3.200	4.400	6.000
Gambia	100	110	150	200	300
Senegal	800	860	1.300	1.900	2.700
Mauritania	21	24	40	70	130
Mali	360	400	640	1.030	1.660
Total Fourth Region	1.281	1.394	2.130	3.200	4.790
General Total	16.574	17.864	26.280	38.700	57.290

It should be emphasized that the change in tonnage is not a valid criterion, since pharmaceutical products are no longer heavy products as they so frequently were in the past.

III.1.7. Prospects for the Development of the Local Industry

(1) If the dimensions, and at certain points, the structure of the market are known, it would be perfectly logical and justifiable to recommend local production in several countries of the sub-region. But the possibility of setting up pharmaceutical plant also depends on other essential factors, which must be studied if one is to make a rational approach to the problem of supply and demand, and provide a satisfactory solution.

When the prospects for the expansion of the pharmaceutical industry are being studied, account must be taken of the characteristic features of this particular type of production. The question of whether an economically paying pharmaceutical factory should be established, where it should be located, and what programme of production should be recommended, must to a large extent be thrashed out by the detailed analysis of the factors.

We shall now endeavour to determine a few of the characteristic features of the pharmaceutical industry.

(a) Not only large-scale factories but also small pharmaceutical industries with a good yield well adapted to local needs, can become going concerns. This problem is a very serious one for the developing countries in West Africa. It is particularly important in the less developed countries, where capital, markets, knowledge and experience of the various techniques and business management are so extremely modest, that each programme for the establishment of large basic factories should be reinforced by a parallel programme for the setting up of small-and middle-size enterprises. There is no doubt that these enterprises could benefit, if need be, from the more advanced techniques of modern factories. Bu African countries are also bound to solve their social problems, their proble of labour and unemployment by industrialization, and that is why it is necessary to adapt technology very carefully to the particular

needs of most of the countries of the sub-region. In our opinion, so far as the programme for expansion in the pharmaceutical industry is concerned there is room first and foremost for technique which is adequate to the local conditions.

(b) The pharmaceutical industry should be developed in stages. In the first phase pharmaceutical substances may be imported, and establishments for packing and producing medical and pharmaceutical products built on the spot, and later extended to produce by-products, intermediary products and the substance itself.

This is a very important aspect for African countries, where governments and private investors are concerned with problems connected with the best [illegible] that can be made of usually limited resources.

(c) To ensure the chances of accelerating, and mastering production technique to guarantee high quality products cheaply, this industry must be based on two fundamental economic principles: specialization and the division of labour on a national, sub-regional and possibly regional scale.

Moreover, the manufacture of certain products, the very products which account for 50 per cent of the turn-over of European industry, like antibiotics, corticoids or Vitamin B, cannot be undertaken for reasons of economic return, except in large factories on a European scale.

(d) The evolutionary process in the pharmaceutical industry is going forward by great leaps and bounds, and each year countless new products appear on the market in different forms. They obviously cannot all be produced, hence the need for choosing the most appropriate types and importing others. The value of imports can be offset by the export of a certain quantity of pharmaceutical articles produced on the spot.

(e) Perfect collaboration and co-operation with the chemical industry are a necessity. The co-ordination of the production programme in the chemical and pharmaceutical industries is the best guarantee of future progress in the pharmaceutical industry.

(f) The pharmaceutical industry requires to be supplemented by the existence of other industrial branches. For instance the manufacture of ampoules, tubes or phials implies the existence of glassware. Similarly, the making of corks and ampoules for phials brings the pharmaceutical industry into contact with the corresponding industries which have to do with cork, aluminium, plastic material or even tin. Even the question of packing calls for factories that can produce solid and light carton boxes, and the requirements of presentation too must tap the resources of printing and photo-engraving.

(g) Socially speaking, it is clear that the pharmaceutical industry requires in the first place extremely well-qualified technicians, at least where manufacture, properly speaking, and verification are concerned. The greater part of the specialized staff may be recruited on the spot, particularly as it is largely composed of women and this would mean that women in Africa would have to evolve quickly along the lines of their Western counterparts.

(h) The pharmaceutical industry should have its own scientific research institute and research establishments in each factory. There should be a central laboratory for verification which would exercise a constant supervision over the standards to which the products in the factories should conform. Such verification is carried out as a matter, of course on raw materials, intermediary products and finished products. The examination of physical properties and micro-analysis should be coupled with biological and bacteriological control which are a necessity as well as with pharmacodynamic laboratory tests on animals.

(i) The steady evolution of the pharmaceutical industry depends also on co-operation with scientific institutions and that is why pharmaceutical plant is almost always sited in the suburbs where the population is dense, and in large towns.

The difficulties enumerated above should not militate against the establishment of a local pharmaceutical industry because the market is developing. No doubt progress in this field should be directed with

extreme caution. An enterprise which has to do with the packing, formulation and possibly the manufacture of pharmaceutical products should offer the most serious guarantees because the health of the people is directly concerned. It is therefore absolutely vital that it should not appear too much like a handicraft enterprise and should be backed by sufficient capital to enable it to acquire modern plant and at the same time make use of proven techniques.

The development of the local industry can be carried out in two stages.

It would appear that a large manufacturing company cannot be set up in the short run, but if there is no new large unit, existing units might be enlarged and small pharmaceutical industries established for packing, formulation or verification. But it will still be necessary for the paper, cardboard, glass and plastic industries which are needed, to be capable of supplying them. However, in the the longer term, the prospects might be more favourable and there is no reason to suppose that large companies may not be set up to manufacture and pack on the spot a whole range of pharmaceutical products (antibiotics, vitamins, etc.)

(2) We can now clearly see that in this branch of the industry, it is impossible without making a careful study of a number of special interrelated items, to draw up an economically rational programme for each State and for the sub-region as a whole. In the present circumstances, and judging from the information received, it would seem possible to concentrate only on indicating the varying size of investment necessary, the necessary means to achieve it, the economic effects and some technical information about certain pharmaceutical products.

(3) On the basis of information gathered during the short time at our disposal, we have indicated below a programme which aims at replacing imports of medical and pharmaceutical products by national products, to the maximum extent. The coefficients used are obviously provisional, but are at least logical deductions from present market trends, and the approximate demand for medical and pharmaceutical products that can be forecast for 1980. The proportion of future requirements which cannot or perhaps should not be met by West African countries, but imported, has

been determined if only arbitrarily, (becuase the precise figures can be had only after serious planning). The figures shown in Table 11 were arrived at on the assumption that in 1970, 70 per cent, in 1975, 50 per cent and in 1980, 20 per cent of the necessary value will be imported.

TABLE 11

Existing Capacity for the Production of Pharmaceutical Products and Estimates for 1970, 1975 and 1980 in West Africa

(value expressed in thousand $)

Countries	Existing Capacity 1964	1970	1975	1980
Nigeria	1,713	8,800	23,400	62,000
Niger	-	300	800	2,000
Dahomey	...	500	1,000	2,000
Togo	-	400	800	2.000
Total First Region	1,713	10,000	26,000	68,000
Ghana	3,440	6,800	13,500	26,000
Ivory Coast	...	1,200	4,000	10,000
Upper Volta	-	-	500	2,000
Total Second Region	3,440	8,000	18,000	38,000
Guinea	...	1,000	3,000	7,000
Sierra Leone	-	600	1,200	5,000
Liberia	...	400	800	2,000
Total Third Region	...	2,000	5,000	14,000
Gambia	-	-	-	-
Senegal	439	1,600	3,000	9,000
Mauritania	-	-	-	-
Mali	...	400	2,000	5,000
Total Fourth Region	439	2,000	5,000	14,000
Grand Total	5,592	22,000	54,000	134,000

It is clear that there is ample room here for discussion on quantity, size, production programme, degree of specialization and co-operation, and the siting of pharmaceutical factories in each country.

According to the consumption trends, it may be concluded that after 1975 the conditions for the manufacture of antibiotics, corticoids and Vitamin B will be favourable in Nigeria and in Ghana for anti-malarial drugs, sulphamides and salicyls, at the sub-regional level. The same prospects exist more immediately, for developing vaccine and serum production in Nigeria, Mali, Niger and Senegal.

Detailed investigations on the spot should determine the effective programmes for each country.

(4) When the data on the developed countries are analysed, it becomes clear that the relation between the capacity of the pharmaceutical factory and fixed investments follows a straight line, with a steady elasticity, that is to say, a fixed relationship between the rate of capacity growth and the rate of the growth of investment. Mr. Lawrence Lynn has studied the relationship between the capacity of 138 pharmaceutical factories and fixed investment[1/]. He discovered the following relationships:

Fixed investment = 0.53 x annual production value.

The relationship between the capacity of the factory and the cost of the fixed investment in the developing countries also seems to follow a straight line. In the general context of Africa, the setting up of a pharmaceutical factory runs the risk of involving supplementary expenditure calculated on the basis of ton capacity, but it must not be forgotten that the of fixed investment in the United States is higher than in Europe. The facts as they relate to America include the cost of a large number of verification apparatus, the cost of installing high-powered automation devices, the cost of building more intricate premises and storage installations, which stand very little chance of being used

1/ C.H. Chilton, Cost Engineering in the Process Industries, New York, 1960.

in Africa. The selling prices according to which we have estimated the annual value of production must also be taken into consideration. Selling prices in Africa are higher than in the United States. Bearing in mind all the factors given above, an approximate evaluation has been made of what is required of investments needed to expand the pharmaceutical industry in West Africa by 1980. This evaluation is reflected in Table 12 below, which is based on the relationship established by Mr. L. Lynn. (See Table 12)

Table 12 also indicates the annual working capital. The figures shown in that table have been reached from an assumption based on an analysis of existing factories, that 20 per cent of the annual production value constitutes the working capital.

(5) British Productivity Council has published the results of an analysis of productivity in the chemical industry in Germany (Federal Republic), Italy and England (see Table 13).

TABLE 12

The evaluation of Fixed Investment and Working Capital Necessary for Additional Production According to the Projections for 1980

(Value in thousand $)

Countries	Annual production capacity to be installed	Fixed investment	Working capital
Nigeria	60,300	32,000	12,000
Niger	2,000	1,100	400
Dahomey	2,000	1,100	400
Togo	2,000	1,100	400
Total First Region	66,300	35,300	13,200
Ghana	22,500	11,900	4,500
Ivory Coast	10,000	5,300	2,000
Upper Volta	2,000	1,100	400
Total Second Region	34,500	18,300	6,900
Guinea	7,000	3,700	1,400
Sierra Leone	5,000	2,700	1,000
Liberia	2,000	1,100	400
Total Third Region	14,000	7,500	2,800
Gambia	-	-	-
Senegal	8,600	4,500	1,720
Mauritania	-	-	-
Mali	5,000	2,700	1,000
Total Fourth Region	13,600	7,200	2,720
Grand Total	128,400	68,300	25,620

TABLE 13

Productivity in the Chemical Industry

	(value in $)		
	1958	1959	1960
Germany (Federal Republic)			
(a) Annual production value per worker	10,640	11,620	11,760
(b) Net production value per worker	5,152	5,572	5,768
Relationship in percentage (b) : (a)	48	48	49
Italy			
(a) Annual production value per worker	12,544	14,000	15,680
(b) Net production value per worker	5,530	5,936	6,664
Relationship in percentage (b) : (a)	44	42	42.5
England			
(a) Annual production value per worker	10,920	11,480	12,250
(b) Net production value per worker	4,970	4,970	5,286
Relationship in percentage (b) : (a)	45.5	43	43

Source: The Chemical Industry in Germany and the Chemical Industry in Italy, British Productivity Council, London (1963).

According to the facts shown in Table 13, an approximate idea of the labour requirements necessary for the expansion of the pharmaceutical industry in Africa for 1980 may be worked out. By taking approximately 50 per cent of the annual production value obtained per German worker in 1960 (US$ 6,000 per worker) it has been possible to arrive at the number of workers (see Table 14).

In the pharmaceutical industry, productive workers comprise approximately 55 to 60 per cent of the general total. In the conditions obtaining in Africa, for 100 workers, 15 to 20 technical employees, and 10 administrative

staff members should be provided. Approximately 70 per cent of the productive labour would consist of skilled and unskilled workers. In the pharmaceutical industry, women employees comprise about 30 per cent of the general total.

(6) From the data given in Table 14, an estimate can also be made of the added value from annual production. It is understood that in the present conditions in Africa, the net value would be 40 per cent of the annual gross production value (see Table 15).

TABLE 14

Labour Needs for the Expansion of the Pharmaceutical Industry in West Africa in 1980

Countries	Annual production value (in '000s US$)	Number of workers
Nigeria	62,000	10,330
Niger	2,000	330
Dahomey	2,000	330
Togo	2,000	330
Total First Region	68,000	11,320
Ghana	26,000	4,330
Ivory Coast	10,000	1,670
Upper Volta	2,000	330
Total Second Region	38,000	6,330
Guinea	7,000	1,170
Sierra Leone	5,000	830
Liberia	2,000	330
Total Third Region	14,000	2,330
Gambia	-	-
Senegal	9,000	1,500
Mauritania	-	-
Mali	5,000	830
Total Fourth Region	14,000	2,330
Grand Total	134,000	22,310

TABLE 15

Annual Gross Value and Added value of Pharmaceutical Production in West Africa in 1980

(expressed in '000 US$)

Countries	Gross Annual Value	Annual Added Value
Nigeria	62,000	24,800
Niger	2,000	800
Dahomey	2,000	800
Togo	2,000	800
Total First Region	68,000	27,200
Ghana	26,000	10,400
Ivory Coast	10,000	4,000
Upper Volta	2,000	800
Total Second Region	38,000	15,200
Guinea	7,000	2,800
Sierra Leone	5,000	2,000
Liberia	2,000	800
Total Third Region	14,000	5,600
Gambia	-	-
Senegal	9,000	3,600
Mauritania	-	
Mali	5,000	2,000
Total Fourth Region	14,000	5,600
Grand Total	134,000	53,600

(7) The distribution of the production cost of medicinal and pharmaceutical products may be illustrated by the following examples:

Cost of manufacture		Percentage of total
1. Raw materials		83.0
2. Energy, fuel and water		0.5
3. Staff and labour costs		10.0
4. Maintenance		2.0
5. Rates, depreciation		2.0
6. Sundries		2.5
Total		100.0
Capacity, ton-day		1
Selling price	¢lb.	200
Production cost	¢lb.	120

Selling price, research and administration constitute 10 per cent of the annual sale.

(8) Steady evolution in the modern pharmaceutical industry depends upon scientific research and technical cadres.

During the first stage, provision must be made for the establishment of a pharmaceutical institute (in Nigeria and Ghana) and technical secondary schools which specialize in chemistry and pharmaceutics.

III.2. The Soap industry

III.2.1 The present market and prospects for its development

1. The consumption of soap in West Africa has increased notably during the past ten years and, judging from local statistics, interesting progress has been made in practically every country examined.

It is estimated that the total consumption for the sub-region in 1964 was of the order of 132,500 tons (approximately US$ 46.9 million).

The market for soap in West Africa is fed particularly by products from local soap factories.

Local production is at the same time about 107,000 tons.

With the exception of Mauritania and Gambia, all the countries in the sub-region at present manufacture soap on the spot.

The day is not far off when West Africa which has vegetable oils in sufficiently large quantities will no longer require to be supplied with soap from abroad. A reversal of the situation. which will put West Africa in a position to export her surplus production may even be envisaged.

What results the increase in local production will have on the evolution of imports can be seen from Table 16.

TABLE 16

Imports of Soap in West Africa

(tons)

Countries	1960	1961	1962	1963	1964
Nigeria					
Total quantity of soap	1,356	1,154	2,119	3,524	2,076
common soap	461	267	1,090	1,614	585
toilet soap	895	887	1,029	1,910	1,491 -
Niger					
total quantity of soap	640[a/]	810	700	577	479
common soap	600[a/]	759	647	486	390
toilet soap	19	28	38	46	60
Dahomey					
total quantity of soap	432	170	260	510	600
common soap	392	144	206	435	524
toilet soap	30	20	46	57	61
Togo					
total quantity of soap	423	583	627	859	1,024
common soap	383	543	587	817	967
toilet soap	30	28	28	26	43
Total First Region					
total quantity of soap	2,851	2,717	3,706	5,470	4,179
common soap	1,836	1,713	2,530	3,352	2,466
toilet soap	974	963	1,141	2,039	1,655
Ghana					
total quantity of soap	23,862	28,092	31,459	12,412	8,245
common soap	21,994	25,653	28,514	10,562	6,695
toilet soap	1,868	2,439	2,945	1,850	1,550

TABLE 16 (cont'd)

Countries	1960	1961	1962	1963	1964
Ivory Coast					
total quantity of soap	1,270	1,420	1,522	1,814	2,051
common soap	845	1,066	1,056	1,211	1,525
toilet soap	208	256	334	450	414
Upper Volta					
total quantity of soap	29	950	1,600	1,240	1,290[a]
common soap	6	904	1,412	1,158	1,200[a]
toilet soap	23	37	171	72	80[a]
Total Second Region					
total quantity of soap	25,161	30,462	34,581	15,466	11,586
common soap	22,845	27,623	30,982	12,931	9,420
toilet soap	2,099	2,732	3,450	2,372	2,044
Guinea					
total quantity of soap	2,134	403	2,826	2,000[a]	2,000[a]
common soap	2,000[a]	300[a]	2,400[a]	1,650[a]	1,650[a]
toilet soap	130[a]	100[a]	400[a]	300[a]	300[a]
Sierra Leone					
total quantity of soap	3,182	3,831	3,125	3,287	3,718
common soap	3,035	3,648	2,856	3,046	3,450
toilet soap	147	183	269	241	268
Liberia					
total quantity of soap	842	2,300[a]	3,021	2,720	2,800[a]
common soap	634	1,900[a]	2,339	2,100[a]	2,200[a]
toilet soap	208	400[a]	682	620[a]	600[a]
Total Third Region					
total quantity of soap	6,158	5,534	8,972	8,007	8,518
common soap	5,669	5,848	7,595	6,796	7,300
toilet soap	485	683	1,351	1,161	1,168

TABLe 16 (cont'd)

Countries	1960	1961	1962	1963	1964
Gambia					
total quantity of soap	719	611	560	606	504
common soap	707	597	550	588	486
toilet soap	12	14	10	18	18
Senegal					
total quantity of soap	1,379 b/	321	408	317	423
common soap	1,089 b/	103	112	89	100
toilet soap	290 b/	203	275	212	232
Mauritania					
total quantity of soap	-	18	16	16	11
common soap	-	13	7	9	5
toilet soap	-	3	6	5	1
Mali					
total quantity of soap	-	860	2,850	670	800 a/
common soap	-	747	2,748	528	645 a/
toilet soap	-	98	79	126	140 a/
Total Fourth Region					
total quantity of soap	2,098	1,810	3,834	1,609	1,738
common soap	1,796	1,460	3,417	1,214	1,236
toilet soap	302	318	370	361	391
Grand Total					
total quantity of soap	36,268	41,523	51,093	30,552	26,021
common soap	32,146	36,644	44,524	24,293	20,422
toilet soap	3,860	4,696	6,312	5,933	5,258

a/ Estimates

b/ Senegal - Mali - Mauritania

The foregoing table also shows the ratio between common soaps and toilet soaps. Other soaps like medical and spedial soaps do not figure largely in the over-all consumption. The total consumption of these soaps may be estimated as being the difference between total imports and the import of common and toilet soaps (approximately 341 tons in 1964 for the whole of the sub-region).

It should also be noted that the market for toilet soaps is still very much open to imported products. It is probable, perhaps even certain that the era of local toilet soaps will return, but this will happen slowly.

A very typical example is furnished by the Ivory Coast where there is a very modern soap works at Abidjan. The soap is manufactured in growing quantities, and its quality is universally accepted. Nevertheless the Ivory Coast imports each year from abroad more common and toilet soap that the year before. The country exports a part of its soap to the neighbouring countries such as the Upper Volta and the Niger, and covers a part of its own needs with imported soap;

2. For some years now a steady increase in local production has been observable.

Most of the local soap works have no difficulty in manufacturing household soap, which is as good as imported soap, but they find it more difficult to manufacture fine-scented toilet soaps. It is worth noting that already there exist in Nigeria, Ghana and the Ivory Coast good quality toilet soaps. Other countries are preparing to embark upon this particular type of manufacture, which until 1960 was practically unknown in West Africa.

For the time being, many of the local soap works operate on out-moded standards and very few enterprises have modern equipment (of the Mazzoni type).

The limiting factor in the production of soap in a number of countries, is the fact that their soap is considered second-rate. The soap works are bound up with the oil factory, whose waste products they use when the conditions for exploitation and marketing make it an advantage to do so.

It is necessary to modernize existing plant, and adopt modern equipment capable of producing products of a quality comparable with those in Europe, as well as meeting an increasingly greater share of the needs of the local markets.

3. Taking into consideration the fact that the demand for soap is constantly on the increase and depends on a rapidly evolving pattern, an estimate has been given in the annex of future consumption of soaps in the West African countries, and the results of these investigations are shown in Tables17, 18 and 19.

TABLE 17

Soap Consumption in 1964 and estimates for 1965, 1970, 1975 and 1980

(tons)

Countries	1964	1965	1970	1975	1980
Nigeria	51,320	55,900	86,000	132,000	204,000
Niger	650	800	1,600	3,300	7,000
Dahomey	2,500	2,700	4,000	5,800	8,500
Togo	1,800	2,000	2,900	4,200	6,000
Total First Region	56,270	61,400	94,500	145,300	225,500
Ghana	31,210	32,400	39,500	48,000	58,000
Ivory Coast	14,000	14,600	17,700	21,500	26,000
Upper Volta	2,700	3,000	4,800	7,800	12,400
Total Second Region	47,910	50,000	62,000	77,300	96,400
Guinea	3,300	3,600	5,200	7,700	11,300
Sierra Leone	3,720	4,000	5,300	7,100	9,400
Liberia	3,300	3,400	3,800	4,300	4,900
Total Third Region	10,320	11,000	14,300	19,100	25,600
Gambia	500	540	750	1,100	1,500
Senegal	11,000	11,450	13,900	16,900	20,600
Mauritania	11	20	100	400	900
Mali	3,480	3,800	5,800	9,000	13,800
Total Fourth Region	14,991	15,810	20,550	27,400	36,800
General Total	129,491	138,210	191,350	269,100	384,300

The total consumption of soap will probably have trebled: in 1964 it was 129,491 and in 1980 will be 384,300 tons. The average rate of increase for the whole of the sub-region will be the same for the three periods 1965-1970, 1970-1975, and 1975-1980 (7 per cent per annum).

TABLE 18

Soap Consumption per head of Population: estimates for 1965, 1970, 1975 and 1980 (in kilogrammes)

Countries	1965	1970	1975	1980
Nigeria	0,96	1,27	1,68	2,24
Niger	0,23	0,44	0,81	1,50
Dahomey	1,14	1,54	1,98	2,53
Togo	1,22	1,59	2,04	2,53
Total First Region	0,94	1,25	1,66	2,22
Ghana	4,19	4,40	4,62	4,78
Ivory Coast	3,81	4,18	4,54	4,83
Upper Volta	0,63	0,92	1,36	1,93
Total Second Region	3,06	3,37	3,70	4,03
Guinea	1,05	1,34	1,78	2,25
Sierra Leone	1,48	1,77	2,15	2,57
Liberia	3,24	3,42	3,68	3,95
Total Third Region	1,52	1,79	2,17	2,58
Gambia	1,67	2,03	2,58	3,06
Senegal	3,29	3,69	4,08	4,45
Mauritania	0,08	0,20	0,49	1,10
Mali	0,83	1,15	1,58	2,13
Total Fourth Region	1,73	2,06	2,48	2,95
General Total	1,41	1,71	2,10	2,60

Table 18 gives a very clear picture of the different levels of soap consumption in the West African countries, and indicates the consumption targets to be achieved in the future.

Table 19 (page 67) shows the value of future soap consumption.

TABLE 19

Soap Consumption in 1964 and estimates for 1965, 1970, 1975 and 1980

(In '000 US$)

Countries	1964	1965	1970	1975	1980
Nigeria	20,933	22,360	31,400	44,000	61,700
Niger	200	230	490	1,020	2,150
Dahomey	750	810	1,190	1,750	2,600
Togo	500	540	800	1,150	1,650
Total First Region	22,383	23,940	33,880	47,920	68,100
Ghana	12,602	13,000	15,000	17,400	20,200
Ivory Coast	4,200	4,380	5,310	6,450	7,800
Upper Volta	1,000	1,100	1,800	2,850	4,600
Total Second Region	17,802	18,480	22,110	26,700	32,600
Guinea	694	750	1,100	1,600	2,400
Sierra Leone	816	870	1,200	1,600	2,100
Liberia	860	880	1,000	1,100	1,300
Total Third Region	2,370	2,500	3,300	4,300	5,800
Gambia	100	110	150	200	300
Senegal	3,300	3,435	4,170	5,070	6,180
Mauritania	4	7	36	144	324
Mali	900	980	1,500	2,300	3,570
Total Fourth Region	4,304	4,532	5,856	7,714	10,374
General Total	46,859	49,452	65,146	86,634	116,874

III.2.f Prospects for the Development of the Local Industry

From the standpoint of raw materials West Africa is in a very good position to produce soap, and development in this respect does in fact provide an ideal market for local vegetable oils.

Actually about 700 grammes of fatty substances are required to produce a kilo of soap, and the major portion of this can be supplied by local plantations.

Fatty substances for the manufacture of soap are derived from ground-nut paste which comes from the refining of local oils, oils from palm oil products, palm oil, copra oil, by-products from the refining of shea butter and the imports from foreign countries of the necessary additional fatty substances (suet acids).

Bearing in mind the present trends of the market and the estimated demand for soap in 1980, as well as the position regarding the supply of raw material and the rapid increase in local production which is going forward by leaps and bounds to satisfy local needs fully, a programme for the development of the local industry has been drawn up below.

Table 20 shows the existing capacities and estimates for the future.

TABLE 20

Existing Capacities for Soap Production in West Africa and Estimates for 1970, 1975 and 1980

(tons)

Countries	Existing capacity 1964-1965	1970	1975	1980
Nigeria	55,000	86,000	132,000	204,000
Niger	1,200	1,600	3,000	7,000
Dahomey	2,000	4,000	6,000	7,000
Togo	1,000	3,000	4,000	6,000
Total First Region	59,200	94,600	145,000	225,000
Ghana	25,000	32,000	44,000	60,000
Ivory Coast	25,000	25,000	25,000	25,000
Upper Volta	1,300	5,000	8,000	12,000
Total Second Region	51,300	62,000	77,000	97,000
Guinea	2,000	5,000	8,000	11,000
Sierra Leone	1,000	5,000	7,000	9,000
Liberia	1,000	4,000	4,000	5,000
Total Third Region	4,000	14,000	19,000	25,000
Gambia	-	-	1,000	1,000
Senegal	18,000	18,000	18,000	21,000
Mauritania	-	-	-	1,000
Mali	3,000	3,000	9,000	14,000
Total Fourth Region	21,000	21,000	28,000	37,000
General Total	135,500	191,600	269,000	384,000

The very thorough investigations made would suggest that a statement should be drawn up of the quantity, size, production programme, degree of specialization, co-operation and siting of soap factories in each country.

Table 21 shows the approximate evaluation of fixed investment and working capital necessary for the expansion of the soap industry in the near future.

This estimate is based on the cost of fixed equal investment, approximately US$ 200 per ton of the annual capacity and the annual amount of working capital, 25 per cent of the annual production value.

TABLE 21

Estimates of Fixed Investment and Working Capital Necessary for Additional Production According to Projections for 1980

(value in '000 US$)

Countries	Annual production capacity to be provided (in tons)	Fixed investment	Working Capital
Nigeria	149,000	29,800	11,200
Niger	5,800	1,160	440
Dahomey	6,000	1,200	450
Togo	5,000	1,000	350
Total First Region	165,800	33,160	12,440
Ghana	35,000	7,000	3,050
Ivory Coast	-	-	-
Upper Volta	10,700	2,140	990
Total Second Region	45,700	9,140	4,040
Guinea	9,000	1,800	480
Sierra Leone	8,000	1,600	450
Liberia	4,000	800	280
Total Third Region	21,000	4,200	1,210
Gambia	1,000	200	80
Senegal	3,000	600	220
Mauritania	1,000	200	80
Mali	11,000	2,200	710
Total Fourth Region	16,000	3,200	1,090
General Total	248,500	49,700	18,780

Assuming that annual productivity is 30 tons per worker a year, the following labour figures have been arrived at (see Table 22).

TABLE 22

Labour Needs for the Soap Industry in West Africa for 1980

Countries	Annual production (in tons)	Number of workers
Nigeria	204,000	6,800
Niger	7,000	233
Dahomey	8,000	266
Togo	6,000	200
Total First Region	225,000	7,499
Ghana	60,000	2,000
Ivory Coast	25,000	833
Upper Volta	12,000	400
Total Second Region	97,000	3,233
Guinea	11,000	366
Sierra Leone	9,000	300
Liberia	5,000	166
Total Third Region	25,000	832
Gambia	1,000	35
Senegal	21,000	700
Mauritania	1,000	35
Mali	14,000	466
Total Fourth Region	37,000	1,236
General Total	384,000	12,800

In the soap industry productive workers are approximately 60 per cent of the total staff. About 70 per cent of the productive labour force is made up of skilled and semi-skilled workers. For 100 workers 15 technicians and 10 administrative officers should be employed.

Table 23 shows the gross value as well as the added value of annual production in 1980. It is estimated that the added value would be 40 per cent of the annual gross value.

TABLE 23

Gross Annual Value and Added Value of Soap Production in West Africa in 1980

(in '000 US$)

Countries	Gross Annual Value	Added annual value
Nigeria	61,700	24,680
Niger	2,150	860
Dahomey	2,420	970
Togo	1,650	660
Total First Region	67,920	27,170
Ghana	20,880	8,350
Ivory Coast	7,480	2,990
Upper Volta	4,440	1,780
Total Second Region	32,800	13,120
Guinea	2,330	930
Sierra Leone	2,000	800
Liberia	1,330	530
Total Third Region	5,660	2,260
Gambia	200	80
Senegal	6,300	2,520
Mauritania	350	140
Mali	3,600	1,440
Total Fourth Region	10,450	4,180
General Total	116,830	46,730

III.3. Surface-active agents and washing preparations

III.3.1. The present market and its prospects of expansion

1. In the statistical summaries, the sector of surface-active agents and washing preparations comes under several headings. The five main headings are "surface-active agents", "non-packed washing preparations containing soap", "non-packed washing materials not containing soap", "packed washing preparations containing soap" and "packed washing materials not containing soap".

It is very difficult to consider the ratio of these groups by country and sub-region, because in English-speaking countries the statistics of surface-active agents and washing materials are given together under one heading. The trend, however, seems to be the same as in French-speaking countries.

The consumption of surface-active agents - products whose cleansing properties act, not through the chemical transformation of impurities, but physical elimination (lather, bubbles etc.) - is steadily increasing even though it has not yet reached a volume that can be regarded as worth-while from the standpoint of local production.

On the other hand, as in more developed countries throughout the world, from year to year washing preparations are vigorously asserting themselves in all West African countries. These products or preparations often replace soap for clothes-washing and domestic cleaning purposes.

In the sector of washing materials, the first thing that can be observed is that those containing soap are generally in less demand than others; secondly, the largest imports are those relating to packed articles.

The market for washing preparations depends entirely on imports.

The trend of the market can be studied from table 24, which shows imports of surface-active agents and washing materials from 1960 to 1964.

TABLE 24

West African imports of Surface-active agents and washing preparations

(in tons)

Countries	1960	1961	1962	1963	1964
Nigeria	1,321	1,408	2,627	3,715	1,599
Niger	32	37	41	38	200
Dahomey	66	59	114	110	140
Togo	20*	28	62	83	91
Total First Region	1,439	1,532	2,844	3,946	2,030
Ghana	1,160	1,747	2,162	2,072	2,548
Ivory Coast	364	446	706	880	1,300*
Upper Volta	21	48	61	93	200*
Total Second Region	1,545	2,241	2,929	3,045	4,048
Guinea	60*	100*	120*	150*	174*
Sierra Leone	112	172	212	250	467
Liberia	100*	150*	200*	300*	400*
Total Third Region	272	422	532	700	1,041
Gambia	6	8	33	54	46
Senegal	675 1/	759	910	1,083	1,229
Mauritania	-	28	72	19	35
Mali	-	61	25	78	100
Total Fourth Region	681	856	1,040	1,234	1,410
General Total	3,937	5,051	7,345	8,925	8,529

1/ Senegal, Mali and Mauritania

* Estimates

Consumption more than doubled between 1960 and 1964. The drop in imports in Nigeria in 1964 which may be regarded as a temporary levelling-off rather than a decline interfered somewhat with the very definite increase in demand.

In five countries - Senegal, Mauritania, the Ivory Coast, the Niger and Dahomey - total imports of washing materials amounted to 2,380 tons in 1964, 1,445 tons of which represented washing materials not containing soap, and 935 tons, washing materials containing soap. Whereas in the Ivory Coast and Mauritania washing materials not containing soap are distinctly ahead of other products (861 tons as against 111 tons in the Ivory Coast, 19 tons as against 14 tons in Mauritania), washing materials without soap are the rule in Senegal (545 tons as against 505 tons), and especially in the Niger (157 tons as against 35 tons) and in Dahomey (108 tons as against 25 tons).

The difference between detergent and non-detergent washing materials in the five countries already mentioned which imported a total of 2,380 tons of washing materials in 1964, is as follows: detergent, 2,254 tons; non-detergent, 126 tons.

The enormous disparity noted between the two types of washing materials in the over-all imports of the five countries considered, is reflected in each single country: Senegal, 979/71 tons; Mauritania, 29/4 tons; Ivory Coast, 932/40 tons; Niger, 183/9 tons, and Dahomey, 131/2 tons.

2. At present, not one of the countries considered has facilities for the local manufacture of washing materials. Detergent production calls for considerable investment, and the point at which it begins to yield economic returns is so high, as to make it unwise to mount a plant to cover the needs of only one country.

Nevertheless, there are possibilities for the local production and packing of articles the constituents of which are received in bulk. Work may be focussed both on the mixtures to be made, and the packing of washing materials to suit demand.

As stated in the annex to this document, Blohorn's at Abidjan pack Helios washing materials based on products imported from France. The annual capacity is 6,000 tons.

An installation comprising an atomizing tower has been set up, and this ensures the local production of washing materials at the rate of 1,000 kg an hour. Manufacture covers articles containing soap, and other types of washing materials in local demand.

3. Taking into account the marked rise in demand, the annex gives an estimate of the future West African demand for surface-active agents and washing compounds and the result of the survey is shown in Tables 25 and 26.

TABLE 25

Consumption of surface-active agents and washing compounds in 1964 and estimated consumption in 1965, 1970, 1975 and 1980

(in tons)

Countries	1964	1965	1970	1975	1980
Nigeria	1,600	5,090	11,170	24,490	53,700
Niger	200	230	490	1,020	2,200
Dahomey	140	160	360	790	1,700
Togo	91	107	240	540	1,200
Total First Region	2,031	5,587	12,260	26,840	58,800
Ghana	2,550	2,880	5,300	9,800	18,000
Ivory Coast	1,300	1,450	2,560	4,500	8,000
Upper Volta	200	235	530	1,200	2,600
Total Second Region	4,050	4,565	8,390	15,500	28,600
Guinea	174	205	480	1,100	2,500
Sierra Leone	470	524	900	1,560	2,700
Liberia	400	436	670	1,030	1,600
Total Third Region	1,044	1,165	2,050	3,690	6,800

TABLE 25 (continued)

Countries	1964	1965	1970	1975	1980
Gambia	46	52	100	200	370
Senegal	1,229	1,360	2,300	3,900	6,500
Mauritania	35	41	85	180	370
Mali	100	120	300	740	1,850
Total Fourth Region	1,410	1,573	2,785	5,020	9,090
General Total	8,535	12,890	25,485	51,050	103,290

The average rate of increase throughout the sub-region is the same for the three periods, 1965-1970, 1970-1975, 1975-1980 (15 per cent per annum).

TABLE 26

Estimated consumption of surface-active agents and washing compounds in per head of population in 1965, 1970, 1975 and 1980

(in Kilogrammes)

Countries	1965	1970	1975	1980
Nigeria	0.09	0.17	0.31	0.59
Niger	0.07	0.14	0.25	0.47
Dahomey	0.07	0.14	0.27	0.51
Togo	0.07	0.13	0.26	0.52
Total First Region	0.08	0.16	0.30	0.58
Ghana	0.37	0.59	0.94	1.48
Ivory Coast	0.38	0.60	0.95	1.49
Upper Volta	0.05	0.10	0.21	0.41
Total Second Region	0.28	0.46	0.74	1.20

TABLE 26 (continued)

Countries	1965	1970	1975	1980
Guinea	0.06	0.12	0.25	0.50
Sierra Leone	0.19	0.30	0.47	0.74
Liberia	0.42	0.60	0.88	1.29
Total Third Region	0.16	0.26	0.42	0.68
Gambia	0.16	0.27	0.47	0.76
Senegal	0.39	0.61	0.94	1.40
Mauritania	0.06	0.11	0.22	0.42
Mali	0.03	0.06	0.13	0.29
Total Fourth Region	0.17	0.28	0.45	0.73
General Total	0.13	0.23	0.40	0.70

This table shows that, despite a fairly high rate, the estimated per capita consumption in 1980 is still very low.

III.3.2. Prospects of local industrial growth

Detergents, the physical and chemical action of which have helped to solve many problems connected with washing, and which have largely taken the place once held by household soap, are increasingly popular in the world markets. Moreover, the fact that they are easy to use have led to their widespread acceptance by consumers; and, because of their reasonable price, they compete with conventional household soaps even in countries whose family purchasing power is low.

The present tendency in the market is to encourage the use of synthetic products for industrial and rough household purposes, and soap for personal hygiene and the washing of delicate materials. Consequently, the consumption of synthetics is advancing rapidly, while the consumption

of soap is somewhat stagnant. But the drop in the consumption of household soap is quantitatively offset, particularly in value, by the increased use of toilet and high quality soaps.

The two detergents in widest use are lauryl sulphate or sulphonate, based on lauric alcohol, large quantities of which are found in palm-kernel oil and copra oil (a valuable potential market for local production), and alkylsulphonates based essentially on dodecylbenzene.

Despite their great efficacy, however, synthetic detergents have failed to solve all washing problems. To make them more effective and convenient for household purposes, it has proved necessary to produce washing powders composed of two essential constituents:

(a) the active agent, which is either a sulphonation agent or a soap, or a mixture of the two;

(b) builders, which are alkali salts in the form of a carbonate, phosphate, silicate, perborate or sulphate.

Small quantities of various adjuvants such as carboxymethylcellulose (for lather persistence), washing blue (for whitening) and scent, are added.

The manufacture of washing powder consists of the following operations:

(1) Manufacture of active agents: manufacture of sulphuric acid based on sulphur; sulphonation and lastly neutralization of the product. This phase of production can be envisaged in the initial stage only when usable by-products can be supplied locally by the chemical and petrochemical industry.

(2) Mixture: slurry is prepared in a series of mixers. The slurry obtained, mixed with 50 per cent water, is placed in homogeneizing mill, then vacuum air removed, and pumped into the atomizing tower.

(3) Atomizing: this consists in pulverizing the slurry, in the form of hollow pellets, in a hot air stream, and drying it until the residual water consistency is 10 per cent. The powder thus obtained is deposited at the bottom of the tower and conveyed to the packing installations by air pump.

(4) Packing by automatic packing machines.

The smallest installation that can be regarded as remunerative is one with a production capacity of 1,000 kg per hour (about 6,000 tons per annum). It can operate continuously.

The achievement of such a project calls for the investment of about 260,000 dollars.

The breakdown of the investment would be as follows:

(1)	Premises:		28,000
	Industrial (atomizing, packing and storing)	20,800	
	Social (showers, changing rooms, WC)	7,200	
(2)	Materials:		168,000
	(a) for production		
	production unit	88,000	
	assembly and installation	20,000	
	stock checking and replenishing	8,000	
	contingencies	12,000	
	structures and masonry	40,000*	
	(b) for packing		12,500
(3)	Car fleet		21,500**
(4)	Staff quarters		30,000
	Total		260,000

* The 40,000 dollars shown against "structures and masonry" come under the heading "materials" rather than "industrial premises", because they do not in fact relate to premises, but represent iron and masonry structures to equip and support the 30 m high atomizing tower, which requires a specially adapted infrastructure.

** The purchase of a vehicle, particularly of an advertising van, is warranted by the fact that the sale of detergents can be promoted only through an intensive advertising campaign. Further, systematic market research in the outlying areas and continuous direct contact with customers should be envisaged, so as to ensure production with the maximum use of soap.

The average cost price of a ton of packed powder can be broken down as follows:

Slurry	298.48
Steam and fuel	0.64
Electricity	2.36
Labour	14.52
Maintenance	7.28
Cardboard packets	126.00
Cardboard boxes	39.72
Total	489.00

It will be noted that packing alone represents 36.05 per cent of the cost price of powder. To this should be added the ratio of the following expenditure: indirect labour, factory over-heads financial costs, commercial costs, depreciation, and taxes and charges. Since the latter are not all proportionate to production, the cost of powder will tend to decrease as production expands.

The estimate is that an annual production of 6,000 tons would entail production costs of around 644 dollars per ton, the breakdown being as follows:

Cost price	489.00
Over-head expenses, financial and commercial costs	60.00
Depreciation	7.00
Taxes and charges	88.00
Cost of powder	644.00

At the second stage, once active-surface agents and packing material are produced locally, production costs can be appreciably lowered.

At the first stage of production development, the following raw materials will have be imported (excluding packing material):

		Quantity (in tons)	Price per kg. (in $)	Cost c.i.f. Abidjan (in $1000)
Alkylaryl sulphate	6,000 x 0.23 =	1,380	0.52	717.6
Fatty alcohol	6,000 x 0.025=	150	0.70	105.0
Carboxymethylcellulose	6,000 x 0.01 =	60	0.36	21.6
Tripolyphosphate	6,000 x 0.33 =	1,980	0.30	594.0
Sodium sulphate	6,000 x 0.26 =	1,560	0.06	93.6
Washing blue	6,000 x 0.001=	6	9.20	55.2
Perfume	6,000 x 0.003=	18	4.20	75.6
	Total for annual production			1,642.6

The labour force required for this undertaking may be estimated as follows:

Manufacture, packing and maintenance	120 persons
General services	60 persons
Total	180 persons

To this figure should be added some twenty new posts in the marketing field: representatives, sales promoters, demonstrators and sales inspectors.

With the above information it is possible to evaluate the prospects for the development of local industry.

As already pointed out, the installation necessary for the manufacture of detergents is costly and the point at which it begins to yield economic returns too high to warrant the operation of a whole plant for the needs of a single country, except in the case of Nigeria and Ghana, and by 1980 the Ivory Coast and Senegal.

Table 27 indicates present and future capacity.

TABLE 27

Present capacity of West African detergent production and estimated capacity in 1970, 1975 and 1980

(tons)

Countries	Present Capacity	1970	1975	1980
Nigeria	-	12,000	24,000	54,000
Niger	-	-	-	-
Dahomey	-	-	-	-
Togo	-	-	-	-
Total First Region	-	12,000	24,000	54,000
Ghana	-	6,000	12,000	18,000
Ivory Coast	6,000	6,000	6,000	12,000
Upper Volta	-	-	-	-
Total Second Region	6,000	12,000	18,000	30,000
Guinea	-	-	-	
Sierra Leone	-	-	-	
Liberia	-	-	-	
Total Third Region	-	-	-	
Gambia	-	-	-	-
Senegal	-	-	6,000	12,000
Mauritania	-	-	-	-
Mali	-	-	-	-
Total Fourth Region	-	-	6,000	12,000
General Total	6,000	24,000	48,000	96,000

Obviously, here there is room for discussion as regards the number of units, the production programme, the degree of specialization and co-operation, and the siting of plants in each country.

Table 28 gives an approximate estimate of the fixed capital investment and working capital needed for an early expansion of the detergent industry.

TABLE 28

Estimated fixed capital investment and working capital needed for further production, based on projections for 1980

(value in thousands of dollars)

Countries	Annual production capacity to be set up (in tons)	Fixed capital investment	Working capital
Nigeria	54,000	2,340	1,350
Ghana	18,000	780	450
Ivory Coast	6,000	260	150
Senegal	12,000	520	300
Total	90,000	3,900	2,250

In estimating the fixed capital investment and working capital, the basis of calculation adopted was a unit of 6,000 tons per annum.

It is easy to realize that the value of fixed capital investment, in particular, might be appreciably reduced by the installation of larger units. The working capital can be reduced at the second stage, when active-surface agents are manufactured locally.

Labour requirements, production costs and the value added can also be estimated on the basis of data previously submitted (see table 29).

TABLE 29

Labour requirements, production costs and value added of the West African detergent industry, in 1980

Country	Production (in tons)	Number of workers	Annual cost of production (in thousands of dollars)	Annual value added (in thousands of dollars)
Nigeria	54,000	1,800	34,776	13,900
Ghana	18,000	600	11,592	4,600
Ivory Coast	12,000	400	7,728	3,000
Senegal	12,000	400	7,728	3,000
Total	96,000	3,200	61,824	24,500

The above data relate only to the first stage of manufacture. Local production of surface-active agents, and the installation of units larger than 6,000 tons per annum, might appreciably reduce production costs.

III.4 Perfumes and cosmetics

III.4.1 The present market and prospects for development

Perfume products and cosmetics are essentially concrete perfumes, prepared perfumes whether alcoholic or not, hygiene or beauty products, toothpaste and shaving cream.

If we were to study the market for perfume products and cosmetics, we should find that the imports of these products are shown statistically under the names of the various groups.

In English-speaking countries, perfumes, cosmetics and beauty products are all lumped together under the same heading (Ghana, Liberia) or are divided up as follows: "perfumery", "dentifrice", "talcum and powders", "pommades", and "other perfumes, cosmetics and toilet preparations".

In the statistics for the majority of French-speaking countries, the following headings are common: "indeterminate essences or oils", "combinations of various odoriferous substances", "distilled aromatic waters", "non-alcoholic liquid perfumes", "concrete perfumes", "alcoholic liquid perfumes, other non-alcoholic perfumed products", "other alcoholic perfume products", "shaving cream" and "other perfume products".

In these circumstances, it is impossible to make any comparisons between the consumption of each of the countries with which we are concerned or for the whole of the sub-region, as regards each particular article or product. Nevertheless, the partial analysis made below in regard to certain French-speaking and English-speaking States, may be assumed to be of interest also from the standpoint of the development of the local production.

Generally speaking, the greater portion of the various perfume products is still covered by imports, but the influence of the local production is now very clearly felt.

The countries where there is not even a small perfume manufactory or beauty products enterprise are few and far between. In some countries,

perfumes or cosmetic products are manufactured cheaply and are serious competitors with the imported products.

Before making a more detailed examination of the existing industry, we should like, as it were, to characterize the importation of these products. (See Table 30).

TABLE 30

Imports of perfume and toilet products in West Africa

(thousands of dollars)

Country	1960	1961	1962	1963	1964
Nigeria	1,520	1,426	1,043	884	964
Niger	120 x)	124	152	108	120
Dahomey	240 x)	248 x)	178	209	242
Togo	338	356	215	210	261
Total first region	2,218	2,154	1,588	1,411	1,587
Ghana	1,546	1,326	673	631	290
Ivory Coast	1,005	1,218	880	1,079	1,230
Upper Volta	31	183	154	135	160 x)
Total second region	2,582	2,727	1,707	1,845	1,680
Guinea	120 x)	140 x)	160 x)	180 x)	200 x)
Sierra Leone	349	490	421	329	436
Liberia	342	350 x)	354	382	394 x)
Total third region	811	980	935	891	1,030
Gambia	55	79	99	76	89
Senegal	1,015 1/	1,014	903	908	865
Mauritania	-	7	17	14	7
Mali	-	198	117	78	57
Total fourth region	1,070	1,298	1,136	1,076	1,018
	6,681	7,159	5,366	5,223	5,315

1/ Senegal - Mauritania - Mali.

x) Estimations.

The first point to note is that the market for perfume and toilet products, after showing a recession in 1962 (particularly in Nigeria and Ghana), has been very stable during the last three years. A similar situation is observable throughout the whole of the West African sub-region, as in the four regions shown in Table 30. Since 1962 (for this particular import) the figure for the whole of the sub-region is in the neighbourhood of US$5.3 million.

Three English-speaking States (Nigeria, Sierra Leone, Gambia) imported perfume and cosmetic products in 1964 to the tune of US$ 1,489 thousand. Of this amount, 46 per cent was accounted for by "other perfumes, cosmetics and toilet preparations", 20 per cent by "dentifrices", 18 per cent by "talcums and powders", 12 per cent by "perfumes", and 4 per cent by "pommades".

The distribution as between the various categories of imported products in 1964 for an over-all sum of US$ 2,942,000 involving 8 French-speaking States (the Niger, Dahomey, Togo, the Ivory Coast, and the Upper Volta, Senegal, Mauritania, Mali) was as follows in descending order of value:

alcoholic liquid perfumes	28.9 per cent
other non-alcoholic perfume products	27.7 per cent
combinations of odoriferous substances	24.7 per cent
non-alcoholic liquid perfumes	10.1 per cent
other alcoholic perfumed products	7.1 per cent
shaving creams	1.2 per cent
concrete perfumes	0.3 per cent

In spite of the fact that the local manufacture is a great competitor, and, in countries where there are perfume manufacturers, has led to a very substantial reduction in imports, "alcoholic liquid perfumes" hold first place so far as imports are concerned. The most popular are perfumes with an alcoholic content, including eau de cologne.

It is also surprising that the second place should be held by "other non-alcoholic perfume products", because these products are

also manufactured in large quantities in the African States, where there are perfume factories. In this class should be included products for make-up, mouth hygiene, hair products as well as, among others, pommades, ointments, beauty creams with a vaseline base, creams to prevent the skin from drying and the lips from cracking, brilliantines, and dentrifrices etc. At the same time it should be noted that the position held by non-liquid perfume products with an alcoholic base (other alcoholic perfume products) is relatively unimportant.

There is every justification for a fairly good stock of "combinations of odoriferous substances", judging from the development of the local production. The essential oils and odoriferous combinations are of course imported by the countries where there is an industry (or a handicraft enterprise) of perfume products. They may be regarded as the raw material for this industry. Non-alcoholic liquid perfumes are particularly appreciated by the Moslem population. The least favoured sector is the sector of concrete perfumes. The market reveals a relatively stable level and only a moderate demand for these products. No substantial development can be foreseen in this sector.

When we look at the imports of perfume and toilet products, we see that generally speaking the products imported are high quality products, and certain creams or special beauty products whose manufacture is not and cannot be visualized locally.

To obtain some idea of the consumption of the products concerned, it would be necessary to add to the import figures, figures for local production which have developed greatly in this sector within recent times.

We have no details for the size of the local production, but it may by a process of deduction be put around US$ 7,400,000.

It should be emphasized that the Ivory Coast, Senegal, Nigeria and, above all, Ghana exported over US$ 30,000 worth of perfume, toilet waters or various cosmetics in 1964.

Bearing in mind imports, local production and exports, the approximate consumption in 1964 for the whole of the sub-region may be evaluated at US$ 12,685,000.

As regards the future, without laying any claim to prophecy, it may be estimated that since the population is likely to grow very rapidly, the consumption of all the products we have just examined will increase considerably.

As is well known, the evaluationary trend in hygiene and beauty products, always follows similar trends in habits and modes of life. Surely, this last-named type of development is taking place much more rapidly than the boldest specialist in these matters had imagined. The stringency suffered in certain sectors of the economy as a result of the low purchasing power of the local population, is felt much less in this field, where the products are sold in packing of a kind that puts their unitary price within reach of the purchasing power, either of the middle class where semi-luxury products are concerned, or of the large mass of the people, where ordinary products are concerned.

Bearing in mind these evolutionary tendencies, the future consumption of the products concerned has been noted in the annex, and the results of these studies are shown in Tables 31 and 32.

TABLE 31

Consumption of perfumed products and cosmetics in 1964, and estimates for 1965, 1970, 1975 and 1980

(thousands of dollars)

Countries	1964	1965	1970	1975	1980
Nigeria	6,460	6,780	8,660	11,000	14,100
Niger	200	215	300	420	600
Dahomey	300	315	400	500	650
Togo	260	270	350	450	600
Total first region	7,220	7,580	9,710	12,370	15,950
Ghana	1,200	1,260	1,600	2,050	2,600
Ivory Coast	1,500	1,560	1,900	2,300	2,800
Upper Volta	300	320	450	630	900
Total second region	3,000	3,140	3,950	4,980	6,300
Guinea	200	215	300	420	600
Sierra Leone	436	460	600	750	950
Liberia	400	420	500	600	700
Total third region	1,036	1,095	1,400	1,770	2,250
Gambia	89	92	110	140	170
Senegal	1,200	1,250	1,500	1,850	2,250
Mauritania	20	22	30	42	60
Mali	120	130	210	340	550
Total fourth region	1,429	1,494	1,850	2,372	3,030
General total	12,685	13,309	16,910	21,492	27,530

Total consumption will have increased in the period 1964 to 1980 almost by 220 per cent. The average rate of increase for the whole of the sub-region is the same for the three periods 1965-1970, 1970-1975, and 1975-1980 (5 per cent).

TABLE 32

Consumption of perfume products and cosmetics per head of population: estimates for 1965, 1970, 1975 and 1980

(in dollars)

Country	1965	1970	1975	1980
Nigeria	0.12	0.13	0.14	0.15
Niger	0.07	0.09	0.11	0.13
Dahomey	0.13	0.15	0.17	0.19
Togo	0.16	0.19	0.22	0.25
Total first region	0.12	0.13	0.14	0.16
Ghana	0.16	0.18	0.20	0.22
Ivory Coast	0.38	0.45	0.49	0.52
Upper Volta	0.07	0.09	0.11	0.14
Total second region	0.19	0.21	0.24	0.26
Guinea	0.06	0.08	0.10	0.12
Sierra Leone	0.17	0.20	0.23	0.26
Liberia	0.40	0.45	0.51	0.56
Total third region	0.15	0.18	0.20	0.23
Gambia	0.28	0.30	0.33	0.35
Senegal	0.36	0.40	0.45	0.49
Mauritania	0.03	0.04	0.05	0.07
Mali	0.03	0.04	0.06	0.08
Total fourth region	0.16	0.19	0.21	0.24
General total	0.14	0.15	0.17	0.19

Table 32 gives a good picture of the position, making it possible to compare the level of consumption. It will be seen that in spite of the local production, the consumption per head of population is still very low.

III.4.2 Prospects of development in the local industry

1. It seems difficult to imagine the time when the market was entirely met by local production without any help from outside, particularly in a field like perfumery, where questions of luxury, fancy, style, taste, snobbery, etc. play such a large part where customers are concerned.

In any case the influence of the local production, in particular in the eau de cologne and toilet sector is already considerable. It may be assumed that local production will gradually follow the increase in demand determined by the inevitable development of the market. It may be assumed also that the quality of the local products will improve, and if prices remain good or become so, local perfumes will present an increasingly serious challenge to imported perfumes.

The substantial progress made during the past few years by the local industry and the results obtained in various countries from the point of view of the quality of the products, are particularly encouraging, and warrant a confident outlook for the future.

Already in Nigeria there are 18 perfume and cosmetic enterprises and their production value in 1964 will be about US$ 5,500,000. Ghana has six workshops with a production capacity of the order of US$ 700,000 a year, and in 1964 exported US$ 29,100 worth of pommades and brilliantines.

In the Ivory Coast, almost all the very popular perfume products especially in the field of hygiene, such as scented waters and toilet lotions, skin products, hair products, dentifrices are either formulated or packed locally. Only quality perfumes and high-class products are imported to meet the needs of the more-favoured section of the customers.

In Senegal, DICOPA is the most important Senegalese concern in the matter of perfumery. It has a modern plant, which enables it to obtain licences for mixing and bottling perfumes of established reputation. It will, at any time now, start packing nail varnish, face powder, English talcum and various powders and perfume pommades of English, German or Italian make. It is proposed to extend it, to include the packing of products containing a certain percentage of mint alcohol.

The SEIB plant contains a workshop for perfume pommades which are packed in glass jars, and liquid brilliantines sold in phials.

SAPROMA has been in operation for almost seven years in Dakar, and produces eau de cologne for current sale, perfumes with or without alcohol, perfume pommades, sweet-scented ointments, brilliantines, talcum powder of various kinds etc. known and appreciated by the local customers. There is an investment project which might soon be carried out, in connexion with the Vicoil Aromatic Society of Senegal. This company is expected to install an essential oils distillery at Guinguineo. The factory will treat vetiver, lemon grass, lemons' basil, and other aromatic plants as are cultivated in Senegal. The production is 250 tons a year.

In Mali, a company known as SOPARCO, sells mainly imported products. In the group of countries including the Upper Volta, Dahomey, the Niger, and Liberia, the local perfume manufacturing enterprises are not numerous (industrially or semi-industrially speaking).

The most important are the African Chemical Works at Cotonou and the Niger Perfume Company (SOPANI) at Niamey. In Togo, there is no factory for the production of perfume products on an industrial or even semi-industrial scale, but certain traders have put on the market powders and perfumed ointments produced locally from imported ingredients, generally in a simple way.

Guinea, Sierra Leone, Gambia and Mauritania, are entirely without any perfume products industry.

2. Bearing in mind the present tendencies of the market, and the approximate demand estimated for 1980, and taking into consideration the rapid increase in local production, a programme of development for the local industry is given below. In Table 33 the existing capacities and estimated capacities for the future are given.

TABLE 33

Existing capacities for the production of perfume products and cosmetics in West Africa, and estimates for 1970, 1975 and 1980

(thousands of dollars)

Country	Existing capacity	1970	1975	1980
Nigeria	6,000	8,000	10,000	12,000
The Niger	110	200	300	500
Dahomey	100	300	400	500
Togo	-	250	350	500
Total first region	6,200	8,750	11,050	13,500
Ghana	700	1,300	1,800	2,200
The Ivory Coast	400	1,500	1,800	2,200
The Upper Volta	80	200	400	700
Total second region	1,180	3,000	4,000	5,100
Guinea	-	150	300	500
Sierra Leone	-	300	500	700
Liberia	50	200	400	500
Total third region	50	650	1,200	1,700
Gambia	-	50	100	100
Senegal	500	1,000	1,300	1,700
Mauritania	-	-	-	-
Mali	60	100	200	400
Total fourth region	560	1,150	1,600	2,200
General total	8,000	13,550	17,850	22,500

The existing capacities in each country are estimated approximately, because there is no definite information on the subject.

The capacities estimated in Table 33 correspond approximately to 80 per cent of the demand. As a result of very thorough studies carried out, it is suggested that a list be drawn up of the quantity, size, production programme, degree of specialization and co-operation, as well as the location of industries for the production of perfume products and cosmetics in each country.

Table 34 shows the approximate increase in fixed investment and working capital necessary for the forthcoming expansion of the industry under consideration.

TABLE 34

The evaluation of fixed investment and working capital necessary for additional production based on projections for 1980

(thousands of dollars)

Countries	Annual production capacity to be installed	Fixed Investment	Working capital
Nigeria	6,000	1,800	1,200
Niger	390	120	80
Dahomey	400	120	80
Togo	500	150	100
Total first region	7,290	2,190	1,460
Ghana	1,500	450	300
Ivory Coast	1,800	540	360
Upper Volta	620	190	124
Total second region	3,920	1,180	784
Guinea	500	150	100
Sierra Leone	700	210	140
Liberia	450	140	90
Total third region	1,650	500	330
Gambia	100	30	20
Senegal	1,200	360	240
Mauritania	-	-	-
Mali	340	100	70
Total fourth region	1,640	490	330
General total	14,500	4,360	2,904

In regard to the increase in fixed investment, 30 per cent has been taken, in accordance with industrial practice, and 20 per cent of the annual production value as working capital.

Table 35 shows the labour needs, the gross value and added value of annual production in 1980.

TABLE 35

Labour needs, gross value and added value of the perfume industry and cosmetics in West Africa in 1980

Countries	Number of workers	Gross annual value (in thousands of dollars)	Annual added value (in thousands of dollars)
Nigeria	2,400	12,000	4,800
Niger	125	500	200
Dahomey	125	500	200
Togo	125	500	200
Total first region	2,775	13,500	5,400
Ghana	440	2,200	880
Ivory Coast	440	2,200	880
Upper Volta	175	700	280
Total second region	1,055	5,100	2,040
Guinea	125	500	200
Sierra Leone	175	700	280
Liberia	125	500	200
Total third region	425	1,700	680
Gambia	35	100	40
Senegal	340	1,700	680
Mauritania	-	-	-
Mali	100	400	160
Total fourth region	475	2,200	880
General total	4,730	22,500	9,000

It is accepted that in the conditions obtaining in Africa, the net value would be 40 per cent of the gross annual production value.

The labour needs have been calculated by taking approximately US$ 5,000 per worker a year, for production in excess of US$ 1 million a year, US$ 3,000 for production up to US$ 100,000 and US$ 4,000 for production within a range of US$ 100,000 and US$ 1 million, on the assumption that where the demand is great, larger units can be established resulting in greater productivity.

III.5 Basic chemical products

This group includes sulphuric acid, phosphoric acid, caustic soda, ammonia and calcium carbide, generally speaking, raw material or supplies used in further transforming processes in the chemical industry or other industries.

The demands for these products have been estimated in relation to the needs of the present industries, and those proposed in the present document and in other studies.

III.5.1 Sulphuric acid

(a) Demand and capacity to be installed

In the sector of non-organic acids, sulphuric acid holds pride of place at least in tonnage. There is hardly an important industry which does not depend upon it, in some measure, directly or indirectly, or upon one of the salts or by-products from sulphuric acid.

The uses to which sulphuric acid may be put are various: fertilizers, petroleum refining, rayon, metallurgy, textiles, chemical products, purification of vegetable oils, paper and cellulose, etc.

Table 36 indicates the quantities of sulphuric acid which will be needed by industries and consumer countries, and the capacities to be installed as estimated for 1970, 1975 and 1980.

As can be visualized, the fertilizer sector is the one which will far and away become the biggest consumer (approximately 85 per cent

of the estimated needs for 1980), with viscose rayon and sulphate of aluminium as runners up.

(b) Process

Apart from cases in which local conditions are exceptional, modern production units of sulphuric acid operate on the basis of sulphur through a catalytic process using vanadium oxide (V_2O_5).

A plant of this kind would include:

- the necessary apparatus for the fusion of sulphur, namely, a melting house, a filter designed to hold back the impurities collected in course of transport, a reserve tank and circulation pumps. The whole outfit should be kept at a temperature in excess of 130° by means of steem circulation.

TABLE 36

Demand for sulphuric acid and capacity to be installed: estimates for 1970, 1975 and 1980

(quantities in thousands of tons)

Countries	Demand			Capacity to be installed		
	1970	1975	1980	1970	1975	1980
Nigeria						
Ammonium sulphate*	173.3	173.3	173.3			
Rayon	20.8	24.7	28.6			
Refinery	3.2	3.2	3.2			
Paper and cellulose	-	0.6	0.6			
Lubricant	-	7.7	10.2			
Total	197.3	209.5	215.9	220	220	220
Togo						
Phosphoric acid	-	100.8	201.6			
Supersimple	66.7	66.7	66.7			
Refinery & DDT (Ghana)	9.0	-	-			
Total	75.7	167.5	268.3	76	180	280
Ghana						
Ammonium sulphate*	-	173.3	173.3			
DDT	-	6.6	6.6			
Refinery	-	2.4	2.4			
Total	-	182.3	182.3	-	200	200

TABLE 36 (Cont'd.)

Countries	Demand			Capacity to be installed		
	1970	1975	1980	1970	1975	1980
Ivory Coast						
Rayon	20.8	24.7	28.6			
Refinery	1.5	1.5	3.0			
Total	22.3	26.2	31.6	30	30	30
Sierra Leone						
Sulphate of aluminium	15.4	19.8	24.2			
Refinery and miscellaneous 1/	1.0	3.2	3.2			
DDT (Guinea)	-	6.6	6.6			
Total	16.4	29.6	34.0	17	34	34
Senegal						
Phosphoric acid	56.0	89.6	140.0			
Ammonium Sulphate ✱	-	-	173.3			
DDT	-	-	6.6			
Refinery	1.2	1.2	2.0			
Total	57.2	90.8	321.9	60	90	330
Mali						
Supersimple	-	20.4	20.4	-	22	22
Grand total	368.9	726.3	1074.4	403	776	1,116

1/ Demand for Sierra Leone, Liberia and Guinea.

✱ See page 130

The combustion furnace into which the liquid sulphur is thrown under pressure across a burner similar to those used for fuel. The reaction is expressed as follows:

$$S + O_2 = SO_2 \quad \text{sulphur dioxide}$$

This reaction is exothermic and the gaseous mixture reaches a temperature of 1000° as it leaves the furnace. The oxygen is taken away by the dry air into a tower watered by sulphuric acid and warmed again in a gas changer; the temperature can be regulated by means of a bypass. When it comes out of the furnace the gaseous mixture, which contains for instance 9 per cent SO_2 (the proportion varies according to the conditions regulating speed), passes through a cauldron.

- The water when heated in an economizing device placed over the circuit of air, is transformed into steam bringing back the temperature of the gases to the steam required for the catalytic process (under 500°). The amount of steam produced is approximately a ton per ton of manufactured sulphuric acid.

- These gases are filtered to eliminate impurities, in particular iron oxide from the cauldron tubes; they then pass through the converter which contains several layers of catalyzer (5 for instance). The access of air brought in from the top then makes it possible to produce the following reaction:

$$2\ SO_2 + O_2 = 2\ SO_3 \quad \text{sulphur trioxide}$$

This reaction is also exothermic and the gases must be cooled between each layer of catalyzer to avoid deterioration. This can be done by introducing fresh air in controlled quantities.

When they leave the converter, the gases pass through a changer, bringing the temperature back to 250°; they are then introduced into the absorption tower where in contact with diluted acid, the following reaction is produced:

$$SO_3 + H_2O = SO_4H_2 \quad \text{sulphuric acid.}$$

Table 37 shows the investment costs, quantities of raw material, auxiliary and motive forces, expenditure on staff and capital necessary per ton of sulphuric acid from pure sulphur (imported), as well as the corresponding costs for the various locations depending upon the capacity envisaged.

TABLE 37

Cost of the production of a ton of sulphuric acid

(in dollars)

Countries			Nigeria		Togo				Ghana		Ivory Coast	
Capacity (t/year)			220,000		76,000		180,000		200,000		30,000	
Investment (US$ 1,000)			2,300		1,200		2,200		2,200		670	
	Units	Quantity	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1. Sulphur	t	0.33	40	13.2	40	13.2	40	13.2	40	13.2	40	13.2
2. Electricity	kWh	30	0.013	0.4	0.048	1.4	0.048	1.4	0.00265	0.1	0.0146	0.4
3. Labour and supervision				0.6		0.9		0.6		0.6		1.5
4. Capital cost				1.4		2.2		1.5		1.4		3.2
Total				15.6		17.7		16.7		15.3		18.3
5. Contingencies				0.8		0.9		0.8		0.8		0.9
I. Workshop price				16.4		18.6		17.5		16.1		19.2
6. Indirect expenses, general costs, selling costs*				1.6		1.9		1.8		1.6		1.9
II. Cost price				18.0		20.5		19.3		17.7		21.1
7. Profits after the payment of taxes				1.3		1.9		1.4		1.3		2.7
8. Profits before the payment of taxes**				2.1		3.2		2.4		2.2		4.5
III. Selling price				20.1		23.7		21.7		19.9		25.6
Estimated import price (c.i.f.)							50 - 70					

* 10 per cent of workshop price

** 20 per cent of fixed capital investment.

TABLE 37 (Cont'd.)

Countries			Sierra Leone				Senegal				Mali	
Capacity (t/year)			17,000		34,000		60,000		330,000		22,000	
Investment (US$ 1,000)			500		850		1,000		3,700		560	
Item	Units	Quantity	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1. Sulphur	t	0.33	40	13.2	40	13.2	40	13.2	40	13.2	54	17.8
2. Electricity	kWh	30	0.065	1.9	0.065	1.9	0.02	0.6	0.02	0.6	0.061	1.8
3. Labour and supervision				1.8		1.4		0.9		0.4		1.8
4. Capital cost				4.4		3.1		2.4		1.2		3.8
Total				21.3		19.6		17.1		15.4		25.2
5. Contingencies				1.1		1.0		0.9		0.8		1.2
I. Workshop price				22.4		20.6		18.0		16.2		26.4
6. Indirect expenses, general costs, selling costs *				2.2		2.1		1.8		1.6		2.6
II. Cost price				24.6		22.7		19.8		17.8		29.0
7. Profits after the payment of taxes				3.5		3.0		2.0		1.3		3.1
8. Profits before the payment of taxes **				5.9		5.0		3.3		2.2		5.1
III. Selling price				30.5		27.7		23.1		20.0		34.1
Estimated import price (c.i.f.)							50 - 70					

* 10 per cent of the workshop price.

** 20 per cent of fixed investment.

III.5.2 Phosphoric acid

(a) Demand and capacity to be installed

The needs in this field are connected with the production of triple superphosphate.

The production of triple superphosphate is envisaged in Togo and Senegal.

Taking into consideration the demand of .9 of a ton of phosphoric acid (40 per cent of P_2O_5), which corresponds to .36 of a ton of phosphoric anhydride (P_2O_5), it may be estimated that the need in phosphoric acid (55 per cent of H_3PO_4 corresponding to 40 per cent of P_2O_5), is as follows:

	1968/69	1973/74	1977/78
Supertriple (46 per cent of P_2O_5)			
Togo	-	100,000	200,000
Senegal	45,000	85,000	135,000
Total	45,000	185,000	335,000
Phosphoric acid (55 per cent of H_3PO_4)			
Togo	-	90,000	180,000
Senegal	40,500	76,500	121,500
Total	40,500	166,500	301,500
relatively in P_2O_5:			
Togo	-	36,000	72,000
Senegal	16,200	30,600	48,600
Total	16,200	66,600	120,600
The capacities of phosphoric acid to be installed (a ton of P_2O_5):			
Togo	-	36,000	72,000
Senegal	20,000	32,000	50,000
Total	20,000	68,000	122,000

(b) Process

Phosphoric acid may undergo a thermal process (blast furnace acid and electric furnace acid) or a humid process with the application of sulphuric or hydro-chloric acid.

Because the thermal process requires, quite apart from cheap electrical energy, considerable quantities of coke which should be imported in West Africa, it is thought that the humid process with the application of sulphuric acid is all the more appropriate.

The main chemical reaction achieved in the course of this operation may be written down as follows:

$$Ca_3(PO_4)_2 + 3\ H_2SO_4 \qquad 2\ H_3PO_4 + 3\ CA\ SO_4$$

The calcium sulphate obtained is practically insoluable, and can be separated from the phosphoric acid by filtration. It appears in a hydrated form (gypsum).

With a few exceptions, it is necessary to break up the phosphate in order to facilitate the chemical attack.

The rate at which the plant responds will depend essentially on two factors bound up with the quality of the natural phosphate used, that is to say:

- the physical properties of the phosphate which influence its aptitude for attack by the sulphuric acid and, consequently, the size of the reaction basins;
- the nature and percentage of the impurities modifying the conditions of filtration, and determining the size of the filters;

Most users prefer to concentrate the acid received, because they believe that additional expense is offset by reducing the storage capacities, the incidental purification of the acid (in particular the elimination of most of the fluor), the diminution of the volume of fertilizer-manufacturing plant and economy in drying fuel.

The installation envisaged would comprise:

- the unit for breaking up the phosphate (this unit will serve for the installations of phosphoric acid and triple superphosphate);
- a device for processing;
- a device for concentration.

Investments, raw materials and motive forces, staff expenses and capital expenses per ton of phosphoric anhydrite (P_2O_5) necessary for

the production of phosphoric acid (55 per cent of H_3PO_4) as well as corresponding costs for the various locations depending on the proposed capacity, will be found in Table 38.

TABLE 38

Cost of the production of phosphoric acid equivalent to a ton of P_2O_5

(in dollars)

Capacity (t/year)			Togo 36,000		Senegal 20,000	
Investment (US$ 1,000)			2,400		1,600	
Item	Unit	Quantity	Price	Value	Price	Value
1. Sulphuric acid (98 per cent)	t	2.8	17.5	49.0	18.0	50.4
2. Phosphate (37 per cent P_2O_5)	t	3.0	11.0	33.0	11.0	33.0
3. Electricity	kWh	200	0.048	9.6	0.02	4.0
4. Labour and supervision				2.2		3.2
5. Capital costs				10.0		13.0
				103.8		103.6
6. Contingencies				5.2		5.2
I. Workshop price				109.0		108.8
7. Indirect costs, general expenses, selling costs*				10.9		10.9
II. Cost price				109.0		108.8
8. Profit after payment of taxes				12.0		15.6
9. Profit before payment of taxes **				20.0		26.0
III. Selling price				139.9		145.7
Estimated import price (c.i.f.)				200-250		

* 10 per cent of the workshop price

** 20 per cent of the fixed investment (H_2SO_4 + H_3PO_4).

III. 5.3. Caustic Soda and chlorine

(a) Demand and capacity to be installed

Caustic soda, one of the most important products in the heavy chemical industry, is used for a number of purposes in particular for the manufacture of aluminium, viscose, soap, paper and cellulose, vegetable oils, textiles, etc.

In Table 39 below are to be found the estimates on the use of caustic soda in 1964, and estimates for 1975 and 1980.

In order to reduce imports of caustic soda, it is absolutely necessary for the production to meet the demand fully, but there arises problem which is likely to postpone the day when such a result will be possible. It is the difficulty of marketing the excess of chloride obtained as a by-product. In this situation, the production of caustic soda should be adapted to the demand for chlorine, because the manufacture of caustic soda by the electrolysis of sodium chloride (sea salt) is not an economic proposition unless use is made of the chlorine obtained.[1/]

In the phase of industrialization in West Africa under consideration, the use of chlorine is limited to the production of plastic materials, pesticides, purification of drinking water, disinfection of sewage, whitening of paper pulp and cellulose, etc.

Table 40 indicates the demand for chlorine estimated for 1970, 1975 and 1980.

1/ There would be some justification for studying whether it would be possible to produce a solution of caustic soda from natural soda (natron) obtainable in Lake Chad.

TABLE 39

Demand for caustic soda in 1964 and estimates for 1975 and 1980

(Quantities in tons)

	1964					1975							1980						
	Soap	Oil refinery	Alumina	Miscel-laneous*	Total	Soap	Oil refinery	Paper & cellu-lose	Rayon	Alumina**	Miscel-laneous*	Total	Soap	Oil refinery	Paper & cellu-lose	Rayon	Alumina**	Miscel-laneous*	Total
Nigeria	5,000	-	-	4,186	9,186	13,200	640	1,050	17,100	-	5,000	36,990	20,400	1,200	1,050	19,800	-	6,000	48,450
Niger	-	-	-	5	5	300	-	-	-	-	10	310	700	-	-	-	-	20	720
Dahomey	200	-	-	225	425	600	-	-	-	-	250	850	800	-	-	-	-	300	1,100
Togo	80	-	-	9	89	400	-	-	-	-	10	410	600	-	-	-	-	20	620
Total 1st region	5,280	-	-	4,425	9,705	14,500	640	1,050	17,100	-	5,270	38,560	22,500	1,200	1,050	19,800	-	6,340	50,890
Ghana	2,300	165	-	-	2,465	4,400	540	2,500		9,200	300	16,940	6,000	600	2,500	-	9,200	400	18,700
Ivory Coast	1,500		-	206	1,706	2,500	300	2,500	17,100	-	300	22,700	2,500	600	2,500	19,800	-	400	25,800
Upper Volta	120	-	-	50	170	800	-	-	-	-	50	850	1,200	-	-	-	-	50	1,250
Total 2nd region	3,920	165	-	256	4,341	7,700	840	5,000	17,100	9,200	650	40,490	9,700	1,200	5,000	19,800	9,200	850	45,750
Guinea	200	-	22,000	100	22,300	800	240	-	-	27,600	150	28,690	1,100	400	-	-	33,100	200	34,700
Sierra Leone	100	-	-	168	268	700	200	-	-	-	200	1,100	900	200	-	-	-	200	1,300
Liberia	50	-	-	45	95	400	200	-	-	-	50	650	500	200	-	-	-	50	750
Total 3rd region	350	-	22,000	313	22,663	1,900	640	-	-	27,600	400	30,440	2,500	800	-	-	33,100	450	36,750
Gambia	-	-	-	18	18	100	-	-	-	-	20	120	100	-	-	-	-	20	120
Senegal	1,150	-	-	1,400	2,550	1,800	240	-	-	-	1,500	3,540	2,100	800	-	-	-	1,500	4,400
Mauritania	-	-	-	11	11	-	-	-	-	-	15	15	100	-	-	-	-	20	120
Mali	300	-	-	210	510	900	-	-	-	-	250	1,150	1,400	-	-	-	-	260	1,660
Total 4th region	1,450	-	-	1,639	3,089	2,800	240	-	-	-	1,785	4,825	3,700	800	-	-	-	1,800	6,300
Grand total	11,000	165	22,000	6,633	39,798	26,900	2,360	6,050	34,200	36,800	8,105	114,415	38,400	4,000	6,050	39,600	42,300	9,440	139,790

* Oil refinery, textile industry, handicrafts, etc.

** Account has been taken of 46 kg of NaOH (100 per cent) equivalent to 60 kg of NaOH (76 per cent) to a ton of alumina (100 per cent).

The production of alumina was estimated as follows:

	1975	1980
Ghana	200,000	200,000
Guinea	600,000	720,000

TABLE 40

Demand for chlorine: estimates for 1970, 1975 and 1980

(Quantities in tons)

Countries	1970	1975	1980
Nigeria			
PCV	12,300	12,300	24,600
Paper and cellulose	--	2,600	2,600
Treatment of water	1,020	1,190	1,430
Miscellaneous	680	910	1,370
Total	14,000	17,000	30,000
Ghana			
PVC	---	12,300	12,300
DDT	5,700	5,700	5,700
Treatment of water	340	420	510
Miscellaneous	560	780	1,490
Total	6,600	19,200	20,000
Guinea			
DDT	---	5,700	5,700
BHC	15,000	30,000	48,800
Treatment of water	200	250	200
Miscellaneous	800	1,050	1,300
Total	16,000	37,000	56,000
Senegal			
DDT	---	---	5,700
Treatment of water	---	---	100
Miscellaneous	---	---	200
			6,000
Grand Total	36,600	73,200	112,000
Caustic soda equivalent	41,000	82,000	125,000
Demand for caustic soda		114,400	139,800

Since the transport of chlorine entails great difficulties, it is necessary to combine electrolysis plant and the industries using the chlorine released (vinyl chloride, DDT, BHC) - in the same industrial group.

The most important factors in the choosing of the location for an electrolysis plant, are again cheap electrical energy, and the presence of NaCl.

Bearing in mind all these factors, the locations and following capacities have been arrived at (in tons of Cl_2).

	1970	1975	1980
Nigeria	14,000	17,000	30,000
Ghana	6,600	20,000	20,000
Guinea	16,000	38,000	56,000
Senegal	--	--	6,000
Total	36,600	75,000	112,000

(b) Process

Sodium and chlorine are now obtained almost entirely by electrolysis, and alkaline chloride through the following process: an almost saturated solution of alkaline chloride is electrolyzed between an anode of graphite and a cathode of mercury. The chlorine is released at the anode and the alkaline metal at the cathode, forming an amalgam with the mercury.

When the amalgam is broken up in water, it gives an alkaline solution of hydrogen and mercury which is again used as a cathode.

In order to use this process, the following equipment is necessary:

- plant for the preparation of the salt solution;
- elements of mercury;
- caustic soda evaporator;
- chlorine-purifying apparatus.

For one ton of chlorine, you can get 1.12 tons of caustic soda and 288 kg of hydrogen.

The mercury cells process has been accepted in the present report, because it enables us to get caustic soda of a quality that makes the manufacture of viscose rayon possible; indeed it is intended to set up a viscose rayon factory in the sub-region. The diaphragm cells process would have been preferable, in connexion with the building of a factory in Guinea, where caustic soda of rayon quality is not necessary.

In Table 41, you will find investments, primary products, subsidiary and motive forces, staff costs and capital costs depending upon the investment costs and the sum-total of the costs in relation to the capacity and the various locations. By way of comparison, the workshop prices for the various locations and different capacities have also been shown.

Hydrogen is one of those products which cannot be used except in combination with chlorine as hydro-chloric gas or hydro-chloric acid. In West Africa, it cannot be sold as a separate product.

That is why it has been assumed that all the costs for the electrolytic process as shown in Table 41 are covered by amounts realized entirely from the sale of chlorine and caustic soda.

As will be seen from this table, electricity represents an important part of the costs, and therefore it is necessary to work out in advance a low cost for electricity, if chlorine is to be produced at the cheapest rate.

TABLE 41

Cost of the production of a ton of chlorine and a ton of caustic soda (in dollars)

Capacity (t/year)			Nigeria 14,000		Ghana 6,600			20,000	V.I. 16,000	Guinea*		16,000	V.II	38,000	Senegal		Ivory Coast 6,000	6,000
Investment (US$1,000)			4,300		3,000			6,200	4,700			4,700		9,000			2,900	2,900
Item	Units	Quantity	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1. Sea salt (100% NaCl)	t	1.75	21	37.0	17	30.0	17	30.0	16	28.0	16	28.0	16	28.0	7	12.2	16	28.0
2. Miscellaneous chemical products				7.0		7.0		7.0		7.0		7.0		7.0		7.0		7.0
3. Fuel oil	t	0.17	20	3.4	20	3.4	20	3.4	20	3.4	20	3.4	20	3.4	20	3.4	20	3.4
4. Electricity	kWh	3600	0.013	46.8	0.00265	9.5	0.00265	9.5	0.035	126.0	0.015	54.0	0.015	54.0	0.02	72.0	0.0146	52.5
5. Labour & supervision				10.7		20.0		8.7		9.3		9.3		8.0		22.7		22.7
6. Capital costs				46.7		68.3		46.5		44.0		44.0		35.5		72.5		72.5
Total				151.6		138.2		105.1		217.7		145.7		135.9		189.8		186.1
7. Contingencies				7.6		6.9		5.3		10.9		7.3		6.8		9.5		9.3
I. Workshop price				159.2		145.1		110.4		228.6		153.0		142.7		199.3		195.4
- Workshop price of 1.12 t of NaOH				67.8		61.8		47.0		97.4		65.2		60.8		84.9		83.3
- Workshop price of a ton of Cl_2				91.4		83.3		63.4		131.2		87.8		81.9		114.4		112.1
- Workshop price of a ton of NaOH				60.5		55.3		42.1		86.6		58.2		54.3		75.9		74.4
8. Indirect costs, general expenses, selling costs**				15.9		14.5		11.0		22.9		15.3		14.3		19.9		19.5
II. Cost price				175.1		159.6		121.4		251.5		168.3		157.0		219.2		214.9
- Cost price of 1.12 t NaOH				74.5		68.0		51.7		107.2		71.7		66.9		93.4		91.6
- Cost price of a ton of Cl_2				100.6		91.6		69.7		144.3		96.6		90.1		125.8		123.3
- Cost price of a ton of NaOH				66.5		60.9		46.3		95.7		64.1		59.8		83.5		81.9
9. Profits after payment of taxes				36.8		54.6		37.2		35.3		35.3		28.4		58.0		58.0
10. Profits before payment of taxes***				61.4		91.0		62.0		58.8		58.8		47.4		96.6		96.6
III. Selling Price				236.5		250.6		183.4		310.3		227.1		204.4		315.8		311.5
- Selling price of 1.12 t NaOH				100.6		106.8		78.2		132.1		96.7		87.0		134.4		132.6
- Selling price of a ton of Cl_2				135.9		143.8		105.2		178.2		130.4		117.4		181.4		178.9
- Selling price of a ton of NaOH				89.8		95.3		69.7		117.9		86.4		77.8		120.2		118.5
Estimated import price (c.i.f.):																		
- of a ton of Cl_2								150 - 200										
- of a ton of NaOH								100 - 150										
- Workshop price of a ton of Cl_2 for the production of 14,000 tons of Cl_2 a year				91.4		64.6				133.6		90.6				91.4		88.7
- Workshop price of a ton of NaOH for the production of 14,000 tons of Cl_2 a year				60.5		42.9				88.7		60.1				60.5		59.1
- Workshop price of a ton of Cl_2 for the production of 6,600 tons of Cl_2 a year				111.4		83.3				156.6		110.4				111.4		108.4
- Workshop price of a ton of NaOH for the production of 6,600 tons of Cl_2 a year				74.4		55.3				104.5		73.4				74.4		72.4
- Workshop price of a ton of Cl_2 for the production of 16,000 tons of Cl_2 a year				88.7		62.0				131.2		87.8				88.7		85.9
- Workshop price of a ton of NaOH for the production of 16,000 tons of Cl_2 a year				59.1		41.0				86.6		58.2				59.1		57.2
- Workshop price of a ton of Cl_2 for the production of 6,000 tons of Cl_2 a year				114.4		85.6				159.0		113.6				114.4		112.1
- Workshop price of a ton of NaOH for the production of 6,000 tons of Cl_2 a year				75.9		57.3				105.6		75.5				75.9		74.4

* In accordance with the present price of electrical energy (Version I), and the price estimated for the future (Version II)

** 10 per cent of workshop price

*** 20 per cent of the fixed investment

III. 5.4. Ammonia

(a) Demand and capacity to be installed

Ammonia provides a basis for a variety of uses. With a nitrogen content of 82.3 per cent, ammonia is a most highly concentrated form of raw material, making it possible to manufacture other by-products in which nitrogen is an element:

- in acid form: nitric acid and nitrates;
- in acid or alkaline form: ammonium nitrate;
- in alkaline form: ammonium sulphate and ammonium chloride, urea.

It is also used as a cooling agent.

In regard to the demand for ammonia in West Africa, with the exception of a few thousand tons intended for the manufacture of industrial explosives, practically the whole bulk of the need is associated with the demand for fertilizers.

The total demand for ammonia, estimated in Table 45, is as follows (in tons):

1970	1975	1980
58,000	117,000	210,000

Three manufacturing ammonia units of 60,000 tons a year are envisaged in connexion with the production of nitrogenous fertilizers, in the following countries:

	1968-1969	1974-1975	1977-1978
Nigeria	60,000	60,000	60,000
Ghana	-	60,000	60,000
Senegal	-	-	60,000
Total	60,000	120,000	180,000

It is necessary to point out, in this connexion, that the demand in 1980 will be only 534 per cent of the estimate given in document E/CN.14/INR/70/Rev.1. It would therefore seem that there is a great discrepancy between the estimate given in the present document and the one in the document just referred to. This would seem to indicate that higher demands are possible and therefore it would be necessary to set up ammonia factories of the very largest capacity.

(b) Process

The two main stages in the manufacture of synthetic ammonia are:

- the preparation of hydrogen;
- the direct combination with nitrogen following the reaction given below:

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

Worked out in 1908 by Haber and Bosch, the combination has given rise to numerous processes in which the following things happen:

- the temperatures vary from 400 to 700 degrees C;
- pressures are spaced out between 100 and 1,000 atmospheres;
- the recirculation of the gases is more or less intensive in order to improve the output (18 per cent conversion at 500°C under a pressure of 200 atmospheres);
- the nature of the catalyst is improved (iron activated by molybdeium, aluminium, and calcium oxide, etc.);
- aluminium is separated by liquefaction or dissolution in water.

But the essential difference between the various techniques, stems from the method of obtaining hydrogen. The following are used:

- the electrolysis of water (a practice now practically abandoned);
- turning carbon into gas by means of water vapour;
- the oxidation of methane for light hydrocarbon fuels according to the reaction:

$$C_nH_{2m} + n\ H_2O \longrightarrow n\ CO + (n + m)H_2 \quad \text{(vapour reforming)}$$

$$C_nH_{2m} + \frac{n}{2}\ O_2 \longrightarrow n\ CO + m\ H_2 \quad \text{(partial oxidation)}$$

Carbon oxide must then be transformed as before:

$$n\ CO + n\ H_2O \longrightarrow n\ CO_2 + n\ H_2 \quad \text{(conversion)}$$

During the last three years, the process of vapour reforming as developed by the ICI changed the production structure of ammonia outside the USA. Naphta used as raw material is considered to be a superfluous product for refineries, though available cheap. As this new process has a lower investment cost, and a lower cost price than is the case when the partial oxidation process is used, it has succeeded in replacing the latter and becoming the basic raw material for the production of ammonia in many countries, where naphta is available in surplus quantities.

The development of new catalysts for the conversion of CO and the replacement of the old installations for converting CO and separating CO_2 in two stages by a single CO conversion unit using two catalyst beds with an intermediary temper and a single unit for separating CO_2, have led to considerable economy in investments and the use of utilities. On the other hand, as the new CO catalyst is more active, the percentage of CO in the gases which enter into the last phase of purification, moves from 3 per cent to 0.6 per cent. Since the MEA system produces less than CO_2 at the end, this innovation has made the MEA system preferable to the system of separating CO_2 by the use of potassium carbonate.

The final purification of synthetic gas for removing the last traces of CO and CO_2 at less than 10 of the smallest multiples is now carried out by methanation, instead of the old-style process with a copper solution, since methanation requires lower investment, its operational costs are negligible and the operations are greatly simplified.1/

1/ Revue de l'Institut français du Pétrole et Annales des combustibles liquides, Vol. XX, No. 7-8, July-August 1965.

Investment, records of material, consumption of utilities, catalysts and chemical products, staff expenses, capital costs and all expenses are given in Table 42, for an ammonia factory of 60,000 tons a year using steam reforming from natural gas and naphta, with various locations.

In order to arrive at some comparison, the calculations for the locations envisaged (in Nigeria, Ghana and Senegal), are shown, and for other possible locations (Ivory Coast and Guinea).

III. 5.5. Calcium carbide

(a) Demand and capacity to be installed

Calcium carbide is used mainly for the production of acetylene which is used for axi-acetylenic soldering.

The relative demand for this product, estimates of which are given for each country in the Annex, is indicated in Table 43. Account has been taken of the installation of a calcium carbide factory at Dahomey with the following capacity (in tons):

1970	1980
8,000	16,000

(b) Process

Calcium carbide is produced by using the electric arc lamp process. The formation of carbide requires a great deal of heat, high temperatures obtained by the aid of an electric arc lamp, but also by the resistance of the molten substance. The reaction temperature should not fall below 2,000°C or exceed 2,650°C.

Production installations comprise the following units:

- plant for treatment of lime;
- plant for treatment of coke or charcoal;
- a carbide furnace;
- carbide processing.

TABLE 42

Cost of the production of a ton of ammonia (in dollars)

			Nigeria		Ghana		Ivory Coast		V.I		Guinea**	V.II		Senegal	
Capacity (t/year)			60,000		60,000		60,000		60,000			60,000		60,000	
Investment (US$1,000)			7,000		7,600		7,600		7,600			7,600		7,600	
	Item	Units	Quantity	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1.	Natural gas	m^3	1,100*	0.0062	6.8	-	-	-	-	-	-	-	-	-	-
2.	Naphta	t	0.8*	-	-	20	16.0	20	16.0	20	16.0	20	16.0	20	16.0
3.	Electricity	kWh	800	0.013	10.4	0.00265	2.1	0.0146	11.7	0.035	28.0	0.015	12.0	0.02	16.0
4.	Catalysts and chemical products				0.5		1.5		1.5		1.5		1.5		1.5
5.	Labour and supervision				4.5		4.5		4.5		4.5		4.5		4.5
6.	Capital costs				18.1		19.6		19.6		19.6		19.6		19.6
	Total				40.3		43.7		53.3		69.6		53.6		57.6
7.	Contingencies				2.0		2.2		2.7		3.5		2.7		2.9
I.	Workshop price				42.3		45.9		56.0		73.1		56.3		60.5
8.	Indirect costs, general expenses, selling costs***				4.2		4.6		5.6		7.3		5.6		6.1
II.	Cost price				46.5		50.5		61.6		80.4		61.9		66.6
9.	Profit after the payment of taxes				7.0		7.6		7.6		7.6		7.6		7.6
10.	Profit before the payment of taxes****				11.7		12.7		12.7		12.7		12.7		12.7
III.	Selling price				58.2		63.2		74.3		93.1		74.6		79.3
	Estimated import price (c.i.f.)							55 - 65							

* Chemical consumption and fuel consumption

** In accordance with the present price of electrical energy (Version I) and the estimated price for the future (Version II)

*** 10 per cent of the workshop price

**** 10 per cent of the fixed investment

Carbide oxide is obtained as a secondary product (0.37 of a ton per ton of carbide). It may be used as heating gas.

Table 44 represents investment, raw material and all expenses connected with the production of calcium carbide for a factory of 8,000 tons per annum, depending on the location in mind (Dahomey) and other possible sites.

TABLE 43

Demand for calcium carbide in 1964 and estimates for 1965, 1970, 1975 and 1980

(Quantities in tons)

Countries	1964	1965	1970	1975	1980
Nigeria	2,205	2,360	3,300	4,650	6,500
Niger	4	6	25	50	100
Dahomey	210	225	320	440	620
Togo	96	110	150	210	300
Total first region	2,515	2,701	3,795	5,350	7,520
Ghana	1,360	1,455	2,000	2,800	4,000
Ivory Coast	520	560	780	1,100	1,500
Upper Volta	70	75	100	150	210
Total second region	1,950	2,090	2,880	4,050	5,710
Guinea	250	270	380	530	740
Sierra Leone	147	160	230	320	440
Liberia	150	160	230	320	440
Total third region	547	590	840	1,170	1,620
Gambia	-	1	5	15	30
Senegal	400	430	600	840	1,200
Mauritania	1	2	10	25	50
Mali	70	75	100	150	210
Total fourth region	471	508	715	1,030	1,490
General total	5,483	5,889	8,230	11,600	16,340

TABLE 44

Cost of the production of a ton of calcium carbide

(in dollars)

			Nigeria		Dahomey*				Ghana		Guinea*				Senegal	
					V.I		V.II				V.I		V.II			
Capacity t/year			8,000		8,000		8,000		8,000		8,000		8,000		8,000	
Investment (US$1,000)			1,900		1,900		1,900		1,900		1,900		1,900		1,900	
	Item	Units	Quantity	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1.	Quick lime	t	1.0	20	20.0	20	20.0	20	20.0	20	20.0	20	20.0	20	20.0	20	20.0
2.	Coke	t	0.65	30	19.5	30	19.5	30	19.5	30	19.5	30	19.5	30	19.5	30	19.5
3.	Electricity	kWh	3.400	0.013	44.2	0.068	230.0	0.004	13.6	0.00265	8.7	0.035	119.0	0.015	51.0	0.02	68.0
4.	Electrode	t	0.02	250	5.0		5.0		5.0		5.0		5.0		5.0		5.0
5.	Packing				10.0		10.0		10.0		10.0		10.0		10.0		10.0
6.	Labour and supervision				4.0		4.0		4.0		4.0		4.0		4.0		4.0
7.	Capital costs				36.0		36.0		36.0		36.0		36.0		36.0		36.0
	Total				138.7		324.5		108.1		103.2		213.5		145.5		162.5
8.	Contingencies				6.9		16.2		5.4		5.2		10.7		7.3		8.1
I.	Workshop price				145.6		340.7		113.5		108.4		224.2		152.8		170.6
9.	Indirect expenses, general expenses, selling costs**				7.1		7.1		7.1		7.1		7.1		7.1		7.1
II.	Cost price				152.7		347.8		120.6		115.5		231.3		159.9		177.7
10.	Profits after payment of taxes				14.3		14.3		14.3		14.3		14.3		14.3		14.3
11.	Profits before payment of taxes***				23.8		23.8		23.8		23.8		23.8		23.8		23.8
III.	Selling price				176.5		371.6		144.4		139.3		255.1		183.7		201.5

Estimated import price (c.i.f.) 140

* In accordance with the present price of electrical energy (Version I) and the estimated price for the future (Version II)

** 3 per cent of fixed investment

*** 10 per cent of fixed investment

III. 6. Fertilizers

(a) Demand and capacity to be installed

Up to the present time, fertilizer consumption in West Africa is concentrated rather more upon simple superphosphates and ammonium sulphate because these products contain sulphur which the soil in West Africa requires, are not hygroscopic, can be mixed without difficulty, have been used for a long time now, and are well known.

All these advantages compensate the disadvantages of these products, which contain few nutritive substances, and thus entail relatively high transport costs.

In French-speaking States use is also made of dicalcium phosphate which contains 40 to 48 per cent phosphoric anhydride (P_2O_5) insoluble in water, but soluble in citric acid. Although it is claimed that its basic reaction is of advantage to acid soils, particularly lateritic soils, its sulphur content is very low and this is a disadvantage.

Dicalcium phosphorus is however produced by heating rock phosphate with hydrochloric acid. Table 41 clearly shows that the electrolytic production of chlorine is very expensive and the price of hydrochloric acid estimated on the basis of chlorine is definitely high. In such conditions, it is impossible to envisage the setting up of a dicalcium phosphate factory which is likely to give economic returns. Moreover the fertilizer obtained is one that can be assimilated only slowly, and its use is of limited application.

The use of hydrochloric acid to manufacture dicalcium phosphate may be justified in exceptional circumstances, for instance, in assessing its value as a by-product from some other kind of manufacture.

Inasmuch as the consumption of phosphate fertilizers is already high, and transport costs go up as soon as these fertilizers are delivered to remote areas, the production of triple superphosphate should also be borne in mind, particularly as triple superphosphate can be produced in a simple superphosphate plant, once a unit of phosphoric acid has been set up.

The other products which are worth bearing in mind in future would seem to be N-P binary fertilizers such as ammonium phosphates, ammoniated superphosphates, mono-ammoniac phosphates, di-ammoniac phosphates, polyphosphates of ammonium and urea.

The principle of associating two fertilizing elements in a single manufacture would seem to be particularly advantageous. It makes it possible to obtain more concentrated types of fertilizers without any intermediary manipulation and to lower the unit price of manufacture by the simultaneous valorization of two useful products. That is why binary fertilizers for some years now have been expanding considerably in all the industrialized countries.

It should also be pointed out that most of the N-P fertilizer production chains admit of the addition of potassium in the course of manufacture.

Among the solid nitrogenous fertilizers, urea has the stronger nitrogenous content (46 per cent). The main characteristics of urea are:

- high solubility;
- ease in stocking and manipulation;
- non-explosive qualities.

On the other hand, the difficulty in using these very highly concentrated products in regions where experience is lacking in the field of fertilizers, should continue, in the first instance, to preserve the popularity of the more conventional forms of fertilizer like sulphate of ammonium.

A detailed analysis of present demands for fertilizers and the estimated demands for the future are set out for each of the West African States in the Annex.

The results of this analysis for the whole of the sub-region are indicated in Tables 45, 46 and 47.

TABLE 45

Demand for Nitrogenous fertilizers in 1964 and estimates for 1965, 1970, 1975 and 1980

(Quantities in tons of N)

Countries	1964	1965	1970	1975	1980
Nigeria	2,270	3,500	12,900	27,400	43,600
Niger	36	50	500	1,500	3,000
Dahomey	100	140	500	1,500	3,000
Togo	50	80	500	1,500	3,000
Total first region	2,456	3,770	14,400	31,900	52,600
Ghana	800	1,000	6,600	13,000	25,000
Ivory Coast	2,500	5,000	9,000	17,000	33,000
Upper Volta	100	160	500	1,500	3,000
Total second region	3,400	6,160	16,100	31,500	61,000
Guinea	1,600	1,700	3,000	6,000	12,000
Sierra Leone	100	150	1,000	2,000	4,000
Liberia	300	600	1,000	2,000	4,000
Total third region	2,000	2,450	5,000	10,000	20,000
Gambia	20	40	300	600	1,200
Senegal	2,620	3,000	8,000	16,000	24,000
Mauritania	350	420	750	1,500	3,000
Mali	500	600	1,500	3,000	6,000
Total fourth region	3,490	4,060	10,550	21,100	34,200
Grand total	11,346	16,440	46,050	94,500	167,800
N for explosives			1,600	2,300	3,200
Total N			47,650	96,800	171,000
Over-all demand expressed in tons of NH_3			58,000	117,000	210,000
In accordance with document E/CN.14/INR/70/Rev.1 total N			53,000	144,000	314,000

TABLE 46

Demand for Phosphate fertilizers in 1964 and estimates for 1965, 1970, 1975 and 1980

(Quantities in tons of P_2O_5)

Countries	1964	1965	1970	1975	1980
Nigeria	2,770	4,120	15,000	34,300	58,000
Niger	33	60	1,000	3,000	6,000
Dahomey	100	160	500	1,500	3,000
Togo	50	80	500	1,500	3,000
Total first region	2,953	4,420	17,000	40,300	70,000
Ghana	500	700	8,700	16,000	30,000
Ivory Coast	1,400	1,800	7,000	13,000	25,000
Upper Volta	100	160	500	1,500	3,000
Total second region	2,000	2,660	16,200	30,500	58,000
Guinea	2,000	2,000	3,500	6,000	12,000
Sierra Leone	200	250	1,000	2,000	4,000
Liberia	500	600	1,000	2,000	4,000
Total third region	2,700	2,850	5,500	10,000	20,000
Gambia	-	30	300	600	1,200
Senegal	5,900	6,000	12,000	24,000	36,000
Mauritania	-	30	100	300	900
Mali	300	400	1,200	2,400	6,000
Total fourth region	6,200	6,460	13,600	27,300	44,100
Grand total	13,853	16,390	52,300	108,100	192,100
In accordance with document E/CN.14/INR/70/Rev.1			57,000	141,000	307,000

TABLE 47

Demand for Potassium fertilizers in 1964 and estimates for 1965, 1970, 1975 and 1980

(Quantities in tons of K_2O)

Countries	1964	1965	1970	1975	1980
Nigeria	1,960	3,030	9,500	19,400	29,500
Niger	20	40	500	1,500	3,000
Dahomey	200	300	1,000	3,000	6,000
Togo	50	80	500	1,500	3,000
Total first region	2,230	3,450	11,500	25,400	41,500
Ghana	900	1,100	6,700	13,000	25,000
Ivory Coast	5,300	7,000	13,000	23,000	43,000
Upper Volta	100	160	500	1,500	3,000
Total second region	6,300	8,260	20,000	37,500	71,000
Guinea	1,600	1,700	3,000	6,000	12,000
Sierra Leone	100	150	1,000	2,000	4,000
Liberia	300	500	1,000	2,000	4,000
Total third region	2,000	2,350	5,000	10,000	20,000
Gambia	-	30	300	600	1,200
Senegal	3,350	4,000	8,000	16,000	24,000
Mauritania	-	30	100	300	900
Mali	-	200	800	1,600	4,000
Total fourth region	3,350	4,260	9,200	18,500	30,100
Grand total	13,880	18,320	45,900	91,400	162,600
In accordance with document E/CN.14/INR/70/Rev.1			52,000	137,000	287,000

The kinds of products, the various locations of the production units and the capacity envisaged for each stage is as follows:

Phosphate Fertilizers (in tons)

	1968-1969	1973-1974	1977-197
Supersimple (18 per cent P_2O_5)			
Togo	180,000 (32,400 t of P_2O_5)	180,000 (32,400 t of P_2O_5)	180,000 (32,40 of P_2
Mali	-	55,000 (9,900 t of P_2O_5)	55,000 (9,900 of P_2
Supertriple (46 per cent of P_2O_5)			
Togo	-	100,000 (46,000 t of P_2O_5)	200,000 (98,00 of P_2
Senegal	45,000 (20,700 t of P_2O_5)	85,000 (39,100 t of P_2O_5)	135,000 (62,10 of P_2
Total of P_2O_5	53,100	127,400	200,40

(Nitrogenous fertilizers (in tons)

	1968-1969	1973-1974	1977-197
Ammonium sulphate (21 per cent N)			
Nigeria	225,000 (47,240 t of N)	225,000 (47,250 t of N)	225,000 (47,2 of N)
Ghana*	-	225,000 (47,250 t of N)	225,000 (47,2 of N)
Senegal*	-	-	225,000 (47,2 of N)
Total of N	47,250	94,500	141,7

* The production of ammonium sulphate has been taken into consideration only for purposes of calculation. According to a more detailed study, it may be replaced by urea or ammonium phosphates (see also page 117).

In the present study imports of potassium fertilizers have been envisaged.

(b) Simple superphosphate

Simple superphosphate is obtained by the decomposition of raw phosphates under the action of sulphuric acid.

The main reaction of sulphuric acid on natural phosphate is to change tricalcic into monocalcic theoretically:

$$Ca_3 (PO_4)_2 + 2\ H_2SO_4 \longrightarrow Ca\ H_4 (PO_4)_2 + 2\ CaSO_4$$

In actual fact, the mixture obtained has about 30 per cent monocalcic phosphate in it, 10 per cent dicalcic, 45 per cent calcium sulphate, the rest consisting of humidity and phosphate impurities (Fe, Al, etc.) more or less in a converted form. These products develop slowly when stocked before achieving a stable form. The interesting point is the fact that the final product contains 16 - 22 per cent of P_2O_5 which is assimilable (depending upon the origin of the phosphate) the major portion of which in excess of 90 per cent is soluble in water. On the other hand, the presence of sulphur is appreciated in most types of cultivation.

The modern installations are constantly in operation and include the following:

- a plant for breaking up the raw phosphate;
- a reaction plant (acidulation);
- bagging plant.

In Table 48 will be found investments, raw materials and all production costs for simple superphosphate in connexion with the factories envisaged.

(c) Triple superphosphate

Triple superphosphate is obtained by treating rock phosphate with phosphoric acid:

$$Ca_3 (PO_4)_2 + 4\ H_3PO_4 \longrightarrow 3\ Ca\ H_4 (PO_4)_2$$

TABLE 48

Cost of the production of a ton of simple superphosphate

(in dollars)

Capacity (ton/year)				Togo 180,000		Mali 55,000	
Investment (US$1,000)				1,100		600	
	Item	Units	Quantity	Price	Value	Price	Value
1.	Rock phosphates	t	0.63	11	6.9	11	6.9
2.	Sulphuric acid (monohydrate)	t	0.37	18.6	6.9	26.4	9.8
3.	Electricity	kWh	30	0.048	1.4	0.061	1.8
4.	Packing	sac	40	0.1	4.0	0.11	4.4
5.	Labour & supervision				0.7		1.2
6.	Capital costs				0.9		1.6
	Total				20.8		25.7
7.	Contingencies				1.0		1.3
I.	Workshop price				21.8		27.0
8.	Indirect costs, general expenses, selling costs x/				2.2		2.7
II.	Cost price				24.0		29.7
9.	Profits after payment of taxes				2.2		3.7
10.	Profits before payment of taxes xx/				3.6		6.1
III.	Selling price				27.6		35.8
Estimated import price (c.i.f.):						45.0	

x/ 10 per cent of the workshop price.

xx/ 30 per cent of the fixed investment (supersimple + sulphuric acid)

In actual fact, a portion of the phosphate impurities is attacked by the phosphoric acid: fluoride and calcium chloride, lime, iron oxides, alumina etc. and in the final product will be found soluble salts introduced by H_3PO_4, particularly if this acid is prepared by the wet process. The "supertriple" content therefore depends on the richness of the phosphates and the purity of the acid used (practically 47 per cent of the total P_2O_5 with 34 per cent phosphate and wet acid.

The phosphate attack is never complete, and there is about 2 per cent insoluble phosphate, which reduces the content to 46 per cent of assimilable P_2O_5.

A modern triple superphosphate plant is made up of the following units:

- a unit designed to break up the rock phosphate;
- acidulation (with phosphoric acid);
- processing;
- a contrivance for packing in bags.

The product can be sold in powder after it has been broken up or granulated in an appropriate plant. If the triple superphosphate should be applied to a mixture, it is advisable to have it granulated. Granulation is not envisaged in the present study.

Investments, raw materials and all triple superphosphate production costs for the first units envisaged in Togo and Senegal are indicated in Table 39.

(d) Ammonium sulphate

Ten years ago ammonium sulphate was entirely a by-product from the manufacture of coke, due to the action of the ammonia in coal gas on sulphuric acid. At present, having regard to the increase in size of ammonia units, the sulphate is manufactured by direct neutralization of the sulphuric acid through synthetic ammonia. The following reaction can be observed:

$$H_2SO_4 + 2NH_3 \longrightarrow (NH_4)_2 SO_4$$

TABLE 49

Cost of the production of a ton of triple superphosphate

(in dollars)

Capacity (ton/year) Investment (US$1,000)			Togo 100,000 930		Senegal 45,000 590	
Item	Units	Quantity	Price	Value	Price	Value
1. Rock phosphate (37% of P_2O_5)	t	0.32	11	3.5	11	35
2. Phosphoric acid (40% of P_2O_5)	t	0.36	109.0	39.2	108.8	39.2
3. Electricity	kWh	60	0.048	2.9	0.02	1.2
4. Fuel oil	t	0.09	20	1.8	20	1.8
5. Packing	sac	40	0.25	10.0	0.25	10.0
6. Labour and supervision				1.4		2.5
7. Capital costs				1.5		3.0
Total				60.3		61.2
8. Contingencies				3.0		3.1
I. Workshop price				63.3		64.3
9. Indirect costs, general expenses, selling costs x/				2.3		3.0
II. Cost price				65.6		67.3
10. Profits after payment of taxes				5.5		7.2
11. Profits before payment of taxes xx/				9.1		12.0
III. Selling price				74.7		79.3
Estimated import price (c.i.f.):					85.0	

x/ 5 per cent of the fixed investment (supertriple + phosphoric acid)

xx/ 20 per cent of the fixed investment (supertriple + phosphoric acid)

Since ammonia and sulphuric acid react directly, the ammonium sulphate is crystallized, separated by centrifugal force, and then dried and cooled.

The production plant consists of the following units:

- ammonia evaporation;
- saturator;
- crystallizator;
- drying tower including the cauldron;
- cooling room.

Investments, raw materials and other elements in production cost for a unit of 225,000 tons/year of ammonium sulphate depending on the various locations are given in Table 50.

III. 7. Explosives

(a) Demand and capacity to be installed

It is proposed to produce industrial explosives with oil-bound ammonium nitrate, "ANFO" explosive.

Up to the end of the second world war, the main customer for ammonium nitrate was the explosives industry. It was not much used as fertilizer because of its resemblance to water. This problem was solved by producing crystals of uniform thickness and wrapping them round with clay or kieselguhr.

Nowadays the grains of ammonium nitrate are used as fertilizers. Since they possess the acid function which is suitable for dry regions and calcareous soils, and at the same time the basic function which is of interest in rainy areas, they can be used in all circumstances. Typical ammonium nitrate compounds contain 34.5; 27.5 and 20.5 per cent nitrogen. However, they are relatively dangerous to handle in concentrated form, because an organic contamination can produce a serious explosion.

The annex contains a very detailed study of the demand for explosives for each State. The figures for the whole of the sub-region have been grouped together in Table 51.

TABLE 50

Cost of the production of a ton of ammonium sulphate

(in US$)

			Nigeria		Ghana		Ivory Coast		Guinea* V.I		Guinea* V.II		Senegal	
Capacity (tons per year)			225,000		225,000		225,000		225,000		225,000		225,000	
Investment (US$1,000)			1,200		1,200		1,200		1,200		1,200		1,200	
	Description	Units	Quantity	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1.	Ammonium	t	0.26	42.3	11.0	45.9	11.9	56.0	14.6	73.1	19.0	56.3	14.6	60.5	15.7
2.	Sulphuric acid (98%)	t	0.77	16.4	12.6	16.1	12.4	16.4	12.6	17.1	13.2	16.5	12.7	16.2	12.5
3.	Electricity	kWh	30	0.013	0.4	0.00265	0.1	0.0146	0.4	0.035	1.1	0.015	0.5	0.02	0.6
4.	Packing	sac	40	0.1	4.0		4.0		4.0		4.0		4.0		4.0
5.	Labour and supervision				2.3		2.3		2.3		2.3		2.3		2.3
6.	Capital costs				0.8		0.8		0.8		0.8		0.8		0.8
	Total				31.1		31.5		34.7		40.4		34.9		35.9
7.	Contingencies				1.6		1.6		1.7		2.0		1.7		1.8
I.	Workshop price				32.7		33.1		36.4		42.4		36.6		37.7
8.	Indirect costs, general expenses, selling costs**				3.3		3.3		3.6		4.2		3.7		3.8
II.	Cost price				36.0		36.4		40.0		46.6		40.3		41.5
9.	Profits after payment of taxes				3.6		3.8		3.8		3.8		3.8		3.8
10.	Profits before payment of taxes***				6.0		6.4		6.4		6.4		6.4		6.4
III.	Selling price				42.0		42.8		46.4		53.0		46.7		47.9

Estimated import price (c.i.f.) 50

* In accordance with the present price of electrical energy (Version I), and the estimated price for the future (Version II)

** 10 per cent of the fixed investment (NH_3 + H_2SO_4 + ammonium sulphate)

*** 13.7 per cent of the fixed investment (NH_3 + H_2SO_4 + ammonium sulphate)

TABLE 51

Demand for Explosives in 1964 and estimates for 1965, 1970, 1975 and 1980

(quantities in tons)

Countries	1964	1965	1970	1975	1980
Nigeria	1,751	1,840	2,340	3,000	3,800
Niger	8	10	20	40	80
Dahomey	150	160	230	320	440
Togo	54	59	100	150	250
Total first region	1,963	2,069	2,690	3,510	4,570
Ghana	2,482	2,600	3,350	4,300	5,500
Ivory Coast	54	58	80	110	160
Upper Volta	77	82	120	160	230
Total second region	2,613	2,740	3,550	4,570	5,890
Guinea	1,200	1,280	1,800	2,500	3,500
Sierra Leone	198	210	300	420	580
Liberia	400	430	600	840	1,210
Total third region	1,798	1,920	2,700	3,760	5,290
Gambia	16	20	40	80	160
Senegal	56	62	100	160	230
Mauritania	300	320	450	630	890
Mali	6	6	15	30	60
Total fourth region	378	408	[illegible]	900	[illegible]
Grand total of which:	3,752	7,137	9,545	12,740	17,120
NH_4NO_3 (55% of the Grand total)	3,700	3,900	5,200	7,000	9,400

In the present report, the following capacities of "ANFO" oil-bound ammonium nitrate are envisaged:

	1970	1975	1980
Nigeria	7,000	7,000	10,000

More detailed studies suggest that in future, new units based either on ammonium nitrate, dynamite, gelignite, or other explosive materials may be contemplated.

(b) Ammonium nitrate

The manufacture of nitrate is practically bound up with the manufacture of nitric acid, for which it provides a regulating market in integrated factories. All that is necessary is to neutralize the acid by using ammonia on an addition reaction basis as follows:

$$H\,NO_3 + NH_3 \longrightarrow NH_4NO_5$$

There are several processes, continuous or discontinuous, in which heat when rel.ased vaporizes part of the water. The product is dried and granulated by various techniques, the most modern being vacuum evaporation. The manufacture of explosives for immediate use, is carried out by mixing ammonium nitrate with small quantities of sawdust or cork fuel oil or diesel. As a rule, it is manufactured in the same plant which produces ammonium nitrate.

The processes followed in the industrial manufacture of nitric acid are based on the following stages:

Direct oxidation of ammonia by the action of air;

The absorption of NO_2 by water:

$$4\,NH_3 + 5\,O_2 \longrightarrow 4\,NO + 6\,H_2O$$

$$2\,NO + O_2 \longrightarrow 2\,NO_2$$

$$3\,NO_2 + H_2O \longrightarrow 2\,HNO_3 + NO$$

The NO nitrous oxide is brought back for a fresh operation. The over-all result of the reactions is 90 to 95 per cent, and this produces a diluted acid containing 60 per cent of HNO_3.

The BAMAG process, which uses platinum sheets as a catalyst and a low pressure, is now replaced by the Fauser process which operates at a pressure of 2.5 to 3 kg/cm^2 or by the Uhde process at a pressure 6 to 7 kg/cm^2.

A plant in constant operation, designed for the production of explosives with a liquid ammonia base, includes the following units:

- NH_3 vaporizator
- plant for the production of nitric acid (ventilator, NH_3 combustion plant, catalyst, absorption plant
- solution and condensation plant
- crystalizator
- mixer
- packing plant

According to Chemical and Engineering News (27 April 1964) the explosive force of ANFO can be increased 1.4 to 6.0 times, by the addition of aluminium (5 - 30 per cent in weight). Table 52 indicates investments, raw materials, and other factors of production cost for a unit of 7,000 tons per annum of ammonium nitrate, depending upon the different locations.

III. 8. Plastics

(a) Demand and capacity to be installed

As regards production capacity and rate of growth, the most important of the plastic group can be classified as follows:

- polyolefines: polyethylene
- vinylics : polyvinyl chloride
- polystyrenes

TABLE 52

Production cost of a ton of oil-bound ammonium nitrate: "ANFO" explosive

(in dollars)

Capacity (tons per year) Investment (US$1,000)			Nigeria 7,000 900		Ghana 7,000 900		Ivory Coast 7,000 900		V.I 7,000 900	Guinea*	V.II 7,000 900		Senegal 7,000 900	
Description	Units	Quantity	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1. Ammonia	t	0.43	42.3	18.2	45.9	19.7	56.0	24.1	73.1	31.4	56.3	24.2	60.5	26.0
2. Diesel	t	0.04	30.0	1.2	1.2	30.0	30.0	1.2	30.0	1.2	30.0	1.2	30.0	1.2
3. Chemical products & catalysts				1.0		1.0		1.0		1.0		1.0		1.0
4. Electricity	kWh	360	0.013	4.7	0.00265	1.0	0.0146	5.3	0.035	12.6	0.015	5.4	0.02	7.2
5. Packing				22.0		22.0		22.0		22.0		22.0		22.0
6. Labour and supervision				13.3		13.3		13.3		13.3		13.3		13.3
7. Capital costs				20.0		20.0		20.0		20.0		20.0		20.0
Total				80.4		78.2		86.9		101.5		87.1		90.7
8. Contingencies				4.0		3.9		4.3		5.1		4.4		4.5
I. Workshop price				84.4		82.1		91.2		106.6		91.5		95.2
9. Indirect expenses, general expenses, selling costs**				8.4		8.2		9.1		10.7		9.2		9.5
II. Cost price				92.8		90.3		100.3		117.3		100.7		104.7
10. Profits after the payment of taxes				21.4		22.0		22.0		22.0		22.0		22.0
11. Profits before the payment of taxes***				35.7		36.6		36.6		36.6		36.6		36.6
III. Selling price				128.5		126.9		136.9		153.9		137.3		141.3

Estimated import price (c.i.f.) 150

* According to the present Price for electrical energy (Version I) and the estimated price for the future (Version II)

** 10 per cent of the workshop price

*** 20 per cent of the fixed investment (NH_3 + NH_4NO_3)

Polyethylene is still the most important plastic in the United States. In Europe, in spite of the competition offered by vinyl polychloride it is likely to meet with the similar success.

The average annual rate of production growth from 1959 to 1963 was 27 per cent in the United States, 31 per cent in West Germany, and 38 per cent in France.

The world production envisaged for 1965 should rise to 2 million tons of low density polyethylene; in 1970, the production of low density polyethylene should reach 3,500,000 tons.

In 1962, the consumption per head of population was approximately as follows:

United States	4.2 kg per head of population
England	2.1 kg per head of population
France	1.9 kg per head of population
West Germany	1.8 kg per head of population

Polyethylene is used in making films for use in packing food, fresh vegetables, textiles, fragile products, toys and chemical products, ...

Other uses to which it may be put apart from packing, apply to agriculture and building: bedding and covering plants, the construction of silos, carpeting reservoirs on farms in order to avoid the loss of water by infiltration. Polyethylene sheets can be converted by thermo-forming into boxes of various sizes for packing or into other articles (refrigerator door panels, picnic trays etc.).

Because of its electrical and di-electrical features, polyethylene is used in the electrical industry. Polyethylene can be converted by bellows into bottles of very diverse shapes and forms, for storing pharmaceutical products, food, chemical products and cosmetics.

Polyethylene tubes are becoming increasingly popular for use on farms, in mines, houses, and the food industries, particularly for conveying cold water, milk, fruit juices, etc.

Polyethylene is placed on paper, cardboard, cellophane, polyester films, aluminium sheets, glass fibres, and fabrics. Materials made with polyethylene, are impervious to water vapour, flexible, endowed with an excellent degree of chemical inertia, are easily welded together under the influence of heat, are odorless, tasteless, and non-toxic.

High density polyethylene is well adapted to the manufacture of articles that need to be rigid, light, and heat resisting. It is well adapted also to non-friable chemical products used as cooking utensils (pails, spoons, cooking pans and sieves and in bathrooms (wash hand basins, and lavatory basins).

Polyvinyl chloride is at present one of the most important plastic materials in the world, from the stand point both of consumption and production. The market for plastic materials in Europe is dominated by polyvinyl chloride, whereas in the United States there is an almost equal balance between polyvinyl chloride, polyethylene and polystyrene.

From 1954 to 1961, the annual increase in production was on the average 26 per cent in France, and 13 per cent in the United States.

In 1962 the consumption per head of population in the different countries was as follows:

West Germany	3.6 kg per head of population
United States	3.1 kg per head of population
United Kingdom	2.7 kg per head of population
France	2.6 kg per head of population
Italy	2.2 kg per head of population
The Benelux countries	2.2 kg per head of population

It is not possible to draw up an exhaustive list of the uses to which PVC may be put, although the markets for this are developing every day. It is used in building (pipes, tubes, connexions for pipe-borne water, and distribution, for removing used water or very corrosive liquids, gutters, window frames, elements of shutters or blinds, corrugated roofing sheets, partitions etc.), in agriculture (for

lining water reservoirs, irrigation canals, for the rapid construction of green houses and silos etc.) for making garmets, industrial fabrics (special filters), curtains, table cloths, seat covers etc., for the manufacture of materials used in the chemical industry for stocking or transport (pumps, ventilators), corrosive acids, or liquids, in making receptacles for cooking oil, detergents, lubricating oils, fruit juice, wines, yoghourt etc. for soil dressing, linoleum, travelling articles, boots, toys, gramophone records, belt conveyors, covering for cables and electric wires, making packing material for foodstuffs and other articles etc.

Large quantities of polystyrene are used particularly in the United States. In 1962 the consumption per head of population was approximately as follows:

United States	3.2 kg per head of population
Great Britain	0.98 kg per head of population
France	1.07 kg per head of population

In 1963, packing accounted for approximately 13 per cent and 24 per cent of the consumption of polystyrene respectively, in the United States and Great Britain. It is used in electricity (partially or completely, TV frames or radio apparatus, battery wrappers, recording spools for magnetic tape recorders); in building (luminous screens, signs, tiling covering kitchen walls and bathrooms), for the production of refrigerator and ice box elements, for making domestic ventilators and different parts of air-conditioning apparatus, the manufacture of household articles and toys, etc.

In the present report production of polyethylene and polyvinyl chloride are envisaged as a possibility for West Africa.

The detailed analysis of the present demand for plastics, and future demand as far as the West African States are concerned, will be found in the Annex for each of the West African countries.

The results of this analysis for the whole of the sub-region are to be found in Tables 53, 54, 55, 56, 57 and 58.

TABLE 53

Demand for Plastic Materials in 1964 and estimates for 1965, 1970, 1975 and 1980

(Quantities in tons)

Countries	1964	1965	1970	1975	1980
Nigeria	4,167	5,620	17,200	42,700	106,400
Niger	281	380	1,160	3,540	10,800
Dahomey	160	195	530	1,400	3,800
Togo	106	132	400	1,200	3,000
Total first region	4,714	6,327	19,290	48,840	124,000
Ghana	1,314	1,780	7,900	19,700	39,700
Ivory Coast	4,229	5,250	12,000	19,000	30,600
Upper Volta	200	250	760	2,330	7,100
Total second region	5,743	7,280	20,660	41,030	77,400
Guinea	1,250	1,500	4,500	9,000	14,500
Sierra Leone	98	132	440	1,340	4,100
Liberia	100	120	300	700	1,800
Total third region	1,448	1,752	5,240	11,040	20,400
Gambia	2	4	50	200	500
Senegal	1,658	1,990	4,900	10,000	16,000
Mauritania	100	115	230	460	900
Mali	80	108	490	1,800	6,800
Total fourth region	1,840	2,217	5,670	12,460	24,200
Grand total	13,745	17,576	50,860	113,370	246,000

TABLE 54

Demand for Plastics Per Head of Population: Estimates for 1965, 1970, 1975 and 1980

(in kg)

Countries	1965	1970	1975	1980
Nigeria	0,10	0,25	0,54	1,17
The Niger	0,12	0,32	0,87	2,31
Dahomey	0,08	0,20	0,48	1,13
Togo	0,08	0,22	0,58	1,27
Total first region	0,97	0,26	0,56	1,22
Ghana	0,23	0,88	1,89	3,27
The Ivory Coast	1,37	2,83	4,01	5,68
The Upper Volta	0,05	0,15	0,41	1,11
Total second region	0,45	1,12	1,97	3,25
Guinea	0,43	1,16	2,08	2,88
Sierra Leone	0,05	0,15	0,40	1,12
Liberia	0,11	0,27	0,60	1,45
Total third region	0,24	0,66	1,25	2,05
Gambia	0,01	0,14	0,47	1,02
Senegal	0,57	1,30	2,41	3,46
Mauritania	0,16	0,30	0,56	1,01
Mali	0,02	0,10	0,32	1,05
Total fourth region	0,24	0,57	1,13	1,94
General total	0,18	0,45	0,88	1,66

TABLE 55

Demand for Polyethylene in 1964 and Estimates for 1965, 1970, 1975 and 1980

(Quantities in tons)

Countries	1964	1965	1970	1975	1980
Nigeria	1,000	1,250	4,500	12,000	28,000
The Niger	100	125	350	1,000	3,000
Dahomey	30	40	130	350	1,000
Togo	20	30	100	300	900
Total first region	1,150	1,445	5,080	13,650	32,900
Ghana	25	100	1,000	4,000	10,000
The Ivory Coast	1,700	2,000	3,000	5,000	8,000
The Upper Volta	40	60	200	650	2,200
Total second region	1,765	2,160	4,200	9,650	20,200
Guinea	-	-	800	1,300	2,100
Sierra Leone	20	30	120	350	1,200
Liberia	60	70	150	300	650
Total third region	80	100	1,070	1,950	3,950
Gambia	-	-	10	50	150
Senegal	250	300	1,400	3,000	5,000
Mauritania	20	23	60	120	270
Mali	20	25	130	500	2,000
Total fourth region	290	348	1,600	3,670	7,420
General total	3,285	4,053	11,950	28,920	64,470

TABLE 56

Demand for Polyethylene per Head of Population Estimated for 1965, 1970, 1975 and 1980

(in kg)

Countries	1965	1970	1975	1980
Nigeria	0,02	0,07	0,15	0,31
The Niger	0,04	0,10	0,24	0,64
Dahomey	0,02	0,05	0,12	0,30
Togo	0,02	0,05	0,15	0,38
Total first region	0,02	0,07	0,16	0,32
Ghana	0,01	0,11	0,38	0,82
The Ivory Coast	0,52	0,71	1,05	1,49
The Upper Volta	0,01	0,04	0,11	0,34
Total second region	0,13	0,23	0,46	0,84
Guinea	-	0,21	0,30	0,42
Sierra Leone	0,01	0,04	0.11	0,33
Liberia	0,07	0,14	0,26	0,52
Total third region	0,01	0,13	0,22	0,40
Gambia	-	0,03	0,12	0,31
Senegal	0,09	0,37	0,72	1,08
Mauritania	0,03	0,08	0,15	0,30
Mali	0,01	0,03	0,09	0,31
Total fourth region	0,04	0,15	0,33	0,79
General total	0,04	0,11	0,23	0,44

TABLE 57

Demand for PVC in 1964 and Estimates for 1965, 1970, 1975 and 1980

(Quantities in tons)

Countries	1964	1965	1970	1975	1980
Nigeria	2,000	2,500	6,000	13,000	28,000
The Niger	100	125	350	1,000	3,000
Dahomey	40	50	150	400	1,000
Togo	30	40	150	400	900
Total first region	2,170	2,715	6,650	14,800	32,900
Ghana	80	300	2,000	5,000	10,000
The Ivory Coast	1,700	2,200	4,000	6,000	9,000
The Upper Volta	60	80	240	720	2,200
Total second region	1,840	2,580	6,240	11,720	21,200
Guinea	1,000	1,150	1,850	3,000	4,850
Sierra Leone	30	40	130	400	1,200
Liberia	10	15	40	150	500
Total third region	1,040	1,205	2,020	3,550	6,500
Ganbia	-	-	20	70	150
Senegal	1,000	1,200	2,400	3,600	5,400
Mauritania	30	35	70	140	270
Mali	30	40	160	600	2,100
Total fourth region	1,060	1,275	2,650	4,410	7,920
General total	6,110	7,750	17,560	34,480	68,570

TABLE 58

Demand for PVC per Head of Population estimated for 1965, 1970, 1975 and 1980

(in kg)

Countries	1965	1970	1975	1980
Nigeria	0,04	0,09	0,17	0,31
The Niger	0,04	0,10	0,24	0,64
Dahomey	0,02	0,06	0,14	0,30
Togo	0,02	0,08	0,19	0,38
Total first region	0,04	0,09	0,17	0,32
Ghana	0,04	0,22	0,48	0,82
The Ivory Coast	0,57	0,94	1,27	1,67
The Upper Volta	0,02	0,05	0,13	0,34
Total second region	0,16	0,34	0,56	0,89
Guinea	0,33	0,48	0,69	0,96
Sierra Leone	0,01	0,04	0,12	0,33
Liberia	0,01	0,04	0,13	0,40
Total third region	0,17	0,25	0,40	0,65
Gambia	-	0,05	0,16	0,31
Senegal	0,35	0,64	0,87	1,17
Mauritania	0,05	0,09	0,17	0,30
Mali	0,01	0,03	0,11	0,32
Total fourth region	0,14	0,27	0,40	0,63
General total	0,08	0,16	0,27	0,46

The various locations for production units and the capacities envisaged for each stage are as follows:

Polyethylene (in tons)

	1974	1978	1979
The Ivory Coast	30,000	30,000	30,000
Nigeria	—	30,000	30,000
Total	30,000	60,000	60,000

Polyvinyle chloride (in tons)

	1971	1976	1979
Nigeria	20,000	20,000	40,000
Ghana	—	20,000	20,000
Total	20,000	40,000	60,000

(b) Polyethylene

Contrary to past or present general practice in the United States, where the production of ethylene first began with refined gas, liquid gas and ethane obtained from breaking up natural gas, ethylene in Europe and Japan was produced from the pyrolysis of naptha.

The production of ethylene from naptha outside the United States, is evaluated at 80 per cent, and the estimates foreshadow an increase in this proportion in the coming years.

In the present report, the production of ethylene from naptha (steam-cracking of naptha) has been envisaged.

The features of naptha have an appreciable influence on yields in ethylene and its by-products, the operative conditions in respect of cracking temperature, contact time and pressure being constant.

The valorization of its by-products has a considerable effect on the operative production costs of ethylene.

Bearing in mind the manufacturing processes, it has become customary to separate polyethylene into high-pressure polyethylene (or low-density polyethylene) and low-pressure polyethylene (or high-density polyethylene). Low-pressure polyethylene has a greater density, and it is more rigid than high-pressure polyethylene.

In this report account has been taken in the first stage of high-pressure polyethylene production. In the following stages, the possibilities of manufacturing low-pressure polyethylene may be examined.

The production of polyethylene from naptha, and polyethylene by means of polymerization, calls for the following operations and partial procedures:

- volatization of naptha
- steam cracking of naptha
- (quick cooling of the gas obtained
- separation of the gas
- ethylene compression;
- polymerization
- separation of circular gas
- granulation
- putting into bags

Investments, raw materials and other elements in the production cost for a unit of 30,000 tons per year of polyethylene, depending on the different locations, are given in Table 59.

TABLE 59

Cost of the production of a ton of high-pressure polyethylene

(in US$)

			Nigeria		Ghana		Guinea I/ V.I.		Guinea I/ V.II		Ivory Coast		Senegal	
Capacity (tons per year)			30,000		30,000		30,000		30,000		30,000		30,000	
Investments (US$1,000)			23,000		23,000		23,000		23,000		23,000		23,000	
	Items	Units	Quantities	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1.	Naphtha	T	3.84	20	76.8	20	76.8	20	76.8	20	76.8	20	76.8	20	76.8
2.	Catalysts & chemical products				22.0		22.0		22.0		22.0		22.0		22.0
3.	Electricity	kWh	3,000	0.013	39.0	0.00265	8.0	0.035	105.0	0.015	45.0	0.0146	43.8	0.02	60.0
4.	Labour and supervision				12.0		12.0		12.0		12.0		12.0		12.0
5.	Capital costs				119.0		119.0		119.0		119.0		119.0		119.0
6.	Credit for by-products intended for sale				-25.0		-25.0		-25.0		-25.0		-25.0		-25.0
	Total				243.8		212.8		309.8		249.8		248.6		264.8
7.	Contingencies				12.2		10.6		15.5		12.5		12.4		13.2
I.	Workshop price				256.0		223.4		325.3		262.3		261.0		278.0
8.	General expenditure, indirect expenditure, selling costs II/				25.6		22.3		32.5		26.2		26.1		27.8
II.	Cost price				281.6		245.7		357.3		288.5		287.1		305.8
9.	Profits after payment of taxes				69.0		69.0		69.0		69.0		69.0		69.0
10.	Profits before payment of taxes III/				115.0		115.0		115.0		115.0		115.0		115.0
III.	Selling price				396.6		360.7		472.3		403.5		402.1		420.8

Estimated import price (c.i.f.) 430 - 500

I/ According to the present price of electrical energy (Version I) and the estimated price for the future (Version II).

II/ 10 per cent of workshop price.

III/ 15 per cent of the fixed investment.

(c) Polyvinyle chloride

Polyvinyle chloride is produced by the polymerization of vinylic chloride.

There are three main methods of preparing vinyle chloride. The first is by a combination of hydro-chloric acid and acetylene. The second starts with chlorine and ethylene, the dichloro-ethane produced is then broken up by thermal force thus producing vinyle chloride and hydro-chloric acid.

Because of the fact that the price of coal and electricity is always on the increase, the production process for acetylene based on calcium carbide is now less attractive, and the expansion of acetylene production will in future be based on natural gas and naptha.

Consequently vinyle chloride may be produced from a mixture of acetylene and ethylene, directly derived from a unit of naptha pyrolyosis.

This last process has been envisaged in the present report.

According to the Kurcha process, by cracking the naptha thermally, one can obtain a gaseous mixture of 50-53 per cent acetylene, 47-50 per cent ethylene, carbon oxide, hydrogen and other hydro-carbon fuels. The latter are separated from the mixture and the gas is purified containing only acethylene or ethylene. After reaction with chlorine and a series of preparatory stages, monomere is obtained. The advantage of this process is that there is no hydro-chloric acid as a by-product, and the escaping gas can be used as heating gas in the cracking operation.

The following plant must be provided for the production process:

- cracking plant
- oxygen-producing plant
- compression and gas-cleansing plant
- acetylene reaction plant
- ethylene reaction plant
- plant for separating and purifying vinyle
- polymerization plant including refrigeration, dehydration, and drying
- granulating plant

In Table 60 will be found investment costs, expenditure in connexion with staff, capital, raw materials and all production expenses for a unit for 20,000 tons per year of polyvinyle chloride based on the pyrolysis of naptha for the various locations.

Another procedure based on acetylene which uses methane (as a natural gas) or other gaseous hydro-carbon fuels, but allows for smaller fractions of naptha, is at present being worked out in the United States (under the direction of Professor Othmer and his team), as well as in other countries. As the operations only produce a single gaseous current which contains acetylene, hydrogen and methane, (when methane is used initially), the costly plant for separating gaseous products is unnecessary, and this will have the effect of reducing equipment expenditure. If the process is commercially feasible, this diminution in joint expenditure for plant coupled with the proceeds from the possible sale of hydrogen to a nitrogenous fertilizer factory, with which the acetylene factory in Nigeria might be integrated, would make it possible for acetylene to be obtained at a lower cost price than is possible at present with any of the other processes in use. As this new process is particularly important for the developing countries, it would be suitable, at the pre-investment stage in our investigations, to take this into consideration as a possible process.

It must also be added that according to Chemical and Engineering News (V.44, No. 24, 13 June 1966) the application of the new Pechiney - St. Gobain mass vinylic chloride polymerization (two-step bulk polymerization or solventless process) may reduce the fixed investment and the production cost of PVC.

TABLE 60

Cost of the production of a ton of polyvinyl chloride (in US$)

			Nigeria		Ghana		Guinea[x] V.I.		Guinea[x] V.II.		Senegal		Ivory Coast	
Capacity (tons per year)			20,000		20,000		20,000		20,000		20,000		20,000	
Investment (US$1,000)			6,200		6,200		6,200		6,200		6,200		6,200	
	Items	Units	Quantities	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1.	Naphtha	T	0.93	20	18.6	20	18.6	20	18.6	20	18.6	20	18.6	20	18.6
2.	Chlorine	T	0.615	91.4	56.2	63.4	39.0	133.6	82.2	90.6	55.7	91.4	56.2	88.7	54.6
3.	Catalysts and chemical products				12.0	12.0	12.0		12.0		12.0		12.0		12.0
4.	Fuel	T	0.3	20	6.0	20	6.0	20	6.0	20	6.0	20	6.0	20	6.0
5.	Electricity	kWh	850	0.013	11.1	0.00265	2.3	0.035	29.8	0.015	12.8	0.02	17.0	0.0146	12.4
6.	Labour and supervision				15.0		15.0		15.0		15.0		15.0		15.0
7.	Capital expenditure				46.0		46.0		46.0		46.0		46.0		46.0
	Total				164.9		138.9		209.6		166.1		170.8		164.6
8.	Contingencies				8.2		6.9		10.5		8.3		8.5		8.2
I.	Workshop price				173.1		145.8		220.1		174.4		179.3		172.8
9.	Indirect expenses, general expenses, selling costs [xx]				17.3		14.6		22.0		17.4		17.9		17.3
II.	Cost price				190.4		160.4		242.1		191.8		197.2		190.1
10.	Profits after payment of taxes				60.0		60.0		60.0		60.0		60.0		60.0
11.	Profits before payment of taxes [xxx]				100.0		100.0		100.0		100.0		100.0		100.0
III.	Selling price				290.4		260.4		342.1		291.8		297.2		290.1

Import price (c.i.f.) 400 - 450

[x] According to the present price of electrical energy (Version I) and the estimated price for the future (Version II).

[xx] 10 per cent of the workshop price.

[xxx] 25 per cent of the fixed investment (Cl_2 + PCV).

III. 9. Pesticides

(a) Demand and capacity to be installed

In West Africa, pesticides are a fairly considerable and steadily progressive market. They deal with products that are of interest not only to housewives but also to the health, agricultural and animal husbandry services, etc.

The most consistent users of pesticides are the hygiene and agricultural services which control malaria, yellow fever and other endemic diseases or protect the crops from attack by insects or mushroom fungoids.

Pesticides are offered on the market in the shape of a number of products, whose names it is impossible to remember.

Nevertheless, in this multitudinous variety, three important groups may be distinguished:

- hydrocarbide chlorides
- organic compounds of phosphoric acid
- N-alkyles - carbonates

When insect control began on a large scale, the first successes were scored by the use of hydrocarbide chlorides in particular.

Owing to their low price and the extensive use made of them, the products in the first group topped the consumption list.[1/]

1/ According to information received from the companies that sell pesticides in West Africa, a new insecticide "sevin" (1-naphthyl N-methylcarbonate) may in future play a very important role alongside DDT and BHC.

DDT and BHC have assumed importance because of the following advantages:

- DDT and BHC are cheaper than the products in the second or third groups.
- DDT is not as toxic as the organic compounds of phosphoric acid, and for this reason does not present any danger to the user,
- DDT and BHC offer a wide range of activity,
- When DDT and BHC can be mixed easily, there are other possible uses to which they may be applied,
- The application of DDT and BHC does not require experts, as is the case in organic compounds of phosphoric acid.

The production of DDT and BHC is relatively easy.

It is not necessary to go to the trouble of taking a lot of safety precautions in the production of DDT and BHC.

The production of DDT and BHC does not require as many raw materials as the production of phosphoric acid organic compounds, which makes the supply of that product easier.

It is difficult to determine the effective consumption of BHC and DDT in the various countries of West Africa for the following reasons:

- The gross purchases of insecticide relate to control campaigns against a given parasite that attacks men, animals or plants. These campaigns are often undertaken at odd moments and are not always repeated every year.
- Statistics of imports make no distinction between the various products.
- The fact that BHC and DDT concentrates are not specified in the products imported, makes it impossible to evaluate the quantity.

In these circumstances, the needs in pesticides have been determined separately for each country in the annex with the help of secondary statistical material, and personal investigations made with the competent authorities.

The results of this study are shown for each of the sub-regions in Tables 61, 62 and 63.

TABLE 61

Demand for Pesticides in 1964 and estimates for 1965, 1970, 1975 and 1980

(Quantities in tons)

	1964	1965	1970	1975	1980
Nigeria	7,716	9,000	14,500	23,300	37,600
The Niger	379	800	1,600	3,200	6,400
Dahomey	129	150	220	440	880
Togo	56	70	140	280	550
Total first region	8,280	10,020	16,460	27,220	45,430
Ghana	3237	3,625	6,387	11,260	19,830
The Ivory Coast	1,694	2,838	4,500	5,900	10,000
The Upper Volta	160	250	600	1,200	2,400
Total second region	5,091	6,713	11,487	18,360	32,230
Guinea	1,000	2,200	3,600	6,000	9,500
Sierra Leone	75	100	200	400	800
Liberia	60	70	140	280	560
Total third region	1,135	2,370	3,940	6,680	10,860
Gambia	2	3	20	50	120
Senegal	1,524	1,800	3,000	4,500	8,000
Mauritania	50	60	120	240	480
Mali	350	500	1,000	2,000	4,000
Total fourth region	1,926	2,363	4,140	6,790	12,600
General total	16,432	21,466	36,027	59,050	101,120

TABLE 62

Demand for BHC (25%) in 1964 and estimates for 1965, 1970, 1975 and 1980

(Quantities in tons)

Countries	1964	1965	1970	1975	1980
Nigeria	800	1,000	2,700	6,500	12,000
The Niger	150	300	600	1,200	2,400
Dahomey	40	50	80	160	300
Togo	20	24	50	100	200
Total first region	1,010	1,374	3,430	7,960	14,900
Ghana	1,000	1,200	2,100	4,000	6,000
The Ivory Coast	745	1,383	1,720	2,200	3,500
The Upper Volta	30	60	180	400	800
Total second region	1,775	2,643	4,000	6,600	10,300
Guinea	590	650	1,050	1,690	2,700
Sierra Leone	30	40	70	140	280
Liberia	20	23	50	100	200
Total third region	640	713	1,170	1,930	3,180
Gambia		1	5	15	40
Senegal	350	500	1,000	1,500	2,200
Mauritania	20	23	45	90	150
Mali	120	200	400	800	1,600
Total fourth region	491	724	1,450	2,405	3,990
General Total	3,916	5,454	10,050	18,895	32,370
As compared with BHC (12-14 %)			20,000	38,000	65,000

TABLE 63

Demand for DDT (50%) in 1964 and estimates for 1965, 1970, 1975 and 1980

(Quantities in tons)

Countries	1964	1965	1970	1975	1980
Nigeria	300	400	1,200	3,000	6,000
The Niger	50	100	200	400	800
Dahomey	10	15	30	60	120
Togo	5	6	15	40	80
Total first region	365	521	1,445	3,500	7,000
Ghana	300	400	900	2,000	3,000
The Ivory Coast	75	152	640	1,100	1,600
The Upper Volta	5	10	30	90	200
Total second region	380	562	1,570	3,190	4,800
Guinea	465	510	825	1,320	2,100
Sierra Leone	8	10	20	50	100
Liberia	5	6	13	31	70
Total third region	478	526	858	1,401	2,270
Gambia	-	-	2	5	10
Senegal	50	100	300	600	900
Mauritania	4	5	12	30	60
Mali	40	50	100	200	400
Total fourth region	94	155	414	835	1,370
General total	1,317	1,764	4,287	8,926	15,440
As compared with DDT (75 %)			2,900	6,000	10,000

In the present report, the production of BHC and DDT is envisaged.

The various locations of the production units and the capacities envisaged for each stage are shown as follows (in tons).

BHC (12-14 %)

	1970	1975	1980
Guinea	20,000	40,000	65,000

DDT (75 %)

Ghana	3,300	3,300	3,300
Guinea	-	3,300	3,300
Senegal	-	-	3,300
	3,300	6,600	9,900

(b) BHC

BHC is obtained by treating a solution of chlorine and benzine photo-chemically. This process results in various isomers, the active portion of which is the gamma isomer. This isomer has a concentration of 12 to 14 per cent, and may with the aid of alcohol reach the desired concentration.

The following installations are necessary for the production of BHC:

- Dehydrated benzine plant
- Chlorine absorption plant
- Photo-chloridation plant
- Plant for the absorption, neutralization and dehydration of HCl gas
- Separation and recovery of benzine.

The benzine required for the production of BHC must be imported.

In Table 64 will be found investment costs, and capital expenditure together with costs involving raw materials and all the production costs for a unit of 20,000 tons per year of BHC (12-14 per cent) for the various locations.

TABLE 64

Cost of the production of a ton of BHC (12 - 14 per cent), in dollars

			Nigeria		Ghana		Guinea[x]				Senegal		Ivory Coast	
Capacity (tons per year)			20,000		20,000		V.I. 20,000		V.II 20,000		20,000		20,000	
Investments (US$1,000)			2,450		2,450		2,450		2,450		2,450		2,450	
	Items	Units	Quantities	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1.	Benzene (pure)	T	0.34	110	37.4	110	37.4	110	37.4	110	37.4	110	37.4	110	37.4
2.	Chlorine	T	0.75	88.7	66.5	62.0	46.5	131.2	98.4	87.8	65.9	88.7	66.5	85.9	64.4
3.	Chemical products				4.0		4.0		4.0		4.0		4.0		4.0
4.	Fuel oil	T	0.4	20	8.0	20	8.0	20	8.0	20	8.0	20	8.0	20	8.0
5.	Electricity	kWh	370	0.013	4.8	0.00265	1.0	0.035	13.0	0.015	5.6	0.02	7.4	0.0146	5.4
6.	Labour and supervision				6.0		6.0		6.0		6.0		6.0		6.0
7.	Capital costs				19.0		19.0		19.0		19.0		19.0		19.0
	Total				145.7		121.9		185.8		145.9		148.3		144.2
8.	Contingencies				7.3		6.1		9.3		7.3		7.4		7.2
I.	Workshop price				153.0		128.0		195.1		153.2		155.7		151.4
9.	Indirect expenditure, general expenditure, selling costs [xx]				6.8		6.8		6.8		6.8		6.8		6.8
II.	Cost price				159.8		134.8		201.9		160.0		162.5		158.2
10.	Profits after payment of taxes				12.2		12.2		12.2		12.2		12.2		12.2
11.	Profits before payment of taxes[xxx]				20.4		20.4		20.4		20.4		20.4		20.4
III.	Selling price				180.2		155.2		222.3		180.4		182.9		178.6

Estimated import price (c.i.f.) 190

[x] According to the present price of electrical energy (Version I) and the estimated price for the future (Version II).

[xx] 3 per cent of the fixed investment (Cl_2 + BHC).

[xxx] 9 per cent of the fixed (Cl_2 + BHC).

(c) DDT

DDT is obtained by the condensation of chloral and 2 molecules of benzine chloride by means of sulphuric acid.

In the production process, chloral and benzine mono-chloride are produced as intermediary products.

The basic raw material is imported benzine and ethylic alcohol.

Production plant includes the following units:

- chloral production plant
- benzine mono-chloride production plant
- DDT production plant

As a secondary product, .93 of a ton of hydro-chloric gas (gas given off) and 1.93 tons of sulphuric acid (acid given off) are obtained for a ton of DDT.

Investments, raw materials and other elements in the production cost of a unit of 3,300 tons per year of DDT (75 per cent) depending on the various locations, are given in Table 65.

TABLE 65

Cost of the Production of a Ton of DDT (75 per cent)

(in US$)

			Nigeria		Ghana		Guinea x/		Senegal		The Ivory Coast	
Capacity (tons/year)			3,300		3,300		3,300		3,300		3,300	
Investment (US$ 1,000 $)			1,800		1,800		1,800		1,800		1,800	
Item	Units	Quantities	Price	Value	Price	Value	Price	Value	Price	Value	Price	Value
1. Benzene (pure)	T	0.69	110	75.9	110	75.9	110	75.9	110	75.9	110	75.9	110	75.9
2. Ethylic alcohol	T	0.36	150	54.0	150	54.0	150	54.0	150	54.0	150	54.0	150	54.0
3. Chlorine	T	1.71	91.4	156.3	83.3	142.4	122.4	209.3	81.9	140.0	114.4	195.6	112.1	191.7
4. Sulphuric acid	T	2.00	16.4	32.8	16.1	32.2	35.0	70.0	35.0	70.0	16.2	32.4	18.8	37.6
5. Other chemical products				4.0		4.0		4.0		4.0		4.0		4.0
6. Electricity	kWh	570	0.013	7.4	0,00265	1.5	0.035	20.0	0.015	8.6	0.02	11.4	0.0146	8.3
7. Labour and supervision				24.4		24.4		24.4		24.4		24.4		24.4
8. Capital expenditure				80.0		80.0		80.0		80.0		80.0		80.0
Total				434.8		414.4		537.6		456.9		477.7		475.9
9. Contingencies				21.7		20.7		26.9		22.8		23.9		23.8
I. Workshop price				456.5		435.1		564.5		479.7		501.6		499.7
10. Indirect expenses, general expenses selling cost xx/				22.8		21.8		28.2		24.0		25.1		25.0
II. Cost price				479.3		456.9		592.7		503.7		526.7		524.7
11. Profits after payment of taxes				73.3		84.2		66.2		66.2		86.2		87.8
12. Profits before payment of taxes xxx/				122.1		140.3		110.4		110.4		143,6		146.3
III. Selling price				601.4		597.2		703.1		614.1		670.3		671.0

Estimated import cost (c.i.f.) 600 - 650

x/ According to the present price of electrical energy (Version I) and the estimated price of the future (Version II).

xx/ 5 per cent of the workshop price.

xxx/ 15 per cent of the fixed investment (Cl_2 + H_2SO_4 + DDT).

III.10 Viscose rayon

(a) Demand and capacity to be installed

According to document E/CN.14/236[1/], the consumption of rayon of all kinds, which was 12 million sq. yards (10 million sq. metres approximately) in 1944, rose to 239 million sq. yards (200 million m^2) in 1960.

The same document puts the estimated projection for 1970 at 340 million sq. yards (285 million m^2).

In Table 66, a breakdown will be found of the consumption of rayon per country in 1960. It is assumed that these percentages will remain valid up to 1980. The productions for each country in 1970 and 1975, are therefore calculated on this assumption.

Because of the more rapid growth in the consumption of synthetic fibres, which can to some extent replace rayon, and also because of the warm and humid climate of the sub-region, it is very unlikely that the future growth rate of the consumption of rayon, will come anywhere near the rates recorded in the past. Consequently, progressively diminishing rates have been applied, leading to the estimates for 1975 and 1980.

In this table each projection has three columns. The first indicates the projection for the consumption in millions of square yards; the second gives the equivalent of the previous figure in weight (in thousands of tons), and the third the tonnage of viscose rayon which might be produced in the sub-region. The figures in the third column concern viscose rayon; they have been calculated on the assumption that 10 per cent of the projections correspond to acetate and 13 per cent represent viscose rayon articles which may come from sources other than the local factory. This means in effect that the necessary capacity is equal to 77 per cent of the projection of demand.

1/ E/CN.14/236. Report of the West African Industrial Co-ordination Mission.

It follows from Table 66 that the projection of viscose rayon consumption in the Central African sub-region is low: 4,800 tons only in 1980. Consequently, it may be suggested that the Central African sub-region should endeavour to obtain its supplies from the West African sub-region, at least until 1980. The production capacity of West Africa has therefore been increased by a quantity corresponding to the consumption for Central Africa.

In the previous document the manufacture of viscose rayon filaments was considered. The stage of processing that follows spinning rightly belongs to the document in which textiles are treated.

The sites for the production unit, and the capacities estimated for each stage are as follows (in tons):

	1970	1975	1980
Nigeria	16,000	19,000	22,000
The Ivory Coast	16,000	19,000	22,000
	32,000	38,000	44,000

In spite of the tendency in favour of synthetic fibres, the sub-region might offer possibilities where treads for pneumatic tyres are concerned.

TABLE 66

Demand for Viscose Rayon in 1960 and Estimates for 1970, 1975 and 1980 for West Africa and Central Africa

	1960		1970			1975			1980		
	MM sq.y.	%	MM sq.y.	1000 t	1000 t V.R.	MM sq.y.	1000 t	1000 t V.R.	MM sq.y.	1000 t	1000 t V.R.
Nigeria	106	44.4	151.0	16.6	12.8	176.0	19.3	14.8	209.0	22.9	17.6
Ghana	44	18.4	62.0	6.8	5.2	72.4	7.8	6.0	86.6	9.5	7.3
Liberia	1	0.5	1.7	0.2	0.2	2.0	0.2	0.2	2.4	0.3	0.3
Sierra Leone	6	2.5	8.5	0.9	0.7	10.0	1.1	0.8	11.8	1.3	1.0
Gambia	4	1.6	5.4	0.6	0.5	6.3	0.7	0.5	7.5	0.8	0.6
Other countries	78	32.6	111.0	12.2	9.4	128.5	14.1	10.9	153.0	16.8	12.9
Total (West Africa)	239	100	340.0	37.3	28.8	395.0	43.2	33.2	470.0	51.5	39.5
Total (Central Africa)	23.4[a]		32.0	3.5	2.7	37.8	4.2	3.2	44.0	4.8	3.7
Grand total	262		372.0	40.8	31.5	432.8	47.4	36.4	514.0	56.3	43.2

V.R. = Viscose rayon

a/ 1960-62.

(b) Process

Preference has been given to the manufacture of viscose rayon rather than to the manufacture of acetate or silk or copper, because it is based on the use of a raw material (cellulose) which is simple, and may be obtained in future by local production in West Africa.

The following is the process of manufacture.

Cellulose is converted into alkaline cellulose by dipping in a solution of caustic soda then by the action of carbon sulphide (sulphurization) into cellulosic anthogenate which is dissolved in a solution of sodium. The viscose solution comes through the spinning shaft into the spinning basin where the liquid viscose is converted into plastic cellulose fibre.

To produce it the following installations are necessary:

- a plant for stripping the cellulose sheets into thin strips;
- a plant for converting the cellulose strips into plastic cellulose strings;
- a centrifugal spinner;
- various plant for later treatment (washing, desulphurization, whitening and drying);
- carbon sulphide production plant including charcoal;
- water preparation plant;
- air conditioning and refrigeration plant;
- sulphuric acid plant (only for the Ivory Coast).

In Table 67 will be found investments and the over-all production of viscose rayon, as they apply to the various locations.

TABLE 67

Cost of the Production of a Ton of Viscose Rayon

(in US$)

			Nigeria		The Ivory Coast		Ghana	
Capacity (tons/year)			16.000		16.000		16.000	
Investment (US$ 1,000)			79.500		80.000		80.000	
Item	Units	Quantity	price	Value	Price	Value	Price	Value
1. Cellulose	t	1,11	160	177,6	160	177,6	160	177,6
2. Sulphur	t	0,82	40	12,8 x)	40	32,8	40	32,8
3. Wood	t	1,1	3	3,3	3	3,3	3	3,3
4. Caustic soda	t	0,9	90	81,0	100	90,0	100	90,0
5. Sulphuric acid	t	1,3	20,1	26,1	-	-	-	-
6. Chemical products				21,0		21,0		21,0
7. Fuel oil	t	4,4	20	88,0	20	88,0	20	88,0
8. Electricity	kWh	8.000	0,013	104,0	0,0146	116,8	0,00265	21,2
9. Labour and supervision				97,0		100,0		100,0
10. Capital costs				770,4		775,0		775,0
11. Credit (sodium sulphate)				-10,0		-10,0		-10,0
Total				1371,2		1394,5		1298,9
12. Contingencies				68,6		69,7		64,9
I. Workshop price				1439,8		1464,2		1363,8
13. Indirect expenses, general expenses, selling costs xx/				72,0		73,2		68,2
II. Cost price				1511,8		1537,4		1432,0
14. Profits after payment of taxes				298,2		300,0		300,0
15. Profits before payment of taxes xxx/				497,0		500,0		500,0
III. Selling price				2008,8		2037,4		1932,0
Estimated import price (c.i.f.)				1,850				

x/ Exclusively for the production of CS_2.

xx/ 5 per cent of the workshop price.

xxx/ 10 per cent of the fixed investment.

III.11 Aluminium sulphate

(a) Demand and capacity to be installed

At present this chemical product is used particularly in the treatment of water. It is also used as an adhesive for sticking paper, and in the manufacture of varnish.

The consumption of alumina sulphate in West Africa is not known, because aluminium sulphate is shown in the import statistics for the sub-region, together with other products designated as sulphates in general.

Since, for a long time to come, the greater portion of the consumption of aluminium sulphate will be used for the treatment of water, it is worth estimating the demand in respect of this particular usage.

Populations in towns with inhabitants of 20,000 and over in West Africa stood at 10.6 million in 1960. If it is admitted that an approximate annual rate of growth of 10 per cent will continue up to 1970[1/] and drop to 5 per cent after 1970, the urban population might rise to 26, 33 and 42 million in 1970, 1975 and 1980 respectively. In addition, if it is assumed that the average consumption of water per head of population will be from 20 m^3 a year, and the treatment of water will require 30 grammes of aluminium sulphate for every cubic metre of water, the demand for aluminium sulphate may be estimated as follows:

1970: 16,000 tons; 1975: 20,000 tons; 1980: 26,000 tons.

Taking into consideration the same quantities for the treatment of water for industrial usage, the figures given above may be doubled.

It is estimated that after 1970, Nigeria will use some 900 tons of aluminium sulphate for paper adhesives, which will being the previous estimates to:

1970	1975	1980
33,000 tons	41,000 tons	53,000 tons

1/ Roughly around the years after 1950 the population growth rate in towns of 20,000 inhabitants and over (with the exception of Gambia and Guinea) exceeded 10 per cent. For towns with over 75 per cent of the total urban population the growth rate stood at 11.5 and 23 per cent.

In the present report, the following capacities (in tons) have been envisaged for each stage:

	1970	1975	1980
Sierra Leone	33,000	45,000	55,000

(b) Process

Aluminium sulphate is obtained by the dissolution of aluminium or bauxite, ground and charred in sulphuric acid.

The reaction of sulphuric acid to bauxite requires the following operations and production units:

- sulphuric acid plant;
- aluminium sulphate plant;
- packing plant.

In Table 68 will be found investments and all production costs in connexion with sulphate ammonia for the first stage of a unit which it is proposed to set up in Sierra Leone.

TABLE 68

Cost of the Production of a Ton of Aluminium Sulphate

in Sierra Leone

(in US$)

Capacity (tons/year)			35,000	
Investment (US$ 1,000)			800	
Item	Units	Quantity	Price	Value
Bauxite (55 per cent Al_2O_3)	t	0.34	4.0	1.4
Sulphuric acid	t	0.44	22.4	9.9
Chemical products				2.0
Fuel oil	t	0.21	20.0	4.2
Electricity	kwh	29.0	0.065	1.9
Labour and supervision				1.0
Packing				4.0
Capital costs				3.5
TOTAL				27.9
Contingencies				1.3
Workshop price				29.2
Indirect expenses, general expenses, selling costs				2.9
Cost Price				32.1
Profits after payment of taxes				2.9
Profits before payment of taxes				4.8
Selling price				36.9
Estimated import price (c.i.f.)			55.0	

IV. CHEMICAL PROJECTS PROPOSED FOR THE WEST AFRICAN COUNTRIES

The notion of inter-industrial relations, is fully exemplified in the chemical industry, particularly where developing countries are concerned. A study in connexion with a unit or an individual factory taken singly, may lead to negative conclusions, whereas the systematic grouping in a specific locality of activities which are technically and economically related, that is to say, the creation of complexes will lead to positive conclusions. The following are some of the advantages of special integration:

- the use of joint plant (larger and more economical) as for instance electrical plant or installations for water and steam etc.;
- savings are effected at the minimum and middle level;
- the use of the same raw materials or secondary products for the production of a large number of finished products;
- the use of or revalorization of by-products ;
- the elimination of expenses in connexion with the transport and storage of intermediary products;
- the diminution in the number of auxiliary workers and persons employed by the administration;
- reduction in investment and production costs.

In this document an attempt has been made to indicate the advantages of special integration, but account has also been taken of raw materials and fuels, markets and the need for diversifying the locations in order to create possibilities for the industrial development of the largest number of countries in the sub-region.

In this chapter, with the help of tables, an attempt has been made to show for all the countries of West Africa, the industries envisaged in the present document, with the possible location of definite units within the countries concerned the capacities required at each stage (1970, 1975 and 1980), the investments necessary according to the capacities involved, the years when take-off is expected, the gross value and the annual added production value at each stage, as well as the needs in manpower.

With regard to the industrial complexes anticipated, as well as further production from existing complexes set up during the previous stages, the main economic indices have been submitted. Outlines have been drawn up also to show the inter-dependence of units or individual activities within the framework of each complex. These outlines have this advantage that they enable one to visualize what is implied in the production of products for a particular complex. Moreover, they may serve as quick references as far the raw materials used are concerned, the methods of processing and techniques envisaged, as well as for the resultant intermediary or finished products. All this information is followed by a brief additional comment.

IV.1 NIGERIA

The Chemical Industries Envisaged in NIGERIA are as follows:

Industry	Year	Capacity (tons)	Fixed Investment (US$ 1,000)	Working capital (US$ 1,000	Annual production value		Labour force
					Gross (US$ 1,000)	Added (US$ 1,000)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Sulphuric Acid	1968/69	220,000	2,300	-	-	-	-
	1975	220,000	2,300	-	-	-	-
	1980	220,000	2,300	-	-	-	-
2. Caustic soda and chlorine	1970	14,000	4,300	-	-	-	-
	1975	17,000	5,200	-	-	-	-
	1980	30,000	7,800	-	-	-	-
3. Ammonia	1968/69	60,000	7,000	-	-	-	-
	1975	60,000	7,000	-	-	-	-
	1980	60,000	7,000	-	-	-	-
4. Ammonium sulphate	1968/69	225,000	1,200	3,570	10,380	5,369	440
	1975	225,000	1,200	3,570	10,380	5,369	440
	1980	225,000	1,200	3,570	10,380	5,369	440
5. Ammonium nitrate	1970	7,000	900	330	900	620	30
	1975	7,000	900	330	900	620	30
	1980	10,000	1,100	440	1,250	860	40
6. Polyethylene	1970	-	-	-	-	-	-
	1975	-	-	-	-	-	-
	1978	30,000	23,000	2,400	11,900	8,500	250
7. PVC	1971	20,000	6,200	1,500	7,440	5,177	300
	1975	20,000	6,200	1,500	7,440	5,177	300
	1979	40,000	11,000	2,800	14,200	9,800	400

NIGERIA (continued)

1	2	3	4	5	6	7	8
8. Viscose rayon	1970	16.000	79,500	5,800	29,000	21,000	1,280
	1975	19,000	92,300	6,500	34,000	24,600	1,350
	1980	22,000	103,400	7,500	39,500	28,800	1,400
9. Pharmaceutical products	1970	7,100*	3,800	1,400	7,100	2,800	1,200
	1975	21,700*	11,500	4,300	21,700	8,700	3,600
	1980	60,300*	32,000	12,000	60,300	24,100	10,000
10. Soap	1970	31,000	6,200	2,800	11,300	4,500	1,030
	1975	77,000	15,400	6,400	25,400	10,200	2,570
	1980	149,000	29,800	11,200	44,700	17,900	4,900
11. Detergents	1970	12,000	520	300	8,000	3,000	400
	1975	24,000	1,040	600	16,000	6,000	800
	1980	54,000	2,340	1,350	36,000	13,900	1,800
12. Perfume, cosmetics	1970	2,000*	600	400	2,000	800	400
	1975	4,000*	1,200	800	4,000	1,600	800
	1980	6,000*	1,800	1,200	6,000	2,400	1,200
TOTAL	1970		112,520	16,100	76,120	43,266	5,080
	1975		144,240	24,000	119,820	62,266	9,890
	1980		220,740	42,460	224,230	111,629	20,430

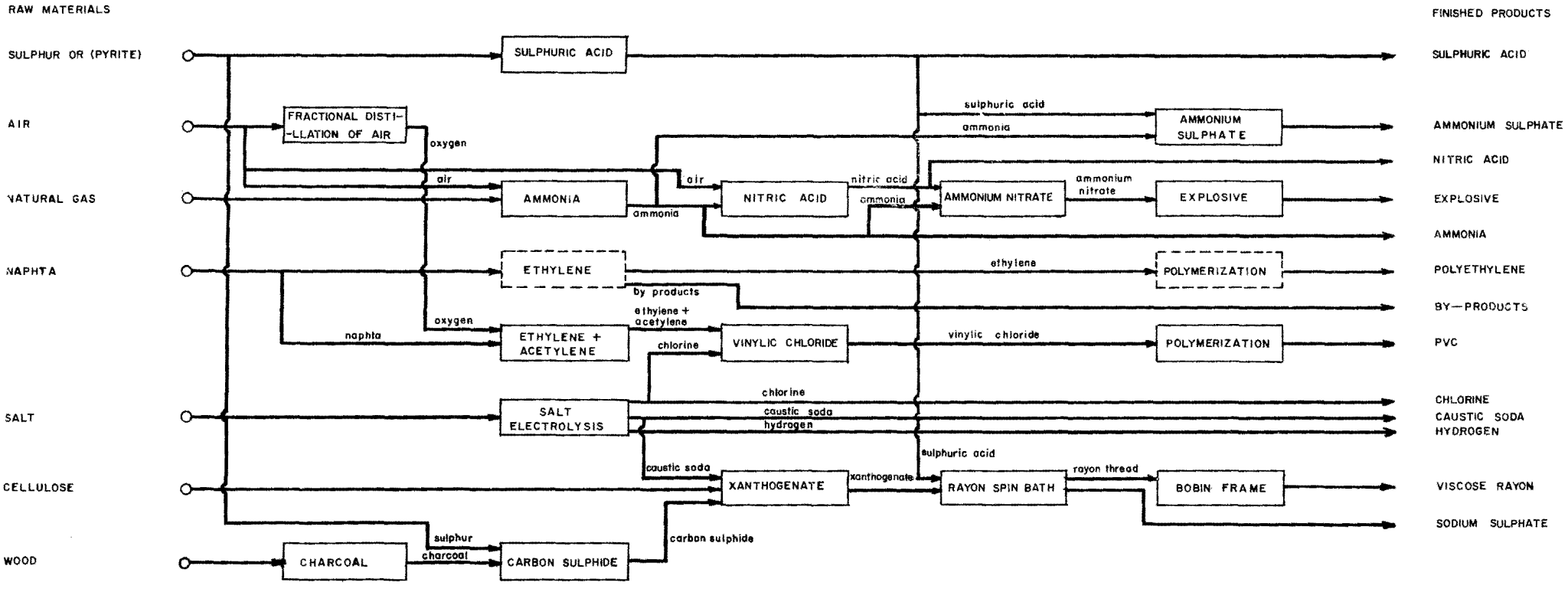
* Annual value in US$ 1,000.

The inter-dependence of the units as part of the complexes proposed is described in the following diagrams. (See Diagram I)

GENERAL DIAGRAM OF THE INTERLOCKING CHARACTER OF PRODUCTION PROCESSES FOR THE INDUSTRIES ENVISAGED

DIAGRAM I

NIGERIA



Note:

The plant denoted by straight lines is envisaged for 1970 (specified for 1 to 2 years)

The plant denoted by broken lines is envisaged for 1975 or 1980 (specified for 1 to 2 years)

The main economic indices for the complexes envisaged are given in Table 69.

The chemical industries proposed for Nigeria are the most complex in the whole of the sub-region. This is due to a number of reasons. Although Nigeria contains 60 per cent of the population of the sub-region, it is not necessarily the biggest consumer per head of population, but will undoubtedly be a force to reckon with in the distribution of chemical products. In addition to a national market which can be expected to assume substantial proportions, Nigeria is well endowed with hydro-carbon fuels (coal, oil and natural gas) which are (the raw materials and the fuels) absolute pre-requisites in the development of a petro-chemical complex. These factors, added to the supply of cheap electrical energy from the Kainji dam project, may put Nigeria on a par with Ghana as regards the products of the electro-chemical industry.

IV.2 NIGER

Chemical Industries as Envisaged in the Niger

Industry	Year	Capacity (tons)	Fixed Investment (US$1,000)	Working capital (US$1,000)	Annual production value		Labour force
					Gross (US$1,000)	Added (US$1,000)	
1	2	3	4	5	6	7	8
1. Pharmaceutical products	1970	300[a]	200	60	300	120	70
	1975	800[a]	450	160	800	320	150
	1980	2.000[a]	1.100	400	2.000	800	330
2. Soap	1970	400	100	30	120	40	15
	1975	1.800	400	140	540	220	60
	1980	5.800	1.600	440	1.740	700	195
3. Perfumes, cosmetics	1970	90[a]	30	20	90	40	30
	1975	190[a]	60	40	190	80	60
	1980	390[a]	120	80	390	160	110
Total	1970		330	110	510	200	115
	1975		910	340	1.530	620	270
	1980		2.380	920	4.130	1.660	635

a/ Annual value in US$ 1,000.

IV.3 DAHOMEY

Chemical Industries as Envisaged in Dahomey

Industry	Year	Capacity (tons)	Fixed investment (US$ 1,000)	Working Capital (US$ 1,000)	Annual production value		Labour force
					Gross (US$ 1,000)	Added (US$ 1,000)	
1	2	3	4	5	6	7	8
1. Calcium carbide	1970	8,000	1,900	230	1,160	610	25
	1975	8,000	1,900	230	1,160	610	25
	1980	16,000	3,200	430	2,200	1,160	40
2. Pharmaceutical products	1970	500 a/	300	100	500	200	90
	1975	1,000 a/	600	200	1,000	400	170
	1980	2,000 a/	1,100	400	2,000	800	330
3. Soap	1970	2,000	400	150	600	240	70
	1975	4,000	800	300	1,200	480	140
	1980	6,000	1,200	450	1,800	720	200
4. Perfumes, cosmetics	1970	200 a/	60	40	200	80	70
	1975	300 a/	90	60	300	120	75
	1980	400 a/	120	80	400	160	100
Total	1970		2,660	520	2,460	1,130	255
	1975		3,390	790	3,660	1,610	410
	1980		5,620	1,260	6,400	2,840	670

a/ Annual value in US$ 1,000.

- The production of calcium carbide is shown in the following diagram (see diagram II).

The main economic indices of this production are shown in Table 69.

Unlike its eastern and western neighbours, Dahomey does not appear to offer any minimum pre-requisite for the establishment of chemical factories. There exist none of the factors that determine the choice of location such as local markets, raw materials, fuels, cheap electrical energy. An exception must however be made in the case of raw materials, as there is a reserve of over 9 million tons of limestone, 18 km from Pobé. It is said to be of good quality, but its value as a chemical raw material still remains to be determined. Even if the limestone could be used from an economic point of view, it would not be possible to use it for the production of calcium carbide, bearing in mind the present cost of electricity (see Table 44 - Version I).

There are two possible solutions. The first is the development of the Mono river. The Heads of State of Dahomey and Togo recently met to discuss this question. The results of their talks are not yet known to the secretariat.

The second solution is to import power either from Ghana or from Nigeria.

The proposal for setting up a calcium carbide factory in Dahomey, would depend upon the existence of one or other of these possibilities.

If the difficulties mentioned cannot be overcome, it would be only natural to set up the factory in Ghana where electrical energy is no problem.

However, as in the case of Dahomey, the position in Ghana as regards limestone has still to be determined.

It must be added that all the promising deposits of limestone in the sub-region, including those in Guinea and Senegal are very far in the interior of the country, or are inaccessible.

TABLE 69

The main economic indices of the chemical complexes envisaged in the West African sub-region

Countries	Nigeria (Port-Harcourt)				Dahomey (Cotonou)		Togo (Lomé)		Ghana (Tema)			The Ivory Coast (Abidjan)		Guinea (Conakry)		Sierra Leone (Freetown)		Senegal (Dakar)			Mali (Gao)
Complexes	I	II	III	IV	I	I	II	I	II	III	I	II	I	II	I	I	II	III	I
1. Capacity (1,000 tons)	A.S 220.0 (46.7)	Cl_2 14.0 (1.7)	R.V 16.0	P.E 30.0	C.C 8.0	A.S. 76.0 (9.3)	A.S. 104.0 (3.2)	A.S. 200.0 (26.7)	Cl_2 6.6 (0.9)	Cl_2 13.4 (1.1)	A.S. 30.0 (9.2)	P.E. 30.0	Cl_2 16.0 (1.0)	Cl_2 5.7	A.S. 17.0 (1.6)	A.S. 60.0 (4.0)	A.S. 173.3	Cl_2 6.0 (0.3)	A.S. 22.0 (1.6)
	A. 60.0	S.C 15.7 (15.7)				S.S 180.0	A.P. 36.0	A. 60.0	S.C. 7.40 (7.4)	S.C. 15.0 (15.0)	R.V 16.0		S.C. 17.9 (17.9)	S.C. 6.4 (6.4)	S.Al. 35.0	A.P. 20.0	S.A. 225.0	S.C. 6.7 (6.7)	S.S. 55.0
	S.A. 225.0	FVC 20.0					S.T. 100.0	S.A. 225.0	DDT 3.3	PVC 20.0			PHC 20.0	DDT 3.3		S.T. 45.0		DDT 3.3	
2. Investment (1,000 $)	15,300	12,000	85,300	25,400	2,130	4,100	6,860	14,600	5,500	10,700	85,900	25,400	8,470	3,780	1,570	4,290	14,500	5,420	1,870
Fixed investment	11,400	10,500	79,500	23,000	1,900	2,300	4,560	11,000	4,800	9,400	80,000	23.000	7,150	3,150	1,300	3,190	10,740	4,700	1,160
	3,900	1,500	5,800	2,400	230	1,800	2,260	3,600	700	1,300	5,900	2,400	1,320	630	270	1,100	3,760	720	710
3. Selling price per ton	A.S. 20.1	Cl_2 135.9				A.S. 23.7	A.S. 21.7	A.S. 19.9	Cl_2 143.8	Cl_2 105.2	A.S. 25.6		Cl_2 130.4	Cl_2 117.4	A.S. 30.5	A.S. 23.1	A.S. 20.0	Cl_2 181.4	A.S. 34.1
	S.A. 42.0	S.C 89.8							S.C. 95.3	S.C. 69.7		402.1	S.C. 86.4	S.C. 77.8				S.C.120.2	
	N.A.128.5	FVC 290.4	1,810	396.6	144.4	S.S. 27.6	S.T. 74.7	S.A. 42.8	DDT 597.2	PVC 260.4	R.V.1837.4		PHC 180.4	DDT 614.1	S.Al.36.9	S.T. 79.3	S.A. 47.9	DDT 612.9	S.S. 35.8
4. Cost price per ton	A.S. 18.0	Cl_2 100.6				A.S. 20.5	A.S. 19.3	A.S. 17.7	Cl_2 91.6	Cl_2 69.7	A.S. 21.1		Cl_2 96.6	Cl_2 90.1	A.S. 24.6	A.S. 19.8	A.S. 17.8	Cl_2 125.8	A.S. 29.0
	S.A. 36.0	S.C. 66.5					S.A. 36.4	S.C. 60.9	S.C. 46.3				S.C. 64.1	S.C. 59.8			S.A. 41.5	S.C. 83.5	
	N.A. 92.8	FVC 190.4	1,511.8	281.6	120.6	S.S. 24.0	S.T. 65.6		DDT 456.9	PVC 160.4	R.V.1537.4	287.1	PHC 160.0	DDT 503.7	S.Al.32.1	S.T. 67.3		DDT 526.7	S.S. 29.7
5. Profit before payment of taxes per ton	A.S. 2.1	Cl_2 7.6				A.S. 3.2	A.S. 2.4	A.S. 2.2	Cl_2 52.2	Cl_2 35.5	A.S. 4.5		Cl_2 33.8	Cl_2 27.3	A.S. 5.9	A.S. 3.3	A.S. 2.2	Cl_2 55.3	A.S. 5.1
	A.S. 6.0	S.C.23.3							S.C. 34.5	S.C. 23.4			S.C. 22.3	S.C. 18.0				S.C. 36.8	
	N.A. 35.7	FVC100.0	298.2	115.0	23.8	S.S. 3.6	S.T. 9.1	S.A. 6.4	DDT 140.3	PVC 100.0	R.V.300.0	115.0	PHC 20.4	DDT 110.4	S.Al. 4.8	S.T. 12.0	S.A. 6.4	DDT 86.2	S.S. 6.1
6. Profit after payment of taxes (1,000 $)	1,021	1,456	4,770	2,070	14.3	414	550	890	458	1,433	4,825	2,070	504	288	107	332	855	434	209
7. Amortization (1,000$)	970	890	6,750	1,950	162	196	388	934	408	800	6,800	1,950	610	268	110	271	914	400	99
8. "Net cash flow" (1,000$)	1,991	2,346	11,520	4,020	276	610	938	1,824	866	2,233	11,625	4,020	1,114	556	217	603	1,769	834	308
9. "Pay-out time"	5.8	4.5	6.9	5.7	6.9	3.8	4.9	6.0	5.5	4.2	6.9	5.7	6.5	5.6	6.0	5.3	6.0	5.3	3.8
10. Added value (1,000 $)	5,989	5,177	21,000	8,500	610	1,866	2,670	5,481	1,931	4,911	21,211	8,540	2,706	1,302	610	1,761	5,440	1,732	872
11. Gross annual value(1,000 $)	11,280	7,440	29,000	11,900	1,160	5,190	7,540	10,170	2,805	6,181	29,636	12,040	5,290	2,525	1,339	3,662	10,800	2,880	2,025
12. "Rate of return on sales"	6.7	12.1	5.6	8.2	5.3	10.0	8.1	6.1	8.3	13.4	5.6	8.2	3.9	7.6	6.8	7.8	5.9	8.0	11.1
13. "Rate of return on investment	9.1	19.5	16.4	17.3	9.8	8.0	7.2	8.8	16.3	23.1	16.3	17.3	9.5	11.4	8.0	9.0	7.9	15.0	10.3
14. "Turn-over ratio"	0.99	0.71	0.37	0.52	0.61	2.25	1.65	0.92	0.58	0.66	0.37	0.52	0.74	0.80	1.01	1.15	1.0	0.61	1.75

The selling quantities of basic products intermediary products are shown in brackets

A.S. Sulphuric acid
A.P. Phosphoric acid
S.C. Caustic soda
Cl_2 Chlorine
A Ammonia
C.C. Calcium carbide
S.S. Super simple
S.T. Super triple
S.A. Ammonium sulphate
N.A. Ammonium nitrate
P.E. Polyethylene
R.V. Viscose Rayon
S.Al. Ammonium sulphate
PVC
PHC
DDT

Litho UNECA 066-497

IV.9 TOGO

Chemical industries envisaged for Togo

Industry	Year	Capacity (in tons)	Fixed investment ($1,000)	Working capital ($1,000)	Annual production value		Labour force
					Gross ($1,000)	Added ($1,000)	
1	2	3	4	5	6	7	8
1. Sulphuric acid	1968/69	76,000	1,200	-	-	-	-
	1973/74	180,000	2,200	-	-	-	-
	1977/78	280,000	2,800	-	-	-	-
2. Phosphoric acid	1970	-	-	-	-	-	-
	1973/74	36,000	2,400	-	-	-	-
	1977/78	72,000	4,300	-	-	-	-
3. Supersimple	1968/69	180,000	1,100	1,800	5,190	1,866	150
	1975	180,000	1,100	1,800	5,190	1,866	150
	1980	180,000	1,100	1,800	5,190	1,866	150
4. Supertriple	1970	-	-	-	-	-	-
	1973/74	100,000	930	2,260	7,540	2,670	250
	1977/78	200,000	1,700	4,200	14,000	5,000	350
5. Pharmaceutical products	1970	400[a]	200	80	400	160	80
	1975	800[a]	450	160	800	320	150
	1980	2,000[a]	1,100	400	2,000	800	330
6. Soap	1970	2,000	400	140	550	220	70
	1975	3,000	600	210	830	330	100
	1980	5,000	1,000	350	1,380	550	170
7. Perfume, cosmetics	1970	250[a]	80	50	250	100	80
	1975	350[a]	110	70	350	140	90
	1980	500[a]	150	100	500	200	125
Total	1970		3,000	2,070	6,390	2,346	380
	1975		7,790	4,500	14,710	5,326	740
	1980		12,150	6,850	23,070	8,416	1,125

a/ Annual value in US$ 1,000.

- The interdependence of the units in the proposed complexes is described in the following diagrams (see diagram III).

- The main economic indices of the complexex envisaged are given in Table 69.

Togo possesses a first class chemical raw material namely phosphate. Togolese phosphates which were brought up to 81 per cent were sold on the world market. It would seem natural that Togo should still improve the quality of its phosphates, in order to meet the needs of the sub-region in fertilizers.

A simple superphosphate factory for Togo has been suggested, and future expansions in terms of triple superphosphate envisaged. The superphosphate industry is however the main consumer of sulphuric acid. Taking into consideration the scarcity of supply and the high cost that can be expected in connexion with sulphur, it would be appropriate at least to mention the processes and methods which imply a minimum dependence upon imports of sulphur. One of the methods is to obtain sulphuric acid from pyrites, gypsum or anhydrite if these are available on the spot. Another method is to reduce the use of sulphur by using the nitrophosphate process in which the nitric acid from the ammonia factory at Ghana may be used as basic acid. The third method would be to do without sulphuric acid, and use cheap electrical energy from Ghana to obtain phosphoric acid which can be used for better quality fertilizers.

It would seem that in the long run the nitrophosphate process and the one using the electrical bl st furnace offer the best possibilities for the processing of Togolese phosphates. It must also be added that in Israel the JMJ process was developed to the point where it could produce phosphoric acid. This process uses hydro-chloric acid as an acidifying agent and C_4 and C_5 alcohols as solvents. It would seem that this method offers advantages when hydro-chloric acid is used as a by-product. It would be a good thing to know whether this is equally advantageous when use is made of hydro-chloric acid obtained directly through an electrolysis salt factory which might be installed for this purpose. If this could be done, it would make it possible to do away with the imbalance as shown in the chlorine and caustic soda industries in the developing countries

Finally, it is worth pointing out here that the possibility of using phosphoric acid from Togo, in the Niger or Ghana, and ammonia from the Niger or Ghana in Togo, for conversion into ammonia phosphate, still deserves to be studied. The transport by sea of ammonia is already being successfully carried out. The first possibility seems promising. The Safi complex (Morocco), for instance, which has a daily capacity of a thousand super phosphoric acid tons, and began operating in 1965 aims at developing its capacity up to 5,000 tons a day, mainly for export. Another example is Trinidad (la Trinité) with its ammonia factories. This ties up with the present tendency of choosing locations for basic chemical production factories near the raw materials.

GHANA

IV.5 Chemical industries envisaged in Ghana

Industry	Year	Capacity (tons)	Fixed Investment ($1,000)	Working Capital ($1,000)	Annual production value Gross ($1,000)	Annual production value Added ($1,000)	Labour Force
	1973/74	200,000	2,200				
	1980	200,000	2,000				
2. Caustic Soda and chlorine	1970	6,600	3,000				
	1975	20,000	6,200				
	1980	20,000	6,200				
3. Ammonia	1970	-	-	-	-	-	-
	1973/74	60,000	7,600		-	-	-
	1980	60,000	7,600		-	-	-
4. Ammonium sulphate	1970	-	-	-	-	-	-
	1973/74	225,000	1,200	3,600	10,170	5,481	440
	1980	225,000	1,200	3,600	10,170	5,481	440
5. PVC	1970	-	-	-	-	-	-
	1975	20,000	6,200	1,300	6,180	4,910	300
	1980	20,000	6,200	1,300	6,180	4,910	300
6. DDT	1970	3,300	1,800	700	2,805	1,931	150
	1975	3,300	1,800	700	2,805	1,931	150
	1980	3,300	1,800	700	2,805	1,931	150
7. Pharmaceutical products	1970	3,300 a/	1,800	660	3,300	1,300	550
	1975	10,000 a/	5,300	2,000	10,000	4,000	1,670
	1980	22,500 a/	11,900	4,500	22,500	9,000	3,750
8. Soap	1970	7,000	1,400	630	2,500	1,000	230
	1975	19,000	3,800	1,650	6,600	2,600	630
	1980	35,000	7,000	3,050	12,200	4,900	1,160

Ghana (cont'd)

Industry	Year	Capacity (tons)	Fixed Investment (1,000$)	Working Capital (1,000$)	Annual production value Gross (1,000$)	Annual production value Added (1,000$)	Labour Force
1	2	3	4	5	6	7	8
9. Detergents	1970	6,000	260	150	4,000	1,500	200
	1975	12,000	520	300	8,000	3,000	400
	1980	18,000	780	450	12,000	4,500	600
10. Perfumes, cosmetics	1970	600 a/	180	120	600	240	150
	1975	1,100 a/	330	220	1,100	440	220
	1980	1,500 a/	450	300	1,500	600	300
Total	1970		8,440	2,260	13,205	5,971	1,280
	1975		35,150	9,770	44,855	22,362	3,810
	1980		45,330	13,900	67,355	31,322	6,700

a/ Annual value in 1,000$.

- The interdependence of the units in the proposed complexes is described in the following diagrams.

GENERAL DIAGRAM OF THE INTERLOCKING CHARACTER OF
PRODUCTION PROCESSES FOR THE INDUSTRIES ENVISAGED

DIAGRAM II
DAHOMEY

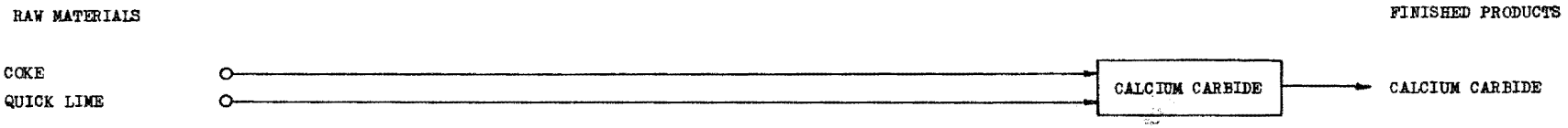


DIAGRAM III
TOGO

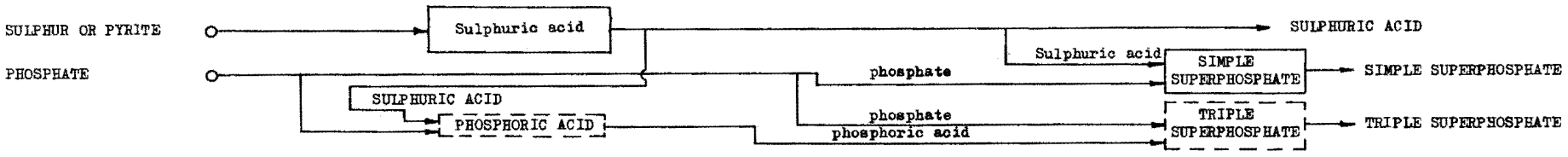
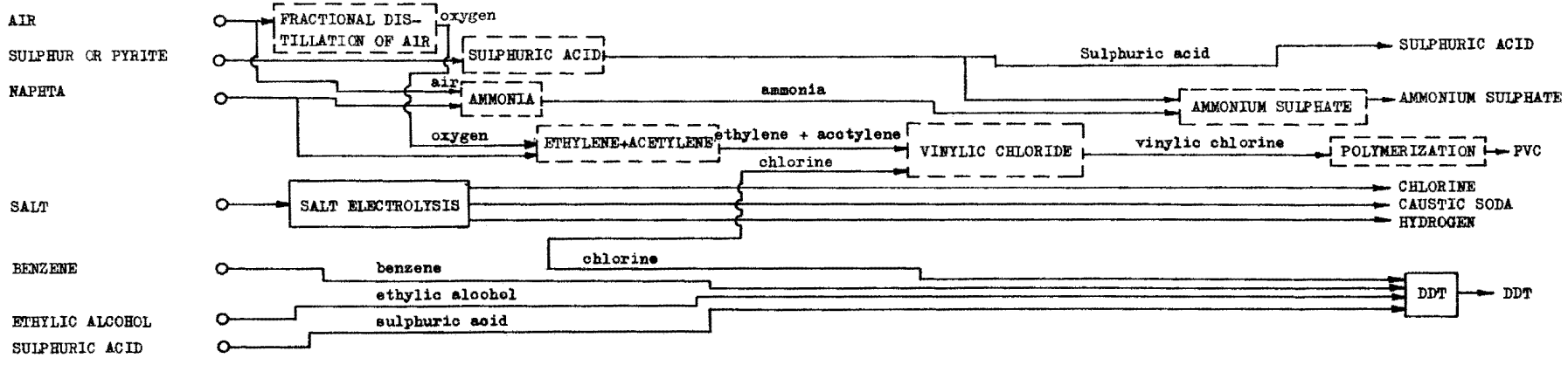


DIAGRAM IV
GHANA



Notes:

The plant denoted by straight lines is envisaged for 1970 (specified for 1 to 2 years)

The plant denoted by broken lines is envisaged for 1975 or 1980 (specified for 1 to 2 years).

- The main economic indices of the complexes envisaged are given in Table 69.

At present, and for a few years yet, Ghana has and will continue to have an advantage over all the other countries. Ghana's abundant and cheap electrical energy resources places that country in the first rank when it comes to locations for electro-chemical industries. With a few exceptions all the chemical products proposed for the sub-region require, directly or indirectly, large quantities of electrical energy. It would be neither just nor a paying proposition economically to refuse to take into consideration the hydro-electric projects envisaged for other countries, and concentrate practically all chemical industries in Ghana. This attempt to achieve an equitable solution and establish the possibility of embarking on industrial development for the largest number of States has been the guiding principle in the apportionment of locations for the chemical industries in the sub-region. A few words are necessary in connexion with the nitrogenous fertilizer factory proposed for Ghana. The production of ammonium sulphate has been envisaged. It is hoped to come back to it in a few years, when it will be possible to make more definite proposals with regard to the kind of nitrogenous fertilizers best suited to the needs of the sub-region.

One of the solutions would be for measures to be taken in conjunction with Togo, in order to achieve the joint production of ammonia phosphate. The production of urea could be another solution.

IV.6 THE IVORY COAST

The Chemical Industries envisaged in the Ivory Coast

Industry	Year	Capacity (Tons)	Fixed investment (1,000$)	Working Capital (1,000$)	Annual production value		Labour force
					Gross (1,000$)	Added (1,000$)	
1	2	3	4	5	6	7	8
1. Sulphuric acid	1970	30,000	670				
	1975	30,000	670				
	1980	30,000	670				
2. Polyethylene	1970	-	-	-	-	-	-
	1974	30,000	23,000	2,400	12,040	8,540	25
	1980	30,000	23,000	2,400	12,040	8,540	25
3. Viscose rayon	1970	16,000	80,000	5,900	29,636	21,211	1,28
	1975	19,000	92,300	6,940	34,700	24,900	1,35
	1980	22,000	103,400	8,000	40,200	28,800	1,40
4. Pharmaceutical products	1970	1,200[a/]	650	240	1,200	480	20
	1975	4,000[a/]	2,200	800	4,000	1,600	60
	1980	10,000[a/]	5,300	2,000	10,000	4,000	1,67
5. Detergents	1970	-	-	-	-	-	-
	1975	-	-	-	-	-	-
	1980	6,000	260	150	4,000	1,500	2
6. Perfumes cosmetics	1970	1,000[a/]	330	220	1,000	400	2
	1975	1,400[a/]	420	280	1,400	560	2
	1980	1,800[a/]	540	360	1,800	720	3
Total	1970		81,650	6,360	31,936	22,130	1,7
	1975		118,590	10,420	52,140	35,600	2,5
	1980		133,170	12,910	68,040	43,560	3,8

a/ Annual value in 1,000$.

- The interdependence of the units in the proposed complexes is described in the following diagrams (See diagram V).

- The main economic indices of the complexes envisaged are given in Table 69.

Polyethylene and viscose rayon are two finished products that come under industries depending upon electric power. The assumption has been made that the rates of electric energy will diminish in future in the Ivory Coast, in favour of these two products.

As in Nigeria, it will be necessary to envisage a cellulose factory in addition to a viscose rayon factory when a suitable type of wood becomes available. Because of the economical aspects of large-scale enterprises and the advantages of location, the integration of the cellulose factory envisaged in document E/CN.14/INR/108 should also be striven after.

IV.7 THE UPPER VOLTA

Chemical industries envisaged in the Upper Volta

Industries	Year	Capacity (tons)	Fixed Investment (1,000$)	Working Capital (1,000$)	Annual Production Value		Labour Force
					Gross (1,000$)	Added (1,000$)	
1	2	3	4	5	6	7	8
1. Pharmaceutical Products	1970	-	-	-	-	-	-
	1975	500[a]	300	100	500	200	90
	1980	2,000[a]	1,100	400	2,000	800	330
2. Soap	1970	3,700	740	340	1,370	500	140
	1975	6,700	1,340	620	2,480	990	220
	1980	10,700	2,140	990	3,960	1,580	360
3. Perfumes cosmetics	1970	120[a]	40	24	120	20	40
	1975	320[a]	100	64	320	60	80
	1980	620[a]	190	124	620	120	150
Total	1970		780	364	1,490	570	180
	1975		1,740	784	3,300	1,250	390
	1980		3,430	1,514	6,580	2,500	840

a/ Annual value in a 1,000$.

IV.8 GUINEA

Chemical Industries envisaged in Guinea

Industry	Year	Capacity (tons)	Fixed Investment (1,000$)	Working Capital (1,000$)	Annual Production Value		Labour Force
					Gross (1,000$)	Added (1,000$)	
1	2	3	4	5	6	7	8
1. Caustic Soda and Chlorine	1970	16,000	4,700	-	-	-	-
	1975	38,000	9,000	-	-	-	-
	1980	56,000	12,500	-	-	-	-
2. BHC	1970	20,000	2,450	1,320	5,290	2,706	230
	1975	40,000	4,000	2,570	10,300	5,300	340
	1980	65,000	6,300	4,150	16,600	8,550	430
3. DDT	1970	-	-	-	-	-	-
	1975	3,300	1,800	630	2,525	1,302	150
	1980	3,300	1,800	630	2,525	1,302	150
4. Pharmaceutical Products	1970	1,000[a]	600	200	1,000	400	170
	1975	3,000[a]	1,600	600	3,000	1,200	500
	1980	7,000[a]	3,700	1,400	7,000	2,800	1,170
5. Soap	1970	3,000	600	160	640	260	100
	1975	6,000	1,200	320	1,280	520	200
	1980	9,000	1,800	480	1,920	780	300
6. Perfumes, cosmetics	1970	150[a]	50	30	150	60	50
	1975	300[a]	90	60	300	120	75
	1980	500[a]	150	100	500	200	120
Total	1970		8,400	1,710	7,080	3,420	550
	1975		18,090	4,180	17,405	8,442	1,265
	1980		26,250	6,760	28,545	13,632	2,170

a/ Annual value in a 1,000$.

The interdependence of the units in the proposed complexes is described in the diagrams on page 197 (See Diagram VI).

The main economic indices for the complexes envisaged are given in Table 69.

The main objective as far as Guinea is concerned, is to supply its alumina industry with as much caustic soda from local sources as possible. This represents at least two difficulties: One is the lack of cheap electrical energy, the other is to find a way of getting chlorine, and being in a position to sell caustic soda at an acceptable price.

As far as electrical energy is concerned, it was assumed as indeed for most of the countries of the sub-region that this would be available in future.

Since this solution would result in the production of chlorine over and above the amount required, it should be used to produce products requiring it. BHC and DDT are therefore envisaged as possible markets for chlorine.

IV.9 SIERRA LEONE

The Chemical Industries envisaged in Sierra Leone

Industry	Year	Capacity (tons)	Fixed Investment (1,000$)	Working Capital (1,000$)	Annual Production Value		Labour Force
					Gross (1,000$)	Added (1,000$)	
1	2	3	4	5	6	7	8
1. Sulphuric Acid	1970	17,000	500	-	-	-	-
	1975	34,000	850	-	-	-	-
	1980	34,000	850	-	-	-	-
2. Aluminium Sulphate	1970	35,000	800	270	1,339	610	55
	1975	45,000	980	330	1,680	780	65
	1980	55,000	1,100	390	2,000	950	75
3. Pharmaceutical Products	1970	600[a]	330	120	600	240	120
	1975	1,200[a]	650	240	1,200	480	200
	1980	5,000[a]	2,700	1,000	5,000	2,000	830
4. Soap	1970	4,000	800	230	900	360	140
	1975	6,000	1,200	330	1,300	520	200
	1980	8,000	1,600	450	1,800	720	260
5. Perfumes, cosmetics	1970	300[a]	90	60	300	120	75
	1975	500[a]	150	100	500	200	125
	1980	700[a]	210	140	700	280	175
Total	1970		2,520	680	3,139	1,330	390
	1975		3,830	1,000	4,680	1,980	590
	1980		6,460	1,980	9,500	3,950	1,340

a/ Annual value in 1,000$.

The production of aluminium sulphate is shown in diagram VII.

GENERAL DIAGRAM OF THE INTERLOCKING CHARACTER
OF PRODUCTION PROCESSES FOR THE INDUSTRIES ENVISAGED

DIAGRAM V
THE IVORY COAST

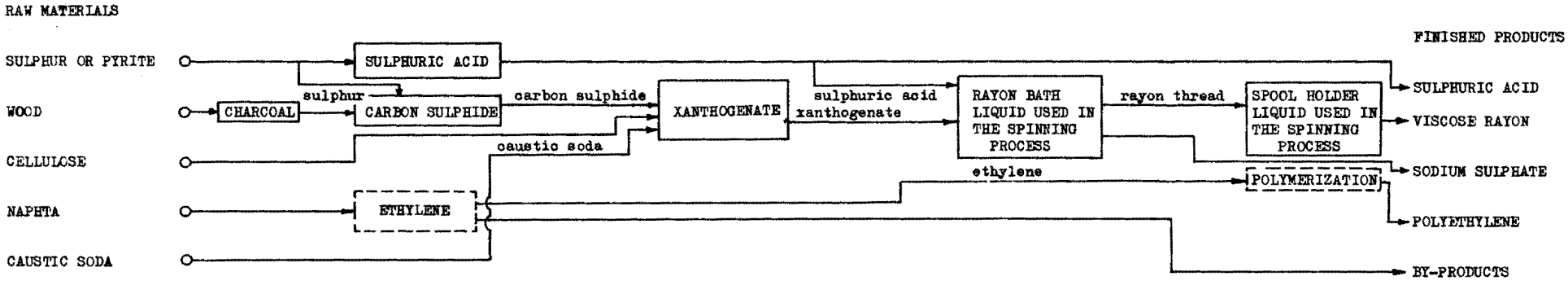


DIAGRAM VI
GUINEA

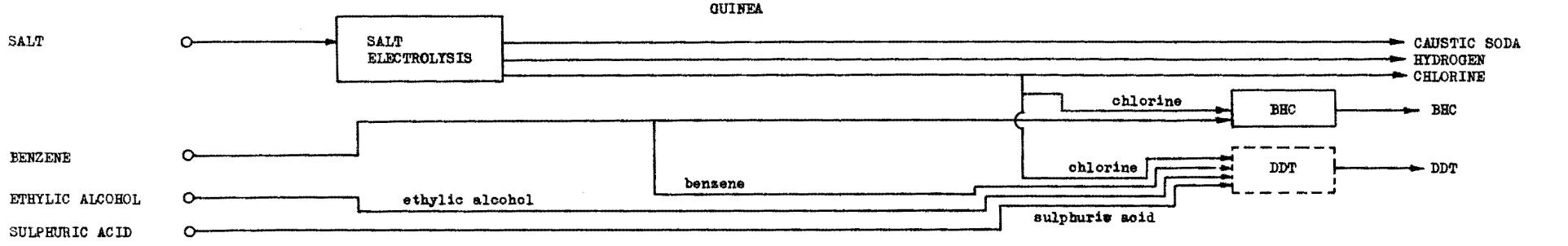
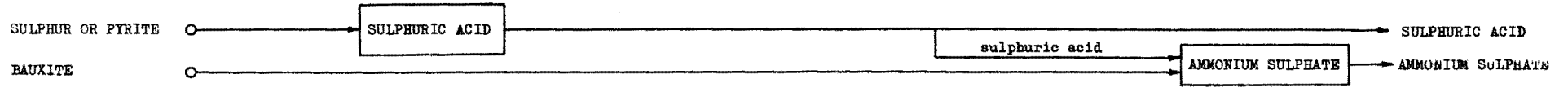


DIAGRAM VII
SIERRA LEONE



Notes:
The plant denoted by straight lines is envisaged for 1970 (specified for 1 to 2 years)
The plant denoted by broken lines is envisaged for 1975 or 1980 (specified for 1 to 2 years)

- The main economic indices of this production are given in Table 69.

The proposal to set up an aluminium sulphate factory in Sierra Leone rests mainly on the presence of bauxite mines which are now being operated. It is one of the industries for which electrical energy is not a decisive factor. One unit of sulphuric acid is envisaged as being enough to meet the requirements in acid of the neighbouring countries.

IV.10 LIBERIA

The Chemical industries envisaged in Liberia

Industries	Year	Capacity (tons)	Fixed Investment (1,000$)	Working Capital (1,000$)	Annual Production Value		Labour Force
					Gross (1,000$)	Added (1,000$)	
1. Pharmaceutical Products	1970	400[a/]	220	80	400	160	80
	1975	800[a/]	450	160	800	320	150
	1980	2,000[a/]	1,100	400	2,000	800	330
2. Soap	1970	3,000	600	200	800	320	100
	1975	3,000	600	200	800	320	100
	1980	4,000	800	280	1,100	440	130
3. Perfumes, cosmetics	1970	150[a/]	50	30	150	60	50
	1975	350[a/]	110	70	350	140	90
	1980	450[a/]	140	90	450	180	110
Total	1970		870	310	1,350	540	230
	1975		1,160	430	1,950	780	340
	1980		2,040	770	3,550	1,420	570

a/ Annual value in 1,000$.

IV.11 GAMBIA

The Chemical Industries envisaged in Gambia

Industries	Year	Capacity (tons)	Fixed Investment (1,000$)	Working Capital (1,000$)	Annual Production Value		Labour Force
					Gross (1,000$)	Added (1,000$)	
1	2	3	4	5	6	7	8
1. Soap	1970	–	–	–	–	–	–
	1975	1,000	200	80	350	140	35
	1980	1,000	200	80	350	140	35
2. Perfumes, cosmetics	1970	50[a]	20	10	50	20	20
	1975	100[a]	30	20	100	40	35
	1980	100[a]	30	20	100	40	35
Total	1970		20	10	50	20	20
	1975		230	100	450	180	70
	1980		230	100	450	180	70

a/ Annual value in 1,000$.

IV.12

SENEGAL

The Chemical Industries envisaged in Senegal

Industries	Year	Capacity (Tons)	Fixed Investment (1,000$)	Working Capital (1,000$)	Annual Production Value		Labour Force
					Gross (1,000$)	Added (1,000$	
1	2	3	4	5	6	7	8
1. Sulphuric acid	1968/69	60,000	1,000	-	-	-	-
	1973/74	90,000	1,400	-	-	-	-
	1977/78	330,000	3,700	-	-	-	-
2. Phosphoric acid	1968/69	20,000	1,600	-	-	-	-
	1973/74	32,000	2,500	-	-	-	-
	1977/78	50,000	3,500	-	-	-	-
3. Caustic Soda and Chlorine	1970	-	-	-	-	-	-
	1975	-	-	-	-	-	-
	1980	6,000	2,900	-	-	-	-
4. Ammonia.	1970	-	-	-	-	-	-
	1975	-	-	-	-	-	-
	1977/78	60,000	7,600	-	-	-	-
5. Super-triple	1968/69	45,000	590	1,100	3,662	1,761	180
	1973/74	85,000	960	2,030	6,750	3,200	235
	1977/78	135,000	1,400	3,240	10,800	5,150	300
6. Ammonium Sulphate	1970	-	-	-	-	-	-
	1975	-	-	-	-	-	-
	1977/78	225,000	1,200	3,760	10,800	5,440	440
7. DDT	1970	-	-	-	-	-	-
	1975	-	-	-	-	-	-
	1980	3,300	1,800	720	2,880	1,732	150
8. Pharmaceutical Products	1970	1,200[a]	650	240	1,200	480	200
	1975	2,600[a]	1,400	520	2,600	1,040	430
	1980	8,600[a]	4,500	1,720	8,600	3,440	1,430

SENEGAL (Cont'd.)

Industries	Year	Capacity (Tons)	Fixed Investment (1,000$)	Working Capital (1,000$)	Annual Production Value		Labour Force
					Gross (1,000$)	Added (1,000$)	
1	2	3	4	5	6	7	8
.Soap	1970	-	-	-	-	-	-
	1975	-	-	-	-	-	-
	1980	3,000	600	220	900	360	100
).Detergents	1970	-	-	-	-	-	-
	1975	6,000	260	150	4,000	1,500	200
	1980	12,000	520	300	8,000	3,000	400
.Perfumes, cosmetics	1970	500[a]	150	100	500	200	125
	1975	800[a]	240	160	800	320	200
	1980	1,200[a]	360	240	1,200	480	240
Total	1970		3,990	1,440	5,362	2,441	505
	1975		6,760	2,860	14,150	6,060	1,065
	1980		29,080	10,200	43,180	19,602	3,060

a/ Annual value in 1,000$.

- The interdependence of the units in the proposed complexes is described in the following diagrams (See Diagram VIII).
- The main economic indices for the proposed complexes are given in Table 69.

The statements made in regard to Togo apply also to Senegal. Nevertheless, Senegal is in a better position to develop a phosphate industry, in future, in conjunction with a local ammonia industry based on the naphta steam reforming process fed by the oil refinery already in operation.

IV.13

MAURITANIA

The chemical industry envisaged in Mauritania

Industry	Year	Capacity (tons)	Fixed Investment (1,000$)	Working Capital (1,000$)	Annual Production Value		Lal For
					Gross (1,000$)	Added (1,000$)	
1	2	3	4	5	6	7	
1. Soap	1970	-	-	-	-	-	
	1975	-	-	-	-	-	
	1980	1,000	200	80	350	140	

IV.14 MALI

The chemical industries envisaged in Mali

Industry	Year	Capacity (in tons)	Fixed investment ($1,000)	Working capital ($1,000)	Annual production value		Labour force
					Gross ($1,000)	Added ($1,000)	
1	2	3	4	5	6	7	8
1. Sulphuric acid	1970	-	-	-	-	-	-
	1973/74	22,000	560	-	-	-	-
	1980	22,000	560	-	-	-	-
2. Super-simple	1970	-	-	-	-	-	-
	1973/74	55,000	600	720	2,025	872	80
	1980	55,000	600	720	2,025	872	80
3. Pharmaceutical products	1970	400[a/]	220	80	400	160	80
	1975	2,000[a/]	1,100	400	2,000	800	330
	1980	5,000[a/]	2,700	1,000	5,000	2,000	830
4. Soap	1970	-	-	-	-	-	-
	1975	6,000	1,200	390	1,550	620	200
	1980	11,000	2,200	710	2,850	1,140	370
5. Perfume, cosmetics	1970	40[a/]	20	10	40	20	15
	1975	140[a/]	50	30	140	60	45
	1980	340[a/]	100	70	340	140	90
Total	1970		240	90	440	180	95
	1975		3,510	1,540	5,715	2,352	655
	1980		6,160	2,500	10,215	4,152	1,370

a/ Annual value in US$ 1,000.

- The production of supersimple is shown in Diagram IX.

GENERAL BI

GENERAL DIAGRAM OF THE INTERLOCKING CHARACTER
OF PRODUCTION PROCESSES FOR THE INDUSTRIES ENVISAGED

DIAGRAM VIII
SENEGAL

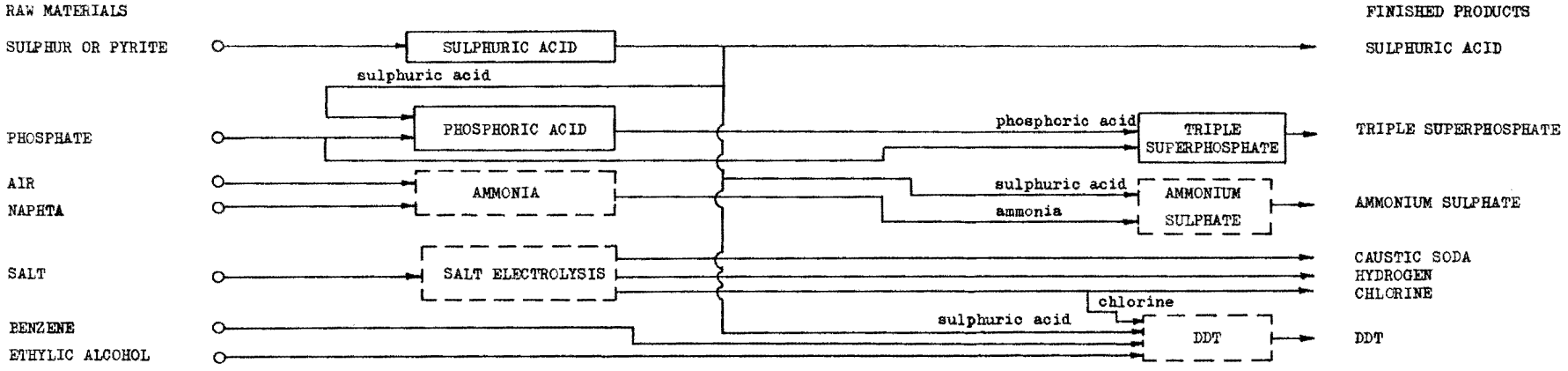
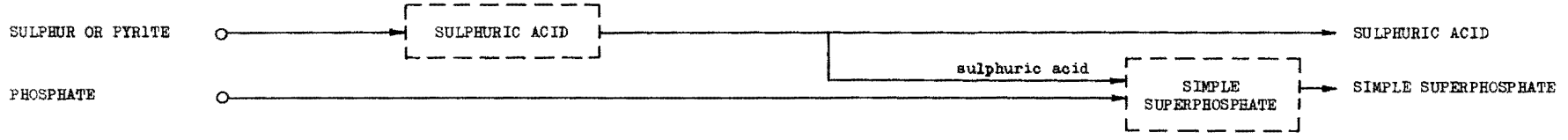


DIAGRAM IX
MALI



Note:

The plant denoted by straight lines is envisaged for 1970 (specified for 1 to 2 years)

The plant denoted by broken lines is envisaged for 1975 or 1980 (specified for 1 to 2 years)

- The main economic indices in respect of this production are shown in Table 69.

The simple superphosphate factory proposed for Mali rests upon the assumption that the phosphate deposits prove capable of being exploited economically. If this project were successfully carried through, it would enable the Mali farmers and certain areas of Mauritanie, Upper Volta and Niger to obtain fertilizers cheaper. This optimistic view is based partly on the savings that may result from the transport costs of sulphur, as compared with the transport costs of fertilizers from the coast to the hinterland.

The investments, annual production values (gross and added), and the need in manpower for all the chemical industries envisaged in the West African countries, will be found in Table 70.

TABLE 70

Investments, annual production values (gross and added) and labour needs for all the chemical industries envisaged in the West African States

Countries	Year	Fixed investment ($1,000)	Working Capital ($1,000)	Annual production value		Labour force
				Gross ($1,000)	Added ($1,000)	
1	2	3	4	5	6	7
Nigeria	1970	112,520	16,100	76,120	43,266	5,080
	1975	144,240	24,000	119,820	62,266	9,890
	1980	222,740	42,460	224,230	111,629	20,430
The Niger	1970	330	110	510	200	115
	1975	910	340	1,530	620	270
	1980	2,380	920	4,130	1,660	635
Dahomey	1970	2,660	520	2,460	1,130	255
	1975	3,390	790	3,660	1,610	410
	1980	5,620	1,260	6,400	2,840	670
Togo	1970	3,000	2,070	6,390	2,346	380
	1975	7,790	4,500	14,710	5,326	740
	1980	12,150	6,850	23,070	8,416	1,125
Ghana	1970	8,440	2,260	13,205	5,971	1,280
	1975	35,150	9,770	44,855	22,362	3,810
	1980	45,330	13,900	67,355	31,322	6,700
The Ivory Coast	1970	81,650	6,360	31,936	22,131	1,700
	1975	118,590	10,420	52,140	35,600	2,540
	1980	133,170	12,910	68,040	43,560	3,880
Upper Volta	1970	780	364	1,490	270	180
	1975	1,740	784	3,300	1,250	390
	1980	3,430	1,514	6,580	2,500	840

Table 70 (cont'd)

Countries	Year	Fixed investment ($1,000)	Working Capital ($1,000)	Annual production value		Labour force
				Gross ($1,000)	Added ($1,000)	
1	2	3	4	5	6	7
Guinea	1970	8,400	1,710	7,080	3,426	550
	1975	18,090	4,180	17,405	8,442	1,265
	1980	26,250	6,760	28,545	13,632	2,170
Sierra Leone	1970	2,520	680	3,139	1,330	390
	1975	3,830	1,000	4,680	1,980	590
	1980	6,460	1,980	9,500	3,950	1,340
Liberia	1970	870	310	1,350	540	230
	1975	1,160	430	1,950	780	340
	1980	2,040	770	3,550	1,420	570
Gambia	1970	20	10	50	20	20
	1975	230	100	450	180	70
	1980	230	100	450	180	70
Senegal	1970	3,990	1,440	5,362	2,441	505
	1975	6,760	2,860	14,150	6,060	1,065
	1980	29,080	10,200	43,180	19,602	3,060
Mauritania	1970	-	-	-	-	-
	1975	-	-	-	-	-
	1980	200	80	350	140	35
Mali	1970	240	90	440	180	95
	1975	3,510	1,540	5,715	2,352	655
	1980	6,160	2,500	10,215	4,152	1,370
Total	1970	225,400	32,024	149,532	83,251	10,730
	1975	345,390	60,714	284,365	148,828	22,035
	1980	495,240	102,204	495,595	245,003	42,895

IV. 15. Final observation

In making use of this report, account must also be taken of the dynamic nature of the chemical industry, and the substantial technical progress observable each year in this field.

It is possible that the improvement in present techniques, the development of new processes, the use of cheaper raw materials than those at present in use, or the combination of these elements and other factors, may result in the possibility of exercising a certain amount of control over present world trends, where certain products are concerned, and bringing about the necessary changes which must be made, particularly in regard to the long-term stages of the industry (1975 - 1980).

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