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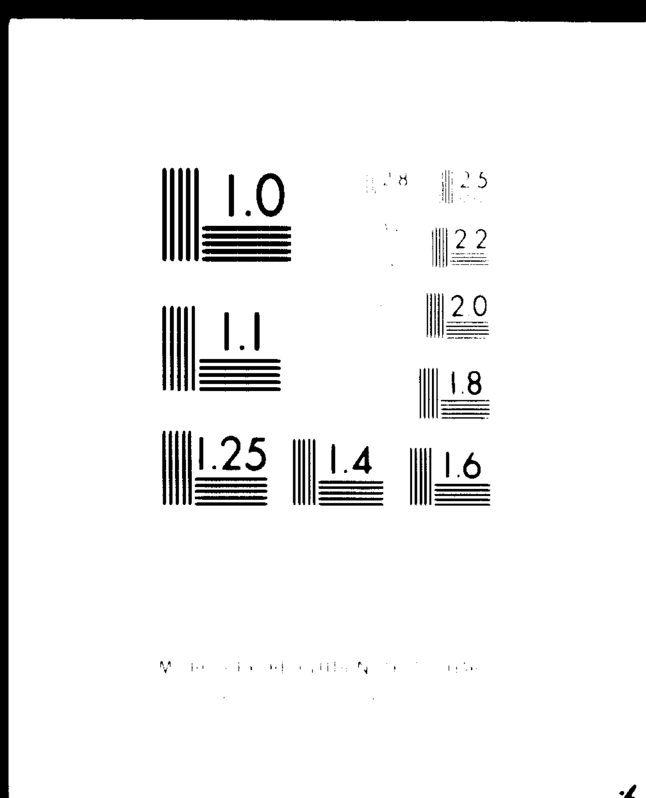

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At the moment, consumption of compound breaks down as follows:

- 31 % for shoe manufacture
- 26 % for films and coated fabrics
- 21 % for cables
- 14 % for rigid pipes.

In 1975 the rigid pipes sector will in all likelihood account for the greatest proportion of the consumption with 37 per cent of the total, followed by shoe manufacture with 24 per cent and cables with 18 per cent. East Pakistan consumed 35 per cent of the production of compounds in 1968, and this proportion will probably increase to 48 per cent by 1975.

7.04 Consumption of alkyd resins was 3,230 t in 1968, and demand is expected to be 5,750 t in 1975, given a growth rate of 8 per cent in West Pakistan and 13 per cent in East Pakistan. The resins consumed in Pakistan are mostly oil modified, with an oil content of 60 per cent. 97 per cent of all alkyd resins are used in paint manufacture.

The report recommends setting up a first plant in 1970 and a second in 1972, each with a capacity of 3 t/day, to supply the smaller paint manufacturers.

7.05 Consumption of nylon fibres was estimated at 4,170 t in 1968, and it is expected to rise to 11,000 t by 1975, representing an average growth rate of 15 per cent.
88 per cent of the consumption in 1967 went on yarn and 8 per cent on twine for fishing nets. The share of yarn is expected to increase to 96 per cent by the end of the period, while that of twine will drop to barely 4 per cent. East Pakistan's share of the consumption is likely to remain roughly constant at 7 to 8 per cent.

Sanctioned or existing capacities come to 4,600 t, and the report suggests that a plant with an additional capacity of 10,000 t/y should go into production in 1972.

The production of nylon seems a particularly attractive propostion as it would release large quantities of cotton for sale abroad, resulting in a net gain in foreign exchange revenue.

7.06 The market for polyester fibres has hardly been developed so far, partly as a result of the export policy and partly owing to the complexity of processing. In the last four years consumption has fluctuated between 150 and 350 t/y.

Such low consumption figures of a mass consumption product like polyester fibres make it impossible to give a reliable estimate of future demand, which can be regarded as potentially very high. We think that it can be raised to approx. 4,000 t by 1975 and have accordingly recommended a plant of this capacity.

7.07 The demand for dioctyl phthalate (DOP) is rising very sharply at the moment as PVC is being increasingly compounded in Pakistan. By 1971 the compounding capacity is to be increased by 15,000 t/y, equivalent to 47.5 per cent of the present-day consumption of soft PVC. The report concludes that after 1970 the entire quantity of soft PVC consumed in Pakistan will be compounded in the country.

Accordingly the demand for DOP is expected to go up from its present level of 1,350 t to 5,200 t in 1975. However, if the price of soft PVC drops, the demand for DOP rises; if the price were reduced 40 per cent, the demand for DOP would most likely go up by 36 per cent.

As the minimum capacity of such plants is generally considered to be 500 t, it would be advisable to establish two 3,000 t production units in 1970, one in East and one in West Pakistan. If PVC prices were reduced by 40 per cent, a third 3,000 ton unit could go into operation in 1975.

7.08 At the moment there is no demand for 2 ethyl hexanol. But if the production of DOP is started, demand will soon become substantial, and will amount to 5,350 t at constant prices of soft PVC in 1975. This figure would be even higher if the price of PVC fell.

7.09 It should be possible to expand the market for dodecyl benzene sulphonate quite considerably. Imports at present come to 625 t, equivalent to 3,125 t of washing powder, but demand is kept at an artificially low level as it is not possible to import raw materials on a sufficient scale. Dodecyl benzene sulphonate is mainly used in the manufacture of industrial detergents in Pakistan.

Lever Brothers (Pakistan) Ltd., Karachi, would be willing to take 10,000 t of powder = 2,000 t of dodecyl benzene sulphonate at any time. In these circumstances, and assuming that there will be a big increase in the consumption of dodecyl benzene sulphonate for industrial detergents, which are chiefly used in the textile sector, Battelle thinks that demand in 1975 can be estimated at very nearly 10,000 t of dodecyl benzene sulphonate. This would require the manufacture of 6,850 t of dodecyl benzene, the primary product.

We estimate that in 1975 37 per cent of the total consumption will go to household detergents and the remaining 63 per cent will be consumed by industry, hotels, the railways etc.

The estimated sales in 1975 are equivalent to a washing powder consumption of 120 g per head of population or about 20 per cent of the total consumption of household detergents.

Battelle recommends the setting up of a 10,000 t plant for dodecyl benzene and sulphonate each in 1972/73.

7.10 The demand for sulphur is undergoing an immense boom at the moment. In 1967/68 demand is estimated at 26,000 t, but it is expected that by 1970/71 it will have soared to no less than 151,000 t. The fertilizer industry will be the main purchaser.

The report suggests that it would be worthwhile to study the possibilities of increasing domestic production of sulphur from ores and gypsum in a separate, detailed investigation.

7.11 Pakistan's needs of glycerine are completely met from domestic production from spent soap lyes. Demand in 1967/68 was 2,210 t, and is expected to be 5,700 t in 1975/76, some 13 per cent of which will be in East Pakistan.

The main purchaser of glycerine is at present the pharmaceutical industry (38 per cent), followed by the cigarette industry (29 per cent) and the cosmetics industry (7 per cent). Nowadays exports are also quite substantial (11 per cent).

After 1970, new capacity will have to be created, in addition to what already exists, but it is advisable to operate these plants too on the basis of either spent soap lyes or fat splitting.

7.12 LPG first appeared on the Pakistan market only a short time ago, but it looks as if its sales prospects are good. Present consumption is 1,500 t, depending primarily on planned and existing capacities. On the basis of the planning of National Refinery, Pakistan Refinery, Attock Oil Company and East Pakistan Refinery, approx. 70,000 t of LPG will be consumed in Pakistan in 1975. This would enable some 20 per cent of the anticipated consumption of kerosene to be saved.

8. Pakistan is poorly supplied with vital raw materials such as metals, timber and fats.

Even these days 50 per cent of West Pakistan's requirements of timber have to be imported, and it is not to be expected that there will be any substantial improvement in this situation in the future, as the demand for wood goes up 6 to 7 per cent every year, while the "growing capital" increases at a rate of only 2 to 3 per cent. Even the planned increase in timber utilization will not solve this problem altogether.

The scarcity of metals of all kinds is evident from the high level of imports. According to available figures, metals and semi-finished metal components to the value of at least 764 million Rupees were imported in 1966/67.

Large quantities of foreign exchange are also required to import fats for the soap industry; imports of coconut oil and tallow amounted to 70 million Rupees in 1966/67.

This makes the replacement of some of the major imported conventional raw materials by petrochemical raw materials a matter of prime importance.

The chief replacements that the report advocates are:

8.1 The replacement of pipes suggested in chapter 5, which is quite likely to be implemented, covers some 70 per cent of the production of G.I. pipes in 1975. Replacement beyond this figure is hardly feasible without damaging the existing G.I. pipe industry.

8.2 Judging by experience in Europe, the wooden crates used for the transportation of drinks can readily be replaced by products on a polypropylene base, which would last an estimated 6 to 8 years under the conditions prevailing in Pakistan. The demand occasioned by the production of PP crates is anticipated to be 240 t of polypropylene in 1970 and 275 t in 1975.

8.3 Metal containers for cosmetics, medicines, food, mineral oils, detergents and other things can be replaced by articles of polypropylene. Packaging materials of all kinds are an important factor in the economies of industrialised countries today.

The report discusses the use of polypropylene to make containers for vegetable oils; 2,000 t of PP could be applied for this purpose in 1975.

8.4 In addition to the traditional raw materials it would be possible to replace some imported plastics by home-produced products. This applies particularly to the greater part of the imported HD polyethylene and to a small proportion of the high-impact polystyrol, which could be replaced by polypropylene. This would lead to an additional demand for polypropylene of approx. 1,600 t in 1975.

8.5 Cotton is one of the relatively few good export articles Pakistan produces. Any increase in cotton exports would therefore be most welcome.

A possible way of achieving this is through substituting nylong for the cotton. As one unit of nylon can replace about 4 units of cotton it is recommendable to increase domestic nylon production and nylon sales. The cost of the imported caprolactam and the depreciation of the plant is substantially less than the revenue from the cotton which is exported, so that considerable sums of foreign exchange are earned. Preliminary calculations suggest that there would be a gain of approx. $ 1,800 in foreign exchange for every ton of additionally sold nylon.

8.6 The study also considers whether it is worthwhile to save petrol additives by using ethyl alcohol for this purpose. If the TEL additives in standard-grade petrol were replaced by an approx. 11.5 per cent addition of alcohol, the consumption of alcohol would go up by 38,700 t in 1969 and by some 47,000 t in 1975. This would make a major contribution towards solving the molasses problem and towards employing the ethyl alcohol production capacity which is standing idle at the moment.

Switching to alcohol additives in the petrol would presumably necessitate certain modifications to the sparking plugs and carburetter adjustment of the engines.

8.7 The preliminary calculations of the report show that it will be beneficial to substitute imported dodecyl benzene for the imported fats. After making allowances for the washing power and the varying efficiency with which it is used, foreign exchange savings of US$ 0.25 per kg of washing powder can be expected.

9. To help ensure that sales of the petrochemical end-products and intermediates analysed in this report develop favourably, Battelle recommends a number of measures designed to promote the home market and the export trade.

9.1 Various measures, some general and some specific, are suggested to promote the domestic market, including:

- wider dissemination of knowledge about possible applications of petrochemical products by means of technical trade journals

- techno-economic studies on the applications of petrochemical products in particular industries

- development and introduction of standards for plastics, semi-finished plastic products etc.

- analysis of technical problems arising when substitutes for certain products are introduced

- direct purchases by Government organisations (polyester, insecticides)

- enlargement of the planned Plastics Service Centre in Sialkot or establishment of a second Plastics Service Centre

- replacement of imported twine by locally-produced products

- promotion of marketing, including market research, by training personnel in foreign firms and by fostering suitable consultant firms.

In connection with the replacement of imported twine, the report suggests making direct grants to the Fisherment's Co-operative Societies.

9.2 The study recommends the institution of joint ventures with experienced foreign firms, which should provide the technical know-how, have a share in the commercial management, and above all should guarantee the sale of the petrochemical products in foreign markets at fixed prices.

It also recommends the setting up of a Government Export Organisation to promote exports of all kinds. Such a company should be organised along strictly commercial lines and should be headed by a highly qualified sales manager. The objectives of this firm might include, among other things:

- selection of suitable new export products
- export market research
- improvement of domestic products
- coordination of domestic production
- pre-shipment control.

It is also suggested that the excise duty levied on nylon yarn should be abolished. This would enable the nylon price to be reduced by about 20 per cent, which would release considerable quantities of cotton for export. The resultant profit is estimated at $ 3.3 million in 1971. The drop in tax revenue could be offset by increasing the tax on cotton yarn by some 0.30 Rs. per kg.

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Measures and Weights

1 US $	=	Rs. 4.76
1 km	=	0.62 British miles
1 m	=	1.09 yards
1 cm	=	0.39 inch
1 mm	=	0.04 inch
1 m^2	=	1.20 sq. yards
1 ha	=	2.47 acres
1 m^3	=	1.31 cu. yard
1 l	=	0.22 Imp. gallons
1 ton	=	0.98 long ton
1 kg	=	2.20 lbs.

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1. Introduction

In May 1968 UNIDO, Vienna - New York, and Battelle-Institut, Frankfurt/Main signed a contract covering a comprehensive market study of petrochemical end-products in East and West Pakistan. In this contract, registered with UNIDO as CON 30/68, Battelle was requested to investigate above all the volume, development and structure of the production and consumption of 25 chemical products and to elaborate proposals for the production programme of the petrochemical industry which it is planned to establish in Pakistan.

Following discussions with UNIDO representatives in Vienna, and members of the UN Project "Pre-investment Studies for the Promotion of the Petrochemical and Fertilizer Industries", Rawalpindi, Battelle further agreed to extend the scope of its work by including sulphur and polyvinyl acetate in the study.

Moreover, in an exchange of telegrams a short time before the conclusion of the contract, Battelle agreed to make a rough estimate of the market for LPG.

Although the time available to the Battelle team was fairly short for this extensive programme, Battelle decided to include a number of other products in the investigation, to obtain a better overall picture of the subject. In most cases it was possible to cover these products with comparatively little expenditure of time. The products concerned were assumed to be of potential importance for the pre-investment studies and planning work which are to follow the market study, even though the market survey might not yield a positive result. Of the synthetic resins, solvents and chemicals additionally included in the investigation, the following should be mentioned:

- melamine formaldehyde
- epoxy resins
- polyurethanes
- tetraethyl lead
- methyl-ethyl ketone
- xylene
- toluene
- benzene
- hexane

Consequently, all the important synthetic resins, solvents, plasticisers, rubber types, and man-made fibres were covered.

It should be noted that the estimate of future demand was extended up to 1985 at the urgent request of the UN Project team in Rawalpindi. We agreed to comply with this request, but we expressed our scepticism about such long-term estimates under the conditions prevailing in Pakistan.

As stipulated in the contract, the work was carried out in co-operation with the Investment Advisory Centre of Pakistan. This Institute did some of the field work in Pakistan and assisted in solving organisational problems. Battelle-Institut was entrusted with the general direction of the project and is responsible for the investigation.

All weights and measures in this report are in metric units. Prices and values are either indicated in Pakistani Rupees or in US $. In writing the report consideration has been given to usage in Pakistan since the study will ultimately be made available to the Planning Commission of Pakistan.

2. Concept

The present investigation is essentially a market study. Besides the usual statements on volume, development and structure of the marketing and manufacture of petrochemical products, it points out possible substitutes for different raw materials and intermediates, and also proposes a series of measures affecting the demand for the different petrochemical products examined, which at present is still relatively small.

In carrying out the investigation the following problems had to be solved:

- The investigation covered a large number of industrial sectors, some of which are made up of several hundred enterprises. Full coverage of the entire industry was out of the question for reasons of funds and time.

- The addresses of the firms in question were unknown or only partly known. There is hardly a line of production which has comprehensive or generally available lists of addresses.

- The persons who gave information did not always make clear statements, either for business reasons or, as is often the case with smaller firms, due to lack of accurate knowledge of the facts. Linguistic misunderstandings also played a certain part.

- Some firms refused to give the information desired on principle, or by various subterfuges they made it impossible to obtain.

Executive Reading

1. This is essentially a market study, analysing the sales of some 40 products on the Pakistani market. The most important groups of products investigated are:

   - thermoplastic resins
   - thermosetting resins
   - synthetic fibres
   - elastomers
   - solvents
   - insecticides
   - detergents.

   In most of these groups, all the products of interest for the Pakistani market are considered in the report.

   The market study is supplemented by a production programme, worked out on the basis of the existing and planned production facilities, or of the minimum capacities in the case of completely new industries. The report also analyses which quantities of the selected chemical end products and intermediates are required, and what effects domestic production will have on the balance of payments.

2. A special feature of conditions in Pakistan is that the prices of many imported chemical products are extremely high, mainly because they have to be imported on Bonus Vouchers or a Cash-Cum-Bonus basis. Some articles are also subject to high import duties. As a result, domestic prices are in some cases 300 per cent above the c&f price.

- Projections to the future can seldom refer to reports which are reliable or have been established on the same basis, or to other basic statistics.

- Basically, in a developing country all predictions meet with the difficulty that the number of applications of a raw material can change radically in a short space of time. In the field of plastics, for example, certain types of applications have not yet been exploited in Pakistan at all.

The working concept of BATTELLE-INSTITUT gave due consideration to these problems and difficulties. The staff members participating in this projects were familiarised with conditions in Pakistan and with related fields of technology. To obviate the risk of delays due to illness or accident, each team member had acquainted himself with at least one field of technology outside his own, so that work could continue without interruption even in the absence of one of the team. Moreover, all the necessary questionnaires and other documents were prepared before the departure of the team.

As indicated before, the limited time available meant that only a section of the total(viz. about 600 firms, associations, and authorities) could be interviewed, while the total number was serveral hundred units larger. To obtain reliable statements in spite of this, a modified concentration principle was applied: only the firms with the biggest "market shares" were interviewed initially, which made it possible to cover at least 50 per cent of the market in the first survey. For the remaining less important firms a representative sample survey was made.

To be able to apply this procedure first of all to the individual products or groups of products, it was necessary to ascertain which lines of manufacture figure as consumers, producers or sellers of the individual raw materials in Pakistan. In this respect it was important to classify the fields of production in such a way that those secondary products were covered which are similar in nature. For example, the processors of PVC have been classified as producers of

- footwear
- films and coatings on fabrics and paper
- wires and cables
- rigid pipes
- various products.

In a number of production lines it was possible to obtain a hundred per cent market coverage. In the other cases involving intermediates and products manufactured by small industries we had to use the selection procedure described above. An average of about 80 per cent of the total consumption of the petrochemical products included in the survey were covered by direct interviews.

Systematic interviews require sufficiently reliable address lists. These were compiled by making inquiries of the competent authorities including the Department of Investment Promotion & Supplies, Directorates of Industries, Central Statistical Office, as well as by consulting the sanctioning banks and large firms in the fields of production concerned. As far as necessary, the lists were supplemented during the interviewing phase. This happened whenever it became clear in the course of field work that one or several enterprises were important in some special fields.

These statements show that it was impossible under the prevailing conditions to make a real random test, a circumstance that is fairly common in developing countries. If a larger number of firms are involved, a complete list of all of them can only be obtained after long and thorough investigations.

To solve the problem of inaccurate and deliberately wrong information the questionnaires contained built-in control questions, refering mainly to the particular firm, but also partly to other firms in the same line. BATTELLE's concept was designed to obtain within the time available as much additional information as possible by complementary inquiries at different levels, such as importers, wholesalers, the authorities, in order to be able to compare several statements with each other. In addition, the available statistics and other relevant publications were evaluated. In fact in this way we have apparently been able to eliminate incorrect statements to a very large extent.

Lack of co-operation on the part of some bigger firms has in most cases been compensated by making estimates with the assistance of the relevant associations and competing firms. In one case the Planning Commission was asked for support.

Our estimates of future consumption and imports are generally not based on an extrapolation of time series of the past, because they were available or could be summarised only in a few cases, or they appeared unreliable. Instead we have derived a series of anticipated growth rates for the individual petrochemical and other products (sulphur), classified by production methods and in some cases also by the Province. These rates of growth have been applied to the present figures to yield the future quantities or values. Thus, the general growth rate in the consumption of PVC results from the sum of all estimated consumptions of the individual sectors in East and West Pakistan. The figures calculated in this way show the consumption estimates for the future under the present conditions and those we expect for the future. This involves the assumption that substitution will not increase above the level prevailing in the past and that the field of application will not be extended very much. Both of these factors are fairly uncertain and are dealt with in section 6.

Regarding the forecasts of consumption, the estimates agreed upon in the contract are indicated and discussed in the appropriate sections of the report. The extension of the estimate subsequently promised to representatives of the UN Petrochemical Project in Rawalpindi is contained in the Appendix. Battelle is of the opinion that the conditions found in Pakistan make seven years the utmost period of time for which an estimate can be made.

A summary of the primary uncertainties may help to substantiate our arguments:

a) The industrial structure and in part also the consumption structure of the population changes rapidly in a dynamic developing country. These chances necessarily imply major shifts in requirements of raw materials, above all of the non-traditional ones such as plastics. It cannot be predicted what the various structural changes will be, what their extent will be within the next ten years, when specific changes will set in, how rapidly they will take place, what the development of technology will be, etc.

b) The import policy in Pakistan is subject to frequent changes, often of a fundamental nature. This implies corresponding effects on price relations and the availability of various goods and, consequently, a serious impact on consumption and manners of application.

c) The chemical products covered by the investigation are for the most part greatly affected by technological progress in their production and application. It is easy to imagine possible changes if we recall the rapid development of certain plastics. Even though one may expect these changes to be not quite as drastic in the future, they are likely to have an effect, all the more so as many forward-looking industrialists, technicians and officials in Pakistan are prepared to adopt quickly new technical developments emanating from the industrial countries.

Therefore, we feel that it is an illusion to take the present structure of the demand for plastics, solvents and other chemicals as a basis for long-term estimates. This viewpoint is underlined by the fact that the probability of alternations of the price relations will increase in the long run.

Another aspect of our concept results from the co-operation with other institutions. Our work was based on the principle of close contact with those participating in the project, that is to say with the members of the "Petrochemical Project", with the Planning Commission, and with our subcontractor, the Investment Advisory Centre of Pakistan. This co-operation was useful on the one hand as it facilitated our work and enabled us to obtain information; on the other hand we were able to give a certain amount of assistance to the respective institutions.

This applies in particular to the IACP. It was the expressed wish of the Planning Commission that the Battelle team might help to enlarge the know-how of the Advisory Centre. The efforts of the Battelle team were directed towards securing the participation of the IACP in every phase of the investigation on the report and in drawing up the report. For this reason the team invited a staff member of the Advisory Centre to spend six weeks in Frankfurt in order to take part in the preparation of the report.

The statements made so far implied that estimates of future consumption depend primarily on the following conditions:

a) constant macroeconomic rate of growth
b) no substantial technical changes
c) constant consumption and working habits
d) constant prices.

The last factor has not yet been discussed. It is generally neglected in studies of this type, at least where developing countries are concerned. Battelle is of the opinion that the assumption of constant prices here will in some cases lead to incorrect results in the forecasts. Above all this applies to cases where the price elasticity is high, as with PVC and polyethylene. It is known that the prices of a number of petrochemical products in Pakistan are very high at present. The main reason for this situation is that certain articles have to be imported on Bonus Vouchers. The domestic PVC price is about 300 % higher than the c&f price. As Pakistan is making considerable efforts to build up an efficient petrochemical industry, however, it may be assumed that the sales prices of the future production in some cases will be much lower than the present prices.

In this connection the price elasticity plays a part that may be very important. Therefore, projections based on the actual price elasticity should be made for various prices. Unfortunately hardly anything is known about the actual figures of price elasticities in Pakistan. Apart from some calculations on corn prices, no investigations in this field are available in Pakistan, as shown by inquiries addressed to the Planning Commission, the Institute of Development Economics, the CSO and several large firms. The data necessary for the calculation of the price elasticities is customarily available only from the enterprises or from certain public institutions. For lack of the necessary data the consultant is not in a position to calculate the elasticities. In order not to ignore them completely, Battelle made the calculations of demand on the basis of estimated elasticities in cases where the price factor is likely to be of major importance.

3. Notes on Price Elasticity

Due to the conditions mentioned in section 2, it is impossible to make accurate statements on the way the demand for particular petrochemical end-products will develop when prices are considerably decreased.

This is without doubt insignificant in a number of cases, as the quantities in demand are in any case too small to make a domestic production dependent to any considerable degree on increases in sales of up to 100 per cent. This applies for example to such products as

- ABS
- synthetic rubbers
- butanol
- chlorinated hydrocarbon solvents
- ester solvents
- refrigerants
- anti-knock additives
- toluene

In other cases, no extreme reductions in price are to be expected in general, either because the present inland prices are not excessively high or because reasons of Pakistan's present production technology conditions rule out price reductions. This group of products includes for example:

- ethyl alcohol
- acetone
- DDT
- BHC
- glycerine

In the cases of DDT and BHC, the price is a less decisive factor, as the products have until now mainly been sold to agricultural authorities, for whom the price is not necessarily the decisive criterion.

As to the second group of products, one could naturally investigate in what manner the demand will alter when prices are increased. But as the aim of these investigations is to determine whether and in what cases domestic production capacities can be created, price increases have in this connection only subordinate significance. This is due to the fact that where new production is considered, the price is either already very high as a result of imports on Bonus Vouchers or studies of existent concerns have shown that domestic production at inland prices is feasible. For this reason, increases on the present price have not been taken into consideration in our study.

In a third group of products, price fluctuations play only a subordinate role because they have very little effect on the price of the end-products. The main product of this group is urea formaldehyde, which is mainly used in small amounts in the manufacture of chipboard and plywood. Similar considerations apply to dodecyl-benzene sulphonate, the market for which can in any case be greatly affected by marketing measures. Indirectly, methanol must also be included in this group. The use of methanol in the aviation field cannot be influenced by price reductions, nor can the price elasticity be very great in the case of the formaldehyde manufactured from it. This is due to the fact that the formaldehyde is in the main used for urea formaldehydes and phenol formaldehydes, whose price is relatively inelastic. In the case of phenolic resins the sale can be affected to a major extent by price reductions. This applies in particular to the moulding compound. The possibilities here are however also limited, as the present preference is for other moulding materials.

Only on the small scale on which it is used in the manufacture of melamine resins can the consumption of formaldehyde be regarded as price-elastic. If one however takes into account what percentage of the price of these resins represents the costs for formaldehyde and calculates the formaldehyde consumption in this limited sector back to the total consumption of methanol, it is found that price changes have only limited effects on methanol sales.

In the cases of carbon black, sulphur and alkyd resin, the demand is hardly affected by price reductions, either because the products have to be used in certain technical relationships in the manufacture of other articles or because the product concerned is already being used in the possible fields of application.

Thus only the following products remained as a basis for an experimental estimate of the influence of price reductions on demand:

- polyethylene
- polypropylene
- PVC
- polyvinyl acetate
- melamine resins
- polymethacrylate
- polyamide fibres
- polyester fibres
- dioctyl phthalate
- 2-Ethylhexanol

The demand for dioctyl phthalate and 2-ethylhexanol itself cannot be described as being highly elastic. There is however a high cross-price elasticity with plasticised PVC.

For the rest price changes have only been discussed where they appeared possible.

It is obvious that such high prices seriously impede the replacement of conventional raw materials by petrochemical ones, but on the other hand preliminary calculations show that in a number of cases the cost of production in Pakistan would be markedly lower than current market prices. Thus it would be possible to reduce the home prices of some products quite considerably, once their domestic production had been started. This would be a great advantage, as a number of the products under investigation must be regarded as highly price-elastic. The result would be an expansion of production, including the replacement of certain products, and a reduction in relative capital expenditure.

Price elasticity is a factor of considerable importance in the estimates of future demand, but no figures are available showing price elasticities in the relevant sectors in Pakistan in the past. Battelle has therefore made use of price elasticities estimated on the basis of income elasticities calculated by the Planning Commission of Pakistan.

3. The country's export policy must be adjudged very favourable to the entrepreneur, but evidently managerial circles in Pakistan have very little inclination to face the rigours of the export trade, except for the traditional export products such as jute, cotton or hides. The calculations of the proposed capacities were therefore based on the estimated demand of the home market only.

This does not however mean that no exports are possible during the first two or three years of the plants' existence. On the contrary, a good deal of unused capacity could be utilised in producing goods for export. If the export business prospers during this period, it would of course be possible and advisable to plan subsequent plants on a correspondingly larger scale.

As we had no empirical values for price elasticities, we have made an attempt to estimate the price elasticities for the above-mentioned petrochemical products from income elasticities. Although our experience gained in years of work in numerous developing countries has been of great value here the estimate is necessarily very rough.

Nevertheless this estimate will provide the planning authorities with better guiding values than figures which are based only on the assumption of constant prices. The planning authorities may possibly be able to determine more accurate values, so that our basic figures can then be correspondingly amended.

We have based the estimate of price elasticity on income elasticities calculated for end-products such as textiles, footwear, rubber articles, electrical goods, etc. for the years 1963/64. [1] The income elasticity for all of these articles was of the order of -1.5. The price elasticities for such products are naturally considerably higher, as the incentive to spend more money for a given product is in the case of price elasticity much greater. After discussions with manufacturers of plastic materials we have come to the conclusion that a value of at least - 2.5 can be assumed for the end-products manufactured from the petrochemical materials in question. If under the conditions prevailing in Pakistan we assume the value of raw materials as 50 per cent of that of the end-product, the result is that a price decrease for raw materials leads to a price elasticity for these of - 1.25.

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1) See Planning Commission of Pakistan, "Report of the Consistency Committee on the 3rd. Five Year Plan", July, 1965, p. 115.

This value takes only the effects on sales through the demand for the end-product into account. Also, in many cases the increased demand is due to technical reasons making the substitution of different raw materials advisable when prices sink. As this substitution process cannot be predicted and our calculations are in any case only to be regarded as a rough estimate, we have assumed a basic value of - 1.25 in our considerations.

This value is however subject to modification for the individual products. In cases where only part of the demand can be considered as subject to price influence we have converted the price elasticity correspondingly for the total demand. The elasticity was thus also modified in cases where the percentage of the raw material costs appeared to deviate widely from the value we had assumed.

We would also like to point out that the value we assumed for price elasticity is valid only under the assumption that no similar petrochemical products of Pakistani manufacture are substituted. This means that we have assumed that the prices of all products manufactured within the country which are in close substitution relationship to each other would be simultaneously reduced at an approximately uniform rate.

If this assumption is not satisfied, substitutions would naturally be carried out. This is particularly true for PVC and polyethylene, where the substitutions could be of considerable extent. In this case, the price elasticity of the cheaper raw material would naturally be very much higher than - 1.25, whereas the demand for the substitute would be reduced.

4. Governmental Activities influencing the Consumption and Production of Petrochemical Products

Whether petrochemical products are produced within the country or imported, in one form or another the demand for such items is greatly influenced by certain Government policies. This applies indirectly even if it is the raw material supplies for domestic production that are affected by such measures.

The main Governmental actions having a bearing on the markets of petrochemical products are

- import regulations
- export policy
- sales taxation (including customs duties)

The importance of these factors is to be discussed in the following sections 4.1 to 4.3.

4.1 Import regulations

Pakistan, like other developing countries, is striving hard to accelerate the pace of development and attain a self-sustaining economy in the shortest possible period. Large amounts of money are being spent each year on imports of industrial raw materials, machinery and capital goods, spare parts and essential consumer items. The imports are partly financed from the country's own resources and partly from foreign credits, loans, grants and foreign private investment. Import controls are regarded in Pakistan as tools of economic planning to achieve the set objectives defined in the Development Plans.

Pakistan had followed a fairly liberal import policy up to 1964-1965. As a result of the availability of loans, grants and commodity aid, most of the industrial raw materials were allowed to be imported freely or through import licences. The flow of economic assistance also enabled machinery and capital goods to be imported without any serious restrictions.

At the end of 1965 Pakistan had to face serious foreign exchange difficulties. These were created by the Indo-Pakistan conflict in September 1965, which caused increased expenditure on defence, heavy imports of food grain because of crop failure, and reduced inflow of foreign economic assistance. The foreign exchange difficulties created the necessity of selective imports and boosting exports to earn more foreign exchange. The import policy in the year 1967-1968 continued to be selective, with the objective of meeting the consumer needs of essential items and at the same time stimulating industrial production and exports through a liberal supply of raw materials to export-oriented industries together with a fairly liberal supply of the inputs of agriculture to achieve self-sufficiency in food.

The import policy is revised every six months and normally announced in January and July. Imports are effected under different rules. Accordingly, the commodities are classified under separate lists, viz:

- Free List
- Licensable List
- Cash-Cum-Bonus List
- Bonus List
- List of Banned Items.

In addition, some items may be imported only by the Trading Corporation of Pakistan.

The major features of current import policy are listed below.

Free List

Items specified under Free List can be imported without obtaining a licence. Although the import procedure is relatively simple, there are limits for the imports, and only certain groups of firms may import under Free List. At present (late 1968) only industrial consumers holding an entitlement and commercial importers who have imported the item in question in the first half of 1968 are permitted to import under Free List. In the case of the industrial consumers the size of the imports is limited by their entitlements, while the commercial importers are not allowed to exceed the imports of the first six months of 1968.

The Free List contains 14 items in the import policy announced for July - December 1968. These items are important industrial inputs like iron and steel, tools and workshop equipment, essential chemicals, fertilizers, wood pulp, asbestos fibre, marine diesel engines, etc. The petrochemical items importable under this category are insecticides and pesticides (excluding BHC), carbon black, and nylon twine for the fishing industry. In addition to these, items classified as "chemicals" are imported under Free List. Among them are solvents, plastizisers, anti-knock compounds, dodecylbenzene. Before 1968 these items were imported under Licensable List. Apparently the Government was endeavouring to simplify import procedures.

The items to be imported under Free List generally have to be imported from specific countries only. At present letters of credit for the items of interest may be opened only with the countries indicated:

- chemicals and dyes: USA, China, France, Czechoslovakia, Poland
- nylon twine: USA
- carbon black: USA, China, France, Czechoslovakia, Poland

Additional sources of supply are announced during the course of a shipping period according to the availability of loans and barter agreements.

Licensable List

Under the Licensable List specified items can be imported by obtaining a licence from the Ministry of Commerce or the Chief Controller of Imports and Exports. In the import policy announced for July - December 1968 this list contains 31 items, whereas there were 93 items in the import policy list for July - December 1967. This list includes essential items like petroleum oils and lubricants, drugs and medicines, books, dyeing and tanning substances, scientific instruments, tractors.

The only petrochemical item of interest included on this list is refrigerant gases in cylinders other than ammonia. This means that at present chloro-fluorine cooling media can only be imported by a few authorised importers.

Cash-Cum-Bonus List

Under this system cash licencing equal to 50 per cent of the c&f value is allowed to the eligible industrial consumers and commercial importers for certain items. The importers, however, have first to buy Bonus Vouchers for the other half and obtain a licence under Bonus Voucher for this portion [1). There are 94 items on this list in the import policy announced

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1) For Bonus Voucher see section 4.2

for July - December 1968. One year earlier this list contained only 11 items. It now includes items such as ball and roller bearings, components for electronic industries, graphite electrodes, pigments and dry colours.

The petrochemicals items included on this list are synthetic rubber, PVC resins for the rigid pipe industry and methanol (for East Pakistan only). Further items discussed in this investigation are raw natural rubber and latex.

Bonus List

This list of items which may be imported against 100 per cent purchase of export Bonus Vouchers is also announced in the import policy. It contains those importable items which are not covered by Free List, Licensable List and Cash-Cum-Bonus List. At the same time the items covered by the first two Lists are also made importable under the 100 per cent Bonus Import List.

Imports of all types of petrochemical items are covered under 100 per cent Bonus List. Generally speaking these items are mainly synthetic fibres, resins, and plastics including plastic raw materials for the paint industries.

Export Performance Licences

In addition to items importable under the above-mentioned lists, import licences are granted against export performance. This system mainly serves to stimulate exports. Certain types of exporter-manufacturers can get a cash licence to import raw materials, packing materials and spare parts for export products up to 30 per cent of the f.o.b. value.

Items Banned for Importation

As mentioned, the importation of certain items produced in the country has been banned to ensure the optimum utilization of country's production capacity. Some of these items are rayon yarn, soda ash, hydrogen perioxide, bleaching powder, sodium sulphate and ammonium chloride. The petrochemical items banned for importation are acetone, formaldehyde, methanol (for West Pakistan only), ethanol, BHC and glycerine (except for the pharmaceutical industries under Bonus Voucher). DDT may only be imported by the Malaria Eradication Programme under USAID loan.

Trading Corporation of Pakistan

This corporation is also an important feature of the import policy. It was set up in July 1967 for the implementation of barter agreements with Socialist Countries. It negotiates contracts for exports to Socialist Countries and also provides certain export facilities to the private sector by imparting specialised knowledge about the Socialist Countries.

The corporation imports some bulk items from countries other than the Socialist ones. It operates only as a commission agent and imports goods on Government account, allocating them to commercial importers and industrial consumers under Government direction. The Government announces from time to time the items and the countries from which imports can be made so that eligible importers can place orders with the corporation.

During the second shipping period 1968, the only items discussed in this study that have to be imported by the corporation are natural rubber and sulphur. The idea behind this system of imports is to secure economy by savings in freight and to invite competitive quotations for bulk purchases. The corporation charges a commission for its services and transfers any profit to the Government.

To make this outline fairly complete, the trade agreements, loans and credits have to be mentioned. In order to expand export markets and the sources of supply of its imports, the Government of Pakistan from time to time enters into trade and barter agreements with other countries. Pakistan concluded such agreements with seven countries between April 1967 and March 1968. These countries were Bulgaria, Rumania, Hungary, Poland, the USSR, China und Ceylon.

In addition to such agreements, there are credit agreements with countries such as the USA, France, the U.K., Japan and the Federal Republic of Germany. These agreements usually stipulate that the items imported with the help of the credit must be purchased from the credit-giving countries. In addition to this it is sometimes required that the only items that can be bought under the credit are those where the national value added surpasses a certain percentage of the total value.

To draw a conclusion from the above statements, the following observations must be made:

The bulk of the petrochemical items in question are either imported on Cash-Cum-Bonus or on 100 per cent bonus. This means that the prices of the products concerned are very high. As a result of the high prices the establishment of local industries is made easier, because they enjoy a protection which is the same as an equivalent tariff protection would afford. On the one hand, the increased prices have reduced the size of the market. In particular, they are a hindrance to the widening of the range of product application to new fields. On the other hand, this situation gives some of the newly established domestic industries a chance to enlarge their markets considerably by price reductions. In other words the markets in general are much larger for new manufacturers than they appear from the actual consumption.

The protective bias of the import policy is underlined by the fact that the Government is prepared to ban the import of items produced locally.

In spite of its import-repressive nature the Bonus Voucher system has the advantage that the imports are regulated by the forces of supply and demand via the price of the Bonus Voucher. There are no quantitative restrictions, and as long as items can be imported on Bonus Vouchers a certain amount of competition exists. In practice, naturally, a competition is a qualitative one and depends mainly on the agio the buyers are prepared to pay for good quality and on the difference in quality between imported and locally manufactured goods. Both these factors can be influenced by the producer.

Another feature of the import policy is that to some extent it is applied to encourage certain lines of production. A typical example is the manufacture of PVC rigid pipes. This industry is allowed to import PVC resin on Cash-Cum-Bonus while in general PVC falls under 100 per cent Bonus.

As far as the imports under loans and credits are concerned, this system seems to have certain disadvantages for the country. Not only may the importer find it difficult to buy a certain product from a country with which he has not had any trade relations, but also we got the impression that in a number of cases this regulation too much restricts competition. As a result, the prices of certain commodities imported under loan or barter may be inflated. The effect is that foreign exchange is lost.

4. Analysis of some products showed that there is no prospect of starting production at the moment, as even by 1975 the demand will be too small in relation to the minimum capacity. A number of these products, together with the estimated demand in 1975, are listed below:

- HD polyethylene	1,720 t
- polystyrol	5,400 t
- polyacrylate (PMMA)	900 t
- epoxy resins	160 t
- SBR	5,300 t
- TEL	260 t
- TML	130 t

The consumption of synthetic rubber could naturally be increased substantially if it were substituted for natural rubber: total consumption is expected to be 26,400 t in 1975, but only 5,600 t of this will be synthetic rubber.

But our researches suggest that starting the production of synthetic rubber in Pakistan is definitely not worthwhile, as the East Pakistan Forest Industries Development Corporation has established several very successful trial plantations of natural rubber in recent years. One of the main advantages of producing natural rubber in East Pakistan is that it utilises land which can hardly be used for the production of foodstuffs in any case. It is to be expected that the number of rubber plantations will increase sharply in the future, which will free Pakistan from dependence on imports of natural rubber in 15 to 20 years.

A certain loss of foreign exchange is probably also caused by issuing too many import licences instead of channelling the imported commodities through a restricted number of dealers to the small consumers. This argument carries increased weight when liquids could be imported in bulk instead of in drums. To some extent the import quantities are enlarged because certain licence-holders sell their licences to other firms. But according to discussions with some foreign manufacturers this does not really solve the problem.

4.2 Export Policy

The export policy is directed towards boosting the country's exports so as to bridge the import-export gap. During the Second Plan Period (1960 - 1965), the export earnings increased at an average annual rate of about 7 % against the projected 3 %. In the Third Plan Period (1965 - 1970) the target is to improve even on this performance.

In spite of a substantial increase in export earnings, the export-import gap is still considerable. In the year 1965/1966 it amounted to 1,517 million Rupees, which increased to 2,321 million Rupees in 1966/1967. This situation slightly improved in the following year due largely to a decline in imports. The import-export gap in 1967/1968 (July - March) was 1,204 million Rupees.

The Government have been trying hard to increase exports and have taken various measures to accomplish it. The following is a brief discussion of various export promotion measures taken by the Government of Pakistan.

Export Bonus Scheme

The Export Bonus Scheme was introduced in the year 1959 to increase exports by giving a bonus on export earnings. Under this scheme for the export of certain items part of the foreign exchange earned can be sold on a free market; the buyer may use the foreign exchange he has acquired on this market to import freely a wide range of products. In practice the scheme is carried out in such a way that the exporter surrenders all his foreign exchange earnings to the State Bank of Pakistan. For a part of them he receives a certificate which entitles the bearer to buy foreign exchange at the usual official rate. This paper is called a Bonus Voucher. It is traded on the stock exchange at a rate which is higher than the exchange rate of the Foreign exchange which it entitles its bearer to purchase. The Bonus Scheme covers all export items except traditional primary commodities such as raw jute, raw cotton, hides and skins, tea, rice, cotton waste, cotton linters and fish. Some service industries are also entitled to bonus on their net foreign exchange earnings.

The rate of bonus depends on the nature of the products but generally it is 20 per cent on primary products and 30 per cent on manufactured goods on net earnings. Bonus earnings are utilized to import consumer goods, industrial raw materials, spare parts, and machinery as described above.

The Bonus Voucher price fluctuates and is quoted daily in the market through the stock exchange. The Bonus Voucher price as quoted between March 1967 and March 1968 was at 187.75 per cent at its highest and 156.00 per cent at its lowest. The fluctuations in the price of Bonus Vouchers are generally related to changes on the Government's import-export policy.

Refund of Customs and Excise Duty and Sales Tax

According to the present laws customs and excise duty charged on raw materials used in the manufacture of goods which are exported is refundable. Similarly, refund can be claimed for excise duties levied on finished products.

Export Performance Licencing

This instrument has already been mentioned under section 4.1. For the sake of completeness, only the percentages of export performance licence on manufactured products made from petrochemical materials are indicated here:

	(% of f.o.b. value)
- artificial leather	25
- cotton-cum-synthetic fabrics	30
- electric cables	30
- plastic shoes	30
- gramophone records	30
- nylon fibre	30
- optical frames	30
- plastic goods	30
- rubber goods	30
- glycerine	10
- DDT	30

Export Credit Guarantee Scheme

For the sake of completeness this scheme is also mentioned; it was introduced in 1962, in order to promote the export trade by providing guarantees against certain financial risks not normally covered by insurance. The scheme provides two types of cover: the Pre-Shipment Export Finance Guarantee to the banks against nonrecovery of the loans given to exporters to facilitate execution of the export order, and the Post-Shipment Comprehensive Guarantee of exporters against non-realisation of sales proceeds from buyers abroad in respect of exports made on credit.

Export Market Development Fund

This fund was created in 1966. The fund assists by grants for the financing of projects relating to the survey of foreign markets for specified products and services, for the designing of Pakistani products to suit the requirements of foreign buyers, for the opening of display centres and the dissemination of information relating to foreign markets amongst exporters through seminars, publications, films and other media.

In summing up the above statements on the instruments of export promotion, it must be said that the export incentives offered are considerable. Whether they are always in the interests of the national economy is not a matter to be investigated here. In spite of the strong incentives it has, however, to be noted that exports of many items have not made as much progress as one might have expected. One important reason for this seems to be that Pakistan, in spite of the existence of very efficient business families, has only a few persons who can be considered pioneers in the export marketing of new products. Apparently, the efficient entrepreneurs are making good profits in other less strenuous fields.

Due to this fact it will probably be difficult to export the petrochemical end-products studied in this report or items manufactured from them. According to information from the Export Promotion Bureau, so far at least the results in this respect have been meagre. Evidently new solutions have to be found. Some suggestions to this end are made in chapter 9.

A factor of importance in our opinion is that the import policy changes too often. The six-monthly announcements of import policy cause serious disruptions in business relations and make importing complicated. This seems to be still truer of the amendments which are issued in the course of a shipping period. Sometimes, according to statements, from industry the importers have not enough time to prepare the imports properly because the letters of credit have to be opened within a short time. That this procedure is unfavourable both to industry and as regards the foreign exchange required for such imports would come as no surprise.

4.3 Taxation

In this section only the so-called indirect taxes are discussed which are supposed to have a direct bearing on the prices.

There are three main types of such duties collected by the Central Government on industrial products. These are import duty, excise duty and sales tax.

Import Duty

Tariffs are levied on all items imported into Pakistan. The tariff rates on semi-processed articles and industrial raw materials vary between 20 - 50 per cent ad valorem. The import duty on finished and luxury products goes as high as 250 per cent, depending on the nature of the products. On the other hand there are concessionary rates on items like medicaments, dyeing and tanning substances, fertilizers, and edible oils.

The import duty so far had to be taken in conjunction with a 25 per cent defence surcharge which was always added to it. However, the defence surcharge on import duty has now been merged with the basic import duty.

From the second shipping period 1968 onwards the following tariff rates, including defence surcharge are applicable on petrochemical end-products:

	Import duty % ad valorem
- synthetic resins	45
- carbon black	50
- synthetic rubber	25
- caprolactam	25
- nylon chips	25
- nylon twine for fishing nets	50
- nylon filaments	25
- industrial solvents	50
- insecticides and pesticides for agricultural use	nil

Excise Duty

The excise duty is levied on a number of finished products. Among these items are rubber and plastic goods, synthetic and cotton fibres, yarn, wire and cables.

The excise duty on plastics and rubber products is 10 % ad valorem and on wires and cables 7 1/2 % ad valorem. The excise duty on plastic radio cabinets depends on size; for large-size radio cabinets it is Rs. 5.- per piece, for medium-size cabinets it is Rs. 3.- and for small-size cabinets Rs. 2.-. The excise duty on plastic telephone and inter-com instruments is Rs. 5.- per piece. Synthetic fibres and yarn are taxed at the rate of Rs. 5.- per lb., i.e. Rs. 11.-/kg.

There are a number of plastic items on which no excise duty has to be paid. These items are fountain pens, ball-point pens, plastic geometrical instruments, tumblers, combs, spectacle frames, and water bottles not exceeding 2 pints.

In addition to these, there is also no excise duty on plastic items manufactured by small-scale industries. These are units which do not use power and run not more than three hand-operated machines.

There is no excise duty on insecticides and pesticides for use in plant protection since these items are generally purchased only by Government agencies and are distributed free of charge or at heavily subsidized rates.

Sales Tax

On most of the manufactured products a sales tax has to be paid in Pakistan. The standard rate of sales tax is 15 per cent ad valorem on normal products and 20 per cent on luxury products. The sales tax on petrochemical products is normally 15 per cent. As in the case of the import duty, there is also a 25 per cent defence surcharge on sales tax and additionally 1 per cent rehabilitation tax.

A number of articles made from petrochemical items are exempted from sales tax. These are toys, imitation jewellery, crockery, insecticides and pesticides used for agricultural purposes, and man-made fabrics.

An evaluation of the indirect taxation in terms of the development of the petrochemical industries leads to the conclusion that in some cases it is not conducive to a speedy development of the industries based on petrochemical raw materials and thus of the petrochemical industries themselves. We had the impression that this is the case with nylon yarn.

In general it seems that the excise tax, in addition to its cost-increasing effect, is a hindrance in the operation of the industries, because due to this tax the processing units cannot move any article out of the factory without notifying the responsible excise officials.

Otherwise it is noteworthy that at present for most of the petrochemical raw materials the customs duties figure mainly as a source of public finance but not as a protective measure. This is due to the Bonus Voucher system.

5. Investigation into the Production of and Demand for Petrochemical End-Products in Pakistan

5.1 Thermoplastics

5.1.1 Polyethylene

5.1.1.1 General Characteristics

5.1.1.1.1 Description of the Material

5.1.1.1.2 Applications

5.1.1.2 Domestic Production

5.1.1.2.1 Existing Capacity

5.1.1.2.2 Problems and Difficulties

5.1.1.2.3 Planned Projects

5.1.1.3 Demand

5.1.1.3.1 Volume and Structure of Past Demand

5.1.1.3.2 Forecast of Consumption Trends

5.1.1.4 Prices

5.1.1.5 Structure of the Market and Main Consumers

5.1.1.6 Recommendations

5. Reference must also be made to carbon black in this connection; the demand for carbon black in 1967/68 was 1,230 t and it will go up to 4,300 t in 1975/76, which is roughly equivalent to the minimum capacity of one carbon black plant. However, Pakistan has undertaken to buy 5,000 t of carbon black from Iran under the RCD, so that production of carbon black during the period under investigation is out of the question.

6. For a number of products capacities are already available which can be considered big enough to meet the anticipated demand up to 1975. The main products of this kind are:

Production	Demand in 1975 1)	Sanctioned and planned capacities
polyvinyl acetate	1,690 t	3,100 t/y
phenolic resins	910 t	1,100 t/y
urea resins	5,550 t	5,700 t/y
melamine resins 2)	60 t	180 t/y
polyurethane	960 t	21,000 t/y
ethyl alcohol	24,000 t	36,000 t/y
formaldehyde	7,600 t	9,000 t/y

1) At constant prices

2) Excluding textile pre-condensates

The production of BHC and DDT presents a special case. Use of insecticides in Pakistan is at present almost entirely controlled by Government departments, which are for the most part convinced that DDT and BHC are obsolescent and should no longer be applied. In East Pakistan, fear of poisoning the fish stock is also a prime consideration. As no change in the situation can be foreseen at the moment, an increase

5.1.1 Polyethylene

5.1.1.1 General Characteristics

5.1.1.1.1 Description of the Material

Polyethylene (PE) belongs to the most widely known thermoplastics which have the widest range of application. The primary material for PE is ethylene, which is polymerised. Depending on the polymerisation method, a distinction is made between

- high density PE (PE HD) and
- low density PE (PE LD).

The different types of PE are characterised as follows:

Type	Density (g/cm^3)	Production Process
Low Density	0.925	High-pressure process
Medium Density	0.926 - 0.940	
High Density	0.940 - 0.965	Low-pressure process

The PE types of low density are flexible and soft. Rigidity hardness, and scratch resistance increase with increasing density and decreasing melting index. Products of all PE types can be used at temperatures below -50°C; PE of high density is resistant to boiling. PE is odourless, tasteless, and physiologically indifferent.

PE is supplied in the form of granules of natural colour or pigmented.

5.1.1.1.2 Applications

The most important applications for PE LD are:

- Injection and blow moulded parts
- Films and sheeting
- Cable and wire casings
- Coatings
- Pipes and sections

PE HD is mainly processed into:

- Sheeting
- Pipes and sections
- Injection and blow moulded parts

PE is applied in all cases where a flexible but stable material is needed for consumer goods and packaging, both in the mechanical engineering and the electrical engineering sector. Especially HD polyethylene is processed into large containers, bottles, transport cases, dust bins, etc.

In Pakistan PE ranges second in the use of thermoplastics, following PVC. So far PE soft has been used almost exclusively especially for

- Injection moulded parts
- Blow moulded parts
- Films and sheeting

The reason is that in Pakistan PE is used chiefly for consumer goods and packaging, and less for large containers, pipings, or in the construction of apparatus and machinery.

Most of the material used in Pakistan, therefore, belongs to the low-density type. But no doubt, also PE HD will be increasingly used in the years to come, above all it will be used for the production of containers.

5.1.1.2 Domestic Production

5.1.1.2.1 Existing Capacity

At present there is only one manufacturer of PE LD in Pakistan, Messrs. Valika Chemicals Ltd. in Karachi. The theoretical capacity of this plant is 17 tons of PE LD per day in three shifts. This corresponds to an annual capacity of about 5,000 tons.

Molasses is taken as starting material for the production of PE. The manufacturing process is continuous and covers the following steps: the molasses is fermented to give ethyl alcohol. Cracking of the ethyl alcohol yields ethylene which is subsequently polymerised to PE by way of the high-pressure process. For the production of 17 tons of PE, 150 to 165 tons of molasses are needed, which are converted into 45,000 l of ethyl alcohol. Fusel oil and mash are the by-products of this manufacturing process. The fusel oil results from the alcohol production and is sold as solvent (cf. section 5.5.1). The mash obtained from the fermentation of molasses, is not yet made use of. Theoretically, however, it would be possible to produce from it dry yeast, a high-quality animal food. The possible volume of production is 2.5 t of dry yeast per day.

The average density of the crude granular material produced by Valika is 0.918 to 0.919. The melting index varies strongly because of the frequent starting and stopping of the plant.

The plant was put into trial operation in March, 1967. It has never been fully utilised. Production was started in autumn of 1967 after some initial difficulties, such as e.g. deficiencies in water supply, had been overcome. The following quantities have been produced

1967	1,010 t
1968 (1st six months)	1,490 t

The consumers of these quantities are

the plastics processing industry in West Pakistan

and Messrs. Valika themselves, who have a processing capacity of their own of 300 t per year (1 shift)

5.1.1.2.2 Problems and Difficulties

The sales market for the locally produced granules is not too good in Pakistan. Exports are impossible on account of the price. Thus the existing capacity of the plant cannot be fully utilised. Because of the sales difficulties, the plant has to be often started and stopped, a fact that leads to variations in the quality of the product (melting index of the granule is not constant). As the products of differing melting indices are not mixed in the granule bunkers to give a uniform granule of a constant average character, the quality of the granules supplied to the processors often differs. This leads to complaints by the processors, and naturally provokes scepticism with regard to the quality of domestic production, so that imported products are used whereever possible.

As the size of the plant just corresponds to the technical minimum capacity, it is clear that it cannot operate profitably at the present volume of production. In addition, it should be noted that the molasses price of 170 Rs./t seems to be too high for the manufacture of a reasonably priced product. At the time the factory was planned, the molasses price was much lower. In the meantime molasses has become an export product and thus has increased in price.

5.1.1.2.3 Planned Projects

In West Pakistan Messrs. Valika intend to establish a new factory operating on the basis of ethylene with a planned capacity of 10,000 t of PE LD per year or to expand the existing plant by that capacity. The total capacity for the production of PE LD thus would increase to 15,000 t/y. It is envisaged to buy the ethylene required for the new unit from the planned naphtha cracker of the Fauji Foundation.

In East Pakistan the EPIDC plans a PE factory of 17,000 t per year. Studies in this direction are under way.

5.1.1.3 Demand

5.1.1.3.1 Volume and Structure of Past Demand

The following table shows the consumption of PE in East and West Pakistan by years and applications.

Table 1: Consumption of PE in West Pakistan, 1965 to 1968 by Applications (in tons)

Application	1965	1966	1967	1968 [1]
PE Low Density:				
- Films and sheeting	1,040	1,312	1,640	1,750
- Coatings	-	-	180	200
- Injection and blow moulded parts	530	610	1,040	1,360
- Cable and wire casings	10	8	10	15
Consumption of PE LD	1,580	1,930	2,870	3,325
PE High Density:				
- Injection and blow moulded parts	230	180	270	410
- Pipes and sections	-	-	-	-
Consumption of PE HD	230	180	270	410
Total consumption of PE LD and PE HD	1,810	2,110	3,140	3,735

[1]) Expected consumption

Table 2: Consumption of PE in East Pakistan, 1965 to 1968 by Applications (in tons)

Application	1965	1966	1967	1968 [1]
PE Low Density:				
- Films and sheeting	950	1,010	1,110	1,300
- Coatings	50	30	150	150
- Injection and blow moulded parts	230	245	270	290
Consumption of PE LD	1,230	1,285	1,530	1,740
PE High Density:				
- Injection moulded parts	2	2	20	25
- Pipes and sections	-	-	5	60
Consumption of PE HD	2	2	25	85
Total consumption of PE LD and PE HD	1,232	1,287	1,555	1,825

[1]) Expected consumption

The consumption for All Pakistan may be summarised as follows:

Table 3: Consumption of PE in Pakistan, 1965 to 1968 by Applications (in tons)

Application	1965	1966	1967	1968 [1]
PE Low Density:				
- Films and sheetings	1,990	2,322	2,750	3,050
- Coatings	50	30	330	350
- Injection and blow moulded parts	760	855	1,310	1,650
- Cable and wire casings	10	8	10	15
Consumption of PE LD	2,810	3,215	4,400	5,065
PE High Density:				
- Injection and blow moulded parts	232	182	290	435
- Pipes and sections	-	-	5	60
Consumption of PE HD	232	182	295	495
Total consumption of PE LD and PE HD	3,042	3,397	4,695	5,560

[1]) Expected consumption

An evaluation of the table for Pakistan shows the following break-down of the total consumption by applications for 1967:

Films and sheeting	55 %
Coatings	6 %
Injection and blow moulded parts	38 %
Others	1 %

The LD types at present have a share of 91 per cent in the total consumption of PE, whereas PE HD accounts only for 9 per cent.

If we consider the regional distribution, we note that the consumption of the two PE types in West Pakistan is twice that of East Pakistan. The application of PE LD in West Pakistan has experienced a rapid development in the last three years; while the increase in the consumption in East Pakistan has been only 50 per cent since 1965, it is 100 per cent in West Pakistan.

The following explanatory remarks pertain to the individual applications:

Films and sheeting are the most important applications with about 55 per cent; this covers small, medium-sized and large enterprises. The existing capacities are estimated by IACP at 8,200 t per year, the small-sized industry accounting for about 40 per cent.

The largest part of the films and sheeting manufactured serves for the production of bags and sacks. Sheeting is produced almost exclusively by means of the blow moulding method. Part of the necessary extruders is already being constructed in Pakistan.

The second most important application of PE is the production of injection and blow moulded parts with about 38 per cent. The objects concerned include toys, combs, household items, such as keys, baskets, soap boxes. In this sector the small industry plays an important part. Both LD and HD polyethylene are used.

Rigid PE pipes have so far been produced only by one manufacturer in East Pakistan. Sections and boards of PE are not yet produced in Pakistan. Only two large firms are using PE for coatings. They produce packagings for the beverage industry (tetrahedron) and coated jute bags.
In the field of cable casings polyethylene is used as yet only to a small extent. In general only PVC is used in this sector.

The following sources of supply have been established:
PE was imported until 1967. Since Valika started production, this firm accounted for about 25 per cent of the consumption of PE LD in West Pakistan in 1967 and for about 30 per cent in 1968. In East Pakistan imports continue to be the only source of supply.

The imports in 1967 came from the following countries, by order of importance:

PE LD:

- Japan (Mitsubishi)
- Italy (Montecatini Edison)
- U.K. (ICI)
- Germany (BASF)

PE HD:

- Germany (Hoechst)
- USA (Philips Petroleum Co.)

in production is not to be recommended. According to Battelle's findings, it would be possible fully to utilise the existing large surplus capacities (particularly for BHC manufacture in East Pakistan) if both products were used in cotton and rice cultivation.

7. The petrochemical end-products and intermediates whose production in the period up to 1975 should be seriously considered are:

- polyethylene
- polypropylene
- polyvinyl chloride
- alkyd resins
- polyamide fibres
- polyester fibres
- dioctyl phthalate
- 2 ethyl hexanol
- dodecyl benzene sulphonate
- dodecyl benzene

The following comments have to be made on the above products:

7.01 In 1968 the consumption of low density polyethylene was approx. 5,100 t. With a mean growth rate of 23 per cent, consumption in 1975 is estimated at 21,200 t. The largest single component of this demand is the films and sheets sector (1967: 59 per cent, 1975: 71 per cent), packaging material for the fertiliser industry being a major item. Injection moulded and blow moulded parts follow, with 33 per cent in 1968 and 28 per cent in 1975. East Pakistan's share of the production is at present 34 per cent, and is expected to remain more or less constant.

5.1.1.3.2 Forecast of Consumption Trends

In order to come to conclusions on the future consumption of PE, the following sectors have to be given special consideration:

- Films and sheetings
- Injection and blow moulded parts
- Pipes and sections
- Cable and wire casings.

Films and sheetings

A comparison of the PE LD consumption for films and sheeting in Pakistan shows that the consumption has increased by 50 per cent between 1965 and 1968. That is an average annual growth rate of about 15 per cent. Undoubtedly, the upward trend will continue, since applications in the packaging sector are extending. The largest quantity should in the future be used for bag production, where PE LD is increasingly replacing the reinforced papers. The future development of the fertilizer industry and its demand for bags will play a special part in this connection.

Therefore, the estimates of the consumption of PE sheeting and films are made separately for the packaging sector in general and the fertilizer industry. The following quantities of PE will be used by the two sectors in 1968:

	West Pakistan	East Pakistan	Total
Fertilizer industry	100	335	435
Packaging in general	1,850	1,115	2,965
Total consumption	1,950	1,450	3,400

Considering he consumption of sheeting and films in the packaging sector in general, it is noted that this sector is the largest individual consumer of PE in Pakistan. While the large-scale production of bags for the packaging of fertilizers did not start before 1967, the manufacture of sheeting bags and sacks for the packaging of food, textiles, general purpose items, detergents has played an important role in Pakistan since about 1964.

Considering the annual growth rates during the last few years in the field of films and sheeting in the packing sector in general for all Pakistan, it is noted that the consumption increased by 16 per cent in 1965/66, by 19 per cent in 1966/67, and will probably increase by 11 per cent in 1967/68. This means an average annual growth rate of about 15 per cent [1]).

The continuously increasing production of food, general purpose items, textiles, detergents, etc. in Pakistan will result in a continuous increase in the demand for packaging materials. In addition to this traditional application of sheeting in the packaging sector, PE will in the future be used to a certain extent also in the agricultural sector as protective sheeting in plantations. In East Pakistan, for example PE sheeting is used already as protective covers for tea plantations.

On the basis of all the criteria an average annual increase of 15 per cent may be expected also in the future for East and West Pakistan, the absolute demand for packaging material in terms of quantity being higher in West Pakistan than in East Pakistan. Table 4 indicates the estimated future quantities of PE LD required in the sector of packaging materials in general.

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1) It should be noted that also in the European packaging industry the consumption of plastics shows an annual increase of 15 per cent.

Table 4: Estimated Demand for PE LD for Films and Sheeting from 1968 to 1975 (in tons)

Year	West Pakistan			East Pakistan			All Pakistan		
	Packaging in general	Fertilizer industry [1]	Total consumption [1]	Packaging in general	Fertilizer industry [1]	Total consumption [1]	Packaging in general	Fertilizer industry [1]	Total consumption [1]
1968	1,850	100	1,950	1,115	335	1,450	2,965	435	3,400
1969	2,130	600	2,730	1,280	800	2,080	3,410	1,400	4,810
1970	2,450	1,390	3,840	1,470	1,800	3,270	3,920	3,190	7,110
1971	2,820	1,500	4,320	1,700	1,900	3,600	4,520	3,400	7,920
1972	3,240	1,800	5,040	1,950	2,000	3,950	5,190	3,800	8,990
1973	3,720	2,000	5,720	2,240	2,100	4,340	5,960	4,100	10,060
1974	4,280	3,000	7,280	2,580	2,200	4,780	6,860	5,200	12,060
1975	4,920	4,740 [2]	9,660	2,960	2,400	5,360	7,880	7,140 [2]	15,020

1) The figures for 1969 and the following years indicate the presumable trend of the expected demand. The exact consumption depends on the implementation of the new investment programmes in the fertilizer industry and on the actual packaging all fertilizers in PE bags.

2) After the report was finished, we got information from the UNO Petrochemical and Fertilizer Project, Rawalpindi, that an ammonium sulphate nitrate plant is planned for establishment in West Pakistan in 1975 in addition to the fertilizer factories projected so far. As a consequence, the demand for PE LD for the packaging of fertilizers estimated by us will increase by about 2,000 t in 1975 on the assumption that the factory operates at full capacity already in that year.

For estimating the consumption for the fertilizer industry it is interesting to consider the information received from governmental planning authorities which stated that it is intended to pack all fertilizers produced in Pakistan, with the exception of ammonium sulphates, in PE bags with or without jute reinforcement. The demand for bags and thus for PE LD can be calculated on the basis of this information and on the installed and planned capacities. Table 4 lists the quantities of PE LD to be expected in this sector up to 1975. These calculations are based on PE bags of the type used by the urea factory at Fenchuganj in East Pakistan. Accordingly about 5,000,000 bags of 67 g weight each are required for packaging about 100,000 t of urea. This corresponds to a quantity of PE of 335 t.

The table shows that the total demand in 1968 will almost increase five times until 1975, one third of the demand coming from East Pakistan and two thirds from West Pakistan. As to the 15,000 t of polyethylene the fertilizer sector as the largest consumer of packaging materials will account for about half of the estimated demand in 1975. The balance will be used for the packaging of beverages, food, cement, textiles and as protective sheeting in agriculture.

Injection and blow moulded parts

Both PE HD and PE LD are used for injection and blow moulded parts. With 38 per cent of the total PE consumption it is the second most important application for PE in Pakistan. While PE LD has played a part in the production of household appliances and cosmetics in Pakistan for some time, the HD type has become popular only recently. PE HD is used mainly in the expanding container industry.

The following comments can be made regarding the growth rates for PE LD and PE HD in West and East Pakistan in the last few years. The increase in consumption from 1965 to 1968 for PE LD in East Pakistan has been about 26 per cent, and in West Pakistan 157 per cent. This indicates that the consumption has shown a special increase in West Pakistan with an average annual growth rate of 37 per cent. In East Pakistan the average annual growth rate is only about 8 per cent. While injection and blow moulded parts have so far been used in East Pakistan only for small general purpose items, such as combs, soap boxes, boxes for cosmetics, pails, etc. they have found a much broader range of application in West Pakistan in household appliances and packing material for industrial products. For the next two or three years it may be expected that the increase in the consumption in West Pakistan will continue at the high growth rate of 37 per cent, but it is likely that the growth rate in the long run will not be above 20 per cent. An analysis of the relatively small increase in consumption and the type of the products in East Pakistan shows that in this Wing new applications, above all in the sector of household appliances and packaging will lead to strong increase in the demand for PE LD similar to West Pakistan. We, therefore, expect, on the basis of conservative estimates, the annual growth rate until 1975 to be 20 per cent also for East Pakistan.

The past conditions for the growth of PE HD in the field of injection and blow moulded parts in East and West Pakistan have been similar to those of PE LD. While in East Pakistan in 1968 for the first time a quantity of PE HD has been consumed that is worth mentioning (about 25 t), the consumption in West Pakistan will probably rise from 230 t in 1965 to about 410 t in 1968. This means an average annual increase by 21 per cent. This relatively rapid increase is caused by the growing demand for packaging material, such as containers, drums, bottles, etc. mainly of the West Pakistan industry. Since expansion of the capacities is being continued in the container industry of West Pakistan, also in the future a high growth rate may be expected. In the long run the processors of PE HD in West Pakistan expect for injection and blow moulded parts annual increases of 15 to 17 per cent. The estimate of the following consumption figures is based on an average annual rate of increase of 15 per cent; the smaller growth rate of 15 per cent appears more probable because polypropylene will compete with PE HD in the field of hollow articles.

For East Pakistan it is more difficult to find an appropriate basis for the calculation of the increase Besides, it should be taken into account that a forecast starting from such small basic figures always meets with extreme difficulties. In view of the small quantity consumed in 1968, an average annual growth rate of 25 per cent seems realistic for a long-range forecast.

Table 5: Estimated Demand for PE LD and PE HD for Injection and Blow Moulded Parts, 1968 to 1975 (in tons)

Year	West Pakistan		East Pakistan		All Pakistan	
	PE LD	PE HD	PE LD	PE HD	PE LD	PE HD
1968	1,360	410	290	25	1,650	435
1969	1,630	470	350	30	1,980	500
1970	1,960	540	420	40	2,380	580
1971	2,350	630	500	50	2,850	680
1972	2,820	720	600	60	3,420	780
1973	3,380	830	730	80	4,110	910
1974	4,060	960	870	100	4,930	1,060
1975	4,870	1,100	1,050	120	5,920	1,220

The table shows that the consumption of PE LD for injection and blow moulded parts will more than treble up to 1975. The expected share of West Pakistan in the total consumption is estimated at 82 per cent, that of East Pakistan at 18 per cent.

The consumption of PE HD presumably also will treble by 1975. The largest part of PE HD will be required by the expanding container industry of West Pakistan, which will account for 90 per cent of the total consumption. The consumption of East Pakistan probably will not exceed 10 per cent.

Pipes and Sections

PE HD pipes have so far played only a minor part in Pakistan compared with the conventional cast-iron and galvanized iron pipes, asbestos pipes and the imported fibre reinforced epoxy pipes. Interviews with public organisations, such as WAPDA, Department of Public Health Engineering, and Water and Sewage Authority (WASA) have shown that the use of plastic pipes on a larger scale is being considered for the future, but that these pipes will be PVC pipes and not PE pipes. Consequently, there is little hope that a larger market will be opened in this field in the near future.

Only two manufacturers of PE pipes have been found. Their production of about 100 t meets the present demand in East and West Pakistan.

Sections and boards of PE have not yet been produced in Pakistan. Indications pointing to a future production have not been found either.

Starting from the assumption that in the near future PVC pipes will be preferred to those of PE [1]) and that the production of sections and board of PE will develop at a low rate, the future demand for PE in these sectors for all Pakistan is estimated to amount to no more than 200 t in 1970 and 500 t in 1975 (cf. Table 8).

Cable and Wire Casings

PVC is likely to compete strongly with PE also in this sector. So far PVC has been used almost exclusively for cable and wire casings both in East and in West Pakistan. Certainly PE LD will find further applications in the course of the expansion of the cable and electrical insulation industries in Pakistan. PE cables could play a major part for instance in the modern telecommunications, since they are waterproof and sturdy and can easily be installed. A special advantage is that the connections can be made rapidly and in a fairly uncomplicated way. Another advantage is that PE has a better insulation effect than PVC.

However interviews with the manufacturers of cables and electrical insulation parts did not permit definite conclusions to be drawn for an estimate of the future demand. Only one major future consumer has been found the telephone cable factory of the EPIDC in Khulna now under construction, which will use PE LD in addition to PVC for cable casings. After its termination in 1969/70, the plant will consume about 55 t of PE. Here once again the problem should be emphasised, that reliable forecasts are rendered extremely difficult owing to the low consumption data available at present.

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[1]) Cf. Section 6.2.2

As there is a close relationship between the increase in the installed capacities in the electrical industry and the consumption of cables, the average annual growth rate of power generation is taken as basis for the estimate of the future consumption of PE LD for cable casings. The power generation in Pakistan will increase by about 15 per cent until 1975 [1]). The demand for PE LD will develop as indicated in table 6.

Table 6: Estimated Demand for PE LD for Cable and Wire Casings, 1968 to 1975 (in t)

Year	West Pakistan	East Pakistan	All Pakistan
1968	15	-	15
1969	20	50	70
1970	50	70	120
1971	60	80	140
1972	70	90	160
1973	80	110	190
1974	90	120	210
1975	100	140	240

According to the table, the total demand for PE LD in the cable sector will not exceed 250 t in 1975. About 60 per cent of this quantity will be consumed in East Pakistan. The higher demand of East Pakistan will result above all from the consumption of the telephone cable factory. Our estimates, however, necessarily are very tentative. If, for instance, West Pakistan authorities should decide to take up the manufacture of PE cables, the picture would change completely.

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[1]) This growth rate corresponds also to the average annual increase in the consumption of PE cables in Europe.

Such deviations in the development of the cable sector, however, should hardly affect the volume of the total consumption of PE LD.

Consumption estimates for PE HD and PE LD in the individual sectors is summarised in the following two tables for all Pakistan.

Table 7: Estimate of the Future Demand for PE LD in the Most Important Sectors of Application for All Pakistan (in t)

Year	Films and sheeting	Injection and blow moulded parts	Cable and wire casings	Total consumption
1968	3,400	1,650	15	5,065
1969	4,810	1,980	70	6,860
1970	7,110	2,380	120	9,610
1971	7,910	2,850	140	10,900
1972	8,990	3,420	160	12,570
1973	10,060	4,110	190	14,360
1974	12,060	4,930	210	17,200
1975	15,020	5,920	240	21,180

On the basis of estimates made by the UN Petrochemical and Fertilizer Project, Rawalpindi, Battelle anticipates a drop in polyethylene prices of 40 per cent, which would mean that demand will increase by some 34 per cent in 1975. We therefore recommend the erection of a plant with an annual output of 25,000 t in 1972 - on the assumption, however, that the existing capacity of 5,000 t/y at Valika Chemicals Ltd. is fully utilised.

7.02 Demand for polypropylene is still extremely small - only 520 t were used in 1967. However, it is expected that consumption will grow at a rate of 20 per cent a year, so that it will amount to 2,000 t in 1975. Up to now the entire consumption has been in West Pakistan, where the material is used for blow moulding and injection moulding.

The study recommends setting up plant for the manufacture of 10,000 t/y of polypropylene in 1972, together with the facilities for PVC and polyethylene production. This recommendation is based on an anticipated demand of 4,900 t in 1975, which presupposes a price reduction of 20 per cent and allows for its use as a substitute for certain products.

7.03 Consumption of PVC is estimated at 8,280 t of compound or 5,440 t of PVC resins in 1968. It is expected to rise to 19,200 t of resins in 1975, at constant prices. With a price reduction of 40 per cent - which seems quite feasible - demand could be of the order of 23,000 t in 1975. Sectoral analyses indicate that the mean growth rate is likely to be 23 per cent in East Pakistan and 14 per cent in West Pakistan.

Table 8: Estimate of the Future Demand for PE HD in the Most Important Sectors of Application for All Pakistan (in tons)

Year	Injection and blow moulded parts	Pipes and sections	Total consumption
1968	435	60	495
1969	500	150	650
1970	580	200	780
1971	680	250	930
1972	780	300	1,080
1973	910	360	1,270
1974	1,060	420	1,480
1975	1,220	500	1,720

In accordance with the tables, the total consumption of PE LD and PE HD in 1975 is estimated at 22,900 t. Out of this quantity about 92 per cent presumably will be PE LD and 8 per cent PE HD. The demand for PE LD can be expected to increase fourfold by 1975. The growth rate for PE HD will be somewhat smaller. The average annual rates of increase are about 23 per cent for PE LD and about 20 per cent for PE HD.

The sector of films and foils will be the largest consumer of LD polyethylene. It will account for 71 per cent of the total demand for PE LD, followed presumably by the sector of injection and blow moulded parts with a share of 28 per cent of the total demand. The remaining 1 per cent will be consumed by the cable and wire casings industry.

About 70 per cent of PE HD is expected to be consumed by the sector of injection and blow moulded parts. The remaining 30 per cent will be consumed mainly by the pipes and sections industry.

The table 9 shows the regional distribution of the estimated quantities of PE LD and PE HD consumed.

Table 9: Regional Distribution of the Estimated Demand for PE LD and PE HD, 1968 to 1975 (in tons)

Year	West Pakistan		East Pakistan		All Pakistan	
	PE LD	PE HD	PE LD	PE HD	PE LD	PE HD
1968	3,325	410	1,740	85	5,065	495
1969	4,380	520	2,480	130	6,860	650
1970	5,850	590	3,760	190	9,610	780
1971	6,730	730	4,180	200	10,910	930
1972	7,930	860	4,640	220	12,570	1,080
1973	9,180	1,020	5,180	250	14,360	1,270
1974	11,430	1,200	5,770	280	17,200	1,480
1975	14,630	1,400	6,550	320	21,180	1,720

The table shows that, according to the present growth tendencies, West Pakistan will also in future have a higher demand for PE LD and PE HD than East Pakistan. In 1975 presumably about 70 per cent of the total PE LD will be consumed in West Pakistan and 30 per cent in East Pakistan. In the case of PE HD the share of West Pakistan compared with East Pakistan will be even higher, i.e. ca. 80 per cent will be consumed in West Pakistan and ca. 20 per cent in East Pakistan.

The main centres of consumption in East Pakistan will be the two cities of Dacca and Chittagong, which will account for about 90 per cent of the estimated demand. In West Pakistan Karachi, already today the centre of the plastics processing industry, will continue to be the centre of consumption. The region of Lahore including the Industrial Estates in Sialkot and Gujranwala will take the second place.

About 75 per cent of the total demand in West Pakistan will come from the two industrial centres of Karachi and Lahore.

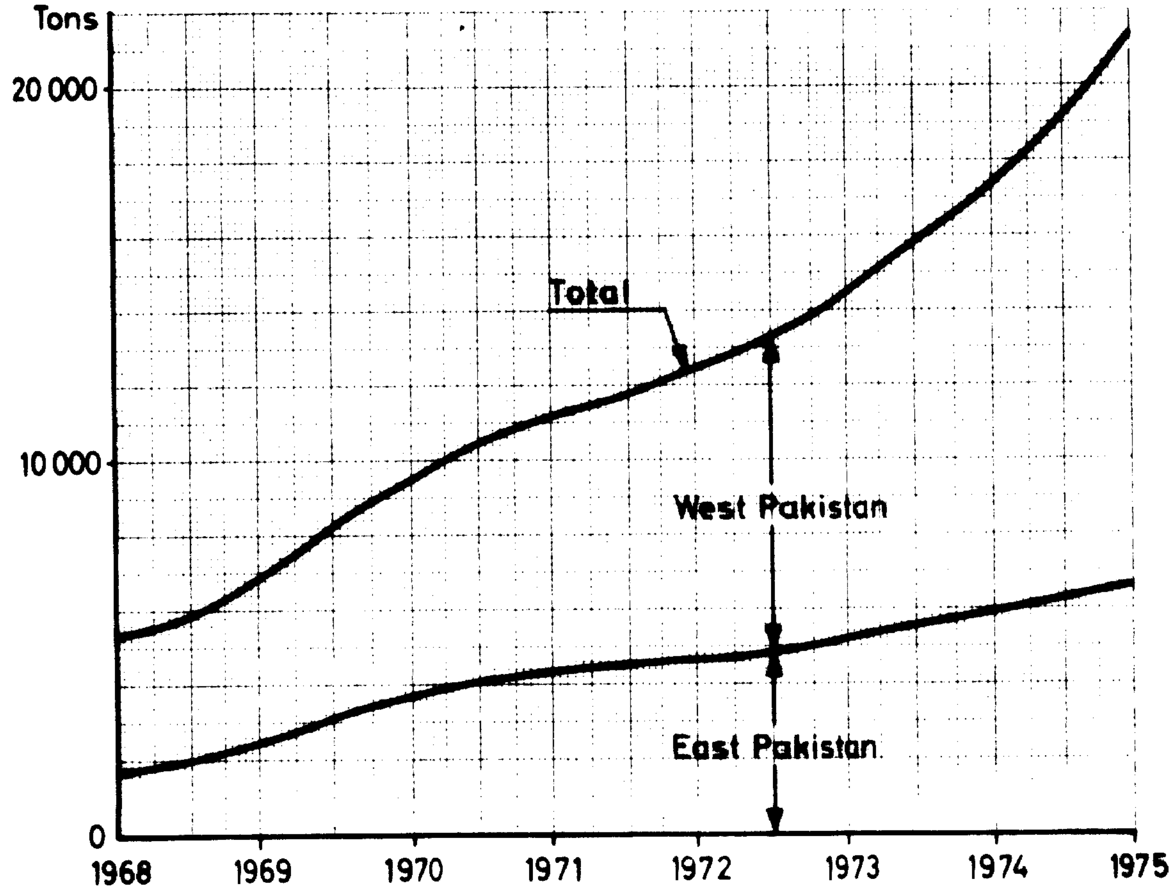

Figure 1: Regional Distribution of the Estimated Demand for Low Density Polyethylene

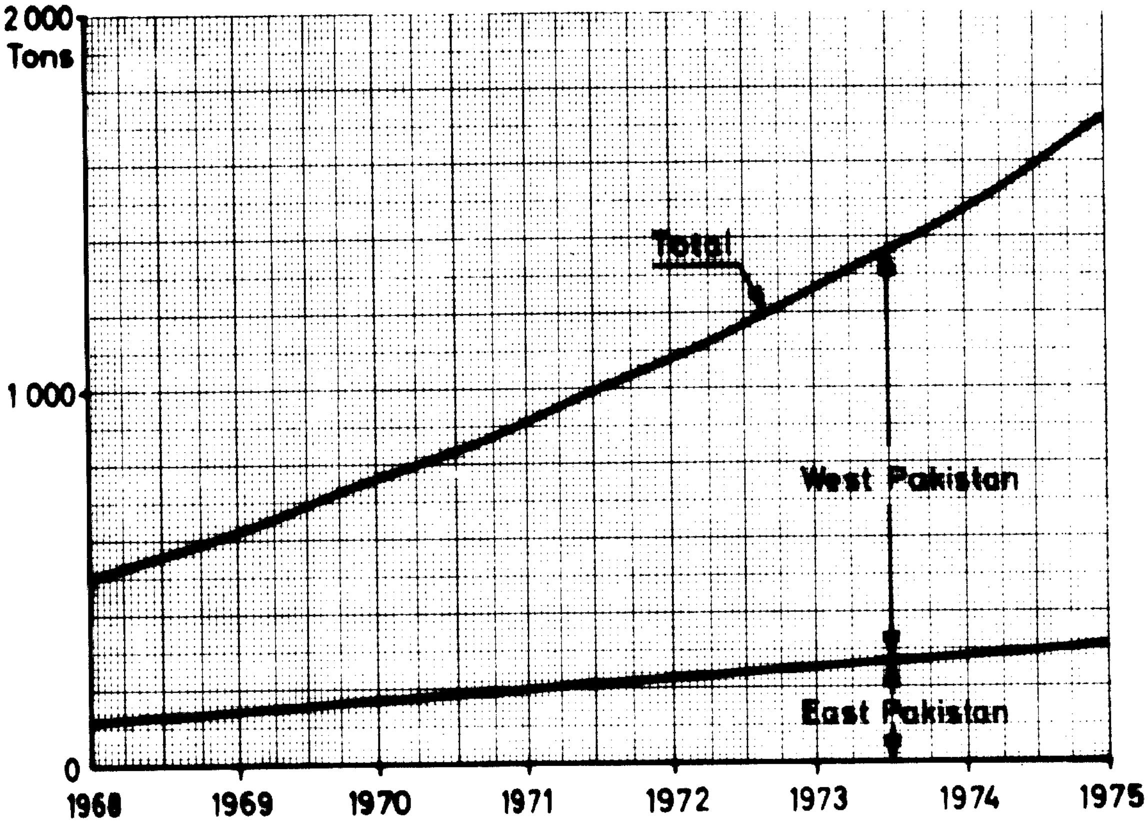

Figure 2: Estimated Demand for High Density Polyethylene

5.1.1.4 <u>Prices</u>

The development of the prices for PE in the world market during the last years is illustrated on the basis of the producer prices in West Germany. The Federal Republic of Germany is a very suitable example, because it pursues a very liberal foreign trade policy.

The sales prices ex-factory for PE LD granules developed in that country as follows:

1960:	0.75 US $/kg
1964:	0.40 US $/kg
1967:	0.35 US $/kg
1968:	0.30 US $/kg

The price for PE HD granules was

1960:	0.88 - 1.00 US $/kg
1964:	0.65 - 0.68 US $/kg
1967:	0.50 US $/kg
1968:	0.45 US $/kg

The prices exclusive sales taxes. PE LD in 1968 thus was sold almost one third cheaper than in 1960. Also the prices for PE HD decreased continuously since 1960; today the price is only half that of 1960.

It is generally expected that the world market price for PE will continue to drop slightly in 1969. A forecast of the long-term development of the price structure is difficult, since this would have to be based on figures regarding new capacities and the increase of unit sizes.

The following diagram is designed to provide the basis for a comparison with the price development of other important thermoplastics. It is referred to also in the sections on PS and PVC.

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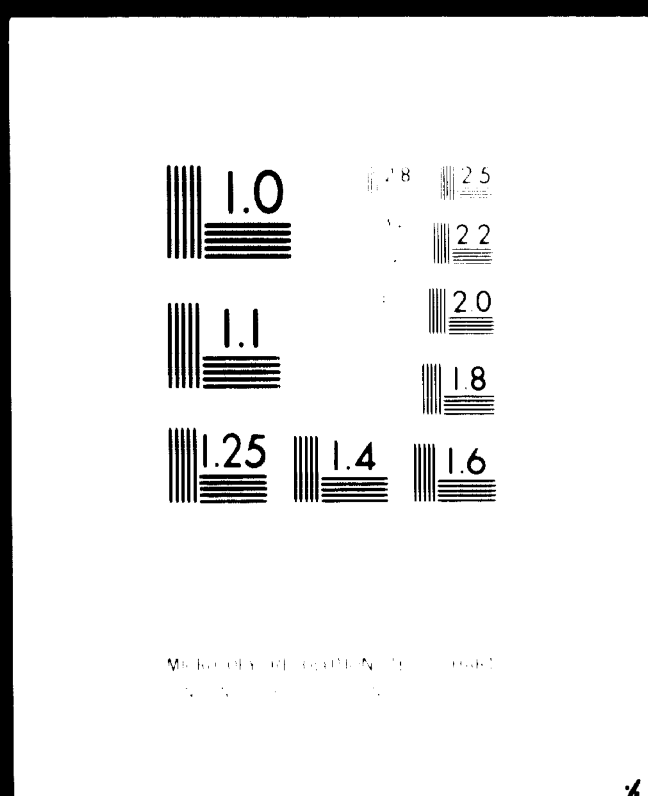

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D

5.1.2 Polypropylene

5.1.2.1 General Characteristics

The polypropylene (PP) obtained by polymerisation of propylene is hard and dimensionally stable.

Compared with HD polyethylene, polypropylene has following advantages: not a "paraffiny" but smooth feel, greater surface hardness, no tendency to stress corrosion cracking (and therefore suitable for nailing), higher tensile strength and dimensional stability under heat, better elasticity properties.

Disadvantages are: embrittlement at temperatures below 0°C and greater sensitivity to oxygen.

PP is marketed in the form of granular compounds, in natural colours or dyed, modified to the melting indices for various processes.

The fields of application for PP are more or less the same as for polyethylene HD, insofar as greater mechanical strength and surface hardness are called for. Among the articles manufactured from PP are for example dye tubes, bobbins, crates, hinges, containers, mailboxes and other technical and household goods.

A further important field of application is the precessing to fibres. The role of PP as raw material for fibres is dealt with in a separate section on synthetic fibres (see section 5.3.3).

In Pakistan, PP is used in the manufacture of among other things bottles, containers, mailboxes, crates of all types, combs and military supplies. The processes applied are injection and blow moulding.

5.1.2.2 Domestic Production

There is as yet no production of PP in Pakistan. The granular material processed is imported. The authorities responsible for investment planning are however considering erecting a plant.

5.1.2.3 Demand

5.1.2.3.1 Volume and Structure of Past Demand

We were unable to discover any consumption in East Pakistan. The consumption in the blow moulding and injection moulding sectors of West Pakistan has developed as follows since 1965:

- 1965: 120 tons
- 1966: 230 tons
- 1967: 520 tons

A consumption of 560 tons is expected for 1968.

One notes that the consumption has almost quintupled since 1965.

The granular material supplied originates mainly from:

- England (ICI)
- Japan and the
- Federal Republic of Germany

5.1.2.3.2 Forecast of Consumption Trends

Polypropylene is at present well on the way to becoming a mass-production plastic like the thermoplastics polyethylene, PVC and polystyrene in all industrialised countries. The reason for this material's favourable sales prospects lies mainly in the combination of good properties and low price.

The plastics-processing industry of Pakistan also predicts good chances of development for this material. A growth rate of 15 to 20 per cent is expected. The previous development of consumption does not lend itself to calculating future trends, as polypropylene is a new plastic for Pakistan whose consumption has more than quadrupled since 1965.

Taking the long-term view, there are many new fields of application for polypropylene in the blow and injection moulding, films and sheeting sectors. Injection moulding will however account for the greater portion of the polypropylene used. There is here a possibility that PP will win a section of the market which has until now been dominated by polyethylene HD. PP will also play a not unimportant role in new plants for blow moulded articles and will replace HD polyethylene.

In addition, PP is expected to replace PVC in ever increasing degrees in bottle manufacture, due to its greater transparency and lower price. Developments in the films field will be slow in the near future, as this is coupled with the introduction of new machines for the processing stages.

In view of all these aspects, a mean annual growth rate of 20 per cent seems to us to be realistic. According to this, the future demand for PP in Pakistan will develop as follows:

- 1968	560 tons
- 1969	670 tons
- 1970	810 tons
- 1971	970 tons
- 1972	1,160 tons
- 1973	1,390 tons
- 1974	1,670 tons
- 1975	2,000 tons

These figures are probably on the conservative side. It is quite feasible that the mean annual growth rate will be as much as 25 per cent. The consumption in this case would rise to 2,700 tons by 1975. On the basis of our estimates, a consumption of almost four times the present amount can be expected for 1975. The estimates however do not take into account

- a possible application for PP in the fibres sector
- a PP consumption for defence purposes
- the complete replacement of polyethylene HD or other plastics

The possibility of substitutions is dealt with separately in section 6.2.6. To the possibility of PP being used in the fibres sector must be said that this is very unlikely in Pakistan, as these fibres would represent in many cases competition to natural domestic products and probably be detrimental to their sale.

5.1.2.4 <u>Prices</u>

The c&f price Karachi was in August, 1968 US $ 350 to 396 per ton granular material. The c&f price in 1965 was US $ 462 per ton.

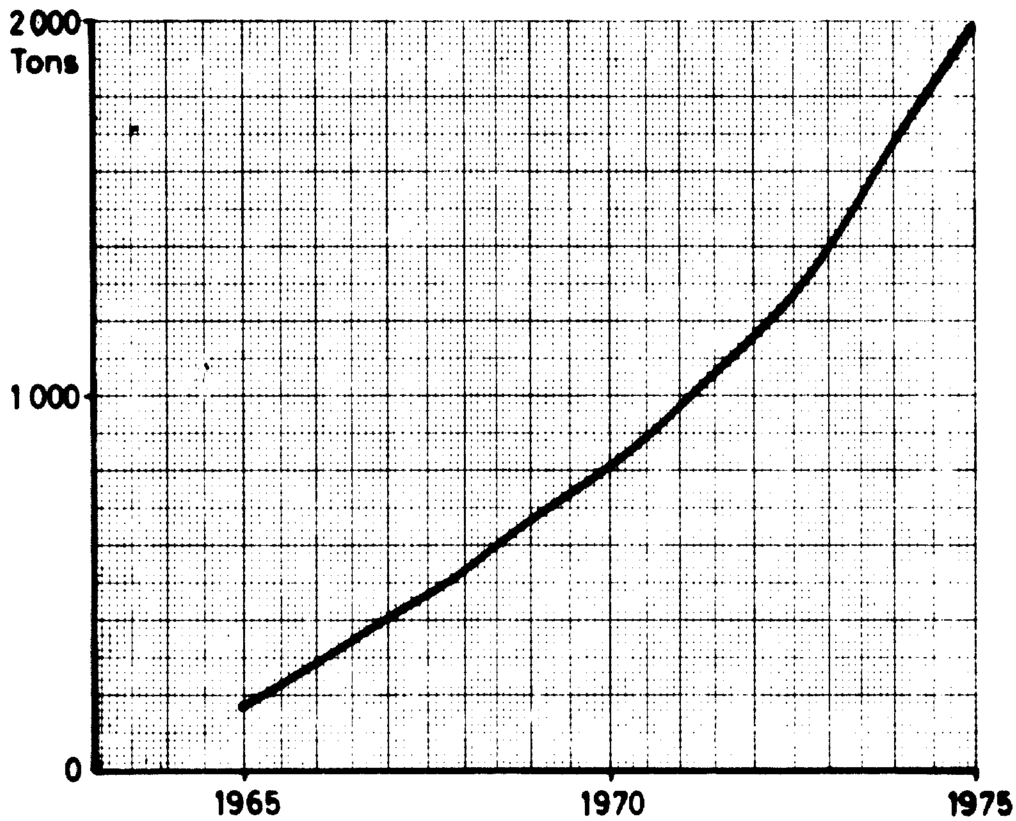

Figure 4: Development of the Consumption of Polypropylene

The present retail price for PP in West Pakistan is 7.70 Rs./kg.

5.1.2.5 <u>Structure of the Market</u>

The present users are the larger plastics-processing concerns in the Karachi area, as for example

- Dada Plastics Industries, Karachi
- Plastic Rafters, Karachi
- Maniar Plastic Industries, Karachi
- Golden Industries, Karachi

and 3 or 4 other processing plants.

Minor industrial concerns, apart from one ball point pen manufacturer in Sialkot, do not process PP.

5.1.2.6 <u>Recommendations</u>

Viewing the PP market alone, we cannot find reasons to recommend the erection of a plant for the manufacture of this material.

It should however be taken into account that the Government has an additional demand for an unknown quantity. We must also point out that the picture is somewhat altered when PED substitution and the increase of the demanf due to reduced price is taken into account. These factors are considered further in section 8.2.3.1.

Should production of PP be considered, perhaps because favourable export prospects exist, efforts should be made to find out whether the new BASF manufacturing process is suitable for Pakistan. This process makes it possible to produce a new type of PP at much lower costs. The new material is an isotactic PP which can be classified as lying between polyethylene LD and HD. It has already proven its value as an injection moulding compound and in the manufacture of piping. It is also well suited for use in the fibres sector.

5.1.3 Polyvinyl Chloride

5.1.3.1 General characteristics

5.1.3.1.1 Description of the Material

5.1.3.1.2 Plasticizers and Fillers

5.1.3.1.3 Applications

5.1.3.2 Domestic Production

5.1.3.2.1 Existing Capacity

5.1.3.2.2 Planned Projects

5.1.3.3 Demand

5.1.3.3.1 Volume and Structure of Past Demand

5.1.3.3.2 Forecast of Consumption Trends

5.1.3.4 Prices and Price Forecasts

5.1.3.5 Market Structure and Major Consumers

5.1.3.6 Recommendations

5.1.3 Polyvinyl Chloride

5.1.3.1 General Characteristics

5.1.3.1.1 Description of the Material

At the present time polyvinyl chloride (PVC) is the most important synthetic thermoplastic in terms of quantity. In general, PVC is obtained from the gaseous monomer vinyl chloride by emulsion or suspension polymerization (E-PVC and S-PVC).

Four types of PVC are in use. These are

- Rigid PVC
- Soft PVC
- PVC paste
- PVC foam

Rigid PVC is the designation given to pure PVC without or with a small addition of plasticizers. It is supplied in the form of dises (2 - 3 mm diameter) or cylinders. The granules are marketed in numerous types of S-PVC and E-PVC for various processes and applications.

Soft PVC contains between 20 and 50 per cent plasticizers. Soft PVC granules are manufactured out of E-PVC or S-PVC and plasticizers, the ratio usually being 80 : 20 and 60 : 40, also 50 : 50 and with S-PVC. The components and the stabilization system are variable, depending on the application. Soft PVC is mainly supplied as a compound ready for processing. Sometimes PVC processors do not buy the ready-mixed compound but mix it themselves out of pure PVC powder, plasticizers, stabilizers, and other processing auxiliaries.

PVC pastes are prepared by mixing and swelling PVC powder with plasticizers. They are often produced by the consumer himself. As a rule, pastes contain 50 to 60 per cent, in rare cases up to 80 per cent PVC; they gelatinize without pressure at 170 to 220°C. The properties of the products are largely similar to other soft PVC.

PVC foams are mixtures of rigid or soft PVC with expanding agents. They can be processed under pressure or without pressure into foam foils with or without basic layer of fabrics.

5.1.3.1.2 Plasticizers[1]) and Fillers

The properties of soft PVC in the form of granules or pastes are dictated by the quantity and type of the plasticizer.

One of the most important plasticizers is dioctylphthalate (DOP). It is most often used as a general purpose plasticizer. For reasons of economy secondary plasticizers are sometimes added which gelatinize with PVC without having sufficient plasticizing capacity. Among this group of plasticizers are certain fatty acid esters and chlorinated paraffins.

Rigid PVC is not filled. But inert inorganic fillers, such as kaolin, chalk, and quartz powder are added to PVC soft mixtures up to 50 per cent for reasons of economy. Larger quantities of fillers are usual in case of products such as floor covering or casing compounds.

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1) More details on plasticizers and their application in Pakistan can be found in section 5.5.6.

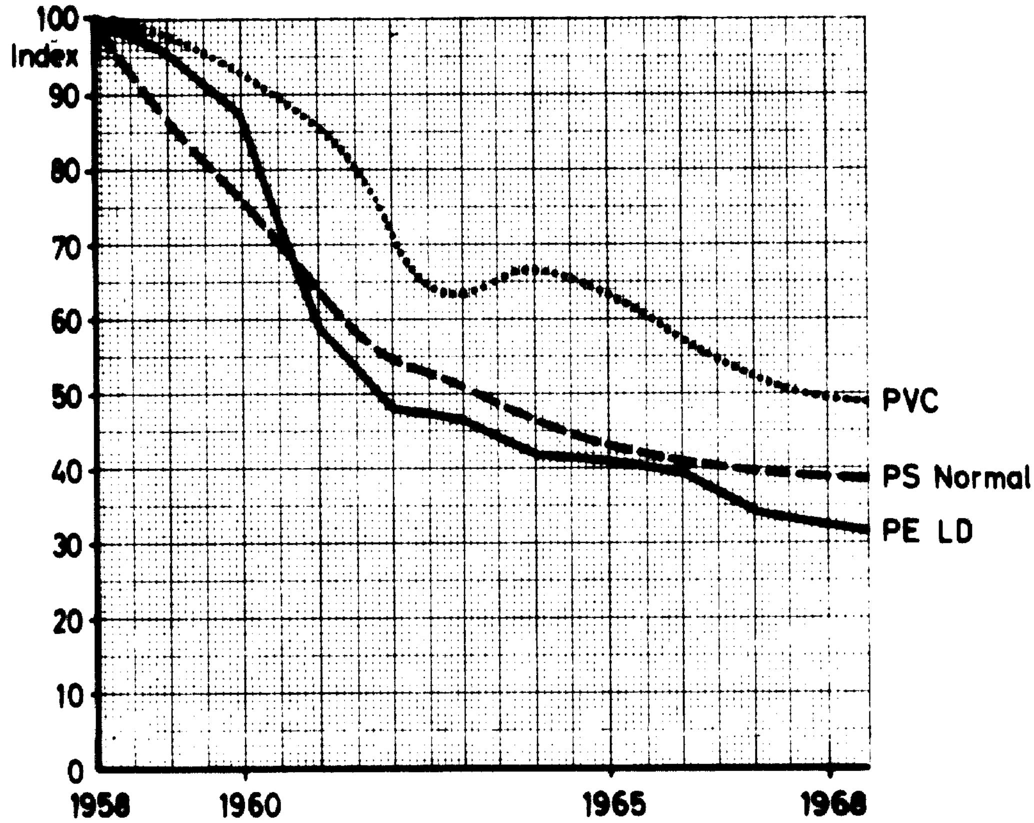

Figure 3: Development of Plastic Price Indices in Germany (1958 = 100)

5.1.3.1.3 Applications

Applications for rigid PVC are found in the production of

- Plates
- Sheets
- Extruded sections and
- Pipes

Soft PVC is used mainly in the manufacture of

- Cables and wires
- Floor coverings
- Films, and coatings
- Shoes
- Other castings and extruded articles

PVC pastes are used for coating fabrics (artificial leather) and for the production of dipped articles and castings, such as dolls, toys, boots, gloves, etc.

PVC soft foams are utilized for upholstering purposes, floats, textile coatings and electrical insulations.

In Pakistan up to now rigid PVC has been used exclusively for the manufacture of pipes, both in the Eastern and the Western Wing.

Soft PVC including pastes is the most commonly used thermoplastic in Pakistan. Its main applications are:

- Shoe production
- Cable and wire manufacture
- Films and sheets
- Other articles, such as
    - dolls
    - flexible pipes
    - disks.

In most cases the ready-mixed compound is imported.

5.1.3.2 Domestic Production

5.1.3.2.1 Existing Capacity

PVC is not produced in Pakistan at present. But some firms in East and West Pakistan produce compound from imported raw-materials. Almost all the manufacturers of artificial leather, for instance, mix the pastes for their own consumption themselves. In addition, four more firms in the cable and shoe sector make compounds, one in East Pakistan,(Bengal Cable Industries, whose plant, however, is inoperative for the moment,) the rest in West Pakistan. The largest producer of PVC compounds there is Arokey Chemicals Ltd., who produce PVC shoe compounds on a commercial basis and compounds are also made by Atlas Rubber & Plastic Industries Ltd., for their own consumption and by Premier Industries partly for their own consumption and partly on a commercial basis.

5.1.3.2.2 Projects

In Karachi Arokey Chemicals Industries intends to put a new plant for the production of PVC into operation before long. The factory has already been built, but production has not yet started owing to difficulties with the raw-material supply. The unit is planned on the basis of acetylene and hydrochloric acid, the acetylene being obtained from calcium carbide. The capacity of the plant is slightly over 5,000 t/y of PVC.

The raw material suppliers envisaged are

- Pakistan Industrial Gases, Karachi, for calcium carbide, and
- Caustic Soda Factory, Karachi, for hydrochloric acid.

The Caustic Soda Factory has not yet been put into operation owing to the lack of a power supply.

5.1.3.3 Demand

5.1.3.3.1 Volume and Structure of Past Demand

The consumption figures of rigid PVC and soft PVC over the last few years are given below, classified according to applications and Wings.

Table 10: Consumption of PVC Compounds in West Pakistan, 1965 to 1968 (in tons)

Application	1965	1966	1967	1968[1]
Rigid PVC:				
Rigid pipes	-	-	300	700
Soft PVC [2]				
Cable and wire coatings	1,350	1,300	1,400	1,435
Shoes	510	560	720	880
Films, and coated fabrics	1,200	1,050	1,300	1,680
Others	540	510	585	655
Total consumption	3,600	3.420	4,305	5,350

[1]) Expected consumption

[2]) The consumption figures listed under soft PVC contain about 40 per cent plasticizers, fillers, stabilizers, and dye-stuffs in addition to the pure PVC, whereas the share of the additives is much below 20 per cent with the rigid PVC figures.

Table 11: Consumption of PVC Compounds in East Pakistan, 1965 to 1968 (in tons)

Application	1965	1966	1967	1968 [1]
Rigid PVC:				
Rigid pipes	-	-	180	450
Soft PVC [2]				
Cable and wire coatings	245	215	220	330
Shoes	850	1,300	1,600	1,700
Films and coated fabrics	310	420	365	450
Others	-	-	-	-
Total consumption	1,405	1,935	2,365	2,930

[1]) Expected consumption

[2]) The consumption figures listed under soft PVC contain about 40 per cent plasticizers, fillers, stabilizers, and dyestuffs in addition to the pure PVC, whereas the share of the additives is much below 20 per cent with the rigid PVC figures.

On combining the above two tables, the resulting figures for All Pakistan are:

Table 12: Consumption of PVC Compound in Pakistan, 1965 to 1968 (in tons)

Application	1965	1966	1967	1968 [1]
Rigid PVC:				
Rigid pipes	-	-	480	1,150
Soft PVC: [2]				
Cable and wire coatings	1,595	1,515	1,620	1,765
Shoes	1,360	1,860	2,320	2,580
Films, and coated fabrics	1,510	1,470	1,665	2,130
Others	540	510	585	655
Total consumption	5,005	5,355	6,670	8,280

The percentage of the total consumption of PVC compounds that is used for each application in the two wings is as follows:

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[1] Expected consumption

[2] The consumption figures listed under soft PVC contain about 40 per cent plasticizers, fillers, stabilizers, and dyestuffs in addition to the pure PVC, whereas the share of the additives is much below 20 per cent with the rigid PVC figures.

Table 13: Percentage of the total Consumption of PVC Compounds used for each Application in 1968

Application	West Pakistan	East Pakistan	All Pakistan
Rigid pipes	13 %	15 %	14 %
Cable and wire coatings	27 %	12 %	21 %
Shoes	16 %	58 %	31 %
Films, and coated fabrics	32 %	15 %	26 %
Others	12 %	-	8 %

In East Pakistan the shoe sector is the largest consumer of PVC compounds with 58 per cent of the total. The sectors of pipes and films follow with a much smaller share of only 15 per cent each. The rest is consumed by the cable and wire coatings sector.

In West Pakistan the main consumption at present comes from the field of films and coated fabrics, which is followed by the cable and wire coatings sector. These two sectors together make up almost 60 per cent of the consumption of PVC compounds. The rest is consumed by the sectors of shoes, rigid pipes, and "other", with almost equal shares.

During recent years PVC consumption has increased in almost all sectors, except for 1966 when it was lower than in 1965.
In 1967, however, consumption was even higher than in 1965. Evidently the decrease in demand in 1966 was conditioned by the Indo-Pakistan War. This decline in industrial activity is also reflected in the consumption figures of the other thermoplastics and duroplastics. Besides, the introduction of the Bonus Voucher system for plastics may also have helped to restrict the importation and consequently the consumption of plastics.

Following interviews with the processors in the various sectors,we compiled the following survey:

There are producers of rigid pipes from rigid PVC in both East and West Pakistan. In each Wing one producer controls the market for irrigation, drainage and drinking water pipes. They are the suppliers of pipes to official and semi-official institutions such as Water and Power Development Authorities (WAPDA), Departments of Public Health Engineering (DPHE), Water and Sewage Authority (WASA), etc., and their production programmes cover pipes of up to 14 inches diameter. In addition to these two big pipe manufacturers, three more producers of water pipes, of smaller diameters and conduit pipes for electric supply lines have started business in East Pakistan this year. The production of PVC rigid pipes is a very young industry in Pakistan - it began as recently as 1967 - but it is already showing great promise. For 1968 a total production of rigid pipes of more than 1,100 t is expected.

The cable industry is especially strong in West Pakistan. In this Wing the demand for PVC is expected to be about 1,400 t in 1968, that is four times as high as in East Pakistan. There are large, medium-sized and small enterprises operating in this sector; the large firms are all in the Karachi area, the medium-sized enterprises are mainly located in Dacca, Karachi, and Lahore. The production programme of the medium-sized and small enterprises is confined to the production of household cables, while the programme of the two large cable manufacturers in Karachi also includes high-tension cables in the form of overhead and underground supply lines. A new cable factory of the EPIDC in East Pakistan will presumably also start with the production of high-tension cables by the end of this year.

The soft PVC needed by the cable industry is mostly imported as a ready-mixed compound. Only two cable manufacturers, one of them in West Pakistan and the other in East Pakistan, are able to produce their compounds themselves. The compound has to meet special requirements as a insulation and casing compound for cables and is traded as "cable grade". This PVC type is marked by high tensile strength and good resistance to abrasion, moisture and to fuels.

The shoe industry is an important consumer of soft PVC, especially in East Pakistan. In 1968 the demand for soft PVC is expected to be 1,700 t in East Pakistan alone. In addition, the demand in West Pakistan will amount to about 880 t, the total demand thus being 2,580 t. This makes the shoe sector at present the largest individual consumer of PVC.

In East Pakistan there are 34 injection-moulding machines specializing in the production of plastic shoes, corresponding to a theoretical annual processing capacity of about 6,800 t of PVC. The installed capacities in West Pakistan are only one third of those installed in the Eastern Wing (about 10 machines) and thus can process about 2,000 t of PVC per year.

The soft PVC used for the production of plastic shoes is a ready-mixed compound conforming to the special requirements, such as softness and rigidity, and traded as "PVC compound shoe grade quality".

The sector of films and coated fabrics is the second largest consumer of PVC in Pakistan. In 1968 it is expected that the demand for soft PVC for the manufacture of films and foils will be about 1,700 t in West Pakistan. The estimated demand in East Pakistan is only a quarter of this figure, i.e. about

450 t. The large and medium-sized enterprises operating in this sector are mostly located in Karachi. Most PVC films and coated fabrics are used for the manufacture of rain-coats, foils for packing, coating for jute carpets, artificial leather and floor tiles. The production of artificial leather is the most important of these applications the material generally contains a basic tissue of cotton. Artificial leather is supplied by the producers to the Railways and the automobile, trunk, bag, and furniture making industries for further processing.

The item "Others" above covers all castings and extruded articles which could not conveniently be assigned to one of the other sectors. It includes for example, the production of flexible pipes, toys, household items discs, balls, and baskets. Only in West Pakistan is the PVC consumption of the manufacturers of these articles of any importance. Large, medium-sized, and small enterprises operate in this line.

The figures listed in tables 10 to 12 indicate the consumption of ready-mixed PVC compounds, which contain plasticizers, fillers, stabilisers, etc., in addition to PVC resin. They do not show the consumption of pure PVC in the various sectors. The compounds are now reduced to their PVC content in order to make an approximate assessment on the consumption of PVC resin.

The average resin content of the granules and pastes, except for rigid PVC which is applied in almost pure form, is 60 per cent. A reduction of the compounds to their pure resin content is given in table 14.

Table 14: Estimate of the Consumption of PVC resin, 1965 to 1968 (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1965	2,160	840	3,000
1966	2,050	1,160	3,210
1967	2,700	1,490	4,190
1968[1])	3,500	1,940	5,440

As mentioned, all the PVC types consumed in Pakistan are imported. The countries of origin of the imports vary continuously and depend largely on the prices of the compounds supplied; the quality is apparently of less importance. At present the most important suppliers are Italy, the Lebanon, Japan, Hongkong, and Taiwan. Further imports come from the Federal Republic of Germany, USA, and France.

5.1.3.3.2 **Forecast of Consumption Trends**

The estimate of future consumption is based on separate discussions of the sectors

- rigid pipes
- cables
- shoes
- films and coated fabrics
- others.

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[1]) Expected consumption

It is characteristic of the price development of the last few years that plastics today only cost about half as much or even less than ten years ago.

The price development for PE LD produced in Pakistan was as follows:

1967: 3.56 - 3.74 Rs./kg
1st half 1968: 3.23 Rs./kg

As we were informed by the producer the price was reduced to 2.42 Rs./kg in mid-1968. This does not necessarily show that also in Pakistan the price has a strongly decreasing tendency since the manufacturers acted under the pressure of the preferred imports.

The c & f price for PE LD at the time of the interviews was between 204 and 216 US $/ton. The cheapest imports were supplied by the Japanese at 204 US $/ton. The price for German products was 216 US $/ton.

The price for HD polyethylene fluctuates strongly because of the varying supplies by the Japanese. In August 1968 it was about 340 US $/ton.

PE LD is sold at about 3.85 Rs./kg in West Pakistan, in East Pakistan the price may be as high as 5 Rs./kg.

5.1.1.5 Structure of the Market and Main Consumers

Large and medium-sized plastics processors buy the granular material directly from Valika or from foreign manufacturers through the general agencies of manufacturers in Pakistan, which in as a rule only act as indenting firms.

Rigid pipes

It is obvious that the PVC pipes still have certain difficulties in replacing pipes of the traditional materials such as galvanized iron, asbestos and cast iron. Consumption trends until now, however, show that the demand for PVC pipes is increasing, both from the governmental and the private sector.

Interviews with the large consumers of pipes in the public sector in East Pakistan, such as the DPHE, WASA, and WAPDA, proved that PVC pipes will be applied much more than in the past in the sectors of household connections, hand-operated water pumps and sewerage as soon as their prices can compete with those of the traditional pipes. According to a study of the Consulting Burea of Camp, Dresser & McKee, the demand for PVC pipes alone with the three organizations will increase to ca. 7,000,000 metres between 1970 and 1975 and to ca. 15,200,000 metres between 1975 and 1980.

A detailed discussion with the responsible institutions showed that, in view of the difficulties the planned programmes face, 50 per cent of the expected consumption figure would be a more realistic estimate. The demand in the public sector in East Pakistan will thus be about 5,000 t of PVC in 1975. The demand in the private sector will go on increasing parallel to that of the public sector, above all in the case of sewage pipes and conduit pipes for electric supply lines. The demand of the private sector, however, will be smaller than that of the public sector.

Assuming that the planned programmes are realized as indicated, the demand for PVC pipes in East Pakistan could grow as follows:

1968:	450 t
1969:	900 t
1970:	1,800 t
1971:	2,500 t
1972:	3,500 t
1973:	4,200 t
1974:	5,000 t
1975:	6,000 t

As far as West Pakistan is concerned inquiries of the public and semi-public institutions there did not provide any indication that a planned mass utilization of PVC pipes for public projects is to be expected at the moment. According to information from the only manufacturer of PVC pipes in Karachi, the market still has to be developed. It is expected that the 1968 consumption will double by 1970. In the long run a 20 per cent growth rate appears feasible for West Pakistan. There are many potential applications for PVC pipes in the Western Wing, e.g. for drainage, household water mains, transmission of gas, electric insulation lines.

The quantity of PVC required for the production of pipes in West Pakistan according to our estimate will develop as follows:

1968:	700 t
1969:	1,000 t
1970:	1,400 t
1971:	1,680 t
1972:	2,020 t
1973:	2,420 t
1974:	2,900 t
1975:	3,490 t

The figures apply only to the normal increases in the demand to be expected from households, industry, and in part from governmental organisations. They do not take into consideration any special increases that might be caused by public planning projects, such as major irrigation and drainage projects, or the construction of gas pipelines.

Addition of the estimated future demand for PVC rigid pipes in East and West Pakistan gives the following figures:

1968: 1,150 t
1969: 1,900 t
1970: 3,200 t
1971: 4,180 t
1972: 5,520 t
1973: 6,620 t
1974: 7,900 t
1975: 9,490 t

According to this estimate the present demand for PVC for the production of rigid pipes will thus increase eightfold up to 1975.

Cable and wire coatings

PVC consumption in East Pakistan increased by 34 per cent between 1965 and 1968. In West Pakistan the increase was only 6 per cent in the same period. The difference in the two growth rates is understandable if the basic figures are considered. Taking the absolute consumption figures, the demand in West Pakistan is higher than that in East Pakistan.

The activity of the cable firms up to now has been concentrated almost exclusively in the field of low tension cables for household connections. It is therefore intended in future to attach more importance to the development of the high-tension cables sector. In West Pakistan, for instance, two large cable factories in Karachi are thinking of extending their production of high-tension cables. In East Pakistan a large high-tension cable factory of the EPIDC is under construction. In addition, the already mentioned factory producing telephone cables is being established in East Pakistan. Thus the PVC consumption in the cable sector will certainly increase more rapidly in future than in the last three years.

As a close correlation exists between the generated electric power and the consumption of cables, the development plans of WAPDA can be taken as a basis for the calculation of the long-term demand for cables and thus also for the PVC cable-coating compounds in East and West Pakistan. Accordingly, in East Pakistan the expected installed capacities for 1968 367 MW are to be increased to 780 MW by 1970 and to 1,180 MW by 1975. This means a doubling of the installed capacity between 1968 and 1970 and an increase by about 50 per cent between 1970 and 1975 [1]).

The masterplan of the West Pakistan WAPDA envisages an average annual growth rate for the installed capacities of 15 per cent up to 1970 and of 14 per cent between 1970 and 1975.

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1) The consumption figures of cable compound which have been based on these figures will probably be somewhat high for the years 1968 to 1971 as far as East Pakistan is concerned. Over the whole period and for the overall consumption of PVC resin this difference is however in material.

If the development plans of the WAPDA are realized, the required quantities of PVC compound for cable and wire coating material can be assumed to be as follows:

Table 15: Estimated Future Demand for PVC Cable Compounds, 1968 - 1975 (in t)

Year	West Pakistan	East Pakistan	All Pakistan
1968	1,435	330	1,765
1969	1,650	480	2,130
1970	1,890	660	2,550
1971	2,160	700	2,860
1972	2,460	750	3,210
1973	2,810	820	3,630
1974	3,200	900	4,100
1975	3,650	990	4,640

The demand for PVC compound cable grade will thus more than double up to 1975; in absolute figures this means that it will increase by about 3,000 t. About 80 per cent of this quantity will be consumed in West Pakistan and 20 per cent in East Pakistan.

Shoes

The shoe sector is the largest consumer of PVC in Pakistan at the moment. It will continue to play an important part in the future, too, plastic shoes are very much in demand, especially by the rural population because of their low price and hard-wearing qualities, and because they can easily be cleaned. Particularly in East Pakistan PVC shoes are ideally suited to the climatic conditions; the consumption of PVC shoes there is already 1,700 t, and it will continue to increase rapidly with the rise in the income of the lower classes. West Pakistan shows less demand for plastic shoes than the Eastern Wing, but according to statements made by the producers demand will continue to increase there, too. Another important factor is that plastic shoes are replacing rubber shoes to an ever-increasing degree in East and West Pakistan. The interviews showed that the producers of rubber shoes are changing over to the production of plastic shoes.

Interviews with the importers of PVC and with the shoe manufacturers showed that an annual growth rate of 10 - 15 per cent for shoe compound is expected over the next few years. On the assumption of a minimum growth rate of 10 per cent, the PVC consumption for shoes will be 3,213 t in East Pakistan and 1,715 t in West Pakistan in 1975. An increase rate of 15 per cent can be regarded as realistic if the prices of PVC and thus the prices of shoes continue to fall somewhat. In this case the demand for PVC would reach 4,600 t in East Pakistan and 2,400 t in West Pakistan by 1975.

We suppose, however, that the real growth rate per annum will range between 10 and 15 per cent. The consumption figures for East and West Pakistan estimated in the following table are based on an annual growth rate of 13 per cent.

Table 16: Estimated Future Demand for PVC Shoe Compound, 1968 - 1975 (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1968	880	1,700	2,580
1969	990	1,920	2,910
1970	1,120	2,170	3,290
1971	1,270	2,450	3,720
1972	1,440	2,770	4,210
1973	1,620	3,130	4,750
1974	1,830	3,540	5,370
1975	2,070	4,000	6,070

According to the table, the overall demand for shoe compound in Pakistan will more than double up to 1975, when it will exceed 6,000 t. About 65 per cent of this quantity will be consumed in East Pakistan and 35 per cent in West Pakistan.

Films and Coated Fabrics

About 26 per cent of the PVC consumed in Pakistan is processed in the form of pastes and granules into films and coated fabrics. The total demand has increased by 41 per cent since 1965. This corresponds to an average annual growth rate of 12 per cent. The interviews with the consumers suggested that in the long run an average annual increase of 10 - 12 per cent can be expected in future. The smaller growth rate of 10 per cent seems more realistic to us, since the actual consumption of 2,130 t is already very high, and since there are no signs of a further sharp increase in this line. It should be mentioned furthermore, that PE is overtaking PVC in the sector of films and foils. PVC floor tiles and artificial leather, however, cannot be replaced by PE, so these articles will be of decisive importance in the further increase on PVC consumption in the sector of films and coated fabrics.

Table 17: Estimated Future Demand for PVC Compounds in the Sector of Films and Coated Fabrics, 1968 - 1975 (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1968	1,680	450	2,130
1969	1,850	500	2,350
1970	2,040	550	2,590
1971	2,240	600	2,840
1972	2,460	660	3,120
1973	2,700	730	3,430
1974	2,970	800	3,770
1975	3,270	880	4,150

The table shows that the consumption will double up to 1975, West Pakistan accounting for 79 per cent and East Pakistan for 21 per cent of that consumption.

Others

Only in West Pakistan could consumption in this sector be detected. The average annual growth rate in the past was about 6 per cent. We think that the increase in demand will remain about the same in future, too. There was no evidence supporting an increase of more than 6 per cent.

Development in this field in East Pakistan lags some years behind that in West Pakistan. If the development of West Pakistan in 1967 is taken as a basis for comparison, it can be assumed that East Pakistan will certainly have reached this level in 1975. Consequently, the estimated demand in East Pakistan in 1975 is at least 500 t. The development of demand in the separate years can only be indicated as a possible trend. It is a rough estimate, but under the prevailing circumstances no better figures can be made available.

Addition of the demand estimates for East and West Pakistan gives the following table:

Table 18: Estimated Future Demand for PVC Compounds in the Sector "Others", 1968 - 1975 (in tons)

Year	East Pakistan	West Pakistan	All Pakistan
1968	655	0	655
1969	690	40	730
1970	740	100	840
1971	780	180	960
1972	830	270	1,100
1973	880	320	1,200
1974	930	400	1,330
1975	990	500	1,490

According to our estimates, the total demand for PVC compounds in the sector "Others" will more than double up to 1975 (about 128 per cent). This means an average annual growth rate of 12.5 per cent.

Addition of the demand estimates of the individual sectors for Pakistan gives the following results:

Table 19: Estimated Future Demand for PVC Compound in the Individual Sectors in Pakistan, 1968 - 1975 (in tons)

Year	Rigid Pipes	Cables	Shoes	Films and Coated Fabrics	Others	Total
1968	1,150	1,765	2,580	2,130	655	8,280
1969	1,900	2,130	2,910	2,350	730	10,020
1970	3,200	2,550	3,290	2,590	840	12,470
1971	4,180	2,860	3,720	2.840	960	14,560
1972	5,520	3,210	4,210	3,120	1,100	17 160
1973	6.620	3,630	4,750	3.430	1,200	19.630
1974	7,900	4.100	5,370	3.770	1,330	22.470
1975	9.490	4.640	6,070	4.150	1,490	25,840

Note: The demand except for rigid pipes contains about 35 per cent plasticisers.

The table shows that the sector of rigid pipes is estimated to develop into the largest consumer of PVC by 1975. It will account for 37 per cent of the total demand for PVC compounds. The shoe sector with about 24 per cent will probably be the second largest consumer. The sectors of cables, films and coated fabrics will together consume about 34 per cent and the sector "Others" about 5 per cent of the total quantity.

The small-scale industry buys from wholesalers or importers.[1])

The importing firms in West Pakistan are located in Karachi, Lahore and Hyderabad. In East Pakistan there are hardly any independent importers of plastics which act as wholesalers. Most of the wholesalers or importers at the same time are producers of plastic articles and sell only part of their own imports to the small firms. As the imported quantities are insufficient, the wholesale price in East Pakistan often is higher than in West Pakistan.

The following list gives a survey of the most important buyers of PE, separately for East and West Pakistan.

East Pakistan

N a m e	Location	End-Products
- Water-Proof Packaging Materials	Dacca	films and bags
- Overseas Agencies	Dacca	films and bags
- Good Luck Traders and Rafique Industries	Dacca	films and bags, household items
- Premier Polyethylene Industries	Dacca	films and bags
- Premier Laminations (Adamjee)	Dacca	films and bags
- Barisal Traders	Dacca	films and bags
- Lira Industrial Enterprise	Dacca	rigid pipes
- Saifuddin Jamaluddin	Chittagong	
- Fertilizer Factory	Fechunganj	films and bags

[1]) This scheme applies throughout the industries dealt within this study. It will, therefore, not be repeated in each section unless there are deviations worth mentioning.

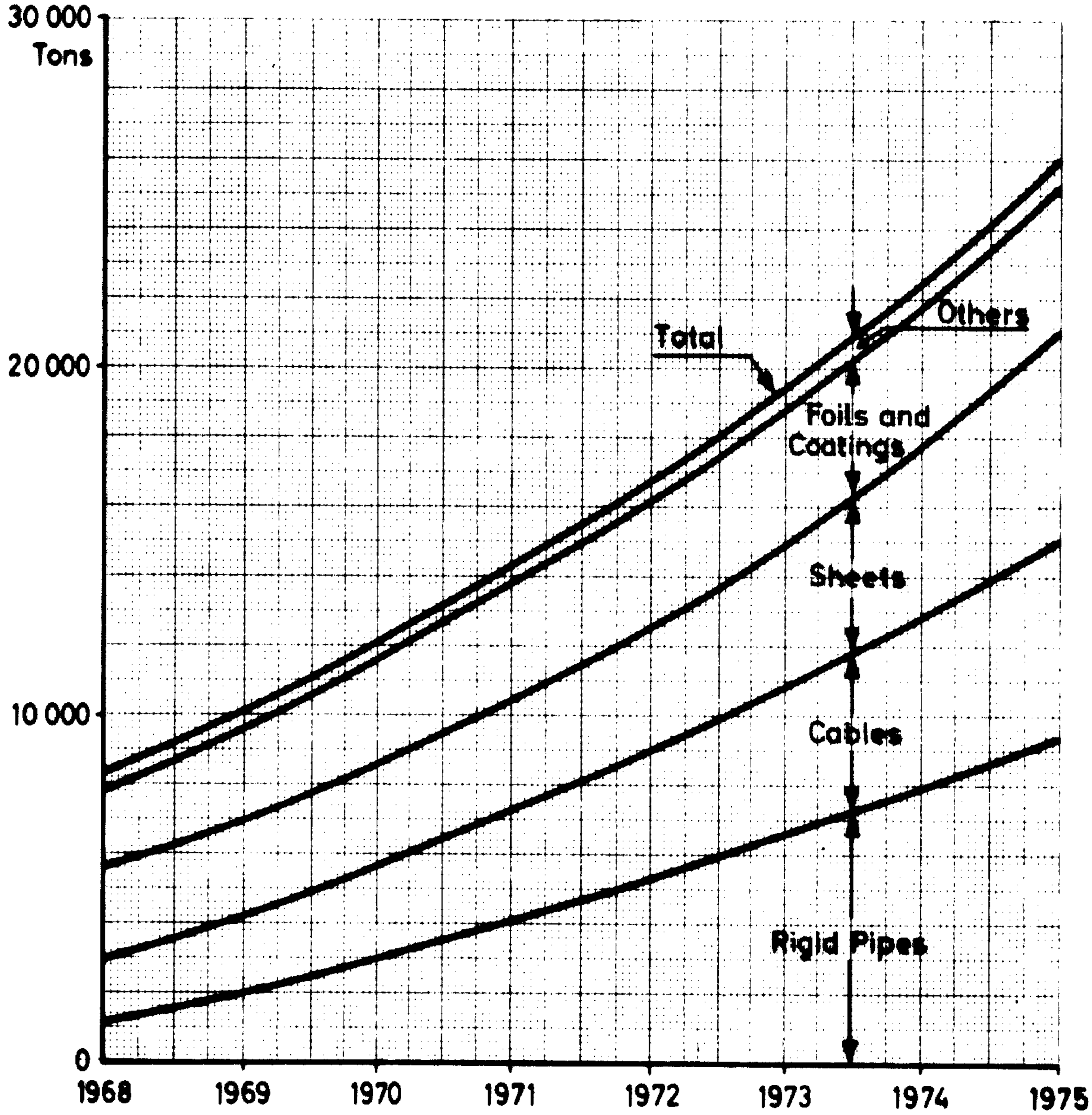

Figure 5 : Future Demand for PVC (All Types) in the Individual Sectors

The regional break-down of the estimated demand figures for all sectors up to 1975 is as follows, for East and West Pakistan separately:

Table 20: Regional Break-Down of the Estimated Total Demand for PVC Compound, 1968 - 1975 (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1968	5,350	2,930	8,280
1969	6,180	3,840	10,020
1970	7,190	5,280	12,470
1971	8,130	6,430	14,560
1972	9,210	7,950	17,160
1973	10,430	9,200	19,630
1974	11,830	10,640	22,470
1975	13,470	12,370	25,840

According to the table, the demand will increase more rapidly in East Pakistan than in West Pakistan. The average annual growth rate up to 1975 will be about 23 per cent in East Pakistan and about 14 per cent in West Pakistan. In 1975 the absolute quantities consumed will be almost the same in both Wings; East Pakistan will account for 48 per cent and West Pakistan for 52 per cent of the total demand. The sharp increase of PVC demand in East Pakistan is caused above all by the planned mass application of PVC pipes in the public sector and the continuation of the large demand for plastic shoes. This picture might change, however, if the competent authorities in West Pakistan also decided, in the course of the next few years, to use PVC pipes on a larger scale.

The estimated consumption quantities indicated in the above tables refer to compounds which contain plasticisers, stabilisers, and in some cases fillers, in addition to the PVC resins. The only exception is the PVC rigid compounds for rigid pipes, which can be considered as almost pure PVC resin and do not need further reduction. The reduction of the PVC soft compounds used in the various sectors to their resin content furnishes the values indicated in table 21. An average PVC content of 60 per cent in the PVC soft compounds is assumed.

Table 21: Estimated Demand for PVC Resin in Pakistan, 1968 - 1975 (in tons)

Year	Soft PVC	Rigid PVC	PVC Total
1968	4,290	1,150	5,440
1969	4,870	1,900	6,770
1970	5,550	3,200	8,750
1971	6,230	4,180	10,410
1972	6,980	5,520	12,500
1973	7,800	6,620	14,420
1974	8,740	7,900	16,640
1975	9,790	9,490	19,280

The demand for PVC resin for the manufacture of compounds in all sectors will thus increase almost fourfold up to 1975. According to our analysis it will be about 19,000 t in 1975.

5.1.3.4 Prices and Price Forecasts

In order to give an idea of the development of PVC prices in the world the producer prices in the Federal Republic of Germany over the last few years are examined.

The ex factory sales prices for rigid PVC fell from 0.43 US$/kg in 1960 to 0.29 US$/kg in 1967. In the first half of 1968 they declined even further to 0.26 US$/kg. Since then the prices have remained stable at this level. At present there even seems to be a slightly upward trend. In this connection we refer to figure 2 in section 5.1.1.4, which compares the development of PVC prices with the development of the prices for polyethylene and polystyrene.

Recently, the PVC prices have started to decline, while the raw material prices have been increasing. Therefore, a price increase of 4 per cent is expected at least in the Federal Republic of Germany, in late 1968 or early 1969.

The c & f prices of PVC resins at the time of the interviews fluctuated between 216.- and 264.- $/t, depending on type, quantity purchased, and supplying country. This price also covered rigid PVC.

For PVC soft compounds the following prices had to be paid:

- for cable grade compound 319.50 - 360 US $/t from Italy and Taiwan, and 365 - 372 US $/t from the U.K. and the USA,

- for shoe grade compound 338 - 360 US $/t from Taiwan, Hongkong, and Italy, and 362 - 374 US $/t from the Federal Republic of Germany, France, and the U.K.

Pastes are scarcely imported. They are mixed in Pakistan from imported PVC resin.

The wholesale price of PVC resin was between 5.50 and 6.40 Rs./kg, and for cable grade compound about 6.60 Rs./kg.

5.1.3.5 <u>Market Structure and Major Consumers</u>

Medium-sized and large enterprises of the PVC processing industry import their raw-materials direct from the producer via general agencies of the manufacturing firms. The small firms buy their PVC in the local market from wholesalers and importers. Very small firms at a bazaar level frequently use waste PVC obtained from the larger firms, since it is cheaper.

In the <u>plastic shoe industry</u> the most important consumers of PVC are in East Pakistan:

- Bata Shoe Industries Ltd., Dacca
- Karim Rubber Industries, Fatullah
- United Plastic & Rubber Industries, Dacca
- Kohinoor Rubber, Dacca
- Hafiz Brothers, Dacca
- Bengal Belting Corporation, Chittagong

in West Pakistan.

- Pakistan Footwear Industries, Karachi
- Jasmeen Industries, Karachi
- SRS Industrial Corporation, Karachi
- Plastiko Industries, Karachi
- Bata Shoe Industries Ltd., Batapur
- Service Industries Ltd., Lahore
- Shahid Industries, Lahore
- Modern Industries, Gujranwala
- Raja Industries Ltd., Sialkot.

In the cable industry in East Pakistan five producers were found who may be classified as medium-sized:

- Bengal Cable Industries, Dacca
- Sunshine Cable & Rubber Works, Dacca
- Evershine Cable Industries, Dacca
- Fecto Ltd., Dacca
- Bengal Belting Corporation, Chittagong.

Two major cable firms are under construction. These are

- Cables Factory of the EPIDC in Chittagong, and
- Telephone Cables Factory of the EPIDC in Khulna.

In West Pakistan larger and smaller cable manufacturers are found than in East Pakistan. The most important of them are:

- Pakistan Cables Ltd., Karachi
- Atlas Rubber & Plastic Industries Ltd., Karachi
- Premier Rubber & Cables Industries, Karachi
- New Karachi Cable Industries, Karachi
- Premier Industries, Karachi
- Elastoplast, Lahore
- New Age Corporation, Lahore
- National Cable Industries, Gujranwala.

In addition, there are many small enterprises in all larger towns. In the sector of films and coated fabrics only one enterprise is operating in East Pakistan at present, viz. Bella Artifitex in Dacca. Two other firms have closed down.

In West Pakistan several plants are in operation. We have to mention above all

- Valika Art Fabrics Ltd., Karachi
- Feroz Burewala, Karachi
- National Tyre & Rubber Co., Karachi
- SRS Industrial Corporation, Karachi
- Master Rubber, Karachi
- Burewala Textile Mills, Burewala
- Watal Linoleum Art Fabrics, Rawalpindi.

In the rigid pipes industry the most important enterprise in East Pakistan was found to be Lira Industrial Enterprise, Dacca, and the biggest in West Pakistan, Arokey Chemical Industries Ltd., Karachi. There are also two smaller producers in Dacca: Overseas Agencies and Polytube Industries.

The following firms are worth mentioning in the sector "Others":

- Kohinoor Plastic Works, Karachi
- Pakistan Footwear Industries, Karachi
- Gramophone Company of Pakistan, Karachi
- Unico Engineering, Lahore.

5.1.3.6 Recommendations

The minimum capacity of a plant for the production of PVC resin under world market conditions at present can be said to be 20,000 to 25,000 t a year. Such a plant, however, would undoubtedly not have very beneficial economic effects.

As it is in the interest of Pakistan to manufacture plastics as cheaply as possible and with the lowest possible foreign exchange expenditure per product unit, we think that no plant below 20,000 t a year should be erected in future in Pakistan, either. Undar the prevailing conditions, such a production could start in 1972 [1]).

With regard to the problems arising from the existence of one small and one large plant, we refer to section 5.1.1.6. A solution similar to the one outlined in that section would be recommendabls for PVC as well.

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[1]) Cf. also section 8.3

5.1.4 Polyvinyl Acetate

5.1.4.1 General Characteristics

5.1.4.2 Domestic Production

5.1.4.2.1 Existing Capacities

5.1.4.2.2 New Projects

5.1.4.3 Demand

5.1.4.3.1 Volume and Structure of Past Demand

5.1.4.3.2 Future Trends in Demand

5.1.4.4 Prices

5.1.4.5 Consumers

5.1.4.6 Recommendations

5.1.4 Polyvinyl Acetate

5.1.4.1 General Characteristics

Polyvinyl acetate is a transparent resin that is practically insoluble in water. It is produced from vinyl acetate obtained by causing acetylene to react with acetic acid. If energy is applied in the form of heat and light, vinyl acetate turns into a resinous material, i.e. polyvinyl acetate. It is possible to copolymerize vinyl acetate with other substances, e.g. with vinyl chloride, crotonic acid, and acrylic esters. If the proportion of vinyl acetate prevails, these copolymers are also called "polyvinyl acetate".

Solid polyvinyl acetate is used for the production of

- paints
- varnishes
- adhesives
- finishes (stiffening agents for felts, textile fabrics, impregnation of paper and cardboard).

Compared with finishing materials on the basis of starch, dextrin, glue etc., polyvinyl acetate finishes offer the special advantage of good water and washing resistance. In addition, they have a better grip and other desirable properties. They are suitable for the finishing of fabrics from cotton, linen, wool, half-wool, rayon, nylon, and other synthetic fibres.

Most of the polyvinyl acetate is applied in the form of dispersions. These are produced by distributing the liquid monomer into a fine emulsion in water by means of emulsifiers

West Pakistan

N a m e	Location	End-Products
- Valika Art Fabrics	Karachi	films and bags, containers, household items
- Plastic Rafters	Karachi	films and bags, containers
- Golden Industries	Karachi	general purpose items
- Rehmat Plastics Industries	Karachi	general purpose items
- Pakistan Plastic Industries	Karachi	general purpose items
- Kohinoor Plastic Works	Karachi	films and bags, general purpose items
- Dawood Cotton Mills	Karachi	containers
- Maniar Plastic Industries	Karachi	household items
- Dada Plastic Works	Karachi	combs
- Chemfabs Ltd.	Karachi	containers
- Durathene Ltd.	Karachi	films and bags
- Plastiko Industries	Karachi	household items
- Jasmeen Industries	Karachi	films and bags
- Packages Ltd.	Lahore	films and bags, coated packaging material
- Unico Engineering Co.	Lahore	films and bags
- Standard Automations Works	Lahore	films and bags, pipes
- Jajuan Plastic Industries	Gujranwala	tubes

and protective colloids and by polymerising it to give finest solid particles. The polyvinyl acetate dried from the dispersion has about the same properties as solid polyvinyl acetate. The main applications are.

- Binders for paints and varnishes
- Wall primers
- Additives for concrete and mortar
- Adhesives for building slabs and tiles
- Paper coatings
- textile finishing materials.

In the sector of paints and varnishes polyvinyl acetate dispersions are of particular importance owing to their favourable properties, i.e. weather resistance, good processability, thixotropy. For the rest, the same remarks as for solid polyvinyl acetate apply to the application of the dispersions.

The polymer content of the dispersions is 40 to 60 per cent. Depending on the application, up to 50 per cent of plasticisers (related to polymer) such as dibutyl phthalate, tricresyl phosphate and others can be added to the dispersion.

In Pakistan polyvinyl acetate is used exclusively in the form of dispersions, especially in the sector of paints and varnishes and of textiles.

Pure polyvinyl acetate is used only rarely in paints and varnishes. Generally in Pakistan the copolymers consist of 80 per cent polyvinyl acetate and 20 per cent acrylics and maleic acid esters. Polyvinyl acetate has proved to be a particularly favourable binding agent for paints and varnishes precisely under the climatic conditions presailing in Pakistan. It is more favourable than other synthetic resin dispersions such as polyvinyl propionate and pure acrylic resin dispersions. The first one is too soft, whereas the latter is too expensive in addition to other disadvantages such as higher chalking.

In the Pakistani extile industry polyvinyl acetates are used above all for the finishing of poplin (shirts, printed cotton cloth).

Only one firm in Karachi uses polyvinyl acetate for the production of office glue and glue for general packaging purposes.

5.1.4.2 Domestic Production

5.1.4.2.1 Existing Capacities

Polyvinyl acetate emulsions have been produced since 1967 by Futehally Chemicals Ltd., Karachi. The firm has a plant for the production of 600 tons per year which was produced in Pakistan. In 1967, 15 tons of vinyl acetate were polymerised, a quantity that corresponds to about 43 tons of emulsion with a solid matter content of 35 per cent. The quantity of monomers processed in 1968 is estimated at 35 tons, corresponding to 100 tons of emulsion.

In the past the emulsions were supplied exclusively to the textile industry of West Pakistan where they are used as stiffening agents. Starting from 1969 the firm will also supply the paints industry of West Pakistan. Under the prevailing conditions the plant could operate at full capacity already in 1969.

5.1.4.2.2 New Projects

The Government is of the opinion that two more polymerisation plants should be established,i.e. one in East Pakistan and one in West Pakistan. Sanctions were already granted to

- Hoechst Pharmaceuticals Ltd., Karachi, for West Pakistan (1,000 tons per year)
- Pakbay Co., Dacca, for East Pakistan (500 tons per year).

The clearance to start the factories, however, has not yet been given by the National Economic Council. For this type of industry more than 20 per cent of the raw materials would have to be imported. Therefore, it is uncertain at present when operation of the plants can be started. In addition to these firms Messrs. Shuja Ind. Ltd., Karachi, intend to establish a plant for 1,000 tpa of polyvinyl acetate emulsion. The production equipment will probably be produced in Pakistan. The date of starting of operation is unknown.

5.1.4.3 Demand

5.1.4.3.1 Volume and Structure of Past Demand

Except for the supplies by Messrs. Futehally, the total consumption of polyvinyl acetate dispersions has so far been covered by imports. The consumption figures are indicated in the table below.

Table 22: Consumption of Polyvinyl Acetate Emulsions [1)] (in tons)

	1965	1966	1967	1968 [2)]
East Pakistan	55	80	80	80
West Pakistan	400	420	450	580
All Pakistan	455	500	530	660

Table 22 shows that over three years the average annual increase in consumption was about 13 per cent. The increase in the two provinces was about the same. It should be noted, however, that in East Pakistan the increase in consumption was relatively high only in 1966 when a paints manufacturer started the production of emulsion paints. Since then the consumption in East Pakistan has practically been stagnating. Besides the high price of the polyvinyl acetate emulsion paints, we see the reason for this stagnation is insufficient information of the potential consumers.

In contrast to this situation the consumption in West Pakistan is increasing continuously, a fact which is largely due to the sales efforts of the paint manufacturers who partly have foreign management. Besides the textile industry of West Pakistan is an important consumer.

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1) Average resin content is about 50 per cent

2) Estimated figures

The break-down of the present consumption by consumers is given in the table below.

Table 23: Break-down of the Application of Polyvinyl Acetate Emulsions (in per cent) in 1967/68

	Paints	Textiles	Adhesives
East Pakistan	100	-	-
West Pakistan	70	25	5
All Pakistan	73.5	22	4.5

All polyvinyl acetate consuming firms have their plants in Karachi, Lahore, and Chittagong.

The imports mainly came from the Federal Republic of Germany (Hoechst), but also from France (Rhone-Poulenc) and England (Vinyl Products). Small quantities recently have also been imported from Japan.

5.1.4.3.2 Future Trends in Demand

The building industry which is closely related to the paints industry is characterised by a considerable upward trend in Pakistan. A study of IACP shows an increase of the cement consumption by 18 per cent per annum. The demand for polyvinyl acetate emulsions naturally is not limited to new buildings; emulsion paints are also used quite often to paint already existing buildings.

Generally it can be assumed that distemper paints which still have the greatest market share, will be gradually replaced by polyvinyl acetate paints. This substitution for the moment is hampered by the difference in price.

Polyvinyl acetate paints cost about 11.- Rs /kg whereas distemper paints can be bought at 5.20 to 8.50 Rs./kg. Moreover, the same quantity of distemper paint covers a 20 per cent larger area. As polyvinyl acetate paints, however, are three times as durable, they are more economical in the long run than distemper paints. This criterion abviously is not yet generally acknowledged.

The cheapest and most often used material naturally is white wash at a price of about 0.50 to 0.75 Rs./kg.

Much of the success in the whole paints sector will depend on the marketing activities of the paint manufacturers.

If import policy does not cause substantial changes in the availability of the polyvinyl acetate emulsions, the producers of emulsion paints expect that the consumption will increase by about 15 per cent per annum. This value is fairly close to the growth rate determined for the past. Therefore, it is taken as basis of the forecast for the paint sector.

The second important sector is the textile industry. Here the results of a very useful study of PICIC on the textile industry provided the basic information. This study indicates an annual growth rate averaging 14 per cent of the production of fine and superfine cotton fabrics. As products are concerned in which polyvinyl acetate finishes predominate, we have assumed for polyvinyl acetate finishes also a growth rate of 14 per cent. This assumption probably is rather conservative.

The adhesives industry in the last few years showed constant consumption figures, certainly as a consequence of price differences and import difficulties. In this case we calculate an average annual rate of increase of 5 per cent, based on the assumption that the raw material is available in sufficient quantity.

Thus a total growth rate of almost 15 per cent results for all sectors. This figure may seem rather high. Still it should be realistic provided that sufficient polyvinyl acetate raw material is available. A comparison with figures of world consumption may illustrate this statement.

The world consumption has increased annually by 17 per cent, the share of polyvinyl acetate in the total production of plastics thus having risen from 3.9 per cent in 1960 to 4.2 per cent in 1965.

The world production ranges in about the same size category as that of the alkyd resins (4.8 per cent share). The consumption of alkyd resins, however, at rate of 10.6 per cent grows considerably more slowly than that of polyvinyl acetate.

A forecast on the basis of the 1968 figures and the growth rates yields the figures summarised in table 24.

Table 24: **Forecast of the Consumption of Polyvinyl Acetate Emulsions (in tons)**

Year	Paints	Textiles	Adhesives	Total
1969	550	170	30	750
1970	630	190	30	850
1971	730	220	30	980
1972	840	250	40	1,130
1973	960	290	40	1,290
1974	1,110	330	40	1,480
1975	1,280	370	40	1,690

The table suggests that the present consumption in the textile and paints sector will more than double by 1975. The demand pattern presumably will not change, since the growth rates are more or less the same.

In 1975 East Pakistan will account for about 1/6 of the paints (about 210 tons). This share, however, may also turn out to be higher, since there should be a pent-up demand.

5.1.4.4 **Prices**

According to information provided by German producers, the prices for polyvinyl acetate emulsions show a tendency to decline slightly owing to capacity extensions. Some domestic prices are indicated in table 25.

It is very probable that PS foams will be used increasingly for the construction of cold stores in both Wings of the country

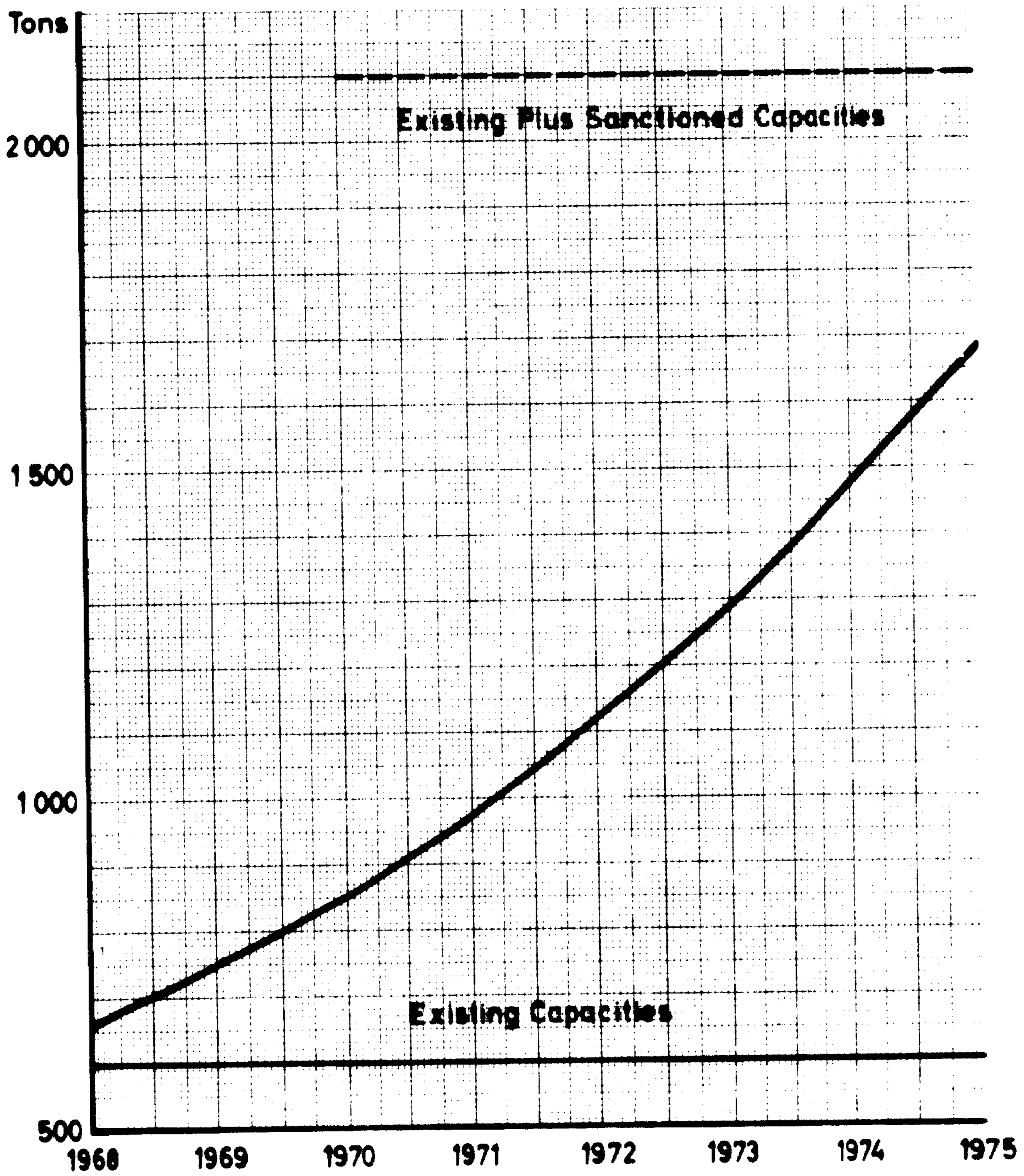

Figure 6: Trends in the Demand for Polyvinylacetate Emulsions

Table 25: Prices of Polyvinyl Acetate Emulsions in some European Countries (in $/ton)

Year	Belgium	France	Germany
1966	316	310	324
1967	290	306	324
1968	290	306	324

Note: The prices include freights but no taxes. In the case of Germany taxes are included also.

The solid matter content of the emulsion is 35 per cent.

The present c&f price of polyvinyl acetate imported from Germany is 425 $/t = 10 per cent. Thus it is higher than the figures indicated in table 25, because of the transport cost and the fact that in most cases the more expensive copolymers are imported.

If the c&f price is converted to landed cost, the following duties and taxes have to be considered:

45 % duty on c&f value

1 % rehabilitation tax on duty paid value

15 % sales tax on duty paid value

25 % defence surcharge on sales tax.

The resulting tax charge is 73.65 per cent on the c&f value. Moreover, polyvinyl acetate ranges on the cash-cum-bonus list. At a Bonus Voucher rate of 170 per cent the overall import charges are therefore

159 % on the c&f value.

cont. **West Pakistan**

N a m e	Location	End-Products
- M.A. Sidiqui	Gujranwala	films and bags
- Khalid & Co.	Gujranwala	films and bags
- Samco Industries	Gujranwala	containers, tubes

5.1.1.6 Recommendations

The minimum capacity for a polyethylene LD plant operating under world market conditions can at present be placed at 25,000 tons per year. Favourable raw material prices are a prerequisite to this figure. Under the particular conditions prevalent in developing countries, smaller plants are naturally also feasible, but there is always the danger that such a plant would represent a burden from a general economic point of view. This is particularly true in regard of the necessary foreign exchange for the polyethylene required. In addition, the production costs of a small plant are high, a fact which would have an unfavourable effect on the development of plastics consumption.

We are therefore of the opinion that as far as possible only plants with annual capacities of 20,000 tons and more should be erected in Pakistan.

Having deducted the present Valika capacity, we arrive at an estimated demand of 7,500 tons for 1972 and approx. 16,200 tons for 1975. If these figures are assumed correct and if we take a plant capacity of 20,000 tons per year as a basis, already a survey which does not take into

The landed cost consequently is 5,240 Rs./t.

5.1.4.5 Consumers

The main consumers are:

In the paints sector
- Paintex Ltd., Lahore
- Jenson & Nicholson of Pakistan Ltd., Karachi
- Buxly Paints, Karachi and Chittagong
- Crescent Paints, Lahore

In the textile industry
- Quadri Silk Mills, Karachi
- Tajuddin Industries, Karachi
- Karim Silk Mills, Karachi
- Haroon & Rashid, Karachi
- Pakistan Cloth Mills, Karachi
- Pakistan Dyeing, Karachi
- Kohinoor Textile Mills, Lahore and Rawalpindi

In the adhesives sector
- Dollar Industries, Karachi

5.1.4.6 Recommendations

The market data show that the sanctioned capacities in the near future are sufficient to cover the demand. This is true even if price reductions are taken into consideration [1]. Before taking any further planning steps, the development and success of the marketing efforts of the firms should be critically observed.

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1) See figure 6. Explanations about the curves are given in section 8.1.

5.1.5.4 Prices

5.1.5 Polystyrene and Related Moulding Compounds

5.1.5.1 General Characteristics

5.1.5.1.1 Description of the Material

5.1.5.1.2 Application of the Product

5.1.5.2 Domestic Production

5.1.5.3 Demand

5.1.5.3.1 Volume and Structure of Past Demand

5.1.5.3.2 Forecast of Trends in Consumption

5.1.5.4 Prices

5.1.5.5 Structure of the Market and Main Consumers

5.1.5.6 Recommendations

moment all possibilities of a further price reduction seem to be exhausted from the raw materials angle, the technology

5.1.5 Polystyrene and Related Moulding Compounds

5.1.5.1 General Characteristics

5.1.5.1.1 Description of the Material

Polymerisation products of styrene, in addition to polyethylene and polyvinyl chloride, at present belong to the best-known thermoplastics. The main application of polystyrene (PS) and its moulding compounds is in injection moulding. In addition to the pure (normal) polystyrene, the copolymers are gaining increasing importance. Polystyrenes and their moulding compounds can be classified as follows:

- Normal polystyrene and copolymers
- Polystyrene moulding compounds
- Polystyrene, foam quality
- High impact polystyrene
- ABS polymers

Normal polystyrene is produced from the styrene monomer by polymerisation in emulsion, block or suspension. It is characterised by extraordinary electrical properties, excellent water resistance and good mechanical properties.

Copolymers with acrylonitrile (SAN polymers) have a higher thermal stability than pure polystyrene and less susceptibility to crack. Polystyrenes and its copolymers are processed as a rule by injection moulding. They are supplied as granular compounds with granules in the form of cylinders or prisms.

5.1.5.5 Structure of the Market and Main Consumers

In addition to its use as injection-moulding compound polystyrene is also used as foam. Polystyrene foam is an excellent heat insulation material. The foams do not decay. The resistance to chemical attack is very good. Polystyrene of foaming quality is supplied in the form of beads containing expanding agents.

Two processing methods are applied for the production of the foam:

With the two phased styropor method the beads are pre foamed at elevated temperature and then are foamed into moulded parts or blocks with addition of steam after storage for several days. In the styrofoam process a special extruder is used under pressure; the liquid expanding agent is added to the molten polystyrene in such a way that the compound foams into a block when leaving through a slotted nozzle.

High impact polystyrenes are obtained by mixing polystyrene with elastomers containing butadiene. These can be processed into moulded parts of high impact resistance, including sheets in deep-drawing quality, blown films and hollow bodies.

The ABS (acrylonitrile-butadiene-styrene) copolymers or graft polymers are a kind of second generation of the high impact polystyrenes. ABS polymers have an improved chemical and mechanical resistance, hardness, thermal stability and resistance to ageing under light and heat.

5.1.5.1.2 Application of the Products

As normal polystyrene and copolymers can be processed without difficulty it can be manufactured to products ranging from simple bulk articles up to parts of the most complex shape from items below 1 g up to large injection moulded parts of more than 10 kg.

Centres of consumption are the sectors of

- Commodities of general use
- Household articles
- Packaging containers
- Electrical articles.

High impact polystyrenes are used above all for the manufacture of

- Cabinets for calculating machines and typewriters
- Cabinets for radio and television sets and tape recorders
- Components for refrigerator cabinets.

Important sectors of application of ABS polymers are, for instance, the production of

- Radio parts
- Trunk handles
- Telephone cabinets
- Automobile fittings
- Typewriter keys.

Polystyrene foam finds a broad spectrum of application for purposes of sound-, low-temperature and heat-insulation of buildings, in the sector of electrical engineering and for packing purposes. The floatability permits the production of buoys, floats for nets and life-jackets. Polystyrene foams in addition are used for the manufacture of toys, cups for drinks and shop window decorations.

In Pakistan mainly the normal polystyrenes and the high impact qualities are used in the following fields:

- Refrigerator industry
- Radio industry
- Manufacture of general commodities (combs, containers, bottles, ball-point pens, rulers)
- Rear lights for motor cars
- Television frames
- Telephone production.

Up to now ABS polymers have been used only to a very limited extend. Possible applications in Pakistan are the manufacture of parts for the motor vehicle industry, textile parts, household appliances, refrigerator breaker strips. After 1969 the Telephone Industries of Pakistan Ltd., (TIP) in Haripur will produce its telephone cabinets from ABS polymers instead of high impact polystyrene.

While in East Pakistan polystyrene foam will be used mainly for the construction of cold stores, in West Pakistan it is required for the manufacture of decorative and insulating foam tiles for air-conditioned buildings.

5.1.5.2 Domestic Production

Polystyrene is not yet being produced in Pakistan. No plans and projects for its manufacture are known to exist.

5.1.5.3 Demand

5.1.5.3.1 Volume and Structure of Past Demand

The following table shows the consumption of polystyrene and its related moulding compounds in East and West Pakistan classified by years and species.

Table 26. Consumption on PS, 1965 to 1968 (in tons)

	1965	1966	1967	1968[1)]
West Pakistan				
PS normal	890	880	1,000	1,045
PS high impact	65	100	230	210
ABS	-	-	14	24
PS foam	-	20	30	70
Subtotal West Pakistan	955	1,000	1,274	1,349
East Pakistan				
PS normal	350	385	435	600
PS high impact	-	4	68	155
PS foam	120	60	150	200
Subtotal East Pakistan	470	449	653	955
All Pakistan				
PS normal	1,240	1,265	1,435	1,645
PS high impact	65	104	298	365
ABS	-	-	14	24
PS foam	120	80	180	270
Total All Pakistan	1,425	1,449	1,927	2,304

1) expected consumption

At present West Pakistan accounts for 64 per cent of the total consumption of PS normal and East Pakistan for 36 per cent.

Since 1965 the consumption in East Pakistan almost doubled, whereas it increased by only 17 per cent in West Pakistan. East Pakistan shows a markedly high consumption of PS foams which is three times that of West Pakistan. ABS so far plays a minor part only in West Pakistan. As to PS high impact, the consumption is higher in West Pakistan than in East Pakistan. While the consumed quantity 1967-1968, however, remained constant in West Pakistan, it doubled in East Pakistan.

A detailed investigation on the consumption of PS and related moulding compounds by sectors and applications provides the following picture:

PS Normal

In East Pakistan 90 per cent of the imported PS is consumed by small industries for the manufacture of general commodities. About 10 per cent is used for the production of radio cabinets.

Also in West Pakistan the small industries are the largest consumers of PS normal (70 per cent). The medium-sized and large enterprises in the Karachi area account for about 30 per cent of the demand.

Summarising, we may say that PS normal is at present the thermoplastic processed most in the small industry. PS normal grade is consumed by small firms for the manufacture of toys, general household items, bangles, fountain pens, etc. PS normal grade is not an important raw material for medium- and large-size enterprises in Pakistan at the present conditions.

PS High Impact

In East Pakistan PS high impact has so far found little foothold in the market. Only three or four major firms at present are processing PS high impact. In the small industry no processor has been found A new important sector of application, though still of modest consumption, is coming up by the assembly of refrigerators. The refrigerator industry imports sheets that are processed into refrigerator linings and doors parts by hot forming. The assembly of refrigerators has started recently in West Pakistan.

In West Pakistan the radio and telephone industry account for 50 per cent of the consumption. The rest is used for the manufacture of containers, bottles, tube caps, and little boxes for the pharmaceutical and cosmetic industry. No consumers could be found in the small industry.

PS Foam

The construction of cold stores is the most important sector in East Pakistan for the application of the PS foam products. Next in importance is the production of life buoys and life jackets. There are three producers of foam products.

In West Pakistan the consumption mainly concentrates on insulation and decorative tiles generally used in the building sector. To a minor extent foams are also used in the packing sector. Two producers of PS foams were found.

ABS

Only two processors have been found in West Pakistan who for the first time imported ABS polymers in small quantities.

These polymers serve for the assembly of motor vehicle and textile parts.

All types of PS were imported. The exporting countries for PS normal and high impact were the following:

- Japan (Mitsubishi Monsanto Chemical Co.)
- Germany (BASF, Chemische Werke Hüls)
- Italy (Montecatini, Mazzuchelli Celluloide)

PS foam (Styropor) was imported from West Germany (BASF).

5.1.5.3.2 **Forecast of Trends in Consumption**

PS Normal

For the next few years an average annual rate of increase of 12 per cent is expected for East and West Pakistan. This value is similar to the growth rate of the last three years (10 %). A strong increase of the consumption of PS normal in the years to come is not expected because the consumers will more and more take the special types instead of PS normal. According to information received from producers of PS who sell the material to Pakistan, they also expect a similar development.

PS High Impact

The consumption of PS high impact, so far rather modest in East Pakistan, will certainly increase during the next few years, since the assembly of refrigerators, television and radio sets has been started recently. We estimate the average annual rate of increase of 15 per cent.

consideration any new possibilities of substitution and increases of demand due to price reductions leads to the conclusion that the production of low-density polyethylene can be expanded considerably at an early date. Details will be given in section 8.2.1.

In this connection one problem should be mentioned. Should another plant be erected Valika with its small plant may become unable to compete. It could be a reason to allow Valika to increase its capacity. This however appears to us to be recommendable only if Valika is granted authorisation to erect the above mentioned plant.

A factual justification for such a decision could be found in the argument that this firm has already experience in the manufacture of plastics. The point of view of the maintenance of competition need not necessarily play a decisive role, as competition would already be present in the form of a simultaneous production of PVC or could be created by additional imports of PE.

Should the sanctioning authorities come to the conclusion that a firm other than Valika should receive authorisation for the project, it is to be recommended for the above mentioned reasons that Valika be given the opportunity of subscribing to stock in the new factory. A decision of accepting neither of these alternatives would also be justifiable, as Valika will in view of the high domestic prices probably be able to amortise the plant by 1972 and the subsequent write-off rates will be much lower.

In West Pakistan the assembly of refrigerators and air conditioners has begun only on a small scale. There is no doubt, however, that owing to the large demand for such goods this industry will develop rapidly in the future, provided that there is a certain tariff protection and a sufficient supply of raw materials. We expect that these conditions will be met. Therefore, we think that this line of industry will establish itself in the next two or three years and that the increase in the demand for high impact polystyrene will be 20 per cent.

ABS

A relatively good forecast can be given only for the consumption of Telephone Industries of Pakistan Ltd. which will need 100 tons after 1968 if the development continues as expected. The consumption of TIP will increase to 120 tons by 1975. The rest of the demand can only roughly be estimated since the material is generally not yet known in Pakistan.

PS Foam

According to information received from the processors, an average annual growth rate of 10 per cent can be expected for East Pakistan. In West Pakistan the consumption will increase more strongly during the next two years since it has been extremely small compared to East Pakistan and since the manufacturers hope to utilise their capacities more fully as a consequence of better marketing. The producers are taking the necessary measures to be able to double their sales both in 1969 and in 1970. After 1970 the average rate of increase may be expected to be 15 per cent per year.

It is very probable that PS foams will be used increasingly for the construction of cold stores in both Wings of the country within the years to come. The foams should be flame resistant. For East Pakistan the consumption in this sector is expected to average 100 tons per year of PS foam

In addition, PS foam will be used increasingly for insulation and decorative tiles in the building industry in general, especially in the construction of buildings with central air conditioning. Only a small part of the consumption will be accounted for by the packing industry also in the future. The floatability of foamed PS will to a certain extent be utilised for the manufacture of buoys, floats for nets and life jackets. The demand of PS for these products, however, will be of minor importance.

The following table gives an estimate of the future consumption of PS and related moulding compounds until 1975. It shows that the estimated consumption of PS normal will more than double by 1975, that of PS high impact will almost treble and that of PS foam will more than treble. The largest share in the total consumption of all types of PS in 1975 will fall to PS normal (about 60 per cent) and PS high impact (about 20 per cent). West Pakistan will provide the largest share of consumers, accounting for about 63 per cent of the total consumption of all PS types.

The PS share of the three products: PS normal, PS high impact [1)] and PS foam, for All Pakistan will be about 2,800 tons in 1970 and about 5,200 tons in 1975.

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1) The content of non-PS matter in the individual types of high impact PS varies strongly and may account for more than 50 per cent. Our calculations are based on an average content of 50 per cent.

Table 27: Estimated Future Consumption of PS and Related Moulding Compounds until 1975 (in tons)

Year	East Pakistan				West Pakistan				All Pakistan			
	PS normal	PS high impact	ABS	PS foam	PS normal	PS high impact	ABS	PS foam	PS normal	PS high impact	ABS	PS foam
1968	600	155	-	200	1,045	210	24	70	1,645	365	24	270
1969	670	180	-	220	1,170	250	124	140	1,840	430	124	360
1970	750	200	-	240	1,310	300	140	280	2,060	500	140	520
1971	840	240	10	270	1,470	360	140	320	2,310	600	150	590
1972	940	270	20	290	1,650	430	150	370	2,590	700	170	660
1973	1,050	310	40	320	1,850	520	165	430	2,900	830	205	750
1974	1,180	360	65	350	2,070	630	185	490	3,250	990	250	840
1975	1,320	410	80	390	2,320	750	210	560	3,640	1,160	290	950

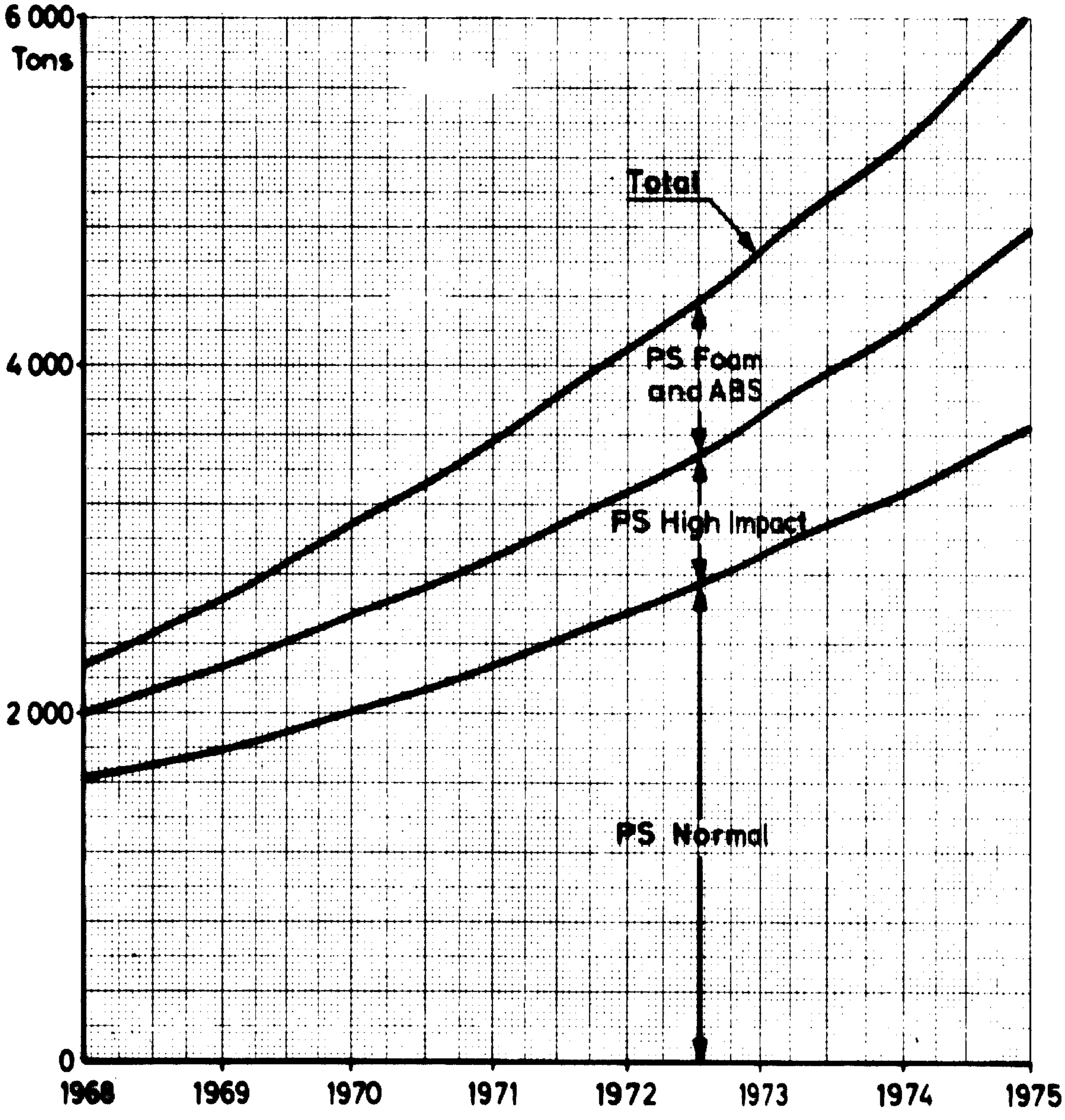

Figure 7: Future Consumption of Polystyrene and Related Compounds

5.1.5.4 Prices

The prices for PS normal constantly declined in the producer countries during the past ten years (cf. also figure 2 in section 5.1.1.4.7).

Average ex factory prices for PS normal in West Germany are used as an example.

1955:	US$	70	per 100 kg
1960:	US$	47.5	per 100 kg
1965:	US$	32.5	per 100 kg
1966:	US$	31.25	per 100 kg
1967:	US$	27.50	per 100 kg
1968:	US$	27.50	per 100 kg

These prices do not include sales taxes and apply only to small quantities. They do not cover discounts for purchase of large quantities.

The price charged in Europe at present (October 1968) fluctuates according to quantity sold:

- PS normal transparent between US$ 0.235 to 0.275 per kg
- PS high impact, natural product between US$ 0.31 to 0.375 per kg
- PS high impact (dyed) between US$ 0.36 to 0.425 per kg.

The price for PS declined so strongly during the last years that a further fall in prices appears unlikely. It is rather expected that they will rise after having been constant in 1967 and 1968. Dow Chemical Company as the largest producer of PS, for instance, slightly increased the prices in September, 1968. Interviews with producers showed that for the moment all possibilities of a further price reduction seem to be exhausted from the raw materials angle, the technology and the internal rationalization of the enterprises.

The present c&f price for PS normal is between US$ 232.80 and 244.80 per ton, i.e. an average of US$ 240.00 per ton. The average cost in 1967 was US$ 278.20 per ton The 1968 price for PS high impact averages US$ 350.00 per ton. PS foam (beads) has been offered at an average price of US$ 600.00 per ton in 1968.

An idea of the possible price reductions for bulk orders is given by the following BASF quotation for beads of Styro-por BR 20

5,000 to 10,000 lbs:	76.8 cents per kg
10,000 to 20,000 lbs:	73.4 cents per kg
20,000 to 50,000 lbs:	70.2 cents per kg

This quotation grants in the most favourable case a discount of about 9 per cent when doubling the ordered quantity. This shows the tight calculation applicable in the case of poly-styrene.

The landed cost for PS normal fluctuates depending on the ordered quantities. In the period of the investigations, for instance, the price ranged between Rs. 3.85 and 4.62 per kg.

For PS high impact about Rs. 5.72 per kg has to be calculated.

According to statements of the Central Statistical Office, Karachi the average wholesale prices for PS normal did not change during the last five years. For West Pakistan in all regions they are Rs. 4.95 per kg and in East Pakistan Rs. 4.40 per kg.

5.1.5.5 Structure of the Market and Main Consumers

The following list provides a survey of the main consumers of PS and PS moulding compounds considering also the raw materials processed.

Name	Location of Firm	Product	
Fecto	Dacca	PS normal,	PS high impact
Mehar Industries	Dacca	PS normal,	PS high impact
East Pakistan Industries	Dacca	PS normal,	PS high impact
EBLIC	Chittagong	PS foam	
Golden East Industries	Dacca	PS foam	
Faves Cold Storages	Dacca	PS foam	
Maniar Plastic Industries	Karachi	PS normal,	PS high impact
Golden Industries	Karachi	PS normal	
Plastico Industries	Karachi	PS normal	
Plastic Rafters	Karachi	PS normal,	PS high impact
Jasmeen Industries	Karachi	PS normal	
Dada Plastic Works	Karachi	PS normal	
Samco Industries	Gujranwala	PS normal	
Durathene Ltd.	Karachi		PS high impact
RGA	Lahore		PS high impact
Syed Bhais	Lahore		PS high impact

Name	Location of Firm	Product	
Telefone Industries of Pakistan	Haripur		PS high impact
National Tyre & Rubber Co.	Karachi	PS foam	
Air Foam Ltd.	Lahore	PS foam	

In addition, the following firms may be considered as potential future consumers:

West Pakistan:

- Congothene Chemical Industries, Karachi
  Automobile parts, radio and air-conditioner components, containers, articles for the building industry
- Ghandara Industries, Karachi:
  Air-conditioner components
- Shahab Industries, Karachi:
  Refrigerator parts

East Pakistan:

- Philipps, Dacca:
  Radio cabinets
- Eastern Radio Co., Dacca:
  Radio cabinets

These firms already have got a sanction for their production.

5.1.5.6 Recommendations

On the basis of the results obtained, we do not recommend the establishment of a polystyrene plant. The minimum capacity of a polymerisation plant only under world market conditions is at least 15,000 tons per year. Even if the special economic conditions in Pakistan are taken into account it does not seem advisable to go too much below this minimum capacity. The estimated demand in 1975 for polystyrene for the production of PS normal, foam and high impact, however, only amounts to 5,400 tons. In these circumstances we think it reasonable for the moment to replace styrene wherever possible by other plastics that can be produced locally.

5.1.6 Polyacrylates

5.1.6.1 General Characteristics

5.1.6.1.1 Description of the Material

5.1.6.1.2 Applications

5.1.6.2 Domestic Production

5.1.6.3 Demand

5.1.6.3.1 Volume and Structure of Past Demand

5.1.6.3.2 Forecast of Consumption Trends

5.1.6.3.3 Consumers

5.1.6.4 Prices

5.1.6.5 Recommendations

The manufacture of HD polyethylene cannot be recommended, as the demand of an estimated 1,700 tons for as late as 1975 is still considerably below the minimum capacity of a low-pressure plant. It should also be pointed out that polyethylene HD would to a great extent be subject to replacement by polypropylene, should this plastic be domestically produced.

5.1.6 Polyacrylates

5.1.6.1 General Characteristics

5.1.6.1.1 Description of the Material

Polyacrylates are thermoplastics which are produced by polymerisation of acrylic acids and their esters. They are either colourless viscous liquids or solid products, depending on the degree of polymerisation.

Of special technical importance among the polyacrylates are the polymers of the ester of methyl methacrylic acid - polymethylmethacrylates - (PMMA). PMMAs are solid materials used for the manufacture of semi-finished products and moulded parts. PMMAs are traded as moulding compounds and in the form of sheets and pipes. The moulding compounds are marketed as clear granules transparent, translucent or in opaque colours. They are used in injection moulding and extrusion. Moulded parts of PMMA have a good mechanical strength, surface hardness, weather and chemical resistance and good colour effects.

PMMA semi-finished products are produced by polymerisation between plateglass panes or in a centrifugal casting process. Sheets and pipes made of high molecular weight PMMA are optically of high quality and have a good thermal stability. They can be hot worked. The most important acrylic glasses are under trade names such as Paraglass, Plexiglass and Perspex.

The usual dimensions of sheets and pipes are as follows.

Sheets

500 x 600 mm to 2,000 x 1,200 mm in surface area

0,8 to 22 mm thickness

Pipes

25 to 457 mm outside diameter

2 to 8 mm wall thickness up to 2,500 mm length

5.1.6.1.2 Applications

Polyacrylates

The dispersions of polyacrylate or its polymer powder are of great importance

- as impregnating agents and finishes in the textile and leather industry and
- in the paint and varnish industry.

In Pakistan they are used especially in the textile and the leather industry. Polyacrylates used in the paint and coating industry are sold as vinyl acetate acrylate copolymers in the form of emulsions.

PMMA

The most important fields of application for PMMA moulded compounds are lenses, watch glasses, commodities, especially fountain-pens, fashion articles and technical components, reflectors, covers for rear lights of cars, household equipments and television parts. Swelling of fine beads in monomeric liquid is used for making dentures in dental medicine.

Sheets and pipes are used for lamps, light strip, light ceilings, cupolas in buildings, curved shock resistant windscreens of all kinds above all in the manufacture of moter vehicles and aircraft construction. For instruments and equipment used in food processing, in chemistry and medicine of high mechanical strength.

In Pakistan mainly semi-finished articles such as sheets and tubes are processed, but hardly any moulding compounds. An industry processing PMMA moulding compounds apart from the fountain-pen industry is hardly existent. The most important fields of application for acrylic sheets and pipes are

- lighting fittings
- car industry and
- household equipments, i.e. soap boxes, toilet-articles

5.1.6.2 Domestic Production

Polyacrylates, especially polymethylmethacrylates are not produced in Pakistan.

5.1.6.3 Demand

5.1.6.3.1 Volume and Structure of Past Demand

Imports of acrylic polymers and copolymers totalled about 420 tons in 1967. As far as they serve as auxiliaries for leather dyeing, for textile and paper printing, specific products are used whose composition is not known to us. The market for these products therefore is not discussed in this report.

The last years' consumption of PMMA in Pakistan is illustrated in the following table.

Table 28: Consumption of PMMA in Pakistan, 1966 - 1968 (in tons)

	1966	1967	1968
Acrylic powder	55	60	70
Acrylic sheets	200	250	270
	255	310	340

PMMA is mainly consumed in West Pakistan. The consumption in East Pakistan is so small that it can be neglected. Processing capacities for PMMA powder and sheets exist at present only in West Pakistan. Processing started not earlier than in 1966 on a noticeable scale. The break-down of raw materials used is about 20 per cent of moulding compounds and about 80 per cent of sheets.

At present the consumption of PMMA is divided into the following fields of application:

Acrylic powder

- pens	78 %
- radio knobs, dials for telephones and other small technical articles	21 %
- other articles, for example dentures	1 %
	100 %

Acrylic sheets

- lighting fittings	60 %
- windscreens for motor rickshaws and other vehicles	35 %
- toilet articles, such as soap boxes etc.	5 %
	100 %

5.1.6.3.2 Forecast of Consumption

The most important field of application which in our opinion will have a decisive effect on the future consumption, is the building sector. In this line a strong trend towards modern office buildings can be noticed. This will probably result in an increasing demand for PMMA products such as lighting fittings, illuminated ceilings, light cupolas and so on.

Also in the motor vehicle sector PMMA will in the future be used for various purposes. It should be considered, however, that the construction of motor rickshaws may decrease. For PMMA we expect an increase in demand of 15 per cent per year which corresponds to the present rate of increase. This rate comprises the demand for powder and sheets.

The following demand figures until 1975 are desired:

1968:	340 tons
1969:	390 tons
1970:	450 tons
1971:	520 tons
1972:	590 tons
1973:	680 tons
1974:	790 tons
1975:	900 tons

Accordingly it may be expected that the demand will nearly triple between 1968 and 1975. The demand for PMMA powder (about 20 %) will play a less important part than the demand for sheets.

5.1.6.3.3 Consumers

The most important consumers of PMMA in Pakistan are stated below:

- moulding compounds
  - -- Golden Industries, Karachi
  - -- Celluko Industries, Karachi
  - -- Azad Friends, Karachi and
  - -- Fazal Industries, Dacca
- sheets
  - -- Feroz Industries, Karachi
  - -- Norden Electric Co., Karachi
  - -- Premier Electric Industries, Karachi
  - -- National Plastic Industries, Karachi

Moreover, the producers of motor rickshaws and vehicles are major consumer.

5.1.6.4 Prices

In the Federal Republic of Germany PMMA moulding compounds in granulated form at present are traded at 0.75 US$/kg ex factory if more than 1 ton is purchased and at 0.80 US$/kg ex factory, if 1 ton or less is bought. In 1960 the price still amounted to 1.50 to 2.00 US$/kg. Thus it has decreased by more than 50 per cent since 1960.

According to information received from PMMA manufacturers in Germany, the prices for moulding compounds and sheets will not continue to decrease for the time being but will remain at its present level. Probably prices will even increase.

The price of sheets imported from Spain, Japan and the Federal Republic of Germany amount to about 3.12 US$/$M^2$ c&f Karachi.

The landed cost for sheets 1.8 x 1.2 m and 3 mm in thickness from Spain are about 124 Rs., from Japan about 105 Rs. and from Taiwan about 100 Rs.

In West Pakistan the present retail price for sheets is about 72.20 Rs./m^2 and for moulding compounds about 13.20 Rs./kg.

In East Pakistan the corresponding prices for sheets are about 111 to 113 Rs./m^2 and for moulding compounds about 22 to 26.40 Rs./kg.

This shows that some of the retail prices in East Pakistan are nearly twice as high as those in West Pakistan.

5.1.6.5 Recommendations

According to our information a plant for the production of PMMA and monomers has a minimum capacity of 8,000 to 10,000 t/year. Owing to the fact that the demand for PMMA until 1975 will be below 1,000 tons, we consider it not advisable to establish a plant for the production of monomers.

We recommend considering the production of PMMA within the market of RCD.

Simple polymerisation might be possible on the basis of imported monomers.

5.1.7 Polyamides

Polyamides (PA) have gained significance in Pakistan in only the manufacture of fibres, and are in very little demand as moulding materials for the general plastics processing industry. The general characteristics of PA are therefore dealt with separately in section 5.3.1 "PA fibres".

The consumption of PA chips by the plastics processing industry was in 1967 less than 5 tons; the material came from domestic sources and imports. We were only able to find two small concerns in West Pakistan which process nylon chips to textile parts. The consumption of PA will however increase considerably in future years. It is for example intended to commence manufacture of ladies' shoe heels from PA in West Pakistan in 1969. It is impossible at present to predict how fast the demand will grow. The use of nylon in plastics processing is in Pakistan in the very earliest stages of development. The future of the use of this material will be decisively affected by the intensity and quality of the manufacturers' marketing. Fields for the use of nylon which could be opened up in Pakistan would appear to be particularly in the manufacture of technical items such as bearings and cogwheels.

5.2 Thermosetting Resins

5.2.1 Phenolic Resins

5.2.1.1 General Characteristics

5.2.1.1.1 The Material

5.2.1.1.2 Applications

5.2.1.2 Domestic Production

5.2.1.3 Demand

5.2.1.3.1 Volume and Structure of Past Demand

5.2.1.3.2 Forecast of Consumption Trends

5.2.1.4 Prices

5.2.1.5 Consumers

5.2.1.6 Recommendations

5.1.2 Polypropylene

5.1.2.1 General Characteristics

5.1.2.2 Domestic Production

5.1.2.3 Demand

5.1.2.3.1 Volume and Structure of Past Demand

5.1.2.3.2 Forecast of Consumption trends

5.1.2.4 Prices

5.1.2.5 Structure of the Market

5.1.2.6 Recommendations

5.2.1 Phenolic Resins

5.2.1.1 General Characteristics

5.2.1.1.1 The Material

Phenolic resins (PF) are obtained by condensation of aqueous formaldehyde solution with phenol in the presence of contact agents like ammonia or oxalic acid. According to the type of reaction - basic or acid - the resulting products are called resols or novalaks.

The condensation of the resol resins continues even in ambient temperature, which means they can be stored only for a limited period. On the other hand, for complete condensation the novolaks need an additional formaldehyde supply, which can be obtained by admixture of hexamethylene tetramine. The novolak type of resins can be stored indefinitely because the final reaction only starts with a rise in temperature during processing.

PF resins are sold in the form of liquid and solid resins, in pieces, or pulverized but chiefly in the form of pulverized moulding compounds.

5.2.1.1.2 Applications

There are numerous fields of application for PF resins. The most important ones along with the kinds of resins which are suited for such purposes are summarized below:

Fields of application	Suitable resins
Moulding compounds	phenol-novolaks with hexamethylene tetramine or phenol-resols with quick hardening properties in a pulverized or liquid form
Hard paper, laminated Fabrics	phenol-resols, slowly hardening in an alcoholic solution [1)]
Grinding wheels	pulverized phenol-novolaks with hexamethylene tetramine in combination with liquid phenol-resols
Wood glue	aqueous liquid phenol-resols
Cast resin for reproductions, high-quality cast resin	liquid phenol-resols
Moulds for metal casting	phenol-novolaks with hexamethylene tetramine in powder form
Phenolic resin foam	highly viscous phenol-resols with light spirit or Frigen as foaming agent

The main field of application of PF resins is that of moulding compounds. PF moulding compounds are the leading thermosetting compounds because of their easy workability and their low price. Moulding compounds are not pure resins, but are

1) For economic reasons xylenol-resols have also been used recently.

filled with inorganic materials like mylonite and asbestos or with organic materials like wood-flour, paper and fabrics. After solidification the phenolic resin, which left the reaction kettle in a liquid state is ground and mixed with pulverized fillers on heated mixing-rolls or kneading machines The mixture reaches the processing plants as a moulding compound in a pulverized form which is especially suitable for processing in automatic presses The resin content of the moulding compounds varies between 40 and 55 per cent

The most important fields of application for PF moulding compounds are:

- commodities like buttons and tube caps
- insulating parts like plugs, plug boxes, knobs, switches.

A further important range of application of PF resins is hard-paper and laminated fabrics, which play an important role among the thermosetting plastics. Absorbent substances like strips of paper and fabrics are saturated with liquid PF resin solution and dried. They can be pressed into laminated sheets or blocks in a second step Besides the purely PF laminated materials, laminated pressed sheets on a PF basis in combination with melamine resins marketed under the trade name of "Formica" are of importance.

The ranges of application of laminated pressed material from hard paper and fabrics are above all the following.

- Construction elements and insulating parts in high-tension, telephone, radio and television engineering (hard paper).

- Slideways in machine tools, covers for bearings and bushings,gear wheels, press wheels, rollers and other heavy duty mechanical parts in engineering (laminated fabrics).

Aqueous phenolic resins are mostly used as a glue for out-door plywood and hardboard. In comparison with urea resins the PF resins have the advantage of being water-resistant. In the case of hard wood they also improve the physical properties such as tensile strength, elasticity and bending strength. The resin content of plywood and hardboard averages 2 - 3 per cent by weight.

In Pakistan PF resins are used in the following fields:

- moulding compounds
- wood glues
- as technical resins for the production of emery paper and grinding wheels.

The most important field of application is the utilization as moulding compounds. PF based glues are of minor importance in the hardboard and plywood industry.

5.2.1.2 Domestic Production

At the time of the survey, i.e. in mid-1968, only one factory in West Pakistan, namely Allied Industries, Wazirabad, was producing phenolic resins in small quantities. A second plant equipped with modern machines, namely that of Azmat Industries, Gujranwala, was expected to start production before the end of 1968. A further unit is under construction and another is being planned.

Capacity, production volume, manufacturing programme and raw materials are described in the following.

Allied Industries, Wazirabad

The enterprise started production in 1958 and has a theoretical production capacity of 10 tons of moulding compound per year with one shift. The raw materials like phenol, formaldehyde, furfurol and oxalic acid are imported. The plant is small and obsolete. Production is restricted to moulding compounds filled with 40 - 50 per cent of wood flour, which in some cases are processed into finished products on the factory premises. All presses installed are hand-operated.

According to the information we were given the factory produced at full capacity only between 1958 and 1960. Accordingly the turnover of 100,000 Rs in 1960 had decreased to 60,000 Rs by 1967. Generally speaking, the enterprise is experiencing considerable difficulty in marketing both its moulding compounds and its finished products. Potential buyers of moulding compounds prefer imports.

It is debatable whether such enterprises at a bazaar level can be profitable. They need to be reorganized and extended.

Azmat Industries, Gujranwala

The planned theoretical production capacity is 280 tons of moulding compounds annually with one shift. The moulding compounds are filled with wood flour. Annual requirements of raw materials come to about 70 tons of phenol, 50 tons of formaldehyde and small quantities of stearate of zinc and hexamethylene tetramine. Apart from 37 per cent formaldehyde solution, which is bought from Valika, the remaining raw materials have to be imported for the time being.

<u>Zaheer Industries, Sialkot</u>

The factory is under construction. The plant is designed for an output of 600 tons of moulding compounds per year.

<u>M.M. Industries, Gujranwala</u>

The factory is due to be erected by 1970/71. The theoretical capacity is 210 tons of moulding compounds per year with one shift.

To sum up, it is striking that the existing and planned factories are all situated in West Pakistan. The construction of works in East Pakistan is not planned during the current Five-Year Plan Period. The production programme of the operating and planned factories is limited exclusively to the production of PF moulding compounds.

Up to 1970 the installed capacities for the production of PF moulding compounds per year and in one shift will develop as follows:

beginning of	1968:	10 tons
end of	1968:	290 tons
	1969:	890 tons
	1970:	1,100 tons

5.2.1.3 <u>Demand</u>

5.2.1.3.1 <u>Volume and Structure of Past Demand</u>

The following tables show the consumption of PF resins in East and West Pakistan, broken down into years and fields of application.

Table 29: Consumption of PF Resins, 1965 - 1968 (in tons)

Fields of application	1965	1966	1967	1968[1]
East Pakistan				
moulding compounds (with filler)	20	15	5	20
wood glue	-	-	-	-
technical resins for emery paper and grinding wheels	-	-	-	-
Subtotal East Pakistan	20	15	5	20
West Pakistan				
moulding compounds (with filler)	343	298	304	344
wood glue	-	-	20	40
technical resins for emery paper and grinding wheels	1	11	16	26
Subtotal West Pakistan	344	309	340	410
All Pakistan				
moulding compounds (with filler)	363	313	309	364
wood glue	-	-	20	40
technical resins for emery paper and grinding wheels	1	11	16	26
Total consumption	364	324	345	430

1) Expected consumption

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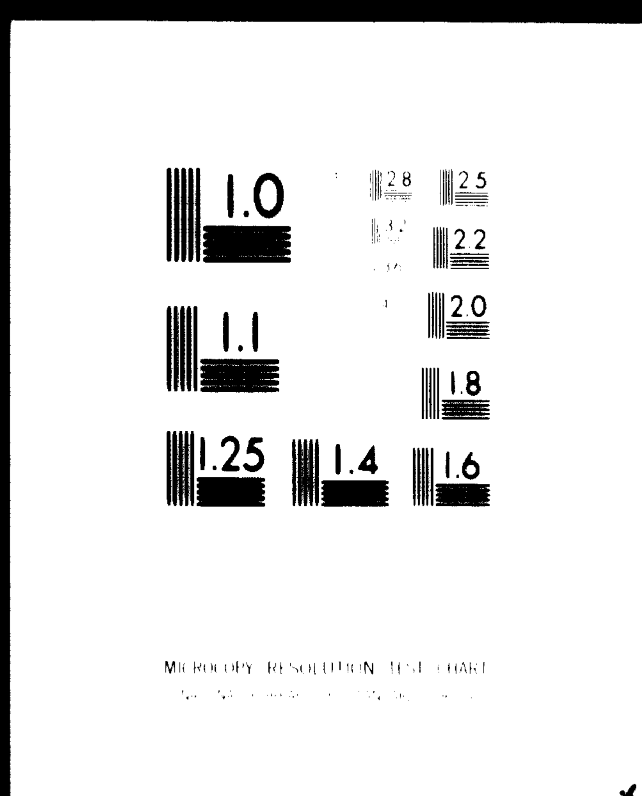

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If we are right in assuming that a considerable increase in the present sales of hardboard can be achieved only by an improvement in quality, i.e. by the use of PF glues, we estimate the requirements of PF glues in 1975 at 275 tons.

Plywood industries

The field investigations have shown that at present PF glues are only used to a small extent for the production of high quality waterproof plywood. This is said to be due to the fact that importing PF glues is too expensive and because there are problems of storage.

The argument that the glues have limited storing stability is in our opinion unfounded, as BASF for example gives a six months guarantee on its glues. If, however, in future phenolic glues are available from local manufacturers at reasonable prices, the plywood factories have expressed themselves willing to include waterproof and marine plywood in their production programmes, because there seems to be a good market for it. The plywood producers estimate their possible requirements of PF glues at 50 tons in 1970 and at about 100 tons in 1975.

Others

This sector covers resins for the production of emery paper, grinding wheels, hardpaper, laminated fabrics, phenolic foams and other articles. There is unlikely to be any marked increase in the consumption of resins in this field in the near future, but potentially the sector could be expanded considerably. We estimate that requirements for 1975 will amount to a maximum of about 100 tons.

To sum up, it can be said that the consumption of PF resins will increase in every field of application, but the total consumption will probably not exceed 1,350 tons by 1975. Our estimates of the requirements in the individual fields are as follows:

Table 34: Estimated demand for PF products, 1968 - 1975 (in tons)

Years	moulding compounds	wood glues	others	total
1968	364	80	26	470
1969	400	140	40	580
1970	440	270	50	760
1971	490	380	60	930
1972	530	420	70	1,020
1973	580	450	80	1,110
1974	650	490	90	1,230
1975	710	520	100	1,330

The table shows that the demand for moulding compounds, wood glues and others will have almost trebled by 1975, the greatest increase in demand being in the wood glues sector. In absolute terms the demand for moulding compounds will however be higher than that for wood glues.

The PF resins listed under moulding compounds contain however only 40 - 50 per cent of pure resins. The wood glues and others can be assumed to consist mainly of pure pulverized PF resins. If the consumption estimates of the above table are converted into the pure resin content, the following estimates of the demand for pure PF resins result [1].

1) The conversion has been effected on the basis of 40 per cent resin content for moulding compounds.

1968:	250 tons
1969:	340 tons
1970:	500 tons
1971:	640 tons
1972:	700 tons
1973:	770 tons
1974:	840 tons
1975:	910 tons

Thus the demand for pure PF resins will have nearly quadrupled by 1975 - equivalent to an average growth rate of ca. 20 per cent.

5.2.1.4 <u>Prices</u>

PF moulding compounds which are produced in Wazirabad by the only local producer cost 5.50 Rs./kg ex factory.

Moulding compounds filled with wood flour and produced in West Germany cost 0.47 $/kg at the moment.

In Germany prices have developed during the last few years as follows:

1962:	0.50 $/kg
1963:	0.46 $/kg
1964:	0.48 $/kg
1965:	0.48 $/kg
1966:	0.48 $/kg
1967:	0.47 $/kg

The prices of technical resins without fillers on the West German market have developed as follows:

1960:	0.68 $/kg
1965:	0.63 $/kg
1966:	0.52 $/kg
1967:	0.55 $/kg

The prices of wood glues are about the same as the prices of technical phenolic resins.

At the time of the field investigations the c&f prices were as follows:

Moulding compounds:	239 - 278 $/ton
Glues:	250 - 300 $/ton
Technical resins:	240 $/ton

The c&f prices of moulding compounds have fallen steadily during recent years. At the moment the People's Republic of China quotes the lowest price at 239 $/ton. The second lowest quotation is made by Japan. No other quotation can compete with these prices.

Taking the c&f price of 245 $/ton for moulding compound as a basis, the landed costs are about 4 Rs./kg of moulding compound. For wood glues, the average cost is about 4.50 Rs./kg for resins in powder form.

The imported moulding compounds have an average retail price of 5.90 Rs./kg. Prices are subject to fluctuations, depending on the countries from which the compound is imported.

The prices of moulding compounds, at least in Europe, are unlikely to decrease in the near future, because the present prices are already close to the cost of manufacture. Nothing can be predicted about the future prices of the moulding compounds offered by the People's Republic of China because it is not known to what extent the prices are based on production costs.

5.2.1.5 Consumers

In East Pakistan the main consumers of PF moulding compounds are small enterprises such as:

- Fazal Industries, Dacca
- Arif Industries, Dacca.

In West Pakistan there are larger enterprises such as

- Pakistan Plastic Industries, Karachi
- Bakelite Industries, Karachi
- Golden Industries, Karachi
- Amewa Brothers, Karachi
- Olympia Plastic Co., Lahore
- Standard Automation Works, Lahore
- TIP, Haripur

The main consumer of PF wood glues is Pakistan Hardboard Mills, Karachi.

The main consumers of technical resins are

- National Commercial Industrial Enterprises, Hyderabad
- Grindwheel Ltd., Karachi

5.2.1.6 Recommendations

Going by present results it seems advisable not to construct other plants for PF moulding compounds up to 1975, in addition to those which are already operating and planned. When the new plants go into production, the total demand for moulding compounds in Pakistan can be met by domestic manufacture. It is recommendable for the producers to undertake thorough market research and to look for new fields of application for their moulding compounds in order to attain a profitable utilization of their capacity.

Furthermore the producers should consider including pure PF resins in their sales programme, to fill the PF wood glue gap in the hardboard and plywood industries.

5.2.2 Urea Formaldehyde

5.2.2.1 General Characteristics

5.2.2.1.1 The Material

5.2.2.1.2 Applications

5.2.2.2 Domestic Production

5.2.2.2.1 Existing Capacity

5.2.2.2.2 Production Trends and Volumes

5.2.2.2.3 New Projects

5.2.2.2.4 Problems

5.2.2.3 Demand

5.2.2.3.1 Volume and Structure of Past Demand

5.2.2.3.2 Forecast of Consumption Trends

5.2.2.4 Prices

5.2.2.5 Market Structure and Consumers

5.2.2.6 Recommendations

5.2.2 Urea Formaldehyde

5.2.2.1 General Characteristics

5.2.2.1.1 The Material

By condensation of formaldehyde with urea, aqueous resins of about 60 to 65 per cent resin content are obtained. These can either be used directly or be processed into fine resin powder by spray-drying, the powder being easily soluble in water. Further processing by pressure, addition of heat or admixture of hardeners transforms the products into a final state where they are infusible. Once hardened, the resins are insoluble in water and all inorganic solvents.

The colourless and transparent urea formaldehyde resins (just like melamine resins) have the advantage over phenolic resins of not changing colour when exposed to sun-light and heat.

Urea formaldehyde resins (UF) are marketed in liquid form and in solid form as crumbs and powder.

5.2.2.1.2 Applications

Urea resins are used mainly as

- binding agents for moulding compounds
- binding agents for wood materials
- wood glues
- foams
- textile, leather and paper processing materials
- raw materials for paints and varnishes.

UF contain pure urea formaldehyde as a binding agent and short-fibre cellulose as fillers. Admixtures of compounds that easily separate acids, such as diisocyanates, serve as hardeners. The resin content is about 60 per cent. The compounds are mostly white or are given a pale colouring. They are traded as fine powder and granules, and also as dustless and equal-sized granules, for processing in automatic pressing machines. Their main applications are unbreakable household articles, sanitary articles and shaped parts for electrical engineering.

As binding agents for wooden materials urea formaldehydes are used in the manufacture of particle board which in average contains 8 per cent of it. The primary materials are e.g. wood chips impregnated with aqueous solution of urea formaldehydes. The dried shavings are formed into boards in multilayer presses. The most important applications are in the construction sector and furniture making.

In addition liquid or powdered urea formaldehydes are used as glues in the manufacture of plywood (hot gluing). Unlike phenolic formaldehyde resins, which are used as outdoor and boat plywood, urea formaldehyde glues are employed for the manufacture of indoor plywood. Special glues on the basis of urea formaldehydes are used for cold-gluing sport goods.

Ure foams are urea formaldehyde solutions to which foaming agents are added and for which phosphoric acid serves as hardener; they are whisked into foam with the addition of air. The foam thus obtained is hardened and dried by storage at ambient temperature (2 to 3 days). It is used in the building sector for the heat and sound insulation of pipe-case shafts and with porous supporting layers (jute fabrics, metal screens etc.) for reinforced hollow spaces in walls, in agriculture, and in horticulture as a soil covering and as a nutrient carrier (plastoponics).

Urea formaldehydes together with melamine resins play an important part in the resinous refinement of textiles, such as creaseproof finishing and dimensional stability. Finished textiles refined with urea are known as "wash and wear" quality. Urea formaldehydes are also suitable for the wet-strength treatment of papers.

Moreover, UF condensation products are used for the re-tanning of shoe uppers and as a filler for sole leather, as well as for the first tanning and re-tanning of chrome leather.

In the applications so far mentioned urea formaldehyde resins used as unmodified resins. As raw materials for paints and varnishes, however, they are utilized only after further modification. Therefore, the urea formaldehyde resins for paints and varnishes are not included in the investigation, especially as their use in Pakistan is negligible.

In Pakistan up to now moulding compounds on the basis of urea formaldehydes have only been used in small quantities. The largest consumption of urea formaldehydes is in the particle board and plywood industries, where they are used as glue. In these two sectors urea formaldehydes are the most common synthetic binding agents. To a certain extent area resins are also utilized in the textile and leather industry as refining agents. In the sports goods industry of Sialkot in West Pakistan special glues on the basis of urea formaldehydes are employed for the cold-gluing of tennis rackets, hockeysticks, etc. Urea formaldehydes are not used in paper refining, nor are they foamed.

The proportion of the PF resins consumed in the individual fields of application in 1968 is as follows:

Table 30: Percentage Break-Down of the Consumption of PF Resins

	East Pakistan	West Pakistan	All Pakistan
moulding compounds (with filler)	100 %	84 %	85 %
wood glue	-	10 %	9 %
technical resins for emery paper and grinding wheels	-	6 %	6 %

If only the pure resin content of the different products is considered, the share of the moulding compounds comes to only 68 per cent while that of glue and technical resins rises to 19 per cent and 13 per cent respectively of the total demand in Pakistan.

A more detailed investigation of the processing methods used in the various industries, the local distribution, the quantities imported and the countries of origin of PF resins in Pakistan reveals the following picture:

PF moulding compounds

The tables show that the major part of the PF resins consumed in Pakistan are used for PF moulding compounds, with the main consumers coming from West Pakistan. The consumption in East Pakistan amounts to less than 10 per cent of the consumption

5.2.2.2 Domestic Production

5.2.2.2.1 Existing Capacity

Three enterprises in Pakistan produce urea formaldehydes. These are

- Valika Chemical Industries Ltd., Karachi
- Eastern Chemical Industries Ltd., Chittagong, and
- Synthetic Resin Products Ltd., Chittagong.

The capacities, production lines, production processes, and raw materials are described in the following.

Valika Chemical Industries Ltd.

The firm has a plant for the production of urea formaldehyde liquid resins with a daily capacity of 9 to 10 tons. A spraying unit of 3.6 tons capacity per day for the manufacture of dry urea formaldehydes is undergoing trials at present.

The resins are designed for glues for the particle board and plywood industries. The resin content of the liquid resin is about 50 per cent. The liquid resin can be stored only a fortnight and, therefore, its selling raises considerable problems; for this reason Valika decided to establish the additional drying plant. The capacity of the plant is somewhat smaller than the theoretical output of liquid resins, so that part of these resins, i.e. about 2.5 tons per day, have to be sold without further drying.

The formaldehyde necessary for the manufacture is supplied to Valika by a formaldehyde and methanol unit of their own. The methanol plant operates on the basis of natural gas (cf. Section 5.5.1.1 and 5.9.4). Valika buys the raw material urea from the fertilizer factory in Multan.

The resin plant started production in 1967.

Eastern Chemical Industries Ltd.

The enterprise comprises

- 1 plant with a capacity of 4 to 5 tons per day for the manufacture of liquid resins as binding agents and glue for the wood industry and
- 1 plant with a capacity of 3 to 4 tons per day for the production of urea moulding compounds for moulded parts
- Plants for further processing of the moulding compounds are available, too.

The raw material formaldehyde is manufactured from imported methanol in a factory-owned installation. The urea is supplied by the fertilizer factory in Sylhet. The plant was installed in 1966/67.

Synthetic Resin Products Ltd.

The firm produces liquid urea formaldehyde as a binding agent for wood materials. The capacity is 4 to 5 tons of liquid resin per day. In addition there is a small drying plant of 1.2 tons capacity a day. Formaldehyde and urea are supplied to the firm by local producers, i.e. formaldehyde (37 per cent) by Eastern Chemical and urea by the fertilizer factory in Sylhet. The plants were being tested and were intended to be put into operation before the end of 1968.

Thus the theoretical annual production by regions is:

	Liquid Resins	Dry Resins	Moulding Compounds
West Pakistan	2,700	1,000	-
East Pakistan	2,700	350	1,000
All Pakistan	5,400	1,350	1,000

5.2.2.2.2 Production Trends and Volumes

The volume of the firms' production was very low up to the end of the interviews. The production quantities in the individual firms are as follows:

Valika has stopped production since there are no consumers of liquid resin. The firm intends however to start again at the end of 1968 when the newly established resin drying plant which is now being tested can be fully utilized.

The installations of Eastern Chemical Industries for the manufacture of liquid urea formaldehyde were stopped until the end of 1967. Since then they have been operating at 10 per cent of their capacity. The output for 1968 will thus presumable be about 150 tons of liquid resin. The plant for the production of UF moulding compounds is also being operated at only 10 per cent of its capacity. The enterprise itself is producing dinner services out of the compounds; the sales potential, however, is very small.

The factory of Synthetic Resin Products is a new one which is to start production at the end of 1968. Initially a monthly output of 125 tons of liquid resin is expected.

The major part of the production will be consumed in a factory-owned plant for the manufacture of particle board. The theoretical consumption of the plant is 720 tons of urea formaldehyde a year.

5.2.2.2.3 New Projects

The Kashmir Development Corporation (K.D.C.), Jhelum, plans to establish a new factory in West Pakistan for the production of urea glues in liquid and solid form. The sanctioned capacity is 14 tons of liquid resin per day. In addition, it is intended to install a drying plant with a dayly capacity of 5 tons of dry resin. The raw materials will be bought in the local market. It is planned to start production in June, 1969.

5.2.2.2.4 Problems

The small production of UF resins is due to sales difficulties for the liquid resins which so far have been the only type manufactured. The plywood and chipboard industries as potential buyers prefer to import dry resins. The dry resins have the advantage over the liquid resins of higher storage stability.

The manufacturers, however, are optimistic about future production. Valika and Synthetic Resin Products hope to provide a substitute for imports by changing over to the production of dry resins.

5.2.2.3 Demand

5.2.2.3.1 Volume and Structure of Past Demand

The following tables show the consumption of urea formaldehydes in East and West Pakistan, classified according to years and applications.

Table 35: Consumption of Urea Formaldehydes, 1965 - 1968
(in tons)

Applications	1965	1966	1967	1968
West Pakistan				
Plywood	140	150	180	208
Particle board	130	170	220	400
Moulding compounds (with fillers)	73	73	82	112
Others	150	160	155	165
Consumption in West Pakistan	493	553	637	885
East Pakistan				
Plywood	530	460	490	565
Particle board	-	280	300	400
Moulding compounds (with fillers)	-	10	15	10
Others	-	-	-	-
Consumption in East Pakistan	530	750	805	975
All Pakistan				
Plywood	670	610	670	773
Particle board	130	450	520	800
Moulding compounds (with fillers)	73	83	97	122
Others	150	160	155	165
Consumption in All Pakistan	1,023	1,303	1,442	1,860

Note: Figures for plywood include solid and liquid resins. The data for 1968 are estimated on the basis of information supplied by the industry.

The percentage of urea formaldehydes used in the individual sectors of application in 1968 is as follows

Table 36: Consumption in the Individual Sectors of Application

Applications	West Pakistan	East Pakistan	All Pakistan
Plywood	24 %	58 %	41 %
Particle board	45 %	41 %	43 %
Moulding compounds	13 %	1 %	7 %
Others	18 %	0 %	9 %
	100 %	100 %	100 %

A more detailed examination of the processing of the urea formaldehydes in the various industries in Pakistan, their regional distribution and the imports by quantities and countries reveals the following situation:

Glue Resins

The plywood and particle board industries in Pakistan are the largest consumers of these resins. The demand for glues and binding agents in these two sectors nearly doubled between 1965 and 1968. The largest share of this big increase in consumption both in East and in West Pakistan can be put down to the particle board industry, whose share in both Wings is about the same. But the centre of the plywood industry is East Pakistan, where consumption is almost three times as high as in West Pakistan. For the production of plywood in both Wings urea formaldehyde glues are used almost exclusively. The share of phenolic formaldehyde glues compared with urea formaldehyde glues is only about 5 per cent (cf. Section 5.2.1).

Up to the end of 1967 the urea formaldehyde glues required were all imported, and that in the form of powdered resins. Since the establishment of the new resin plants in West and East Pakistan some of the powdered resins so far imported could be replaced by locally produced liquid resin. The quantity of local resins consumed in West Pakistan, however, is still very small, whereas the consumption in East Pakistan is higher, especially in the plywood industry. The main supplier of liquid resins up to now has been Eastern Chemical Industries. The consumption of locally produced liquid resins was about 120 tons in 1967 and will presumably be 300 tons in 1968, which regresents 10 per cent in 1967 and 20 per cent in 1968 of the total resin consumption in the wood industry for hot-gluing plywood and particle board. The consumption of these liquid resins is included in Table 35.

It should be mentioned in this context that the quantity of resins material required for the manufacture of a certain quantity of finished wood products differs according to the form in which the resin material is supplied. One ton of powdered resin is comparable to about two tons of liquid resin. As the quantity of liquid resins consumed is relatively small, a separation or conversion to one of the two resin types is not necessary.

The dry resin glues imported up to the present come mainly from Switzerland (CIBA) and West Germany (BASF). Smaller quantities also are imported from England.

Moulding Compounds

The consumption of moulding compounds is relatively small, especially in East Pakistan, although Eastern Chemical Industries has a rather large plant for the production of urea formaldehyde moulding compounds and also machinery to process them. There is a demand for the urea formaldehyde moulding compounds especially in West Pakistan, namely from 2 or 3 major plastics processors in Karachi producing small electrical parts, buttons, bottle-caps and other consumer articles. They still import the bulk of their raw materials. Small-scale industry accounts for only about 30 per cent of the total consumption.

The consumption figures for UF moulding compounds indicated in Table 35 must be converted since moulding compounds contain about 40 per cent fillers in addition to the pure resins. The following table lists the consumption figures of pure resin.

Table 37: Estimated Consumption of Urea Formaldehyde in Moulding Compounds Consumed, 1965 - 1968 (in tons)

Year	Moulding Compounds with Filler	Resins
1965	73	44
1966	83	50
1967	97	58
1968	122	73

The moulding compounds are imported above all from

- Italy
- United Kingdom
- Federal Republic of Germany.

Others

The column "Others" covers the consumption of tanning auxiliaries, cold glues for the sports goods industries in the Sialkot area, and textile auxiliaries. In detail, the annual consumption of tanning auxiliaries at present amounts to 40 to 50 tons, that of cold glues to 100 tons on an average, and that of textile auxiliaries to about 20 tons. There is a market for these products at present only in West Pakistan, whereas sales are negligible in East Pakistan.

5.2.2.3.2 **Forecast of Consumption Trends**

The various sectors of application and the possible future development of the demand for urea formaldehydes in these sectors will be dealt with separately in order to create a sound basis for statements on the future consumption of urea formaldehydes.

The particle board and plywood industries, at present the largest consumers of urea formaldehydes for glues and binding agents, will continue to have a decisive influence on the demand for urea formaldehydes in the future too. The following facts can be stated about their present and future market situation:

Particle Board Industry [1)]

The following can be said on the development of this sector up to now:

The first enterprises started production in 1965. Since then the sector has developed favourably. The capacities so far installed are

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1) This section does not include hard-board, which in dealt with separately.

in West Pakistan	13,800 tons a year
in East Pakistan	8,400 tons a year
in All Pakistan	22,200 tons a year

The establishment of more enterprises is envisaged for the Five-Year Plan period 1965 to 1970 (cf. Table 38).

Table 38: Breakdown of the Installed and Sanctioned Capacities of the Particle Board Industry (in tons)

	West Pakistan	East Pakistan	All Pakistan
Existing Capacities			
Star Particle Board Mills, Dacca	-	8,400	8,400
Pakistan Particle Boards, Karachi	4,500		4,500
Pakistan Chip Boards, Jhelum	3,000	-	3,000
Al-Athar Ltd., Karachi	3,300	-	3,300
K.D.C. Board Ltd., Jhelum	3,000	-	3,000
Existing Capacities, Total	13,800	8,400	22,200
Sanctioned Capacities			
Haji Dossa Particle Board, Mirpurkhas	9,000	-	9,000
Dada Wood Products, Khanpur	9,000	-	9,000
Kalurghat, Chittagong	-	6,300	6,300
Crescent Sugar Mills, Lyallpur	25,000	-	25,000
Sanctioned Capacities, Total	43,000	6,300	49,300

If all the projects are realized by 1975, the installed capacities by that year will total in

West Pakistan	56,800 tons per year
East Pakistan	14,700 tons per year
All Pakistan	71,500 tons per year

in West Pakistan. The chief consumers of PF moulding compounds are 4 - 5 largish plastics manufacturers in the area of Karachi and the telephone factory in Haripur(TIP).

The products made of PF moulding compound in Pakistan include electrical items such as switches, knobs, plugs, plug sockets, telephone casings [1] and so on.

The figures for moulding compounds quoted in the above table contain about 60 per cent of fillers in addition to the resin. A conversion of the consumption of moulding compounds to pure resin component gives the following data:

	moulding compounds (with filler)	resin share
1965:	363 tons	145 tons
1966:	313 tons	125 tons
1967:	309 tons	124 tons
1968:	364 tons	146 tons

Up to now almost all the moulding compounds have been imported. The quantities produced in Pakistan up to the time of the investigation were very small, amounting to less than 10 tons per year. The main suppliers at present are the following countries:

- Japan
- People's Republic of China
- Hongkong
- United Kingdom

1) See chapter 5.2.1.3.2

As part of the wood processing industry, however,is alreadv suffering from wood shortage today, it is doubtful whether all the new projects will be realized.

Between 1966 and 1967 the increase in production was 20 per cent; it will rise to 55 per cent in 1967/68. Too much should not be read into these figures, however, since the production of particle board was started only recently.

A comparison of the present production with the existing capacities shows that the plants are working only at about 50 per cent of capacity.

Interviews with the manufacturers proved that the market for particle board is expanding. An average growth rate of 20 to 40 per cent is expected in the long run. Particle board will play an important part above all in furniture production. Battelle expects a longterm overall rate of increase up to 1975 of 25 per cent. This rate of increase also is in the line with the expectations of the manufacturers, who are making efforts to establish new plants. The future demand for urea formaldehyde glues is calculated as follows:

Table 39: Appraisal of the Demand for Urea Formaldehyde Binding Agents in the Particle Board Industry 1968 - 1975 (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1968	400	400	800
1969	500	500	1,000
1970	600	650	1,250
1971	900	660	1,560
1972	1,250	700	1,950
1973	1,670	780	2,450
1974	2,200	860	3,060
1975	2,870	950	3,820

Note: The demand figures for East and West Pakistan have been calculated according to the expected realization of the planned projects. They indicate presumable trends.

The table takes especially into account the projected plants to be established above all in West Pakistan Thus in West Pakistan the demand for urea formaldehyde glues will be three times as high as that in East Pakistan in 1975.

The estimated future consumption quantities include about 15 per cent of liquid resins, the rest being dry resins.

Plywood Industry

The interviews showed that capacities in this industry are only 50 per cent utilized, both in East Pakistan and in West Pakistan. Problems occur in the supply of wood as well as in the sales of plywood. The increase in production during the last two years was about 10 per cent a year for All Pakistan, the market situation in East Pakistan being more difficult than in West Pakistan. For East Pakistan no substantial increase in production is expected for the next few years (rate of increase 4 to 5 per cent) In the opinion of the manufacturers, the annual growth rate of demand will be 14 to 15 per cent in West Pakistan, where wood is very scarce but sales prospects for plywood are better. This presupposes that the problem of wood shortage has been solved [1].

We estimate that the average annual rate of increase in this sector for All Pakistan will be 8 per cent. On this basis the consumption of urea formaldehyde glues for the next few years is calculated as follows:

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1) The establishment of a Formica factory might help to this end (cf. section 6.2.5).

Table 40: Appraisal of the Demand for Urea Formaldehyde Glues in the Plywood Industry 1968 - 1975 (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1968	208	565	773
1969	240	590	830
1970	280	620	900
1971	320	650	970
1972	370	680	1,050
1973	420	710	1,130
1974	480	750	1,230
1975	560	770	1,330

Note: The composition of the demand is about 85 % dry resins and 15 per cent liquid resins.

The calculated figures of consumption for 1975 represent the quantities of glue theoretically needed by the plywood industry if the existing enterprises work at full capacity. East Pakistan would need about 770 tons and West Pakistan about 560 tons of urea formaldehyde glue per year. The establishment of new enterprises is not projected for the moment.

Moulding Compounds

The consumption of urea formaldehydes for moulding compounds will probably continue to be of little importance in relation to the total demand for urea formaldehydes. At present moulding compounds account for 7 per cent of the total consumption of urea formaldehyde materials, the share in East Pakistan being 1 per cent and that in West Pakistan 13 per cent. The resin quantities needed for the manufacture of moulding compounds are small, still being less than 75 tons. There will be no considerable change in the near future, since resin types with a broader range of application and better properties, such as phenolic resins and thermoplastics, restrict the demand for urea formaldehyde moulding compounds. We estimate that the future increase in the demand for urea formaldehyde moulding compounds will amount to about 10 per cent a year. The following figures for the period up to 1975 are calculated on this basis:

Table 41: Estimated Demand for Urea Formaldehyde Moulding Compounds 1968 - 1975 (in tons)

Year	West Pakistan		East Pakistan		All Pakistan	
	Moulding Compounds with Filler	Resin Content	Moulding Compounds with Filler	Resin Content	Moulding Compounds with Filler	Resin Content
1968	112	67	10	6	122	73
1969	120	72	10	6	130	78
1970	140	84	10	6	150	90
1971	150	90	10	6	160	96
1972	160	96	10	6	170	102
1973	180	108	20	12	200	120
1974	200	120	20	12	220	132
1975	220	132	20	12	240	144

Note: The resin content of the moulding compounds is 60 per cent.

Some of the figures are rounded off.

The table shows that the consumption of moulding compounds and of the resins needed as binding agents for them will double up to 1975. About 10 per cent will be consumed in East Pakistan and about 90 per cent in West Pakistan. Compared with the consumption of phenolic moulding compounds, urea formaldehyde moulding compounds will be of minor importance.

Others

For the urea formaldehyde condensates listed under "Others" we expect a rate of increase of 10 per cent in West Pakistan. Forecasting the development of the growth rates of the individual sectors, is rather difficult. The consumption of urea formaldehyde resins as tanning auxiliaries, for instance, depends heavily on the future export prospects of leather shoes and chrome leather, since 75 per cent of the leather products treated with urea formaldehyde condensates are designed for export. As we found out, the scope for using urea formaldehyde resins as textile auxiliaries is limited. Ethylene urea precondensates are preferred [1]. The consumption of urea formaldehyde cold glues for the manufacture of sports goods has been constant for years and will not increase much in the future either according to information provided by the importers.

It is difficult to say anything about the scope of application of these products in East Pakistan during the next few years because information on possible applications was almost impossible to obtain. The general agencies of the manufacturers said that the consumption of all three products is not likely to exceed 200 t by 1975.

To sum up, we estimate the development of consumption in the sector "Others" to be as follows:

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[1]) The Bawany and the Adamjee concerns may treat part of the textiles they produce with urea formaldehyde resins. But no information on details could be obtained.

Table 42: Estimated Consumption of Urea Formaldehyde[1] for "Others", 1968 - 1975 (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1968	165	0	165
1969	180	20	200
1970	200	50	250
1971	220	70	290
1972	240	90	330
1973	270	110	380
1974	290	150	440
1975	320	200	520

[1]) Figures contain about 70 % of pure resin in average.

A final summary of the future demand for urea formaldehyde resins in Pakistan by individual applications is given in the following table:

Table 43: Estimated Demand for Urea Formaldehyde Resins in Pakistan by Applications, 1968 - 1975 (in tons)

Year	Particle Board	Plywood 1)	Moulding Compounds 2)	Others 1)	Total
1968	800	715	73	115	1,703
1969	1,000	770	80	140	1,990
1970	1,250	830	90	170	2,340
1971	1,560	900	100	200	2,760
1972	1,950	970	100	230	3,250
1973	2,450	1,040	120	270	3,880
1974	3,060	1,140	130	310	4,640
1975	3,820	1,230	140	360	5,550

1) In tons of dry resin content
2) Round figures

The table indicates that the total demand for resins will more than treble up to 1975. This corresponds to an average annual rate of increase of approx. 18 per cent.

5.2.2.4 Prices

The individual manufacturers charge the following ex-factory prices for resin produced in Pakistan:

- Valika: 1.35 Rs./kg liquid resin
- Synthetic Resin Products: 2.42 Rs./kg liquid resin
- Eastern Chemical: 2.20 Rs./kg liquid resin

The price of Valika was reduced to its present level in mid-1968. It had been considerably higher. For local dry resins there is no standard price as yet.

Imported glues and binding agents at present cost

c & f Karachi: 200 - 216 US $/t
c & f Chittagong: about 216 US $/t

These prices apply only to powdered resins, since no liquid resins are imported.

The price of moulding compounds is 740 US $/t.

The landed costs for glues and binding agents in powder form were between 3.22 and 3.78 Rs./kg in August 1968. For moulding compounds they are about 3.80 Rs./kg. Imported moulding compounds are about 95 per cent more expensive than those offered by Eastern Chemical, but they are also of better quality.

The world market prices for urea formaldehyde resins have declined continuously during the last few years. Liquid urea formaldehyde resins in Europe cost about 12 US cents/kg in 1966 and about 8 US cents/kg in 1967. It is expected that the price will not go on falling, because it is already close to the present manufacturing costs.

5.2.2.5 <u>Market Structure and Consumers</u>

The local producers of resins and moulding compounds for the most part offer their products direct to the processors without wholesale and retail traders being involved. Imported resins and moulding compounds are supplied to the consumers via the general agencies of the manufacturers in Pakistan. The local producers were not successful in providing substitutes for the imports, although foreign goods can be importad only against Bonus Vouchers.

The most important consumers of urea formaldehydes and moulding compounds are divided into the following industrial sectors:

<u>Producers of particle board</u>:

In East Pakistan there is at present only one manufacturer of particle board,

Star Particle Board Mills, Dacca,

which controls the market in East Pakistan and also has a major influence on the market in West Pakistan. At present it is the largest producer of particle board in Pakistan.

In West Pakistan we located four producers of particle board:

- Pakistan Particle Boards,	Karachi
- Al Athar Particle Boards,	Karachi
- Pakistan Chip Boards,	Jhelum
- K.D.C. Boards,	Jhelum

<u>Producers of Plywood</u>:

In East Pakistan there are at present five factories for the production of plywood, whose production programme concentrates on the manufacture of commercial plywood, e.g. for tea chests. The factories are located in and around Chittagong:

- Sangu Valley Plywood Factory,	Sangu Valley
- A. Khan Plywood Factory,	Chittagong
- Sterling Plywood and Pakistan Timber,	Chandragona
- Ruby Plywood Factory,	Chittagong

In West Pakistan the sales programme tends more toward the production of decorated plywood for manufacturing furniture and flush doors. The factories are in Karachi and the northern part of West Pakistan:

- Dawn Industries,	Karachi
- Bombay Plywood,	Karachi
- Al Athar Ltd.,	Karachi
- Kashmir Development Corporation (K.D.C.)	Jhelum
- Wood Industries,	Lalamusa

Producers of Electro-Insulating Parts and Articles:

In East Pakistan we found only one major manufacturer

Fazal Industries, Dacca.

In West Pakistan the main consumers are the large plastics processing enterprises in Karachi:

- Pakistan Plastic Industries, Karachi
- Golden Industries, Karachi
- Answa Brothers, Karachi
- Premier Industries, Karachi

5.2.2.6 Recommendations

The capacities for the manufacture of urea formaldehydes installed in Pakistan are sufficient for the next few years. If the new project of the K.D.C. is realized, the demand up to 1975 will be satisfied. The resins so far imported, except for special resins like those used for the cold gluing of wood or as paints and varnishes, can be replaced by local production.

The following conditions, however, should be fulfilled to induce the consumers to use locally produced resin to a larger degree:

- A dry resin should be offered of a quality similar to that of the imported ones.

- The price should not be higher than that of the imported resin.

Wood glue

The consumption of PF wood glue accounts for only 10 per cent of the total consumption of PF resins. PF glues are only used in West Pakistan although East Pakistan too has a large wood-working industry. Theoretically, the whole hardboard and plywood industry of East and West Pakistan is a potential consumer for the production of waterproof out-door plywood and hardboard. But in practice the industry hardly takes the chance to produce waterproof plywood. For the potential users of hardboard, especially in East Pakistan, it is annoying that no synthetic resins are used in its manufacture.

The PF glues for the hot gluing of plywood and hardboard are all imported from

- West Germany (BASF)
- Switzerland (CIBA).

Technical resins for the production of emery paper and grinding wheels

The emery paper and grinding wheels industry is still at a rudimentary stage in Pakistan, so that the consumption of PF resins is very small in this sector. In addition to this the producers of emery paper prefer locally produced animal glue to the imported resins, for reasons of price. This results in lower production costs, but the quality is also affected.

- Distribution channels and service should be improved.

In case the demand for moulding compounds increases more rapidly than expected, it might be worth considering whether the manufacturers of resins should include moulding compounds in their production programme, too.

The firms should conduct a marketing study in order to determine how to increase their sales more rapidly. In this connection especially the sales of moulding compounds and of foams should be investigated.

5.2.3 Melamine Resins

5.2.3.1 General Characteristics

5.2.3.1.1 Description of the Material

5.2.3.1.2 Application of the Product

5.2.3.2 Domestic Production

5.2.3.3 Demand

5.2.3.3.1 Volume and Structure of Past Demand

5.2.3.3.2 Forecast of Consumption Trends

5.2.3.4 Prices

5.2.3.5 Recommendations

5.2.3 Melamine Resins

5.2.3.1 General Characteristics

5.2.3.1.1 Description of the Material

Melamine formaldehyde resins (MF) are obtained by condensation of melamine and formaldehyde. The manufacturing process is the same as for urea resins. The pre-condensate obtained is an aqueous resin solution with a resin content of 60 to 65 per cent. Spray drying of liquid resin results in a fine powder which is readily soluble in water. Whilst storage of the dry resin presents no problems, the liquid form has a shelf life of only three months. The liquid resin is usually immediately processed.

The MF resins are comparable with urea resins in respect of transparency and fastness to light; they are however superior to these in respect of their thermal stability, water resistance and resistance to boiling.

5.2.3.1.2 Application

The applications for melamine resins are numerous, as are those for urea formaldehyde and phenol formaldehyde resins. They are used as

- binders for moulding compounds
- binders for laminates
- finishing agents for textiles and paper
- wood glue and
- coating bases.

Melamine resin moulding compounds are obtained by adding fillers such as wood flour, wheat flour, short-fibered cellulose, textile fibres, textile chips, asbestos fibre and stone flour to the aqueous melamine resin solution as produced in the reaction vessel.

The special fields of application for the moulding compounds are determined by the fillers used. Thus, for example

- melamine resin moulding compounds with cellulose and flour fillers are predominantly used in the manufacture of tableware. They are for this application superior to most thermoplastics, due to their greater resistance to high temperatures and scratching.

- Moulding compounds with wood flour and asbestos fibre fillers are used in the manufacture of electrical parts such as terminal boards and explosion pots, as they have a high tracking resistance.

- Moulding compounds with wood flour fillers are used in the manufacture of household and utility goods of all types; for example, handles, buckles, buttons, furniture fittings, electrical plugs and sockets, light switches, etc.

Melamine laminates are manufactured by continuous processing in which paper or fabric webs are passed through an impregnating bath of aqueous melamine resin solution and subsequently pressed. These laminates are used as coatings and decorative sheetings (Formica) of high mechanical strength, mainly as furniture surfacinga, wall panelling and for other purposes in the interior decoration field.

Melamine resins are also very suitable for use as impregnating agents: as wash fast and crease-resistant finishes for textiles and for improving the wet strength of paper. The products are marketed as water-soluble powders or viscous solutions with a pre-condensate content of 50 to 100 per cent. Polycondensation causes cross-linking to form water-insoluble substances on the fibre.

Superior to urea resin adhesives are melamine resin products, which are used in the waterproof jointing of wood.

Characteristic of all the above-mentioned applications for MF resins is that the resins are used in their pure, unmodified form. However, they only obtain significance as coating bases upon further modification.

Coating bases which are compatible with alkyd resins and cellulose nitrate are obtained from melamine resins which undergo condensation in the presence of alcohols, e.g., butanol. The manufacturing process for the resins consists of reaction of the initial condensates in acid solution with the relevant alcohol. The majority of the melamine coating resins at present on the market is manufactured with n-butyl alcohol as the esterifying alcohol. Melamine-alkyd resin films are characterised by hardness and adhesive strength coupled with high elasticity and good weather resistance. Main applications: coatings for motor vehicles, refrigerators and washing machines.

These are not further considered in this section, as their use in Pakistan is limited to small quantities of imported special coatings.

In Pakistan MF resins have until now found only insignificant application, although a number of MF resin manufacturing plants exist.

As reasons for this can be quoted that

- MF resins are relatively expensive and
- MF resins have special fields of application

These reasons also apply in highly industrialised countries, where MF resins can also not be counted among the mass-produced plastics.

MF resins are imported into Pakistan in the form of intermediates and finished products such as, for example, decorative laminates (Formica), electrical insulation parts (terminal boards), coatings and textile finishings.

The MF resins manufactured in Pakistan are used in producing

- moulding compounds for tableware and
- textile finishes

MF wood adhesives and paper finishing agents have until now neither been manufactured nor imported.

5.2.3.2 Domestic Production

The Eastern Chemical Industries, Chittagong have a plant with a theoretical production capacity of 300 tons of moulding compounds per year. The plant is however at present to all intents and purposes inoperative, as no trade outlets are available. The melamine raw material has to be imported, whilst formaldehyde is available from the company's own production. The plant was erected in 1966/67 in connection with the building of a formaldehyde and urea resin plant.

The Synthetic Resin Products Ltd., Chittagong also plans to begin production of MF resins at their urea resin plant in 1970. No details are known.

Futehally Ltd., Karachi manufactures 100 tons of textile precondensates with a 40 per cent solids content per year. Production commenced in 1957; output has stagnated since then. The melamine is imported, whilst the formaldehyde is obtained from local sources.

Shuja Industries, Karachi, also use imported melamine and locally-bought formaldehyde in the manufacture of a melamine formaldehyde pre-condensate with 30 per cent solid content. The annual output in 1967 was 80 tons and in the first six months of 1968 also 80 tons.

5.2.3.3 Demand

5.2.3.3.1 Volume and Structure of Past Demand

The following table shows the consumption of MF resins in Pakistan, classified by provinces and fields of application.

Table 44: Consumption of MF Materials during the Period 1965 - 1968 (in tons)

Year	West Pakistan		East Pakistan		All Pakistan	
	Moulding Compounds	Textile Finishes	Moulding Compounds	Textile Finishes	Moulding Compounds	Textile Finishes
1965	30	100	-	-	30	100
1966	30	100	-	-	30	100
1967	30	180	20	-	50	180
1968[1])	40	240	20	-	60	240

[1]) Expected consumption

Note: The moulding compounds comprise approx. 60 per cent resin and 40 per cent filler, the resin component in textile finishings is approx. 30 to 40 per cent.

A survey of the user sectors, regional distribution and origin of the MF resins processed in Pakistan gives the following picture.

At present, 80 per cent of all MF resins used in Pakistan go into textile finishings. Only 20 per cent are used in the manufacture of moulding compounds. A demand for moulding compounds exists in East and West Pakistan. In East Pakistan, Eastern Chemical Industries as the moulding compounds manufacturer is simultaneously the only concern engaged in the processing of MF moulding compounds. MF moulding compounds are not imported into East Pakistan. Two users were found in West Pakistan, a manufacturer of tableware and a large electrical company which processes intermediates from MF moulding compounds to switchboards, terminal boards, etc. Granular material and intermediates are imported.

Textile finishings are only in West Pakistan in any considerable demand. They are used by the textiles industry for crease-resistant ("wash and wear") finishing of fabrics. Consumption has risen by 140 per cent since 1965. Only relatively few textile companies use MF pre-condensates.

Imported decorative sheeting (Formica) is also used in Pakistan. The consumption of this is not included in the above table. Section 6 deals with the possible substitution of domestic products for these imported goods.

5.2.3.3.2 Forecast of Consumption Trends

An assessment of the future demand for moulding compounds depends to a very considerable extent on whether MF resin tableware wins in popularity. The demand at present is slight. The end products are relatively expensive, e.g., a plate costs 5 Rs., and the products are not of the best quality (the tableware is not scratch-resistant).

A new concern in Sialkot whose plant is already erected intends to commence production of tableware at the beginning of 1969. Enquiries at the head offices of this concern revealed that the demand for moulding compounds for the first years of production is estimated at 15 to 25 tons per year.

The demand for MF moulding compounds for the manufacture of electrical insulation parts such as terminal boards, etc. will according to the main user remain fairly constant over the next few years.

The demand for moulding compounds in the coming years is expected to develop as follows:

Table 45: Estimated Demand for MF Moulding Compounds for the Period 1968 - 1975 (in tons)

Year	West Pakistan	East Pakistan	Total
1968	40	20	60
1969	55	20	75
1970	55	20	75
1971	60	22	82
1972	60	24	84
1973	65	26	91
1974	65	28	93
1975	70	30	100

At present the resins are imported from the following countries:

- United Kingdom
- West Germany
- United States.

5.2.1.3.2 Forecast of Consumption Trends

The consumption of PF resins will be forecast separately for the three main fields of application in Pakistan up to 1975. Our detailed conclusions are as follows:

Moulding compounds

The consumption of PF moulding compounds has not increased since 1965; it has stagnated and in some cases has even decreased. The reasons for this are on the one hand the replacement of PF resins by thermoplastics and on the other hand a lack of suitable new fields of application, which have not been developed. Originally Telephone Industries of Pakistan, Ltd. (TIP), in Haripur used PF moulding compounds for the production of their telephones, but later they changed over to high-impact polystyrene. At present this factory is using PF only to produce spare parts for the discontinued products.

There will certainly be a further increase in consumption as soon as the new plant of Azmat Industries, Gujranwala starts production in 1969, so that PF moulding compounds will be available locally.

According to our estimates the annual rate of increase of PF moulding compounds will be 10 per cent. This is not least due to the fact that the expanding electrical industry requires

Note: The figures contain not only resin but also 40 per cent fillers.

If we consider the demand for resin for the manufacture of moulding materials during the years to come, we arrive at the quantities given in the following table:

Table 46: Estimated Demand for MF resins for the Manufacture of Moulding Compounds for the Period 1968 - 1975 (in tons)

Year	West Pakistan	East Pakistan	Total
1968	24	12	36
1969	33	12	45
1970	33	12	45
1971	36	13	49
1972	36	14	50
1973	39	16	55
1974	39	17	56
1975	42	18	60

The table shows that according to the estimates the total consumption will scarcely rise before 1975. The capacity of Eastern Chemical is sufficient to meet the entire demand for moulding compounds until 1975.

In the textile finishings sector, melamine pre-condensates are at present in fierce competition with ethylene urea and urea pre-condensates. The present total consumption of such products is approximately 600 tons, some 40 per cent of this demand being met by melamine formaldehyde precondensates.

The entire market is subject to fluctuations and depends very much on factors such as the type of fibres mainly processed at a given time.

Ultra-fine finishing of textiles will however in future win far greater significance than it at present enjoys. This will become particularly true when Pakistan increases her efforts to export finished textile goods. Interviews of the manufacturers of textile finishings showed that at a long term, conservative estimate annual growth rates of 8 to 10 per cent are to be expected Assuming a mean growth rate of 10 per cent, the following future consumption of liquid MF resins can be calculated:

1968: 240 tons	1972 350 tons
1969: 265 tons	1973: 390 tons
1970: 290 tons	1974 425 tons
1971: 320 tons	1975: 470 tons

If the export drive in textiles were increased in the coming years, the growth rates could increase considerably.

The above figures show that the demand will only double by 1975. These figures also include the estimated demand quantities for East Pakistan, which are expected to represent 10 to 12 per cent of the total consumption in the coming period. If we consider the pure solids content of textile finishings (approx. 35 per cent), we arrive at a figure of about 165 tons of solid MF resins for the year 1975.

The estimated total demand for moulding compounds and textile finishings for 1975 is approximately 570 tons, ca. 80 per cent of this being used in the textile finishing sector. Converting this to resin contents, 25 per cent of the 1975 consumption will be for moulding materials and 75 per cent for textile finishings.

5.2.3.4 Prices

We were unable to discover the producer prices for MF moulding compounds of Eastern Chemical Industries, owing to the fact that the factory processes the greater portion of its own products.

A basis for forming an impression of price levels for MF moulding compounds can be taken from the European situation, where the mean price for white, uncoloured moulding materials ex works is 3.57 Rs. exclusive of sales tax.

C & f Karachi, the price for white, uncoloured moulding compound is approximately US $ 830/ton

Locally-manufactured MF pre-condensates with approx. 30 per cent resin content used as textile finishings cost in Pakistan between 6.05 and 7.15 Rs./kg ex works (Shuja Industries). Comparable resins are sold in Germany at about $ 0.87/kg or 4.17 Rs./kg.

5.2.3.5 Recommendations

Further extension of plant for the manufacture of MF moulding compounds is not considered necessary, as the Eastern Chemical Industries (ECI) plant is capable of meeting the demands for moulding compounds of East and West Pakistan until 1975. ECI could also supply the new manufacturer of tableware in Sialkot with MF moulding compounds. There exists however a certain danger that, as there are very few substitutes for MF, prices might rise too sharply in the absence of competition in the form of imported resins or moulding compounds.

The use of MF moulding compounds seems in our opinion to be economically scarcely justifiable, as MF moulding compounds on the one hand are very expensive and almost the only field of application for these in Pakistan is tableware, whilst tableware on the other hand can be produced at far lesser expense from other, local materials such as china clay.

We recommend that a separate market study be carried out in respect of MF pre-condensates as textile auxiliary. This study should include possible applications for MF resins and also for competitive products. A central feature of this investigation should be a study of the effects of ultra-fine finished textile goods on exports. It is possible that this sector also uses materials which are not so greatly dependent on imported raw materials.

5.2.4 Polyurethanes

5.2.4 Polyurethanes

5.2.4.1 General Characteristics

A clear differentiation must be made between the two types of polyurethane (PUR):

- linear PUR suitable for thermoplastic processing and
- cross-linkable PUR

Linear polyurethanes which are suitable for thermoplastic processing should properly be dealt with in the section on thermoplastic resins. As PURs however play only a subordinate role among thermoplastics, we have included them in this section Being polyadducts, they have a structure similar to that of the polyamides and greatly resemble these in their behaviour. The possible fields of application are also the same.

Cross-linkable PURs are formed by polyaddition. The components of the reaction are isocyanate and polyether or polyester. Depending on the reaction process, the product is either a curing resin for coatings and adhesives or a solid thermosetting plastic which can be modified from hard to rubbery-elastic or foams which can be modified from hard to soft.

The most important field for cross-linkable PUR is the production of foam plastics. The initial products isocyanate and polyether or polyester, which are available under brand names such as "Desmophen" and "Desmodur" (German products), are foamed during the reaction process by the addition of water; the ratio in which the components are mixed and the reaction control determine the unit weight and whether hard or soft foams are produced.

PUR foam plastics are highly resistant to chemical attack. As soft foams, they have an advantage over foam rubber in being less susceptible to ageing under the effects of light and tropical climatic conditions.

Soft PUR foam plastics under the brand name "Moltopren" are available in Pakistan. These are used in the manufacture of upholstery, mattresses and wall panelling. The manufacture of foamed-in-the-mould plastics has begun. There is as yet no production of foam laminates in Pakistan.

Linear PURs are not used in Pakistan.

5.2.4.2 Domestic Production

There is no domestic production of the initial products isocyanate and polyester or polyether. These are imported and foamed at three plants in West Pakistan. These are:

- Air Foam, Lahore
- Master Rubber, Karachi
- National Rubber Works, Karachi

The average capacities of these plants are 30 to 55 kg/min. At a mean capacity of 40 kg/min. and 260 working days of 8 hours, this gives a theoretical total annual capacity of approx. 16,000 tons for West Pakistan. To this must be added the capacity of the new Karim Rubber Works plant in East Pakistan, approx. 5,000 tons per year.

The foaming of PURs began in 1966. In West Pakistan, the production showed the following development:

1966	39 tons
1967	128 tons
1968[1)]	220 tons

The initial products are supplied exclusively by Farbenfabriken Bayer, West Germany.

The foam plastic products are mainly sold in West Pakistan. They represent heavy competition for foam rubber articles.

1) expected consumption

5.2.4.3 The Demand in the Past

We were unable to discover any considerable imports of polyurethanes in foam or other forms. The demand since 1966 has therefore mainly been satisfied by domestic production.

5.2.4.4 Forecast of Consumption Trends

The demand for PUR foam will continue to increase in future. One reason leading to the expectation of an increase in consumption during the next 2 or 3 years is that latex foam articles are being replaced by PU foam goods. PU foams have an advantage over latex in that

- the initial products are cheaper than latex, as chemicals can be imported on Free List whilst latex has to be imported on a cash-cum-bonus basis

- PUR foams are better suited to the tropical climate

Interviews held with manufacturers of PUR foams revealed that consumption is expected to double by 1970 followed by a subsequent growth rate of 15 to 20 per cent. These growth rates are in our opinion quite realistic. We base our forecast on a mean growth rate of 17 per cent and arrive thus at the following future demand figures:

1968:	220 tons
1969:	330 tons
1970:	440 tons
1971:	510 tons
1972:	600 tons
1973:	700 tons
1974:	820 tons
1975:	960 tons

The present consumption for the whole of Pakistan will, assuming a 17 per cent growth rate, almost quadruple by 1975. If one assumes a minimum annual growth rate of 15 per cent and a maximum annual growth rate of 20 per cent for the period after 1970, the 1975 consumption will lie between 880 and 1,100 tons. The greater demand for the products will probably remain in West Pakistan also in the future.

5.2.4.5 Prices

The c & f prices for the two main initial products are at present

- Desmophen 3,800 US $ 0.62/kg and
- Desmodur T-80 US $ 1.15/kg

The other additional chemicals necessary cost c & f Karachi

- Desmorapid PS US $ 16.45/kg
- Desmorapid SO US $ 3.99/kg and
- Stabiliser OS-2 US $ 6.40/kg

An example for the prices of end products is the price for mattresses. PUR foam mattresses are sold at 400 to 500 Rs. each, whilst latex foam mattresses cost 500 Rs. As a comparison, the price of the same mattresses in the Federal Republic of Germany is 104 Rs. and 40 to 110 Rs., respectively. The great difference in price between the two articles appears to be mainly due to the fact that the initial products for foam production cannot be imported into Pakistan in sufficient quantities .

Owing to the high demand, manufacturers can at present charge high prices for their products. This is an example of the basic problem that a restrictive import policy may lead to scarcity prices.

5.2.4.6 Recommendations

In view of the present total capacity of approximately 20,000 tons per annum and an expected demand for PUR foam plastics of 1,000 tons per annum for 1975, no further expansion of this industry can be recommended.

The question arises of whether the imports of raw materials for this sector should on the other hand not be greatly increased. There is without doubt a market for a greater quantity of goods. Such a policy however seems to us to be of very little practical value for certain basic reasons: while all raw materials for the manufacture of PUR foam plastics have to be imported, it will certainly be possible to obtain latex from domestic sources after some years. In spite of the advantages of PUR foam plastics over foam rubber, we are of the opinion that preference should be given to the latter.

This means that the tax and duty on foam rubber mattresses should be lowered at least to the level which is usual for PUR foams, or those for PUR raw materials increased. In addition, we consider it advisable that the growth rates for synthetic produts be somewhat checked by suitable import control measures. A certain growth should however be encouraged in order to ensure that the capacities of the existent plants are better utilized.

this material for manufacturing electrical accessories. Whether an increase of 10 per cent can be attained or not depends primarily on the availability of phenolic resin.

Under the above conditions the following estimated figures result for the period 1969 - 1975:

Table 31: Estimated Consumption of Phenolic Moulding Compounds, 1968 - 1975 (in tons)

Years	West Pakistan	East Pakistan	All Pakistan
1968	344	20	364
1969	380	20	400
1970	420	20	440
1971	460	30	490
1972	500	30	530
1973	550	30	580
1974	610	40	650
1975	670	40	710

By 1975 there will presumably be double the demand for PF moulding compounds that there is today. The installed capacities for the production of moulding compounds will probably amount to about 1,100 tons per year by 1975. It is questionable whether the capacities existing then can be fully used.

Wood glue

The future main consumer of PF glues will probably be the still expanding hardboard and plywood industries. There follows a detailed analysis of both industries to enable the demand for PF wood glue to be estimated on the basis of a more precise knowledge of the trade.

5.2.5 Alkyd Resins

5.2.5.1 General Characteristics

5.2.5.2 Domestic Production

5.2.5.2.1 Existing Capacity

5.2.5.2.2 New Projects

5.2.5.3 Demand

5.2.5.3.1 Volume and Structure of Past Demand

5.2.5.3.2 Forecast of Consumption Trends

5.2.5.4 Prices

5.2.5.5 Consumers and Market Structure

5.2.5.6 Recommendations

5.2.5 Alkyd Resins

5.2.5.1 General Characteristics

Alkyd resin are classed as polyesters. They are produced by polycondensation of polyalcohols such as pentaerythritol or glycerol with dibasic acids such as phthalic acid, maleic acid, adipic acid or their anhydrides.

The large variety of specifications and the possibility of selecting among a number of raw materials make the production of alkyd resins a process that requires know-how and an efficient quality control. To check the properties of an alkyd thorough analytical testing is necessary, which is something small-scale buyers cannot afford. They, therefore, have to depend on sufficient and correct information from the producers.

Alkyd resins are used mainly for ths production of paints for interior and outside coatings of all kinds. About 60 per cent of all film-forming subatances in lacquers are alkyd resins.

In addition they are used for the production of printings inks, adhesives, insulation materiala, ssaling compounds, as textile finishing materials and as floor coverings. Only 5 per cent of all alkyd resins are used for these purposes, however.

Unmodified alkyd resins are of no importance, since the polycondensates are brittle and do not adhere to the surfaces. Products with the desired propertiss are obtained by adding oils or fatty acida to the reaction mixture; the resultant "modified" alkyd resins are tough and elastic.

Oils suitable for the modification are

- linseed oil
- soya bean oil
- dehydrated castor oil
- safflower oil
- cottonseed oil
- tall oil
- fish oil
- and others.

The linseed oil alkyds have the widest range of application whereas dehydrated castor oil is used mainly to produce high-quality alkyd resins.

Alkyd resins are classified by their oil content:

Type	Oil Content (%)	Phthalic Anhydride Content (%)
Short	33 - 45	> 35
Medium	46 - 55	30 - 35
Long	56 - 70	20 - 30
Very long	> 71	< 20

Very long oil alkyds are liquid even without solvents.

Alkyd resins for first-class outside paint coatings have an oil content of about 60 per cent. Highest-quality stove enamels are obtained by the combination of alkyd resins with urea or melamine resins. Nowadays combinations of this type in varying relations are among the most important industrial lacquers, especially for coating automobile parts, refrigerators, washing machines, and automats, i.e. for most of the stove enamels applied by spraying and dipping.

In Pakistan, too, alkyd resins have a wide range of applications in the paints industry. They are mainly used as a basic material for the production of drying synthetic enamels for industrial, marine and household purposes, but also for the manufacture of stove enamels and printing inks.

In most cases medium to long oil alkyds with an oil content of 55 to 60 per cent are used. They are mainly linseed oil modified, but a small proportion is modified with soya bean, cotton seed and dehydrated castor oil.

5.2.5.2 Domestic Production

5.2.5.2.1 Existing Capacity

Jenson & Nicholson of Pakistan Ltd., Karachi, has so far been the only producer of alkyd resins in Pakistan. Since 1966 the firm has operated a plant producing three tons of resin per day. The alkyd resins are processed into paints and varnishes in the factory itself. As far as possible the firm uses locally available raw materials such as cottonseed oil, dehydrated castor oil and glycerine. But phthalic anhydride and pentaerythritol, as well as the small quantities of linseed oil, soya bean oil and safflower oil used, have to be imported.

Following the expansion of paint and varnish production, output of alkyd resins rose from about 180 tons in 1966 to about 480 tons in 1968.

5.2.5.2.2 New Projects

In the near future, i.e. probably in 1969/70 the following firms will put new plants into production:

- Crescent/Reichhold, Lahore (3 tons/8 h)
- Evershine Paints, Karachi (3 tons/8 h)
- United Paints, Karachi (2 tons/8 h)

Except for Crescent/Reichhold these plants are also designed only to meet the requirements of the factories themselves and to substitute imports. The firms expect to be self-sufficient in alkyd resins from about 1970 onwards. The output of the alkyd resin producers is expected to be

1,500 to 2,000 tons a year.

As it is not known definitely which firms will establish new plants after 1970, the production forecast is limited to the above statements. The consumption figures, however, show that even after these three plants come into production the demand will be higher than the supply. Besides, a considerable part of the required raw materials are available locally, so it can be asumed that more production plants will be established at a later date.

5.2.5.3 Demand

5.2.5.3.1 Volume and Structure of Past Demand

Except for the production of Jenson & Nicholson the demand was covered entirely by imports. The total consumption up to now is indicated in table 47.

Table 47: Consumption of Alkyd Resins in Pakistan (in tons)

	1965	1966	1967	1968 [1])
West Pakistan	2,300	2,480	2,680	2,910
East Pakistan	220	250	280	320
All Pakistan	2,520	2,730	2,960	3,230

The figures listed in table 47 indicate an average growth rate for the consumption of 8.5 per cent a year. The increase in East Pakistan at 13 per cent a year is considerably higher than in West Pakistan (8 per cent a year). This becomes understandable if the total quantities are considered. East Pakistan accounts for only 1/10 of the total consumption.

The sectoral break-down of the consumption is shown in table 48. It shows that the printing ink manufacturers are of relatively little importance compared with the paint manufacturers, particularly in West Pakistan.

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[1]) Expected demand

Table 48: Sectoral Break-Down of the Consumption of Alkyd Resins in Pakistan, 1968 (in %)

	Paint Industry	Printing Ink Manufacturers
West Pakistan	97.5	2.5
East Pakistan	90	10
All Pakistan	97	3

Almost all of the processing units are located in Karachi, Lahore, and Chittagong. Only the printing ink industry is represented in Dacca with two manufacturers.

During the last few years about 30 per cent of the alkyd resins were imported from the Federal Republic of Germany (Bayer, Albert/Reichhold) and a further 30 per cent from the Netherlands (Synres). The rest came from the United Kingdom, the USA and Japan, the annual shares of each of three these countries being subject to marked fluctuations.

Alkyd resins are imported not only as raw materials for further processing, but also in the form of finished paints and printing inks. Though imports of finished paints have in general been banned for several yeare now, special paints can still be imported against Bonuw Vouchers. These are:

- Aircraft finishee
- Luminous paints
- Tin printer's lacquer
- Pencil lacquer (dipping quality)
- Automotive lacquer on a cellulose basis.

The three last-mentioned lacquers can also be produced in Pakistan. In addition, the imports of printing ink are worth mentioning. Recently it has been possible to obtain better qualities against licences and cheaper ones against Bonus Vouchers.

The imports of printing ink and paints, as well as the content of alkyd resin determined on this basis, are listed in table 49. The basic assumption was that 100 per cent of the printing ink and 60 per cent of the paints were based on alkyd resins. The alkyd resin content in each case is 30 per cent.

Table 49: Total Imports of Printing Ink, Paints and Varnishes, and the Quantity of Alkyd Resins Contained therein (in tons)

	1965/66	1966/67
Printing ink	415	500
Paints and varnishes	740	514
Alkyd resin content	257	242

Later on it will no doubt also be possible largely to substitute these imports of special paints and printing ink by local production, if the necessary know-how can be made available.

5.2.5.3.2 Forecast of Consumption Trends

For the period from 1960 to 1965 the statistics indicate an increase in world production of alkyd resins - and thus also of world consumption - averaging 10.6 per cent a year. This figure is somewhat higher than that determined for All Pakistan and West Pakistan, in the past but it is lower than that for East Pakistan. Also in future, consumption in general will grow relatively slow, according to information provided by paint manufacturers, since competing materials such as polymer emulsions are penetrating deeper and deeper into the alkyd resins sector. Our forecast is based on the average growth rates of the last few years of 8 per cent for West Pakistan and 13 per cent for East Pakistan. Regarding the pent-up demand of East Pakistan compared with West Pakistan, it appears justified to assume that growth in this part of the country will continue to be more rapid in the future. The predicted values are listed in table 50.

Table 50: Forecast of the Consumption of Alkyd Resins in Pakistan (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1969	3,140	360	3,500
1970	3,390	410	3,800
1971	3,670	460	4,130
1972	3,960	520	4,480
1973	4,270	590	4,860
1974	4,610	670	5,280
1975	5,000	760	5,750

According to our estimate, consumption in West Pakistan will increase by only about 60 per cent up to 1975, whereas consumption in East Pakistan will more than double in the same period. East Pakistan's share of the total consumption is therefore expected to rise from 10 per cent today to only 13 per cent in 1975.

Hardboard industries

The following tables provide a survey of the existing and planned enterprises, their capacities and production figures.

Table 32: Existing and Sanctioned Capacities of the Hardboard Industries in Pakistan (in tons)

	West Pakistan	East Pakistan	All Pakistan
Existing capacities			
Chittagong Board Mills Ltd.	-	4,500	4,500
Khulna Board Mills Ltd.	-	10,000	10,000
Pakistan Hardboard Mills Ltd., Karachi	3,000	-	3,000
Total existing capacities	3,000	14,500	17,500
Sanctioned capacities			
Crescent Sugar Mills Ltd., Lyallpur	15,000	-	15,000
Setwood Industries Ltd., Islamabad	2,500	-	2,500
Total sanctioned capacities	17,500	-	17,500

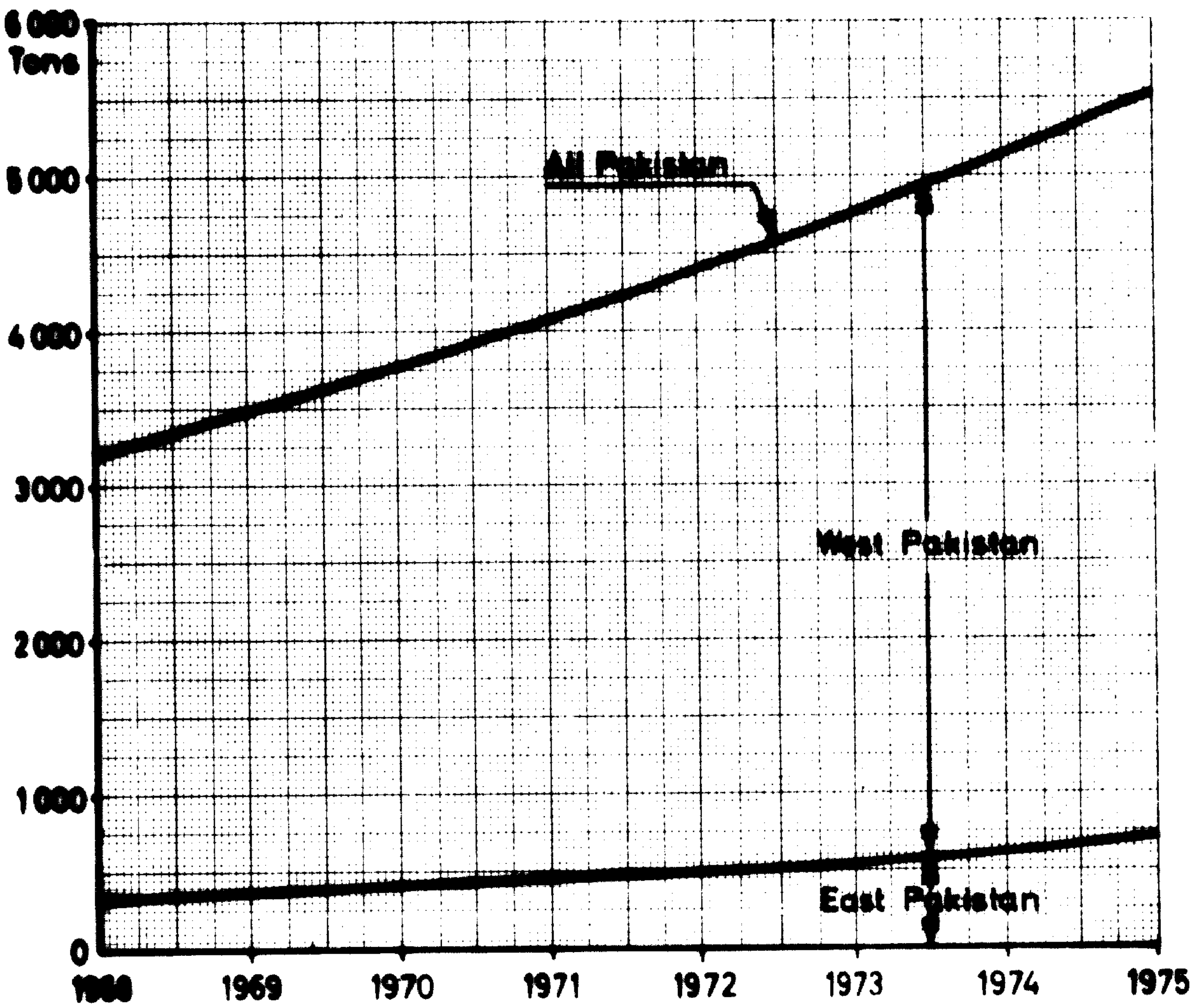

Figure 8: Trends in the Consumption of Alkyd Resins

5.2.5.4 Prices

According to information from German producers, the resin prices have been declining for many years in all parts of the world, and in Pakistan too. This has been due to rationalization and falling raw material prices. At the present time, however, the rationalization reserves seem fully exploited and the prices of various raw materials are beginning to rise, especially those of tall oil and soya bean oil. While in recent years the resin prices declined by about 5 per cent a year they are tending to rise again now since the lowest level has apparently been passed.

The c & f price of the most commonly used types (60 to 65 per cent oil content, linseed or soya bean oil modified) is

450 to 480 $/ton.

Soya bean oil modified resins tend towards the lower price, linseed oil modified towards the more expensive one.

Since July 15th, 1968, the taxes, duties and Bonus Vouchers are:

Import duty	45 % on c & f value
Rehabilitation tax	1 % on duty paid value
Sales tax	15 % on duty paid value
50 % Bonus Voucher (170 %)	85 % on c & f value

The resulting total charge is about

153 % on c & f value.

The present landed cost is thus

5,420.- to 5,780.- Rs./ton.

5.2.5.5 Consumers and Market Structure

The main consumers of alkyd resins are

- Evershine Paints, Karachi
- Buxly Paint Ltd., Karachi and Chittagong
- Jenson & Nicholson of Pakistan Ltd., Karachi
- Paintex Ltd., Lahore
- United Paints, Karachi
- Imperial Paint & Varnish Works, Karachi.

These firms consume about 75 per cent of all alkyd resins. The remaining 25 per cent of the alkyd resin consumption is distributed among some 25 small and very small enterprises.

5.2.5.6 Recommendations

A number of raw materials excellently suited for alkyd resin production are available locally or can easily be produced in Pakistan. These materials are glycerine, and oils such as cottonseed oil, tall oil, and castor oil. Tall oil can be obtained from the waste lye in cellulose production.
It can be, and possibly is already being, extracted from it by acidification. In addition, Pakistan provides good conditions for the cultivation of castor. It should therefore be investigated whether the systematic cultivation of castor

for the purpose of producing resin is possible or can be extended.

Glycerine is also produced in Pakistan. Today pentaerythritol is often preferred in industrialized countries, since its esters have a higher fusion point and a greater resistance, but this criterion is of major importance only where competition is very keen.

The present trend of alkyd resin production in Pakistan is towards the self-supply of all large paint factories. Only Crescent/Reichhold intends to offer alkyd resins in the market. There will probably be a tendency not to admit any further imports of alkyd resins into Pakistan in the future. But small paint manufacturers at present account for no less than 25 per cent of the total consumption, and in view of this it does not seem advisable to protect one producer too much. Therefore, a supply of alkyd resins of satisfactory quality, price and quantity should be guaranteed either by the concession of import licences or by the establishment of at least one more plant producing for the market.

By 1972 the amount of resins consumed by small paint factories in West Pakistan is likely to increase to 1,000 tons. This quantity would be sufficient for two production units of a capacity of 3 tons/day each, with an initial capacity utilization, related to one shift, of about 50 per cent. One of these plants might possibly be sanctioned for 1970. We would recommend establishing this plant in East Pakistan.

5.2.6 Epoxy Resins

5.2.6.1 General Characteristics

5.2.6.2 Application of Epoxy-Base Pipes in Tube-Well Construction

5.2.6.3 Domestic Production

5.2.6.4 Demand

5.2.6.5 Prices

5.2.6.6 Recommendations

5.2.6 Epoxy Resins

This group of resin materials has been additionally included by Battelle into the investigation programme, since it was found that a large and perhaps further increasing number of fibre-reinforced pipes for tube-well construction will be imported to Pakistan. These "glass fibre" pipes are bounded with epoxy resins.

According to information received, two groups of firms are developing plans for the local manufacture of such pipes. Thus, epoxy resins might in the future be imported for this new line of production.

5.2.6.1 General Characteristics

The types of epoxy resins (EP) generally used are produced by condensation of epichlorohydrin and Bisphenol A. The resulting diglycidyl ether of Bisphenol A has to be cured with the help of curing agents to yield a thermosetting resin which finds various industrial applications.

According to tender conditions issued by WAPDA in 1965, the pipes used in West Pakistan are required to be made of the diglycidyl ether or cyclo-aliphatic diepoxides and have to be cured with aromatic diamines, polycarboxylic acid anhydrides or eutectics therefrom. A resin which suits the requirements is Epikote 828 or Epon 828 produced by Shell International Chemical Company and its subsidiaries.

In principle, these types of resins can be manufactured in Pakistan, especially at a later stage when the petrochemical industry has become more advanced. Bisphenol A is produced from acetone and phenol. Epichlorohydrin is usually produced from propylene and chlorine via allyl chloride. The production of epichlorohydrin is, however, problematic since the reaction is very violent.

Epoxy resins are characterised by very low shrinkage and excellent adhesion properties on wood, metals, ceramics and glass. Owing to these qualities and in spite of the relatively high price they are used for the production of fibre-reinforced articles, adhesives for metals, concrete and other materials and for corrosion resistant coatings. They are further applied as casting resin for electrical and components.

5.2.6.2 Application of Epoxy-Base-Pipes in Tube-Well Construction

Glass fibre pipes with EP bond have been used mainly in the petroleum industry, in aeroplanes but also in chemical industries. According to information received from irrigation experts working in Pakistan, they are now being used on a larger scale in this country for the installation of tube-wells. Mostly EP bonded glassfibre pipes are used at present for the WAPDA tube-well programme in West Pakistan. This is in the first instance due to the existance of aggressive ground water more or less all over West Pakistan.

For this reason conventional GI pipes cannot be used. The problem is corrosion and encrustration which is caused by certain anaerobic and aerobic bacteria. Bacterial action creates electrolytical conditions which lead to corrosion. The "sulphate-reducing bacteria" were found to have the most harmful effect on the pipes. The aerobic bacteria or iron bacteria are generally not as harmful, but they are mainly responsible for the clogging and blocking of screens and the formation of encrustrations.

It might be useful in this context to summarise the disadvantages of various materials compared with fibre reinforced materials This is intended to elucidate our assumption that such pipes will in the future be used for the construction of tube-wells to an increasing extent [1].

Brass

There is the danger of electrochemical corrosion when brass strainers are used in West Pakistan. A high content of salts in the water usually promotes the destructive process (dezincification). Moreover copper alloys form copper sulphate which deposits in the slots.

Galvanized mild steel

This material is also corroded when immersed in saline water.

Bakelised wood

It swells in saline water. Moreover there is a problem in cleaning the slots. The most economic method for cleaning slots is by well-dosed explosions. This method cannot be applied with bakelised wood since the material does not tolerate the pressure.

Electrophoretically coated rubber on mild steel

The rubber coating is somewhat porous which leads to corrosion. Moreover, there seems to be the danger that the coating is damaged during installation.

Polyethylene coated mild steel

The danger is too high that the coating is damaged during installation.

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[1] According to a report in "Khairpur Tubewell Drainage Project. Engineers' Report on Tenders Received by the Authority on 31st August, 1964", by Sir M. Macdonald & Partners.

PVC

The WAPDA consultants report about this material which is of great interest because of the domestic production possibilities: "PVC itself has an exceedingly high resistance to micro-biological attack, both fungi and bacteria, but authorities on the subject agree that the plasticisers .... are very often the main cause of bacterial and fungal action".

Naturally, one could avoid this damage by taking rigid PVC which does not contain plasticisers. But here the problem is that "the material will not stand up the clearence of encrustration of the screens by explosions". Moreover, the material has to be handled carefully and the pipes have to be protected against shocks from the pumps. These are conditions not easily satisfied. Another problem is the thickness of the walls. The walls thickness in PVC pipes has to be fairly high owing to the relatively low mechanical strength of the material. This, however, results in heavy slots which tend to be encrustrated earlier than thinner slots in the case of other materials. The consultants came to the conclusion that PVC might find a good application in future tube-well programmes, but for the time being the problems involved are not yet solved.

Asbestos cement

Again the slots are too thick.

Stainless steel

The pipes are satisfactory but too expensive. In 1964 for instance 10 " pipe was offered to WAPDA

in fibre glass at Rs. 151.-/metre
in stainless steel 304 at Rs. 475.-/metre.

Kunifer 10

This alloy of copper, nickel and iron shows slight erosion in aggressive water.

On account of these disadvantages of the competitive materials the consultants considered the epoxy based pipes be the most suitable ones.

5.2.6.3 Domestic Production

So far there is no local production of epoxy resins or tube-well pipes based on this type of material. However, there are two groups of firms which intend to manufacture fibre-reinforced pipes. Both are joint ventures with foreign firms: one with Bristol Aeroplane Plastics, England, and the other with Koppers Co., USA.

5.2.6.4 Demand

The bulk of the epoxy resins in case of their production in Pakistan would have to be consumed by the manufacturers of fibre-reinforced pipes for tube-wells. Since so far it cannot be taken for granted that a production of this type will be started in the country, the demand figures given in the following show the amount of resin that would be required if the pipes had been produced in Pakistan.

According to statements from WAPDA, the imports of fibre-reinforced pipes during the period 1965 to mid 1967 have been in the order of 119,000 m. The average diameter of these pipes can be assumed to be 9 " and its weight as 3,140 g/m. The pipes containing 45,5 per cent by weight of glass-fibre and the resin

Table 33: Production of the Hardboard Industries, 1965 - 1968 (in tons)

Years	Chittagong Board Mills	Khulna Board Mills	Pakistan Hard-board Mills	Total
1965	1,170	-	-	1,170
1966	1,300	200	-	1,500
1967	1,100	2,000	1,000	4,100
1968 [1)]	1,200	3,000	2,000	6,200

[1)] Expected Demand

A comparison of the production with the installed capacity shows that the production level is far below the capacity. In detail, the position is as follows:

- Chittagong Board Mills works only 3 months per annum; the factory is closed during the rest of the year.
- Khulna Board Mills uses only 30 - 40 per cent of the capacity.
- Pakistan Hardboard Mills uses 60 - 70 per cent of the capacity.

The general economic situation in the hardboard industry is depressed. The producers have sales problems. The hopes that were entertained when the factories were established have not been realized. It is all the worse that potential buyers of hardboard have lost interest due to high prices and inferior quality. At present the market seems to be saturated.

part of it about 43 per cent of curing agents and accellerators, the weight of the "monomer" content of these imports totals about 116 t [1].

The approximate distribution of this consumption over the period is not sufficiently well known. However, it is said that the programme has not come into full swing before 1967.

The pipes have been imported from the USA and England, the bulk of it probably from the latter country. The pipes from England are delivered by Bristol Aeroplane Plastics Ltd., who use for their manufacture Epikote 828 resin from Shell International Chemical Company, London. The American supplier is Koppers Co., Inc.

It should be noted that WAPDA at present is the most important consumer of this type of pipe.

According to statements from the WAPDA Planning Division and various consultants and contractors we have come to the conclusion that during the period up to 1975 the consumption of fibre-reinforced pipes can be estimated at roughly 122,000 to 220,000 rm per annum (see following table).

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1) The specific gravity of the pipes is 1.8 while that of the cured resin is 1.2 and that of the fibre-glass 2.52.

Table 51: Estimated Demand for Fibre-Glass Pipes for Tube-Wells, 1968/69-1975/76

Year	WAPDA		DPHE		ADC		Private		Total (rm)
	No of wells	pipes (rm)	No of wells	pipes (rm)	No of wells	pipes (rm)	No of wells	pipes (rm)	
1968/69	2,000	122,000	150	9,200	-	-	20	1,200	132,400
1969/70	2,000	122,000	200	12,200	100	6,100	20	1,200	141,500
1970/71	3,000	183,000	300	18,300	200	12,200	30	1,800	215,300
1971/72	3,000	183,000	300	18,300	200	12,200	40	2,400	215,900
1972/73	3,000	183,000	300	18,300	200	12,200	60	3,700	217,200
1973/74	3,000	183,000	300	18,300	200	12,200	80	4,900	218,400
1974/75	3,000	183,000	300	18,300	200	12,200	100	6,100	219,600
1975/76	3,000	183,000	300	18,300	200	12,200	120	7,300	220,800

Note: The figures for rm. are rounded off from rft.

For the ADC of East Pakistan a much larger figure of planned tube-wells has been reported to us. After discussions with various other authorities concerned we came to the conclusion, however, that it might be more realistic to assume that only 100 to 200 tube-wells will be installed with fibre-glass piping material.

Our figures should be considered as a first approximation, serving as a basis for deciding whether a local production of epoxy resins might be feasible. The estimates for East Pakistan are much less certain than those for West Pakistan. In most cases we have been told that the East Pakistan figures for the period after 1970 are not yet available. Moreover, at the time of our interviews the question, whether in that Wing fibre-reinforced pipes would be used in future, had not been studied well enough. As a result, the authorities or firms interviewed could not state whether this material would in future be applied or not.

Since the fibre glass pipes so far have proved very useful in West Pakistan and since also in East Pakistan aggressive water seems to be fairly common, we have assumed that most of the pipes required by WAPDA, the Department of Public Health Engineering (DPHE) and the Agricultural Development Corporation (ADC) will consist of that material.

As the demand of East Pakistan apparently is fairly small the over-all figures will hardly be affected by the uncertainties of the data from the Eastern Wing Taking the above figures as basis, a manufacture of fibre glass pipes in Pakistan would require the amounts of uncured monomer which are shown below.

Table 52: Potential Demand of Epoxy-Base Pipes and Epoxy "Monomers" (in tons)

Year	Weight of Pipes	"Monomer" Content
1968/69	415	97
1969/70	444	104
1970/71	676	158
1971/72	678	159
1972/73	682	160
1973/74	685	160
1974/75	690	161
1975/76	693	162

The figures show that the demand for uncured epoxy resins for the pipe manufacture is fairly small. It is only about 100 to 160 tons per year.

5.2.6.5 Prices

The current c&f price for Epikote 828 packed in drums of approx. 200 kg is

1,585.00 $/ton

for Karachi or Chittagong.

Local prices are not quoted since the material is not used so far.

5.2.6.6 Recommendations

In view of the relative small amount of epoxy resin "monomer" required for the pipe manufacture it does not seem advisable to produce this type of resin in the near future. This opinion is supported by the fact that at least epichlorohydrin cannot be produced in Pakistan in the time to come. Since also the curing agents and the phenol component of bisphenol A would have to be imported, there is a little chance that a large proportion of the value added can be created within the country.

For the time being it is also not sure whether the pipes from epoxy resins will be manufactured in Pakistan. The manufacture involves a number of technical difficulties and requires therefore competent know-how. Moreover, from certain quarters within the country it is criticised that WAPDA is relying too heavily on glass fibre pipes although experience with this type of pipe is not very extensive. The degree of deterioration by ageing may be higher than expected. If local manufacture were started after all, it would be best to produce the uncured resin from imported raw material with the production equipment for alkyd resins.

5.3 Synthetic Fibres

5.3.1 Polyamide Fibres

5.3.1.1 General Characteristics

5.3.1.1.1 The Material

5.3.1.1.2 Application

5.3.1.2 Domestic Production

5.3.1.2.1 Existing Capacity

5.3.1.2.2 New Projects

5.3.1.2.3 Past Production

5.3.1.2.4 Problems of Domestic Production

5.3.1.3 Demand

5.3.1.3.1 Volume and Structure of Past Demand

5.3.1.3.2 Forecast of Consumption Trends

5.3.1.3.3 Consumers

5.3.1.4 Prices

5.3.1.5 Recommendations

5.3.1 Polyamide Fibres

5.3.1.1 General Characteristics

5.3.1.1.1 The Material

Polyamides (also called nylon) are thermoplastics produced by

- Polycondensation of higher w-amino acids (e.g. nylon 11)
- Polycondensation of dicarbonic acids with diamines (e.g. nylon 66 and nylon 610)
- Polymerization of lactams, e.g. ε-caprolactam (nylon 6).

In addition to these nylon types, a series of others are known which are of minor importance. In the Federal Republic of Germany nylon 12 is produced commercially, and nylon 7 in the USSR. Nylon 6 and nylon 66 are the most common types.

Though the various polyamide types show differences in individual properties, the characteristic properties are independent of the type. The only important difference between nylon 6 and nylon 66 is that the latter can be textured rather more easily; the temperature interval admissible for nylon 66 is slightly larger than for nylon 6.

It has often been pointed out that "nylon plants are the first synthetic fiber plants to be erected in newly developing countries. Such plants may be nylon 6 plants because that is perhaps the easiest polymer to make, particularly if monomeric caprolactam is purchased or even imported. ... (so) process simplicity plus the availability of several competing processes makes nylon 6 the material of choice". [1])

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[1]) Marshal Sitting, "Caprolactam and Higher Lactams", N.J. 1966.

Therefore, the further considerations in this section are confined to nylon 6.

The polymerization of caprolactam into nylon 6 is effected in the low-pressure kettle at high temperature and in the presence of catalysts. The product obtained, i.e. nylon chips, is then washed with water and thus cleaned of the monomers clinging to it. For the manufacture of textile fibres it is dried, melted in a spinning machine, extruded into the atmosphere by a spinneret, and then taken off and rolled up at high speed. As the take-off speed is much higher with small titres than with larger ones, the capacity of such a melt spinning plant is largely independent of the fibre thickness.

The yarn so obtained is subsequently stretched by 300 to 400 per cent, and thus is given stable physical properties. In that state it can either be processed as filament or as staple fibre.

5.3.1.1.2 Application

Polyamides are used mainly for the manufacture of synthetic textile fibres for

- Clothing (outer wear, ladies' stockings)
- Tyre cord
- Fishing nets
- Carpets/rugs.

But they are also employed in the plastics industry (e.g. as injection moulding compounds) or in the form of ribbons, films or monofilaments for the production of driving belts, conveyor belts, tennis strings, fishing-lines, etc.

Special advantages of polyamide fibres and of the finished products manufactured out of them are:

- Excellent tensile strength and extremely high abrasion resistance, superior to all other fibres
- High elasticity
- Good dyeability

Specific disadvantages are:

- Strong electrostatic charging
- Affinity to dirt and foil/fat
- Modest resistance to light, especially of delustred material
- High elongation at small drawing load, which makes processing difficult
- Slow elastic recovery
- Somewhat dead feel
- Products made of staple fibres show "pilling effect"

In Pakistan the bulk of the polyamides are used by the clothing industry as filament. In addition polyamides are used as

- Tyre cord for locally produced tyres
- Twine for fishing nets
- Guts for sports goods

The non-textile applications, however, account for less than 10 per cent of the consumption.

Potential applications might be bed-spreads, parachute ropes and fabrics, umbrella cloth, marine ropes, and tents. In the form of staple it could be blended with wool and cotton for work clothing, uniforms and the like. Textured yarn, which has practically no applications at present could be used for the manufacture of sportswear, swim-suits, stockings, and other articles.

5.3.1.2 Domestic Production

5.3.1.2.1 Existing Capacity

Four plants for the production of nylon 6 or nylon yarn already exist in Pakistan, one of them in East Pakistan and three in West Pakistan. Table 53 gives an outline of the individual units.

Table 53: Manufacturers of Nylon 6 and Nylon 6 Yarn

Name	Equipment	Polymerization Process	Required Raw Material	Present Capacity (t/y)
Fazal Nylon Ltd., Lyallpur	polymerization, melt spinning	batch	caprolactam	300 - 330
Pylon Industries Ltd., Chittagong	melt spinning	-	nylon chips	700

It is difficult to make an assessment of the further development of the market. Data are scarce because hardboard has only been produced in Pakistan since 1965/66.

A considerable increase in demand can only be achieved by

- improvement of quality, especially by using synthetic resin
- price reductions
- informing the consumers about all the possible applications and advantages of hardboard.

Interviews with the producers of hardboard about the use of PF glue showed that only Pakistan Hardboard Mills have made use of PF glue, consuming 40 tons annually. The remaining two producers stated that until now they have not used PF finishings for price reasons. They prefer to put up with the inferior quality of their products.

For the sake of quality Khulna Hardboard Mills are considering importing PF finishings from the beginning of 1969 onwards. They expect an initial demand of 55 tons per annum. If Khulna Hardboard Mills start to use PF resins it can be expected that Chittagong Board Mills will follow suit (perhaps 1970), to remain competitive in quality. Their requirements of PF resins can be estimated at 30 tons per year at the beginning. In this case Crescent Sugar Mills, too, will be bound to use PF resins when realizing their project at the beginning of the seventies. On the assumption of a 50 per cent capacity utilization, their requirements of PF resins will initially be about 150 tons.

cont. Table 53: Manufacturers of Nylon 6 and Nylon 6 Yarn

Name	Equipment	Polymerization Process	Required Raw Material	Present Capacity (t/y)
Dawood Industries Ltd., Karachi	polymerization, melt spinning	batch	caprolactam	1,000
Bengal Fibres Ltd. Karachi	polymerization, melt spinning	batch	caprolactam	1,000

The four firms and their development are briefly described in the following:

Fazal Nylon Mills Ltd., Lyallpur, was the first firm to start production of nylon yarn in Pakistan in 1965. During the starting phase only imported chips were processed; later on the polymerization of caprolactam was added. The present capacity of the polymerization unit is 1.1 tons per day, and that of the spinning unit for yarns is 1 ton per day. An expansion of the plant to 1,000 tons per year (textile yarn and twine) has been sanctioned, but cannot be implemented under the prevailing conditions; the main obstacle is that the sale of twine would meet with considerable difficulties (cf. 5.3.1.2.4). The spinning plants for the twine exist, but they are not in operation. Various types of guts for sports articles made in Sialkot make up a small part of the production.

The firm is making efforts also to sell chips as material for injection moulding, and expects that they will chiefly be used for the manufacture of gear wheels, bushes and the like. At present, however, yarn production is in full swing, so that there is little idle capacity at the polymerization plant for moulding compounds. Consumers consider the quality of Fazal's yarn to be good. The yarns and chips are marketed in West Pakistan only.

Pylon Industries Ltd., Chittagong started the production of yarn on the basis of imported nylon chips in 1966. The firm still has only a spinning plant and the associated stretching and coiling machines, the capacity of which was extended to 700 tons per year in 1967/68. A further enlargement of the capacity to 1,000 tons per year has been sanctioned; the sanctioned production programme covers yarn, tyre cord and twine, but up to now only yarn has been produced, some of which has been sold in East Pakistan, but the great majority in West Pakistan. The sales prospects for tyre cord are so unfavourable that its production is out of the question at present. It seems that the capacity of the firm is not fully utilised. More details could not be obtained on this matter, since the management of the firm did not respond either to verbal or to written inquiries.

Dawood Industries Ltd., Karachi put into operation a polymerization and yarn spinning plant with a capacity of 1,000 tons per year in July 1968. In the sanction 400 tons per year of this capacity were earmarked for yarn and 600 tons per year for tyre cord and twine. For the reasons already mentioned, however, the management of the firm does not intend to manufacture tyre cord and twine, but only yarn. They are waiting for a sanction for the necessary equipment changes, required above all for the stretching and coiling devices.

At the time of the interviews trial production had just been completed and normal production was starting. The management of the firm expects to find a market for its yarns mainly in West Pakistan.

Bengal Fibres Ltd., Karachi intended to start trial production of nylon-6 yarn on the basis of caprolactam in late 1968. The sanctioned capacity of the polymerization and melt spinning plant is 325 tons per year for textile yarn and 675 tons per year for twine and tyre cord. For the production of the latter articles the above statements apply, so that it can be assumed only textile yarns will be produced for some time.

The management of the firm is optimistic as regards the sales prospects: they expect that the plant will operate at 90 per cent of its capacity in 1969 and at full capacity from 1970.

5.3.1.2.2 New Projects

In addition to the sanctions for the expansion of existing enterprises, three firms were granted sanctions for the establishment of new polymerization and spinning plants. The data of these firms and the planned expansions of the existing plants are listed in table 54.

Table 54: New Sanctioned Capacities for Nylon Manufacture

<table>
<tr><th>N a m e</th><th>Wing</th><th colspan="3">Sanctioned Production Capacity Programme</th></tr>
<tr><td>Pakistan Nylon, Karachi</td><td>East Pakistan</td><td rowspan="3">each</td><td rowspan="3">textile yarn
tyre cord and twine</td><td rowspan="3">200 t/y
400 t/y</td></tr>
<tr><td>Ahmed Bros. Ltd., Karachi</td><td>East Pakistan</td></tr>
<tr><td>Chemical Fibres Ltd., Karachi</td><td>West Pakistan</td></tr>
<tr><td>Pylon Ind. Ltd., Chittagong</td><td>East Pakistan</td><td colspan="2">textile yarn
tyre cord and twine</td><td>300 t/y</td></tr>
<tr><td>Fazal Nylon Ltd., Lyallpur</td><td>West Pakistan</td><td colspan="2">textile yarn</td><td>670 t/y</td></tr>
</table>

The first two firms which received a sanction only for East Pakistan are no longer interested in implementing the projects. The reasons they give for their lack of interest are:

- Unfavourable prospects in the East Pakistan market
- Difficulty of transporting to West Pakistan
- Workers unqualified compared to West Pakistan, a handicap that cannot be offset by possibly lower wages
- Pakistan Nylon claims to have an organizational problem, too, since the firm is located in West Pakistan.

Chemical Fibres Ltd. are looking for a suitable foreign partner. This firm may also produce only textile yarn.

5.3.1.2.3 Past Production

As has been described, only textile yarn and guts have been produced so far. Chips served only as an intermediate product and thus are not considered separately. Guts made up about 2 per cent of the total production in 1968. The production figures are given in the table below.

Table 55: Production of Nylon Yarn and Guts, 1965 - 1968 (in tons)

	1965	1966	1967	1968 [1])
West Pakistan	25	170	150	730
East Pakistan	-	100	300	520
All Pakistan	25	270	450	1,250

[1]) Estimated on the basis of information given by the manufacturers

This table covers practically the entire production of polyamides in Pakistan. Applications other than yarn and guts have not yet been found by the local production.

In East Pakistan, production is based exclusively on imported chips, whereas in West Pakistan chips have not been imported since 1967.

While in East Pakistan Pylon Industries Ltd. are the sole producers, production in West Pakistan in 1968 is shared among

Fazal Nylon Mills Ltd. (45 %)
Dawood Industries Ltd. (27.5 %)
Bengal Fibres Ltd. (27.5 %).

The production figures for Dawood and Bengal can be considered only provisional, since Bengal, as already mentioned, had not yet started production at the period of the investigation, while Dawood had only just finished test production.

If Dawood and Bengal work at full capacity, Fazal's share will decline to only 15 per cent due to its small production plant.

Taking the provisional production figures for 1968 as the final ones, the rate of increase of production is 120 per cent per year in East Pakistan, 110 per cent in West Pakistan and 115 per cent in all Pakistan over the last two years. This high rate of increase is naturally only a consequence of the take-off effect after starting production.

5.3.1.2.4 Problems of Domestic Production

Thanks to protection by tariffs and Bonus Voucher imports and the heavy demand for nylon yarn, this industry profits from a favourable economic climate. Taxation of local industry, however, is considered too high. On imported caprolactam, for instance, fees totalling 43 per cent of the c & f value are charged. In addition, a sales tax of 20 per cent ad valorem and an excise duty of Rs. 11.- per kg are levied on locally manufactured nylon yarn. The resulting high prices for nylon yarn make nylon fabrics, even today, a kind of luxury commodity with a limited market. Naturally this has an effect on the manufacturing industry, which is unable to fully exploit its potential market.

A serious handicap to the nylon industry is the importation of twine for fishing nets by the Fishermen's Cooperative Societies. They can import twine from abroad and have to pay only custom duty and sales tax. Naturally the Pakistani producers cannot compete with these imports; evidently a sector of the economy that is important in terms of development policy is being promoted at the expense of nylon production.

The small capacities of the plants are a drawback, both with regard to the production costs and the foreign exchange to be raised. It is understendable that the Pakistan Government is eager to promote competition, but the establishment of four plants must have cost much more foreign exchange than would have been required if only two plants had been sanctioned.

According to information from manufacturers of such plants, the cost of a complete plant (i.e. polymerization, spinning machine, stretching equipment, take-up machine, air conditioning, chip drier) excluding the buildings with a capacity of 3,000 tons per year, is only about 60 per cent higher than that of a plant producing 1,000 tons per year. Moreover, with smaller units it is not economic to recover the monomers from the wash water of the chips, the loss of monomers, thus being up to 15 per cent compared with a maximum of 5 per cent if the water is treated.

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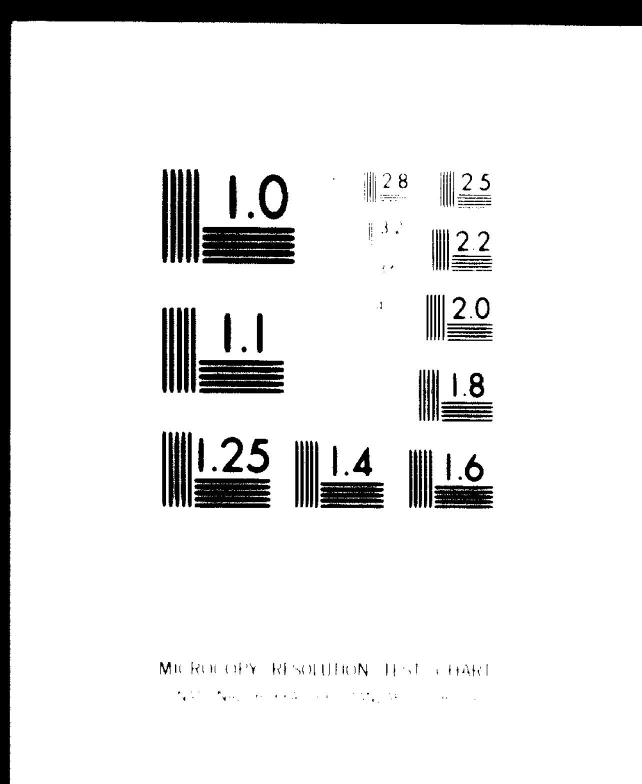

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fibres we think that a rate of increase of 15 per cent a year is realistic for West Pakistan if the Government does not take any measures. Only for East Pakistan do we take 20 per cent as a basis for our estimates, since there is a strong pent-up demand, and since substitution by polyester can be expected to begin later than in the Western Wing of the country.

A forecast based on the present consumption figures and on these values is given in the following table.

Table 60: Forecast of the Consumption of Nylon by Provinces and Sectors, 1969 - 1975 (in tons)

	West Pakistan				East Pakistan				All Pakistan			
	twine	cord	yarn	total	twine	cord	yarn	total	twine	cord	yarn	total
1969	150	20	4,320	4,490	120	-	170	290	270	20	4,490	4,780
1970	150	40	4,970	5,160	130	-	210	340	280	40	5,180	5,500
1971	160	40	5,720	5,920	140	-	250	390	300	40	5,970	6,310
1972	170	40	6,570	6,780	150	-	300	450	320	40	6.870	7,230
1973	180	40	7,570	7,790	170	-	360	530	350	40	7,930	8,320
1974	180	40	8,700	8,920	190	-	430	620	370	40	9,130	9,540
1975	190	40	10,000	10,230	200	-	520	720	390	40	10,520	10,950

Note: The figures do not include the cord consumption of the automobile tyre industry.

According to the results of the projection, the consumption will rise by about 163 per cent by 1975. The figures show, that the fishery industry will still account for only 4 per cent of the total demand by 1975. The same will probably apply to the tyre industry if the automobile tyre production is included. In other words, the textile sector will continue to account for by far the largest part of the consumption, i.e. about 96 per cent. A marked tendency towards regional concentration also appears to exist for the reasons mentioned. By 1975 presumably only 7 per cent of the total consumption of nylon fibres will be in East Pakistan.

In this connection it is interesting to mention a forecast on the basis of a regression analysis carried out by Farbwerke Hoechst on the development of textile fibre consumption. This regression analysis covers data from 70 countries on fibre consumption up to now (divided into cotton, wool, cellulosics, synthetics), past and predicted per-capita incomes, and population figures. Of the forecasts accessible to us, that of Hoechst used the largest amound of statistical material. We feel that this investigation sheds a good deal of hight on the development of world consumption as well as that of individual countries. The average values determined by Hoechst for the synthetic fibres sector (polyamides, polyester, PAN) in Pakistan are listed in the next table.

Table 61: Forecast by Hoechst of the Consumption of Synthetic Fibres in Pakistan

Year	Predicted Consumption in t
1969	5,600
1970	6,600
1971	8,600
1972	9,300
1973	11,800
1974	13,400
1975	15,400
1980	31,800

Hoechst expects that in Pakistan, too, the share of the polyamide fibres will decrease in favour of polyester and PAN. The result of our forecast, i.e. about 10,000 tons of nylon in 1975, is more or less confirmed by the figures of the Hoechst forecast.

5.3.1.3.3 Consumers

The most important consumers of nylon yarn are

in East Pakistan:

- Kerilin Silk Mills, Chittagong
- Royal Textile Industries, Chittagong

in West Pakistan:

- Karim Silk Mills, Karachi
- Sabina Ltd., Karachi
- M.M. Silk Mill, Karachi
- Dadabhoy Silk Mills, Karachi
- National Silk and Rayon Mills, Lyallpur
- Liberty Silk Mill, Karachi
- Iqbal Ltd., Karachi
- Abid Industrias, Karachi.

These 10 firms absorb 70 to 80 per cent of all nylon yarns produced.

5.3.1.4 Prices

The wholesale prices in Karachi for yarns produced in Pakistan are

40 to 60 Rs./kg
(40 to 15 deniar).

These prices include

20 % sales tax and
11 Rs./kg excise duty.

The total tax payable, including customs duties on caprolactam, thus comes to

34 to 42 % of the wholesale price.

For import, only yarns of substandard quality are admitted. Their present price c & f Karachi is

1.36 to 1.54 $/kg (40 to 20 denier).

The import charges are as follows:

250 % duty on c & f value
15 % sales tax on duty paid value
1 % rehabilitation tax on duty paid value
25 % defence surcharge on sales tax
170 % on c & f value for Bonus Voucher

If these figures are added up, it is found that the total charge for imported yarns is a remarkable

489 % on the c & f value.

The landed cost thus amounts to

38 to 43 Rs./kg.

Nylon twine is imported by the two Fishermen's Cooperative Societies duty free under foreign loan. The c & f price is 1.76 $/kg for Japanese twine (when available) and 2.64 $/kg for US twine.

The world market price for polyamides, which declined over a long period, steadied in 1968, and has recently shown a tendency to rise. This is attributed mainly to the big demand for textile floor coverings in the USA. Yarn manufacturers expect export prices to Pakistan to be some 10 per cent higher in 1969.

5.3.1.5 Recommendations

It is likely that by 1971 the existing capacities of 3,000 t/y, as well as the sanctioned capacities of at the moment 2,775 t/y, will be insufficient to meet the demand. It therefore seems reasonable to establish additional capacities. The future establishments, however, should no longer be very small plants.

Further details will be given in section 8.3.1.

5.3.2 Polyester Fibres

5.3.2.1 General Characteristics

5.3.2.2 Domestic Production

5.3.2.3 Demand

5.3.2.3.1 Volume and Structure of Past Demand

5.3.2.3.2 Problems of the Processing Industry

5.3.2.3.3 Forecast of Consumption Trends

5.3.2.4 Prices

5.3.2.5 Recommendations

5.3.2 Polyester Fibres

5.3.2.1 General Characteristics

As defined by the US Federal Trade Commission Rules, polyester fibres (PES) are long-chained synthetic polymers at least 85 % composed of the ester of a dihydric alcohol and terephthalic acid. Formerly raw materials were produced exclusively from ethylene glycol (EG) and dimethyl terephthalate (DMT), but for some years it has also been possible to start on the basis of glycol and terephthalic acid direct. Acid and alcohol esterify at increased temperature in the presence of catalysts. Starting from DMT, methanol of ca. 98 % purity is obtained, together with impurified ethylene glycol as a waste product. It is difficult to find further applications for the EG, but the methanol is of technical grade and is impurified virtually only by water.

In the production process chips are obtained which are washed, dried and extruded into the atmosphere by the melt spinning method. The resulting yarn then has to be stretched by 300 to 600 per cent and thus obtains stable physical properties.

Polyester fibres have a number of favourable qualities:

- high tensile strength
- elasticity
- high abrasion resistance (inferior only to that of nylon)
- light-fastness
- resistance to chemical substances
- heat resistance
- good dyeability

- low dirt affinity
- in fabrics little "synthetic feel" and good permeability to air
- very good compatibility in blending with cotton and wool

Thanks to these properties PES fibres have a broad range of applications in the textile industry. They are mostly processed into fabrics as staple fibres (71 % of the world production of PES) in blends with cotton, but also with wool and rayon. The usual proportion of PES in blends is 50 per cent with wool, 65 per cent with cotton, and 50 - 65 per cent with rayon. But polyesters are also widely used in the form of filament. All polyester fabrics are marked by very good wash and wear properties.

The following products are made of polyester:

- Polyester/cotton blends: Trousers, uniforms, suits, shirts
- Polyester/rayon blends: Uniforms, trousers
- Polyester/wool blends: Suits
- Polyester filament: Ladies' wear, shirts, curtains, underwear

The fibres can be spun and processed by most of the conventional machines, but the processing of pure polyester fibres or blends is in any case more difficult than the processing of pure cotton, for instance. It is especially important to maintain a specific yarn tension, since the elasticity of the fibres is higher than that of pure cotton. Much the same applies to wool/PES blends, although the tensile strength of the yarn is many times higher than that

5.3.1.3 Demand

5.3.1.3.1 Volume and Structure of Past Demand

The consumption of nylon in fibre form more than doubled in the course of only three years. It was 1,915 t in 1965 but rose to 4,170 t in 1968, representing an average rate of increase of 30 per cent for all sectors of consumption together. Sales, however, did not rise continuously, but made a leap of 120 per cent in 1966 and then remained more or less on that level (cf. table).

Table 56: Consumption of Polyamides, 1965 - 1968 (in tons)

		1965	1966	1967	1968
West Pakistan	twine	160	125	145	140
	cord	150	160	135	20
	yarn, guts	1,375	3,670	3,330	3,760
	total	1,685	3,955	3,610	3,920
East Pakistan	twine	100	140	190	105
	cord	-	-	-	-
	yarn	130	120	110	145
	total	230	260	300	250
All Pakistan	twine	260	265	335	245
	cord	150	160	135	20
	yarn, guts	1,505	3,790	3,440	3,905
	total	1,915	4,215	3,910	4,170

Note: The table indicates only the final consumption. Imported chips which are processed into nylon yarn are therefore not indicated separately. The consumption of chips as injection moulding material has been negligible so far. For 1968 it is indicated in section 5.1.7.
The 1968 figuresare estimated.

of pure wool. Thermofixing, sizing, dyeing, and finishing are also rather complicated and require a good deal of know-how if the products are to be of high quality This fact sometimes limits the applicability of PES fibres in developing countries

Compared with polyamide fibres, PES fibres have been but little used so far in Pakistan, though this fibre in blends with cotton should have particularly good sales prospects under the climatic conditions prevailing in the country

At present Pakistan produces suitings, popeline shirts, uniforms, and saris out of PES. In addition, considerable quantities of PES in the form of metallic effect yarns ("Lurex", "Lumiyarn") are used for ladies' wear (saris) [1)]

5.3.2.2 Domestic Production

Polyester fibres are not yet manufactured in Pakistan. No entrepreneur in Pakistan is known to be seriously interested in the production of PES fibres for the time being. Fateh Mohd. Ali Ltd., Karachi, had a sanction for the production of 7500 t/y of PES fibres from imported DMT and ethylene glycol. The project, however, has been dropped in the meantime. But there is at least one European firm that seems to be interested in the establishment of a plant for the production of polyester fibres in Pakistan.

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1) The production of effect yarn differs considerably from the described production of PES yarn, since cut foils are concerned.

5.3.2.3 Demand

5.3.2.3.1 Volume and Structure of Past Demand

Past consumption figures are listed in Table 62.

Table 62 Consumption of Polyester Fibres, 1965-1968 (in tons)

	1965	1966	1967	1968[1)]
East Pakistan				
effect yarn	10	10	10	10
West Pakistan				
staple fibre	20	50	30	30
filament yarn	80	110	50	50
blends (PES content only)	5	80	15	15
effect yarn	35	65	95	95
total	140	305	190	190
All Pakistan				
staple fibre	20	50	30	30
filament	80	110	50	50
blends (PES content only)	5	80	15	15
effect yarn	45	75	105	105
total	150	315	200	200

1) Expected consumption

As can be seen from this table, the consumption of polyester fibres in 1967 and 1968 comes to only about 200 tons per year, representing some 5 per cent of the consumption of polyamide fibres. The small scale of this consumption means that non-recurring orders of large organizations, such as the Defence Ministry, make a big impact, and the consumption figures are therefore subject to considerable fluctuations. The most widely used poyester products are still the metallic effect yarns, which have already about 70 per cent replaced the yarns of cellulose acetate that were always used in the past. In East Pakistan polyester is used only in this form as yet.

In 1967 about 90 per cent of the imports came from Japan (Toyo Rayon, Teijin), and the rest originated from the U.K. (ICI), the Federal Republic of Germany (Hoechst, Bayer, Glanzstoff), the Netherlands, and Italy.

About 60 per cent of the polyester staple fibres and yarn go to the cotton mills, such as

- Firdous Textile Mills, Karachi
- Lawrencepur Woollen & General Mills, Rawalpindi
- Star Textile Mills, Karachi
- Haroon Textile Mills, Karachi

The rest is distributed to a number of silk mills, which mainly produce saris on this basis, such as

- H.M. Silk Mills, Karachi
- Karim Silk Mills, Karachi
- Elite Silk Mills, Karachi
- National Art & Spinning Mills, Lyallpur.

5.3.2.3.2 Problems of the Processing Industry

The small consumption shows that the use of polyester fibres has hardly left the test stage Pakistan's textile industry possesses the machinery necessary for processing PES, both as filament and as staple, since this is possible in most cases on normal cotton machines The blending and spinning, which has to be carefully supervised, can only be done by good, efficient spinning mills (machinery is locally available). Such firms might be

- Star Textile Mills, Karachi
- Hussein Industries, Karachi
- Firdous Textile Mills, Karachi
- Dost Mahomed Cotton Mills, Karachi
- Rashid Textile Mills, Karachi
- Adamjee Cotton Mills, Karachi
- Kohinoor Textile Mills, Lyallpur.

Some firms already have concessions from European staple fibre manufacturers to use well-known brand-names for their products. But as the landed costs of the fibres are high, the mills have so far imported polyester only to a very limited extent. This is understandable, because the polyester fabrics produced in Pakistan face the competition of the local cotton articles, as well as of the Japanese fabrics which can be obtained on Bonus Voucher; both groups are much cheaper.

Thus, up to now no continuous production of PES/cotton fabrics has developed in Pakistan.

The market for polyester filaments is to a considerable extent the same as for nylon filaments. As the price of PES filaments is higher, nylon is usually preferred.

Besides, the yarns of substandard quality, the only ones whose importation is permitted, are said to have the following disadvantages, which naturally show up in the processing Variable denier, frequent knots, variable colours, dirtiness and variable cop weight.

5.3.2.3.3 Forecast of Consumption Trends

As is shown by the above statements, the actual consumption figures cannot be taken as a yard stick of the latent demand for polyester fibres. It is remarkable that both Pakistani and foreign experts expect that in the long run PES fibres will gain a market share of at least 50 per cent of the nylon consumption. There is, however, no indication of the date by which this share will be reached, which will depend very much on the availability of the fibres. In this situation the only instructive comparisons are those with other countries According to information obtained by us the consumption of polyester fibres in 1967 was 8,000 t in Turkey, 3,100 t in India and 8,000 t in Brazil. Reference to world production is also informative. The following table shows the world production of various synthetic fibres and their percentage of the total.

Table 63: World Production of Synthetic Fibres 1967

	Production in 1,000 tons	Share in production (in %)
Polyamides	1,320	45
Polyesters	770	27
Acrylics	550	19
Others	250	9
Total	2,890	100

This proves that the share of polyester fibres already amounts to more than 50 per cent of the polyamide share. This relationship will swing even more in favour of polyesters whose rate of increase in world production is at present 30 per cent per year whereas that of polyamides is only 10 per cent and that of acrylics 20 per cent per year.

As stated in 5.3.1.3.2. according to the analysis of Hoechst the demand for synthetic fibres will be about 15 000 t in 1975. If the fibres are available, consumption should be at this level. As we expect a consumption of about 10 000 t of nylon yarn for 1975, there remains about 5 000 t distributed among other fibres (polyester and acrylic fibres). As acrylics, however, can generally be replaced by polyester, a local production of polyester could cover this whole market, provided that it is protected by import restrictions. Acrylic fibres are certainly superior to polyester fibres in some fields of application, such as in the wool sector, but for climatic reasons this should not be of too much importance in the case of Pakistan. A replacement of polyester fibres by acrylics would not be possible to the same extent, because the latter are not as versatile.

On the basis of the figures of Farbwerke Hoechst and the demand for nylon yarn determined by us, it is possible to calculate the gaps that might be filled by another fibre. These figures are given in the following table.

Table 64: Expected Development of the Demand for Synthetic Fibres in Pakistan, 1969 - 1975 (in tons)

Year	Nylon Yarn	Polyester Yarn and Staple 1)	Total Demand for Synthetic Fibres
1969	4,400	1,200	5,600
1970	5,100	1,500	6,600
1971	5,800	2,800	8,600
1972	6,700	2,600	9,300
1973	7,700	4,100	11,800
1974	8,900	4,500	13,400
1975	10,300	5,100	15,400

1) Acrylics could also be used here in some cases.

It may be that polyester fibres will in some cases replace nylon yarn, e.g. in the sector of shirtings and suitings, which at present - according to Table 59 - together account for 35 per cent of the applications of nylon yarn. Naturally, nylon may equally well profit from the market for polyester fibres, if these are not available. Therefore, the figures in Table 64 indicate the maximum consumption. No doubt, an appropriate import and investment policy could prevent sufficient polyester fibres being available. It must be stressed once more that the coverage of this demand depends mainly on the availability of the fibres.

5.3.2.4 Prices

Continuous expansions of the capacities have resulted in continuous reductions in the prices of polyester fibres. As an example price trends for filament and staple fibre in three producer countries are indicated below:

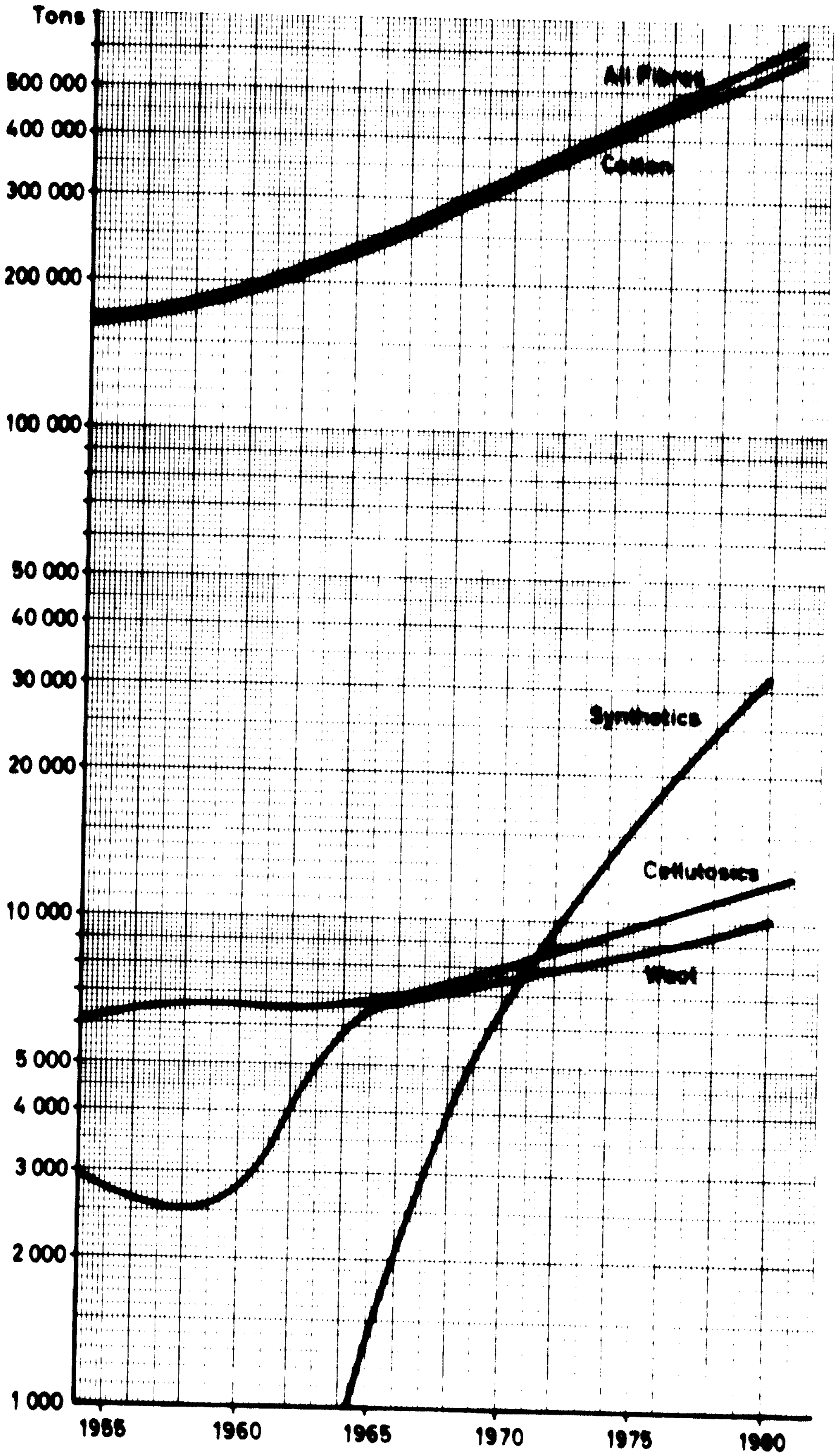

Figure 9: Trends in the Textile Fibres Consumption in Pakistan

Table 65: Price Development for Polyester Fibres, 1962 - 1968 (in $/kg)[1]

Year	Filament 100/36 den, semidull, in tubes			Staple Fibre 3 den, normal tenacity, semidull		
	West Germany	U.K.	USA	West Germany	U.K.	USA
1962	4.70	3.58	4.16	3.36	2.84	2.50
1963	3.98	3.58	3.84	3.36	2.84	2.50
1964	3.98	3.58	3.84	2.81	2.30	2.15
1965	3.96	3.58	3.84	2.81	2.04	1.85
1966	3.96	3.58	3.84	2.81	2.04	1.85
1967	..	3.58	3.58	2.15	1.52	1.58
1968	..	3.08	3.58	2.07	1.36	1.34

1) These are minimum quoted prices.

At present, however, the countries of the West cannot supply enough filament, owing to lack of capacities. Therefore, these countries hardly offer any filament yarn on the world market.

The world market price of filament yarn of 1st quality is between 2.75 and 4.15 $/kg depending on the denier number, shrinkage and twisting. For staple fibres the price on the world market is quoted as 1.10 to 1.40 $/kg. The higher price refers to branded goods and the lower price to non-branded ones, stimulated by Japanese competition. German producers, do not think that the export prices will continue to fall; they rather expect price increases of 10 to 20 per cent. But the domestic prices in Europe will go on falling.

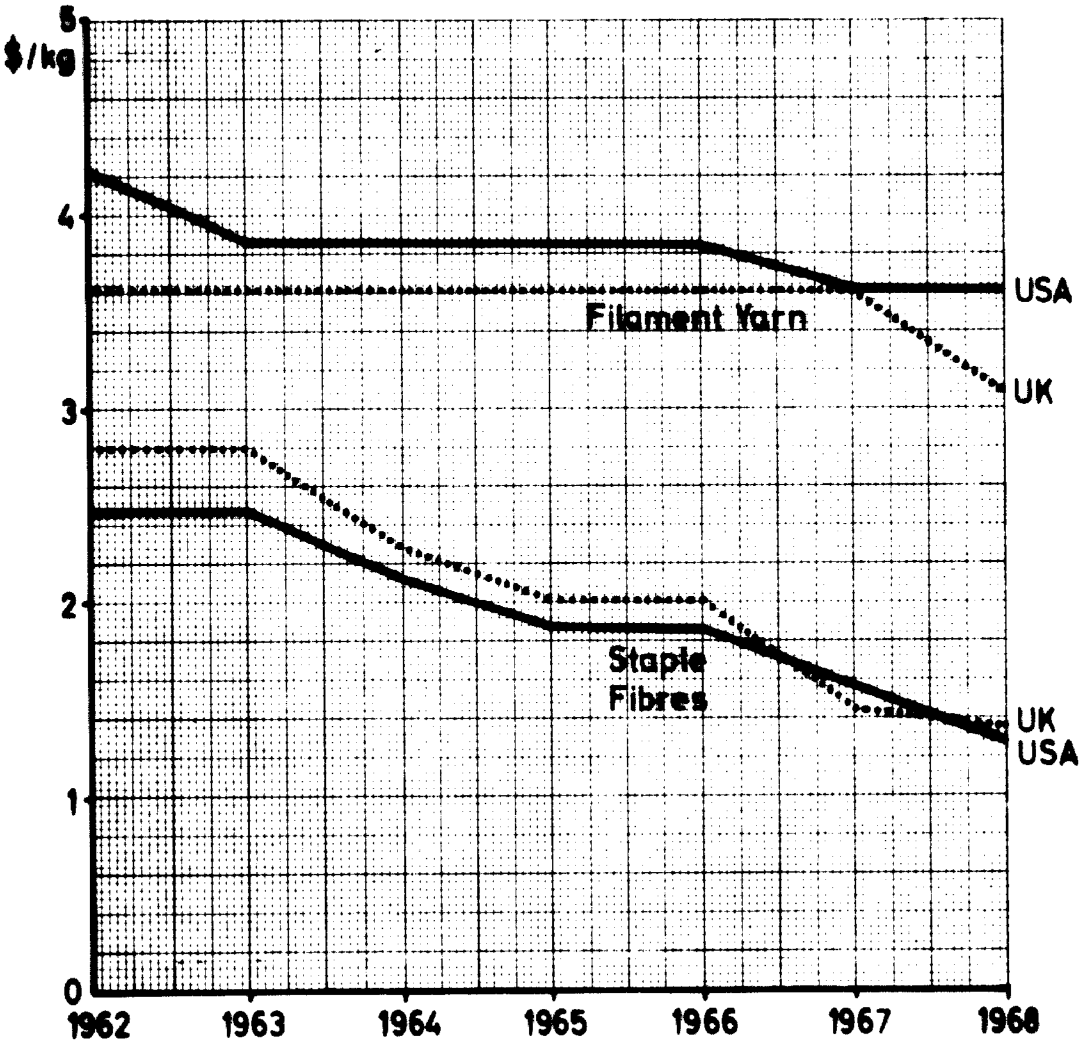

Figure 10: Development of Domestic Prices in the USA and UK for Polyester Filament Yarn and Staple Fibres

A comparison of the consumption in the two Wings of the country shows that in 1967 East Pakistan accounted for only 8 per cent of the total in terms of quantity. This is due mainly to differences in the consumption of yarn. Consumption is extremely small in East Pakistan, not simply because of the differences in income, but mainly because of the climatic conditions. Due to the interior water-absorbing qualities of nylon fibre it is less suitable for a hot and humid climate.

If the consumption of the two provinces and of Pakistan is shown as a percentage of the individual products, it becomes evident that the main item in the western part of the country is yarn and in the eastern part twine.

Table 57: Break-Down of the Consumption in 1967 according to Provinces

	twine	cord	yarn
West Pakistan	4 %	4 %	92 %
East Pakistan	63 %	-	37 %
All Pakistan	9 %	3 %	88 %

The instability in the development of demand is caused exclusively by the imports of ready-made yarns. Domestic production, however, has increased substantially, as mentioned, and the share of imports has declined accordingly. Nevertheless, they still account for about 70 % of the expected demand in 1968. This is due to the fact that the two newly established plants were put in operation only in mid and late 1968.

In Pakistan only yarn imports of substandard quality are permitted. The c&f price of Japanese twisted filament yarns of substandard quality is

1.54 to 2.20 $/kg (100 to 45 den).

The same taxes, duties, and Bonus Vouchers are levied on them as on nylon yarn, i.e. a total of

489 per cent on c&f value.

The landed costs thus are

43 to 62 Rs./kg.

The charges levied on staple fibres are

320 per cent on c&f value.

The landed costs of staple fibres are thus

20 to 28 Rs./kg.

5.3.2.5 Recommendations

It can be recommended to establish a plant for the production of polyester fibres. This plant should be designed for about 4,000 t/y. Such a plant in our opinion could be operating at full capacity by 1973/74.

It is recommendable to examine in a feasibility study whether such a plant should work on the basis of terephthalic acid or dimethyl terephthalate. If DMT is decided on,the methanol obtained could contribute to secure competition on this market.

Finally, we refer to the chapter "Substitutions", in which the various synthetic fibres and cotton are compared.

5.3.3 Acrylic Fibres

5.3.3.1 General Characteristics

5.3.3.1.1 The Material and its Production

5.3.3.1.2 Properties of Acrylic Fibres

5.3.3.2 Domestic Production

5.3.3.3 Demand

5.3.3.4 Prices

5.3.3.5 Recommendations

5.3.3 Acrylic Fibres

5.3.3.1 General Characteristics

5.3.3.1.1 The Material and its Production

Acrylic fibres is the name given to a class of chemical fibres obtained by straight-chain polymerization of a vinyl compound with at least 85 % by weight of acrylonitrile. Somewhat inaccurately, such fibres are often called "polyacrylonitrile fibres", though pure polyacrylonitrile fibres are very rarely produced.

The polymer is not meltable since it disintegrates before hand. Therefore, the fibre manufactured from it can be spun only by the dry or wet spinning process, for which dimethyl formamide is generally used as a solvent. After the spinning a 3 to 8-fold after-stretching is carried out, then the fibre is curled and mostly cut to staple fibres.

5.3.3.1.2 Properties of Acrylic Fibres

Acrylic fibres have some properties in which they are superior to the other two "great" fibres, polyamide and polyester. These are above all

- their excellent light and weather resistance
- their excellent dyeability
- low dirt affinity
- their relatively natural feel

The light resistance makes them especially suitable as curtain material, the good dyeability as material for fashion articles. Moreover, they have good chemical resistance and in fabrics good wear and tear properties, as well as excellent permeability to air. But in addition to these advantages they also have some real disadvantages, which restrict their application. These disadvantages are, above all,

- fairly small abrasion resistance
- tendency to "pilling"
- permanent deformation of textiles even with little stress in damp or wet and hot state

The most striking phenomenon about acrylic fibres is their similarity to wool. They are even superior to wool as regards

- warmth retention
- freedom from moths
- dyeability
- specific weight
- non-deformability
- quick drying after washing

Hence, acrylic fibres in staple form are applied in the same sectors as wool, either unblended or in blends with up to 30 % wool. These blends cover textiles for everyday use, such as

- worsted fabrics
- suits (e.g. tropical suits)
- blankets
- pullovers
- carpets
- embroidery yarns
- ladies' wear
- ties.

Acrylic fibre products are suitable for tropical clothing because of their high permeability to air, and the absorptive capacity of the fibres.

For the rest, it remains to be stated that only about 1 % of all acrylic fibres are used in filament form.

5.3.3.2 Domestic Production

Hyesons, Karachi, some years ago had a sanction for the manufacture of acrylic fibres. In the meantime the project has been cancelled.

It emerged from our investigation that at present no entrepreneur is definitely committed to establishing a production plant in the near future.

5.3.3.3 Demand

So far the application of acrylic fibres in Pakistan has been negligible, and possibly non-existent.

As other synthetic fibres are available, too, acrylics today are chiefly considered a substitute for wool. It therefore seems appropriate in this connection to make some statements on wool consumption in Pakistan and the utilizability of synthetic fibres.

According to information given by experts from Pakistan, the supply of good wool qualities is much too small. Accordingly, large quantities of wool, above all wool tops, are imported.

As early as 1965/66 the total value of the imports of various types of wool amounted to JS $ 4 million, in 1966/67 it was no less than US $ 5.2 million. Part of this wool, however, is used for the manufacture of hand-made carpets of good quality, most of them designed for export. For carpets of this quality a blend with synthetic fibres is probably out of the question for traditional reasons. The rest of the wool goes into the production of knitwear (pullovers, etc.) and worsted fabrics (suits, trousers). Here wool can partly be replaced by synthetic fibres. Acrylic fibres, however, are not well suited for the manufacture of suits, because of the low abrasion resistance. In this case polyester fibres would certainly be preferred if available. Thus, chiefly the sector of knitwear would remain for acrylic fibres.

In contrast to worsted, condensor yarn and semi-worsted is available in Pakistan in sufficient quantity. It is used for the manufacture of blankets and also carpets. Both products are exported in large quantities. Here, synthetic fibres could improve the quality in some cases but these fibres need not be acrylics.

Having considered all these factors and after discussions with manufacturers of fibres, it is our opinion that there will be a certain demand for synthetic wool substitutes in future. But we believe that it need not be acrylics that meet this demand. Polyester and even polyamide staple fibres can perfectly well be used as a wool substitute. If polyester fibres are locally available, they will certainly be a favourite material for the improvement or substitution of wool. Polyester fibres, thanks to their universal applicability and their properties, placing them between the polyamides and the acrylics, have displaced the latter from the second place in world production during the last few years.

5.3.3.4 Prices

In Germany the price of acrylic staple fibres today is 1.00 to 1.10 $/kg. In the USA it is 0.85 $/kg. Due to the constantly increasing capacities, the prices have been declining over the last few years. This development has now stopped. The German industry expects the prices for 1969 to be 10 % higher.

It was not possible to obtain information indicating at which prices fibre manufacturers would sell in Pakistan.

The tax on imported acrylic staple fibres would be

320 % on c & f value

just as in the case of polyester staple fibres.

5.3.3.5 Recommendations

The example of other developing countries (e.g. Turkey, India, Brazil) shows that the establishment of synthetic fibre production under the prevailing conditions generally follows the order: polyamides - polyesters - acrylics. This sequence is conditioned by

- simplicity of production
- availability of raw materials
- wide range of application of the fibres.

No reason was found to deviate from this rule in Pakistan. As polyester fibres are not yet locally available, we believe that the installation of capacities for acrylic fibre production is not recommendable for the moment. Polyester manufacture should develop first. A simultaneous production of both fibres would have unfavourable effects on the development prospects of both.

In our opinion the production of acrylic fibres should not be considered before the mid-seventies. It is advisable, however, to investigate the whole problem in a separate study after prior observation of the development of the polyester fibre industry over a period of several years.

5.3.4 Polypropylene Fibres

Polypropylene can also be used for producing fibres by melt spinning. The manufacture is analogous to that of nylon fibres from nylon chips.

The advantages of polypropylene fibres are:

- low specific gravity (0.91)
- good tensile strength
- good abrasion resistance
- especially good resistance to chemical and biological influences
- good weather resistance
- low dirt affinity
- in machine-made carpets, no soiling by the natural dyestuffs in the jute
- low price

The disadvantages are:

- bad dyeability
- low melting point
- problem of the resilience of carpets

The tensile strength of polypropylene fibres is comparable to that of nylon and polyester fibres. The price is nearly the same as that of nylon. Processed with cotton, the polypropylene staple fibres show stronger filling and warmth retention than polyester/cotton fabrics, and they can be used in much the same manner. Their bad dyeability restricts their use in the field of textiles, while their low melting point (160^{o} C) excludes their use altogether in several technical fields.

Table 58: Consumption of Imported and Locally Produced Nylon Yarn, Twine and Guts, 1965 - 1968

	1965	1966	1967	1968
Local production	1 %	6 %	11 %	30 %
Imports	99 %	94 %	89 %	70 %

The following can be said about the individual sectors of consumption:

Twine is used solely for the manufacture of fishing nets. Consumption is very small compared to the sanctioned capacities for local production of twine. The fishing nets produced on this basis are knotted by hand.

Twine is imported mainly by

- East Pakistan Provincial Fishermen's Cooperative Society, Chittagong,

- Karachi Fishermen's Cooperative Society, Karachi

which sell some of the imported twine to other fishermen's societies and to private fishermen. As stated by the Marine Fisheries Department, Karachi, the bulk of the nets in West Pakistan are already of nylon. In East Pakistan only the fishermen's societies use nylon nets exclusively. Most of the landings in this wing, however, are not brought in by private or official fishermen's societies but by individual fishermen for the supply of the villages.

Due to their low specific gravity (lighter than water) polypropylene fibres are very suitable for hawsers. They are also used for:

- fishing nets, cables, bags
- working clothes, decoration material
- filters
- ground material for carpets
- in blends with wool or cotton: underwear, blankets, articles for babies.

Today polypropylene fibres are next to nylon, polyester and acrylic fibres the most widely used fully synthetic fibres. They are, however, utilized predominantly in special fields; in Europe today approximately 50 % of all polypropylene fibres are used as wavy groundmass for carpets.

During the last two or three years, a substitution process has been in progress in the jute-sisal-coco fibres processing industry as well. The natural fibres are being replaced by cut polyolefine foils, the so-called split fibres, made of polypropylene and low-pressure polyethylene and having competitive prices. Polyethylene has a "softer", more textile character, while polypropylene is more suitable where roughness is a desirable feature of the material, as with bags designed for piling up without sliding.

Several producers are of the opinion that within a few years the polyolefin split fibres will have largely replaced the natural hard fibres like jute, sisal and coco fibres in industrial countries. The jute-producing countries, therefore, will leave to take special marketing measures today, in order to develop new markets and applications for jute.

In Pakistan polypropylene fibres have scarcely been used so far, and we did not observe any special conditions which would make polypropylene fibres superior to other synthetic fibres like nylon, polyester and acrylics in Pakistan. There is in our opinion no market for non-textile utilization (as a substitute for hard fibres, fishing nets) in Pakistan because of the availability of jute and nylon.

The production of polypropylene fibres in Pakistan therefore cannot be recommended in the near future.

5.4 Elastomers

5.4.1 General Remarks on Properties, Application and Production

Elastomers are materials which

- can be expanded to several times their original length by pulling them at low energy
- have a high tensile strength even in the expanded state
- can contract quickly to their original length.

Elastomers which consist of long polymer chains are devided into

- Natural and
- Synthetic rubber.

Although natural rubber is not covered by the present investigation, it has to be discussed to some extent in this context because there is a high degree of substitution of synthetic for natural rubber.

5.4.1.1 Natural Rubber

Crude rubber is obtained by coagulating the latex by means of appropriate agents. The rubber substance is then dried by smoking or the crepe-rubber process. Natural rubber is traded as

- Latex
- Crude rubber
  - -- Ribbed smoked sheet
  - -- Crêpe rubber

Natural rubber, still one of the most important raw materials of our time, is used up to 65 per cent in the tyre industry. There is a very keen competition in prices and quality between natural and synthetic rubber. Still, natural rubber has not been replaced and is expected to keep its position on the world market also in the future.

Apart form the production of tyres and tubes, natural rubber is used in compact form for the production of

- ~~many~~ technical rubber articles
- driving belts, conveying belts
- shoes, rubber slippers, soles
- toys.

5.4.1.2 Latex

Stabilised latex with 60 per cent rubber content is mainly used for the production of foam rubber.

Further fields of application are rubber articles produced by dipping:

- hygienic articles
- sports goods
- balloons

5.4.1.3 Synthetic Rubber

Synthetic rubber is a development of the war. Originally it was produced mainly to be independent of remote raw material sources. In the meantime, however, the substitute has covered the largest part of the market on a world average. In many cases low prices and better technical properties have been decisive a factor. The synthetic rubber especially has one advantage compared with natural rubber: there are a number of different kinds which have special desired properties and therefore often are preferred to the natural product in different fields of application.

The importance of the individual synthetic rubbers is shown in Table 66.

Table 66: World Production of the Most Important Types of Synthetic Rubber (in 1,000 tons)

	1962	1970
SBR	2,812	4,237
Cis-polybutadiene	145	978
Cis-polyisoprene	40	492
Ethylene-propylene terpolymers	2	134
Butyl rubber	236	409
Neoprene	208	403
Nitrile rubber	167	269

Source: "Rubber, Asbestos, Plastics", 1/1968

We note that SBR in 1970 still will take the largest share in the total consumption of synthetic rubbers. A rapid increase in production is expected especially with regard to stereospecific types of rubber and the ethylene-propylene terpolymers.

It is interesting to compare the presumable use of natural and synthetic rubber in the future. In 1970 the world synthesis capacity will total 7 million tons. This figure exceeds the expected production volume of natural rubber by more than 100 per cent.

Properties and chemical composition of the synthetic rubber lead to specific applications in the industry, for example:

- car tyres (SBR)
- inner tubes (butyl rubber)
- paints (chlorinated rubber)
- oil hoses (nitrile rubber)

It would exceed the scope of this study to state all ranges of synthetic rubber application.

5.4.1.4 Rubber Compound

In order to save the manufacurers of certain rubber from the trouble of mixing which does not only require technical equipment but also extensive know-how, there are standardised rubber compounds available on the market. These blenda are of different compoaitions.

Rubber ompounds are used above all in the tyre industry and for tyre retreading. Only small quantitiea are used for the production of special rubber articles such as battery boxes.

5.4.2 Domestic Production

At present there is no production of any synthetic rubber in Pakistan. The production of SBR has been discuased and studied but no final plans have come to the knowledge of Battelle.

Since 1961 the East Pakistan Forest Industries Development Corporation has been operating trial plantation near

- Raozan (Chittagong): 730 ha
- Ramu (Cox's Bazar): 485 ha
- Batthere (Sylhet): 405 ha

These plantation have proved to be very successful. A considerable expansion is therfore planned. The yield is so far very low; it amounts to 16 tons in 1968/69.

5.4.3 Demand

5.4.3.1 Volume and Structure of Past Demand

5.4.3.1.1 Natural Rubber

The consumption of natural rubber in solid form increases every year in Pakistan. The demand originates from goods for the home market and from export items. The following articles should be mentioned here:

- bicycle tyres and tubes
- conveyor belts
- sports goods
- shoes and rubber sandals.

The present consumption of solid natural rubber in Pakistan amounts to 10,270 tons/year; the share of West Pakistan is 88 per cent. The composition of this consumption is shown in the following table.

Table 67: Consumption of Natural Rubber in Pakistan 1965/66 and 1967/68 [1] (in tons)

Year	West Pakistan	East Pakistan	Total
1965/66	7,500	1,000	8,500
1966/67	8,400	1,150	9,550
1967/68	9,037	1,238	10,275

1) Including production of car and truck tyres

As can be seen form the table, there have been no great changes in the demand for rubber during the last few years. Production increases in the tyre and shoe industry were decisive in leading to a rising rubber consumption. General Tyre & Rubber Co. has reached its peak production in 1966/67 causing on irregular rise in the overall consumption of rubber.

A break-down of the present consumption of natural rubber shows that the production of footwear totalling 53 per cent has the largest share in the total demand. This is followed by tyres with 25 per cent and technical rubber articles with 13 per cent.

Table 68: Break-down of Natural Rubber Consumption by Sectors in Pakistan, 1967/68

Sector	West Pakistan (%)	East Pakistan (%)	All Pakistan (%)
Tyres and tubes	27	10	25
Shoes, soles and sandals	54	45	52
Technical rubber articles	12	22	13
Sports goods	1	-	1
Belts	3	-	3
Hose pipes	3	1	3
Upholstery material	-	22	3

Like other industrial sectors, the tyre industry started its development after the country had become independent, first manufacturing bicycle tubes and tyres. In line with the increasing motorisation the production of tyres for passenger cars and lorries was taken up in 1965. Tyres for scooters have only been produced since 1967.

The term technical rubber articles as used in the table refers to products like: rubber bands, rubber gaskets, sleeves, vibration and shock absorbers.

The upholstery material referred to in the table is a porous vulcanised mat consisting of thin rubber threads. Its trade-name is "Fibriflex". It can be readily cut - similar to foam rubber - to give parts of any shape. The only producers are Rahimani Industries Ltd., Chittagong.

The most important country supplying natural rubber to Pakistan is Malaysia.

These fishermen use only a limited amount of nylon, and much more hemp and cotton. The reasons are

- Ignorance of the material and its advantages
- Comparatively high purchase price
- Availability of the natural fibres
- Non-availability of nylon twine outside Dacca and Chittagong.

The fact that the nylon twine is virtually unavailable outside the large towns of East Pakistan is a special handicap, since the major part of the fish landings come from inland waters.

It is remarkable that the only manufacturer of mechanically knotted nets in Pakistan (Pakistan Rope Works, Chittagong) processes only natural fibres. The firm is not thinking of changing over to the processing of synthetic fibres in the near future.

Tyre Cord

The only consumer of tyre cord up to 1967 was General Tyre and Rubber Co., Karachi. This enterprise used nylon cord for the manufacture of automobile tyres. For scooter and bicycle tyres cotton cord is used. Since February, 1968 the plant has been idle, however. It is not known at what date production will be started again. For the rest, the statements made in section 5.4 apply in this case, too.

Since 1968 the Pakistan Belting Co., Lahore, has also been processing imported nylon cord into driving belts and conveyor belts.

Far less important as suppliers of natural rubber are

- Indonesia
- Thailand
- Ceylon.

5.4.3.1.2 Latex

The consumption of latex in Pakistan totalled 745,000 l in 1967/68. West Pakistan processed 82 per cent and East Pakistan 18 per cent.

This consumption by sectors is shown in the following table.

Table 69: Break-down of Latex Consumption by Sectors in Pakistan in 1967/68

Sector	West Pakistan (%)	East Pakistan (%)	All Pakistan (%)
Foam rubber	60	87	65
Sports goods	30	-	24
Hygienic articles Balloons etc.	10	13	11

According to a detailed survey among the latex processing industry no increase in production is expected in the near future because of the lack of sales outline. Partly the market is also restricted on account of inferior quality of the products. This is the case, for example with football bladders and some technical rubber items which are preferably imported. At present the installed capacities are utilised to only 50 or 60 per cent.

It should be noted that synthetic polyurethane foam is gradually replacing foam rubber. This material is cheaper and has better qualities. Its market share is steadily increasing not only in the industrialised countries but also in Pakistan [1].

5.4.3.1.3 Synthetic Rubber

The consumption of synthetic rubber in Pakistan has not only depended on its advantageous applications in the different fields but has also been determined by the import policy of the Government. The present consumption of synthetic rubber in Pakistan amounts to 2,500 tons per year; West Pakistan has a share of 96 per cent.

Table 70: Synthetic Rubber Consumption [*] in Pakistan, 1965/66 - 1967/68 (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1965/66	2,100	100	2,200
1966/67	2,370	110	2,480
1967/68	2,395	122	2,517

[*] Including tyres for passenger cars and lorries.

West Pakistan has shown an irregular increase in consumption of synthetic rubber during the last two years (13 and 1 per cent). This can be attributed to the production peak of General Tyre & Rubber Co. After a decrease of 20 per cent in 1967 the production of tyres for passenger cars and lorries was completely stopped early in 1968.

[1] See section 5.2.4

The other consumers of synthetic rubber in West and East Pakistan are the shoe industry, the technical rubber goods industry and the scooter tyres sector. A break-down into sectors shows the demand for 1967/68.

Table 71: Break-down of the Synthetic Rubber Consumption in Pakistan in 1967/68

Sector	West Pakistan (%)	East Pakistan (%)	All Pakistan (%)
Tyres	8	6	8
Shoes, soles, sandals	71	77	71
Technical rubber items	16	8	16
Belting, Tubes etc.	5	-	5
Upholstery material	-	9	-

Similar to natural rubber, the synthetic rubber is mainly used in the shoe industry, where it is mixed to the compound in small quantities in order to increase the resistance to abrasion. In line with the enlargement and setting up of a tyre industry the emphasis of synthetic rubber consumption however will gradually shift to that industrial sector.

The technical rubber articles, depending on their use, contain additions of synthetic rubber or do not contain any natural rubber at all.

In Pakistan SBR has a share of 96 per cent in the demand in terms of quantity. Other kinds like

- Chloroprene
- Neoprene
- Nitrile rubber

are used only in small quantities for special items and can therefore be neglected in the consumption forecast.

The main suppliers of synthetic rubber to Pakistan are:

- West Germany (Buna-Werke Huels and Bayer)
- England (ICI)
- USA/Holland (Shell Chemicals)

5.4.3.1.4 Rubber Compound

Because of the increasing motorisation the retreading industry for tyres of passenger cars and lorries has developed favourably during the last few years. That industry is the major consumer of rubber compound. The present demand for rubber compound in Pakistan is 543 tons per year:

- West Pakistan 410 tons
- East Pakistan 133 tons

Table 72: Break-down of the Consumption of Rubber Compound in Pakistan

Sector	West Pakistan (%)	East Pakistan (%)	All Pakistan (%)
Tyre retreading	76	100	82
Battery boxes	24	-	18

Corresponding to the further increase in the number of passenger cars and lorries and thus in the demand for tyres also the retreating industry for the production of cheaper spare tyres is expected to expand significantly. In the following discussions the small quantities of natural and synthetic rubber contained in compound, are considered under "Manufacture of Tyres for Passenger Cars and Lorries".

At present the rubber compound is imported from different countries in small quantities. It may be assumed that in the course of the development of the tyres industry the compound for retreading purposes will be produced in Pakistan. A development of this type would be highly desirable because the production of rubber compounds would be rationalized and the overall quality of the compound could be improved. The application of rubber compounds would have special advantages if smaller firms producing bicycle tyres and shoe soles were making use of it.

5.4.3.2 Forecast of Consumption Trends

5.4.3.2.1 Demand in West Pakistan

Car Tyres

The most important single consumer of natural rubber and rubber auxiliaries, the General Tyre & Rubber Co. (GTR) closed down early in 1968. In this way the firm is showing its opposition to the high Government taxes on raw materials and the comparatively less expensive imports of tyres. GTR also regards the import allotment of rubber by the Trading Corporation of Pakistan Ltd. as an essential obstacle. The firm intends to resume production only if it is sure to work at a sufficiently high utilisation of its capacities and if import stop is granted for the tyre sizes manufactured. The company has filed an application for this type of protection.

At full capacity utilisation the firm would have the following rubber requirements per year

- about 2,000 tons of natural rubber
- about 1,000 tons of synthetic rubber.

Since at the time of investigations it was not possible to find out when and to what extent the General Tyre & Rubber Co. will start its production again, the production of tyres for passenger cars and lorries is treated separately for estimating the future rubber requirements (see Table 77).

Scooter Tyres

The production of scooter tyres and tubes which has only been started in 1967 will develop rapidly because of the relatively great demand and with the help of import stops granted by the Government. Especially the motor rikshaws(mini cabs) which are partly used for day and night drives have a high wear and tear of tyres. But also the two-wheeled scooters which are very popular in Pakistan, will increase the future demand for scooter tyres. The annual demand amounts to 60,000 to 70,000 tyres, of which according to statements of producers about 60 to 70 per cent were imported at the time of investigation. It is to be expected that these imports will very soon be replaced entirely by home production. According to the two producers

- Master Tyre & Rubber Co.
- National Tyre & Rubber Co

it is likely that their installed capacity will fully be used in 1970 and that at the same time the demand of the home market will be met by these two companies.

According to reliable information, the Municipal Corporations of Karachi and Lahore intend to prohibit the use of motor rikshaws because in the increasing traffic density in the big cities they are too dangerous as means of transportation for passengers. Therefore, during the next few years the vehicles which are now in use will probably shift over to middle and small towns of West Pakistan, similar to the development in Lyallpur and Multan.

As motor rikshas are not only a convenient but also a not very expensive means of transportation for the majority of the population, we do not believe that the number of these vehicles will decrease considerably by withdrawing them from service in Karachi and Lahore. It is more likely that their number will decrease slowly in the course of the next 5 or 10 years. On the other hand, it might be possible that the motor rikshaws will enjoy great popularity in the provincial towns of West Pakistan in future. In this case the number of rikshaws would increase and consequently the consumption of tyres as well. But we consider this latter case unlikely because

- the average income in the provincial towns is smaller than in Karachi and Lahore and is not expected to increase so quickly
- the road conditions are less favourable
- these towns presumably will not severely restrict the traffic of horse carts (tongas) in the near future so that other inexpensive means of transportation are availabls
- the working and living conditions do not require fast means of transportation as they are necessary in the modern business centrs of Lahore and Karachi.

In general the two-wheeled scooters have a high rate of increase (about 11 per cent). They are very popular in the warm nearly rainless zones of the country. Their consumption of tyres is however much smaller compared to mini-cabs not only because they have only two wheels but also because the mileage of mini-cabs is very high.

Taking these two aspects into consideration we are of the opinion that in the circumstances considered here an average growth rate of 2 per cent is adequate for the period 1971 to 1975.

Bicycle Tyres

During the last ten years the sector of bicycle tube and tyres showed an annual production increase of 10 per cent. From this past rate of increase it seems that the demand for bicycles is very strong among the population of Pakistan. Infact, according to our estimates, there are only 5 to 10 bicycles per 1,000 inhabitants. The urgent desire of the Pakistani population to own a bicycle is due to the fact that the cycle is not only the universal means of transportation of the "little man" but also the cheapest one. This situation suggests that the lower income classes will continue to strive for the possession of a bicycle in the future. This will depend on the increase of their income. The latter is again closely related to the growth of the national income. Based on the assumption that the future rise in national income will be equal to that of the last years, the future demand for tyres is estimated to increase at a rate of 10 per cent.

Footwear

Owing to the higher standard of living and the different climatic conditions, the leather industry has developed much more quickly in West Pakistan than in the Eastern Wing. It is expected that footwear industry will continue to expand substantially also in future. The industry supplying rubber soles will develop at a similar rate. Compared with East Pakistan rubber sandals and athletic shoes are not only manufactured for the home market but also for the export. According to statements of producers they are able to compete with Japan in East Africa, the Middle East and alledgedly also on European markets. The annual growth rate for shoes, sandals, soles and heels calculated for the past amounted to 5,5 per cent. The producers expect similar growth rates for the future. Therefore we base our forecast on that rate.

Rubber Articles

All rubber articles except those produced from latex [1] are summarised under technical rubber articles. They are mostly produced by the small industries which develop differently. The annual average growth rate of the past has been calculated at 7 per cent. Also in this case it will approximately remain constant according to the manufacturers.

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1) For latex articles see chapter 5.4.3.4

Table 73: **Estimated Future Demand for Natural Rubber in West Pakistan by Sectors, 1967/68 - 1975/76**

(in tons)

Year	Bicycle Tyres	Scooter Tyres	Shoes Sandals Soles	Technical Rubber Articles 1)	Total 2)
1967/68	2,015	35	6,715	2,260	11,025
1968/69	2,200	70	7,100	2,420	11,790
1969/70	2,420	100	7,500	2,580	12,600
1970/71	2,670	130	7,900	2,760	13,460
1971/72	2,940	140	8,340	2,940	14,360
1972/73	3,240	140	8,800	3,140	15,320
1973/74	3,560	150	9,300	3,360	16,370
1974/75	3,920	150	9,800	3,600	17,470
1975/76	4,320	150	10,200	3,850	18,520

1) The figures do not include products manufactured from latex.

2) Without car tyres.

According to Table 73, the rubber consumption in total shows an annual increase of about

6.7 per cent

Table 74 summarises the estimated future overall consumption of

- natural rubber and
- synthetic rubber.

The firm uses the nylon cord only for export qualities, though. The belts sold in the country (which account for only 10 per cent of the production) are still being produced on a rayon and cotton basis.

Textile Industry

The textile industry, centred on Karachi, consumes the majority of the nylon. As shown in table 59, fabrics for ladies' wear and saris make up the major part of the manufacturing programme of the nylon textiles industry.

Table 59: Approximate Break-Down of the Application of Nylon Yarn in the Textile Industry in 1967/68

Fabrics for ladies' wear, saris	60 %
Shirt cloth, pure or blended with artificial silk	20 %
Suitings	15 %
Other (curtains for export, hosiery, etc.)	5 %
Total:	100 %

According to information obtained from yarn and machine importers, about half of these nylon articles, mostly saris and fabrics and more recently also ready-made shirts, are exported to a number of different countries. Substantial quantities are sent to Singapore, the states on the Persian Gulf, and England. Exports of textiles made from synthetic fibres, however, come to only about 10 per cent of total textile exports; the rest is mainly made up of cotton products.

Table 74: Estimated Future Demand for Natural and Synthetic Rubber in West Pakistan, 1967/68 - 1975/76 (in tons)

Period	Natural Rubber	Synthetic Rubber	Total
1967/68	8,630	2,395	11,025
1968/69	9,250	2,540	11,790
1969/70	9,920	2,680	12,600
1970/71	10,630	2,830	13,460
1971/72	11,340	3,020	14,360
1972/73	12,100	3,220	15,320
1973/74	12,970	3,400	16,370
1974/75	13,830	3,640	17,470
1975/76	14,700	3,820	18,520

As bicycle tyres and all types of tubes are only made from natural rubber in Pakistan with no substantial chance of this situation expected for the future, natural rubber will show a greater growth rate than synthetic rubber. Natural rubber consumption is expected to increase by about 7 per cent, while synthetic rubber will increase at a rate of about 6 per cent per year. Thus the share of natural rubber of 78.5 per cent in 1968 will increase to 79.5 per cent in 1975/76.

5.4.3.2.2 **Demand in East Pakistan**

Scooter Tyres

The production of scooter tyres and tubes was started in 1967. The two producers

- Karim Rubber Industries, Ltd., Fatullah
- Bux Rubber Industries Ltd., Mirpur

expect their capacity to be fully utilised in 1970 and this will cover the demand almost completely. In line with increasing motorisation, a further growth rate of 10 per cent may be expected.

Bicycle Tyres

Bicycly tyres and tubes have shown an average increase of 17 per cent during the last decade. The most important consumers are the bicycle rikshas because in the narrow and overcrowded streets of the cities they are a means of transportation which is nearly as fast as motor vehicles. The bicycle rikshas probably will continue to dominate in the streets for some time because town planning in the old parts of the cities is making slow progress. We therefore expect that the number of rikshas will increase approximately to the same extent as the growth of the larger towns and cities. The most important cities are Dacca, Chittagong, Narayanganj and Khulna. They have on the whole an annual population increase of 5 per cent. Another factor which is even more important for the rise in bicycle tyre manufacture is the substitution of supplies from West Pakistan. Considering these factors we expect a growth rate of 17 per cent also for the future.

Table 75: Estimated Future Demand for Natural Rubber in East Pakistan by Sectors, 1967/68 - 1975/76 (in tons)

Year	Bicycle Tyres	Scooter Tyres	Shoes Sandals Soles	Technical Rubber Articles 1)	Upholst. Material	Total 2)
1967/68	100	30	650	270	310	1,360
1968/69	120	50	680	290	330	1,470
1969/70	140	70	720	310	340	1,580
1970/71	160	90	750	330	360	1,690
1971/72	190	100	790	350	380	1,810
1972/73	220	110	830	380	400	1,940
1973/74	260	120	870	400	420	2,070
1974/75	300	130	910	430	440	2,210
1975/76	350	150	960	460	460	2,380

1) Without products made of latex

2) Without production of car and truck tyres and tubes

Footwear

In West Pakistan and also in The Eastern Wing the shoe industry has so far been the most important consumer of natural and synthetic rubber. Rubber shoes are however losing their market share to PVC shoes because PVC shoes are easier to produce and at a lower price and also have a longer life time. On the other hand, sponge sandals have prevailed over PVC sandals because of their comfort. Owing to the climatic conditions the leather shoe industry is developing at a low rate. This affects the supply of rubber soles and heels. Although more than half of the population is not in the possession of shoes, the annual growth rate does not exceed 5 per cent on account of the low national income.

<u>Upholstery Material</u>

FIBRIFLEX supplied by Rahmani Industries Ltd. in Chittagong according to statements of the directors are said to have an annual increase in consumption of 5 per cent.

<u>Technical Rubber Articles</u>

Technical rubber articles such as gaskets, bands, mats and hard rubber items, showed different rates of increase during the last few years. Interviews of producers and dealers revealed an approximate average growth rate of 7 per cent for the technical rubber articles.

An evaluation of the consumption figures of table 75 results in an estimated annual growth rate of somewhat above 7 per cent for the future total rubber consumption in East Pakistan.

In table 76 the total consumption is shown separately for

- natural rubber
- synthetic rubber

as has been the case with the rubber consumption in West Pakistan.

Table 76: Estimated Future Demand for Natural and Synthetic Rubber in East Pakistan, 1967/68 - 1975/76 (in tons)

Time	Natural Rubber	Synthetic Rubber	Total
1967/68	1,238	122	1,360
1968/69	1,340	130	1,470
1969/70	1,440	140	1,580
1970/71	1,540	150	1,690
1971/72	1,650	160	1,810
1972/73	1,770	170	1,940
1973/74	1,880	190	2,070
1974/75	2,000	210	2,210
1975/76	2,160	220	2,380

The rubber processing industry in East Pakistan is still very small. At present the quantity of rubber processed is only a fraction of that consumed in the Western Wing. According to our findings, however, progress is faster than in West Pakistan. This trend might even be enhanced by the establishment of further rubber plantations.

In contrast to West Pakistan, synthetic rubber in East Pakistan shows a growth rate about 25 per cent higher than that of natural rubber. This can be attributed to the beginning manufacture of scooter tyres. According to the estimated production increase in the individual sectors, there will be an annual growth rate of natural rubber by about 7 per cent and of synthetic rubber by about 7.5 per cent.

5.4.3.2.3 Demand for Passenger Car and Truck Tyres

As outlined in 5.4.3.1 there has been no production of tyres for passenger cars and trucks during the period under investigation. Therefore the estimates are not based on the present production volume but on the demand calculated on the basis of the official statistics for Pakistan. At present it has to be left undecided when the indicated number of tyres will be produced in Pakistan. As there are no special difficulties hampering the production of car tyres within the country and because Pakistan has gained wide experience in this field, it is unlikely that the competent Government authorities and the interested private companies will accept a continuing stagnation of the car tyre production without trying to resume the manufacture. In fact the volume of demand and the foreign exchange required for tyre imports have made the tyre industry an important industrial sector. Even if this aspect is neglected for the time being because of considerations relating to trade policy, it is to be assumed that in the long run due attention will be paid to the domestic production.

At the present traffic density the demand for new tyres of passenger cars and trucks amounts to

240,000 units per year.

In this number the tyres for passenger cars have a share of 55 per cent and those for trucks of 45 per cent. The annual capacity of General Tyre & Rubber Co. which is the only producer at the moment, amounts to

150,000 tyres per year

of the sizes selling most satisfactorily.

By number of tyres this company could have a share of the present tyre market in Pakistan of 62.5 per cent. The company's production equipment is well suited to the requirements of the market

The remaining 37.5 per cent or

90,000 tyres/year

have to be imported also in the future. At least General Tyre & Rubber Co. has convincing arguments for such a development. This is due to the fact that there will always be some types of tyres which cannot be produced in the country owing to the small number required. No doubt, there will be some sizes in the course of time which will reach the minimum economic quantity and then will be produced within the country. On the other hand, the demand for the remaining imported tyres should increase without reaching the minimum quantity necessary for production, or new types might be required in addition. Thus the number of tyres to be imported will more or less remain the same, unless the Government of Pakistan takes special measures to prevent the import of "unusual" tyre sizes. As there are no indications in this respect, we base our considerations on the asumptions made before

According to interviews of the producers of tractor tyres in West Germany, the production of large volume tyres is profitable only at an output of at least 10,000 units per month under the present conditions in Germany. In Pakistan the minimum number will be smaller, say, 5,000 tyres. Since there are only 2,484 tractors in Pakistan according to 1967/68 statistics and other vehicles with large volume tyres are not registered, the demand for these tyres sizes is far below the economic minimum capacity even under Pakistani conditions.

An annual 5 per cent increase for passenger cars and trucks can be calculated from the official statistics. This figure will hardly change if the import policy remains unchanged. According to this growth rate, the tyre demand will also increase by 5 per cent.

Table 77: Estimated Future Demand for Tyres for Passenger Cars and Trucks and the Quantities of Rubber Required

	Demand for Tyres (1,000 Units)			Rubber Required for Local Production (in tons)		
Year	Total Demand	Import Share	Local Production	Natural Rubber	Synthetic Rubber	Total
1967/68	240	90	150	1,800	900	2,700
1968/69	252	90	162	1,930	970	2,900
1969/70	265	90	175	2,100	1,050	3,150
1970/71	278	90	188	2,250	1,130	3,380
1971/72	292	90	202	2,420	1,210	3,630
1972/73	306	90	216	2,600	1,300	3,900
1973/74	322	90	232	2,780	1,390	4,170
1974/75	388	90	248	2,980	1,490	4,470
1975/76	355	90	265	3,180	1,590	4,770

Note: The figures do not include the requirements of the Army.

The increase in the total demand is the weighted average of the increase in imports and local production. Because there is no growth rate of imports, the increase in local production has to exceed that of the overall demand. At an increase in consumption of 5 per cent the local production will rise by 7.5 per cent under the assumptions made and under the present conditions. The total rubber consumption will therefore rise from 2,700 tons in 1967/68 to about 4,800 tons in 1975/76.

5.4.3.2.4 Demand for Latex

In order to integrate the latex consumption into table 78 we have to convert it into its rubber substance. At a weight of 0.96 kg per litre and a solid content of 60 per cent, the rubber content of the latex consumed (see 5.4.2.2) in 1967/68 was about 430 tons. This corresponds to 4 per cent of the total natural rubber processed. Because of the difficulties in estimating the future consumption of this very new industry we shall only take into consideration the latex requirements for the whole of Pakistan.

In order to find out the growth rate in the demand for latex the different sub-sectors are discussed. According to information received from producers, the demand for foam rubber is not increasing at present. The industry expects the stagnation to continue also in future. According to 5.2.4.4, however, there is a considerable increase in demand for polyurethane foam rubbers, especially for upholstery purposes. The sector of foam materials as a whole is characterised by an increasing tendency. As we are of the opinion that it will be in the interest of Pakistan to produce above all foam rubber on the basis of natural rubber we expect an increase of 2 per cent.

The sports articles industry which is concentrating on exports and which succeeded in doubling the value of its exports between 1960/61 and 1967/68, is expecting constantly rising export rates, especially to Europe and the USA. According to information from the Institute of the Rubber Industry (Pakistan Section), Lahore, an annual growth rate of 8 to 10 per cent is expected. Our survey among the 16 registered firms suggests that the higher rate of 10 per cent is correct.

In our interviews we obtained differing statements about the increase in the demand for hygienic articles produced by dipping. Our calculations are based on an average of 15 per cent.

Based on the above growth rates, we estimate the latex consumption, in terms of dry rubber content, to develop as follows.

Table 78: Estimated Future Latex Consumption in Pakistan (in tons of dry rubber content)

Year	Litres	Tons of Rubber
1967/68	840,000	480
1968/69	885,000	510
1969/70	940,000	540
1970/71	995,000	570
1971/72	1,055,000	610
1972/73	1,115,000	640
1973/74	1,180,000	680
1974/75	1,250,000	720
1975/76	1,320,000	760

According to this estimate the latex consumption in Pakistan will increase by about 6 per cent per year.

5.4.3.2.5 Summary

The rubber consumption of Pakistan, including tyres and tubes for passenger cars and trucks, but excluding the demand for military vehicles is summarised in table 79. The overall growth rate amount to 6.8 per cent, West Pakistan accounting for 6.8 per cent and East Pakistan for 7.1 per cent.

The textile yarn imported in 1967 came from the following countries:

West Germany (Bayer, Hoechst, Glanzstoff)	55 %
Japan (Toyo Rayon)	16 %
Italy (Snia Viscosa)	16 %
U.K.	4 %
Others	9 %

Japan's share (1965: 44 %, 1966: 29 %) has declined considerably, while the Federal Republic of Germany has increased its share both absolutely and relatively (1965: 32 %, 1966: 44 %).

Twine for fishing nets is imported under foreign loan and mostly comes from the USA and Canada. Guts for tennis rackets were usually imported from Japan, and tyre cord from France, Belgium and Switzerland.

5.3.1.3.2 <u>Forecast of Consumption Trends</u>

<u>Twine</u>

A forecast of the consumption has to start from the fact that the West Pakistan market cannot absorb much more twine; however, nylon twine is imported on preferential terms, so that the Pakistani producers might possibly expand their market to the extent of these imports.

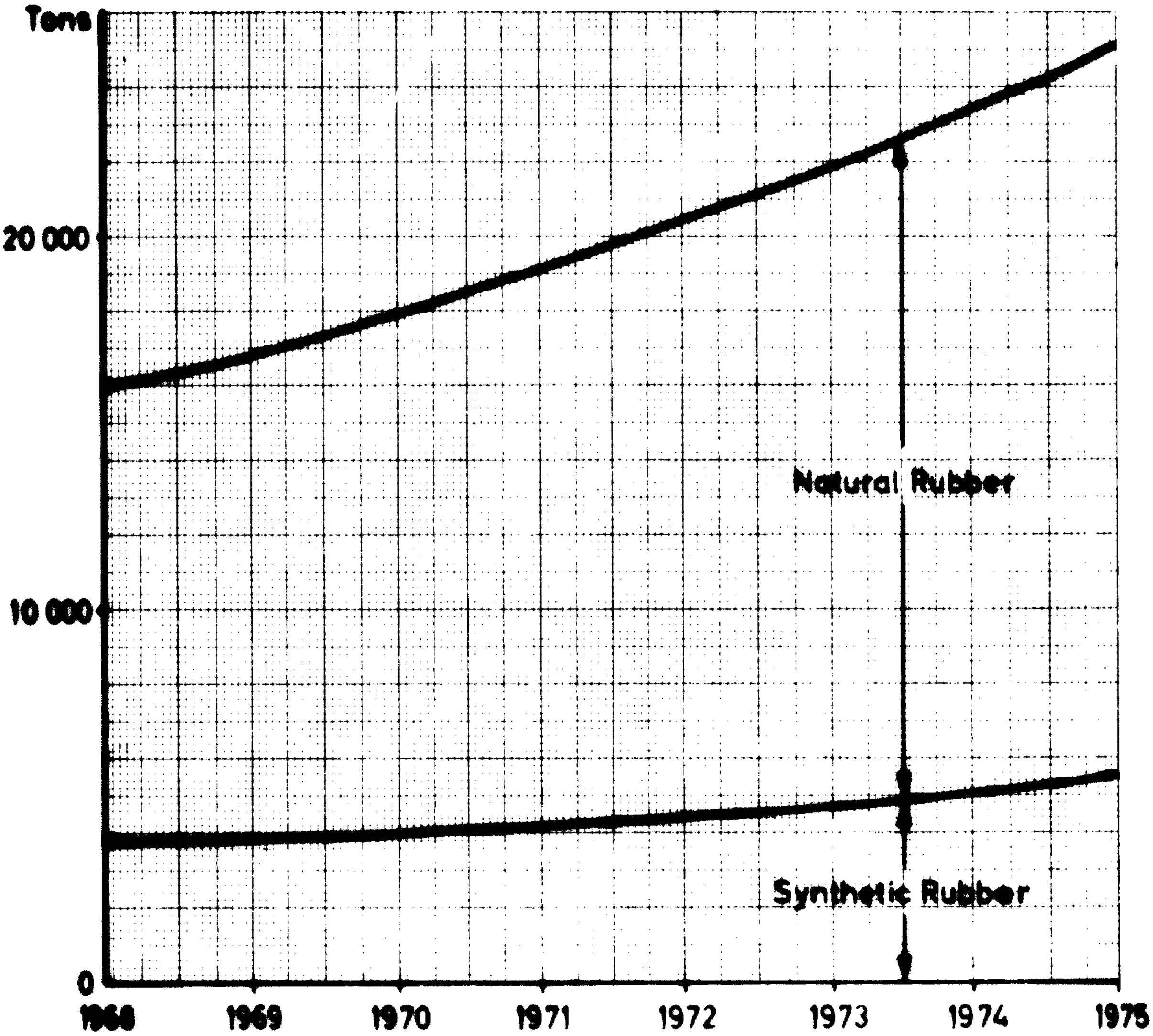

Figure 11: Future Trends in the Demand for Rubber

Table 79: Estimated Rubber Consumption for Pakistan, Including Tyres for Passenger Cars and Trucks (in tons)

Year	Natural Rubber		Synthetic Rubber	Total
	in solid form	Latex (Rubber Component)		
1967/68	11,668	480	3,417	15,565
1968/69	12,520	510	3,640	16,670
1969/70	13,460	540	3,870	17,870
1970/71	14,420	570	4,110	19,100
1971/72	15,410	610	4,390	20,410
1972/73	16,470	640	4,690	21,800
1973/74	17,630	680	4,980	23,290
1974/75	18,810	720	5,340	24,870
1975/76	20,040	760	5,630	26,430

The rubber to be processed in Pakistan in 1975/76 is expected to amount to

- 20,800 tons of natural rubber
- 5,630 tons of synthetic rubber.

The present proportion of natural rubber to synthetic rubber is unlikely to change substantially. Once sufficient quantities of rubber are produced in the country, the ratio might change provided that it has no major technical disadvantages.

The shoe industry will lose its leading position to the tyre producers in the course of time. The tyre industry in turn will increase its present share in the total rubber consumption of 25 per cent to about 37 per cent by 1975/76, 50 per cent of this being required for the manufacture of tyres and tubes for passenger cars and trucks. The shoe industry with a present share of 52 per cent will decrease to about 42 per cent during the some period.

5.4.4 Market Structure

The most important consumers of natural and synthetic rubber are importing their raw materials themselves, while the small industries are buying from importers. The "Rubber and Tyre-Group" comprising 21 small enterprises has been established in Karachi. It saves the small producers the trouble of handling their own imports transaction by undertaking commonly transacted imports.

At present all rubber imports are channelled through the Trading Corporation of Pakistan Ltd., a Government organisation which fixes quotas if the demand exceeds the imports.

The most important consumers of natural and synthetic rubber are:

West Pakistan

General Tyre & Rubber Co.,	Karachi
National Tyre & Rubber Co.,	Karachi
Master Tyre & Rubber Co.,	Lahore
Servis Industries Ltd.,	Lahore
Bata Shoe Company of Pak. Ltd.,	Batapur
Basco Industries Ltd.,	Gujrat
Pakistan Belting Co.,	Lahore
Premier Rubber Cable Ind.,	Karachi
Longman Mills,	Lahore
Darson Rubber Works,	Wazirabad
Atlas Rubber and Plastic Ind.,	Karachi
Pakistan Rubber Products,	Karachi

East Pakistan

Karim Rubber Ind. Ltd.,	Fatullah
Bux Rubber Ind. Ltd.,	Mirpur
A.T.I. Industries Ltd.,	Dacca
Bengal Rubber Industries,	Dacca
East Pakistan Rubber Industries,	Dacca
Paruma Eastern Ltd.,	Postogola

There are two centres of consumption in West Pakistan

- Karachi
- Lahore with the Gujranwala - Sialkot - Gujrat area

Because of its size and location and the imports of the raw materials, this industrial line has developed best in Karachi. All kinds of rubber articles are produced, especially tyres and tubes for passenger cars,trucks, scooters and bicycles. The production of shoes, tyres for bicycles and rubber parts for sports goods is mainly concentrated in and around Lahore.

In East Pakistan the capital Dacca has become the most important industrial centre because of its central situation and its favourable location regarding transport facilities. About 90 per cent of the total rubber industry - related to the production volume - is concentrated in or near Dacca. With the planned extension of the harbour the rubber industry will form a second centre of consumption in Chittagong.

5.4.5 Prices

5.4.5.1 Natural Rubber

The world market price for natural rubber has been decreasing since 1960 (see figure 12). On account of constantly rising outputs there is an excessive supply of natural and of synthetic rubber on the world market. In addition kinds of synthetic rubbers have been put on the market which often exceed natural rubber in quality.

This applies especially to stereospecific rubbers. Of course, this situation has affected the prices of natural rubber.

At the time of the vestigation the price c&f seaport Pakistan was quoted as follows:

RSS 1	=	$ 0.37/kg	in bales
RSS 2	=	$ 0.36/kg	in bales
RSS 3	=	$ 0.35/kg	in bales
RSS 4	=	$ 0.34/kg	in bales
RSS 5	=	$ 0.26/kg	in bales

5.4.5.2 Synthetic Rubber

As to the prices of synthetic rubber, similar statements can be made as in the case of natural rubber; as a rule the capacity is higher than the demand. At increasing plant capacities it is not surprising that prices tend to fall. Its price generally is lower than that of natural rubber of comparable quality.

According to statements from the producers the import of synthetic rubber to Pakistan is only possible against Bonus Voucher [1] This increases the c&f price by 170 per cent for the home consumption. In this way the synthetic rubber becomes more expensive than the natural rubber in Pakistan although it is cheaper on the world market. Therefore, it is only used in quantities absolutely necessary for chieving a better quality of the final product. This limited consumption of

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1) According to the latest import regulations it is importable under Cash-Cum-Bonus List.

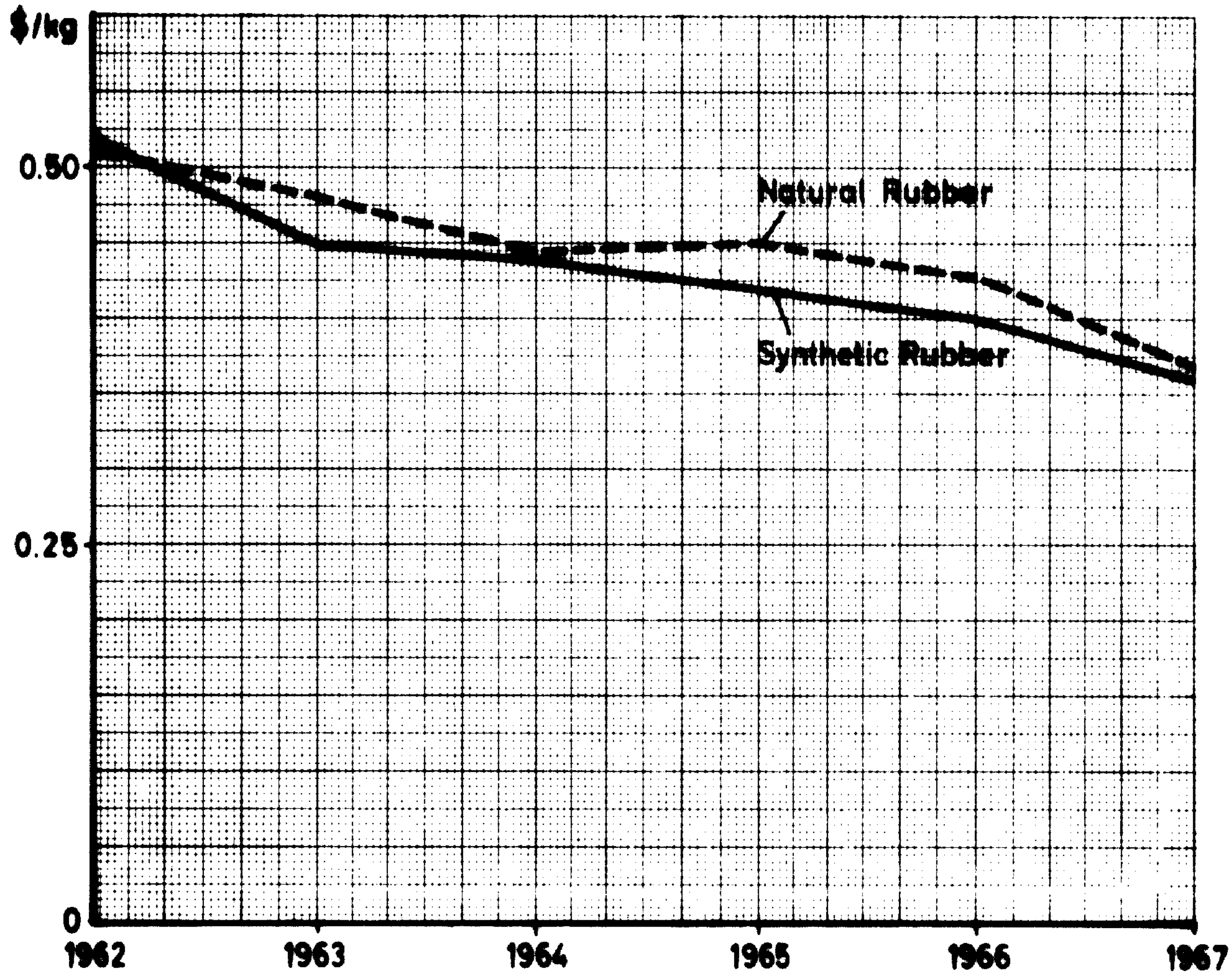

Figure 12: Development of World Market Prices for Natural Rubber and Synthetic Rubber synthetic rubber naturally leaded to higher foreign exchange expenditures. Nevertheless it is beneficial to the foreign trade in natural rubber among the developing countries in Asia.

At the time of the investigation synthetic rubber was supplied from West Germany c&f seaport Pakistan at a price of

$ 331,- per ton SBR - 1,500 or
$ 280.- per ton SBR - oil extended.

5.4.6 Recommendations

According to the present experiences and calculations, the cultivation of rubber is highly recommended in East Pakistan. There are ample prospects that the country will become independent of imports of natural rubber within 15 to 20 years.

The trial plantations of the EPFIDC have shown such an encouraging result that a further 3,200 hectares have been provided for plantations in 1969 and 1970.

The yield (in tons of dry rubber content) of the trees planted until 1970, is estimated by the FAO adviser of the EPFIDC as follows:

1968/69	=	16
1969/70	=	194
1970/71	=	433
1971/72	=	678
1972/73	=	819
1973/74	=	988
1974/75	=	1,193
1975/76	=	1,977

1976/77	=	3,272
1977/78	=	4,030
1978/79	=	4,732
1979/80	=	5,313
1980/81	=	5,708
1981/82	=	5,787

In view of the advantages offered by a domestic latex production we consider this project one of the most encouraging we have found in Pakistan. The special features are that

- soil is used which is hardly suitable for agricultural purposes
- hardly any imports are necessary
- satisfactory employment effect and
- good yields can safely be expected.

Therefore, new plantations will definitely be established at an increasing rate. An intensified and careful cultivation of rubber trees of bud-grafted quality should make it possible to cover the demand for natural rubber in Pakistan from local sources by 1985.

In our opinion is not advisable at present to erect a plant for synthetic rubber because the economic minimum capacity of 20,000 tons/year will only be utilised to 30 per cent in 1975. There is no hope of exporting the excess output because of the saturation of the world market.

We recommend to limit the number of imported tyre sizes by enforcing appropriate import restrictions in order to encourage the production of the proper type of tyres in Pakistan.

If specific types of tyres are still uneconomical to produce after the introduction of the proposed restrictions it should be examined whether their production can be arranged within the scope of RCD or in cooperation with other tyre-producing countries (e.g. Ceylon) so that each of the participating countries could exclusively produce one or several of these types. It would be highly recommendable if individual countries would decide to solve this problem by mutual purchase commitments.

5.5 Solvents and Plasticisers

The main subject of this section is a detailed treatment of

- methanol
- ethanol
- ethyl hexanol
- dioctyl phthalate (DOP)

We have in addition attempted to give a survey of the present market for solvents and plasticisers in Pakistan; the remarks on most of the additional products studied are brief. Our aim was to present the Pakistani planning authorities with an overall picture of the present consumption of solvents.

5.5.1 Alcohols

An increase in total consumption is possible only as a consequence of a rise in the number of fishing boats. This rise is estimated by the Marine Fisheries Department to be 50 units per year [1]). Although at present surveys are being carried out with a view to opening up new fishing grounds off the coast of West Pakistan, the Marine Fisheries Department does not yet consider it possible to draw any conclusions about the future development of the fisheries industry on the basis of these surveys.

The demand for nylon nets is estimated by this authority to be 250 kg for 1 gillnetter, 70 kg for 1 trawler, and 50 kg for 1 sailing boat.

In the East Pakistan market the replacement of hemp and cotton by nylon will go on for a long time to come. The authorities and cooperatives are very optimistic about this development. But in view of the preliminary steps that still have to be taken, such as supply of the interior of the country, instruction of the fishermen, etc. an increase in consumption of only 10 per cent a year appears realistic.

Cord

With cord Pakistan Belting Co., the only consumer apart from the General Tyre & Rubber Co., thinks that it will double its capacity and its consumption in 1970. It intends to go on producing driving belts and conveyor belts mainly for export. As no further expansion of the production of belts containing

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1) 30 of these units are trawlers and 20 gillnetters. The present fleet is about 500 gillnetters, 150 trawlers and 100 sailing boats.

5.5.1.1 **Methanol**

5.5.1.1.1 **General Characteristics**

5.5.1.1.2 **Domestic Production**

5.5.1.1.2.1 **Existing Capacity**

5.5.1.1.2.2 **Problems**

5.5.1.1.3 **Demand**

5.5.1.1.3.1 **Volume and Structure of Past Demand**

5.5.1.1.3.2 **Forecast of Consumption Trends**

5.5.1.1.4 **Prices**

5.5.1.1.5 **Recommendations**

5.5.1.1 Methanol

5.5.1.1.1 General Characteristics

Methanol or methyl alcohol is the first component of the alcohol series. It is a strongly toxic liquid, which is easily mixable with water and most organic solvents. Methanol dissolves many inorganic substances.

Methanol is used as

- solvent for resins, dyestuffs, rosin, polyvinyl acetate and many inorganic substances
- diluent, plasticiser and purifier in many industrial lines, e.g. the perfume and paints industry
- additive in the aceotropic distillation, e.g. in the extraction of toluene and butadiene
- purifier for natural gas
- methylation and antifreezing agent
- cooling brine for refrigerating machines
- fuel additive
- primary product for the manufacture of formaldehyde.

In Pakistan methanol is used for the production of formaldehyde. The paint industry absorbs only small quantities of this material.

Fairly large quantities of methyl alcohol at present are consumed by Pakistan International Airlines Corporation (PIA). This company is operating a number of turboprop aircraft for which it uses a mixture of methanol and water during the take-off. The water is needed for cooling the air during the start in order to achieve a better compression in the turbines. Since pure water would freeze during flights at high altitudes, 36 to 38 per cent by weight of methanol is added

The "water methanol" is the procedure required for the Fokker Friendship planes which PIA is operating. There are other types of planes which use pure water. In this case freezing is avoided by ejection of the water after the start.

5.5.1.1.2 <u>Domestic Production</u>

5.5.1.1.2.1 <u>Existing Capacity</u>

Methanol is produced on the basis of natural gas by Valika Chemical Industries Ltd., Karachi, by catalytic conversion of synthesis gas. This plant can produce about 9.3 t of crude methanol per day. Distillation yields 8.8 t/d (2640 t/y) of "A-methand" and about 0.5 t/d of "technical-grade-methanol". "A-methanol" is 99.9 per cent pure methanol, while the technical methanol consists of

70 % methanol
20 % water
10 % higher alcohols

The plant was put into operation early in 1967 and was designed to supply above all the raw material for the factory owned formaldehyde and urea formaldehyde production. For this purpose only A-methanol can be used. The Technical-grade methanol was offered in the market where it was bought occasionally by the paint industry. The producer firm, however, finds difficulties in selling the technical product.

As difficulties have been encountered also in the sale of urea formaldehyde, and as there were rarely any other buyers of A-methanol, the plant has so far been in operation only for a short period. In 1967 only about 135 t and in 1968 until the end of July not more than 55 t of A-methanol were manufactured.

5.5.1.1.2.2 Problems

The Valika management hopes soon to be able to extend the production of urea formaldehyde. This would at the same time mean a better utilisation of the methanol plant. Other buyers of methanol, however, have not been found so far.

The methanol required for turboprop planes must be of high purity. The specifications usually for aviation-type methanol are as follows:

- specific gravity: 0.7925 at 20°C
- purity : 99.8 - 99.9 %
- water content : 0.05 % max.
- boiling range : 63.7 - 64.4°C at. 75.6 mm Hg.
- flash point : 7°C

Owing to the high purity requirements it is absolutely necessary that the methanol is forwarded in new lined containers or tanks

As far as the locally manufactured product is concerned, Esso made a test of whether it would be suitable for PIA. The results of these tests are said to have been not entirely satisfactory. The local product did not pass two of the tests

Another potential consumer is Eastern Chemical Industries in Chittagong. As production of this company is in direct competition with that of Valika, they should not be made dependent on raw material supplies from that company.

If one day a polyester fibre factory operating on the basis of dimethyl terephthalate and ethylene glycol should be established, this would mean a strong competition to Valika. The technical grade methanol obtained as by-product in large quantities in this process is of high purity (98 - 99 per cent) and practically contains only water as impurity.

5.5.1.1.3 Demand

5.5.1.1.3.1 Volume and Structur of Past Demand

The most important consumers of methanol were

- Pakistan International Airlines
  and, as formaldehyde manufacturers,
- Valika Chemical Industries Ltd., Karachi
  and
- Eastern Chemical Industries Ltd., Chittagong.

The consumption in the paint industry is so small that there is no need to describe it.

PIA made some estimates about their requirements of water-methanol mixture for the period 1968/69 to 1972/73. For 1968/69 PIA estimated its total consumption of mixture at 506,800 US gals. This figure seems to be too high and, therefore, we made our own estimates.

Our calculations are based on the following facts and assumptions:

- The methanol content (by weight) varies between 36 and 38 per cent. Since 1966 the concentration required in Pakistan is 38 per cent by weight or about 43.5 per cent by volume at 15°C. It is assumed that the present figures will also be applicable in future.

- Under the climatic conditions in Pakistan a Fokker F 27 ("Friendship") plane per start and engine consumes between 19 and 23 litres of mixture. We have estimated an average consumption of 42 litres of mixture per start and plane which is equivalent to 14.55 kg of pure aviation grade methanol.

- According to the time table issued in April 1968, PIA makes at present about 30,000 starts with turboprop planes per annum. Out of this East Pakistan accounts for 13,000 starts and West Pakistan for 17,000 starts per year, the interregional flights being assigned to the wing from where they originate. Similarly, the number of start units of turboprop planes has been estimated with the help of the time schedules of the past two years as follows:

Year	West Pakistan	East Pakistan	All Pakistan
1965/66	16,900	1,100	18,000
1966/67	14,500	9,900	24,400

According to the number of engines, one start of a Vis-
plane has been assumed as two starts of an F 27 plane.

Taking the above data as basis, the annual consumption at present is 189 t in East Pakistan and 247 t in West Pakistan. Thus, for the year 1967/68 the total consumption has been assumed as 429 t, which is 1 1/2 per cent lower than the sum of the two figures. This reduction has been made in order to make allowance for the increase in the April 1968 schedule compared with the period considered.

The demand figures for 1965/66 may not give a realistic picture of the actual demand. The figures represent only what might be considered the normal civil aviation requirements and do not take into consideration whether PIA has increased or reduced its services as a consequence of the Indo-Pakistan war.

The remarks made in 5.2.1 to 5.2.3 apply to the consumption of methanol by the formaldehyde manufacturers. The low demand for UF, MF, PF products has resulted in a correspondingly small consumption of methanol. The figures of methanol input used for the conversion to formaldehyde, are based on Valika stating that the quantity of methanol required for the production of 1 t of formalin (37 per cent formaldehyde solution in water) is 0.455 t. This figure is somewhat higher than the usual 0.423 t of methanol per ton of formalin.

The consumption of methanol in the two sectors mentioned has developed as follows:

Table 80: Consumption of Methanol, 1965-1968 (in tons)

	1965/66	1966/67	1967/68
West Pakistan			
PIA	238	254	243
Formaldehyde manufacture	-	-	190
Total	238	254	433
East Pakistan			
PIA	16	144	186
Formaldehyde manufacture	-	-	100 1)
Total	16	144	286 1)
All Pakistan			
PIA	254	398	429
Formaldehyde manufacture	-	-	290 1)
Total	254	398	719 1)

1) Import figures are considerably higher, since Eastern Chemical Industries Ltd. still has on stock a large quantity of unprocessed methanol

Nearly 57 per cent of the methanol consumed by PIA is from West Pakistan and the balance from East Pakistan. The demand from East Pakistan again originates mostly from Dacca (75 per cent) because water-methanol fuelling for the most of the flights is done here.

In West Pakistan the concentration of the demand is less pronounced. The figures available suggest that about 50 per cent of the demand must be attributed to Karachi. The consumers of technical-grade methanol are found in Chittagong and Karachi. Valika in Karachi is self-supporting, while Eastern Chemical Industries Ltd., Chittagong, is dependent on imports.

Most of the water-methanol mixture for aviation purposes is supplied by Esso and Burmah Eastern. PIA are said to import certain quantities themselves.

There are certain agreements which divide the supplies as follows:

- Esso covers the demand of West Pakistan except Karachi and East Pakistan except Dacca
- Burmah Eastern covers the demand of the Dacca Airport, i.e. the Dacca flight region

5.5.1.1.3.2 <u>Forecast of Consumption Trends</u>

As indicated in 5.2.1 to 5.2.3, a considerable expansion is planned for the local manufacture of formaldehyde resin products (UF, MF, PF). This development has a direct influence on the formaldehyde and thus on the methanol production. Our forecast for this sector, therefore, is based on the development of the consumption of formaldehyde discussed in 5.9.4. Moreover, the assumption is maintained that 0.455 t of technical grade methanol will be needed for the production of 1 t of formalin

The same rates of increase as have been used by PIA to make their forecasts have been taken as basis for estimating the demand of PIA for the period 1968/69 to 1972/73. For the two years following this period figures slightly lower than the average rates during the 1968/69 to 1972/73 period have been used, i.e. 12 per cent in the case of East Pakistan and 10 per cent in the case of West Pakistan. For the years 1967/68 and 1968/69 an increase of starts by 5 per cent has been assumed in both wings according to discussions with PIA representatives.

When trying to assess the long-term aspects of the methanol requirements for aviation purposes one is confronted with the following situation:

- According to statements of the Planning Department, PIA has not yet taken any decisions for the years beyond 1972/73.

- The airline also in the future intends to extend the feeder services in East and West Pakistan. Among the new routes to be opened in the near future are the following:

  - Dacca - Sirajganj - Bogra - Dinajpur
  - Dacca - Faridpur
  - Dacca - Khulna
  - Khulna - Barisal - Bhola - Matia - Sandwip - Chittagong
  - Dacca - Chandpur - Noakhali - Matia
  - Lahore - Sialkot - Rawalpindi

- It is not yet known definitely whether in future jet planes will penetrate in fields where turboprops are still in use, i.e. in the short distance flights. The nylon cord is planned after 1970, the consumption of cord can be regarded as constant from that year onwards.

As it is not known at what date the General Tyre & Rubber Co. will start production again. The potential consumption of this firm is therefore stated separately as it is already done in the case of rubber consumption (c.f. section 5.4.4.3). The figures on cord consumption for car tires are based on the same assumptions as those listed in section 5.4.

The potential consumption of cord for the production of truck and passenger car tyres is estimated to be:

1969	320 t
1970	330 t
1971	350 t
1972	360 t
1973	380 t
1974	400 t
1975	420 t

<u>**Nylon Yarn**</u>

Compared with an annual consumption of cotton amounting to about 300,000 t, the present consumption of nylon yarn of about 4,000 tons a year seems rather modest. Almost everywhere in the world the consumption of synthetic fibres is undergoing a big increase. Manufacturers, importers, and the textile industry in Pakistan are also very optimistic as regards the sales prospects for nylon products, provided that the yarns are available. In view of the high import duties and the competition that will probably arise from polyester fibres, however, we do not believe that these expectations of an annual increase of nylon fibre consumption of 20 to 30 per cent will be fully realised. On the basis of discussions with a European manufacturer of polyamide indications are in favour of the turboprops For instance Douglas is planning a new turboprop plane. But only the development within the next few years will show whether new jets can also compete on routes of less than 300 miles.

- Even if we assume that the turboprops will in any case be more economical on the short routes, the question remains whether it is justified to believe that the methanol-water mixture will be used.

These few remarks show that any prediction of the demand beyond 1975 is highly speculative, as far as aviation-type methanol is concerned

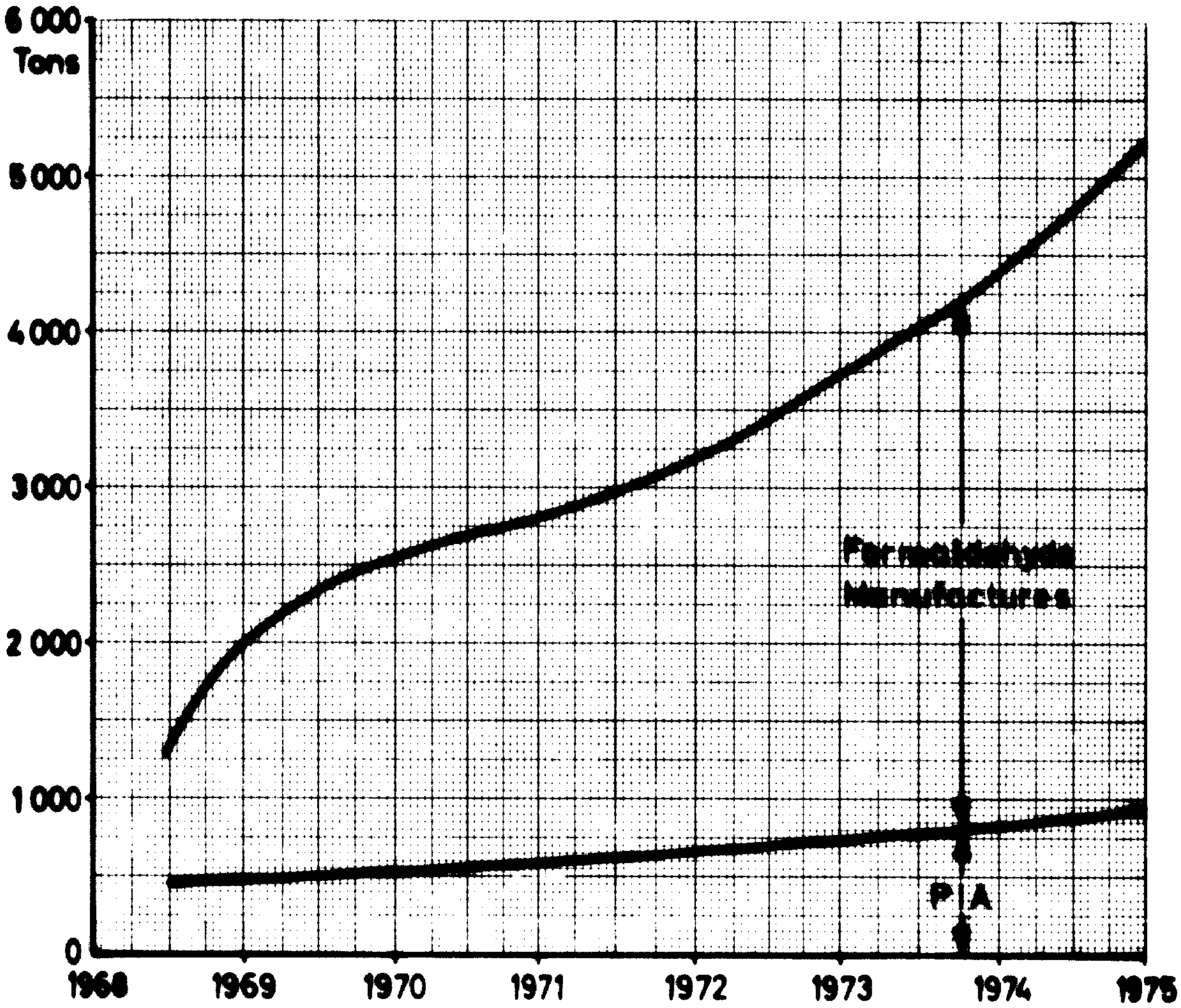
For our estimates we have assumed that owing to the difficulties of providing distilled water in most of the airports PIA will also in the future prefer planes using the mixture. Further, it is believed that turboprops will play a vital role on short routes and that the long-term rate of increase will not be much lower than at present.

The values obtained on this basis are summarised in Table 81.

TABLE 81: **TRENDS IN METHANOL DEMAND, 1968/69 - 1974/75[1)]** (in tons)

	West Pakistan			East Pakistan			All Pakistan		
	PIA	Formaldehyde manufacture	Total	PIA	Formaldehyde manufacture	Total	PIA	Formaldehyde manufacture	Total
1968/69	260	630	890	190	625	815	450	1.255	1.705
1969/70	260	765	1.025	220	745	965	480	1.510	1.990
1970/71	300	1.000	1.300	240	775	1.015	540	1.775	2.315
1971/72	350	1.260	1.610	270	825	1.095	620	2.085	2.705
1972/73	380	1.550	1.930	310	900	1.210	690	2.450	3.140
1973/74	420	1.910	2.330	350	985	1.335	770	2.895	3.665
1974/75	460	2.360	2.820	390	1.070	1.460	850	3.430	4.280

1) **Other groups** (paints industry, etc.) presumably will continue to have a very low share in the consumption. Therefore they are not listed separately.



<u>Figure</u> 13: Trends in the Consumption of Methanol

As can be seen from Table 81, a strong increase in the consumption of methanol for the production of formalin can be expected already for 1968/69. The consumption in this sector in East Pakistan will rise by 79 per cent between 1968/69 and 1974/75, i.e. an average annual increase of about 10 per cent. For West Pakistan aquivalent figures are 220 and 21 per cent, for All Pakistan 151 per cent and 18 per cent. All these figures, however, are based on the assumption of the development and regional distribution of this industrial sector made in 5.2.1 to 5.2.3 and 5.9.4. Thus, the problems involved in the consumption forecast for methanol in this sector are the same as described in these sections.

Table 81 also shows that PIA will lose its first place as consumer of methanol to the formaldehyde manufacturers presumably already in 1968/69.

PIA's requirements are expected to increase by 98 per cent between 1967/68 and 1974/75, i.e. an average annual increase of 10 per cent. The share of this company in the total demand in 1974/75 is expected to be reduced to one sixth of the total.

Under the conditions discussed here East Pakistan will account for 61 per cent of the total consumption of methanol in 1974/75.

5.5.1.1.4 <u>Prices</u>

Valika's present price for A-methanol is

2,500 Rs./t

including all taxes.

According to Esso Standard Eastern Inc., Karachi, the c & f price for aviation grade methanol is at present 415.- $/t. This price refers to imports in barrels from the USA.

It seems that methanol can be imported at cheaper rates from countries such as Italy and West Germany. The present price c & f Karachi from West Germany (Degussa) is for instance about 275 $/t for supplies of 500 tons per year.

A survey on the price situation of methanol technical grade is given in Table 82 which compiles the domestic prices of some important consumer countries.

Table 82: Prices for Methanol[1] (in $/ton)

Year	USA	West-Germany	Italy	England
1964	96.5	74.5	108	83.5
1965	96.5	77	108	83.5
1966	89.5	72.5	112	83.5
1967	83	72.5	99	83
1968	83	59.5	97	83

[1] The prices include freight, but not taxes

There is evidence that the price trend in the world market is going down. In Germany for example it is expected that a large plant will be put into operation which by using cheaper raw materials will reduce costs of production considerably.

The development of the future prices for bulk purchases has been estimated by a large consumer of methanol as follows:

1968	=	100
1969	=	94
1970	=	73

In these circumstances the manufacture of methanol in small plants might become uneconomic.

5.5.1.1.5 <u>Recommendations</u>

The capacity of Valika will be sufficient to meet the demand in West Pakistan at least until 1974/75.

The East Pakistan producer of formaldehyde should not be expected to buy his raw materials precisely from his only competitor. Therefore, the firm should be given the possibility of importing part of its methanol. Setting up a plant for East Pakistan on the basis of synthesis gas still does not appear recommendable in view of the present low demand. Thus, it may be worthwhile considering to make methanol from pyroligneous liquor obtained by wood distillation.

In case the mentioned polyester factory is based on dimethylterephthalate, the problem probably would be solved. In any case the decision on the polyester plant should be taken before a further plant for the production of methanol is sanctioned.

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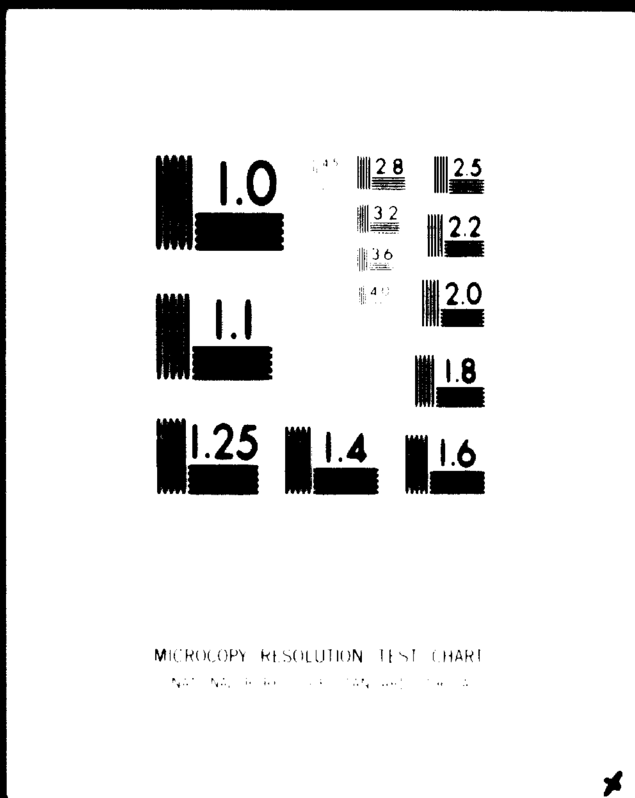

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5.5.1.3 Butanol

Butanols are alcohols of the formula C_4H_9-OH, of which four isomers exist.

Normal butyl alcohol is used as a reactive solvent in the manufacture of butylated amino resins such as UF, MF and PF. Used in conjunction with ketones, it enhances the diluent tolerance of nitrocellulose lacquers. It is also used as an extractive solvent, for example, for antibiotics, hormones and vitamins and as a raw material in the manufacturer of plasticisers, etc.

The total consumption in Pakistan at present does not exceed 50 tons per year. The paint industry is the main user. Butanol is imported.

5.5.2 Ketones

5.5.2.1 Acetone

5.5.2.1.1 General Characteristics

5.5.2.1.2 Domestic Production

5.5.2.1.3 Demand

5.5.2.1.4 Prices

5.5.2.1.5 Recommendations

5.5.2.1 Acetone

5.5.2.1.1 General Characteristics

Acetone (CH_3 CO CH_3) is the simplest and the most important compound of the ketone group. It is a colourless flammable liquid of a pleasant smell which can be mixed with water, ethanol, methanol and many other solvents.

Acetone is produced

by butanol-acetone or ethanol-acetone fermentation or by certain petrochemical processes starting from

ethanol, acetaldehyde,

acetic acid,

isopropyl alcohol, or

cumene.

The cumene process in our opinion is of special importance for developing countries because it produces two essential products at the same time and thus leads to a relatively large capacity of the production plant.

Acetone is a multi-purpose solvent. In addition to this it serves for syntheses of methyl methacrylate, chloroform, higher ketones like methyl isobutyl ketone (MIBK), diacetone alcohol (DAA) and other petrochemicals. In the paint and varnish industry it is used among other solvents, as a component in nitrocellulose and acrylic lacquers. In the production of rayon it serves as a solvent of cellulose acetate, from which threads are spun in a dry spinning process. Its capacity to dissolve about the hundredfold volume of acetylene allows the safe handling of steel cylinders filled with acetylene. In this process acetone acts as stabiliser in contact with kieselguhr. In extraction processes it is used for the production of tanning agents, resins, perfumes and pharmaceuticals. Another field of application is the oil seed extraction, especially of cotton seed. Moreover, it is used for degreasing sheep's wool.

In Pakistan it is used mainly for dissolving acetylene and for producing cellulose acetate. Moreover, it is used in the manufacture of paints and varnishes, in the shoe industry (tanning) in the pharmaceutical line and the tobacco manufacture. Acetone is not yet used for the extraction of oil seed. In this sector hexane is preferred because it is less expensive.

5.5.2.1.2 Domestic Production

The Pakistan Ordnance Factories Ltd., Wah, and, since 1966, the Kohinoor Rayon Ltd., Lahore, are producing acetone in Pakistan. According to an agreement with the Planning Commission of Pakistan we do not report on the first-named plant.

The Kohinoor plant produces acetone from acetaldehyde by a catalytic process. Two tons of acetone can be produced per day. This capacity is in principle harmonised with that of the cellulose acetate plant. Kohinoor is able to produce ten tons of rayon per day; an average of 20 per cent of this quantity can be expected as loss of solvents.

Only the surplus production is offered on the domestic market. It amounted to about thirty tons in 1966 and to about hundred twenty tons in 1967. According to statements of the enterprise in 1968 about hundred twenty tons will be sold.

5.5.2.1.3 Demand

With the exception of the consumption by the Pakistan Ordnance Factories and Kohinoor, the total consumption is at present of the order of fifty tons per year. The main consumers are Pakistan Oxygen Ltd., Karachi and Pakistan Industrial Gases Ltd., Karachi, which are using acetone as solvent for acetylene gas. The consumption of other consumers (paints, tobacco, pharmaceuticals) is very small.

As sources of supply only foreign countries can be considered besides Kohinoor and the occasional surplus production of Pakistan Ordnance Factories. The acetylene suppliers have to rely on imports because of the fact that Kohinoor's acetone allegedly contains too much water and therefore it would corrode the steel cylinders. Nothing is known about the quality of the acetone produced in Wah. But in any case it is not used for storage of acetylene either.

The acetone consumption in the acetylene sector is relatively high (about forty tons). Ten tons out of this quantity are required by Pakistan Oxygen Ltd. for East Pakistan.

The volume of acetone consumption for dissolved acetylene can be explained by improper treatment of the steel cylinders. It often happens that welding gas is taken from cylinders in horizontal position so that acetone escapes at the same time.

A clear idea about the total consumption and its development cannot be given because the Wah has not been interviewed. In general it can be said that the consumption of the acetylene producers has shown hardly any increasing tendency during the last few years. This can presumably be traced back to a gradually improving handling of gas cylinders. The two acetylene producing firms have been of the opinion that only a small increase in consumption may be expected for the future.

Basically it can be assumend that the acetylene consumption is closely related to the development of the metal working industries. However, since National Oil Co. intends to replace part of the acetylene required for welding purposes by liquefied petroleum gas an important increase in acetone consumption cannot be expected.

According to our findings the same is true with regard to the paint and varnish industry because the sector of nitrocellulose lacquers is not very important. An increasing demand would have to originate in other sectors, which are not important as yet. The production of methyl methacrylate can be taken into consideration as a potential consumer. Whether a production of this type will be taken up in the next few years is in our opinion uncertain. Thus, every statement about new fields of application is speculative at present.

The maximum growth rate of the total consumption is estimated at ten per cent and this is presumably not a conservative forecast. A reliable prediction can, however, not be made because essential parts of the total consumption are unknown.

5.5.2.1.4 Prices

Kohinoor's ex factory price without taxes amounts at present to

3,300.00 Rs./t.

Including all taxes the factory price is

3,951.00 Rs./t.

According to statements by Pakistan Oxygen Ltd. imported acetone must be bought against Bonus voucher.

The total import charges on acetone are

236.5 per cent on c & f value.

The present price c & f Karachi of acetone imported from England is

264 $/t.

Therefore, the landed costs amount to about

4,220.00 Rs./t.

A survey of prices in some producer countries is shown below.

Table 85 Inland Prices of Acetone in Some Producer Countries a) 1964 - 1968 (in $/t)

	USA	France	Germany	Italy
1964	143	136	119	108
1965	143	132	110	103
1966	143	132	132	132
1967	143	132	132	128
1968	143	136	119	128

a) Prices do not include taxes but freight

5.5.2.1.5 <u>Recommendations</u>

In view of the small local demand, apart from the cellulose acetate factory of Kohinoor, a further local production of acetone for the domestic market does not seem expedient. It should be examined whether the quality of Kohinoor's acetone can be improved so that it can also be used for the storage of acetylene.

The question about the enlargement of the acetone production might become acute after a decision has been taken about a plant for the production of acrylic polymers. The problem of acetone production would have to be considered in that connection.

5.5.2.2 Methyl Ethyl Ketone

Methyl ethyl ketone (MEK), CH_3 - CO - CH_2 - CH_3, is a flammable liqid with an odour similar to that of ether. MEK has similar properties to acetone.

It is a by-product contained, for example, in wood spirit, and acetone oils. It is produced on an industrial scale by dehydrogenation of secondary butanol over zinc oxide on pumice.

MEK is used as a solvent for cellulose nitrate and cellulose acetate paints, for acrylics, phenolic and alkyd resins, and for vinyl copolymers. Further uses are in the manufacture of smokeless powder, flavourings, perfumes and insecticides, the dewaxing of lubricating oils and extracting purposes.

In Pakistan, MEK is mainly used by the National Refinery Ltd., Karachi and the Attock Oil Co., Rawalpindi, for the dewaxing of lubricating oils. These two concerns account for 75 per cent of the country's total consumption, the remaining 25 per cent being accounted for mainly by the paint industry.

The total consumption in 1967 was about 240 tons. Consumption seems mainly to develop by a series of jumps connected with the expansion of refinery capacities. MEK is not produced in Pakistan.

5.5.2.3 Methyl Isobutyl Ketone

Methyl isobutyl ketone (MIBK), $(CH_3)_2-CH-CH_2-CO-CH_3$, is a colourless liquid with properties similar to those of methyl ethyl ketone. It is usually obtained by dehydrogenation of diacetone alcohol and subsequent catalytic conversion of the resultant mesityl oxide. MIBK is a favourite of the paint industry because it can carry a high solid content at low viscosity.

Further fields of application are the manufacture of antibiotics such as penicillin and aureomycin and the extraction and separation of rare metals, such as uranium.

The use of MIBK in Pakistan has until now practically been limited to the paint industry, where it is largely used in the manufacture of nitrocellulose lacquers. The consumption figures lie between 30 and 40 tons per year. The entire demand is covered by imports.

5.5.1.2 Ethyl Alcohol

5.5.1.2.1 General Characteristics

Ethanol or ethyl alcohol, CH_3-CH_2 (OH), is a colourless liquid which is easily inflammable. It often occurs in nature because it is generated during fermentation.

Ethyl alcohol is produced b alcoholic fermentation of raw materials containing carbohydrates, and by petrochemical processes starting from ethylene, acetaldehyde or synthesis gas.

Fermentation produces only alcohol of a maximum concentration of 20 per cent because the bacteria necessary for fermentation die at this concentration. But a subsequent simple distillation can produce a concentration of up to about 96 per cent. A further separation of water and alcohol cannot easily be made because the mixture is azeotropic.

Ethyl alcohol is used as

- a primary product for certain chemical goods, for example acetaldehyde, dyestuffs, scents
- a solvent for fats, oils, resins, numerous dyestuffs, iodine, medicine preparations and other
- a fuel and anti-knock fuel component
- a component of alcoholic drinks.

In Pakistan, since 1968, the largest part of the ethanol has been processed into ethylene for the production of polyethylene. The second most important sector of demand is the beverage industry. Large quantities are also used for the production of acetone and acetic anhydride. Finally considerable quantities are utilized in the pharmaceutical industry or destined for export.

5.5.2.4 Diacetone Alcohol

Diacetone alcohol (DAA), $CH_3-CO-CH_2-C(OH)(CH_3)_2$, is a colourless, high-boiling liquid which is miscible with water and many organic solvents. It is obtained from acetone by liquid phase condensation in the presence of an alkaline catalyst.

It is used, like most ketones, as a solvent in the surface coatings field. It is also one of the few organic solvents which is suitable for use as a vehicle for castor oil in brake fluids, as it is miscible with the oil over a wide temperature range and does not attack rubber.

70 per cent of the present total consumption of about 80 tons per year goes into the paint field. About 30 per cent is used in the local manufacture of brake fluid.

We wish to point out here that until now the greater quantity of brake fluid used has been imported. The import figure in 1966/67 was 759 tons, in 1967/68, 418 tons. United Chemical Industries Ltd., Karachi, however intends to start large-scale production of brake fluid before the end of 1968. The capacity of the plant is reported to be 1,000 tons per year. Larger imports of DAA and smaller imports of brake fluid must therfore be expected in future.

If we assume a mean consumption of brake fluid of approx. 600 tons per year, about 240 tons of DAA will have to be imported, as the DAA content of brake fluid is about 40 per cent. The DAA consumption would rise to about 360 tons by 1974/75 if we assume a growth rate of 5 per cent for the number of motor vehicles.

5.5.3 Chlorinated Hydorcarbons

The chlorinated hydrocarbons tetrachloroethylene (CCl_2-CCl_2), carbon tetrachloride (CCl_4) and trichloroethylene ($CHCl$-CCl_2) are used in the dry cleaning industry and for general cleaning purposes.

This sector is in the early stages of development in Pakistan: there are at present about seven dry cleaners in West Pakistan and one in East Pakistan who use tetrachloroethylene. As far as we were able to find out, the total consumption of this chlorinated hydrocarbon is about 65 tons per year.

Carbon tetrachloride and trichlorethylene are used to a limited extent for cleaning machines, in repair shops, etc.

5.5.4 Ester Solvents

Among the ester solvents in Pakistan at present only butyl acetates are of some importance.

Butyl acetates are isomers of the empirical formula $CH_3COOC_4H_9$. All isomers are colourless liquids with a fruity odour, and are usually obtained from butanol and acetic acid by esterification.

Butyl acetates are mainly used as solvents and extraction agents. They are however largely replaced by MEK and MIBK in the surface coatins sector, as these have higher solid contents for a given viscosity.

The main user of butyl acetate in Pakistan is the WPIDC penicillin factory. Paint manufacturers also use small quantities. As far as we were able to determine, the total consumption is of the order of 50 tons per year.

5.5.5 Aromatics

5.5.5.1 Benzene

Benzene, C_6H_6, is the base of all aromatic compounds. It is present in petroleum, coke-oven gas and coal tar. Nowadays it is mainly extracted from petroleum by catalytic reforming and from toluene.

Benzene is one of the most important raw materials in organic chemistry. Phenol, insecticides, chlorobenzene, aniline, styrene and detergents are among the products manufactured from it. It can also be used as a motor fuel, having an octane number above 100. Further applications are as solvents and extraction agents.

Benzene is mainly used in the manufacture of insecticides (DDT, BHC) in Pakistan. Refineries, paint manufacturers and firms extracting plant alkaloids import small quantities.

The consumption figures to date are given in table 86. The figures for the insecticides industry were extracted from the DDT and BHC production figures. We based our calculations on 0.69 tons benzene per ton of DDT and 0.48 tons of benzene per ton of BHC.

Table 86: Consumption of Benzene[1] in the Period 1965/66 - 1967/68 (in tons)

	1965/66	1966/67	1967/68
West Pakistan			
DDT	344	415	598[2]
BHC	-	-	179[2]
Others	30	40	50
Total West Pakistan	374	455	827
East Pakistan			
DDT	-	125	308
All Pakistan			
DDT	344	540	906
BHC	-	-	179
Others	30	40	50
Total All Pakistan	374	580	1.135

[1] The possible consumption of benzene for the production of detergents has not been taken into consideration (see section 8.5.2)

[2] See critical remarks in section 5.6.3.2.2 concerning consumption volume.

5.5.5.2 Toluene

Toluene, $C_6H_5CH_3$, is a colourless liquid with an odour similar to that of benzene. It is present in crude oil and is produced also by hydroforming.

It was in the past used almost exclusively in the manufacture of trinitro toluene and as a component of aviation spirit. Now, it is an important raw material for the chemical industry, being employed, for example, in the manufacture of benzene, caprolactam and phenol. Toluene is also used as a solvent and as an extraction agent.

The National Refinery Ltd., Karachi is at present the largest private consumer in Pakistan, having a consumption of approx. 175 tons per year. Smaller quantities, at an estimate 30 tons per year, go into the surface coatings industry.

5.5.5.3 Xylene

Xylene is an aromatic hydrocarbon of the general formula $C_6H_4(CH_3)_2$ of which there are three isomers (ortho-, meta- and paraxylene).

Whilst xylene was in the past extracted from coal tar, it is now usual in the industrialised countries of the West to produce it by hydroforming together with benzene and toluene from crude oil. As excessive quantities of xylene are obtained when producing it with other aromatic hydrocarbons, refineries mainly use it as an additive to increase the octane number of petrol. Xylene mixtures are also important solvents for greases, oils, synthetic resins, rubber etc. In the surface coatings industry, such mixtures play an important role as diluents.

Ortho- and paraxylene are important industrial raw materials necessary to the manufacture of phthalic anhydride and terephthalic acid. Whilst phthalic anhydride is widely used in the manufacture of plasticisers, alkyd resins and other polyester resins, teraphthalic acid is essential in the manufacture of polyester fibres.

In Pakistan, xylene takes second place among the solvents only to mineral turpentine at least if petrol and solvent oil are neglected. It is used in smaller quantities by the surface coatings industry and in the formulation of liquid insecticide mixtures. As far as we were able to determine, it has in the past mainly been bought by the Department of Agriculture and in smaller quantities by the General Tractors and Machinery Co. Ltd., Karachi for insecticidal purposes.

Attempts to estimate the consumption in the past are hindered mainly be the fact that xylene cannot always be definitely identified from the data given by the competent authorities, as in some cases only the importation of "solvents" has been recorded.

A summary of the positively identified imports of xylene and a rough estimate of the demand of the surface coatings industry leads to the following consumption figures:

Table 87: **Consumption of Xylene During the Period 1963/64 - 1966/67 (in tons)**

	1963/64	1964/65	1965/66	1966/67
West Pakistan				
Insecticides	150	-	-	150
Others[1)]	100	100	120	140
Sub-total	250	100	120	290
East Pakistan				
Insecticides	230	300	260	106
Others[1)]	100	100	100	100
Sub-total	330	400	360	206
All Pakistan				
Insecticides	380	300	260	256
Others[1)]	200	200	220	240
Total[1)]	580	500	480	496

1) Mainly surface coatings industry, estimated

Our studies have shown that the consumption figures given are to be regarded as minimum values.

5.5.6 Plasticisers

5.5.6. Plasticisers

5.5.6.1 General Characteristics

Plasticisers are usually low-molecular weight solid or liquid organic compounds which can be worked into polymers. They give the high-polymeric structures certain desired physical properties, as for example increased elasticity, reduced hardness, plasticity and lower the second order transition temperature. These properties last for a considerable time.

Phthalic acid esters are at present in wide use as plasticisers, and as dioctyl phthalate, dibutyl phthalate, dimethyl terephthalate and phosphoric acid esters, polyglycol esters from fatty acids and chlorinated paraffins. Plasticisers are above all important to the coatings, plastics and rubber sectors. Their most frequent application (up to 70 per cent of the entire consumption of plasticisers) is however in the manufacture of plasticised PVC.

The addition of plasticisers to PVC (20 - 50 per cent plasticiser content) is necessary in the manufacture of moulding compounds for cable insulation, shoes, films and other extruded and injection-moulded articles. Plasticisers are also used in the manufacture of PVC pastes for artificial leather, floor coverings and cast article production. The plasticisers in main use for PVC are the phthalic acid esters; of these, dioctyl phthalate (DOP) takes first place. Phosphoric acid esters such as trioctyl- and tricresyl phosphate and chlorinated paraffins are however also in use.

Almost the only field in which plasticisers haved gained any greater significance in Pakistan is the manufacture of PVC compounds and pastes. Here, dioctyl phthalate is the main product used.

5.5.1.2.2 Domestic Production

In Pakistan ethyl alcohol is only produced by fermentation of molasses, which occurs in large quantities as a by-product of sugar production. The capacities set up for the production of 96 per cent alcohol are as follows:

West Pakistan	Capacity (in t/y)
Valika Chemical Ind. Ltd., Karachi	10,700
Premier Sugar Mills, Mardan	4,300
Kohinoor Rayon Ltd., Lahore	3,600
Frontier Sugar Mills, Takht-i-Bhai	2,100
Habib Sugar Mills, Nawabshah	2,100
Hyesons Sugar Mills, Khanpur	2,100
Quetta Distillery Ltd, Quetta	2,100
Kotti Distillery Ltd., Hyderabad	not working
Crescent Sugar Mills, Lyallpur	2,100
Murree Brewery Co. Ltd., Rawalpindi	not known

East Pakistan	Capacity (in t/y)
Carew & Co. Ltd., Dacca	2,500

It is the sugar mills and distilleries which buy the molasses on the market that are the real suppliers of ethyl alcohol to the general market.

Valika Chemical Industries Ltd. utilizes ethanol for the production of ethylene/polyethylene. The capacity of the plant is so designed that the entire requirements of the polyethylene plant can be met.

Kohinoor's plant is integrated in a cellulose acetate factory, where ethanol is processed into acetaldehyde and acetone. Acetladehyde is the raw material for producing acetic anhydride, which is the primary product for the manufacture of cellulose acetate. Acetone is used as a solvent for the dry-spinning process. Kohinoor has sold ethanol from

The main demand of the rubber sector is directed towards spindle oils, which comprise about 3 per cent of the mix for most rubber products. Being purely refinery products, these oils are not considered in this study. We were unable to discover any consumption of plasticisers in the paints field.

5.5.6.2 Domestic Production

There is no domestic production of the plasticisers considered in Pakistan, nor are any such projects planned, as far as we were able to determine.

5.5.6.3. Demand

5.5.6.3.1 Volume and Structure of Past Demand

The following considers only the demand of the PVC sector for plasticisers. The table below shows the consumption of the past four years.

Table 88: Consumption of Plasticisers in East and West Pakistan, 1965 - 1968 (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1965	480	125	605
1966	450	110	560
1967	850	250	1,100
1968*)	1,330	180	1,510

*) Estimated consumption

Approximately 90 per cent of the consumption figures given in the above table represent consumption of dioctyl phthalate. The remaining 10 per cent represent in the main consumption of dibutyl phthalate and chlorinated paraffins.

The plasticisers consumed in 1967/68 went in the main - 67 per cent- into paste production. A further 13 per cent were used for shoe compound and 20 per cent in the manufacture of cable compound.

Only about 12 per cent of the total demand for plasticisers in 1968 originated from East Pakistan. This is explained by the fact that the main user - the artificial leather industry - is much more widely represented in West Pakistan than in the Eastern Wing. At the time of our survey, we were only able to find one concern manufacturing compounds in East Pakistan. Two further plants were closed down.
In West Pakistan, there are at present about nine manufacturers of artificial leather who prepare their own pastes. Two to three further plants are closed down. Two further firms are manufacturing compounds: the Atlas Rubber & Plastic Industries Ltd., a cable manufacturer, and Arokey Chemicals Industries.

DOP is mainly supplied by England and the USA. Other plasticisers are in the main either of West German or British origin.

5.5.6.3.2 Forecast of Consumption Trends

The mean annual growth rate for the consumption of plasticisers in Pakistan over the period 1965 to 1968 was approximately 36 per cent. The fact that this quota is higher than the growth rate for PVC consumption indicates that compounding has until now been expanding in Pakistan. The rising consumption was, as is true for other cases, only interrupted briefly in 1966 by the economic recession which followed the Indo-Pakistani War.

Further great expansions are without doubt to be expected in both East and West Pakistan in the future. The first signs can already be seen.

The following firms for instance plan to start the production of compounds in or after 1969 or to extend the existing capacities:

- Karim Rubber, Dacca: 2,000 t of shoe and cable grade compound

- Cable factory of the EPIDC, Chittagong: 3,000 tons of cable grade compound

- Atlas Rubber & Plastic Cables Industries Ltd.: 5,000 t of shoe compound, cable compound and paste in the first phase; 10,000 t of compound from 1970.

If all these projects were realised to the desired extent, quite obviously on principle all PVC soft types would be produced in Pakistan by 1970. The demand for plasticisers thus should develop in the next two years according to the extension of the capacities until the demand for PVC soft is fully met. After 1970 the further development of the demand for plasticisers will depend on the increase in the demand for PVC soft. The following individual consumption figures are estimated by us:

1968	1,510 t
1969	2,365 t
1970	3,220 t
1971	3,600 t
1972	4,100 t
1973	4,600 t
1974	5,100 t
1975	5,750 t

According to this estimate the demand for plasticisers will increase almost fourfold up to 1975. By then East Pakistan will account for about 30 per cent and West Pakistan for about 70 per cent of the demand. About 90 per cent of this quantity should still be DOP. The remaining 10 per cent are chiefly dibutylphthalate, chlorinated paraffins, and paraffin-sulphonic acid phenyl/cresyl esters.

5.5.6.4 Prices

The prices for DOP have in recent months risen sharply, at least in Germany. The price rise was from US $ 380 per ton to approx. US $ 600 per ton. The manufacturers have given no reason for this rise of two-thirds of the old price. It is certain that the worldwide DOP production capacities are too small to meet the demand. The question of whether or not the present high price will in the near future fall equally sharply remains open.

The c & f prices for DOP at the time of the study were between 400 and 450 US $ per ton. Chlorinated paraffin are sold at about US $ 240 per ton. C & f prices probably also have risen sharply in the meantime.

5.5.6.5 Consumers

Worthy of mention among the present users are above all Arokey Chemicals Industries and Atlas Rubber & Plastics Industries Ltd.

Further important users are all firms which manufacture PVC coatings. These are listed in section 5.1.3.5. Future large-scale users are the Karim Rubber Industries and the EPICD Cable Factory.

5.5.6.6. Recommendations

In view of the results presented above, we consider it advisable to begin with the manufacture of plasticisers in particular DOP, as soon as possible. The minimum economic capacity of a plant for the manufacture of DOP is approximately 500 tons. As compounding operations are carried out in both East and West Pakistan, we suggest that plants are erected in both Wings.

We also suggest that the PVC factory be allowed to carry out only a minor share of the compounding operations for moulding compounds, in order to prevent the introduction of monopolistic marketing practices. As long as its PVC compound has only a small share in the market, one need normally have no fears that the resin will be supplied to the compounding concerns at prices which are excessively high in comparison with the compounds manufactured by the PVC factory itself.

5.5.7 Hexane

5.5.7.1 General Characteristics

5.5.7.2 The Pakistan Oil Extraction Industry and its Problems

5.5.7.3 Domestic Production

5.5.7.4 Demand

5.5.7.4.1 Volume of Past Demand

5.5.7.4.2 Forecast of Consumption Trends

5.5.7.5 Prices

5.5.7.6 Recommendations

5.5.7. Hexane

5.5.7.1 General Characteristics

Hexanes belong to the group of alkanes. They are hydrocarbons of the formula C_6H_{14} with 5 isomers. Hexanes are transparent, highly flammable liquids.

Hexanes are components of motor fuels, branched hexanes are noted for their knock-resistent character. In addition, hexanes are used as solvents and extracting agents for fats. In general oil cake forms the basis for fat extraction. Soybeans usually are not pre-pressed but can be directly extracted. Hexane as a solvent extracts from the oil seed or the oil-cake the major part of the oil that still remains after expelling. After extracting the oil, the largest part of the solvent is recovered from the oil by fractional distillation. It is returned to the extraction process. In modern extraction units the loss of hexane thus is not higher than 1/2 per cent of the processed quantity of oil cake.

5.5.7.2 The Pakistani Oil Extraction Industry and its Problems

In West Pakistan nine oil extraction plants of a total throughput capacity of 700 t of oil cake per day use hexane for the extraction of oil cakes from cottonseed and also from rapeseed, mustard and groundnut. The soybean very common above all in the USA and especially suitable for direct extraction is not yet grown in Pakistan.

Most of these plants have been added to already existing expelling plants during the last few years. But some of the nine firms depend on purchasing the required oilcake on the market.

By the establishment of these plants it was intended to make Pakistan more independent of vegetable oil imports. Before, the unextracted oilcakes had been exported or used as animal feed in the country.

The oil extracting industry is just undergoing a crisis. As this crisis has direct effects on the consumption and the potential future production of hexane, it seems advisable to explain its causes here.

The price of cottonseed oil cake, including shells, hulls and linters fluctuates from season (October to March) to off-season (April to September) between 270 Rs./t and 490 Rs./t. It is precisely the opposite direction in which the world market price for pure meal obtained from the oil cake after extraction moves periodically namely between 113 $/t in winter and 94 $/t in summer. Though an exporter of meal receives 30 per cent Bonus Voucher, it is at least during the off-season more favourable for a mill owner not to extract his oil cake but to sell it unextracted on the local market. It is worth noting that at present the proceeds from the extracted oil cannot make the extraction business profitable during the off-season. This is shown in the following confrontation:

Feasible proceeds from oil-cake utilization during the off-season

in case of sale of the cake:

1 t oil cake (undelinted, undecorticated, unextracted)	Rs. 348.00

In case of extraction the proceeds are:

1/2 t meal, exportrate	Rs. 160.00
30 per cent B.V. at 170 per cent	Rs. 81.50
60 kg oil at 2.15 Rs./kg	Rs. 129.00
440 kg shells, hulls, and linters	-
	Rs. 370.50

The difference of 22.50 Rs./t cannot make up for the cost for solvents, power, wear and tear of the plants for extracting, delinting and decorticating as well as for transport of the meal and removal of the shells and hulls.

The situation is somewhat more favourable during the season:

1 t oil cake (undelinted, undecorticated, unextracted)	Rs. 268.00

1/2 t meal, exportrate	Rs. 194.00
30 per cent B.V. at 170 per cent	Rs. 99.00
60 kg oil at 1.85 Rs./kg	Rs. 111.00
440 kg shells, hulls, and linters	-
	Rs. 404.00

its excess production in rectified or denaturated form to various buyers such as paint manufacturers, pharmaceutical firms, hospitals, rubber companies, scientific laboratories and Pakistan Ordnance Factories Ltd.

Kotti Distillery's plant is standing idle, Habib Sugar Mills had only one trial run in 1963, and Hyesons Sugar Mills has never been in operation. The reasons are lack of demand and the high prices of molasses.

The capacity in operation is at present about 29,000 tons per year. In addition to this, there is a capacity of about 7,000 tons which is stated to be standing idle.

Production increased strongly in 1966/67, namely to about 17,400 tons (see table 83). In 1968/69 another sharp rise is expected, because now Valika's ethylene production is in operation.

Table 83: Production of ethyl alcohol, 1965-1968 (in tons)

	1964/65	1965/66	1966/67	1967/68
East Pakisten	977	851	1,355	874
West Pakistan	3,628	8,160	16,030	15,470
All Pakistan	4,605	9,011	17,385	16,344

Note: These production figures cover ethyl alcohol for processing into ethylene, acetone and acetaldehyde. Alcohol produced in the form of beer and other alcoholic drinks is not included in the data.

The production is heavily concentrated in West Pakistan (95 per cent). While production in East Pakistan shows pronounced fluctuations, in West Pakistan it had an average rate of increase of 52 per cent per year. Such rapid growth will of course not continue because the firms are already complaining about excessive supplies. The scope for exports is limited as molasses is exported against Bonus Voucher and is there-

Therefore, the oil extraction plants are run intermittently and mostly operate only during three months a year.

Large imports of soybean oil under US aid are the reason for the low price of oil in the country. These imports were not taken into consideration in the planning of many of the plants. Indeed, in 1966 when the foreign aid had been stopped after the war, the wholesale price of cottonseed oil was about 100 per cent higher than today.

The real problem does not consist in the lacking demand for meal, which can always be exported, but in the ignorance of the farmers who pay much too high a price for oil cake. They actually buy cellulose of almost no value in the form of shells and linters, and also the oil which is of little use either as animal food. The profit from the sales of the otherwise unsaleable shells ultimately is the reason for the profitabillity of the policy pursued by the mill owners.

The imports of soybean oil on the other hand make the capital investments so far effected in this industrial sector a losing business.

5.5.7.3 Domestic Production

Up to now hexane is not recovered in pure form in Pakistan.

5.5.7.4. Demand

5.5.7.4.1 Volume of Past Demand

As no locally produced hexane is available at present, the total demand is met by imports. The consumption figures for the last four years are:

1965	:	400 t
1966	:	600 t
1967	:	510 t
1968	:	600 t[1]

1) The figur for 1968 has been estimated.

The consumption figures reflect the utilisation of the capacities of the extraction plants. A strong increase in the consumption was registered in 1966 when four extraction plants were put into operation. But also these plants soon were run only intermittently. In 1967 another three plants were installed. Then the expansion of this industrial sector stopped. With regard to the bad experience made so far nobody is thinking of establishing the remaining sanctioned capacities.

5.5.7.4.2 Forecast of Consumption Trends

As long as the relationship between oil price and the price for unextracted oil cake does not change fundamentally, oil extraction and hexane consumption are unlikely to increase.

On the basis of a processing capacity of 700 t of oil cake per day, an average consumption of 7.5 kg of hexane per ton of oil cake and an operating period of 100 days a year, the annual hexane consumption is estimated at 525 tons. This hexane consumption can be considered as the present normal consumption.

As stated by the mill owners, the plants are operating at a loss because of too long inoperative periods. Therefore, the establishment of new plants is unlikely as long as the existing ones are not used to full capacity.

There are the following alternatives for making the oil extraction attractive also during the off-season:

- Increase of the Bonus Voucher for the export of meal. In this way the difference between the proceeds from the exports of meal and the sales of oil on the one hand and the proceeds for unextracted oil cake on the other would become large enough.

- Stop of the imports of soybean oil from the USA. This unpopular measure certainly would result in a considerable rise of the oil price.

But none of these measures appears really recommendable. Therefore, the only possibility is to wait until the farmers gradually learn to estimate the value of meal and thus cause the oil cake price to fall. At present the farmers do not buy the meal. Such a development certainly depends to a large degree on the information by the oil extraction firms. But so far these hardly seem to hεve taken steps in this direction.

After considering all the facts we are of the opinion that the annual consumption of hexane at present amounting to about 600 tons should not rise considerably in the next few years. A forecast, however, is very difficult. By a change of the import policy the unfavourable situation of the oil extraction industry may be improved instantaneously. As a consequence also the consumption of hexane would increase.

5.5.7.5 Prices

The price of hexane varies strongly in different countries (cf. Table 89).

Table 89: Domestic Prices of Hexane in some Industrial Countries,*) (in $/ton)

	USA	Belgium	Italy	France
1964	64	79	70.5	149
1965	64	55	68	149
1966	62	46	68	149
1967	62	84	75	149
1968	62	88	79	147

*) The prices include transport charges but exclude taxes.

In Pakistan hexane is supplied only by Esso. This is due mainly to the required capacity of the storage tanks since the demand for one year usually is met by a single shipment. In Karachi only Esso has sufficient storage capacity.

The c & f price of the hexane supplied by Esso was

$ 85 per ton

in 1968.

5.5.7.6 Recommendations

The small quantity of 600 t of hexane per year cannot be produced profitably. According to our experience and discussions with manufacturers of plants, the size of the plant should not be below 4000 to 5000 t per year even in developing countries. We recommend, therefore, not to start a hexane distillation in Pakistan in the near future.

5.5.8 2-Ethyl Hexanol

5.5.8.1 General Characteristics

5.5.8.2 Possible Applications in Pakistan

5.5.8.3 Prices

5.5.8.4 Recommendations

5.5.8. 2-Ethyl Hexanol

5.5.8.1 General Characteristics

2-ethyl hexanol, $CH_3-CH_2-CH_2-CH_2-CH(CH_2-CH_3)-CH_2OH$, is an isomer of the octanol group and is one of the commercially important higher alcohols It is a slightly viscous liquid. 2-ethyl hexanol is obtained either by oxosythesis from isoheptene or by hydrogenation of the ethyl-propyl acrolein formed in the aldol condensation of n-butyraldehyde. The n-butyraldehyde in its turn originates from oxosynthesis of propylene or by aldol condensation of acetaldehyde, by oxidation or dehydrogenation of butanol or by partial hydrogenation of crotonaldehyde.

The phthalic acid, acrylic acid and adipic acid esters of 2-ethyl hexanol are used as plasticisers for PVC. The most important of these is dioctyl phthalate (DOP), which may indeed be looked upon as the most important of all plasticisers.

5.5.8.2 Possible Applications in Pakistan

As far as we were able to determine, 2-ethyl hexanol is not yet used in Pakistan or, if at all, only in minute quantities. It would however be used in considerable quantities in the event of the creation of domestic facilities for the production of plasticisers.

We wish to refer to section 5.5.(in this connection. On the basis of the estimated consumption of plasticisers stated in that section, the following consumption for 2-ethyl hexanol would apply should DOP be manufactured locally:

1971	2,460 tons
1972	3,810 tons
1973	4,270 tons
1974	4,740 tons
1975	5,350 tons

As in that section, we have assumed here that

- 90% of the plasticisers are dioctyl phthalate (DOP)

and

- the entire demand for DOP is satisfied by domestic sources

The basis of calculation is the use of 0.76 tons of ethyl hexanol per ton of DOP.

5.5.8.3 <u>Prices</u>

The price for ethyl hexanol in the West is approx. $ 300/ton for small orders of 10 to 20 tons.

5.5.8.4 <u>Recommendations</u>

The manufacture of 2-ethyl hexanol from propylene might be advisable since it is usually cheaper than that via acetaldehyde. The minimum capacity for this process to be economically justifiable is approx. 12,000 tons per year. However, there is a high ratio of by-products such as butanol and iso-butanol.

Production from acetaldehyde on the other hand appears to be favourable from the point of view of minimum capacity and the point of view of raw materials. The minimum capacity for this process is about 3,000 tons per year; the raw material acetaldehyde could be produced from ethyl alcohol, which is available locally.

At the present stage of investigations it cannot be decided which of the possible processes is the most suitable one for Pakistan. A feasibility study should be prepared on this subject at an early date.

5.5.9 Summary

The following is a summary of the present total annual consumption (1967/68) of plasticisers and solvents by private industry as described in the previous sections (in tons):

Alcohols	
Methanol	
Ethanol	
Butanols	50
Ketones	
Acetone	50
MEK	240
MIBK	40
DAA	80
Chlorinated hydrocabons	70
Butyl acetate	50
Aromatic hydrocarbons	
Benzene	1,150
Toluene	200
Xylene	300
Plasticisers	
DOP	1,360
DBP, DIOP etc.	70

Mineral turpentine	3,050
2-Ethyl hexanol	
Hexan	600
Total of solvents covered	7,310

Not included in this table are petrol and solvent oil. By far the most important solvent is mineral turpentine, which is locally available. Mineral turpentine alone accounts for around 50 per cent of all the above mentioned solvents. It is produced by the Attock Oil Co.

fore rather expensive in Pakistan. As a result, less than 45 per cent of the installed capacity was in operation in 1967/68.

5.5.1.2.3 Demand

5.5.1.2.3.1 Volume and Structure of Past Demand

Ethyl alcohol excepting in the form of drinks is only imported in small quantities in a high concentration for laboratory use. Both can be ignored for our purposes.

The consumption, including exports, of 96 per cent ethyl alcohol produced in Pakistan therefore corresponds to the figures indicated in table 83. In 1967 it went into

- locally produced alcoholic drinks	25 per cent
- Pharmaceuticals	17,5 " "
- Acetone, acetic acid and acetic anhydride produced by Kohinoor Acetate Rayon Ltd., Lahore	19 " "
- Acetone produced by Pakistan Ordnance Factories Ltd., Wah	7,5 " "
- Ethylene produced by Valika	6 " "
- Exports	25 " "

In 1967 about 50 per cent of the total production was destined for the domestic market, the remainder was processed by the producers for their own purposes, or exported. In 1968 this picture will change as the quantity of ethylene manufactured by Valika will increase during this year.

5.6 Insecticides

5.6.1 General Observations on the Application of Insecticides in Pakistan

Pakistan is one of the developing countries which recognized the importance of pest control at an early stage. Indeed, back in the thirties certain measures of pest control were applied for the first time in the territory that is now West Pakistan. After the independence of the country had been declared, these efforts were continued and increased throughout the country [1].

One can hardly overestimate the importance of pest control, since the damage caused each year by vegetable and animal pests of all kinds is tremendous. In 1967 the average damage done on a world-wide scale was

- 24.5 per cent to wheat
- 48 per cent to rice
- 53 per cent to sugar cane
- 24 per cent to cotton seed
- 34 per cent to cotton
- 42 per cent to millet
- 24 per cent to natural rubber

of the potential harvests, according to an estimate of Farbenfabriken Bayer. "Potential harvest" means the yield that would have resulted if there had been no damage by pests.

These are average values. The values for individual countries or continents may deviate considerably. The loss of sugar cane in Asia, for instance, was estimated at 65 per cent, compared with a world average of 53 per cent.

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1) Cf. A.S.K. Ghoury, "Chemical Pest Control in West Pakistan (1947 - 70)", Lahore 1967, page 1

It can be assumed that the losses in Pakistan are smaller in some cases, but they are still surprisingly high. Thus CIBA for instance, working on a sample basis, estimated the damage to rice caused by insects to be an average of 30 per cent in East Pakistan. Stemborers generally account for the greater part of the destruction. The damage caused in the cultivation of cotton in West Pakistan is estimated at 30 - 50 per cent [1].

These statements, however, do not characterize sufficiently the importance of the pests. Above all, the human diseases directly or indirectly caused by insects or other pests have to be mentioned, especially malaria and other infections spread by mosquitoes and flies (e.g. haemorrhagic fever, dengue fever, encephalitis).

In all these cases pesticides can form a remedy. Depending on the type of pests to be destroyed, a distinction is made between

- insecticides
- miticides
- fungicides
- herbicides
- rodenticides

and others. The insecticides are the most important ones in terms of the quantity consumed. The synthetic organic insecticides most widely used today can be classified mainly as

- chlorinated hydrocarbons
- organo-phosphatic compounds
- carbamates.

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1) Cf. S.A. Rahman, "Cotton Protection for Better Yields", in "10 Years of Agricultural Development in Pakistan", page 140

The chief members of the chlorinated hydrocarbons group are DDT, BHC, Methoxychlore, Chlordan, Aldrin, Dieldrin, and Endrin. DDT, BHC and certain others of these products were the very first synthetic organic insecticides ever put on the market. Their effect, extraordinary for their time, led to a considerable improvement of pest control.

The group of organic phosphorus compounds, which was discovered later, above all had the advantage of being very efficient against sucking pests such as spider mites. Moreover, it produced a new type of toxic agents, the so-called systemic insecticides which act mainly through the sap circulation of the plants and thus in general only affect the real pests. Among the phosphorus compounds are Parathion, Malathion, Diazinon, Systox, Metasystox, and Dimecron. The three last-mentioned compounds are of a systemic nature.

The group of carbamates has gained importance during the last few years. Carbamates are esters of carbamic acid. Well-known products are Dimetan, Pyrolan, Dicarbam and, above all, Sevin.

In Pakistan as elsewhere the chlorinated hydrocarbons, especially DDT and BHC, played a dominant role after 1945. During the last few years a strong tendency has been noted to replace the chlorinated products, primarily by phosphates and carbamates. According to an article which was published recently [1] the share of the three groups of insecticides in the total quantities imported into Pakistan developed as follows from 1960/61 to 1964/65:

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1) Cf.K.U. Siddiqui, "Pesticides in Pakistan", in "10 Years of Agricultural Development in Pakistan", Karachi 1968

	Chlorinated Hydrocarbons	Phosphatic Compounds	Carbamates
1960/61	59.2 %	10.6 %	-
1961/62	53.5 %	25.8 %	-
1962/63	18.8 %	30.7 %	39.0 %
1963/64	26.5 %	54.8 %	6,0 %
1964/65	11.1 %	42.7 %	31.6 %

It is the old standard pesticides DDT and BHC that have mainly been affected by this trend. Unfortunately, precisely these two products have been manufactured in the country for a short time, with the result that most of the insecticide industry in Pakistan can neither really flourish nor die.

For a better understanding of the following statements it might be useful to recapitulate the method of distribution of insecticides in Pakistan. The most important factor is that imports of insecticides and their consumption were almost entirely controlled by the Agricultural Departments in East and West Pakistan and partly by the Central Government. The Central Government buys insecticides for aerial spraying and for locust control. The Provincial Governments supply insecticides which are generally used in agriculture. In most cases they are supplied free of charge or at very low cost [1]. The only non-governmental buyer of importance is the Pakistan Tea Association in Chittagong which imports for its members. In addition, DDT powder for the Malaria Eradication Programme is imported independently of the governmental purchases.

1) In West Pakistan 25 per cent of the cost is charged at present. In East Pakistan the large plantations have to pay the full cost plus 20 per cent.

Almost all insecticides are imported on the basis of so-called Lists of Standardized Pesticides. In practice it is especially the modern insecticides that have been purchased. The traditional chlorinated hydrocarbons and above all DDT and BHC are usually rejected as obsolete and not very suitable. For some years they have not been included any more on the List of Standardized Insecticides in East Pakistan [1]. This attitude is fairly common among almost all competent authorities and is only in part based on the fact that the prices of DDT and BHC are relatively high, due to the local production of these products.

Domestic production has so far been limited to these two products. Going by the existing applications and sanctions, however, it can be expected that several more insecticides will be locally produced within two or three years. At the moment plans exist for instance for the production of

- Carbicron (EPIDC)
- Dimecron (EPIDC)
- Malathion (IPS)
- Ekothion (IPS)
- Sevin
- Diazinon
- Methyl-Parathion (Insecticides Ltd.)
- Endrin
- Heptachlore
- Petkolin (WPIDC)

Of these, only the last three are chlorinated products. Petkolin is a product developed in Pakistan by the Pakistan Council of Scientific and Industrial Research (PCSIR).

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1) Situation in mid-1968.

It must be stressed that at present a rather large number of different insecticides are free for importation. From various expert quarters in Pakistan, it is pointed out that this variety of imports is unfavourable, and we think this comment is justified. In particular, the strain on the technical staff who apply these insecticides in practice is too great. But also the effect on the prices is not likely to be favourable. As far as DDT and BHC are concerned, this variety helps to conceal the fact that in many cases it would be perfectly possible to apply traditional standard insecticides like DDT and BHC.

5.6.2 Dichloro-Diphenyl Trichloro-Ethane (DDT)

5.6.2.1 General Characteristics

Dichloro-diphenyl-trichloro ethane (DDT) with the empirical formula $C_{14}H_9Cl_5$ was the first widely applied organic insecticide. Thanks to its application, it was possible to save millions of people from illness and death during and after World War II. It became particularly famous on account of its use against the insects spreading malaria, but all over the world it was even more effective in helping to reduce agricultural damage.

In general DDT is industrially produced by condensation of trichloro-acetaldehyde (chloral) and chlorobenzene. The industrial product is a mixture of several isomers with traces of other compounds. Though some of the by-products obtained also have insecticide properties and the quality of the product is little affected by them, for reasons of further processing the product it is preferable to keep the share of the main component, i.e. p,p -dichloro-diphenyl-trichloro ethane, as high as possible. The product thus becomes harder and can be more easily milled.

DDT acts as a contact or stomach insecticide. Its effect is better at lower temperatures than at higher ones. Besides, it acts more quickly in the form of solutions and emulsions than in powder form. It has outstanding properties as a residual insecticide. Since it is not soluble in water, it is not leached away by rain.

DDT is an effective control instrument against the various types of beetles, caterpillars, weevils, cockroaches, bugs, and others. It has a wide spectrum of effectiveness. Of the many different damaging insects of the Indo-Pakistan subcontinent it can be effectively applied against:

- mosquitoes
- jassids
- white flies
- mango hoppers
- crickets
- ball worms
- ordinary flies.

It can, however, not be successfully applied against mites.

DDT is usually traded in the form of technical material, emulsion concentrates (E.C.), dusts and wettable powders (W.P.).

In Pakistan

- technical DDT
- W.P. 75 per cent
- W.P. 50 per cent
- dust 5 per cent

are usually sold in the market and also produced locally.

The application of DDT often causes a considerable increase in the mite population due to the killing of their natural enemies. It is further maintained that the application of DDT leads to a higher production of eggs. In cases where mites are a problem DDT must, therefore, be applied in combination with mite-killing insecticides.

Another disadvantage of DDT is the possibility that specific insects may become resistant to it. This is known to be the case with ordinary flies, for example. It means that in such cases the lethal dose increases more or less rapidly. The insects in question can still be killed if major quantities of the insecticide are applied, but there will come a point when a further application becomes uneconomic.

According to information provided by various institutions, a certain resistance already exists in some places in Pakistan. However, our experience was that the problem is exaggerated in many cases. Detailed interviews with experts always showed that such phenomena could be traced only in very limited areas and that the resistance is usually still comparatively low. In our experience this argument often plays too big a role in decisions on the application of insecticides.

The toxicity of DDT against mammals is low. But it must be taken into account that DDT is stored in the bodies of men and mammals and may possibly be harmful to them It can be supposed that this applies to the population of developing countries to an even greater degree, since the damaging effect of the stored poison largely depends on the fat content of the human body. People in the said countries are often undernourished. Therefore, DDT should not be applied for the treatment of animals nor in the time before the harvest period.

5.6.2.2 Production

5.6.2.2.1 The Producers and their Output

In Pakistan at present there are three factories producing DDT, two of them in West Pakistan and one in East Pakistan:

- DDT Factory, Nowshera
- Insecticides (Pakistan) Ltd., Kala Shah Kaku near Lahore
- DDT Factory, Barabakund near Chittagong.

The first enterprise to produce DDT in Pakistan was the DDT Factory Nowshera, which is now run under the management of Technical Enterprises, Inc., New York/USA for the Ministry of Health. Originally, the plant was operated by WPIDC. The capacity of this plant is 600 tons of technical DDT per year. The production programme also includes powder formulations.

The plant of Insecticides Ltd. was only put into operation in 1967. Its capacity is stated as 1.350 tons. The firm manufactures powder and dust formulations and could also produce liquid mixtures.

The Chittagong factory belongs to the East Pakistan Industrial Development Corporation. Its capacity is 1.600 tons of technical DDT per annum. Production was started in October, 1966.

All these plants are operated on imported benzene, while chlorine and alcohol are purchased from local sources. Insecticides Ltd. obtain their chlorine requirements from United Chemicals, a nearby plant of the same concern (Saigol). DDT Factory, Barabakund get their chlorine supplies from the caustic soda plant of Chemical Industries of Pakistan Ltd., which is located close to it.

5.5.1.2.3.2 Forecast of Consumption Trends

Forecasting the further development of production and consumption is a rather delicate and uncertain matter, in view of the following facts:

- According to statements of the Board of Revenues, Lahore, the government intends to restrict the consumption of alcoholic drinks more and more by continuously increasing the taxation. But there are no detailed plans at the moment.

- Valika intends to buy ethylene from a Naphtha-Cracker when it is set up. It is uncertain what will happen to the ethanol plant. The producers themselves do not know how their ethanol production will develop in the near future.

- As agreed with the Planning Commission, no data were collected about the future requirements of Pakistan Ordnance Factories Ltd.

- Whether exports will be possible is largely dependent on the prices of molasses.

Thus, the Kohinoor cellulose acetate plant and the pharmaceutical industry remain the only fairly reliable consumers.

Kohinoor's plant will probably be in full operation very soon, increasing its production and consumption to about 3,600 t/y. Valika's ethylene plant may also be fully employed in 1969. Under present conditions a further strong increase seems very unlikely. An increase of only 10 per cent per year has to be regarded as optimistic.

The overall production is at present about 1.300 tons (cf. Table 90). The increase during the period was very high at 100 per cent per annum, but, as will be shown later, this is not a proof of good sales conditions. The ratio of the production between East and West Pakistan was about 1 : 3 in 1967/68 in favour of the Western Province. The production capacities are nearly equally distributed (55 : 45 in favour of West Pakistan).

Table 90: Production of Technical DDT in Pakistan 1965/66 to 1967/68 (in tons)

Firm	1965/66	1966/67	1967/68
DDT Factory Nowshera	499	601	333
Insecticides Ltd.	-	-	534
DDT Factory Barabakund	-	181	446
Total	499	782	1.313

The future production of Insecticides Ltd. and of the DDT Factory Barabakund is uncertain, due to the delicate sales conditions. The Nowshera factory states that it will produce 600 tons of technical DDT a year in the next two years, which will be formulated to 75 per cent W.P.

5.6.2.2.2 Problems of Domestic Production

Whereas the plant at Nowshera is run for the Health Ministry at Rawalpindi and, therefore, does not face any sales problems, the other two factories come up against considerable difficulties in selling their production. [1] The outlets for their

1) Cf. Section 5.6.2.3

products are largely blocked for the following reasons:

- The agricultural authorities generally do not like to use DDT because it is considered out-dated and because the accumulation effect is feared.

- The Malaria Eradications Programme receives most of its requirements under USAID from abroad.

- The demand of the Municipal Corporations and other local bodies is very small due to the non-availability of sufficient funds for sanitation purposes.

- The formulators of household insecticides do not like DDT any more because DDT is considered not effective enough and because the locally available product is too expensive. First and foremost they want insecticides with a high knock-down effect. Furthermore, they and apparently some of their customers have become heavily biased as a consequence of the circulating resistance stories.

The future of this industry, therefore, does not look too bright. The production plants are already suffering. Insecticides state that they have not operated their factory for eight months, and similarly the Barabakund Factory has only been working at 25 per cent capacity for 18 months.

The factories moreover state that they are suffering from power problems; as in many other cases, the voltage is generally too low and power break-downs are frequent. It was reported by the Barabakund factory that the power supply occasionally fails for several days. The result of break-downs is that the DDT condenses within the pipes and in the reaction vessel so that the lining has to be dismantled and the installations have to be cleaned.

The Barabakund plant also suffers from inadequate storage facilities for raw materials and finished products.

Both the Saigol factory at Kala Shah Kaku and the EPIDC plant apparently have certain problems in the formulation. It has been noticed by the buyers of their products that the product is not up to their requirements. Usually the suspensability is said to be not good enough. Moreover, in some cases no proper packing material is used: barrels should be lacquer-lined.

5.6.2.2.3 By-Products

The DDT factories produce as by-products

- hydrochloric acid (35 per cent)
- black sulphuric acid containing benzene sulphonic acid
- dichlorobenzenes.

The main problem in selling these products is the dichlorobenzenes. According to the DDT Factory Barabakund they obtain per ton of DDT about 70 kg of dichlorobenzenes. Insecticides Ltd. state that they have 15 to 20 kg of dichlorobenzenes per ton of DDT.

The dichlorobenzenes which are produced together with dichlorodiphenyl trichloro ethanes are a mixture of the ortho and para isomers. EPIDC suggests that this mixture could be taken as a snake repellent and degreasing agent.

If separated, o-dichlorobenzene could serve as a solvent for lacquers and certain resins and for the defatting of metal surfaces. The p-dichlorobenzene could be used as a deodorizer and in the manufacture of anti-moth formulations and floor disinfectants.

5.6.2.3 Demand

5.6.2.3.1 Demand in the Past

The total demand for 100 per cent DDT in the past three years reached a maximum of 8,400 tons in 1965/66. After that it declined sharply. The distribution of the demand between the two Wings was fairly equal. On the average East Pakistan consumed about 53 per cent of the total. The share of the imports over the period was 82 per cent. It was higher in East Pakistan (92 per cent) and lower in West Pakistan (72 per cent). Due to the establishment of two more factories and because of the lower demand, the import share came down from 95 per cent in 1965/66 to 65 per cent in 1967/68.

Table 91: DDT Imports and Sales Figures for 1965/66 - 1967/68 (in tons of DDT content)

Organization	1965/66	1966/67	1967/68
West Pakistan			
Insecticides Ltd., (sales)	-	-	534
DDT Factory Nowshera, (sales)	443	480	424
Malaria Eradication Programme: imports	2,484	1,125 [1)]	1,125 [1)]
sub-total, West Pakistan	2,927	1,605	2,083
East Pakistan			
Malaria Eradication Programme: imports	5,475	-	1,500
DDT Factory Barabakund: production	-	181	446
sub-total, East Pakistan	5,475	181	1,946
grand total, Pakistan	8,402	1,786	4,029

1) For 1966/67 and 1967/68 only one figure has been quoted, which has been divided between the two years.

There is every likelihood that this ratio will improve still more in the future because there is at present a strong tendency for DDT consumption to decrease further.

This can be seen from the demand of the main consumer of DDT, viz. the Malaria Eradication Programme (MEP). Under this program an anti-malaria campaign has been carried out in the villages and towns with less than 20,000 inhabitants over a period of 14 years. The strategy followed is that of breaking the contact between the sick persons and the mosquito population by house spraying. MEP's requirements of 75 per cent DDT powder are shown in table 92.

Table 92: Requirements of 75 per Cent DDT Powder by Malaria Eradication Programme (in tons)

Year	West Pakistan	East Pakistan	total
1962/63	1,220	383	1,603
1963/64	1,210	1,715	2,925
1964/65	3,700	3,080	6,780
1965/66	3,312	7,300	10,612
1966/67	1,500	-	1,500
1967/68	1,500	2,121	3,621
1968/69	2,730	3,500	6,230
1969/70	1,212	2,200	3,412

This table does not show the decline in consumption clearly enough because in 1966/67 and 1967/68 there were certain disruptions which were probably consequences of the Indo-Pakistan War. In future, according to existing plans, the requirements of the Malaria Eradication Programme will decrease year by year until it reaches nil in mid-1970. By that time malaria will have been eradicated in the countryside.

5.6.2.3.2 General Remarks on Future Demand

It has already been pointed out that the demand of the major consumer, i.e. the MEP, is going to disappear. This does not affect the actual demand of the DDT factories in operation but it takes away a big potential market which they have not exploited because they started late, because the product was not up to the mark and because the prices where too high.

Another small but increasing potential market which is vanishing is insecticide formulation. While production is increasing by at least 25 per cent every year, the demand of this sector for DDT will go down if the DDT factories do not make special marketing efforts. But if the formulators of household insecticides could be induced to put 1 per cent of DDT in all their formulations, the resultant demand would only be about 10 tons per annum.

The future of DDT production therefore lies in agriculture, in the sanitation programmes of the towns and cities and perhaps in a few new developments such as special packing materials for food items.

The local bodies are already using DDT formulations for their anti-mosquito and anti-fly programmes and it seems sure that these efforts will have to be carried out on increasing scale for many years to come. But the total consumption so far is very low. If we draw a conclusion from the figures received for Karachi, Rawalpindi, Lahore, the Armed Forces and the Pakistan Western Railway we may guess that in the towns, cities, cantonments and railway installations of West Pakistan at present not more than 50 tons of 100 per cent DDT are used per annum. In East Pakistan the consumption seems to be even less.

After discussions with experts working in the field of sanitation it appears that so far only a few per cent of the actual requirements are really satisfied. The quantities actually needed seem on the average to be at least ten times as high as the present consumption.

The largest potential demand can be seen in agriculture. If DDT mixtures in the form of dust or emulsions were used for cotton alone the demand would be sufficient to virtually solve the DDT problem in Pakistan. For calculation purposes we assume that 30 % of the cotton-growing land is treated with a cotton dust containing 10 per cent DDT, and the percentage of field coverage corresponds to the actual percentage of spraying at present. The insecticide is a kind of standard cotton dust. The number of treatments is assumed to be 5 and the quantity of dust to be 15 kg/ha for each treatment.

The total requirements are therefore

$$1.5 \text{ kg} \times 5 \times 1{,}600{,}000 \text{ ha} \times 0{,}3 = 3{,}600{,}000 \text{ kg}.$$

The 3,600 tons which could thus be utilised for cotton protection would represent about 100 per cent of the capacity of all the plants operating in Pakistan. Considering the fact that the protection measures for cotton will definitely be expanded, the full utilization of the existing capacity in Pakistan should not be a problem at all.

5.6.2.4 <u>Prices</u>

The domestic price level for DDT and formulations of DDT is high. In 1968 the manufacturers charged for 100 per cent DDT:

- DDT Nowshera	Rs. 9.26/kg
- Insecticides Ltd.	Rs. 9.26/kg
- DDT Barabakund	Rs. 9.91/kg

All these prices are inclusive of sales tax and defence surcharge.

For comparison, the ex-factory price of 75 per cent and 50 per cent W.P. is also indicated:

	75 % W.P.	50 % W.P.
- DDT Nowshera	Rs. 7.97/kg	Rs. 5.77/kg
- Insecticides Ltd.		Rs. 6.26/kg
- DDT Barabakund	Rs. 8.81/kg	Rs. 6.60/kg

The price development can be read to some extent from the average sales returns of the DDT factory Nowshera:

1965/66	Rs. 6.94/kg
1966/67	Rs. 6.74/kg
1967/68	Rs. 9.26/kg

Recently prices have apparently gone up considerably, which might be due to the banning of normal imports.

World market prices are much lower. At present the c&f price of DDT 75 per cent W.P. shipped under USAID is only one third of that produced in West Pakistan.

The c&f prices on which the USAID supplies have been based were as follows for 75 per cent W.P.:

1965: US$ 390.70/ton
1966: US$ 560.90/ton
1968: US$ 491.75/ton.

The high inland prices are much criticized by all consumers.

We found the main reasons for these high prices to be:

- small plant sizes
- high raw-material prices
- low utilization of capacity
- fairly high packing charges (ca. 8 per cent of cost).

The high cost due to the small size of the factories can probably not be avoided at an initial stage of industrial development, because on a small market one larger plant instead of several smaller ones would lead to a monopoly.

The high raw-material prices seem to be mainly due to problems in financing the foreign exchange part of the transport for bulk quantities (see para 5.6.3.2.3). This problem should be solved. And so should that of the low utilization of existing capacity.

5.6.2.5 Recommendations

Under the prevailing conditions, planning new DDT factories or increasing the production capacity cannot be recommended. On the contrary, in order to avoid waste of productive assets it is advisable for steps to be taken to secure the proper utilization of existing plants.

In order to achieve this we recommend

- taking appropriate action to ensure that formulations containing DDT are used in agriculture for such crops as cotton, rice (West Pakistan) and mangoes,

- considering whether it is not possible to start a centrally organized sanitation programme in the cities and towns after 1970, or whether the local bodies cannot be provided with the necessary funds for such programmes from an internal loan,

- reducing the import licences of the insecticide formulators in order to force them to apply more DDT and BHC,

- granting special import licences for raw-materials to the manufacturers for steady, undisrupted purchase in bulk.

On the firm level, marketing studies should be carried out to find the right approach for increasing sales. The DDT factory at Barabakund is very new; it appears that it would be advantageous to increase the efficiency of the enterprise still further. Moreover, the factory should be provided with better storage facilities.

After careful consideration of the factors having a bearing on the future consumption of alcohol, we have arrived at a rate of increase of 6,5 per cent a year. It is calculated as a weighted average from the following rates of increase;

Sector	Share	Rate of increase
alcoholic drinks	25 p.c.	5 p.c.
pharmaceuticals	17.5 " "	12 " "
cellulose acetate	19 " "	10 " "
acetone	7.5 " "	10 " "
ethylene	6 " "	0 " "
exports	25 " "	2 " "

Our estimates are based on the assumption that Valika will switch its production to ethylene supplies from Central Naphtha Crackers in the near future and we therefore take a consumption of 15,400 tons in 1967/68 as a basis. At a rate of increase of 6,5 per cent, which implies the following development of alcohol consumption in all Pakistan, will result:

1967/68	15,400 tons
1968/69	16,400 tons
1969/70	17,500 tons
1970/71	18,600 tons
1971/72	19,800 tons
1972/73	21,100 tons
1973/74	22,500 tons
1974/75	24,000 tons

During the whole period the present consumption would increase by only 50 per cent. A comparison with the installed capacities shows that even in 1975 the established plants will probably not be fully utilized. Our calculations are however based on the traditional applications and their continuous development in conformity with other estimates of demand made in chapter 5, and do not take into consideration any special substitution measures that may be taken. The

The increased application of formulations containing DDT in agriculture should not be difficult. It could for instance be stipulated that in cotton only DDT cotton dust may be applied at the low Government subsidized rates.

As far as the sanitation is concerned, it is apparent that the Municipal Corporations and other local bodies have great difficulties in coping with the essential sanitation requirements. Due to the high rate of increase in population and development measures their funds are limitsd. But the personnel available is restricted, too. It therefore seems that a centrally directsd campaign similar to that of MEP would have big advantages. As for the import licences of the household insecticide formulations, ws believe that some of their foreign exchange licences could be reduced. The formulators and part of the public seem to be under the exaggerated impression that DDT and BHC are not good enough. If the licences are curtailed, the Government should on the other hand take steps to induce the DDT manufacturers to reduce their prices.

The effectiveness of all these measures togsther could be further improved if the Government were to guarantes the DDT manufacturers a certain purchase, say 80 per cent of their capacity, for a number of years, provided the quality is good enough. Sub-standard qualities should be rejected or taken at a considerably reduced price which is generally agreed.

However, the public authorities should take the DDT only at a rate which leaves the factories at 80 per cent capacity utilisation and good management a profit of say 10 - 15 per cent on their own invested capital. The decreased sales cost should be duly considered. Basically such a price could be calculatsd by experienced persons without much difficulty.

5.6.3 Hexa-chloro Cyclo-hexane (BHC)

5.6.3.1 General Characteristics

Hexachloro-cyclohexane, or BHC as it is usually called, acts as an inhalation and contact insecticide. Its formula is $C_6H_6Cl_6$. The technical grade is a mixture of various isomers, of which the γ -isomer has insecticide properties. Concentrated products with at least 99 per cent of γ -isomer are called "Lindane" or "Gammexane". BHC, unlike DDT, is easily volatile.

Benzene hexachloride is usually produced from benzene and chlorine with the aid of light rays. The product thus obtained generally contains 10 to 15 per cent of γ -isomers, which can be increased by fractional crystallization and separation. It is relatively easy to increase the γ -share to 40 - 60 per cent. Difficulties arise in the separation of the ineffective isomers with regard to the utilization of the 85 per cent of by-products. The mere storage of the waste, for instance, may prove to be problematic.

BHC has a wide range of effectiveness. Only against a small group of pests is it less suited, above all against spider mites and a number of caterpillars. It is notable for its relatively quick effect, which, however, does not last long. BHC can be applied as dust, spray and fumigant. It can also be used against soil pests. To a small degree, BHC penetrates into the plants and acts via the sap circulation, but since this effect is small it is not considered a proper systemic insecticide.

BHC is traded as

- technical grade with various γ contents

- dust preparation with about 5 per cent effective substance
- emulsion concentrate of up to 12 per cent effective substance
- W.P. up to 75 per cent BHC.

Under normal conditions of application it is harmless to man but is strongly toxic to fish. Therefore, its application may be questionable with rice and other plants growing partly in water. This applies above all to areas where fish living in rice fields form an important protein source for the population. Another disadvantage is the occurrence of resistance phenomena. Above all the application of BHC is in general limited by its disagreeable, musty taste and smell. If not applied competently fruit and vegetables may be spoilt. This handicap is especially marked with the technical grade. It can be avoided completely only if the purest Lindane is applied carefully.

5.6.3.2 Local Production

5.6.3.2.1 Producers

In Pakistan there are only two factories for the production of BHC:

- Insecticides (Pakistan) Ltd., Kala Shah Kaku

  and

- Chemical Industries of Pakistan Ltd., Barabakund/ Chittagong.

Each Wing could thus be supplied by local production.

The production capacity of Insecticides Ltd., which belongs to the Saigol concern, is 1,320 tons a year, but it is said that it could be increased with slight modifications to 2,000 tons. Production started in 1967. The plant operates according to the Stauffer process and yields a direct gamma isomer content of 25 per cent. Part of the product manufactured is processed by a sister concern into household sprays ("Shoot"). The firm markets its products as

- technical BHC (25 per cent γ)
- 12 per cent W.P.
- 50 per cent W.P.
- 12 per cent dust.

It is planned to produce Lindane, too, from approx. 1970 onwards. The capacity for Lindane will probably be one ton per day by then. As it is intended to concentrate only 50 per cent of the BHC produced, the firm thinks that waste products can be avoided. The manufacture of granules is projected for 1969. The expected capacity is one ton per hour.

The production of Insecticides Ltd. is based on imported benzene. The chlorine required is supplied by United Chemicals, which belongs to the same concern [1].

The East Pakistani producer, i.e. Chemical Industries of Pakistan, possesses a plant with a production capacity of 960 tons per year.

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1) It may be mentioned that this firm has a surplus production of chlorine. After the increase of their plant capacity expected at the end of 1968, the surplus at full capacity will probably be 45 tons per day.

This plant was installed at the end of 1966. Due to various difficulties, however, the firm has not yet gone into production; nor is it possible at present to predict at which date production will begin. The plant, which was supplied by a Japanese firm, can produce technical BHC of 12 to 14 per cent content of gamma isomer. As benzene is not yet produced in Pakistan, this firm too depends on imports. Chlorine is manufactured in the same factory (salt electrolysis).

5.6.3.2.2 Production

According to the statements of Insecticides Ltd., about 1,000 tons of technical BHC containing 25 per cent gamma isomers were produced in 1967. During the first 6 months the production was said to come to 630 tons of technical grade; for the whole of 1968 an output of 1,500 tons was expected. Prior to 1967 there was no production in Pakistan.

If we compare the sales and the imports of benzene with the production figures, we have serious doubts whether production was as high as claimed. According to information from the Agricultural Department, Insecticides Ltd. supplied only 650 tons of 12 per cent W.P. and 300 tons of 5 per cent dust in 1967/68. This means that only 372 tons of technical BHC 25 per cent were used, plus one ton for the production of household formulation, which adds up to 373 tons. It seems unlikely that 77 per cent of the production of one year was warehoused. Similarly, the 850 tons of benzene imported up to August 1968 would not have sufficed to produce the indicated amounts of BHC and DDT together.

It should therefore be a good approximation to assume that production during the said period was only 1,630 tons of formulated products and not of technical BHC.

As far as the future prospects of this local production are concerned, we think it probable that the firm will manage to make use of the greater part of its capacity. It seems that they were able to convince the agricultural authorities that BHC products should be used.

If the plan is implemented by which the private firms would be allowed to sell their products direct to agricultural consumers, Insecticides Ltd. feel competitive and active enough to secure a high turn-over.

5.6.3.2.3 <u>Problems of Local Production</u>

Both the BHC factories in the country were faced with serious difficulties. This applies especially to Chemical Industries of Pakistan Ltd. This firm has not yet been able to start production. The first and foremost difficulty resulted from the fact that for some time it did not get an import licence for benzene. As was stated by the enterprise, a licence was granted only for the 1st shipping period 1968, providing the possibility of importing the raw materials under US loan. But then a new difficulty emerged. The firm wants to import 450 tons of benzene in bulk since importation in that form is about 30 per cent cheaper than in barrels. However, according to existing regulations, imports under US loan can only be effected on Pakistani or US ships. Apparently, US ships are not willing to transport such small quantities in bulk, whereas ships from Pakistan are not available. Consequently, this firm has to continue to fight for an additional licence permitting transport on ships of other nations.

If this fight is successful, another fundamental difficulty will have to be tackled. As already indicated, in East Pakistan most of the insecticides are made available to agriculture free of charge by the Government. There are no BHC consumers of importance except for the Agricultural Department, which is responsible for the distribution. If the enterprise wishes to manufacture BHC, it must first of all succeed in having BHC put on the List of Standardized Insecticides. But since 1963 BHC has no longer been included on that list, and as the fish toxicity of the product is heavily stressed by the competent authorities, it will probably be extremely difficult to bring about a change.

As the high cost, caused above all by the expensive raw materials and the small size of the plant, makes exports appear most unlikely, it can be expected that the plant will not go into production in the near future.

The difficulties confronting Insecticides Ltd. were less serious, but nevertheless annoying. Substantially, they related to two items: expensive imports of spare parts and difficulties with the power supply. The first item does not need to be explained in detail. It implies the postponement of necessary repairs and thus the risk of a lengthy suspension of production. As in the case of DDT, the power problems cover

- too small a power supply
- insufficient voltage
- power break-downs.

According to the statement of the firm, the power problems have sometimes caused serious hindrances. The firm maintains i.a. that it could consume only 50 to 60 per cent of the power requirements of the factories of the concern concentrated in Kala Shah Kaku.

It may, however, be doubted whether the production of BHC and DDT was affected, since the markets for these products have not yet been sufficiently developed after the decline in their application.

If the firm in Chittagong started production, it would have to contend with the same difficulties, plus an additional communications problem: the factory, which is about 35 km from Chittagong, cannot get a telephone.

The consumers in many cases underlined that the gamma isomer content varies and that the suspensibility of the product is not up to the requirements. This seems to show that the producing firm is not yet fully in control of all the production problems. For the rest, the remarks on the packing made in connection with DDT apply in this case as well.

5.6.3.3 Demand

5.6.3.3.1 Demand in the Past

The consumption of BHC and Gammexane/Lindane has always been small in the past. Only recently has a slight change been detected in West Pakistan under the influence of the domestic production.

Table 93: Imports and Local Supplies of BHC and Lindane, 1965 to 1967 (tons of gamma isomer content)

Year	West Pakistan	East Pakistan	All Pakistan
1965	12	18	30
1966	7	2	9
1967	8	12	20
1968	100	5 1)	105

1) Estimated figure of Lindane imports

During the four years, a total of 164 tons of BHC gamma isomers or 1,100 tons of technical BHC of 15 per cent gamma isomer content was consumed. Of this quantity, 100 tons of gamma isomers (61 per cent) were supplied from domestic production. With the exception of 1968 West Pakistan imported slightly more than East Pakistan; the ratio was about 65 : 45. Owing to the fluctuations in the figures it is not useful to speak of a rate of increase or decrease.

The supplies to insecticide formulators in the period averaged 27 per cent. From 1965 to 1967 they consumed nearly four fifth of all supplies. On this basis the insecticide formulators mainly produce household sprays and dusts, which are used both in rural areas and in towns. A small proportion of these products are used by Municipal Corporations and other public authorities. The remaining 73 per cent of the quantities of gamma isomers purchased are supplied almost entirely to the Agricultural Department of the West Pakistan Government.
BHC was bought by the Agricultural Department during the period covered by the investigation in the form of 5 per cent granules, 5 per cent dust, and 12 per cent wettable powder.

Private industry imports the raw material mainly as 26 per cent W.P. and as 12 per cent W.P. Minor quantities of Lindane are also imported. 26 per cent W.P. accounts for about 85 per cent of the imports, but it may be assumed that the Lindane share will increase in future, since some factories intend to use Lindane, together with other effective substances, as a component of aerosols.

5.6.3.3.2 Comments on Future Demand

In view of the already-mentioned situation in the insecticide market, the development of consumption cannot be forecast. Only the following general statements can be made:

- The formulators are increasingly using substitutes for BHC and Lindane, in those cases where they are still applied.

- The East Pakistan Government is likely to remain opposed in general to the application of the product in the future. A decisive reason for this is the high fish toxicity of BHC.

- In West Pakistan it seems that the local producers have succeeded in convincing the Agricultural Authorities of the usefulness of the domestic product.

It is not clear how things will develop if one day the private firms themselves sell insecticides direct to the agricultural sector. Insecticides Ltd., however, is optimistic in this respect.

In any case it seems certain to us that BHC, as with DDT, is used nowhere near the extent that would be desirable from the point of view of sustaining a domestic production.

From a macro-economic point of view, it appears mainly disadvantageous if existing new capacities are not utilized or at least not utilized to a sufficient degree. This obviously means a loss of available production capital and of the foreign exchange invested.

possible utilization of ethyl alcohol as a knock-resistent fuel component will be dealt with in detail in chapter 6.

The estimates of the future consumption indicated above, do not contain the consumption for a possible production of plasticizer. As will be discussed in 5.5.6, the production of dioctylphthalate is worth considering; for this, large quantities of 2-ethylhexanol are required, which might be produced from acetaldehyde (cf. 5.5.8). If 2-ethylhexanol were to be produced on the scale indicated in 5.5.8, it would have repercussions on the ethanol consumption. In 1974/75 the consumption of this sector would amount to about 7,500 tons of ethyl alcohol.

5.5.1.2.4 Prices

The producers sell ethanol only direct to certain licence holders. The stock is under the control of the Excise Department.

The domestic prices including all taxes are:

for rectified spirit	1,47 - 1,58 Rs./kg
for denaturated spirit	1,38 - 1,43 Rs./kg

While home prices assure the alcohol producers of good profits, the export prices are considered too low.

The export price fob Karachi for pure alcohol (100 per cent) was

69,50 $/t

in 1968.

Table 84 compares prices and their development during the last few years in certain industrialized countries.

There is no doubt that the chlorinated insecticides, and especially BHC and DDT, are increasingly being replaced by phosphatic and other organic compounds. But his definitely does not mean that they are ineffective means of controlling plant pests. And indeed in a number of countries, like Japan, the Philippines, Korea, the Soviet Union and Poland, they are applied on a large scale in cultures such as cotton, rice, and in forests. They can also be used in Pakistan in a similar way, especially in cotton and rice cultures in the Western Province. On the assumption that per hectare and harvest it would be feasible to use 9 kilos of BHC 25 per cent [1)] with cotton and 12 kilos of BHC 25 per cent with rice, the resulting quantity, for West Pakistan only, would currently be

4,310 tons for cotton
1,690 tons for rice [2)]

With this quantity, as in the case of DDT, the capacity of the existing plants could easily be utilized.

For cotton, for instance, it would be possible to use cotton dust, a mixture of DDT, BHC, and sulphur. Then, the spider mites would have to be fought by special admixtures or by campaigns. Miticides that could be used are Kelthane, Ethion or Tedion.

In general it may be said that, according to information from leading Pakistani scientists, about three-quarters of all pest control measures could be based on a mixture of BHC, DDT, and Methylparathion. In addition to this, BHC could play a major part in locust control and be used like DDT in the measures against mosquitoes and flies undertaken by the Municipal Corporations and similar authorities in charge of sanitary measures in residential areas.

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1) DDT/BHC dust

2) The calculations are based on the assumption that 30 per cent of the cotton cultivation area and 10 per cent of the rice cultivation area in West Pakistan are treated with insecticides.

5.6.3.3.3 Consumers

The consumers are the Agricultural Departments concerned and most of the important insecticide formulators, such as

- Standard Finis Oil Co., Karachi
- Standard Finis Oil Co. (E.P.), Dacca
- Petar Filits Oil Co., Narayanganj
- People Chemical Industries, Dacca
- Tyfon Ltd., Karachi
- Osmansons, Karachi

A potential consumer is Agrochemicals, Chittagong. In future ICI, too, might be considered a potential consumer for their aerosol plant in East Pakistan.

5.6.3.4 Prices

The prices of the domestic producers are at present

- Rs. 1.94/kg for 5 per cent dust
- Rs. 4.96/kg for 12 per cent W.P.

A discount of 5 per cent may be granted on these prices. Sales tax, defence surcharge, and rehabilitation tax, however, have to be added. It seems as if the manufacturers are thinking of generally reducing these prices to some degree.

The c&f prices for W.P. 12 per cent were said to be as follows:

1965: $ 26.54/100 kg
1967: $ 33.80/100 kg
1968: $ 35.43/100 kg

The first two prices relate to imports from the USA, the 1968 price to imports from the Federal Republic of Germany. The figures relate to minor imports totalling less than 5 tons.

The price of Lindane is at present about US$ 194.- per 100 kg c&f Karachi.

5.6.3.5 Recommendations

The general recommendations given under 5.6.2.5 apply also to BHC. In particular, appropriate measures should be taken to ensure that the use of BHC for cotton and rice is given priority in West Pakistan. The prices of the manufacturers in this case should also be examined.

In East Pakistan BHC should be included on the List of Standardized Insecticides. Its application should, however, be restricted to the drier parts of the country.

Chemical Industries of Pakistan and Insecticides Ltd. should be allowed to import benzene on European or Japanese ships, if necessary.

5.7 Alkyl-aryl Sulphonates

5.7.1 Alkyl Benzene Sulphonate Detergents and their Production

5.7.2 The Detergent Market in Pakistan

5.7.3 The production of DDBS in Pakistan

5.7.4 Demand

5.7.4.1 Past Demand

5.7.4.2 Forecast of Consumption Trends

5.7.4.3 Consumers

5.7.5 Prices

5.7.6 Recommendations

5.7 Alkyl-aryl Sulphonates

5.7.1 Alkyl Benzene Sulphonate Detergents and their Production

Dodecyl benzene (DDB) the intermediate for the production of dodecyl benzene sulphonate has nowadays become the most important of the detergent raw-materials. It is a water-white oily liquid. The sum formula is $C_{12}H_{25} - C_6H_5$. In contrast to tetrapropylene benzene (TPB), which has the same sum formula, the alkyl chain is straight.

Historically, its importance must be attributed to the efforts of some industrialized countries to avoid the effects of using non-biodegradable detergents. It was found that the widely used TPB-based detergents were chiefly responsible for the pollution of surface and underground waters. The reason is that the branched alkyl benzenes are very little affected by bacterial action and therefore remain solved in the water. Therefore the TPB was widely replaced by DDB, which hae a linear side-branch.

Dodecyl benzene is made from dodecene or dodecylene and benzene. The recovery of the first component is based on certain hydrocarbon fractions from mineral oils.

Dodecyl benzene sulphonate (DDBS) is made from dodecyl benzene or mixture of alkylates by means of sulphonation with SO_3, concentrated sulphuric acid or oleum. The sulphonic acid thus produced is neutralized with natron lye. The detergent produced in this way is the washing-active substance in the normal household washing powders and also in a number of industrial detergents, which are mostly applied in a liquid form.

A typical household washing powder has roughly the following composition:

- tensides	10 - 25 per cent
- soap	0 - 10 per cent
- polyphosphates	20 - 50 per cent
- alkaline salts (sodium silicate, sodium orthophosphate)	5 - 10 per cent
- sodium perborate	10 - 25 per cent
- brightener	0.1 - 0.5 per cent
- carboxy methyl cellulose	1 - 2 per cent

In addition to the above items there are, or at least can be, other components such as dyes, scents, anti-caking agents, foam regulators.

In the manufacture of washing powder the components are mixed, diluted to a slurry and then dried in a spraying tower.

The DDBS content of the domestic washing powder produced at present in Pakistan is 20 per cent, rising up to 35 - 40 per cent for industrial detergents.

It may be noted finally that in the application of washing powder an average optimum concentration is 4 to 6 grms per litre. It cannot, however, be expected that detergents are used so economically in Pakistan at present.

5.7.2 The Detergent Market in Pakistan

For a better understanding of the different factors involved it might be useful to provide an idea of the total market for detergents in Pakistan. We have therefore attempted to estimate the imports and production for 1966/67 and 1967/68.

Table 94: Imports and Production of Washing Agents in 1966/67 and 1967/68 (in tons)

Imports production	1966/67	1967/68	1967/68 demand in terms of soap units
1. Production of DDBS detergents 1)	1,750	2,740	7,120
2. Production of other synthetic detergents 2)	110	150	450
3. Imports of detergents 3)	600 - 800	1,500-1,700	7,200
4. Soap production by factories	82,000	84,000	84,000
5. Production of soap flakes	65	67	70
6. Soap production by households 4) 5)	94,000	96,000	96,000
Total of soap equivalent			194,840

1) In terms of washing powder with 20 per cent active matter. The washing power has been taken as 250 per cent of that of an average washing soap.

2) In terms of standard washing powder equivalents.

3) Imported detergents are mostly synthetic, on various basis. Active matter content may be taken as about 30 per cent equal to 4.5 soap units.

4) Based on estimates by Lever Bros.

5) No differentiation has been made between the soaps produced in factories and those made at home.

The table shows some remarkable features. The most striking fact is the high proportion taken up by soap in the total consumption and in the production of washing active materials. According to our tentative evaluation of washing powder demand, the production of soap still accounts for about 93 per cent of total production and imports together in terms of equal washing power.

An analysis of the domestic consumption of the washing preparations based on synthetic detergents shows that, in terms of the estimated washing power, in 1967/68 only about 50 per cent of the total quantity available in the country was produced locally on the basis of imported raw materials. In spite of the considerable increase in domestic production, our estimates show that the share of imports went up substantially between 1966/67 and 1967/68.

Moreover, it is noticeable that the domestic production of washing active materials not based on DDBS accounts for only 3 - 5 per cent of the total production of synthetic detergents.

It is not known precisely to what extent the imported detergents are based on DDBS; estimates made by affected importers suggest that the figure may be about 35 per cent. In any case it seems to be certain that other kinds of detergents are preferred, because the main demand is for special detergents for industry. It has, however, at the same time to be emphasized that experts of the washing powder industry are of the opinion that under the present conditions in Pakistan at least two thirds of the imported detergents can be produced on the basis of DDBS.

As for the geographied distribution of production, synthetic washing preparations are only produced in West Pakistan. In the case of soap about 46 per cent of the total production and a little less than 40 per cent of the industrial production comes from East Pakistan.

As mentioned above, only small quantities of other detergents than those based on DDBS have been produced in Pakistan up to the present. These other products are currently being marketed by Textile Chemical Industries, Karachi and CIBA, Karachi. Besides washing preparations on a DDBS basis, Textile Chemical Industries mainly produces detergents based on polyglycols and nonylphenols. CIBA gets its products, based on ethoxylated compounds and derivatives of polyglycols formulated by Futehally Chemicals Ltd., Karachi.

In the near future other firms in Pakistan will start producing detergents not based on DDBS. The chief of these firms are:

- Imperial Chemical Industries, Karachi
- Sandoz (Pakistan) Ltd., Karachi
- Agrochemicals, Chittagong

In addition to these, Farbwerke Hoechst is considering the establishment of a plant. It seems that now the time has come for the detergent market to start developing very fast. It is therefore quite likely that more firms are seriously contemplating similar plants than those which came to the notice of the Battelle team.

As regards the capacity and output of these new units, ICI is known to be planning a plant of 1,000 tons for the manufacture of its product "Lissapol". Sandoz intends to start tha production of 100 tons of "Sandopan DTC", a product based on polyglycols, early in 1970. Agrochemicals will produce a product based on cyclohexyl taurine one year earlier; the initial production will probably not exceed 25 tons in 1969.

5.7.3 The Production of DDBS in Pakistan

So far only the sulphonation and formulation of washing agants on a DDB base has been carried out in Pakistan. The main manufacturer of washing preparations on a DDBS base has hitherto been Futehally Chemicals Ltd., Karachi. This well-managed firm has a plant with a usable sulphonation capacity of 200 kg per hour and a spray-drying capacity of 500 kg/hour. When working in three shifts, the factory could produce 3,600 tons of washing powder par year of 300 working days. It would then consume 720 tons of DDBS.

Futehally sells the major part of its production to Laver Bros. (Pakistan) Ltd., Karachi and Burmah Shall Oil Storage and Distribution Company of Pakistan Ltd., Karachi. Lever Bros. have successfully introduced household washing powder under the brand name of "Surf" in Pakistan. Burmah Shell sell an industrial detergent named "Teepol", mainly to the textile industry.

In addition to this firm, there are two smaller producers of synthetic detergent items, namely Textile Chemical Induatries and Shuja Industries, both located in Karachi. They predominantly produca induatrial detergents which they sell themselves.

Table 84: Domestic prices of denaturated ethanol 1964/68 [1]

(in $/t)

	USA	Belgium	France	Germany	Italy
1964	174	294	220	134	338
1965	174	294	220	238	316
1966	184	294	220	236	272
1967	242	294	220	236	257
1968	242	294	220	231	257

1) exclusive of taxes, inclusive of freight: road or rail tank cars holding 10 - 20 tons.

5.5.1.2.5 Recommendations

A further enlargement of the production capacities does not seem recommendable for the present.

The utilization of ethanol as a fuel component would, however, promptly change the situation of the ethanol manufacturing industry. A discussion of this subject is included in chapter 6.5 substitution.

If the measures proposed there should not be considered opportune, it would be advisable to examine whether, by reduction of the Bonus Voucher for molasses, alcohol exports can be expanded considerably, thus improving the utilization of the present capacity.

The statements of these three enterprises are summarized in table 95 indicating the estimated consumption of detergent raw materials in the form in which they were imported.

Table 95: Estimated Consumption of Alkyl Benzene Raw Materials, 1965-1968 (in tons of DDB equivalents)

Year	Consumption of Alkyl Benzene	Consumption of Sulphonic Acid	Consumption of DDBS	Total
1965	120	-	3	123
1966	150	9	3	162
1967	300	23	8	331
1968	400	28	13	441

The table showe that most of the raw materials were imported in the form of alkylates (an average of 92 %).
Nearly all of this type of raw material wae consumed by Futehally Chemicals Ltd. One of the smaller manufacturers tried to sulphonate alkylates in 1955, but he switched over to imported sulphonate in the following years, probably implying that he had overestimated his chances of producing a good detergent with the production equipment at his dieposal.

While the above figures give the input data, the table 96 indicates the output figures of the different items produced.

Table 96: Production of DDBS and Ready-Made Detergents, 1965 - 1968 (in tons)

Year	DDBS	Detergents formulation [1])
1965	175	875
1966	230	1,150
1967	470	2,350
1968 [2])	625	3,125

[1]) Quantities indicated are in terms of washing powder containing 20 % DDBS.

[2]) Expected production.

The figures in the last column give the overall production in terms of a standard washing powder containing 20 per cent DDBS as active matter. Naturally, not all detergents are sold in this form; indeed, recently only a relatively small proportion of them have been sold as household washing powders.

The share of these household washing powders in local production has been as follows:

1965	50 - 55 per cent
1966	50 - 55 per cent
1967	30 - 35 per cent
1968	30 - 35 per cent

The drop in the percentage need not indicate a corresponding rise in industrial consumption. Apparently, in the last few years home production has been successful in penetrating the market of imported industrial detergents.

The above data refer only to domestic production in the real sense. In addition, washing powders have been marketed from time to time under names such as "Pride", "Tide" and others. These products have usually been based entirely on imported ready-made detergent powders. Only the packing was done in Pakistan. Their share in the washing powder market has never been of importance.

In the third quarter 1968 the capacity and production of detergents based on DDB were expected to double since Dada Soap Factory, Karachi intended to start its new plant. This firm has more or less the same production equipment as Futehally.

According to a list of sanctioned units prepared by the Dacca branch of the Department of Investment Promotion & Supplies, there will be two more units for the production of synthetic detergents, in addition to this. Their names and the capacities sanctioned were given as

Cordova Soap Factory, Dacca (300 tons)
Kaptai Chemicals, Dacca (600 tons).

Although it is not known for certain whether these firms will produce DDBS detergents, it seems very likely, since such washing preparations have the widest range of applications and are easy to manufacture.

Moreover, Messrs. Kohinoor Chemical Co. Ltd., Dacca are planning to establish a washing powder plant with a capacity of 1,000 tons per annum. The time when this plant would take up production is not known.

In 1969 the production can be expected to rise by more than 100 per cent to a washing powder equivalent of at least 6,100 tons. So far production has always been restricted by lack of raw materials, while the marketing firms could have sold much larger quantities. Since the Dada factory is well provided with import licences the above figure should be within easy reach.

5.7.4 Demand

5.7.4.1 Past Demand

The total demand for DDBS-based detergents in recent years is given below.

Table 97: Consumption of DDBS Detergents in Equivalents of Standard Washing Powder 1) 1965 - 1968 (in tons)

Year	Household Washing Powder	Industrial Detergents		Total Consumption
		Local Production	Imports 2)	
1965	480	395	210	1,085
1966	590	560	290	1,440
1967	710	1,640	560	2,910
1968	1,000	2,125	750	3,875

1) 20 % DDBS content

2) Estimated from CSO import figures of surface-active agents.

If we calculate the rates of increase from these figures, the following percentages are obtained.

Table 98: Rates of Increase of Consumption of DDBS Detergents in Equivalents of Standard Washing Powder 1), 1966 - 1968 (in per cent)

Year	Household Washing Powder	Industrial Detergents		Total Consumption
		Local Production	Imports	
1966	22.9	41.8	38	32.7
1967	20.3	192.8	93	102.1
1968	40.8	29.6	34	33.2
average 1966 - 1968	27.8	75.4	53	52.8

1) 20 % DDBS content

A comparison of the average growth rates shows that the consumption of industrial detergents and emulsifiers has grown at a much faster rate than that of domestic detergents. While the household washing powder consumption has increased at an average rate of about 28 per cent that of industrial detergents, according to our estimates, has grown by about 68 per cent a year.

What is the reason for this difference in growth rates ? With the exception of Lever Bros., all the firms dealing in detergents were primarily interested in the industrial detergents market. While household detergents are a substitute for soap and vice versa, in industrial applications synthetic surface-active materials cannot easily be replaced by soap products due to their superior properties. Apparently an increasing number of producers in the fields of textiles, leather tannery and paper making etc. are realizing that the proper use of surface-active substances is essential if the products are to be of a sufficiently high standard. It can be assumed that demand from these industries will continue to grow, not only because their production is rising but also because the range of application of such textile auxiliaries and other surface-active materials is widening.

In the past, expansion in the household cleaning preparations market has been hampered considerably by lack of raw materials. Lever Bros. and other firms could easily have sold 20 - 30 per cent larger quantities in each of the years mentioned if the supplies had been sufficient.

It is fairly obvious that the market for household washing materials which is growing at a rate of 5 per cent per annum altogether (i.e. including soap), has not been energetically developed by the manufacturers and marketing firms of synthetic washing agents. Nor has this been necessary, because the demand has been satisfied anyhow by soap and soap flakes.

A detailed geographical break-down of the total demand is not available since it is not known how much of the local production of industrial detergents is sold in the Eastern Wing. However, it is apparent that the greater part of it is consumed in West Pakistan. This is the picture which consumption of household detergents as well as of imported detergents shows. The distribution of the household detergents is given in table 99.

Table 99. Index Numbers and Distribution of the Consumption of household detergents in East and West Pakistan (1964 = 100)

Year	West Pakistan	East Pakistan	Share of East Pakistan
1964	100	100	3 per cent
1965	116	350	9 per cent
1966	139	525	11 per cent
1967	163	875	15 per cent
1968	234	1,417	17 per cent

The figures reveal that the share of East Pakistan is small but growing fast.

The import figures are not so clear. They show that the share of East Pakistan must be between 20 and 40 per cent of the imported items. But it seems that the East Pakistani share of industrial detergents is diminishing.

Since apparently the bulk of the industrial detergents produced are consumed in West Pakistan, it appears that at present only about a quarter of all synthetic detergents are consumed in East Pakistan.

5.7.4.2 Forecast of Consumption Trends

Trying to evaluate the future growth of demand, we will first make a rather conservative estimate and then consider a proposal made by Lever Bros.

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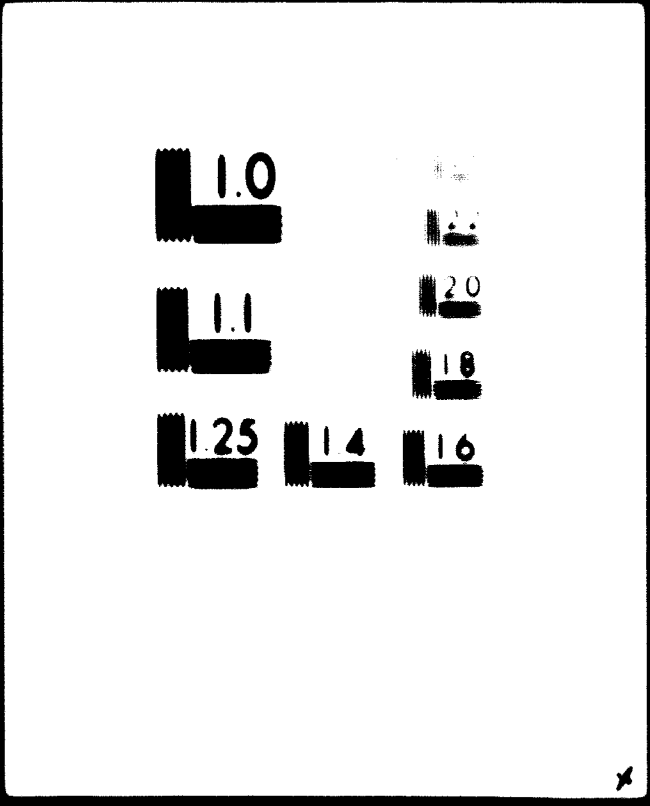

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5.8 Carbon Black and Sulphur

5.8.1 Carbon Black

5.8.1.1 General Characteristics

5.8.1.2 Domestic Production

5.8.1.3 Demand

5.8.1.3.1 Volume and Structure of Past Demand

5.8.1.3.2 Forecast of Consumption Trends

5.8.1.3.3 Consumers

5.8.1.4 Prices

5.8.1.5 Recommendations

5.8. Carbon Black

5.8.1.1 General Characteristics

Carbon black is a technically important modification of carbon. It is either produced by incomplete combustion or by thermal desintegration of liquid or gaseous hydrocarbons. We have to distinguish between:

- lamp black
- channel black
- furnace combustion black
- thermal black.

Only two of these four types of carbon black are important for large scale industrial production: channel black and furnace black. Channel blacks are produced by incomplete combustion of natural gas at an oxygen defizit. As to the furnace blacks, the incomplete combustion is effected in a closed furnace. Hydrocarbons in liquid or gaseous state or both can be used simultaneously.

The production of carbon black from natural gas has nearly been replaced completely by production from oil residues which are not only less expensive but also yield carbon blacks of better quality and purity. According to estimates made by European carbon black producers about 95 per cent of all carbon blacks are produced in the furnace process.

The rubber industry consumes 95 per cent of the roughly 1.6 million tons of carbon black annually produced in the western world. The remaining 5 per cent are used as dyestuffs for printing ink, special papers, plastics and paints of all kinds.

5.8.1.2 Domestic Production

Carbon black is not produced in Pakistan. To our knowledge there are also no plans because according to an RCD agreement Pakistan will purchase up to 5000 tons of carbon black per year from a joint venture in Iran.

5.8.1.3 Demand

5.8.1.3.1 Volume and Structure of Past Demand

As is generally the case on the world market, the demand for carbon black in Pakistan depends on tyre fabrication in the first place. Carbon black is added to the rubber for the different tyre types in different quantities and qualities. It serves as a filler or strengthening agent. The same is true for the production of rubber shoes, soles or heels, and for technical rubber articles. In the production of sponge sandals the carbon black is only used als black dyestuff. Only a small percentage is added as strengthening agent to foam rubber.

The types of carbon black mainly used in Pakistan are

- H A F
- I S A F
- F E F

Table [illegible] [illegible]

[illegible]	West Pakistan	East Pakistan	Total Pakistan
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

The increased consumption of carbon black in West Pakistan in [illegible] [illegible]

The [illegible] (see Table [illegible])

Table [illegible] [illegible] (in per cent)

[illegible]	West Pakistan	East Pakistan	Total Pakistan
Rubber industry	[illegible]	[illegible]	[illegible]
Printing ink	[illegible]	[illegible]	[illegible]
Paint industry	[illegible]	[illegible]	[illegible]
Carbon paper and ribbons	[illegible]	[illegible]	[illegible]

Because of the low consumption of carbon black and owing to the fact that the rubber industry is not yet fully developed East Pakistan presents a non-typical picture. The paint and carbon paper sectors therefore play at the moment a comparatively large part. In the course of the further industrial development of the Province, the distribution of the consumption of carbon black by sectors will become similar to the consumption in West Pakistan.

The main supplier of carbon black for both parts of Pakistan is

- West Germany (Degussa).

Next in importance but with considerably smaller shares are:

- the United Kingdom
- Italy
- Japan

According to statements by the carbon black consuming industry in Pakistan, the Government intends to buy carbon black from the Socialist Countries on an increasingly scale. But a trend in this direction has not been noticed yet.

5.6.1.3.2 Forecast of Consumption Trends

Rubber Industries

As indicated before, the consumption of carbon black is in the first place dependent on the future development of the rubber industries and especially on the tyre industry. The forecast for trends in the consumption is therefore based on the statements made in section 5.4.4. The probable future consumption of carbon black is thus calculated from the increasing demand in the manufacture of scooter and bicycle tyres, shoes and other rubber articles (see Table 105). The rubber consumption for passenger cars and trucks will be discussed separetely.

According to our estimates the demand for carbon black by the West Pakistan rubber industry will approximately double until 1975/76. In East Pakistan where the rubber industry is still not very important but still developing faster than in the West, the carbon black consumption is expected to treble until 1975/76. But even then it will only attain 10 per cent of the consumption in West Pakistan.

Table 105 Estimated Future Demand for Carbon Black in Pakistan, 1968/69 - 1975/76 [1] (in tons)

Year	West-Pakistan			East-Pakistan			All Pakistan
	Rubber Ind.	other Ind.	sub total	Rubber Ind.	other Ind.	sub total	total
1968/69	1,130	95	1,225	80	35	115	1,340
1969/70	1,230	100	1,330	90	35	125	1,455
1970/71	1,340	105	1,445	105	40	145	1,590
1971/72	1,440	110	1,550	120	40	160	1,710
1972/73	1,540	115	1,655	135	45	180	1,835
1973/74	1,670	120	1,790	150	50	200	1,990
1974/75	1,800	125	1,925	165	50	215	2,140
1975/76	1,940	130	2,070	185	55	240	2,310

1) The consumption of carbon black for the production of tyres for passenger cars and trucks is not included in these figures.

Various Industries Processing Carbon Black

Because of the small quantities of carbon black used in Pakistan for the production of carbon paper, typewriter ribbons, printing ink and paints, we have summarised these industrial sectors in Table 106 under "Other Industries".

The producers of carbon paper and ribbons have not been able to give any details about the future demand of their products. Owing to the fact that there is a close relationship between the rate of increase of typewriters and the demand for carbon paper and ribbons we have based our demand estimates in this sector on the rate of increase for typewriters. According to our calculations it amounts to about 4 per cent per annum.

The main consumer of printing ink, the newspaper industry, did not realise a higher output in the last few years. According to information received, the demand will presumably continue to stagnate so that the consumption of carbon black is unlikety to increase as well. However the Printing Ink Association of Pakistan, expects an increasing rate of book printing especially of schoolbooks so that the consumption of printing ink can be expected to rise by 5 per cent per year. There are no prospects that major projects will stimulate the demand for printing ink.

In the paint industry according to section 5.2.5, the demand will increase in West Pakistan by 8 per cent/year and in East Pakistan by 13 per cent/year. The consumption of carbon black is expected to increase at the same rate.

Tyres for Passenger Cars and Lorries

General Tyre and Rubber Co. has estimated its output at 150 000 tyres for passenger cars and trucks at full production. The quantity of carbon black required if the plant is operated and utilised to full capacity is estimated at 1100 tons. However, since the firm had completely stopped its production at the time of our survey (see section 5.4.4.3) we calculate the consumption of carbon black according to production figures which we consider feasible.

The possible rate of increase of the local production amounting to 7,5 per cent applies therefore also to the future consumption of carbon black (see Table 106).

Table 106 Estimated Future Demand for Carbon Black 1967/68 - 1975/76 (in tons)

Year	Rubber Ind.	Other Ind.	Tyres for Passenger Cars and Lorries	Total
1967/68	1 106	124	1 100	2 330
1968/69	1 210	130	1 180	2 520
1969/70	1 320	135	1 280	2 735
1970/71	1 445	145	1 380	2 970
1971/72	1 560	150	1 480	3 190
1972/73	1 675	160	1 590	3 425
1973/74	1 820	170	1 700	3 690
1974/75	1 965	175	1 820	3 960
1975/76	2 125	185	1 950	4 260

The demand for carbon black calculated in the table 106. for all Pakistan in 1975/76 is estimated at

ca. 4 300 tons.

This estimate is based on the assumption of a constant economic policy and the requirement that all tyres for passenger cars and trucks calculated in section 5.4.4.3 are produced in the

Every estimate must take into consideration that Dada Soap will probably produce a considerable quantity of washing powder and liquid formulations in 1969 which the market can be expected to absorb without difficulty, provided the firm manages the marketing efficiently; since it is one of the major old manufacturers of soap in Pakistan; this can be taken for granted From 1969 onwards we anticipate rates of increase of 25 - 50 per cent as shown in table 100. For 1969 we expect an increase of 57 per cent against the previous year

Table 100: Estimated Future Development of Consumption of DDBS-Based Surface Active Substances, 1968-1975

Year	Estimated Consumption		rate of increase (per cent
	in washing powder equivalents (tons)	in dodecyl benzene equivalents (tons)	
1968	4,400 1)	620	
1969	6,900	970	57
1970	10,350	1,460	50
1971	15,000	2,120	45
1972	21,000	2,970	40
1973	27,300	3,860	30
1974	34,100	4,830	25
1975	42,600	6,050	25

1) In this figure an estimated replacement potential of 50 per cent of the present imports has been included (800 tons in all)

We estimate that the present high rate of growth will fall to 25 per cent in 1974. Whether these consumption are levels reached depends entirely a availability and marketing. Skilful marketing would no doubt lead to even better results.

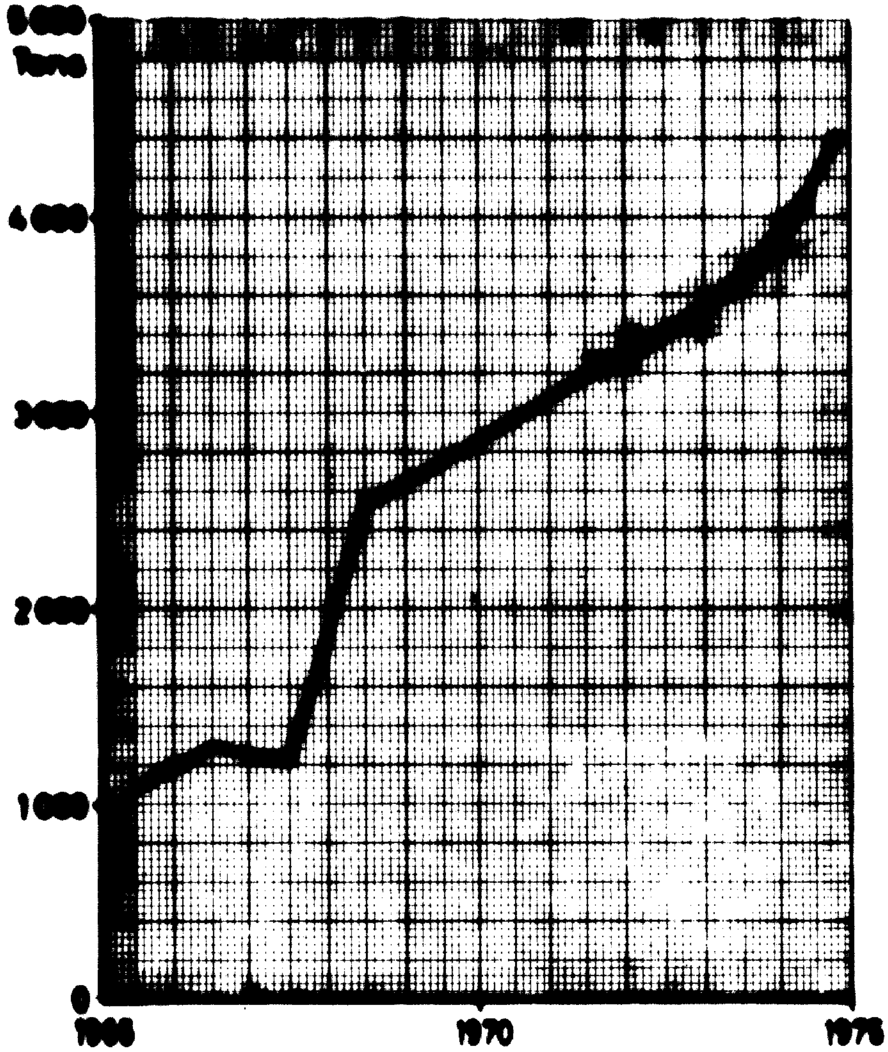

Figure 15: Trends in the Demand for Carbon Black

country. The share of carbon black of this industrial sector would then amount to 46 per cent in 1975/76.

The producers of tyres for bicycles and scooters will buy in 1975/76 another 26 per cent of the calculated consumption of carbon black. This makes the tyre industry (72 per cent) and the total rubber industry (96 per cent) the predominant consumer of carbon black in Pakistan.

5.8.1.3.3 Consumers

The main consumers of carbon blacks in Pakistan are in West Pakistan:

- General Tyre & Rubber Co Ltd.,	Karachi
- National Tyre & Rubber Co. Ltd.,	Karachi
- Master Tyre & Rubber Co. Ltd.,	Karachi
- Bata Shoe Factory of Pak. Ltd.,	Batapur
- Longman Mills,	Lahore
- Service Industries Ltd.,	Lahore
- Basco Industries Ltd.,	Gujrat
- Karachi Carbon Paper & Ribbon Ind.,	Karachi
- Riaz Carbon Paper & Ribbon Industries,	Karachi

in East Pakistan:

- Karim Rubber Ind. Ltd.,	Fatullah
- Bux Rubber Industries,	Mirpur
- ATJ Industries Ltd.,	Dacca
- East Pakistan Paper Converting Co.,	Dacca

The consumption centres are the same as those of the rubber industry, i.e.

- Karachi
- Lahore - Wazirabad
  - Sialkot area
- Dacca area

5.8.1.4 Prices

The prices of the different kinds of carbon black vary according to their quality. The carbon black, processed in the rubber industry which is supplied by Degussa (West Germany) is sold on the average at

$ 275.00

per ton c&f sea port in Pakistan, packing included.

The landed cost amounts to

about RS. 2 040.00 per ton.

5.8.1.5 Recommendations

According to our rough estimate a carbon black factory of an economic minimum capacity of 5 000 tons per year could not be established before 1976. Pakistan holds about 25 per cent of the capital stock of a carbon black factory near Teheran and has agreed to buy 5 000 tons annually of the production. This prevents any domestic production for the time being.

5.8.2 Sulphur

5.8.2.1 General Characteristics

5.8.2.2 Domestic Production

5.8.2.2.1 Sources of Sulphur in Pakistan

5.8.2.2.2 Producers

5.8.2.2.3 Production Programme

5.8.2.2.4 Problems

5.8.2.3 Demand

5.8.2.3.1 Volume and Development of Demand

5.8.2.3.2 A Problem of TSP I in Chittagong

5.8.2.4 Prices

5.8.2.5 Recommendations

5.8.2. Sulphur

5.8.2.1 General Characteristics

Sulphur is an odourless and tasteless mineral. The most important sulphur raw materials are:

- elementary sulphur
- pyrite
- sulphide non-ferrous metal ores
- coal
- natural gas
- petroleum
- gypsum

In the processing of ore, coal and hydro-carbon raw materials, sulphur is merely a more or less annoying by-product, taking the form of sulphur dioxide or hydrogen sulphide.

Sulphur is an essential raw material and auxiliary product in many sectors of industry, but it is not always used in large quantities. Its consumption is generally considered a criterion for rating the standard of industrialization of a country.

The most important fields of application of sulphur are generally:

- Phosphatic fertilisers
- Pigments
- Ammonium sulphates
- Sodium sulphates
- Iron and steel pickling
- Petroleum refining
- Aluminium sulphates
- Rayon fabrication

- [illegible]
- cellulose films
- Bleaching raw sugar or syrup
- Vulcanizing natural rubber
- Matches
- Black powder
- sulphite pulp

Because the bulk of the sulphur is used in the form of sulphuric acid and only about 10 per cent in the form of elementary sulphur, in many cases sulphuric acid is recovered direct from the natural products of the sulphur. On the other hand, elementary sulphur can be transported easily and without high transport costs. Therefore, where long distances and large quantities are involved, it is easier to transport sulphur than sulphuric acid and sulphur dioxide.

Of all the possible ways of recovering sulphur, the only ones of importance for Pakistan are those based on:

- sulphur ore
- gypsum
- coal
- petroleum and natural gas

The possibility of recovering sulphuric acid from gypsum will be of special importance for Pakistan, because this material is available in abundance in West Pakistan and because the triple-superphosphate factories produce gypsum sludge which contains sulphuric acid.

5.8.2.2 Domestic Production

5.8.2.2.1 Sources of Sulphur in Pakistan

Local sulphur ore deposits have already been found in the vicinity of the extinct volcano Koh-i-Sultan near the Iranian border

There are other deposits at Miri, Sanni and Jawani in West Pakistan. The estimated sulphur ore reserves in these areas amount to about 86,000 tons. The average sulphur content is 50 per cent. On this basis, the reserves of pure sulphur would come to about 43,000 tons. Further large deposits of unknown size and quality have been found in Baluchistan, Shikarpur and other areas of West Pakistan. They are said to extend far into Iran. Hence, it is at present not possible to make a precise estimate of the total sulphur reserves in Pakistan.

A second but smaller source of sulphur is the coal mined at Makarwal. It contains up to 6 per cent of sulphur.

There are no known sulphur deposits of importance in East Pakistan.

5.8.2.2.2 Producers

While in the Eastern Province there is no sulphur refinery, in West Pakistan there are two firms processing sulphur ore:

- Ureka Chemicals, Karachi
- Rock Sulphur Refinery, Karachi

They have an installed capacity of 10 tons of sulphur per 8-hour day.

The production process of both firms consists in melting out the sulphur from the ore. About 90 per cent. of the sulphur contained in the ore is extracted. The remaining 10 per cent left in the ash, which is sold as fertiliser. Both the firms are able to produce simple refined sulphur as well as double refined sulphur in the form of powder or block or roll sulphur.

During our investigations concerning sulphur, we came to the conclusion that in West Pakistan more ore could be mined under better technical conditions and therefore more sulphur could be produced. This opinion has been confirmed by various persons conversant with the situation. It seems worthwhile to subject the whole problem to a thorough scrutiny. A detailed investigation would show how the production can be increased effectively.

One more sulphur producer in West Pakistan should be mentioned: the Fertilizer factory in Daudkhel. This firm uses the sulphur - containing coal found in Makerwal for the production of ammonia. The hydrogen sulphide contained in the coal was to processed into sulphuric acid direct which is then used in the production of the fertilizers. No precise information about the amount of sulphuric acid produced and its cost could be obtained.

[illegible] Development of Production

The total sulphur production of both the firms located in Karachi are given as follows:

[illegible] - [illegible] tons (one refinery only)
[illegible] - 1,[illegible] tons
[illegible] - 1,[illegible] tons

During the next three years production is to be increased considerably. The total production will then be:

[illegible] - [illegible] tons
[illegible] - [illegible] tons
[illegible] - [illegible] tons

The further development of local production is not at present foreseeable.

The present consumption of sulphur refined in Karachi breaks down as follows:

Chemical industries [illegible] %
Sugar refining [illegible] %
Matches, rubber etc. [illegible] %

Due to the fact that the production of sulphur in Pakistan covers only [illegible] per cent of the total consumption, large quantities have to be imported.

5.8.2.2.4 <u>Problems</u>

The two sulphur refineries in Karachi labour under the following disadvantages:

- the sulphur deposits are located in mountainous and very remote regions of the country
- the rail transport is in adequate and unreliable
- the plants are obsolete.

The geographical location of the sulphur ore resources is a fact of nature, and cannot be changed. The yield can however be increased substantially by appropriate plants and better plant location. A labour shortage could most probably be avoided - even in remote areas - by providing adequate lodgings for workers, staff and their families and by provisioning them regularly.

The present inadequate and unreliable transport for ore always leads to hold-ups production and delays in delivery, which affect and annoy other industries. The producers are also of the opinion that the high rail transport costs have a serious effect on the final selling price. Obsolete and neglected equipment, inefficient methods of work and poor organisation are also obstacles to a smooth production flow.

A confirmation of this, leading at the same time to the second approach, is the proposal of Lever Bros. From Lever Bros we learnt that they are prepared to market 10,000 tons of washing powder annually as soon as it is available.

Asked when they would like to have this quantity of detergent powder, one of the directors officially stated that his company would be prepared to take over the 10,000 tons of washing powder at any time. Lever Bros feel sure that their sales could reach this level within two years. According to the director, in this case the firm would invest the profits wholly in the marketing for some time.

We further asked Lever Bros. whether they are prepared to invest their own capital in a plant producing DDB or a mixture of alkanes, or in a plant for the production of DDBS. At this, they expressed their willingness to invest in a plant producing DDBS and washing powder, but not in the manufacture of alkylates.

If we base our estimates of future consumption on these statements of Lever Bros., the following assumptions seem to be realistic:

- A sizeable plant for the production of DDBS and detergent formulations will be established in 1970/71 and will start production in 1972.

- By that time Lever Bros. should be able to market 12,000 tons within two years, i.e. by 1974. In 1975 and the ensuing years the rate of increase of household detergents will be 25 per cent.

5.8.2.3 Demand

5.8.2.3.1 Volume and Development of Demand

Sulphur consumption in Pakistan, which was negligible when the country became independent, is now quite considerable, amounting to about 26,000 tons. In both parts of the country the demand for sulphur is still increasing rapidly because of the construction of big new fertilizer factories. The estimates, summarized in table 107, show the sulphur consumption in Pakistan for the years 1965/66 - 1970/71 excluding the quantities used for defence purposes.

Table 107: Demand for Sulphur, 1965/66 - 1970/71 (in tons)

Year	West Pakistan	East Pakistan	Total
1965/66	..	..	7,000
1966/67	..	..	6,200
1967/68	23,556	2,582	26,138
1968/69	51,640	7,440	59,080
1969/70	53,480	13,270	66,750
1970/71	99,550	51,490	151,040

Note: The figures for 1965/66 and 1966/67 are based on statements by Central Statistical Office, Karachi.

The projected demand figures contain only the requirements of the industries producing fertilizers, sugar, rubber, and matches.

In the calculation of the demand figures 1968/69 - 1970/71 corrected fertilizer production figures submitted by UN Petrochemical Project, Rawalpindi, have been used.

According to discussions with the UN Petrochemical Project it has been assumed that the fertilizer factories will work with about full capacity from the start of production.

The sudden increase of sulphur consumption in West Pakistan in the financial year 1968/69 is a consequence of the expansion of production of the fertilizer factory at Daudkhel and the establishment of the new factory in Jaranwala. A further, even sharper increase in sulphur consumption is expected when the triple-superphosphate factory in Karachi is put into operation in 1970/71. The consumption of this fertilizer factory will come to about 45,500 tons per year.

In East Pakistan the conditions are similar. When the Triple-superphosphate Factory I (TSP I) in Chittagong starts production (probably in December 1968), sulphur consumption will be increased by 9,700 tons per year by this factory alone. The consumption will increase by a further 36,400 tons per year when the factory TSP II is put into operation. This is estimated for 1970. A third factory (TSP III) with the same capacity is planned for Khulna, but there are as yet no data about the beginning of construction.

Sulphur consumption in Pakistan at present breakdown as follows:

- sulphuric acid	92 per cent
- sugar industry	6 per cent
- rubber industry	1 per cent
- match industry	1 per cent

Sulphuric acid, one of the key products of industry, is used directly or indirectly in nearly all sectors. The major part of it is processed directly into other products, the sulphuric acid mainly being used for the production of mineral fertilizers. The bulk of the sulphuric acid consumed in

Pakistan (ca. 60 per cent) is used for processing phosphates into

- superphosphates
- triplesuperphosphates

and for the production of

- ammonium sulphate.

Due to the establishment of new factories the percentage will go up to ca. 80 per cent in 1970/71.

Moreover, sulphuric acid is directly or indirectly used for the production of

- fibres
- paper
- car batteries
- synthetic detergents
- sulphate of aluminium
- magnesium sulphate
- hydrochloric acid

Other important buyers in Pakistan are:

- petroleum refineries
- the iron and steel industry
- tanneries

With the exception of the Daudkhel fertiliser factory, sulphuric acid in Pakistan is produced by contact process from sulphur powder.

After the producers of sulphuric acid, the second biggest consumers of sulphur in Pakistan are the sugar manufacturers, who use the sulphur as a bleaching agent for the production of white sugar. The proportion of sulphur they use is 1/3 per cent by weight of the quantity of white sugar.

The rubber industry, on the average adds about 2 per cent by weight of sulphur as a vulcanizer to the rubber mixture. The match industry uses sulphur for the production of match-heads at a rate of about 11 per cent by weight of the match-head mixture.

5.8.2.3.2 A problem of TSP I in Chittagong

According to a statement made by the management of TSP I about 50,000 tons of gypsum sludge containing sulphuric acid are produced per annum as a waste product. The problem of the utilization or removal of this item has not yet been clarified. The management of this firm requested Battelle to make some suggestions.

Battelle therefore makes the following proposal about this problem:

In our opinion and before studying the problem in detail, the best solution seems to be to construct a cement works to process the sulphorous gypsum sludge of TSP I - and later on of TSP II too - into Portland cement. Simultaneously, sulphuric acid should be recovered, which can then be used in the original fertilizer process.

It is, however, advisable to investigate this problem in more detail in a smaller feasibility study.

5.8.2.4 Prices

The present selling price for sulphur refined in Karachi was quoted at

Rs. 600.- per ton

and both the firms mentioned in 5.8.2.2.2 intimated that they are working at a loss.

Prices are tending to increase because the demand for sulphur on the world market is greater than the supply. Rising costs of mining and more expensive methods of sulphur production which have to be applied in new areas due to the exhaustion of certain American sulphur deposits, will mean that the increase in world market prices will continue into the future.

At the time of our investigations in Pakistan, the price of solid sulphur c&f seaport Pakistan, packed in bags, was about

95 $ /t.

5.8.2.5 **Recommendations**

In order to reduce the high sulphur imports into Pakistan detailed investigations should be made to show which new resources should be developed or whether those already in existence can be extended.

The possibilities which could be investigated are:

- expansion of sulphur ore extraction and processing
- sulphuric acid from gypsum
- sulphur from natural gas
- sulphuric acid from the waste products of the TSP factories.

5.9 Various Products

5.9.1 Anti-knock Compounds

5.9.1.1 General Characteristics

5.9.1.2 Demand

5.9.1.2.1 Consumers

5.9.1.2.2 Volume and Structure of Past Demand

5.9.1.2.3 Forecast of Consumption Trends

5.9.1.3 Prices

5.9.1.4 Recommendations

5.9.1 Anti-knock Compounds

5.9.1.1 General Characteristics

Motor cars and motorcycles usually are equipped with four-cycle carburettor engines which run on a mixture of volatile petrol and air. The combustion takes place in the form of a flame front which proceeds from the spare plug at a rate of 10 to 25 m per s. During the combustion a pressure is built up driving the piston.

This process may be disturbed so that "knocking" is encountered. It causes a heavy wear and tear of various parts of the engine. Often under the influence of the high heat also coking of oil takes place so that at the same time the oil consumption rises heavily.

Knocking can be avoided by improving the fuel as follows:

- Suitable choice and proper mixing of fuels. (Especially branched molecules of paraffins, as well as olefins, naphthenes and benzene are less sensitive.)

- Admixture of small amounts of anti-knock compounds which are highly resistant to knocking.

For our purpose mainly the second group is of interest. Of the first group only ethyl alcohol as an "anti-knock fuel" which may be added to petrol is of some potential importance in this connection (see section 6.4).

Among the proper anti-knock compounds tetraethyl lead (TEL) under normal conditions has been found to be the most effective agent. It is added to petrol in proportions up to 0.8 cc per litre. With every 0.1 cc/litre the octane number can be increased by 5 to 10 units. In Germany usually

0.5 cc TEL/litre is added.

TEL is normally used in a mixture which is called "additive". This mixture contains in addition ethylene dibromide and/or ethylene dichloride which prevent the formation of lead oxide in the cylinder. Since petrol with additives is toxic a dye is usually added to mark it.
The following discussion refers to a typical additive which is sold by the manufacturers in industrial countries.
It has the following composition:

- Tetraethyl lead	61.48 %	by weight
- Ethylene dibromide	17.86 %	by weight
- Ethylene dichloride	18.81 %	by weight
- Dye	0.06 %	by weight
- Kerosene and impurities	1.79 %	by weight
	100.00 %	

TEL at present is the only candidate for a possible production in Pakistan. It is generally manufactured from ethyl chloride and an alloy consisting of 90 per cent lead and 10 per cent sodium.

5.9.1.2 <u>Demand</u>

5.9.1.2.1 <u>Consumers</u>

The consumers of fuel additives are the refineries, while the oil companies sell the products to the final consumers. In Pakistan there are at present only three firms purchasing for anti-knock additives:

- The consumption of industriel detergents and that of household washing preparations up to 1972 will be as indicated in table 100

- In 1971 household cleansing preparations are expected to account for 30 per cent of the total consumption, i.e. somewhat more than in 1968 (25 per cent)

Table 101: Possible Consumption of Detergent Formulations, 1968 - 1975 (in tons of standard washing powder equivalent)

Year	washing powder	industrial detergents	total
1968	n.a.	n.a.	4,400
1969	n.a.	n.a.	6,900
1970	n.a.	n.a.	10,350
1971	4,500	10,500	15,000
1972	6,000	14,700	20,700
1973	12,000	19,100	31,100
1974	15,000	23,900	38,900
1975	18,800	29,800	48,600

On these assumptions we arrive at a total consumption in 1975 which is 14 per cent higher than the first estimate.

The estimate means that in 1975, with a prospective population of 156 million, the per capita consumption would be 310 g of all kinds of synthetic detergents, or approximately 120 g of household detergents.

- Eastern Refinery Ltd., Chittagong (ERL)
- Pakistan Refinery Ltd., Karachi (PRL)
- Attock Oil Co., Rawalpindi (AOC)

The largest potential consumer is the Pakistan Refinery having an intake of 2.5 million tons per year and a maximal output of 140,000 tons of regular motor fuel plus 20,000 tons high-octane petrol (premium).

Second in importance as a consumer of TEL additives is the Eastern Refinery. This plant has been installed recently with a total capacity of 1.5 million tons. It has a production capacity of 126,000 tons of petrol.

The Attock Oil Company has only a total throughput of 500,000 tons but it is going to increase its capacity considerably by 1970 (about 1.5 million tons). Around the same year a fourth consumer will join, the National Refinery Ltd., Karachi, which intend to have a petrol production capacity of 75,000 per year.

5.9.1.2.2 Volume and Structure of Past Demand

According to information received from the refineries a total of 218 tons of TEL additives containing 133 tons of pure TEL was consumed in Pakistan in 1967.

Table 108: Consumption of TEL Additives, 1965 to 1968 (in tons)

Enterprise	1965	1966	1967	1968 *)
PRL	n.a	n.a	120	200
AOC	110	97	98	100
ERL	-	-	-	33
total	n.a.	n.a.	218	345

In 1968 the consumption will probably rise to 345 tons which means an increase of 58 per cent over the previous year. The demand figures for 1965 and 1966 are incomplete. Those for Pakistan Refinery are missing because this firm was of the opinion that the data were not representative. From the discussions we may conclude that the demand by PRL in those year was only 25 per cent of the demand in 1968. Before 1967 the PRL operated the refinery in a different way which must have been less profitable.

It should be noted that PRL for some years has also produced premium for which tetramethyl lead (TML) additive is used. This additive contains 50.82 per cent TML by weight. Their consumption of this additive amounted to 18 tons in 1967 and 57 tons in 1968. PRL expect a further growth in 1969 and 1970 to 71 tons and 86 tons respectively.

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*) Estimated figures. The total of all estimates for 1968 seems to be overrated.

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table 110: Theoretical Consumption of TEL and TEL Additive, 1964 to 1968 (in tons)

Year	TEL Additives	TEL Content
1964	242	149
1965	290	178
1966	258	159
1967	267	164
1968	269	165

The figures show a peak in the war year of 1965. During the rest of the time there was a fairly constant growth of 4 per cent per year.

Out of the total demand only an average of 20 per cent was from East Pakistan. The figures also show that even if all the petrol consumed contained additives, the total demand of TEL never exceeded 200 tons per year.

5.9.1.2.1 Forecast of Consumption Trends

On the basis of 0.85 g TEL additive per kg of petrol we have estimated the future consumption as shown in Table 111. For comparison also the figures for petrol have been included. The estimates of the petrol consumption are based on data supplied by Esso Eastern Inc., Burmah Eastern and Eastern Refinery Ltd.

Table 111: **Estimated Consumption of Ordinary Petrol and TEL mixtures, 1968 to 1975**

Year	West Pakistan		East Pakistan		All Pakistan	
	petrol (1,000t)	TEL additive (tons)	petrol (1,000t)	TEL additive (tons)	petrol (1,000t)	TEL additive (tons)
1968	243	206	74	63	317	269
1969	250	213	87	74	337	287
1970	226	192	95	81	321	273
1971	229	195	103	88	332	283
1972	237	201	114	97	351	298
1973	245	208	126	107	371	315
1974	251	213	137	116	388	329
1975	256	218	153	130	409	348

It is surprising to note that the growth rate in the demand for TEL additives over the whole period is only about 4 per cent. In 1970 it even declined. The explanation for this is the expected heavy increase in the sales of premium petrol in West Pakistan. The present experience shows that high-octane fuel is sold more readily.

Therefore, for the years to come about 12 times higher increase rates for premium have been assumed by the business circles concerned.

It should be noted that such a development is expected only for West Pakistan. According to our information for East Pakistan no increases in the production of premium has been planned. For this reason and a growth rate of 11 per cent the share of East Pakistan in the total demand for TEL additives might rise to about 35 per cent in 1975.

Table 112: Expected Demand for High-octane petrol and TML in West Pakistan, 1968 to 1975 (in tons)

Year	High-octane petrol	TML Additives *)	TML Content
1968	34,000	57	29
1969	42,000	71	36
1970	85,400	144	73
1971	99,000	168	85
1972	112,000	191	97
1973	123,000	209	106
1974	138,000	232	118
1975	155,000	264	134

Despite the fact that the average growth is expected to be 24.5 per cent, the quantities of TML required until 1975 are very small. Comparing TML with TEL it is found that the demand of the latter will probably be 30 % higher than that of TML in 1975.

At this point we should like to point out that the demand for TEL and TML additives will develop very erraticly and inpredictably. Whether our expectations will come true is uncertain even if the consumption of petrol and its composition develop as forecast. The reasons for this uncertainty is that the consumption of TEL compound depends on a number of factors whose influence can hardly be predicted even in a detailed and specialized study. These factors are:

a) Effects of the import policy
b) Legislation concerning the maximum lead content of petrol

*) These figures have been based on a TML admixture of 1.7 per mille in weight.

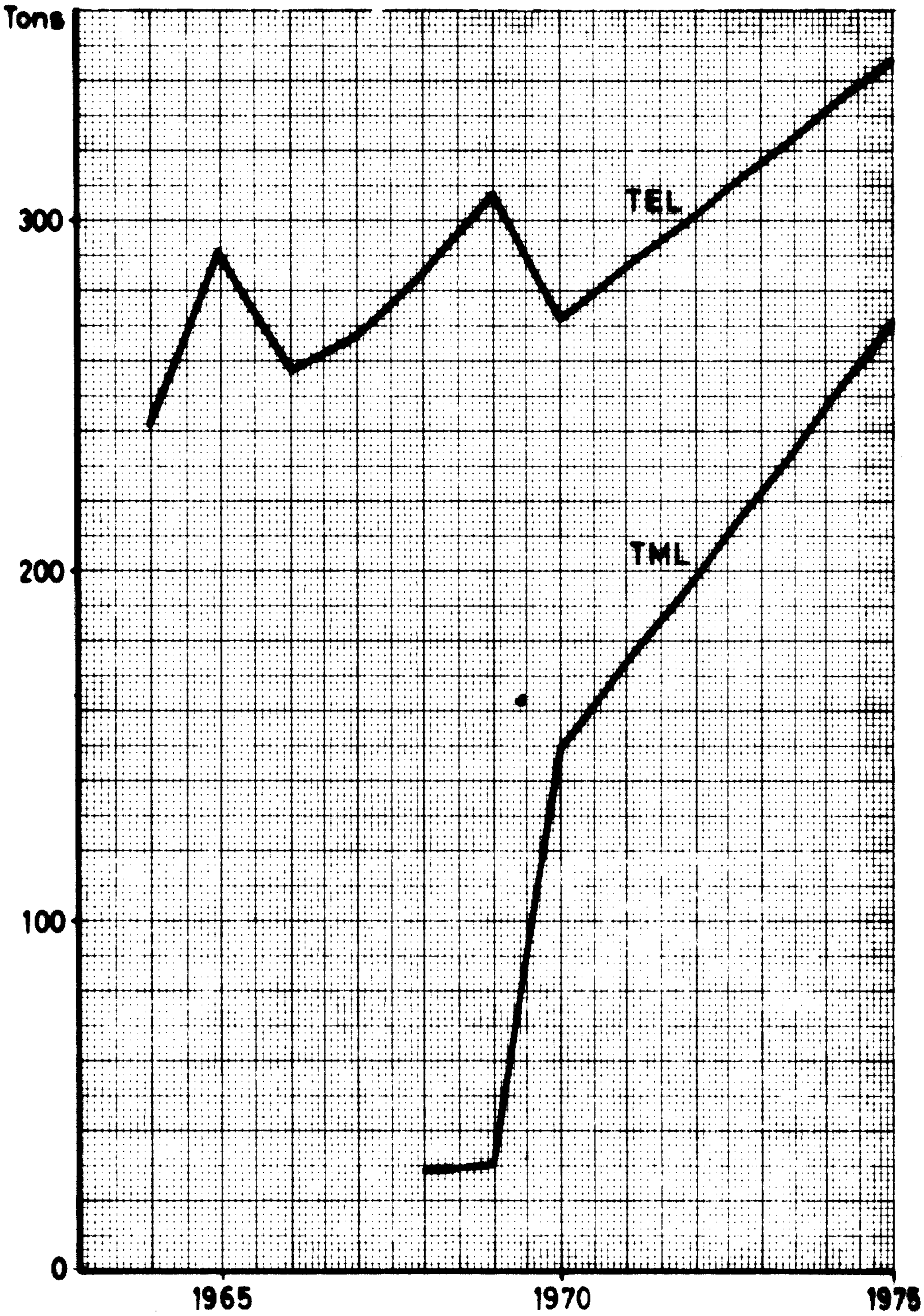


Figure 16: Trends in the Demand for TEL- and TML-Additives

c) Price of the anti-knock compounds

d) Octane number fixed for regular and premium gasoline

e) Availability and price of high-octane gasoline blending stocks which again depend to a high degree on the types of refinery installations to be established in future

f) Type of blending stocks mixed together

g) Technical innovations which might lead to other anti-knock compounds especially those which are free of lead

The most decisive two factors will generally be the price of the TEL/TML solutions which depends largely on the lead price and the policy of the refinery management. Especially the latter factor is important since the management must produce the desired octane number at the lowest possible cost because blending affects the economy of a refinery.

With respect to blending, the refinery management usually has vast opportunities. Even without the use of additives it can vary the octane number within wide limits by mixing various types of stocks together according to their availability and price. Similarly, the octane number can be increased without the use of anti-knock compounds.

This short enumeration of refinery operation shows that there is no way which must be observed to yield a petrol with a specific octane number.

The above discussion of difficulties encountered in making predictions in the anti-knock field was not necessarily based on the assumption that anti-knock compounds are used. If we now consider the case that additives are used, it is still extremely difficult to make a forecast. This is due to the fact that without knowing the petrol composition one cannot predict how much additive is required in order to obtain a certain octane number of the blend. It is not sufficient to know only the octane number of the plain petrol because the value of the lead containing additives depends on the chemical composition of the blend and the occurrence of certain sulphur compounds.

These remarks show that an exact forecast on anti-knock additives is not possible at least under the conditions prevailing in Pakistan which are characterised by free enterprises, changing import polices, fast establishment of new capacities and low demand figures for additives. Our estimates have therefore a certain degree of uncertainty.

5.9.1.3 Prices

The price of TEL anti-knock compounds does not show a constant trend. There are certain fluctuations which are probably due primarily to varying lead prices and differing freight rates. The prices per 100 kg c & f Pakistan main ports as indicated by the Associated Octel Company are as follows:

$ 69.43 from 1- 1-64 / 30- 6-64
$ 71.23 from 1- 7-64 / 31-12-65
$ 74.11 from 1- 1-66 / 31- 8-66
$ 74.61 from 1- 9-66 / 31-10-66
$ 69.98 from 1-11-66 / 18- 7-67
$ 71.44 from 19- 7-67 / 18-12-67
$ 62.01 from 18-12-67 / 31-12-67
$ 69.31 from 1- 1-68 until present

5.9.1.4 Recommendations

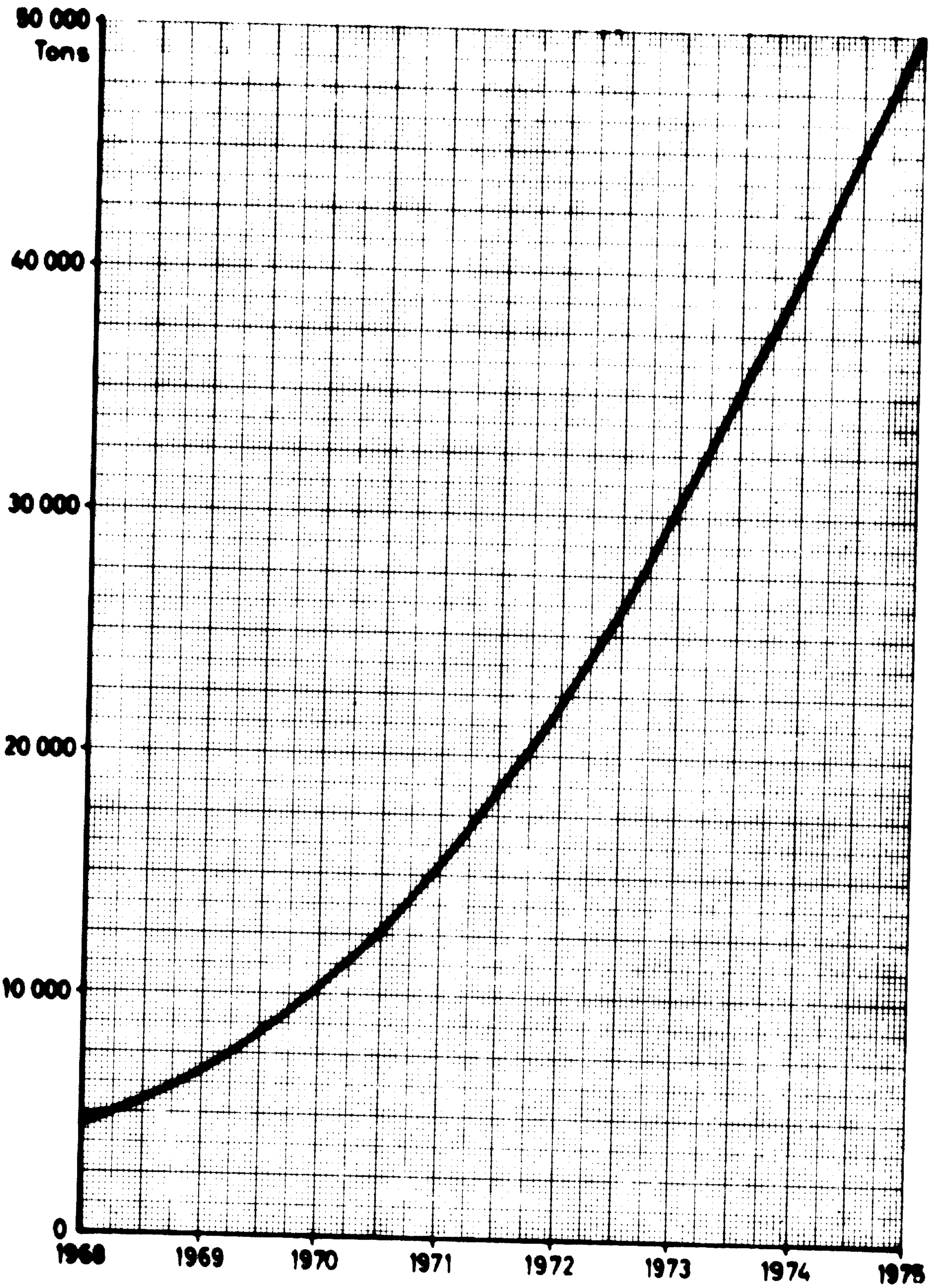
The present demand for anti-knock additives is low in Pakistan. It cannot be expected to exceed 400 tons in the case of TEL solutions and 300 tons per year in the case of TML solutions till 1975. Although the exact minimum capacity of plants producing TEL and TML is not known, it can safely be assumed to exceed 5,000 tons per year. Hence the Pakistani market alone does not justify taking up production in the foreseeable future.

Naturally, it might be considered to produce TEL or TML for exports within RCD or to the whole Asian region. Although no import figures are available, the demand should be fairly high since so far there is no manufacturer of TEL and TML in Asia, at least outside the communist countries. According to our information only one plant is being established in Japan.

Despite this apparently favourable situation we do not recommend taking up the production of anti-knock compounds for the following reasons:

- The TEL problem is presently discussed by the RCD Authorities. We understand that Iran is interested in establishing plant of this type. We do not think it justified to have two plants in RCD since the overall petrol consumption is relatively low owing to the limited number of cars in operation.

- The production process involves a number of technical difficulties. According to information received from the only West German manufacturer of lead additives which has been in operation for only three years, a number of problems have been encountered for some time.



<u>Figure</u> 14: Future Consumption of Detergent Formulations in Tons of Standard Washing Powder Equivalent

- Know-how is not easily available from western countries. In the non-communist world there are only about 11 manufacturing firms. Out of these four are in the USA and three in Italy. Nearly all of the firms are associated to one of the two large manufacturers of TEL.

  - Ethyl Corporation, Houseton, USA and
  - The Associated Octel Company Ltd., London/England

  To our knowledge only two Italian manufacturers:

  - Compagnia Italiana Petroli and
  - Industria Chimica Additiva Prodotti Petroliferi Affini

  are independent.

  In these circumstances it might be difficult to obtain the assistance of the producers under favourable conditions.

- The manufacturing risk is fairly high, especially if the plant is designed fairly large in order to export the surplus not consumed within the country. The product can be used only for one single purpose, namely as an additive to petrol. If another anti-knock agent became available which is not as toxic and about as effective as the lead compound, the plants would probably have to be closed down before long.

- Pakistan apparently does not have any major lead deposits of its own. Lead, however, is the main raw material accounting for 40 % by weight of the TEL and TML additives.

- The production requires a high capital-investment and provides only a few jobs.

In these circumstances we do not consider the manufacture of TEL and/or TML to be a valuable contribution to the economic development of Pakistan.

5.9.2 Glycerine

5.9.2.1 General Characteristics

5.9.2.2 Domestic Production

5.9.2.2.1 Producers

5.9.2.2.2 Volume and Future Development of Production

5.9.2.2.3 New Projects

5.9.2.3 Demand

5.9.2.3.1 Volume and Structure of Past Demand

5.9.2.3.2 Forecast of Consumption Trends

5.9.2.4 Prices

5.9.2.5 Recommendations

5.9.2 Glycerine

5.9.2.1 General Characteristics

Glycerine is a transparent liquid of sweetish taste. Its chemical formula is $C_3H_3(OH)_3$.

Glycerine is a component of all vegetable and animal fats and oils in the form of triglycerides as a combination with fatty acids.

In industrialized countries glycerine is mainly used in the production of

- Alkyd resins
- Explosives
- Cellophane
- Tobacco products.

In addition, it is used as a moisture-retaining agent in the manufacture of

- Cosmetics
- Ointments
- Stamp pad inks
- Modelling compounds
- Cyclostyling inks, etc.

In other industrial sectors it is used as a

- Antifreeze agent
- Heat conductor
- Lubricant.

Important ways of obtaining glycerine are:

- Recovery from spent soap lyes by distillation
- Splitting fats
- Synthetic production.

The spent lye obtained as a by-product in the production of soap contains about 5 per cent of glycerine which is extracted by concentration and distillation. Even in industrialized countries, this process is still an important source of glycerine supply.

Fat splitting means chemical separation of fats or oils into fatty acids and glycerine. The glycerine-containing liquid (sweet water) obtained by this method is refined in another process similar to that used with spent lye.

For synthetic glycerine production propylene is the primary product. The industrially applied processes mostly operate via acrolein - allyl alcohol or allyl chloride - epichlorohydrin

Though glycerine, owing to its favourable chemical and physical properties, is a very useful raw material for the types of production mentioned some competing products have been developed, such as:

- Ethylene glycol
- Pentaerythritol
- Sorbitol.

Pentaerythritol for example has made great inroads into the sector of alky resin production, since it is cheaper than glycerine but has the same good properties. Sorbitol competes as a moistening agent; it has the advantage of being less hygroscopic than glycerine. In view of this competition it is generally assumed that world demand for glycerine will not rise any further.

In Pakistan, however, different conditions prevail. There are still a great many applications that are not yet exploited. Besides, glycerine as a domestic product should be preferred to imported chemical products even in cases where the imported items have minor advantages.

The pharmaceutical industry is the main consumer of glycerine in Pakistan. It is followed by the tobacco and the cosmetics industries. Other industries consume only minor quantities of glycerine.

5.9.2.2 Domestic Production

Before giving any details, it must be emphasized that this study does not include the quantities of glycerine consumed by Government institutions. For reasons of secrecy the capacities of the individual firms were not mentioned either. In the following, therefore, only the quantities supplied to private industry and for export are considered.

5.9.2.2.1 Producers

In Pakistan glycerine is obtained only as a by-product from spent lye in soap production. The firms producing glycerine for the domestic market and for export purposes are

West Pakistan

- Crescent Pak Soap & Oil Industries, Karachi
- For[illegible] Gujranwala
- Combined Industries, Lahore
- Lever Brothers (Pakistan) Ltd., Karachi

East Pakistan

- Kohinoor Chemicals Co. Ltd., Dacca
- Lever Brothers (Pakistan) Ltd., Chittagong

1.0.5.3.[illegible] Trends and Future Development of Production

The steady increase in soap production in Pakistan enables the producers to recover glycerine easily as a by product from the spent lye. The development of production in the past can be seen from following table.

Table 113 Glycerine Production in Pakistan (in tons)

Year	West Pakistan	East Pakistan	All Pakistan
1965-66	403	230	633
1966-67	900	300	1,200
1967-68	1,160	1,050	2,210

Note. The figures do not include the quantity consumed by the state.

As glycerine production is rather small, the establishment of new enterprises results in sudden jumps in the total production. The increase in production in West Pakistan in 1966-67, for instance, was due to the fact that Lever Brothers Ltd. extended its plants and Crescent Pak Soap and Oil Industries started production.

In East Pakistan Kohinoor Chemicals reported a slight increase in the production of glycerine. The new installation of Lever Brothers Ltd. in Chittagong resulted in a sizeable increase in production for private purposes of 750 tons a year.

5.9.2.2.3 New Projects

The following new projects are already under construction or have at least been sanctioned:

West Pakistan

- Wasir Ali Industries, Hyderabad started the production of glycerine in mid-1968 and will presumable produce about 110 tons a year for the local market. The production of glycerine for the free market in West Pakistan will increase to at least 1,275 tons a year in 1968/69.

- Zulfecar Industries, Karachi. The glycerine production of this firm will presumably start at the beginning of 1969 and will come to about 300 tons a year from 1969/70. Thus the production in West Pakistan will increase in 1969/70 to about 1,575 tons.

East Pakistan

- Crescent Pak. Soap & Oil Ltd., Karachi: This firm is establishing a new plant for glycerine distillation in Chittagong. The plant will start production at the beginning of 1969 and will manufacture about 150 tons a year.

Thus the production of glycerine in East Pakistan for private consumption will rise in 1969/70 to about 1,200 tons a year.

5.9.2.3 <u>Demand</u>

5.9.2.3.1 <u>Volume and Structure of Past Demand</u>

In 1967/68 2,215 tons of glycerine were available for the civilian market in Pakistan. 60 per cent of this amount was produced in West Pakistan and 40 per cent in East Pakistan. The break-down of consumption was as follows:

- Pharmaceuticals	38 per cent
- Cigarette industry	29 per cent
- Cosmetics	7 per cent
- Paper industry	5 per cent
- Paints, alkyd resins	4 per cent
- Cellophane	3 per cent
- Other industries	3 per cent
- Exports	11 per cent

The pharmaceutical industry is the largest consumer of glycerine in Pakistan. It uses glycerine mainly as a basic material for the production of ointments.

Glycerine is applied as a moistening agent only to the tobacco of the better quality products of West Pakistan's cigarette industry. The most widely consumed cheap cigarettes and all cigarettes produced in East Pakistan are not treated with glycerine.

In Pakistan's cosmetics industry glycerine is used for the production of cosmetics, lipsticks, tooth-paste, shaving-cream, etc. In the preparation of special papers glycerine is needed for surface treatment.

The paints industry uses glycerine as a softening agent for tube paints, cyclostyling inks, stamp pad inks, copying inks, and modelling compounds. In the production of alkyd resins it is used as a basic raw material.

It serves as a softening agent in cellophane production as well. According to the producers small quantities of glycerine are utilized by industry as lubricants, heat conductors, textile auxiliaries, and for pressure transmission in hydraulic units, etc.

5.9.2.3.2 Forecast of Consumption Trends

On the basis of interviews with the processing industry the following growth rates of glycerine consumption were calculated or estimated:

- Pharmaceutical industry	11 %/y
- Cigarette industry	15 %/y
- Cosmetics industry	18 %/y
- Other consumers	11 %/y

The average growth rate of the demand for glycerine is thus estimated at

about 13 per cent/y

for the period up to 1975. The estimated development of demand in the next few years, excluding the consumption of Government institutions is shown in table 114.

This is still not much. The present soap consumption per head is about 1.35 kg[1]. It is expected to grow by about 2 per cent per annum and would, therefore, be 1.55 kg in 1975. The consumption of household wahsing powder would then be equivalent to about 20 per cent of the consumption of all household detergents.

If the demand for DDBS-based detergents develops as in the second model and is satisfied entirely by domestic production, the requirements for n-paraffins, alkylate and DDBS would be as indicated in table 102. Whether the demand does develop in this way mainly depends on the Government.

Table 102: Estimated Requirements of Detergent Raw Materials, 1968 - 1975 (in tons)

Year	Requirements of DDBS	Requirements of DDB	Requirements of n-paraffins
1968	880	620	500
1969	1,380	970	780
1970	2,070	1,460	1,170
1971	3,000	2,120	1,690
1972	4,140	2,970	2,340
1973	6,220	4,380	3,500
1974	7,780	5,480	4,390
1975	9,720	6,850	5,480

The table shows that the DDB demand fairly soon reaches interesting proportions provided that the market is not depressed by restrictive measures of any kind.

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1) This estimate is based on the soap consumption figures given in table 94.

Table 114: Estimated Future Demand for Glycerine in Pakistan, 1968/69 to 1975/76 (in tons)

Year	Pharma-ceuticals	Cigarettes	Cosmetics	Other Industries Export	Total
1967/68	840	640	160	570	2,210
1968/69	930	740	180	630	2,480
1969/70	1,020	850	220	700	2,790
1970/71	1,120	970	250	780	3,120
1971/72	1,240	1,120	300	870	3,530
1972/73	1,360	1,280	350	960	3,950
1973/74	1,500	1,470	420	1,070	4,460
1974/75	1,660	1,690	490	1,190	5,030
1975/76	1,830	1,940	580	1,320	5,670

In the course of Pakistan's industrial development glycerine consumption will almost treble by 1975/76. By that date the pharmaceutical industry, at present the largest consumer with a share of 38 per cent, will probably have been caught up by the more rapidly growing cigarette industry. By 1975/76 the shares of the two industries will be 32 and 34 per cent of the total consumption of glycerine, respectively.

Another important consumer of glycerine will be the cosmetics industry, which is relatively little developed at the moment but which will undergo a rapid expansion in the future. It is estimated that the share of this industry will increase from 7 per cent at present to 10 per cent in the years to come.

5.9.2.4 Prices

The development of glycerine prices in Pakistan cannot be described here. The interviewed firms could not be induced to give any information on this subject. The sales price at the time of the investigations was

Rs. 5,500.- per ton.

The export prices were stated to be

US$ 600.- per ton

c&f European seaport.

A German importer, however, informed us that he recently bought glycerine from Pakistan at a price of

US$ 392.- per ton c&f Hamburg.

The supplied commodity, however, had to be distilled once more, since it was not up to the required standard. In addition to the cost involved, the distillation resulted in a loss of substance of 10 per cent, the price for the buyer thus increasing to

US$ 444.- per ton.

The price of glycerine in the world market has declined by 50 per cent in the last two years due to oversupply. We have been reliably informed that the price is expected to continue decreasing. The price for chemically pure glycerine in Germany is at present

US$ 400.- to 425.- per ton

for immediate supply franco the consumer's factory.

5.9.2.5 Recommendations

The calculated demand for glycerine in Pakistan can be satisfied only if further expansions of production are planned after 1969/70, in addition to the new installations that are already projected up to them.

We noted during our investigations that a large proportion of the spent lyes are not yet used in Pakistan for glycerine production; so it is undoubtedly recommendable to continue with the same production procedure in the future, too. A petro-chemical production seems not recommendable.

As already mentioned, glycerine can also be obtained as a by-product of fat splitting. The application of this process depends in the first instance on the market for free fatty acids. It is advisable to analyse separately whether the industrial consumption of fats and caustic soda and the production of glycerine could be rationalised by establishing a fat-splitting plant. Above all,it should be determined in this context how advantageous it would be to utilise fatty acids in the production of soaps and other detergents.

5.9.3 Liquefied Petroleum Gases

5.9.3.1 General Characteristics

5.9.3.2 Local Production

5.9.3.3 Demand

5.9.3.3.1 Distributors and Markets

5.9.3.3.2 Present and Future Demand

5.9.3.3.3 Substitution of Kerosene

5.9.3.3.4 Competition with Natural Gas

5.9.3 Liquefied Petroleum Gases

5.9.3.1 General Characteristics

The term liquefied petroleum gas (LPG) is usually applied to liquid propane, butanes or a mixture of the two. These liquid gases are recovered either from wet natural gases or from distillation and cracking processes in petroleum refineries. In the latter case the gases contain a certain amount of olefines unless especially purified.

The calorific value and specific gravity of LPG varies according to the composition of the gas. For the three major component compounds they are as follows:

	calorific value	specific gravity
propane	11,370 kcal/kg	0.5089
n-butane	11,380 kcal/kg	0.5788
i-butane		0.559

Propane, butane and mixtures of the two are used

- as fuel in industry and households, especially for cooking purposes

- as feed stock for petrochemical processes

- as ingredient to gasolines and as fuel for combustion engines

- as welding gas

and for some other less important purposes. For Pakistan, its use as domestic and industrial fuel is the most interesting aspect of its production.

A special feature of LPG is that it requires special transportation and storage facilities. For temperatures of 40 - 45°C propane needs a pressure of 22 kg/cm^2 and butane one of 7 kg/cm^2. This means that either high-pressure equipment or freezing facilities are necessary for the transport and storage. Usually the first alternative is the more economic. Most LPG is transported in pressure tanks by rail and truck or by sea on board ship. Bulk volumes are also transported by pipelines. The gas is supplied to households in small pressure containers of varying sizes.

5.9.3.2 Local Production

At present LPG is only produced by Pakistan Refinery Ltd. in a pilot plant having a capacity of 1,500 tpa. The plant is located at Karachi. Production started in early 1967. The Eastern Refinery Ltd. intended to produce another 10,000 tons of LPG, beginning some time in late 1968.

Besides these two plants already in existence, there are more or less definite plans, sanctioned as well as unsanctioned, for further units. The following table gives a summary of all units planned or in existence which have come to the knowledge of the Battelle team.

Table 115: Existing and Planned Capacities for the Production of LPG

Name of Refinery	tons/year	expected or actual start of production
Pakistan Refinery Ltd.	1,500	1967
Pakistan Refinery Ltd.	20,000	1971/72
National Refinery Ltd.	7,000	1969/70
Attock Oil Co.	16,000	1969
Easter Refinery Ltd.	10,000	1968
Total capacity	54,500	1971/72

In addition to these capacities it can be expected that National Refinery Ltd., after the expansion of their refinery capacity, will enlarge their LPG plant by another 20,000 tpa. We suppose that this might happen around 1974.

If the expected development takes place, the LPG capacity will increase in the coming years as follows:

Table 116: Annual Development of LPG Producing Capacities (in tons/year)

Year	West Pakistan	East Pakistan	total
1968	1,500	10,000	11,500
1969	17,500	10,000	27,500
1970	24,500	10,000	34,500
1971	44,500	10,000	54,500
1972	44,500	10,000	54,500
1973	44,500	10,000	54,500
1974	69,500	10,000	79,500
1975	69,500	10,000	79,500

The capacity for East Pakistan has been taken as constant since the development of the LPG sales is expected to be slow. Moreover, we do not expect the capacity of the existing refinery to be increased before 1974/75, and only then would more propane and butane be available.

Both from the point of view of demand and of the capacities available, the situation in West Pakistan contrasts sharply with East Pakistan. The capacities, which are initially lower in the western Wing, will probably be 46 times greater by 1975. At that time the capacity is expected to be nearly seven times that of East Pakistan. A big increase is expected to take place in 1968 and again in 1971 and 1974.

Whether the development takes place is likely to depend to a considerable extent on whether the Government gives the incentives which are deemed necessary by the industry. This refers in the first instance to import facilities and taxes. The companies concerned point out that the necessary investment is high, especially on the distribution side.

5.9.3.3 Demand

5.9.3.3.1 Distributors and Markets

So far only one firm has marketed LPG in Pakistan: Burshane (Pakistan) Ltd., Karachi, a subsidiary of Burmah Shell Company. The firm has a contract with Pakistan Refinery for the delivery of 1,000 tons of LPG per annum, but the quantities delivered so far have been somewhat higher. The balance of PRL's production has been supplied to National Refinery, which needs about 300 - 400 tons of propane and 100 - 200 tons of butane as solvent and refrigerant for lube production.

Burshane distributes the gas in cylinders of about 11,5 kg through a number of agents in the area of Karachi, and has no difficulty in disposing of the quantities of LPG available. The firm is optimistic about the development of demand, although it is doubtful whether there will not be over-competition in Karachi.

In the near future four or five more companies will probably join the LPG marketing business. These will be in the first instance:

- National Oil Company
- Attock Oil Co. or a subsidiary
- Esso
- Burmah Eastern.

Initially, efforts of the firms concerned can be expected to concentrate mainly on sales in

- Karachi
- Rawalpindi
- Chittagong
- Dacca

However, fairly soon (probably depending on the availability of foreign exchange for transport facilities) such places as Lahore, Lyallpur, Multan, Hyderabad, and Gujranwala will be served, too. In the longer term the marketing will extend to other cities and also the countryside.

From East Pakistan it might be possible to export some of the LPG to nearby countries for a few years.

5.9.3.3.2 <u>Present and Future Demand</u>

The firms involved in the present or future production and marketing are of the opinion that at least the urban households with an income of Rs. 500.- and above are potential consumers. The number of potential consumers in Karachi alone was estimated by one party at 50,000. We feel that this estimate is rather conservative. At present only about one tenth of this potential has been tapped but perhaps even this cannot be fully satisfied. Thus, Karachi could probably at present absorb about 10,000 to 15,000 tons of LPG if it were available.

Our discussions with the parties interested in the LPG business showed that these firms are themselves not very certain how sales will develop in Pakistan. Due to the expected keen oligo polistic competition they were generally not prepared to reveal what their estimates are.

Since it is generally believed that figures from other countries are little help in making LPG demand forecasts, we have confined ourselves on an assessment of the extent to which the expected capacities could probably be utilised in the different years. Success in marketing LPG naturally depends on the effectiveness of the marketing companies and on the availability of suitable transport and storage facilities, which have had to be imported so far. Since marketing effectiveness can vary widely we have tried to be conservative in our estimates.

Keeping this in mind it can be assumed that the marketing of the LPG produced by Attock Oil Company will develop in the northern market of West Pakistan in the following manner:

1969	1,000 tons
1970	8,000 tons
1971	16,000 tons

The 7,000 tons to be produced by National Refinery in 197[illegible] will probably be absorbed in the same year in Karachi. The 20,000 tons from Pakistan Refinery will probably not be consumed in 1971. We expect that the sale of this output will develop roughly as follows

1971	10,000 tons
1972	15,000 tons
1973	20,000 tons

The possible additional capacity in 1974 of 20,000 tons would be utilised in two years time.

5.7.4.3 Consumers

In Pakistan at present DDBS types of detergent preparations are used in

- households, mainly for washing textiles
- the textile industry for washing purposes and as a dispersing agent
- the leather industry as a dispersing agent
- the paper industry as a dispersing agent
- hotels for washing purposes
- laundries for washing purposes
- train cleaning by the Railway Authorities
- the insecticide industry as an emulsifier.

The percentage of the sales consumed by each sector could not be ascertained. But it is fairly safe to say that the textile industry is the largest single consumer of the sectors indicated. Households are likely to be second in importance, followed by hotels and laundries. According to our findings the paper industry consumes less than 10 tons with 35 per cent active substance. The consumption of the insecticide industry is negligible.

5.7.5 Prices

The price of soft alkylates c&f Carachi is at present approximately:

USA, Allied Chemicals Corp.	$ 340.-/ton
West Germany, Chemische Werke Hüls:	$ 318.-/ton
Japan, Nissan - Konoko:	$ 312.-/ton

In East Pakistan the picture might be like this

Table 117: Expected Consumption and Exports of [illegible], East Pakistan (in tons)

Year	Consumption	Exports	Total
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	-	[illegible]

While in East Pakistan the local consumption is expected to rise only slowly, the local demand in West Pakistan will develop fast. There will probably also be surplus capacities during most of the period (see table 118). But it is doubtful whether an export trade will develop since a major part of the [illegible] surplus capacity is located far away from the sea.

Table 118 Expected Installed Capacity and Consumption of LPG in West Pakistan during the period 1968-1975 (in tons)

Year	Consumption	Surplus capacity	Installed capacity
1968	1,500	nil	1,500
1969	4,500	13,000	17,500
1970	16,500	8,000	24,500
1971	36,500	8,000	44,500
1972	42,500	2,000	44,500
1973	44,500	nil	44,500
1974	55,000	14,500	69,500
1975	69,500	nil	69,500

The LPG service might expected to be extended to the major cities as follows

- Chittagong from 1968
- Dacca from 1969/70
- Rawalpindi and Islamabad from 1969
- Lahore from 1972

The consumption indicated above includes only domestic use and industrial consumption other than for petrochemical purposes. Of the gas used in industry, about 500 - 1,000 tons might be utilized to replace acetylene as a welding gas for certain applications. The National Refinery requires a certain quantity as already mentioned, and this might be increased in the years to come to about 14,000 tons. If butanes, propane or a mixture of the two are taken as feedstock for a cracker unit the whole picture will be radically affected, since the quantities available for domestic and industrial fuel will be reduced accordingly.

This brings up a point which has not been mentioned so far: according to all the statements made by experts concerned the consumption of LPG in Pakistan in the long run and even so far, is mainly limited by the availability of LPG. Most of the world's consumption of liquefied petroleum gases is recovered from wet natural gases, which are rare in Pakistan. This restricts the production of LPG in this country in the first instance to recovery from refinery gases.

5.9.3.3.3 Substitution of Kerosene

The LPG component of the refinery gases has so far been utilized internally as fuel. As soon as it is consumed outside the refinery it will replace other fuels such as kerosene, wood and coal, but primarily kerosene. According to statements from the mineral oil industry this is very desirable since there is a shortage of kerosene in the country. Since the kerosene consumption for non-aviation purposes is increasing at a rate of 11,5 per cent p.a. and since jet traffic can also be expected to increase at a high rate kerosene will continue to be in rather short supply in the future. According to an estimate by Esso, kerosene consumption (excepting consumption by jet aircraft) is expected to develop as shown in table 119.

Table 119: Development of Kerosene Consumption in Pakistan 1968 - 1975 (in tons)

Year	Consumption
1968	371,500
1969	414,200
1970	461,900
1971	515,000
1972	574,200
1973	640,200
1974	713,800
1975	795,900

Due to the different calorific value, 1,000 kg of LPG on average can replace 1,110 kg of kerosene. It mus also be taken into consideration that the efficiency of the usual kerosene burners is only about 28 per cent while that of the burners of LPG can be taken as 50 per cent, meaning a ratio of 1.786. Hence in practice 1,000 kg of LPG are equivalent to 1,982 kg of kerosene. If the possible LPG consumption as shown in tables 117 and 118 is compared with the figures of table 119 it is found that in 1970 about 8 per cent and in 1975 about 20 per cent of the consumption of normal kerosene could be replaced by LPG.

5.9.1.3.4 <u>Competition with Natural Gas</u>

It might be questioned whether, at the places where natural gas is available to consumers, liquified petroleum gas has a chance in the market. This must be answered in the affirmative. It has been found that the introduction of city gas supplies at the same time tends to promote the demand for LPG as well. One of the reasons for this phenomenon is the fact that city gas supplies do not reach all potential consumers, while they have a certain publicity effect. It is much more convenient to use natural gas than kerosene or coal.

One further point has been raised by the LPG producers. According to them, connecting a consumer to the gas mains costs about Rs. [illegible] - in foreign exchange, while it is said to be much cheaper to supply LPG

5.9.4 Formaldehyde

5.9.4 Formaldehyde

5.9.4.1 General Characteristics

Formaldehyde, H-CHO, is a colourless gas of pungent smell which is soluble in water. Formaldehyde is obtained either by catalytic oxidation of lower parafins, such as methane, butane, propane, or from menthanol. It is generally marketed as a 37 per cent aquaous solution, mostly called "formalin". Formaldehyde formalin serve as

- disinfectants
- tanning agents
- fixing agents for anatomical preparations
- material for mould fungus control

In addition, large quantities of formaldehyde are used for the manufacture of dyes, phenolic resins (PF), aminoplastics (UF), melamine resins (MF) and others.

In Pakistan formaldehyde is used almost exclusively as an intermediate product in the production of melamine and urea formaldehyde. Negligible quantities of formalin are needed by laboratories etc. and by the tanning industry.

5.9.4.2 Domestic Production

In Pakistan

- Valika Chemical Industries Ltd., Karachi, and
- Eastern Chemical Industries Ltd., Chittagong

produce formaldehyde solution from methanol for their urea formaldehyde and melamine formaldehyde production. Both plants started operation only in 1967.

Valika has a capacity of 19.5 tons per day = 5,850 tons per year of formalin, corresponding to a quantity of about 2,200 tons per year of pure formaldehyde. The capacity of Eastern Chemical Industries is 10 t/d = 3,000 t/y of formalin or 1,100 t/y of pure formaldehyde. The statements of sections 5.2.1 to 5.2.3 apply to both plants: as there is no demand for UF and MF resins, both plants were inoperative for most of the time. The total production of formalin, for instance, was only about 400 t in 1967 compared with a capacity totalling almost 9,000 t per year.

5.9.4.3 Problems

The formalin manufacturers are naturally faced with the same problems as the manufacturers of UF, MF and PF. The packing material also seems to present certain difficulties. For formalin lacquer-lined drums are needed, which according to the manufacturers of formaldehyde are not locally available. It should therefore be made possible for the drum manufacturers to produce such lacquer-lined drums locally. [1)]

5.9.4.4 Demand

So far the manufacturers of UF, MF, and PF were the only consumers of formaldehyde. These manufacturers are:

- Valika Chemical Industries Ltd., Karachi (UF)
- Tutehally Chemicals Ltd., Karachi (MF)
- Shuja Industries Ltd., Karachi (MF)
- Allied Industries, Wazirabad (PF)
- Eastern Chemical Industries Ltd., Chittagong (UF, MF)

Except for Allied Industries, all the enterprises started production only in the course of 1967. The consumption of formalin in Pakistan in 1967 was equivalent to a production of 400 t, West Pakistan accounting for 3/4 and East Pakistan for 1/4.

In the immediate future, however, there will be a number of new consumers:

- Synthetic Resin Products, Chittagong (1968, UF)
- Kashmir Development Corporation, Jhelum (1969, UF)
- Asmat Industries, Gujranwala (PF)
- Zaheer Industries, Sialkot (1969, PF)
- M.M. Industries, Gujranwala (1970/71, PF)

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1) It may be mentioned that similar drums are also needed for the manufacture of DDT, BHC and aviation methanol.

Table 120 shows the consumption figures for formalin, calculated on the basis of the estimated production figures for UF, MF, and PF quoted in sections 5.2.1 to 5.2.3.

Table 120: **Forecast of the Development of Demand for Formalin*) 1968 - 1975 (in tons)**

Year	West Pakistan				East Pakistan				All Pakistan			
	UF	**PF**	**MF**	**sub total**	UF	PF	MF	sub total	UF	PF	MF	total
1969	1,100	180	100	1,380	1,280	70	20	1,370	2,380	250	120	2,750
1970	1,300	240	105	1,645	1,320	95	20	1,635	2,620	335	125	3,320
1971	1,730	370	115	2,215	1,580	105	20	1,705	3,310	475	135	3,920
1972	2,230	410	125	2,765	1,680	115	20	1,815	3,910	525	145	4,580
1973	2,820	450	135	3,405	1,830	125	25	1,980	4,650	575	160	5,385
1974	3,560	495	145	4,200	2,010	135	25	2,170	5,570	630	170	6,370
1975	4,500	535	160	5,195	2,180	145	30	2,355	6,680	680	190	7,550

Note: For the calculation of the methanol content of formaldehyde resins the following conversion figures have been applied:

UF Resin **x** 1,2 = **Formalin** (37 per cent)
PF Resin **x** 0,75 = **Formalin** (37 per cent)
MF Resin **x** 0,85 = **Formalin** (37 per cent)

*) 37 **per** cent **Formaldehyde** content

The prices refer to soft types of alkylates. The hard types are generally about $ 30.- cheaper per ton.

The prices of linear chain alkyl benzenes have remained stable during the last few months. Since the existing capacity corresponds to the consumption, no market changes are expected in the near future.

5.7.6 Recommendations

As the preceding reflections show, in the period up to 1975 a considerable growth of the consumption of DDB-based detergents can be achieved. If we interpret correctly the figures published by the sanctioning authorities, a capacity of 1,900 tons DDB input = 2,700 tons DDBS output has been sanctioned so far. This includes the two plants mentioned for East Pakistan. To this figure we add 40 tons for small plants with local equipment and tentatively another 250 of DDBS for Kohinoor Chemicals. This brings the total up to 3,000 tons of DDBS.

A comparison with table 102 shows that these plants will be fully utilized in 1971. It is therefore recommended to begin work on a new plant for the sulphonation and the production of detergent formulations around 1,972, so that it can start operation in 1973. This plant should have a capacity of about 10,000 tons of sulphonate per annum. Further, we suggest starting a plant for the production of linear alkyl benzenes (DDB) in 1973. The capacity of this plant could also be 10,000 tons. The recovery of n-paraffins for the production of alkyl benzenes could in our opinion be started in 1975 at the earliest.

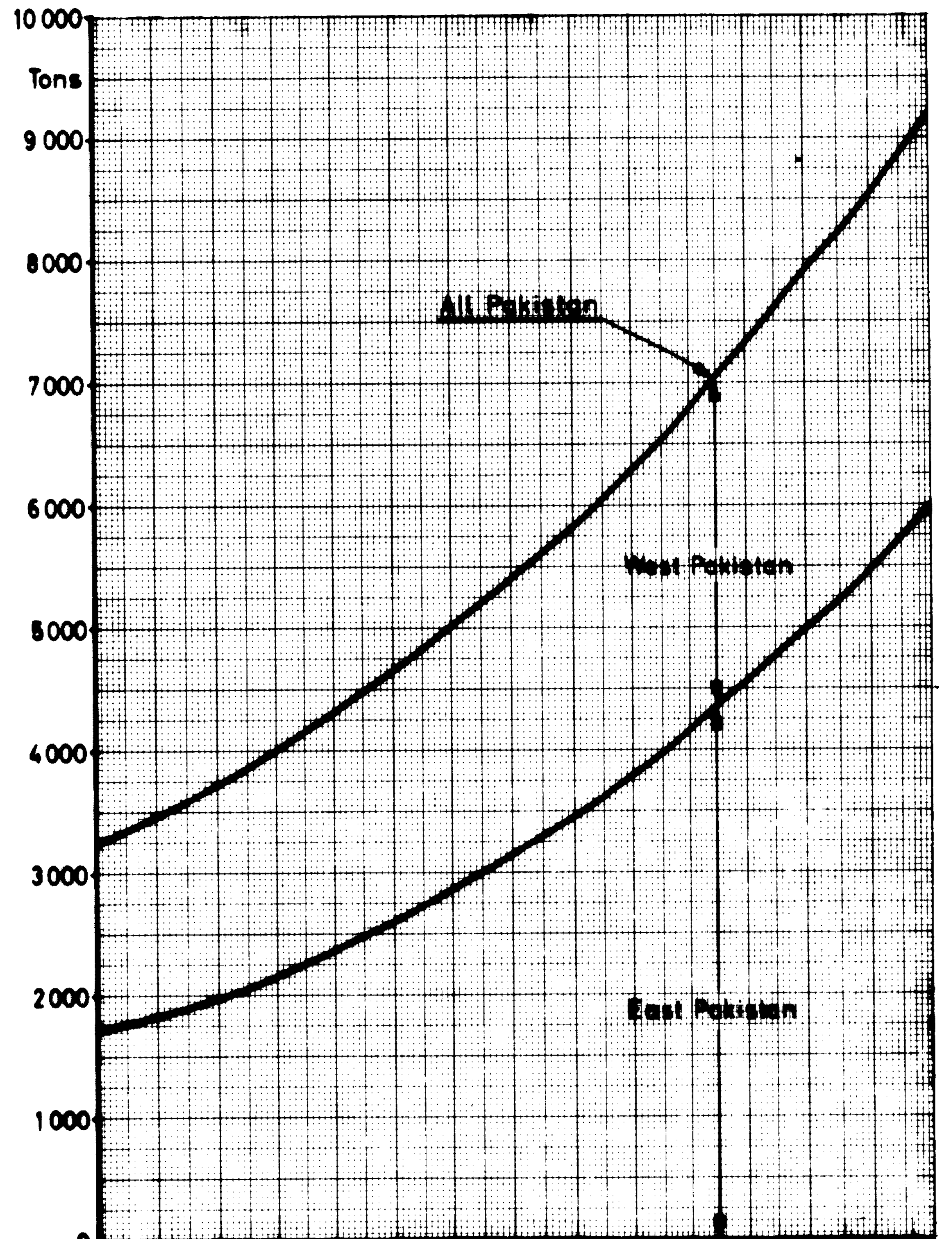

Figure 17: Trends in the Demand for Formalin (37 per cent Formaldehyde Content)

The calculations are based on the assumption that the final product (UF, MF, PF) is produced in that Wing of the country in which it is consumed.

Table 120 has to be interpreted with the same reservations as the production of the different resins. The development of the consumption figures in the way indicated will depend largely on a corresponding expansion of the wood-working industries.

The table shows that the bulk of the formalin will presumably be used for UF production, a sector in which East Pakistan will be the principal buyer.

According to our estimates, by 1975 about 89 per cent of the formalin will be used for UF manufacture, 9 per cent for PF and 2 per cent for MF. The consumption is expected to be more than three times that of 1968.

5.9.4.5 Prices

The price for domestically produced formalin in Karachi is between 750 and 790 Rs./t. For East Pakistan a reputable manufacturer indicated a price of 1,500 Rs./t. The import of formalin is banned.

A survey of the price situation in other countries is given in Table 121.

Table 121: Prices of Formalin (37 per cent) in some manufacturing countries [1] (in $/ton)

	USA	France	Germany	Italy
1964	82.5	90	90	64
1965	82.5	90	92.5	94.5
1966	78	90	97	94.5
1967	78	90	90	72.5
1968	78	90	78	72.5

1) The prices are inclusive of freight but exclusive of taxes. They apply for shipments of 10 to 20 t.

5.9.4.6 Recommendations

Altogether, the existing capacities are sufficient to meet the demand up to 1975 if capacity is fully utilized. But as the greater part of the presently installed capacity is located in West Pakistan, whereas the consumption of the final product urea formaldehyde is much higher in East Pakistan, it would be necessary to transport considerable quantities of formalin to the Eastern Wing.

This would certainly be a disadvantage, since formaldehyde is a very transport-intensive product. The reason is that the formalin traded in Pakistan contains only 37 per cent formaldehyde. And, moreover, suitable containers of stainless steel or rubber-, lacquer- or glass-lined steel are required.

Consequently, it is recommendable to put a new plant into operation in East Pakistan in 1973/74. We hold the opinion that this plant should be projected for a capacity of at least 5,000 tons per year.

As developments in the sector are still somewhat uncertain, however, it would be better to wait and see what happens in the next three years before taking a decision on the establishment of this plant.

1.9.1 Acetaldehyde

Acetaldehyde, CH_3CHO, is a colourless, highly flammable liquid.

It is obtained on an industrial scale from acetylene ethylene, lower paraffins or ethanol.

Acetaldehyde is an intermediate for a number of substances obtained in large-scale production, particularly acetic acid and its anhydrides n-butanol and 2-ethylhexanol, pentaerythritol, chloral, etc.

It is also an intermediate in the manufacture of acetone, acetic acid and acetic anhydride from ethanol.

Acetaldehyde is presently being manufactured in Pakistan and is used in cellulose acetate production by Kohinoor Rayon Ltd., Lahore.

At Kohinoor Rayon, acetaldehyde is obtained by oxidation of ethanol. The plant has a capacity of [illegible] tons day. The acetaldehyde produced is used exclusively to meet the internal demand of the company.

We were unable to find any other instances of the use of acetaldehyde in the course of our survey. Where this substance was imported, the total figure was in all cases below 2 tons per year.

There are at present indications of possible applications of acetaldehyde outside the sector of cellulose acetate production, above all in the plasticiser field. Acetaldehyde could be the raw material for 2-ethylhexanol for further processing to dioctyl phthalate (DOP). Should production commence on the scale mentioned in section 3.3.8, the consumption of acetaldehyde in this sector will be approximately 1,[illegible] tons in 1971 and 8,[illegible] tons in 1975. (See section 6.4.2 in this connection.)

Acetaldehyde is also a potential raw material for future pentaerythritol production. Robinson further sees certain possibilities of selling acetic acid and acetic anhydride to insecticide manufacturers. This could also affect acetaldehyde production.

6. Substitution of Petrochemical Products for Conventional Materials

6.1 General Background

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6. Substitution of Petrochemical Products for Conventional Materials

6.1 General Background

Replacement of conventional materials like metals, wood and natural fibres by petrochemical products is a very important factor in the rapid growth of the petrochemical industries. This is demonstrated by the far more rapid growth of the petrochemical industries, compared with other industrial sectors.

The group of plastic materials of various types is one of the fastest growing members of the petrochemicals family. As has been shown in the previous chapter, all over the world plastics and resins have found numerous applications in practically every walk of life. Their versatility and their wide range of interesting properties mean that these raw materials are much in demand. Moreover, in contrast to most conventional materials they have the big advantage that they can usually be processed into intermediates and end-products without a significant loss of substance. Thus, they are in most cases cheaper raw materials than the conventional ones.

These features make plastics and resins, in whatever form they are used, extremely important primary products in times of hardship and in countries which are short of raw materials and resources. This does not mean that they are of little importance for other countries and in better times, but it underlines their enhanced value in these cases.

Pakistan must be considered a country where raw materials are scarce. As a whole, it is short of

- timber
- iron
- non-ferrous metals

and a number of other raw materials and semi-finished products which have to be imported. Since this investigation has been made with a view to helping the promotion of local plastics industries and other petrochemical industries, one might even mention in this connection certain imported petrochemical products for which there is little or no hope that they can be produced in the country in the near future. The replacement of these items, too, is certainly worth considering. The same is true of a number of glass, earth, rubber and paper articles.

In the following two sections the situation relating to timber and metals is described in more detail.

6.1.1 Timber Resources

Pakistan's timber resources fall considerably short of requirements. The situation in East Pakistan, however, is better in this respect than in West Pakistan. The Eastern Wing is more or less self-sufficient in timber production except for small imports of quality Burmah teak, plywood for tea chests, and wood for railway sleepers.

But the situation in West Pakistan is quite serious. The total annual requirements of all kinds of timber in West Pakistan were about 1,150 cu. metres in 1966-67, of which only [illegible] per cent was met from local resources and the remaining [illegible] per cent was imported.

The consumption and production of timber in West Pakistan are shown below:

	1,000 cu. metres
House building	265
Non-residential construction	90
Rural construction	165
Packaging, including paper and board	265
Mining	70
Railway and transport, including body building	170
Furniture making	40
Sports goods	15
Miscellaneous wood-based industries	70
Total	1,150

This does not include the wood used as fuel. To what extent the country is short of wood for industrial and building purposes can be seen from a statement made by the Forest Department, Government of West Pakistan, according to which the present supplies in that line can be taken as [illegible] per cent short of the actual demand at the current prices.

The local supplies of wood in West Pakistan break down as follows.

A capacity of 15,000 to 20,000 tons per annum would be feasible; if it is decided to build a plant of only 10,000 tons per annum, it could be installed in 1973 or 1974. But this plant size is generally considered to be too small.

Following the assumptions we have made, the plants would reach full capacity as follows:

Dodecyl benzene sulphonate	(10,000 tons):	1977
Alkyl benzene	(10,000 tons):	1977-79
n-paraffins	(15,000 tons):	1980-82

We do not recommend producing tetrapropylene since sooner or later Pakistan, too, will feel the necessity of using only bio-degradable detergents. Production costs are much the same, in any case. Furthermore, the n-paraffins can be obtained in Pakistan form kerosene fractions.

Whether and to what extent these figures are realized will largely depend on the policy of the Government, as has been pointed out earlier.

	per cent
- Hill forest trees (cedar, blue pine, chir, fir)	56
- Irrigated plantations (shisham)	15
- Kikar	8
- others	21
	100

While the annual demand for wood is growing at a rate of 6 - 7 per cent the increase in the "growing capital" is only 2 - 3 per cent. Even the exploitation of the forests, perhaps happily, is growing at only 2 - 3 per cent p.a. at present. However, through the launching of certain timber production projects in the Northern Area the recovery rate is expected to go up to 6 per cent. Systematic afforestation, however, is carried out only in exceptional cases.

Due to the short supply situation the timber prices have risen continuously in the past, but are said to be more or less stable now. The approximate prices per cubic metre of several types of wood are indicated for comparison.

	Rs./cu. metre
- Cedar (Deodar)	[illegible] to [illegible]
- Blue Pine (Kail)	[illegible] to [illegible]
- Fir	[illegible] to [illegible]
- Chir (long-leafed pine)	[illegible] to [illegible]
- Shisham	[illegible] to [illegible]
- Kikar	[illegible] to [illegible]

Compared with plastics local wood on a volume basis is still very cheap. The present wholesale price of a medium type of soft PVC is about Rs. [illegible],000 per cubic metre. But the losses in wood-working are very high, the processes are more complicated and production is time-consuming, so that even with the present high plastics prices the cost of production of many of the items produced from plastics is lower.

This is all the more true in the case of imported wood. The present price of Burmah teak varies between Rs. 1,700 and Rs. 2,120 per cubic metre.

6.1.2 Metal Resources

The mineral resources of Pakistan for producing ferrous and non-ferrous metals are very poor. Pakistan has not so far discovered worthwhile deposits of ore for the production of aluminium, copper, zinc, or tin. Inferior quality iron ore deposits have been located in the north-west region of West Pakistan and are at present being studied with a view to their exploitation.

The metal producing industry in Pakistan is virtually non-existent except for one small plant at Chittagong producing 150,000 tons of steel annually from imported scrap iron. This plant is now being expanded to produce an additional [illegible] tons of steel, and the expansion is likely to be completed by [illegible]. A feasibility study is currently in progress for the erection of two steel mills in West Pakistan, one on the basis of local ore deposits in the Northern region and the other on imported scrap iron at Karachi. Once these plants have been established the need to replace iron and steel by other local materials will be only a matter of business policy.

At the moment the entire requirements of all kinds of metals, except for the small local production of steel in East Pakistan, are met by heavy imports. Shortage of metals is common and local prices are much higher than world market prices.

Reference to the import figures for 1966/67 of some of the ferrous and non-ferrous metals and products made from them will give an idea of how heavily Pakistan is importing these metals.

	Total value in Million Rupees
Pig iron including sponge iron	62.27
Iron and steel ingots	152.17
Scrap iron	11.36
Iron plates and sheets	262.00
Iron and steel tubes and pipes	59.41
Iron and steel bars, rods etc.	2[illegible].30
Strip iron and steel	11.69
Rails and railway track construction materials	10.10
Iron and steel wire	13.71
Iron and steel forgings in rough	0.30
Wire products and fencing grills	18.51
Nails, screws, bolts, nuts	17.61
Aluminium	30.28
Copper and alloys	39.10
Zinc and alloys	18.11
Tin and alloys	20.30
Lead	3.94
Total	703.99

Besides the above items there are other iron and steel products that have to be imported.

Some of the non-ferrous metals and their alloys are the most promising metals for replacement by plastic materials. For instance, lead pipes can be replaced by PVC rigid pipes, brass required for certain gear wheels by reinforced phenolic resin materials or aluminium required for electrical switch boxes by PVC or phenol formaldehyde moulding compound. Opportunities for substituting plastics for metals occur throughout the electrical and metal-working industries. In most cases the replacement of traditional well-known materials is dependent on dissemination of the requisite knowledge to scores of small industrialists and craftsmen. Besides this, in certain cases the application of plastics is only economic if standardization widens the market for certain intermediate products. All these factors cannot be fully investigated in the present study. As a rough estimate of ours it may be mentioned that by appropriate measures at least 20 million Rupees-worth of the 116 million Rs. spent on the importation of copper, aluminium, tin, lead and their alloys can be replaced by plastics with a lower proportion of imports.

6.1.1 Replacement of other Raw Materials

In addition to wood and metals, substitutes for other raw materials are of interest. In this connection the replacement of imported fats in soap production and the replacement of anti-knock additives have to be mentioned. Similarly it might be useful to replace local materials such as cotton in order to make them available for export purposes. These possibilities are studied in some detail in sections 6.3 to 6.5.

Apart from this, elsewhere in this study more examples of substitution have been given. This is especially the case in chapters 3.8.2, 3.8.3, 3.9.6, 3.2.3, 3.2.8, 3.4, 3.3.6.

6.2 Replacement by Plastics

In chapter 5.2.6 the replacement of imported glass fibre reinforced pipes and also of some other piping materials has been discussed. Moreover, in various sections of paragraphs 5.1, 5.2 and 5.4 the expected replacements have been mentioned. In addition to this, some more possibilities which seem to be of interest to Pakistan are indicated in the following. These fields of substitution in many cases require additional support from public authorities or promotional institutions.

Section 6.2.1 contains only general ideas, while the subsequent sections of this chapter go into greater detail.

6.2.1 General Possibilities

In practice it is not possible to make a clear-cut distinction between the replacement of conventional materials and the development of new applications. In the following, therefore, both of these occur in varying degrees. The following are fields where an increase in the use of plastics in Pakistan may be expected, in addition to those discussed later.

- sections from PVC
- foam materials
- book-binding materials
- textile- and paper-reinforced materials on UF, PF and MF bases
- PVC fibres
- glass fibre reinforced products other than pipes for tube-wells
- floor tiles
- films for insulation in building construction.

As far as sections are concerned according to our findings they are not manufactured in Pakistan.

Figures about the scale of consumption at present are not available since most of these items, if used, have been made of wood.

PVC sections could be used mainly

- as protective strips where walls and floor join
- as sliding rails and protective materials for edges in furniture making
- for the manufacture of door frames and window-frames.

Foam materials from UF, PVC and PS are cheap materials that might be used for replacing natural cork in fields such as

- crown corks
- insulation of cold-stores
- floats
- sun-helmets.

For certain insulation purposes in refrigeration and construction such material may also replace glass wool, which still has to be imported if used. (But in this field a small plant will start production in the [illegible] soon.) PVC foam materials may also be used in certain cases to replace PUR foam.

In the form of coated textiles, PVC articles can replace paper and cardboard used in book-binding. The substitution effect, however, is in this case less important than the improvement in quality. But with loose-leaf notebooks quite a lot of binding material can be saved over the book's lifetime.

Sizeable amounts of non-ferrous metals and alloys made from them can probably be saved when the use of textile and paper reinforced materials is extended. Possible applications have been indicated in section 5.2.1.

Most probably it would be worthwhile to produce PVC fibres in Pakistan. Such fibres can be produced from PVC by additional chlorination with pure chlorine up to a CL content of between 57 and 61 per cent. The resulting plastic solved in acetone can be spun into endless fibres. Staple fibres produced on this basis can be used to advantage in technology. They are fairly heat-resistant, non-inflammable and cannot be destroyed by most of the agressive chemicals. Such fibres can be used to manufacture filter cloth, protective clothing, and diaphragms. In shipbuilding they could be used for making mattresses and decoration material. Such types of fibre would mainly act as a substitute for cotton but probably also to some extent for imported items (filter cloth).

At present a few firms in Pakistan are considering the manufacture of glass-fibre reinforced articles other than pipes. Possible applications which are under discussion are the manufacture of

- boats
- transparent screens
- safety helmets
- structural parts.

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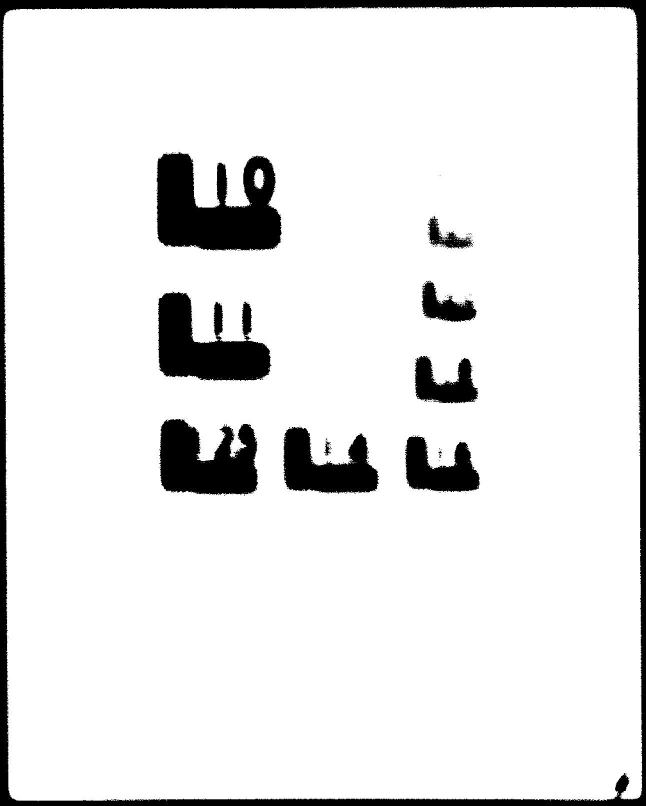

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made in melamine resin. It contains [illegible] - [illegible] g per square metre. In addition to the melamine layer there are 3 - [illegible] layers made of phenolic resin, each containing [illegible] - [illegible] g per square metre. Besides the resin the layers contain paper.

On the basis of one melamine resin layer of [illegible] g and [illegible] layers on a phenolic resin base of [illegible] g each the quantities of [illegible] required to manufacture the above quantities of Formica sheets are then:

	phenolic resin	melamine resin
1970:	126 t	37 t
1971:	146 t	41 t
1972:	171 t	52 t
1973:	205 t	61 t
1974:	238 t	70 t
1975:	280 t	85 t

It would be advisable to set up a plant for the manufacture of such sheets at an early date. If this plant can start full production in 1971 a capacity of 300,000 square metres would be a suitable size.

Of the raw materials required only melamine and phenol would have to be imported. Production capacity for resin is available.

6.2.6 Substitution of Locally Produced Plastics for Imported Plastics

We understand that the Government of Pakistan is interested in domestic production of polypropylene, while the production of high-density polyethylene as a close substitute is not being considered. Under such circumstances it is advisable to replace the imported HD polyethylene largely by PP.

In the sector of injection-moulded and blow-moulded items such as containers, toys etc. the replacement does not raise any problems. Similarly, polypropylene can be used in the manufacture of pipes. The replacement of HD polyethylene by PP will be nearly 100 per cent.

On the assumption that production of polypropylene in Pakistan starts in 1972, the demand for the replacement of HD polyethylene will be as follows 1):

1972	-	[illegible] tons
1973	-	[illegible] tons
1974	-	[illegible] tons
1975	-	[illegible] tons

In addition to these quantities, polypropylene could also replace high-impact polystyrene to a small extent. But we do not expect that such substitution demand will exceed 150 tons in 1975.

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1) Substitution factor is 95 per cent.

[illegible] Substitution for Natural Fibres

The natural fibres grown in Pakistan are mainly cotton and jute. [illegible] cotton can be replaced by synthetic fibres.

The reason for this is the [illegible] situation. [illegible] of cotton [illegible] would be possible to increase exports considerably if the cotton were not needed for the supply of the [illegible] population.

[illegible] per cent of jute, the most important export [illegible] of the country, is exported. Contrary to cotton, this fibre is facing serious competition by polypropylene fibres and other synthetic materials which might serve as substitutes. [illegible] considerable rates of demand increase can be expected for [illegible] also in future (see Table [illegible]), the sales of jute are more liable to setbacks.

Table [illegible] [illegible] Consumption of Textile Fibres [illegible]

	Cotton	Jute	Cellulose Fibres	Fully Synthetic Fibres
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] 1)	[illegible]	[illegible]	[illegible]	[illegible]

1) Forecast by Farbwerke Hoechst

[illegible]

[illegible]

[illegible]

[illegible][1]

[illegible][2]

[illegible]

[1] [illegible]

[2] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]

In addition to the market differentiation, the improvement of the balance of payments is an important aspect. It should be considered, to what extend a substitution would have favourable effects on the balace of payments. As far as this was possible in this investigation, a tentative calculation is made in the following section.

6.1.2 Comparative Calculation on Foreign Exchange Savings by Nylon-Cotton Substitution

Considering the foreign exchange effects of a substitution of nylon for cotton, we start from the following assumptions:

- The quantities of cotton replaced as a consequence of an existing demand for nylon can be sold at somewhat lower than world market prices. The export price is 600 $/t of cotton

- The substitution ratio between cotton and nylon is 4:1

- The nylon taken for substitution is manufactured in a plant of 10,000 t/year, whose foreign exchange cost is estimated at 5.5 million $.

- The depreciation rate is 10 per cent.

- The average utilization of the plant is 75 per cent.

- The foreign exchange cost of the plant is raised by a foreign credit at an interest rate of 6 per cent. The average interest rate during the amortization period thus is 3 per cent of the credit received.

With regard to the substitution ratio, it should be stated that the factor 4 is composed of two values. One factor is that the specific gravity of nylon is smaller than that of cotton, so that 16 per cent more clothing can be produced from nylon at the same thickness of the yarn; secondly the lifetime of polyamide fibres is at least three times that of cotton at the same thickness of the yarn. In view of this the value indicated by us can be considered to be on the lower side.

Based on the above assumptions, the following calculation can be made per ton of nylon:

1. <u>Foreign Exchange Expenditure</u>

1.1 Raw material imports: 1,050 t of caprolactam at 450 $/t	$ 472.50
1.2 Depreciation: $\frac{\text{10 per cent of 4.4 million \$}}{\text{7,500 t}}$	$ 58.65
1.3 Interest on foreign exchange: $\frac{\text{3 per cent of 4.4 million \$}}{\text{7,500 t}}$	$ 17.60
1.4 Spare parts: $\frac{\text{1 per cent of 4.4 million \$}}{\text{7,500 t}}$	$ 5.85
Total foreign exchange expenditure per ton of nylon yarn	$ 554.60

2. <u>Foreign Exchange Revenue</u>

4 t of cotton at 600 $/t	$ 2,400.00

The net foreign exchange earnings thus are

1,845.40 $/t.

According to this calculation, the substitution of cotton seems to be an extraordinarily favourable possibility of earning foreign exchange. [1)]

Apart from the foreign exchange effect, it can be expected that such a substitution would have favourable effects also on the textile industry, since part of the cotton made free for exportation would certainly be exported in the processed state.

Naturally, there is a limit to this type of substitution because nylon products are much more expensive than those of cotton, partly they will also be rejected in some cases for climatic reasons. But after all the marketing activity and the prices of the nylon industry will be the decisive factor.

The nylon prices certainly could be reduced, if

- larger units were established
- the state would reduce the taxes on nylon
- the capacities of the plants were better utilised, which is partly a problem of the preference given to imports of twine.

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1) In a certain way our calculation is very conservative: the costs of the plant for nylon production include also the costs for the yarn manufacture, whereas these latter costs were not taken into account for cotton. Moreover, our cotton price is rather on the low side.

6.4 Ethyl Alcohol as Petrol Component

Although ethyl alcohol is not produced on a petrochemical basis in Pakistan, it is still important to discuss possibilities of its application. The main argument in this respect is that at present the plant capacities for its production are only utilised to a low extent, while the raw material (molasses) is available in abundance.

This situation will probably not change significantly,since the outlook for a strong increase in the demand for ethyl alcohol is not bright. On the other hand, there is reason to assume that the availability of molasses will increase considerably. despite the fact that the natural conditions for growing sugar cane and sugar beet are not bad, the country is still importing some quantities of sugar. In 1966/67 for example these imports amounted to about Rs. 300,000.[1] This sugar deficit occured in spite of a very high internal sugar price, which reduces the demand. The sugar deficit in Pakistan is due to extremely low yields per hectare and apparently also fairly high losses in sugar content encountered after harvesting. Since the Government of Pakistan is paying increased interest to agricultural production, it can be expected that the subject of sugar production will be thoroughly studied in all its aspects. This in turn, through the implementation of the necessary improvement measures, would then lead after some time to an increased availability of molasses. Since, according to several Battelle investigations, the availability of molasses in many developing countries is a problem, it seems also under this aspect highly important to investigate possibilities of its use at an early stage in Pakistan.

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1) According to CSO statistics. This figure includes the category "sugar and syrup n.s."

6.4.1 General Remarks on the Application of Ethyl Alcohol as Engine Fuel

It is a known fact that engine fuels contain additives which avoid knocking. These additives for their largest part consist of tetraethyl lead (TEL), which has to be imported into Pakistan by the refineries. (See section 5.9.2)

But there are fuels, which are so knock-resistent that they do not need these additives. They can even be admixed to fuels of high knock susceptibility and thus improve them. These fuels include, e.g. benzene, toluene,xylene, but also ethanol. The following quantities have about the same antiknock effect:

Pure benzene	1550 cm^3
Isooctane	1520 cm^3
Isopropyl ether	1220 cm^3
Toluene	1000 cm^3
Xylene	925 cm^3
Ethyl alcohol	460 cm^3
TEL	1 cm^3

Consequently, more than the threefold quantity of pure benzene is needed to reach the same effect as ethyl alcohol.

For four reasons ethyl alcohol is a suitable admixture to engine fuels:

- It has excellent antiknock properties.

different goods. These new products would substitute an appreciable part of the range of articles produced in the country. In a number of cases articles made from polyester materials are likely to have much better properties than the conventional ones. However, we do not consider their effect important from the point of view of substitution. They are too costly and the raw materials have to be imported. They will mainly replace iron, steel, wood and rubber.

In certain cases plastic materials, first and foremost PVC, also replace rubber. Since some rubber will have to be imported for several years to come, finding a substitute may [illegible]. The field in which such substitution will [illegible] take place is in the manufacture of floor tiles. It seems highly probable that floor tiles of PVC will soon completely replace those made of rubber.

Besides this, it is to be expected that rubber will be replaced in certain less essential items like floor and door mats.

The application of films in the construction sector seems to offer good prospects of replacing materials like corrugated iron sheets and roof tiles. It could be applied in connection with roof insulation with mud, [illegible] layers etc.

[illegible] **Pipes**

In Pakistan four types of larger-sized pipes are manufactured in the main:

- M.S. pipes
- cast iron pipes
- cement asbestos pipes
- reinforced and prestressed concrete pipes

- Because of their large heat of evaporation alcohols reduce the temperature of the fuel/air mixtures. From this a larger cylinder filling and power output per unit of displacement result. This phenomenon is made use of above all in racing engines and in the take-off propeller planes.

- The lower temperature of the fuel mixture with ethanol reduces the susceptibility to self-ignition.

- Alcohols burn cleanly and without residues.

However, substantial quantities of alcohol would be needed if attempts were made to replace the traditional anti-knock additive TEL completely by ethyl alcohol. In Pakistan the normal petrol contains 0.052 % by weight TEL. If the additives were fully replaced, ethanol would have to be added to petrol in concentrations of 11.5 per cent by weight or about 12 per cent by volume.

In principle such an admixture of alcohol to petrol seems possible. But such a fuel should be used in normal motor cars only after modification of the engines, since it differs from the original petrol in its chemical and physical properties.

By the admixture of methanol the following combustion properties of the petrol would be affected:

- Combustion speed
- Peak pressure
- Exhaust gas temperature.

It can be said with a fairly high degree of certainty that the admixture of ethanol to the petrol would require

- spark plugs of another calorific value
- different carburettor adjustment, i.e. change in main jet, idling jet and mixture adjustment.

These changes should not be difficult and may be neglected under the conditions prevailing in Pakistan. Nevertheless, the whole problem should be investigated by a competent research organisation (e.g. PCSIR).

It should be noted that prior to such investigations we cannot decide whether such a petrol would be a better or a less suitable fuel than the traditional one.

Since the admixture of alcohol might require certain changes of the engines the whole petrol used in one Wing should be mixed with alcohol if this proposition is to be considered seriously. After a transition period minor disturbances should only occur in border traffic. As there is little traffic across the border, however, this problem is of minor importance.

6.4.2 Comparative Calculations

According to section 5.9.1 we have compared in Table 123 the quantities of pure TEL expected to be consumed in the individual Wings with the corresponding quantities of ethanol required to replace TEL.

Table 123: Comparison of the Expected Consumption of TEL with the Corresponding Quantity of Alcohol (in tons)

Year	West Pakistan		East Pakistan		All Pakistan	
	Pure TEL	Corresp. Alcohol Quantity	Pure TEL	Corresp. Alcohol Quantity	Pure TEL	Corresp. Alcohol Quantity
1969	131	28,800	45	9,900	176	38,700
1970	118	26,000	50	11,000	168	37,000
1971	120	26,400	54	11,900	174	38,300
1972	123	27,000	60	13,200	183	40,200
1973	128	28,200	66	14,500	194	42,700
1974	131	28,800	71	15,600	202	44,400
1975	134	29,500	80	17,600	214	47,100

The figures refer only to the use of ethanol in ordinary grade petrol. However, its use in premium would be convenient as well, since it can be expected that consumers of premium also consume normal grade petrol. In that case the values would increase correspondingly.

The results of the above table show that the existing excess capacity for ethanol could easily be utilised and that, in addition, considerable new capacities could be installed.

It remains to be discussed how such a change would affect the foreign exchange situation. A replacement of the additives would involve a foreign exchange profit of about US $ 700: because the import of 1 ton of TEL additive could be saved. If the corresponding quantity of alcohol of 135 tons could be exported, this would naturally mean a foreign exchange loss of about $ 12,100. Yet this comparison is unrealistic, because

- the excess alcohol would probably not be exported since already the exporters are faced with difficulties

- the foreign exchange savings for the replaced petrol are not considered (depreciation of refinery, reduced imports or possible exports of petrol).

It is more realistic to assume that the application of alcohol implies a corresponding decrease of the molasses exports. A quantity of about 4.5 t of molasses yields about 1 t of pure alcohol, and 1 t of molasses is exported at about

$ 21.00 [1]. This means a reduction in the foreign exchange earnings by

US $ 1,275.00 for 608 t of molasses.

This difference still is more than 80 per cent above the foreign exchange expenditure for TEL additives, but as stated above it does not include the foreign exchange savings for the replaced petrol.

In this calculation the proportional plant costs of the ethanol production are not considered. This is justified in so far as idle capacities are concerned, for which foreign exchange expenditure has already been paid or is to be raised in any case.

All considerations made here have been based on the assumption that the use of alcohol as engine fuel is feasible also with regard to the price. Presumably the ethyl alcohol will be somewhat more expensive than the petrol. However it should be taken into account that at full utilisation of the ethyl alcohol producing plants the price for the alcohol could be reduced considerably. A price difference that might still remain could be compensated by an increase in the petrol prices if this should prove necessary. At consumption of large quantities of alcohol the price difference between fuel and alcohol is expected to be 0.35 to 0.40 Rs./t.[2]. The actual prices thus would have to be increased by only 3 % (Rs. 0.12) per gallon of petrol.

1) Approximate value based on statements in "Foreign Trade of Pakistan, Statistical Report for the Period July/June 1963/64 to July/June 1966/67", published by Export Promotion Bureau, Karachi

2) Exclusive of taxes

6.5 Replacement of Imported Fats

In chapter 5.7 it was indicatad that the bulk of the detergents usad in Pakistan are washing and toilet soaps manufactured largaly from imported fats. In 1966/67 imports of tallow and coconut oil used mainly for soap manufacture amounted to Rs. 70 million. In addition to this amount, other oils and fats ara imported for use in soap-making.

From our preliminary calculations it appears that the partial replacement of the imported fats for soap-making is strongly advisable. However, it has to be noted that a final assessment can only be made after comparing the figures from a feasibility study on the production of synthetic detergents with the average consumption of the soap industry in Pakistan.

We have based our subsequant calculations on the assumption that the capital costs per unit of washing powder are the same for soap and synthetic detergents. This assumption probably comes fairly close to reality since the capital cost of modern automatic soap-making plants such as have been installed in Pakistan, too is quite high. On the other hand the cost of raw materials per unit of washing powder is high in small industries due to less efficient production methods.

The comparison is based on the following assumptions:

- Tha washing powder has a DDBS content of 20 par cent.

- The ratio of washing powder for the same quantity of detergents is 1 : 2.5 in favour of synthetic washing powder. This ratio already involves ardatively inefficient use of washing powder compared to that of soap, as must be expected in Pakistan.
- An average type of soap contains about 62 per cent of fatty matter and requires about 0.7 kg of fats per kg. of soap.
- The fat input is composed of 20 per cent local oils, 64 per cent imported tallow and 16 per cent imported coconut oil.
- The synthetic washing powder is produced from imported dodecyl benzene. Besides DDB about 175 per cent of its value has to be added for other imported raw materials such as tri-polyphosphates, brighteners, sodium perborate etc.

Thus, the comparative calculation of the import contents produces the following results, taking one kg of detergent washing powder as basis

1. <u>Import requirements</u>

1.1 detergent raw material for 1 kg of washing powder: 141 g of dodecyl benzene á Rs. 1.51 kg.	Rs. 0.21
1.2 Additional charge of 175 per cent for other imported raw materials	Rs. 0.37
total imported raw materials	Rs. 0.58

2. Import savings

(For 1.5 kg of soap)

2.1 1.12 kg tallow @ Rs. 1.-/kg	Rs. 1.12
2.2 0.2[illegible] kg. coconut oil @ Rs. 2.00/kg.	Rs. 0.6[illegible]
Total import savings	Rs. 1.[illegible]

The comparison shows that for each kg of washing powder foreign exchange worth approximately Rs. 1.2[illegible] can be saved. Probably this difference could be increased still further if the detergent raw materials for washing powder can be imported in bulk, which would be possible with higher production figures.

Thus, the replacement of soap probably has to be regarded as a matter of priority, especially if the further expansion of the petrochemical industries into the field of detergent intermediates is considered.

It should also be mentioned that the availability of synthetic detergents might lead to a reduction of wear and tear to clothing due to decreased stress in the washing process.

The disadvantage inherent in the substitution is that 10 per cent by value of the imported fat is accounted for by coconut oil, which comes from another developing nation. Thus, the substitution results in a reduction of inter-regional trade.

[illegible]

[illegible]

[illegible]

The best prospects for the export of petrochemical products from Pakistan are offered by the developing countries of Asia and Africa. On the one hand their demand for petrochemical products is strongly increasing; on the other hand the possibilities of domestic production are often insufficient in these countries so that the gap between demand and supply can only be filled by imports. Besides, these countries frequently have more modest requirements with regard to product diversification and product quality. Thus they offer a sales market potential to Pakistan which can more easily be met as regards the technical production requirements. One more factor in favour of the export to countries of Asia and Africa are the comparatively low transportation costs. All these conditions make appear favourable in general the prospects of exporting petrochemical products from Pakistan into countries of Asia and Africa.

But this does not mean that Pakistan should exclude the market of the industrial countries completely from her export efforts. Although the sales possibilities abroad that can actually be utilised are based in the first place on the demand, finally they are always the result of investigations into the individual country markets, qualifications in over-all production techniques, economical production methods, appropriate sales and competition policy of the entrepreneurs and export promotion measures of state officials. It has often been proved by the experience in international trade that it is rather these five "export stimuli" than the individual petrochemical products per se, which determine the export chances. Therefore, a well-designed export policy has to take into consideration chiefly these components.

In addition to these, small sized conduit pipes are manufactured from imported steel sheets.

Of these pipes only G.I. pipes and conduit pipes are [illegible] propositions for replacement by plastic materials. The other pipes are too inadequate for replacement by PVC pipes to be economic for the [illegible]. For a 1 inch pipe the price per metre (according to information from [illegible]) is Rs. [illegible] for conduit [illegible], [illegible] for cast iron, and [illegible] for a rigid PVC pipe.

The total production of G.I. pipes in 1967 according to [illegible] was [illegible] million metres or [illegible] tons. The growth rate of galvanized iron pipe requirements has been estimated at 15 per cent in Pakistan. This means that the demand would be

22,[illegible] tons in 1970
29,[illegible] tons in 1972
33,[illegible] tons in 1973

if the plastic pipes do not make heavy inroads. On the assumption that PVC rigid pipe replacing G.I. pipe indicated in section 3.1.2 weighs about 10 per cent of the iron product, the PVC pipes according to our estimate under 3.1.3 would have gained a market share of

56 per cent in 1970
61 per cent in 1972
70 per cent in 1973.

This is a rough estimate since the conversion does not take into consideration that the expected growth figure of 15 per cent for

The most important condition for export prospects of petrochemical products from Pakistan: the demand for these products - is fulfilled in many countries of Asia and Africa and in the industrialised countries. Pakistan can suppose that in numerous countries of Asia and Africa not only at present but also in the long run there are insufficient national capacities for self-support in this field of production. It seems that above all the following petrochemical products are suitable for export as intermediates or consumption goods: polyethylene, polypropylene, polyvinyl chloride, polyvinyl acetate, nylon fibres and chips, phenolic resins, urea resins, melamine resins, alkyd resins, methanol, alcohol, DDT BHC, detergents, glycerine and formaldehyde.

The example of East Africa makes obvious that the demand for and the processing of petrochemical products already is rather dynamic and differentiated in many developing countries. The plastic processing industry of Kenya, Tanzania, Uganda, Zambia, Malawi, and Ethiopia, e.g., is presently producing the following consumption goods: householdware, furniture, shoes, fountain pens, records, packing material, window shutters, PVC pipes, PVC floor coverings, films and cable insulations.

In many developing countries the establishment of production units for manufacturing and processing of petrochemical products is the object of investment plans. In East Africa, for instance, according to our information the following investments are considered.

Table 124: Capacities for the Production of Petrochemicals to be Established in East Afrika

Product	Capacity (tons/year)	Start of Production	Country
DDT	4,000	1970	Tanzania
	4,000	1975	Uganda
	4,000	1980	Zambia
	3,000	1980	Kenya
	3,000	1980	Madagascar
	2,000	1980	Ethiopia
BHC	9,000	1975	Kenya
	5,000	1980	Madagascar
PVC	20,000	1980	Ethiopia
Poly-ethylene	20,000	1975	Tanzania
	20,000	1980	Tanzania

The countries Iran and Turkey, which together with Pakistan form the Regional Cooperation for Development (RCD) offer export prospects to petrochemical products of Pakistan. It must be stressed however, that especially Iran with her own petroleum extraction and processing industry has a natural cost advantage in the manufacture of many petrochemical products and generally has no cost disadvantages in supplying her domestic market as well as the RCD market. Nevertheless, Pakistan should steadily pursue export chances also in these two partner countries; maybe they are not yet fully self-sufficient in spite of small economical minimum capacities, maybe the domestic markets of these countries are too small for utilising the requested minimum capacities and Pakistan can establish production units under a coordinated investment policy, supplying the total RCD market. Iran intends to import from Pakistan methanol, urea formaldehydes, phenol formaldehydes and other chemicals.

Moreover the following details should be mentioned:
A coordination of investments with Iran and Turkey regarding the relatively large economical minimum capacities seems reasonable, e.g. in the field of caprolactam, certain types of tyres, polymethylmethacrylate and polyesterfibre production. As to such raw materials as polyethylene and PVC, however, their own domestic demand is relatively high. For this reason these products tend to give rise to the establishment of factories within the countries which are the potential export markets of Pakistan.

Presently Pakistan exports about 10 per cent of her production of PVC-coated power cables, which are produced in Karachi. The main importers are countries of the Middle East. A new production plant is under construction in East Pakistan. Its export prospects can be judged favourable, since the production method requires larger plants combined with a considerable know-how. Potential importers of this product are numerous developing countries of Asia and Africa which do not yet offer these conditions - sufficiently large domestic markets and technical know-how.

The textile industry of Pakistan, which already exports a large part of its production, is another sector with good export prospects. Of the synthetic fibres only nylon has up to now been processed into finished textiles and exported, e.g. to Singapore. In addition it would be possible to start the processing of polyester fibres in Pakistan and to export especially textiles of polyester cotton blends. For the export of nylon yarns, e.g. to East Africa, Hongkong, and Ceylon, chances are likewise favourable.

Polyvinyl acetate which is used for paints and textile finishing, can soon be produced in large quantities as intermediate and may also be a suitable export product.

Summarising we may say that for most of the mentioned products a rather large market exists in countries such as Afghanistan, Malaysia, Indonesia, Ceylon, Saudi Arabia, Kenya, Tanzania, Ethiopia, and Nigeria. But this market will have to be conquered against the competition of suppliers from Europe, Japan, and the USA who still are dominating there. Pakistan's success in these markets will depend on the product prices and qualities, as well as on the export marketing.

8. Production Programme, Material Balances and Savings of Foreign Exchange

8.1 Preliminary General Remarks

In the following, we have compiled a production programme on the basis of the studies described in sections 5 and 6 which comprises the manufacture of

- polyethylene LD
- PVC
- polypropylene
- polyvinyl acetate
- alkyd resins
- polyamide fibres
- polyester fibres
- dioctyl phthalate
- 2-ethyl hexanol
- dodecylbenzene sulphonate
- dodecylbenzene

In the discussion of the individual petrochemical products which can be recommended for an (additional) domestic production, we have based our considerations on the demand estimates of the above sections. Only that part of the demand which we consider to be easily realisable has been taken from the section 6 on substitution products.

The demand quantities thus determined are valid under the provision that prices remain constant at the present level or that the demand does not increase considerably should prices fall. Neither assumption is valid in the majority of cases. Comparison of the tentative estimates of the UN Petrochemical Project, Rawalpindi, concerning the sales prices of domestically manufactured products with prevailing prices shows that at least in the case of plastics in general drastic price reductions would be possible. The validity of this is made all the more indisputable by the fact that we have recommended far greater capacities than those upon which the UN calculations were based.

As indicated in section 3, such price decreases will in general lead to increased demand. We have estimated a value of 1.25 as the basic price elasticity factor. We have assumed this value to be generally valid for price-elastic products. However our calculations are based on mean averages for the individual products. This takes into account that isolated subsectors must be considered as inelastic or only partially elastic with reference to demand. The calculation of the averages is based on the expected average demand structures for the period 1970 to 1975.

The demand is then suitably modified with the average price elasticity obtained in this manner. Three new sales lines corresponding to price decreases of 20 per cent, 40 per cent and 60 per cent have been plotted in each case for the purpose of comparison. These sales lines are logarithmically plotted in the diagrams together with the expected demand lines corresponding to the individual products, assuming constant prices. The curve P_0 is based on present prices, the curve P_1 on a price decrease of 20 per cent. P_2 and P_3 are valid for price decreases of 40 per cent and 60 per cent respectively.

Our decision on the prices to be expected is based on the above-mentioned UN Petrochemical Project figures which - to the best of our knowledge - contain a "normal" profit margin oriented on the conditions prevailing in industrial countries. According to this, for instance the sales prices for PVC and polyethylene on erection of a 10,000 ton plant may be assumed to be Rs. 2.46 and Rs. 2.06, respectively. Compared with the present landed costs of Rs. 4.00 and Rs. 3.40 per kilo, respectively, there are differences of 38 per cent for PE and 40 per cent for PVC.

As the capacities suggested by us are so much higher than those assumed in the UN Project estimates, these differences would be considerably larger if the suggested programme is implemented.

We have in spite of this based our calculations for PVC and PE on price decreases of 40 per cent because we are of the opinion that the managements of the future firms will probably calculate with greater profit margins than those upon which the UN calculations are based. The large Pakistani concerns are used to high profits and will therefore without decisive reason not lower prices to a point at which the profits achieved could be considered normal by the standards of industrial nations. The validity of this is increased by the fact that the new plants would probably have little cause to fear any true competition.

We have based our calculations of the effects on the balance of payments on the assumption that the depreciation rate for the plants will be set at 10 per cent and that foreign credit will be taken up to the value of the foreign exchange component, this credit being subject to 6 per cent interest.

It should be noted that the calculations may only be regarded as provisional as certain decisive data will not be available before feasibility studies have been carried out after completion of this report.

The effect of import substitution on public finance has been neglected throughout section 8.

8.2 Plastics

8.2.1 LD Polyethylene

8.2.1.1 Suggested Production Programme and Expected Sales

8.2.1.2 Material Input

8.2.1.3 Effects on the Foreign Exchange Balance

8.2 Plastics

8.2.1 LD Polyethylene

8.2.1.1 Suggested Production Programme and Expected Sales

As shown by the results in section 3, low-density polyethylene (PE LD) is to be counted among the price-elastic products. This however does not apply to all fields of application of low-density polyethylene in Pakistan. If one classifies the demand by individual fields of application such as films and sheeting, coatings, injection moulded parts, blow moulded parts and cable, the following inferences may be made:

Alterations in the price for PE LD will have no noticeable effect on the sales of end products in the cable and wire coating sector. This is on the one hand due to the fact that copper is the decisive cost factor in cable manufacture, so that changes in the PE LD price will have but little effect on the end product. On the other hand, sales of cable are above all dependent on the progress of the country's electrification programme.

The demand for sheeting and sacks used for packing fertilisers must also be considered as inelastic. The basis of our consumption estimate was the official statement that all fertilisers produced in Pakistan are to be packed in PE sacks. This makes it clear that this sector will not react to price alterations. The remaining forms may be considered as price-elastic.

The G.I. industry already supplies a certain rate of replace[illegible] and other piping material (the smaller pipes) can be [illegible] the share in the market [illegible] the market of the G.I. pipes alone should be somewhat less [illegible] of the indicated percentages.

The outlined development would mean that in absolute terms the G.I. industry would have orders for about

[illegible] tons in [illegible]
[illegible] tons in [illegible]
[illegible] tons in [illegible]

Compared with the present production, which must be some 17,000 tons per year, the production would even decline. Although in principle a replacement of galvanized pipes by PVC pipes appears to make sense, we do not think the volume of an existing industry should be reduced too much unless some out-moded and ill-managed producers leave the market. A further substitution in this sector does not seem to be advisable provided the requirement figures of public authorities are not much higher than indicated.

Tube-well pipes for the time being cannot be made from PVC for the reasons given under 3.2.6.2. Before PVC pipes can be used certain difficulties have to be overcome. Therefore, at present this sector cannot be considered in this context.

But there is another sector where PVC pipes might replace imported materials; that is the sector of gas pipes. According to experience gained in Holland such pipes can be used successfully with gases that do not contain many aromatics. It would be interesting to find out whether the same types of pipes can be used in Pakistan in cases where the pipe does not run much risk of being damaged.

In calculating the demand curves for the various prices, one must therefore determine the mean average for price elasticity from the elasticities of all fields of application. The known factor - 1.25 is applied to the price-elastic sectors. The calculation is carried out as follows:

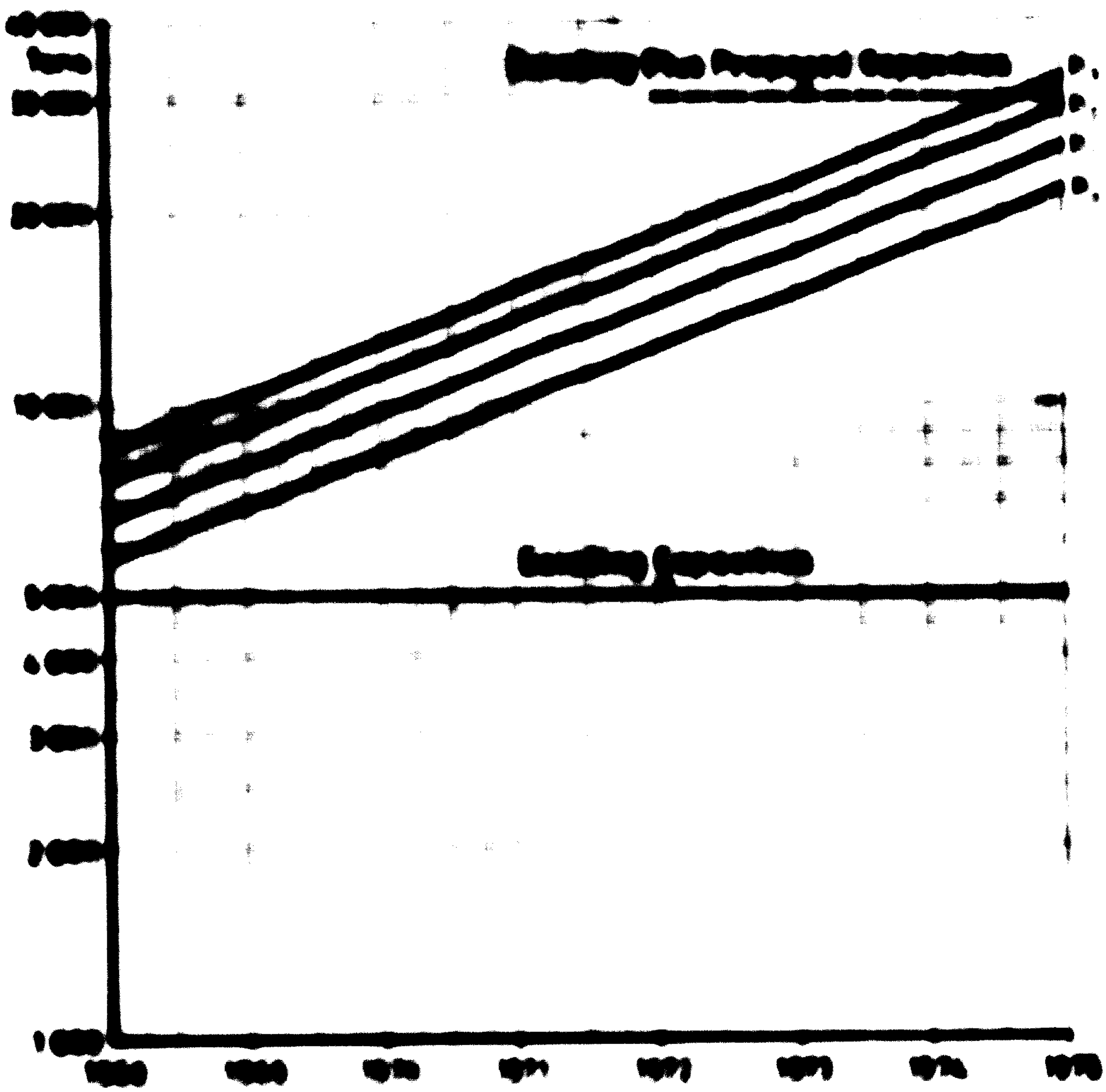
The shares of the individual fields of application in the total demand(in per cent) are determined and a percentage representing the share of price-elastic demand in the affected sector is applied. Following this, we multiply by the price elasticity factor of -1.25. The addition of the results for the various sectors gives the mean average of 0.84.

Table 125: Calculation of Mean Price Elasticity for LD Polyethylene

Fields of Application	Percent of total demand (1)	Price-elastic Percentage (2)	Price elasticity factor (3)	(1x2x3)
Sheeting and Coatings				
-General	39 %	100 %	1.25	0.488
-Fertilizer	32 %	0	1.25	0
Cable and Wire Coatings	1 %	0	1.25	0
Injection and blow Moulded Parts	28 %	100 %	1.25	0.350
Mean Average				0.838

The price elasticity of the total demand is approximately - 0.84. According to this, the demand quantities for individual years will increase by 16.8 per cent when the price decreases by 20 per cent, 33.6 per cent when the price falls by 40 per cent and 50.4 per cent when the price falls by 60 per cent.

Details of the changes in demand in differing price situations are given in the diagram 18.



The diagram shows both existent and planned PE manufacturing capacities. The lower straight line represents the present capacity of the Valika Chemical Industries' PE plant of 5,000 tons per year. The level of the upper straight line represents the sum capacity of the Valika plant and a proposed second 25,000 ton plant. The intersections of the demand curves with the capacity lines give the points in time when the supply and demand quantities correspond at the various prices. As mentioned the values upon which the curve P_2 is based seemed to us to be the most probable. In accordance with these, it was presumed that the present prices will sink by 40 per cent when PE is locally manufactured on a large scale. The time at which demand is met by supply would in this case be 1976.

In view of the values shown in the diagram, 1972 appears to us to be the adviseable time to start a 25,000 ton plant. The new plant would at this time be able to work to almost 50 per cent of its capacity, assuming the Valika plant to be simultaneously producing to full capacity. We regard the erection of a smaller (perhaps 20,000 ton) plant at an earlier date as inadvisable, as this would be less economical. Another argument against a smaller plant is that it is uncertain that it would either be ready to produce nor that it would be fully exploited at an earlier date. One reason for this is that in view of the higher costs one would certainly have to expect smaller price decreases and correspondingly low demands. It is also in general questionable whether a new plant could be ready to begin production before 1972, as the decision to invest, planning, erection of the plant and test production scarcely allow a shorter span of time.

One might possibly consider whether the new plant should not have an even larger capacity. We have not suggested this, as a considerable increase in the size of the plant would indicate a later date of erection and because we assumed that it is also an important aim to commence polyethylene production in East Pakistan at the earliest possible date. Under the conditions we assumed, 1976 seems the most suitable year in which production with a further 20,000 ton plant should begin. Prerequisite to this is good marketing on the part of the new firm, which would at that time have to compete for a place in the market with the already existing factories in West Pakistan. The plant could in our opinion expect a 35 - 40 per cent exploitation of its capacity in the first year of production, provided that it is properly managed.

It remains to be considered to what extent PE LD can replace PVC, or vice versa. Consideration of a substitution of this type could have the advantage that a PE plant larger than the suggested capacity could be erected, with the large-scale production of PVC commencing at a later date. This would allow both plants to be built on a more profitable scale than suggested in the preceding sections. After having carefully considered this, we came to the conclusion however that the substitutable quantities of about 15 per cent of the total demand could not change the results very much. Our reason for considering the percentage to be so low is that the majority of the machines in Pakistan are specially equipped for processing one or the other plastic and that retooling the machines is scarcely possible.

8.2.1.2 Material Input

A 25,000 ton PE LD plant working at full capacity requires about 27,500 tons of 95 per cent ethylene per year.

Assuming that the Valika plant is working to full capacity and that the demand quantities are as shown by curve P_2, the new plant's consumption of 95 per cent ethylene would be as follows:

1972: 13,000 tons
1973: 15,600 tons
1974: 20,800 tons
1975: 25,600 tons

8.2.1.3 Effects on the Foreign Exchange Balance

In estimating the effects of additional domestic production on the balance of payments, we have assumed that

- all presently imported quantities of PE will be replaced by domestically produced PE as of 1972;

- the demand will be determined by curve P_0, should the plant not be erected;

- the world market prices for PE LD will have fallen only slightly (max. 5 per cent) and will then remain constant at $ 200/ton,

- Plant costs for machines and equipment will be approximately US $ 2.4 million.

Under these conditions, the foreign exchange savings shown in the following table can be effected.

Table 126: Foreign Exchange Savings on the Erection of a 25,000 ton PE LD Plant (in $)

Year	Credit	Debit		Exchange Saving
	Exchange Requirement for importet PE	Depreciation on Plant	Credit Interest	
1972	2.513.600	240.000	72.000	2.201.600
1973	2.868.200	240.000	72.000	2.556.200
1974	3.438.600	240.000	72.000	3.126.600
1975	4.232.000	240.000	72.000	3.920.000

It should be noted that the table can give only a rough survey. One of the reasons for this is that only the proportion of exchange for the company's own investments can be shown on the assets side, whereas it is not possible to consider that of the raw materials. Figures concerning the exchange proportion of raw materials are not available, as these are part of the feasibility study to be made later.

8.2.2 Polyvinyl Chloride

8.2.2.1 Plant Sizes and Expected Sales

8.2.2.2 Material Input

8.2.2.3 Effects on the Balance of Payments

8.2.2 Polyvinyl Chloride

8.2.2.1 Plant Sizes and Expected Sales

Owing to its demand structure, PVC has to be counted among the price-elastic petrochemical products. This does not apply, however, to all sectors in which PVC is used. An example is the cable sector: changes in the PVC resin price are not expected to lead to changes in the demand for end products; the reasons for this have been outlined in section 8.2.1. Nor can PVC resin price changes be expected to have any effect on the sales of rigid pipes. The reason for this is that the rigid pipe industry is already able to import the required resins under preferential conditions. Also, our demand estimates for these pipes are based on Government programmes in which the possibility of substitution has been taken into account. The remaining production sectors such as shoes, artificial leather, toys and soft pipes may be regarded as price-reactive.

The price elasticity coefficient corresponding to the classification of demand by price-elastic and non-price-elastic fields of application which was calculated for the overall demand, is an average value (see Table).

Table 127: Calculation of the Price Elasticity for the Overall Demand for PVC

Fields of application	Per cent of overall demand (1)	Price-elastic percentage (2)	Price elasticity factor (3)	(1x2x3)
Rigid Pipes	42	0	1.25	0
Cable	17	0	1.25	0
Shoes	21	100	1.25	0.2625
Sheeting and Coating	17	100	1.25	0.2125
Miscellaneous	3	100	1.25	0.0375
				0.5125

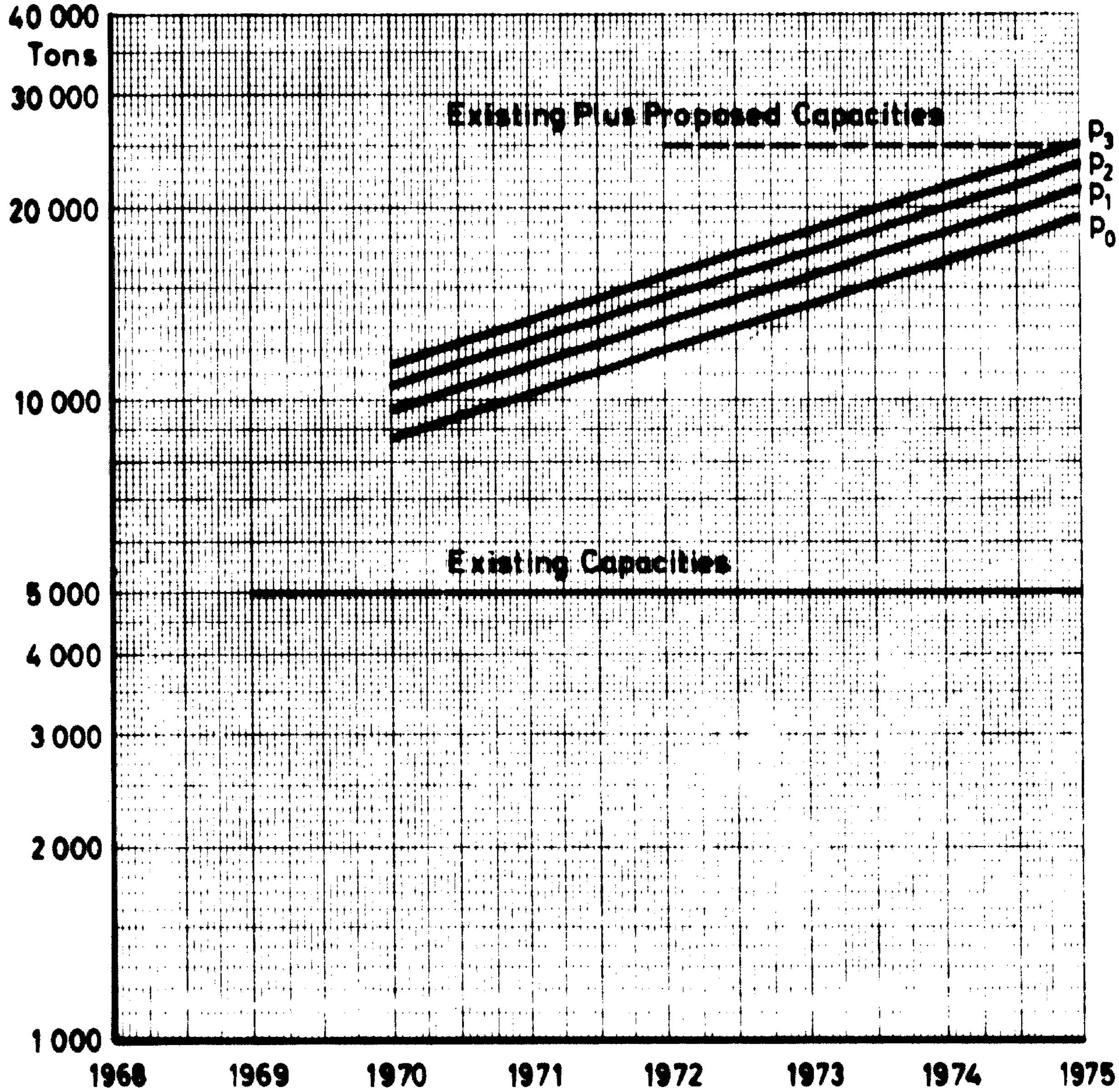


Figure 19: Demand for PVC Resin at Different Prices p_i

4.2.1 <u>Crates</u>

A sector where polypropylene should have a good chance of replacing a conventional material is the manufacture of crates. At present only wooden crates are used in Pakistan for soft drink bottles. The consumption of non-alcoholic beverages is growing fast in Pakistan. Most of the internationally known drinks such as Coca-Cola, Fanta, Seven-up, Pepsi-Cola and Canada Dry are produced in the country.

According to an estimate by the Coca-Cola company in Pakistan the country will need about one million wooden crates designed for 24 bottles each in 1970. In their opinion the annual growth rate of soft drinks in Pakistan is 15 to 20 per cent.

The wooden crates used in Pakistan are made of local wood. The average life span of such a crate is 6 months only. The cost is Rs. 1.-- per piece (painted), but during the period of use an average of 0.25 Rs. has to be spent on repairs.

Against this, the price of a PP crate would probably amount to Rs. 12.-- if produced at the present landed cost of Rs. 5.20 per kg of polypropylene. However, the advantage of the plastic crate lies in its longevity. In Europe the average life of such crates is estimated at 10 - 15 years. Crates made 8 years ago are still going strong, to the exasperation of the producers. Owing to their susceptibility to ultra-violet rays in Pakistan, the life of the crates would be less, but probably not below 6 - 8 years.

The price elasticity of the overall demand is thus approx. 0.51. This means that the following increases in demand may be expected if the stated price decreases are effected:

Price decrease	Demand increase
20 %	10 %
40 %	20 %
60 %	30 %

Details of changes in demand in various price situations are shown in the graph on page 600.

The horizontal lines represent the existing and planned total capacities of PVC plants, the lower showing the Arokey Chemical Industries plant capacity of 5,000 tons. It is clearly seen that the capacity of this company is less than the present demand of PVC. The upper horizontal line represents the sum of the Arokey capacity and that of a new 20,000 ton plant.

We have come to the conclusion that the capacity of 20,000 tons is the most suitable under the given conditions. Such a plant can be justified from the point of view of national economics. Its capacity of 20,000 tons is only 5,000 tons (20 %) less than the generally accepted minimum for a plant operating under world market conditions.

The intersection of the upper capacity line and the line p_2 represents a price 40 per cent below the present PVC price and would indicate full utilisation of the capacity of a 20,000 ton plant in about 1976.

The establishment of an increased capacity does not seem advisable, unless the feasibility studies show much greater price reductions to be possible or if it becomes apparent that the price elasticity upon which we have based our calculations is too low. The feasibility studies should also examine the advisability of planning the plants to reach full capacity utilisation after a period of more than four years. Without doubt opinions may vary concerning this point. In practice, 2 to 5 years are usually considered a reasonable period before full capacity is reached, while some theorists suggest much longer periods.

We would also like to point out that we have given the possibility of exportation no special consideration in determining the size of the plant to be recommended, both for PVC and for polyethylene. We are of the opinion that exports on a large scale will not be easely to realize.

This does however not mean that Pakistan will not be able to export PVC or polyethylene. On the contrary, our findings suggest that considerable quantities of PVC and polyethylene could be made available for exportation during the first years of operation. These excess capacities would provide the opportunity of gaining a foothold in foreign markets. In case of success, the possible start of a second new plant, probably in East Pakistan, might be considered.

8.2.2.2 <u>Material Input</u>

In determining the necessary input of raw materials, the question arises of whether production will be based on acetylene or ethylene. The petrochemical experts of the UN Petrochemical Project, Rawalpindi and also the Battelle members after discussions are of the opinion that the future plant should operate on ethylene for the following reasons:

- ethylene could be supplied from the naphtha cracker, which could then be built sufficiently large
- ethylene is cheaper to produce than acetylene,
- the safety hazard is less high when using ethylene.

There is therefore a clearly visible trend towards ethylene in modern petrochemistry.

As we do not know which process will eventually be used in Pakistan, we have based our raw materials balance on typical values for conventional processes, where the manufacture of 1 ton of PVC requires approximately

- 0.5 ton ethylene and
- 1.27 tons chlorine

Assuming the Arokey plant to be working at full capacity with 5,000 tons per year and that the curve p_2 gives a true representation of the quantities in demand, the input quantities for the new plant will be as follows:

Table 128: Estimated Output of a New PVC Plant and Material Input for the Period 1972 to 1975 (in tons)

Year	Output	Ethylene Input	Chlorine Input
1972	10,000	5,000	12,700
1973	12,300	6,150	15,620
1974	15,000	7,500	19,100
1975	18,200	9,100	23,120

Neither of the stated raw materials have to be imported, but both will have to be produced in imported plant. They therefore include indirect exchange costs.

8.2.2.3 Effects on the Balance of Payments

In estimating the effects on the balance of payments of a 20,000 ton PVC plant, we have based our calculations on plant cost US $ 5 million. These include the manufacture of the vinyl chloride monomer. The costs represent only the import component. A price of US $ 230 was assumed for imported PVC. The savings thus achieved are summarized in the table below:

Table 129: Estimated Foreign Exchange Savings on Erection of a 20,000 ton PVC Plant (in US $)

Year	Credit	Debit		
	Exchange for imported PVC	Plant depreciation	Credit interest	Exchange saving
1972	2,875,000	500,000	150,000	2,225,000
1973	3,316,000	500,000	150,000	2,666,000
1974	3,827,000	500,000	150,000	3,177,000
1975	4,434,000	500,000	150,000	3,784,000

In a preliminary survey which does not take into account the foreign exchange component of domestically manufactured raw materials, considerable exchange savings have been calculated, although the assumed quantities of PVC to be manufactured were considerably larger than those which would otherwise have to be imported.

8.2.3 Polypropylene

8.2.3.1 Production Programme

8.2.3.2 Material Input

8.2.3.3 Effects on the Balance of Payments

8.2.[illegible] Polypropylene

8.2.[illegible].1 Production Programme

The future demand for PP is composed of that stated in section [illegible].1.2 and of the substitutions indicated in section 6. The substitution of PP for polystyrene high impact is not included, as our estimates indicate that the quantity which might thus be substituted in Pakistan amounts to only 10 per cent. The substitution of PP containers for tinplate containers for edible oils was also excluded, as the packaging of oils in Pakistan most probably will present a number of problems. Experiences in industrialized countries have shown that the development of this type of packaging requires a number of years. A further demand for national defence purposes could also not be taken into account for lack of information.

In view of the conditions prevailing in Pakistan polypropylene must also be included among the price-elastic petrochemical end products. A study of the fields of application for this material has shown that all sectors are fully price-elastic.

We consider a price reduction of [illegible] per cent of the present price to be the most probable development. We have figures prepared by the petrochemical experts of the [illegible] in which the price for PP manufactured at a [illegible],000 ton plant in Pakistan is quoted at approximately Rs. [illegible]/kg. The present landed costs are approximately Rs. [illegible]/kg. This corresponds to a possible price reduction of [illegible] per cent. As the plant's full capacity will by no means be exploited during the first few years, we consider a greater price reduction than 20 per cent as a result of domestic production to be highly unfavourable, even assuming the erection of a plant with a capacity of more than 1,000 tons per year

The sum of the expected future demand quantities is indicated in table [illegible]

We consider it possible that the use of PP for the packaging of oils, fats, etc. will increase an erection of a plant, providing tests and development of suitable containers are begun immediately

Although the minimum capacity of a PP plant operating under world market conditions is [illegible],000 tons, we consider the erection of a [illegible],000 ton plant to be justifiable, as the naphtha cracker for ethylene production also supplies propylene which can then be utilized

A technically favourable erection date for the plant would be [illegible], as the production of PE and PVC will also be taken up in this year. The plant would however then only be working to about [illegible] per cent of its capacity and would not be fully utilized until [illegible]. This does not present a very favourable picture. On the other hand our estimates represent the minimum demand for PP which can be expected for the next few years

[illegible] __Material Input__

Approximately [illegible] tons of [illegible] per cent propylene are required to manufacture 1 ton of PP. The material input for the individual years will therefore be as follows

Table 130: **Estimated Output and Material Input of the PP Plant During the Period 1972 - 1975 (in tons)**

Year	Expected PP production	Propylene input
1972	2,940	3,230
1973	3,500	3,850
1974	4,130	4,550
1975	4,890	5,380

8.2.3.3 **Effects on the Balance of Payments**

In estimating the effects of the erection of a PP plant on the balance of payments, we have assumed the following:

- that all PP imports are replaced by domestic production with effect from 1972;
- that the import quantities substituted correspond to a constant price (p_0);
- that the world market prices will by 1975 have fallen by 10 per cent (all our calculations are based on this low price of US $ 340/ton c&f Karachi);

The foreign exchange component for the raw material propylene could not be taken into account, as the calculation of this is a subject of later feasibility studies.

We have determined the costs of a polymerisation plant for PP to be approximately US $ 6.25 million. This includes only the imported plant and no buildings.

Table 131: Estimated Foreign Exchange Savings on Erection of a 10,000 ton Polypropylene Plant (in US $)

Year	Credit	Debit		
	Exchange for PP	Plant depreciation	Credit interest	Exchange savings
1972	799,000	625,000	187,500	13,500
1973	952,000	625,000	187,500	139,500
1974	1,125,400	625,000	187,500	312,900
1975	1,329,400	625,000	187,500	516,900

The table shows that no foreign exchange can be saved during the first year but that it would be cheaper to continue importing. If, however, the demand in 1972 is 40 tons more than that estimated by us, production without loss of foreign exchange will be possible under our assumptions.

8.2.4 Alkyd Resins

In section 5.2.5 we recommended the establishment of two new plants for the production of alkyd resins. These two plants having a daily capacity of 3 tons (one shift) are intended to supply mainly the resin required by the small paint manufacturers. Since about 25 per cent of the paint is produced by small industries the demand of these two plants is expected to develop about as follows:

1969:	875 tons
1970:	950 tons
1971:	1,030 tons
1972:	1,120 tons
1973:	1,220 tons
1974:	1,320 tons
1975:	1,440 tons

As the first plant, according to our recommendation, should start production in 1970 it could theoretically be utilized to 90 per cent of its one shift capacity in that year. Practically, however, the utilization rate should be lower since Crescent/Reichhold also intend to supply this market.

The second plant should take up production in 1972. At that time both plants would utilize about 50 to 60 per cent of their one shift capacity.

To produce the above quantities of alkyd resin, on the basis of 60 per cent oil content and on the assumption that glycerine is used as alcohol component and phthalic anhydride as acid component, the following quantities of raw materials are required.

The replacement of wooden crates by those [illegible] of high-density polyethylene or polypropylene is going ahead [illegible] in Europe and the USA. There are, for example, [illegible] in circulation in West Germany for soft drinks [illegible].

While in Germany all crates are made of HD polyethylene, in Britain polypropylene is used. In [illegible] Britain consumed [illegible] tons of PP for the manufacture of crates alone, out of a total production of [illegible] tons of PP.

The crate material most suited for Pakistan 1) is polypropylene, too, which is most likely to be produced in Pakistan before long. However, in Pakistan care will have to be taken to protect these crates from ultra violet light by pigmentation or adding U.V. screening agents, which improves their light resistance substantially.

It is expected that if polypropylene crates for soft drink are introduced in Pakistan it will not be difficult to capture [illegible] per cent of the crate market existing in [illegible] and another 20 per cent in the subsequent year. Moreover, it is to be expected that the total expected increase ([illegible] per cent per year) can be covered by PP crates.

Since an average of 1.6 kg of polypropylene is required for

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1) This presupposes that normal PP is produced. Should the new BASF type of polypropylene be chosen, it will probably not be possible to produce crates of that material.

Table 132: Estimated Raw Material Inputs for the Production of Alkyd Resins, 1970-1975 (in tons)

Year	Alkyd Resin	Glycerine[1)]	Phthalic Anhydride[1)]	Vegetable Oils
1970	950	195	239	570
1971	1,030	210	258	620
1972	1,120	230	283	670
1973	1,220	250	308	730
1974	1,320	271	333	790
1975	1,440	297	365	860

1) Theoretical values

In assuming the effect of a local production on the balance of payments, we base our calculations on the following assumption:

- The cost of a 3000 l plant is estimated at $ 30,000
- The c & f price for phthalic anhydride is assumed to be $ 300/ton and expected to remain unchanged during the period concerned.
- All imports of alkyd resins are replaced by local products, the c & f price of alkyd resins being $ 470/ton.

Table 133: Estimated Effect of the Establishment of Two Alkyd Resin Plants on the Balance of Payments (in $)

Year	Credit	Debit			Foreign Exchange Savings
	Exchange for Alkyd Resins[1)]	Depreciation of Plant	Credit Interest	Imports of Phthalic Anhydride	
1970	446,500	3,000	900	71,700	370,900
1971	484,100	3,000	900	77,400	402,800
1972	526,400	6,000	1,800	84,900	433,700
1973	573,400	6,000	1,800	92,400	473,200
1974	620,400	6,000	1,800	99,900	512,700
1975	676,800	6,000	1,800	109,500	559,500

1) The imported resins which are replaced by local products would probably be of higher quality. This,however, has no influence on foreign exchange saving.

The foreign exchange content in the local raw materials used for the production has not been taken into consideration.

Irrespective of the missing foreign exchange component, the production of alkyd resins shows appreciable net savings of foreign exchange.

8.3 Fibres

8.3.1 Polamides

8.3.1.1 Suggested Production Programme and Expected Sales

8.3.1.2 Material Input

8.3.1.3 Effects on the Balance of Payments

8.3 Fibres

8.3.1 Polamides

8.3.1.1 Suggested Production Programme and Expected Sales

A survey of the price elasticities for nylon articles shows the following:

Fishing twine is already being sold within the country at fairly lower prices. Further price decreases do not seem possible even if the domestic production is expanded, unless the state encourages these by means of subsidies. The price elasticity must therefore be regarded as zero. Tyre cord is also not considered because of the difficulties referred to in 5.3.1. The full price elasticity of 1.25 has on the other hand been allocated in the case of textiles.

The mean average of these three sectors gives a price elasticity of 1.13 for the overall demand.

The following demand increases therefore apply to the price decreases stated (based on 1968 prices):

Price decrease	Demand increase
20 %	23 %
40 %	45 %
60 %	68 %

Fig. .. shows the development of the demand for nylon, tyre cord excluded, at differing prices. It demonstrates clearly that even at the very high 1968 prices an unsatisfied demand of approx. 4,000 tons/year will exist over and above the capacities of the previously erected plants as early as in 1972/73.

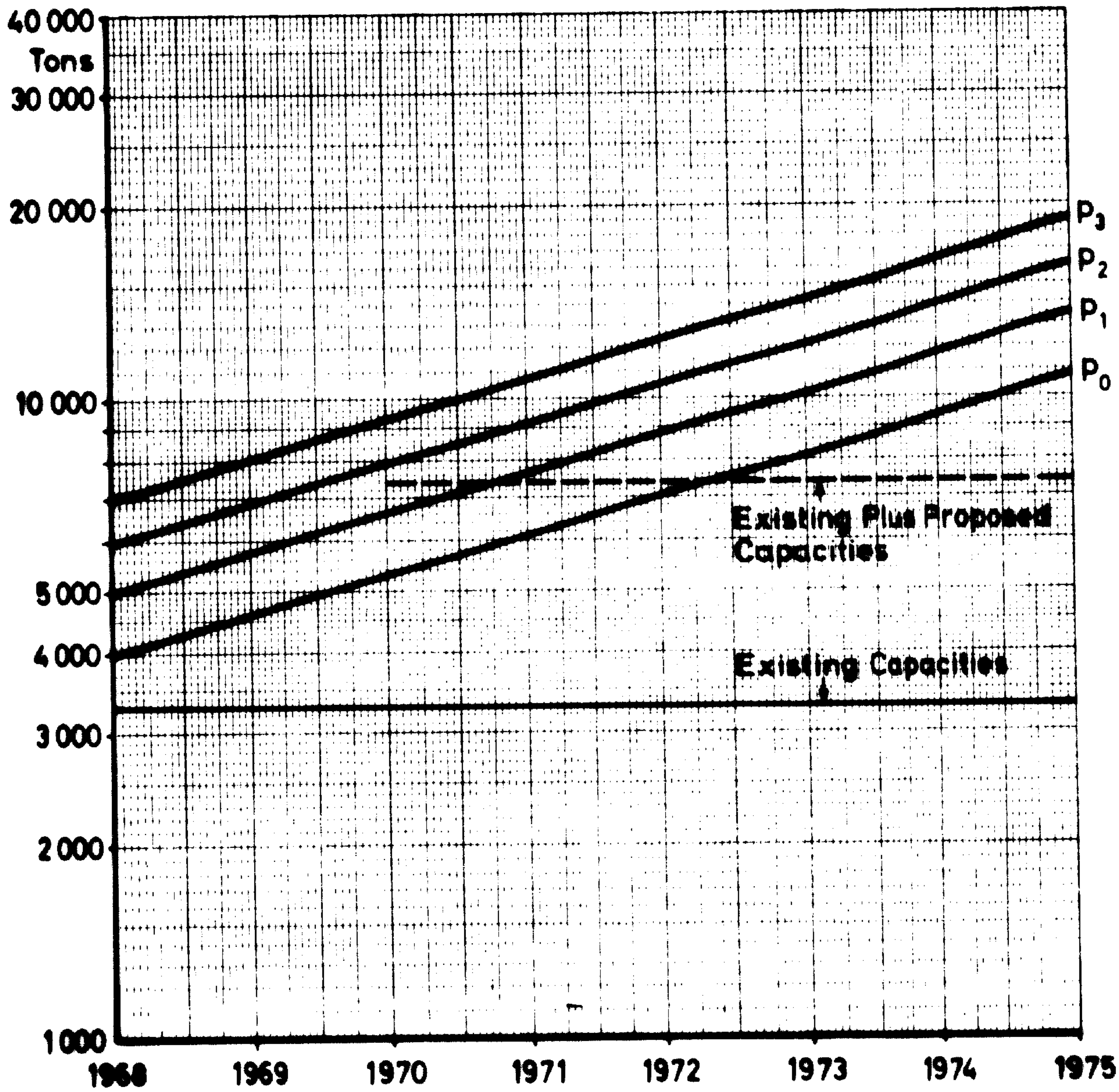


Figure 20: Trends in the Demand for Nylon Fibres (All Types Except Tyre Cord) at Different Prices p_i

Under the given conditions, we suggest that an additional plant with an annual capacity of 10,000 tons be erected. This capacity should for reasons of economy not be split up over smaller plants. In order to protect the owners of the previously-erected, smaller plants - which necessarily produce on a less economical basis - from excessively fierce competition, one should consider whether they could not be allowed some form of participation in the new plant.

It must be expected that a plant with an annual capacity of 10,000 tons could manufacture at much lower prices than smaller units. In view of the high taxes wied on nylon products and the existence of numerous small concerns, we believe that price decreases will however be only of the order of 10 per cent. Our provisional estimates indicate that such a decrease would lead to an 11 per cent increase in demand. After deducting the existing and planned capacities, the following demands remain to be met by the new plant:

1971:	2,800 tons
1972:	3,800 tons
1973:	5,000 tons
1974:	6,400 tons
1975:	8,000 tons

Under these conditions, the plant would in 1975 be werking to 80 per cent of its full capacity. If one accepts the hypothesis that a plant should be working to at least 35 per cent of its capacity during the first year of operation, the earliest date for commencing production at the new plant would be 1972.

8.3.1.2 Material Input

1.05 tons of caprolactam are required to produce 1 ton of nylon. The following approximate quantities of caprolactam will therefore be required for future production:

1971:	2,900 tons
1972:	4,000 tons
1973:	5,300 tons
1974:	6,700 tons
1975:	8,400 tons

These quantities of raw material will have to be imported.

8.3.1.3 Effects on the Balance of Payments

We have based our estimate of the effects of expanding domestic production on the balance of payments on the following additional assumptions:

- that no more nylon is imported once the new plant is in operation
- that one quantity unit for nylon replaces four quantity units of cotton
- that the cotton replaced by nylon is exported at a price of US $ 600.-/ton (this price is 10 per cent below the present world market price for comparable cotton)
- that the costs of a plant including polymerisation, spinning, air-conditioning and transport amount to approximately US $ 4.4 million

- that caprolactam is imported at US $ 450.-/ton.

Under such conditions, the foreign exchange savings achieved would be as shown in the following table.

Table 134: Estimated Foreign Exchange Savings on Erection of a 10,000 ton Nylon Plant (in million US $)

Year	Credit	Debit			Foreign Exchange Savings
	Exchange for Cotton Export	Depreciation of Nylon Plant	Credit Interest [1]	Import of Caprolactam [2]	
1972	9,120,000	440,000	132,000	1,800,000	6,748,000
1973	12,000,000	440,000	132,000	2,385,000	9,043,000
1974	15,360,000	440,000	132,000	3,015,000	11,773,000
1975	19,200,000	440,000	132,000	3,780,000	14,848,000

[1]) Only the mean value for interest due is given

[2]) US $ 450.-/ton

As pointed out in 6.3.2, this provisional evaluation gives the result that the substitution of nylon for cotton would be beneficial to the national economy. Even the nylon production of the first year of operation could lead to a net exchange saving which is higher than the exchange investment of 4.4 million US $ by making additional quantities of cotton available for export. One must however emphasise that the substitution effect will only manifest itself partly during the first year; the buyers of nylon textiles will also buy less cotton goods than normal in the following 3 or 4 years.

8.3.2 **Polyester Fibres**

As has been pointed out earlier (cf. section 5.3.2) the consumption figures of the past cannot be considered a suitable basis for estimating the future requirements of polyester fibres. In the past the demand was kept down artifically by the import policy, and moreover there was a lack of experience in processing this fibre.

According to findings in other developing countries and in view of the favourable properties of these fibres we are of the opinion that a polyester fibre plant with an annual capacity of 4,000 t should start production as soon as possible. Since the sanctioning procedures as well as the planning and the establishment of the plant require some time, we do not expect that a plant would start production before 1971. We then envisage that the demand would develop approximately as follows:

1971:	1,000 tons
1972:	2,000 tons
1973:	3,000 tons
1974:	4,000 tons
1975:	4,000 tons

The demand envisaged for 1975 is still fairly small; it amounts to only about 1 per cent of the total fibre consumption in terms of quantity expected for that time.

The production of the above quantities of polyester fibres required the raw materials indicated below:

Table 135: [illegible]

Year	[illegible]	[illegible]
1971	1,[illegible]	[illegible]
1972	2,[illegible]	[illegible]
1973	[illegible]	1,2[illegible]
1974	[illegible]	1,[illegible]
1975	[illegible]	1,[illegible]

Both of these two raw materials have to be imported for some time to come.

Estimating the balance of payment effect of the production programme outlined above, we start from the following prices and assumptions

- The foreign exchange cost of a plant of [illegible] t per year totals about $ [illegible] million
- The price of DMT is $ [illegible]/t and is expected to remain constant
- The price of glycol is $ [illegible]/t over the whole period
- One kg of polyester yarn can replace 1,5 kg of cotton yarn
- The c & f price of methanol is $ [illegible]/t
- Cotton is expected to be sold at $ [illegible] ton

Under these assumptions the foreign exchange savings would develop as shown in the following table 136 [illegible] crate of [illegible] bottles, requirements of the polymer would develop as follows

1970	[illegible]
1971	[illegible]
1972	[illegible]
1973	[illegible]
1974	[illegible]
1975	[illegible]

6.2.[illegible] Plastic Containers

There is considerable scope for developing the plastic container industry in Pakistan. So far this industry has not been given much chance in Pakistan, considering that plastic containers are now one of the fastest growing industries in Europe and America. Plastic containers are used for cosmetics, medicines, food, mineral oils, confectionery, beverages and detergents.

The question of using plastic containers must be seen in the light of the heavy imports of tin and alloys and tinned sheets. During the period July 1966 to June 1967, Pakistan imported tinned plates and sheets worth 11.4 million Rupees and tin metal and alloys in the form of bars, blocks, plates and sheets worth Rs. 26.2 million.

Among the tin containers which could be replaced by plastic ones are containers for hydrogenated oil (vegetable ghee), mineral oil, and confectionery items such as biscuits, toffee etc. All these three industries consume a major part of Pakistan's imported tin materials. As an example, the case of hydrogenated oil production may be considered in some detail.

[illegible]

[illegible]	[illegible]						[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Our rough evaluation of the balance of payment effects shows that much foreign exchange can be earned by a process substituting polyester fibres for cotton.

As in the case of polyamide fibres it has to be pointed out, however, that only part of the cotton replaced will be available in the year of the production of the polyester fibres. It is not known how the substitution process for one unit of polyester fibres will develop over the time. We, therefore, have assigned the cotton exports made possible by the sale of PE fibres to the year in which the synthetic fibres are produced. In reality the export earnings resulting from the sale of cotton are shifted to later years resulting in a slower increase in foreign exchange savings in the first years.

8.4 Plasticisers and Intermediates

8.4.1 Dioctyl Phthalate

8.4.1.1 Production Programme

8.4.1.2 Material Input

8.4.1.3 Effects on the Balance of Payments

8.4 Plasticisers and Intermediates

8.4.1 Dioctyl Phthalate

8.4.1.1 Production Programme

The demand for dioctyl phthalate (DOP) will depend less on the DOP price than on factors determining the domestic production of plasticised PVC. The compounding plants are - as already described in detail in section 5.5.6 - being rapidly expanded to be able to manufacture plasticised PVC, so that by 1970 practivally the entire demand for soft PVC compound can be met from domestic sources. The demand for DOP will from 1970 onwards develop in proportion to the overall demand for plasticised PVC.

The demand curve for plasticised PVC is to a very large extent dependent on the material's price elasticity. This will play an important role, particularly in the years following 1971, when the PVC resin plant we have recommended will start production. The elasticity coefficient is determined in the manner explained in the previous sections. If we classify the fields of application for plasticised PVC as cable, shoes, sheeting, coatings, and miscellaneous, we find that all sectors with the exception of cable are fully price-elastic. The reasons for the inelasticity of the cable sector were given in section 8.2. Using the known elasticity factor of 1.25, the mean average for the price-elastic and price-inelastic sectors is as follows:

Table 137: Calculation of the Price Elasticity of Overall Demand for Plasticised PVC

Field of Application	per cent of Total Demand (1)	per cent of Price Elasticity (2)	Price Elasticity factor (3)	(1x2x3)
Cable	28	0	1.25	0
Shoes	36	100	1.25	0.450
Sheetings and coatings	27	100	1.25	0.338
Miscellaneous	9	100	1.25	0.11[illegible]
				0.900

The price elasticity of the overall demand is thus 0.90. The demand will rise by 18 per cent should prices fall 20 per cent, by 36 per cent on a price decrease of 40 per cent, and by 54 per cent should prices fall by 60 per cent.

As the demand for DOP develops in direct proportion to the demand for plasticised PVC, the demand values will be as shown in the diagram 21, page 626 assuming that 90 per cent of all plasticisers used are DOP.

We consider the curve P_2 to be most probably representative of the development in demand after 1972, also in the case of DOP.

As there are compounding activities in both East and West Pakistan, we suggest erection of plants in both provinces. As far as we have been able to determine, the minimum plant capacity is about 500 tons. We therefore recommend that several plants be erected in order to create competition. One 3,000 ton

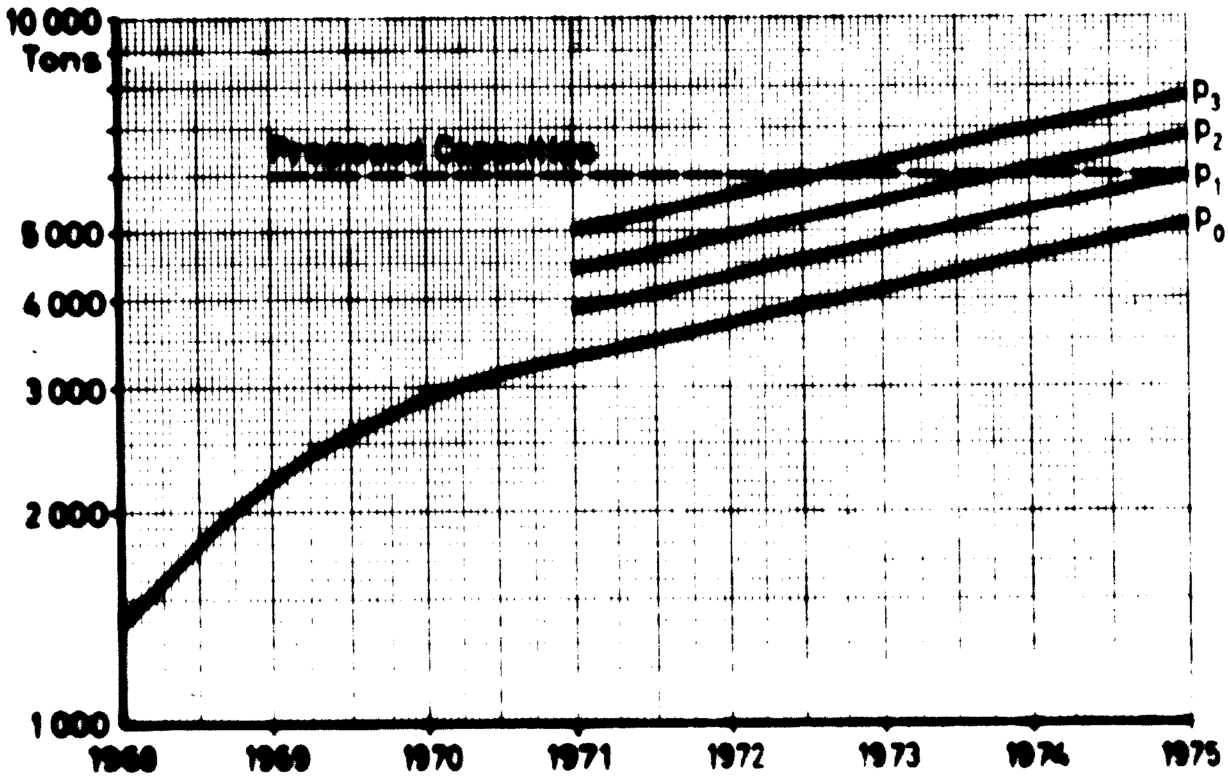


Figure 21: Future Demand for Dioctyl Phthalate at Different Prices p_i for Plasticised PVC

plant each in East and West Pakistan could begin production in 1970. Taking curve P_2 as a basis, those will be working to full capacity in 1974. Even in the most unfavourable of cases - if the demand only develops to the level of P_0 - 75 % of the capacity will be utilised in 1974.

If the demand expectations as represented by curve P_2 are fulfilled, a third plant with a capacity of 3,000 tons could take up production in 1975. These relatively high capacities seem to be justifiable not only in view of the domestic market. There is at present a scarcity of DOP also on the world market, so that there would also be a possibility of exporting DOP. The determination of the prices at which DOP could be produced in Pakistan is the task of a feasibility study, which should be started immediately.

8.4.1.2 Material Input

Approximately 0.76 tons of 2-ethyl hexanol and 0.36 tons of phthalic anhydride are required to manufacture 1 ton of DOP. If demand will develop as shown in curve P_2 and the first DOP plants will start production in 1971 the following quantities of 2-ethyl hexanol and phthalic anhydride will be required (in tons)

Table 138 Expected Requirement of Raw Materials for DOP Production (in tons)

Year	DOP	2-Ethyl hexanol	Phthalic anhydride
1971	3,270	2,480	1,170
1972	5,020	3,810	1,800
1973	5,630	4,280	2,020
1974	6,240	4,750	2,240
1975	7,040	5,350	2,540

Note The DOP figures correspond to line P_2 in the above diagram

While phthalic anhydride will at first still have to be imported, 2-ethyl hexanol might be available from domestic sources (see section 5.5.8).

8.4.1.3 Effects on the Balance of Payments

In estimating the effects of domestic production of DOP on the balance of payments, we assume that

- the previously imported DOP is completely replaced by domestically-produced material after 1971;
- 2-ethyl hexanol and phthalic anhydride will continue to be imported;
- the demand for DOP will develop as shown by curve P_2;
- the c & f price for DOP remains stable at the present level of US $ 425 per ton;
- the price for ethyl hexanol and phthalic anhydride remains stable at the present level of about US $ 300 per ton.

Table 139: Estimated Foreign Exchange Savings on Domestic Production of DOP (in US $)

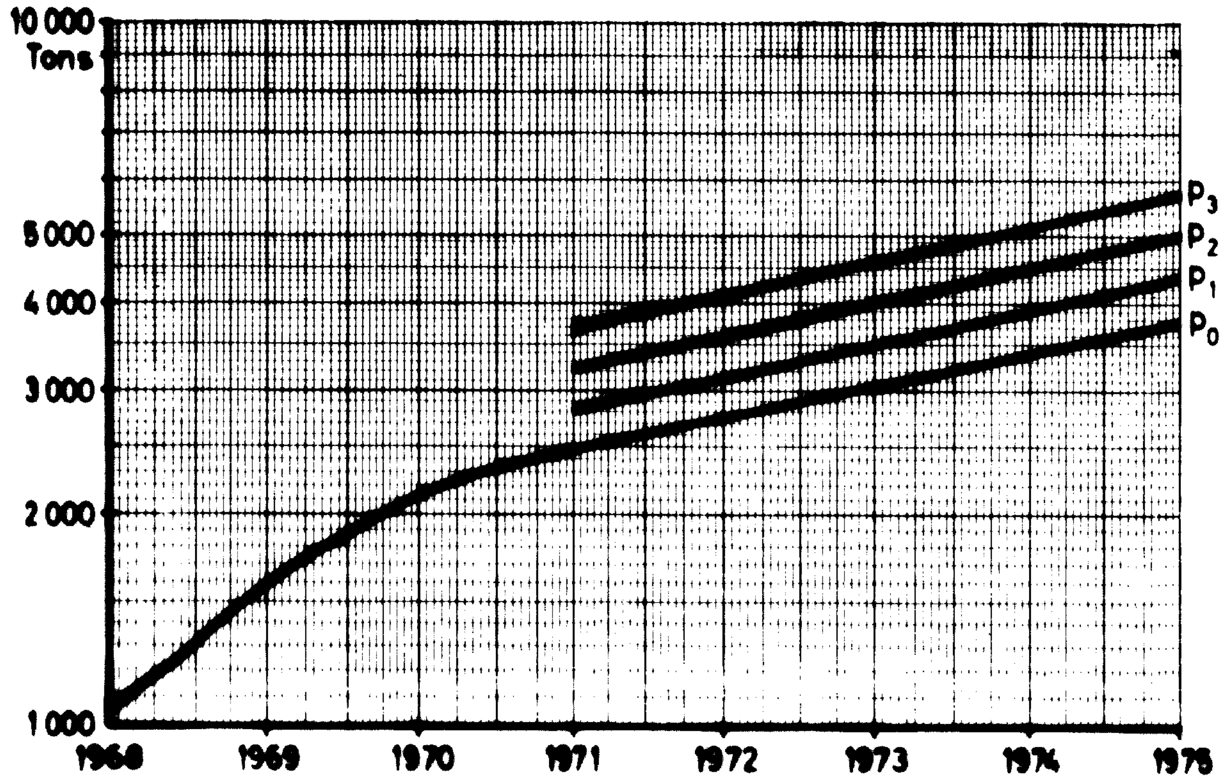
Year	Credit	Debit			
	Exchanges for DOP Imports	Depreciation on plant	Credit Interest	Imported Phthalic Anhydride	Exchange Savings
1971	1,380,000	22,000	6,600	351,000	1,351,400
1972	2,133,000	22,000	6,600	543,000	2,104,400
1973	2,393,000	22,000	6,600	610,000	2,364.400
1974	2,653,000	22,000	6,600	675,000	2.624,400
1975	2,991,000	33,000	9,900	762,000	2,186,100

According to our information, a 3,000 ton plant is sold at about US $ 110,000. This represents the actual foreign exchange expenditure for machinery without buildings. The above calculation shows that from a foreign exchange point of view the establishment of a DOP plant is highly recommendable

8.4.2 2-Ethyl Hexanol and Acetaldehyde

The production programme for diocthylphthalate has been described in section 8.4.1 together with the raw-material requirements. The figures are once more indicated in figure 22.

On the assumption that 2-ethyl hexanol is produced from acetaldehyde the demand for this chemical will develop as shown in the diagram of figure 23. This diagram indicates only the quantities needed for the production of DOP from 2-ethyl hexanol since the remaining demand is already met by an existing plant (see section 5.9.5).



<u>Figure</u> 22: Future Demand for 2-Ethylhexanol at Different Prices p_i for Plasticised PVC

In the year 1966 6. the production of such oils has been estimated at 93,000 tons. About 60 per cent of this quantity is said to be packed in 35 lbs (15.9 kg) tin containers for customers consuming large quantities, while the remaining 40 per cent is packed in containers of 2 lbs (0.9 kg) 5 lbs (2.3 kg) and 10 lbs (4.5 kg) for household consumption.

On the basis of 2 lbs. containers 41.85 million units are required for the packing of the small portions. Each container has a plastic requirement of 48 g*), so the total quantity of polypropylene required would be 2,000 tons.

Not only can a substitution programme based on local production of polypropylene save large sums of foreign exchange spent on imported tin material; polypropylene containers stand a good chance of competing with tin containers in cost as well. A two lbs printed tin container for hydrogenated oil costs Rs. 0.55 in Pakistan. Even at the present high rate of Rs. 5.20/kg, the raw material cost of a 2 lbs polypropylene container comes to only Rs. 0.25. This leave enough margin for its moulding and printing cost to compete with a 2 lbs tin container.

It has however to be mentioned in this connection that the production of containers for different liquid materials raises a number of problems. The development of such containers is therefore said to be a time-consuming matter. For example the development of a Shell oil-container took about 4 years.

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*) Containers of comparable size used in Germany are slightly lighter. Under the climatic conditions of Pakistan the containers will have to be made a little stronger.

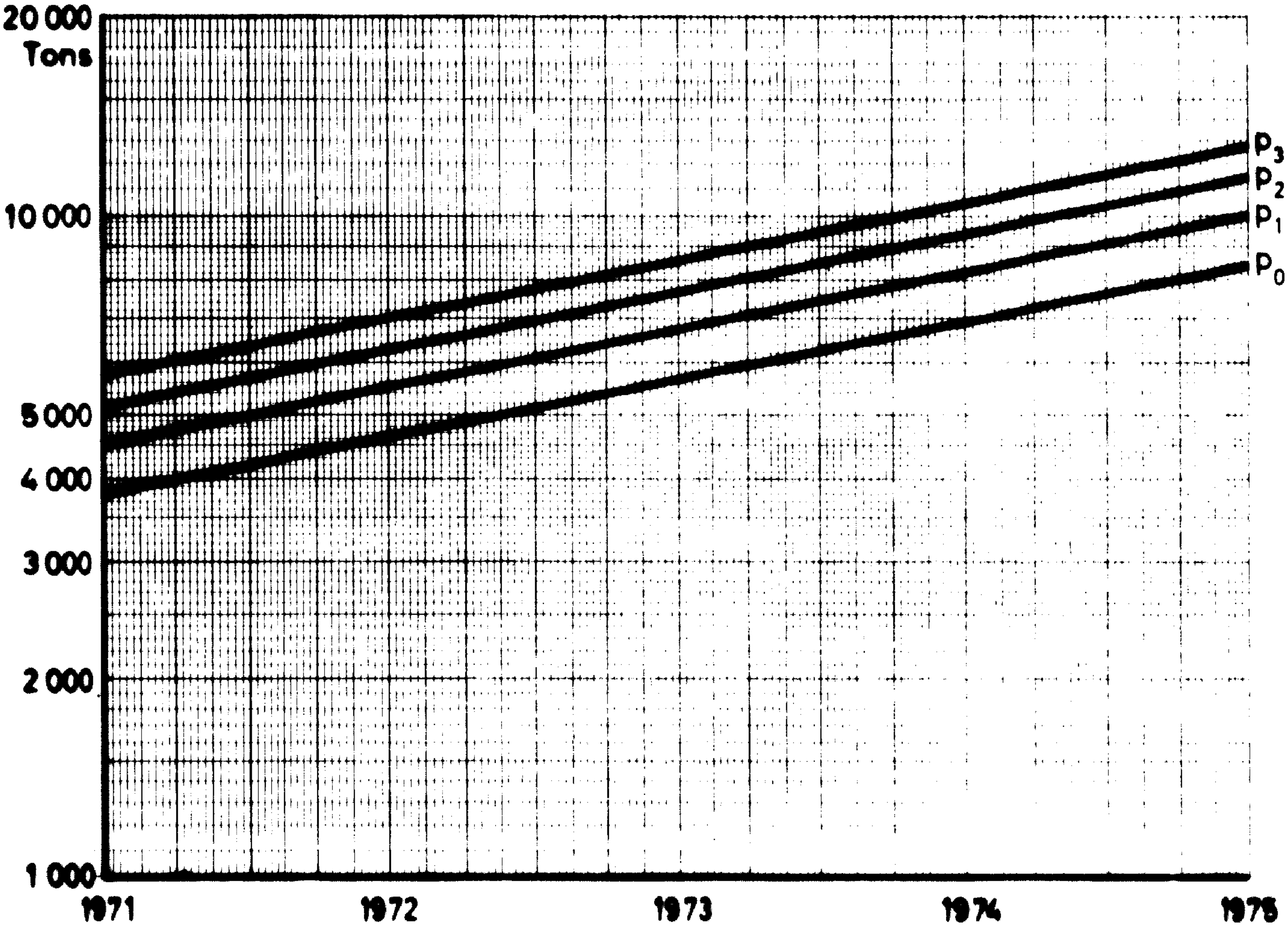

Figure 23: **Future Demand for acetaldehyde (for Manufacture of 2-Ethylhexanol only) at Different Prices for plasticised PVC).**

8.5 Detergent Raw Materials

8.5.1 Dodecyl Benzene Sulphonate

As described earlier, the application of some kind of price elasticity factor to the expected demand figures for DDBS cannot be justified. We have come to this conclusion because the important factor in the development of this market will be effective marketing. Most probably additional profits arising from higher production will not lead to reduced prices but to increased marketing efforts [1].

Under these circumstances we base our recommendations for new plants on the surplus demand resulting from the difference between sanctioned and existing capacity on the one hand and estimated demand on the other hand. We thus conclude that in 1973 one additional plant producing 10,000 tons of dodecyl benzene sulphonate or 50,000 tons of washing powder should start operation.

In the first year this plant might only have a capacity utilization of 30 per cent. But the low utilization factor is not problematic because

- this has been a fairly common phenonenon in the past in this line of production
- there is a good chance that Lever Bros. can market larger amounts of the product
- the capacity utilization in the following year would reach a reasonable level (43 per cent).

We do not know today what the actual future development will be in this line, for the reasons already discussed. But taking our demand estimates as a basis, the surplus demand and accordingly the sales of the new plant will develop as follows:

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1) Compare also statements in section 5.7

1973: 3,220 tons DDBS
1974: 4,780 tons DDBS
1975: 6,720 tons DDBS.

For these sales the following quantities of dodecyl benzene would be required:

1973: 2,276 tons
1974: 3,379 tons
1975: 4,750 tons

The dodecyl benzene might be imported or might be produced locally. If it is imported the savings of foreign exchange according to the calculation made in section 6.5 will amount to $ 1.271.- per ton of DDBS. For the production visualized in the aforegoing, we thus arrive at net foreign exchange savings of

$ 4,093,000.- in 1973
$ 6,075,000.- in 1974
$ 8,541,000.- in 1975.

But for these amount the capital costs have not been taken into account, for the reasons explained under 6.5.

8.5.2 Dodecyl [illegible]

According to the statements made in section 5.7.6 it is recommended to start production of dodecyl benzene ([illegible]) as of 1973. The local production of DDB, however, is subject to further expansions in the production of detergents on the basis of DDB. We propose an annual capacity of 10,000 tons per year.

A suitable process for Pakistan seems to be the Rheinpreussen process which is characterised by intermediate chlorination and operation with pure aluminium as catalyst.

The capital investment required for this process is relatively small. On the other hand it produces as by-product 1.36 tons of hydrochloric acid per ton of alkylate. It can only be decided at a later stage of petrochemical planning whether the hydrochloric acid can be properly utilised.

For the time being we base our calculations of the input of raw materials and of the effects on the balance of payment on the figures of the Rheinpreussen process. According to the data available to the following quantities of raw materials are required per ton of alkylate:

890 kg n-paraffins (molecular weight 167)
460 kg benzene
490 kg chlorine.

In accordance with the estimates of table 104 (section 5.7.4.2) for the local production of detergent the quantities of alkylate indicated in the following table will be required.

Table 100: Estimated Requirements of Alkylates and Raw Material Imports, 1973 - 1975 (in tons)

Year	Alkylates	n-paraffins	Benzene	[illegible]
1973	4,180	3,100	2,010	2,130
1974	5,400	4,400	2,320	2,640
1975	6,830	6,100	3,130	3,360

As the foreign exchange required for a plant of 10,000 t per year is about $ 1.41 million, the effect of a local production on the balance of payments is estimated as indicated in the following table.

Table 101: Assessment of the Effects of a Local Production of Dodecyl Benzene on the Balance of Payments (in $ 1,000)

Year	Credit	Debit				Foreign Exchange Savings
	Substituted imports of alkyl benzene	Benzene imports	n-paraffin imports	Depreciation of plant	Interest on foreign credits 1)	
1973	1,397	261	448	[illegible]	[illegible]	[illegible]
1974	1,763	320	610	[illegible]	67	[illegible]
1975	[illegible],170	410	763	[illegible]	67	[illegible]

1) Average interest payments

The calculations of the imports and the substituted imports have been based on a cif price of

$ 130 / t for benzene
$ 125 / t for n-paraffin
$ 310 / t for dodecyl benzene

Table 101 shows that the production of dodecyl benzene under the conditions assumed will yield a considerable net foreign exchange effect amounting to 111 per cent of the original investment during the three years considered.

9. Measures of Public Institutions to Promote the Sales of Petrochemical Products

9. Measures of Public Institutions to Promote the Sales of Petrochemical Products

9.1 Preliminary Remarks

It is generally acknowledged that optimal economic development cannot be guaranteed by entrepreneurial initiative alone. It is also necessary for public institutions to take additional measures designed to expand or stimulate the different sectors of production, according to their priority in the macroeconomic structure.

In this connection for the expansion and differentiation of the domestic market and the export sector are of decisive importance. The measures taken should not be isolated and uncoordinated but should form part of a carefully balanced system of interventions and influences, so devised as to eliminate inherent strains of any kind.

The proposals made in the following sections refer mainly to the promotion of the sales of the investigated petrochemical products. Wherever it was necessary we have tried to show consequences of a more indirect nature, e.g. for public finance. To avoid repetition, the proposals already put forward in chapter [illegible] have generally been omitted from this section.

9.2 Measures to Expand the Domestic Market

9.2.1 Indirect Promotional Measures

The measures for promoting the expansion of the domestic market can be classified into measures increasing the market for certain products directly and measures having only indirect effects. The indirect promotional measures we propose are:

- measures to improve the marketing
- studies on the possibility of replacing scarce raw materials and imported articles
- investigation of certain technical and economic problems which have to be solved prior to replacing a commodity
- determination of price elasticities
- wider dissemination of practical technical know-how
- development of standards.

Marketing

In the marketing sector we learnt in the course of our investigations that most entrepreneurs do not have an adequate knowledge of the market situation or of modern sales techniques. This applies not only to small and medium-sized enterprises but also to many large ones.

As far market research, in most cases entrepreneurs planning an investment evidently investigate the future market prospects very sketchily or do not care about them at all. Such a procedure must necessarily have unfavourable effects even in a strongly expanding economy like that of Pakistan. As a consequence, the factories are often planned too large or too small due to ignorance of the true situation. Sometimes the technical and qualitative standards of the plants are not in line with the requirements of the market [illegible] And in many cases a potential market is simply not recognized and, therefore, is not developed or is [illegible]. It is quite conceivable that a number of under-utilized factories could operate at full capacity if their managements were able to trace and develop potential markets. In the past, for instance, the producers of polyamides could have profited by developing the market for plastic shoes, This situation can be improved only if the entrepreneurs can be induced to have more market investigations conducted on their own initiative. Such market-research-mindedness can be stimulated by appropriate measures. The banks for instance might be encouraged to demand an investigation by a reputable market research institute (e.g. Investment Advisory Centre of Pakistan) for credits exceeding a certain amount or for credits connected with investments in fields where competition is very keen. Such a policy naturally requires sufficient market research capacities, and it seems that this is not yet the case in Pakistan if it is intended to expand market research activities. But the gap could be closed if necessary by in-work training under technical aid programmes.

With regard to the second factor, i.e. marketing know-how, we believe that the best way of bringing about an improvement in this sector would be the establishment of joint ventures such as are described later. But also the

- employment of foreign marketing managers for a limited period
- training of local executives in foreign firms
- establishment of consulting firms for advisory services in the marketing sector

might help considerably in narrowing the existing marketing gap. It seems unreasonable to tackle the problem [illegible] by recourse to the universities; the [illegible] with practical knowledge in the field is indispensable to the solution of such problems.

Studies on Substitutions

Possible ways of making substitutions can be analysed only to a limited extent in a study with the scope of the present one and in the short period of time available. Therefore, we recommend continuing investigations into this subject at a later date. In the manufacturing sectors of interest, it is desirable to make concrete proposals as to where the traditional raw materials should be replaced by petrochemical ones. In the electrical industry, for instance, it should be ascertained for which specific purposes phenol formaldehyde intermediates could reasonably be applied in Pakistan. Needless to say, special attention should be paid to the substitution of domestic intermediates for imported ones.

Technoeconomic Investigations

In some cases it is necessary to solve technical problems before expanding the market. First of all it should be determined if and how the use of petrochemical raw materials for certain purposes is technically feasible under the specific conditions in Pakistan. The most important tasks of this type are the following four:

- How can PVC pipes suitable for the construction of wells be produced?
- Should in view of the conditions in Pakistan the TEL additive [illegible] be replaced by ethyl alcohol?
- In which [illegible] of PVC be used in Pakistan?
- How favourable are the prospects of developing intensive agricultural structures using PVC houses, pipes, and foams in Pakistan (possibly near Karachi for vegetable growing)?

All of these points also raise economic questions. The technical part could certainly be handled without difficulty by the laboratories of the Pakistan Council of Scientific and Industrial Research.

6.2.5 Laminated sheets

Plastic laminated sheets ("Formica") have excellent prospects as a substitute for wood veneers in Pakistan. The present annual consumption of wood veneers has been estimated by IACP at 185,000 square metres. Most of these veneers are either imported or made from imported teak. In addition to the wood veneers, plastic laminated sheets are also imported under Bonus Voucher. The imports are of the order of 90,000 square metres. The selling price of plastic and natural veneers at present comes to about Rs. 12.-- per square metre. The market for veneers is tight, the shortage of veneers is a serious obstacle to the development of the plywood industry.

Due to the scarcity of local wood the production of plastic veneers appears to be of the utmost importance. It seems realistic to assume that by 1970 and in the years thereafter plastic veneers will capture a share of at least 50 per cent of the veneer market. With the present growth rate of 18 per cent the consumption will then be approximately as follows:

	all veneers (m^2)	plastic veneers (m^2)
1970:	380,000	230,000
1971:	450,000	270,000
1972:	530,000	320,000
1973:	630,000	380,000
1974:	740,000	440,000
1975:	880,000	530,000

In the manufacture of Formica sheets 150 - 195 g of melamine resin is required for the first layer. If a second layer is

Determination of Price Elasticity

As is shown by our statements in section 1 we have made our calculations on the basis of estimated price elasticities. It can scarcely be expected that the coefficients used by us coincide with the actual values. In order to determine exactly how the demand would develop in the case of price reductions, a planned price reduction should be implemented for PVC and polyethylene. The easiest way to achieve this target would be to reduce the customs duties on these products. If Valika and Arokey alone were persuaded to reduce their prices, the result would certainly be too favourable since the increasing price difference would lead to the replacement of imported PVC and PE respectively by local products.

Once a more exact value for the price elasticities has been found on this basis, our estimates could be corrected if necessary and the plant sizes projected accordingly.

Dissemination of Knowledge

The most important question affecting the success of any substitution measures is how well-informed are the entrepreneurs operating the processing firms. They must know which petrochemical products can be applied in their sector and what their advantages are. In Pakistan small and medium-sized enterprises make up a large share of the production in numerous sectors of industry. Therefore, it can be taken for granted that an improvement in the flow of information will lead in many cases to an increased application of plastics and other products of the petrochemical sector. The small enterprises are usually very poorly informed about the numerous opportunities available to them to improve their production.

Battelle-Institut is of the opinion that technical trade journals are very important for disseminating such knowledge. These journals should be issued in Urdu and Bengali, if possible, so that the broad mass of the craftsmen and small industrialists are able to read them. Such trade journals might publish translations of articles from foreign reviews, abstracts of books on the special subject of interest, as well as the above-mentioned investigations into possible ways of making substitutions, presented in such a manner that they appeal to the persons concerned. One of the advantages of this approach is that the deficiencies of the production and ways to overcome them can be outlined impartially. So-to-speak as a "by-product", the replacement of specific articles could be promoted. The application of hard tissues may serve to illustrate the above statements. This material, which could easily be produced in Pakistan, is very suitable for the production of rather silent, high impact gear wheels. Today such gear wheels are mostly made of brass. By changing over to hard tissues, not only would the product be improved but at the same time foreign exchange would be saved.

In addition, such trade journals would be excellent media for drawing attention to new projects in the plastics sector and elsewhere. A suggestion such as that of producing hard tissue would probably not only find a quick response but would also interest suitable processors in its application.

Plastics are likely to be the most widely used substituents. For this reason a training and consulting institute in the plastics sector could play a major part in the large-scale introduction of plastics. Such an institute could help considerably to ensure the correct application and processing of plastics, thus meeting an important condition for their diffusion; craftsmen who do not know how to treat the material in the right way will produce a bad article, and then the processors naturally prefer traditional materials which are better known.

The value of such an institute is thus obvious. In West Pakistan preparations are now being made for the establishment of a Plastic Manufacturing Service Centre in Sialkot. More precisely, it will be set up as part of the existing Sports Goods Service Centre of the West Pakistan Small Industries Corporation. It seems to us that the institute is not being planned on the scale that its importance makes seem desirable. Such a Centre should undoubtedly serve the whole plastics processing industry of the country, for investigations and applied research as well as for training and advisory purposes. For this reason we propose either planning the Sialkot Institute on a much larger scale or establishing a second centre in Karachi. The second solution would have the advantage of placing the institute directly in the main production centre of the plastics industry.

Development of Standards

It can be assumed that standards are a rather important factor in market expansion. Their value depends, however, on how far the standards are known and accepted. In this connection we may refer once more to the usefulness of articles in technical trade journals, read directly by the responsible people in the trade.

Standards not only help to simplify production processes and to make the properties of a material or a component more readily ascertainable; by standardisation of the demand they might result in the creation of larger markets. The production of window frames on a plastic basis or of ready-mixed rubber compound, for example, would be boosted considerably by the creation and popularisation of standards.

For this reason it is recommendable to investigate soon which standards would be of importance to industrial consumers producing and using plastics and other petrochemical products.

For example, suggest developing and popularising standards for

- Various PVC compounds
- PE grades
- Plastic pipes
- Glued hardboard
- Marine plywood and tropical plywood
- Food containers of plastic

9.2.2 Direct Promotional Measures

As the Government is the most important consumer in the country, it is able to exercise a pow ful influence on the development of certain industries through its demand of the petrochemical products investigated, the textile purchases of the Armed Forces seem the most practicable tool for exercising this influence.

It may well be of advantage for the Armed Forces to buy nothing but polyester-cotton fabrics for their uniforms from the date of the establishment of a domestic industry for the production of these fabrics. On the other side due to the increased demand, the polyester producing industry could then operate at higher capacities and at lower cost. Moreover, exporting the quantities of cotton thus released would lead, according to our calculations, to a rise in foreign exchange earnings.

Sales of BHC, DDT, and plastic pipes could be increased in a similar way. This has already been pointed out in the relevant paragraphs in sections 5 and 6.

In the fibre sector one more case of the direct promotion of market expansion must be mentioned. We are referring to the twine imported by the fishermen's co-operative societies on preferential terms. Here the promotion of one economic sector harms another sector. The nylon industry suffers because the installations for making twine that were imported from abroad stand idle. If this situation does not change, one day the plants for twine production may become useless.

We propose solving this problem by granting the fishermen's co-operatives a direct subsidy from the Government instead of the import preferences. This might be done as follows: The nylon industry could be induced to supply the twine at a price calculated on the basis of the depreciation rate when the plants are being fully utilized plus a nominal profit of perhaps 2 - 3 per cent of the turnover. If the price calculated in this way still is higher than the price paid by the fishermen for the imported twine, the Government pays a subsidy equivalent to the difference between the two prices. This subsidy could be paid in the form of tax bonds to the fishermen's co-operatives, which could then pay for part of their purchases from the twine producers with these bonds. The twine producers in turn could use them to pay their taxes.

From a fiscal point of view it has to be mentioned that the drop in tax revenue resulting from the reduced tax payments by the nylon producers is not offset by any corresponding increases in the revenue from other fields. Nevertheless, there is a solution which would be extremely favourable to the exchequer. If twine is replaced by the raw material caprolactam, foreign exchange savings of about 1,900 $ result per ton of twine. The problem of the fall in tax revenue would be solved if the exchequer were allowed to sell the authorisation to utilise this foreign exchange wholly or partly in the Bonus Voucher market.

9.3 Measures to Expand Exports

9.3.1 General Measures

In a general way, exports of petrochemical end products and of articles manufactured from them can be promoted by

- carrying out market surveys in potential foreign markets

- setting up joint enterprises, with the foreign partners agreeing to take over the export marketing

- creating a special export marketing organisation.

To start with the first suggestion, market surveys are no doubt very valuable tools in marketing, both in domestic markets and abroad. But there is a considerable difference between selling in the local market and export marketing. Not only are new foreign markets not known so well, at least as regards matters of detail, a successful market organisation has also to be established and the exporter has to face competition from the industrialised countries. This means that the price and quality of the products exported must stand comparison with those of the most respected and efficient firms of the industrially advanced countries. For obvious reasons, it is not easy to be competitive in either respect. Therefore in export marketing the preparation of market reports is not in itself necessarily enough to ensure increasing exports.

We would therefore suggest that one of the other two possibilities is seriously considered. As Iran and other countries have shown, one of the most promising ways of setting up petrochemical industries is to interest a well-known foreign

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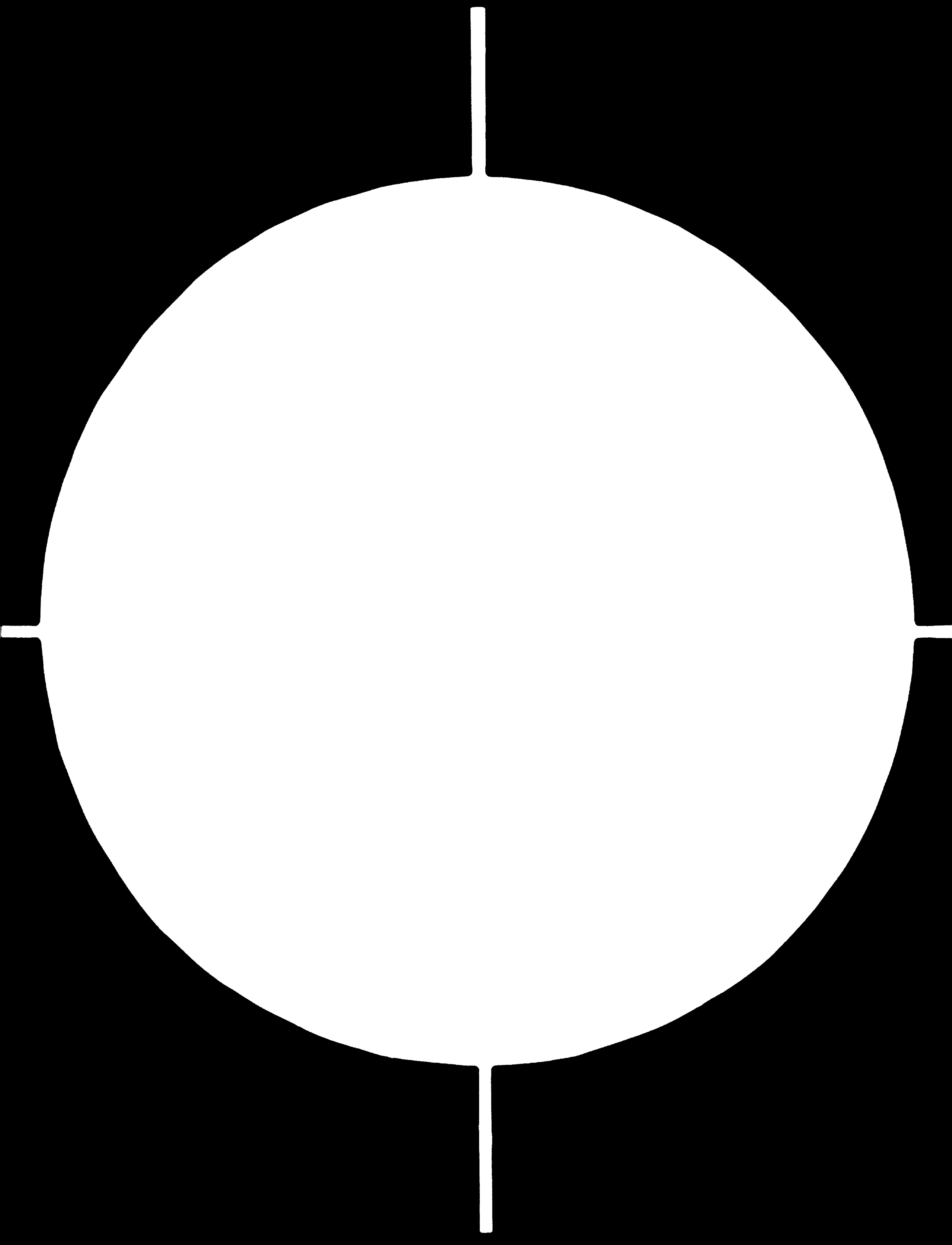

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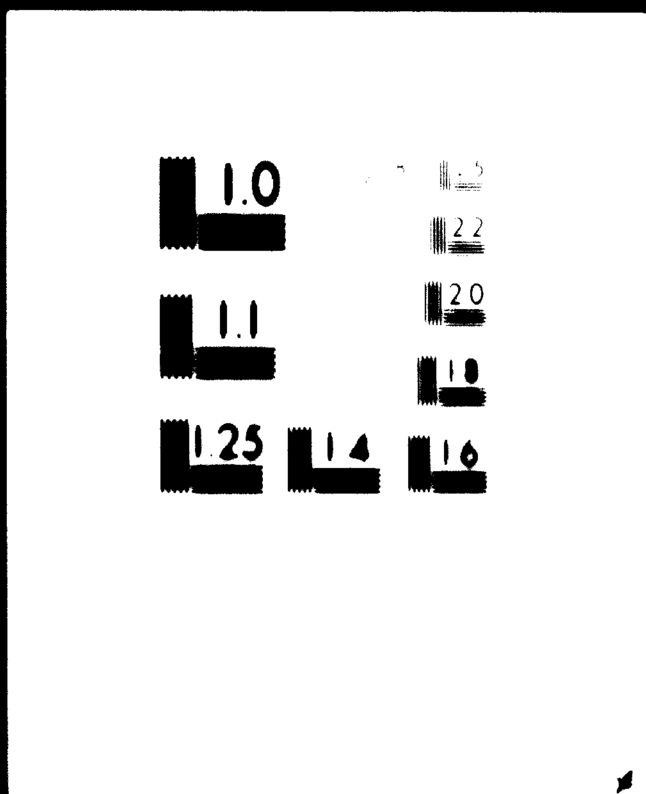

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manufacturing company in participation. The company then not only supplies the technical know-how and takes a share in the management but also guarantees that it will export the surplus production at a price not below a certain minimum level. This opens up the way to the establishment of capacities which are large enough to compete with those existing in Western Europe, Japan or the USA. Since under normal conditions surplus capacities exist for the first three to four years even in plants designed to supply only the local market, such export joint venture arrangements are in general a sound proposition.

We would suggest that a joint venture of this nature should incorporate the following features:

- The foreign partner takes a major share in the management and the technical running of the plant
- Exports are guaranteed at prices not below a minimum level
- The foreign partner participates only for a limited period (5 - 10 years)
- The share of the foreign partner is below 50 per cent
- The Government of Pakistan has a stake in the company if it produces vital raw materials
- Any competing firm which is much smaller is given a chance to hold a fairly large minority share
- The rest of the shares are evenly distributed among the general public, to promote the capital market and to prevent the company being controlled by small minorities.

Since most of the petrochemical industries are of vital importance and occasionally have a monopoly in the country for some while, it seems advisable to make sure that such enterprises are not controlled by one industrial group only

The arguments in favour of establishing an export organisation are as follows

According to our findings, the exporting of non-traditional goods is neglected in Pakistan It seems that the most efficient businessmen in the country have already found enough opportunities to earn a good profit on the local market. The lack of interest in exporting is not so much due to the non-availability of non-traditional items which can be exported as to the fact that exporting is much harder work.

Advantageous as it may be for the individual firms to concentrate on the domestic trade, for the country as a whole it is an extremely unsatisfactory state of affairs since it is much in need of foreign exchange If the private entrepreneurs are not taking the measures which are necessary for the sake of the entire economy, the Government should initiate them

To this end we suggest the Government should form an export marketing firm, but in accordance with private company law. The private sector should be involved by issuing shares to the general market But the Government should keep a strong hold on the company

The export marketing should be devised in such a way that it can operate as successfully as possible Therefore we suggest that it should incorporate the following features

- The company is run strictly on private business lines, the only condition being that it has constantly to open up new fields of export

- The company is run absolutely independently of the Government

- Efficiency is the supreme requirement. One top-class manager is engaged who is personally responsible for certain minimum targets being achieved.

If necessary a top-class manager from abroad should be engaged. He should be completely free to carry out the measures he deems necessary within the financial limits of the company. In particular, he or his executives should have the right to dismiss any staff member who is not considered to be an efficient and willing worker. But on the other hand if the manager, in spite of the powers given to him, is not able to produce good results within a reasonable period, he will be dismissed himself.

The fields of work of the company can be outlined as follows:

- selection of suitable export products
- export market research
- export market development
- initiating improvements in local products
- coordination and improvement of local production
- pre-shipment quality control.

With these general aims the company is not restricted to the exporting of petrochemical end-products or items manufactured out of such raw materials. A restriction of this nature would probably not be conducive to the underlying idea of promoting exports in general. But, besides other products, the company could also export petrochemicals. Under the present system of export promotion measures, a company of this type would have a vast field of activity simply in promoting exports of petrochemicals and their secondary products.

9.3.2 Special measures

In the textile sector another example may illustrate how direct intervention by the Government can increase net export earnings.

In section 6.3.2 it was shown that a replacement of cotton by polyamide fibres would result in a considerable increase in foreign exchange earnings. It would, therefore, be reasonable to promote the consumption of nylon, which could best be done by a reduction in price, nylon articles being very price-elastic. According to our preliminary estimate it can be expected that a price reduction of 20 per cent would result in an increase of demand of about 23 per cent.

Considering that one kg of nylon can replace about 4 kg of cotton, 5,500 t of cotton could be exported in 1971, for example, if the price is cut by 20 per cent. Through this measure, an additional 3.3 million $ could be earned.

Under such conditions abandoning the excise duty if Rs. 11 per kg of nylon yarn should be seriously considered. This is equivalent to a price reduction of about 20 per cent.

From a public finance point of view it should be considered that the abolition of this tax results in a reduction of tax revenue of about 81 million Rs. That would be a high price to pay for obtaining the stated increase in foreign exchange earnings. We, therefore, suggest transferring the excise duty to cotton yarns. This would mean an additional charge of the order of 0.20 - 0.30 Rs. per kg of yarn. The transfer of the tax would not only have the advantage that the foreign exchange would be earned free of cost to the Government but it would also promote the substitution process and at the same time simplify taxation. Since excise duties are already being levied on cotton yarns, the said rate of tax could be levied without additional expense being incurred.

Annex

Long-Term Development Tendencies of the Demand for Certain Petrochemical Products, 1975 - 1985 [1]) (in tons)

Product	1975	1980	1985	Average Growth Rate
LD Polyethylene	21,200	59,800	168,800	23 %
HD Polyethylene	1,700	4,200	10,500	20 %
Polypropylene [2])	4,900	14,900	45,500	25 %
PVC Resin	19,300	48,000	119,500	20 %
Polyvenyl Acetate	1,700	3,400	6,900	15 %
Polystyrene [3])	5,800	11,600	23,400	15 %
Polyacrylates	900	1,800	3,600	15 %
Phenolic Resins	900	2,300	5,600	20 %
Urea Resin	5,600	12,800	29,400	18 %
Melamin Resin	500	800	1,200	10 %
Polyurethane	1,000	2,200	4,800	17 %
Alkyd Resins	5,800	8,500	12,500	8 %
Polyamide Fibres [4])	11,000	22,100	44,400	15 %
Polyester Fibres [4])	5,100	12,700	31,600	20 %
Synthetic Rubber	5,600	7,900	11,000	7 %
Methanol	4,300	9,400	20,600	17 %
Ethanol [5])	24,000	32,100	42,800	6 %
DOP	5,200	9,600	17,600	13 %
Dodecylbenzene Sulphonate	9,700	19,500	39,200	15 %
Carbon Black	4,300	6,000	8,500	7 %
Glycerine [5]) [6])	5,700	10,500	13,300	13 %
Formaldehyde	7,600	17,400	39,800	18 %

[1]) Figures are extrapolations from the data of the period 1968–1975. In case of dodecylbenzene sulphonate estimated rates have been chosen
[2]) Requirements for substitution programmes are included in the figures in accordance with section 4.2.3
[3]) ABS is not included
[4]) It is assumed that the synthetic fibres consumed in Pakistan will be only polyamide or polyester fibres
[5]) Figures relate to fiscal year starting with the year indicated
[6]) Demand for public purposes not included

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