FEASIBILITY STUDY REPORT
THE CONSTRUCTION PLAN OF
THE ASEAN FERTILIZER PROJECT
THE REPUBLIC OF THE PHILIPPINES

DECEMBER 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

No. 19

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PREFACE

At the request of the Government of the Republic of the Philippines, the Japanese Government agreed to undertake a feasibility study of the plan to construct a fertilizer plant in Isabel district of Leyte in the Philippines by joint investment and management of the ASEAN member countries, and entrusted its execution to the Japan International Cooperation Agency.

Japan International Cooperation Agency has organized a study team headed by Mr. JIRO INOUE and consisting of other 8 experts for the purpose of this study. The study team visited the Philippines for about one month from 15th October 1978 to discuss with the authorities of the Government of the Philippines concerning all aspects of this project, investigate site conditions of the contemplated plant site, collect necessary data and information including visits to existing fertilizer plants in the Philippines. During this period, some members of the team have also visited other ASEAN countries to investigate fertilizer markets.

This report is to build up the scheme and features of the project on the basis of findings, data and information collected through such visits and field surveys. The study, as a conclusion, has proven the feasibility of this project which contemplates to set up a new fertilizer manufacturing plant utilizing the total volume of by-product sulfuric acid of 412,000 T/Y from the Copper Smelting Project in the Philippines.

We, Japan International Cooperation Agency, present this report with our sincere hope that this study will contribute to further economic development of the ASEAN countries as well as further promotion of amity and cooperation between the ASEAN and Japan.

We also take this opportunity to express our gratitude and appreciation to His Excellency Vicente T. Paterno, the former Minister of Industry (present Minister of Public Highway), Board of Investment, Fertilizer and Pesticide Authority and other officials or authorities concenred of the Government of the Republic of the Philippines for thier vast assistance and cooperation extended to the execution of this study.

December, 1979

Shinsaku Hogen
Shinsaku Hogen
President
Japan International Cooperation Agency

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EXECUTIVE SUMMARY

1. This project aims to establish a new fertilizer manufacturing plant utilizing all by-product sulfuric acid of 412,000 T/Y from the copper smelting project in the Philippines.

   This project is expected to be the Philippines' portion of so called ASEAN Complementation Project, under the joint investment of ASEAN countries with the idea to distribute the product to ASEAN countries.

2. Among fertilizers, sulfuric acid-oriented fertilizers are ammonium sulfate and phosphate fertilizers, i.e., ammonium phosphate, superphosphate, complex fertilizers.

   Financially analysed over 20 cases of product-mix, the most favorable profitability has been resulted in Case 10.

   Following shows the kinds of products, annual production volume, internal rate of return and rate of return on equity for Case 10.

	Case 10
Ammonium sulfate (T/Y)	150,000
Complex fertilizers (T/Y)	369,000
Internal rate of return (%)	10.41
Rate of return on equity (%)	26.2

3. In view of the results of financial analyses and market aspects, this project is judged to be profitable and it will meet the expectation of the Philippines.

   Further, this project will provide the Philippines with favourable opportunities for utilization of human resources, savings of foreign currencies, security of stable fertilizer supply, etc.

4. Major elements to consist this project are as follows:

   a) Capital Requirement

      124.28 million US dollars

b) Raw Materials

Major raw materials other than sulfuric acid are phospahte rock and ammonia.

Many of phosphate rock producing countries are located in NorthAmerica and in North Africa region, and its FOB prices are almost same and are quite stable.

Consequently it is advisable to select the geographically advantageous locations and the appropriate size of vessel to save the cost for ocean freight, for example, Jordan and 50,000 DWT class vessels. But it is also necessary to consider big suppliers such as Florida or Morocco to maintain stable supply.

A required volume of phosphate rock estimated is 206,000 T/Y.

Only imported phosphate rock is considered for this study, because quantity of phosphate rock domestically available in the Philippines is very small.

Ammonia is supposed to be imported from Indonesia at the favourable price by means of shattle services of small sized tanker. A required volume of ammonia is 105,000 T/Y in Case 10.

c) Market

An estimated volume of import-required fertilizers in 1985 in ASEAN countries and a planned production volume in this project are summarized as follows:

The volume of import-required is much larger than the projected production volume.

(In thousand tons/year)

	Import-required	Case 10 Production
Ammonium sulfate	683	150
Complex fertilizers	537	370

d) Product Sales Price:

Ex-factory Philippines price is determined as follows:

(Current C&F price of importing ASEAN countries) minus (Actual ocean freight cost between the Philippines and each of the ASEAN countries) minus (a range of 5 to 10 US$/T.)

In addition to the above, an escalation is taken account of.

Market price, projected sales price (F.O.B. Philippines plant site) and sales price to give 8% and 20% I.R.R. are as follows:

(US$/T)

	Ammonium sulfate	15-15-15	16-20-0
Market price			
1979	120	230	200
1983	152	291	241
Projected price			
1979	100	200	165
1983	127	253	209
Sales price to give 8% IRR (1983)	119	238	196
Sales price to give 20% IRR (2983)	163	324	268

e) Construction Period and Timing of Start-up

Construction period: Approx. 30 months after conclusion of construction contract

Start-up time: January, 1983 (To correspond with the schedule of PASAR's copper smelter)

f) Plant Site

The plant site under this project is decided to be an adjacent place to the PASAR's copper smelter at Isabel district in Leyte Islands.

The acquisition of land is about 50 ha., about 17 ha. of which will be prepared for plant construction. As an enough depth is available to lay a tanker of 50,000 DWT alongside a pier at about 130 m away from the present coastline, it is possible to construct port installations exclusive for the fertilizer plant at less expensive cost.

g) Major Plants and Off-site Facilities

- o Ammonium sulfate manufacturing plant
- o Phosphoric acid manufacturing plant
- o Fertilizer granulation plant
- o Port installations
- o Raw material receiving and storage facilities (unloading, storing facilities and tanks for sulfuric acid and ammonia, etc.)
- o Product storage and shipping facilities (bagging facilities, product storages, loading facilities, etc.)
- o Treatment facilities for waste water and exhaust air.
- o Utility facilities (boiler, water treatment facilities, substation, emergency power generator, sea water pumps, etc.)
- o Other off-site facilities (offices, repair & maintenance shop, test & laboratory room, clinic, fire station, air-conditioner, etc.)

(Note that this project will cover for direct infrastructures, while indirect infla-structures such as housing colonies, public roads, hospitals, schools will be covered by either of the Philippines central government or Leyte local government.)

CHAPTER I

SUMMARY

I. SUMMARY

I.1 Outline of The Study

(1) This is a feasibility study concerning the project to manufacture fertilizers with use of by-product sulfuric acid of 412,000 tons per year to be supplied from the copper smelter of PASAR now being undertaken in the Philippines, and to distribute the product fertilizer among the ASEAN countries. This project is to be carried out by a joint company which will be established in the Philippines as joint investment company by all of the ASEAN countries, together with Japanese credit loans. Japan International Cooperation Agency has been entrusted by the Government of Japan to conduct its feasibility study, as per the request from the Government of the Philippines.

(2) Scope of The Study

This study covers following items:

a. Worldwide and ASEAN markets of sulfuric acid oriented fertilizers, i.e. ammonium sulfate and phosphate fertilizers

b. Raw materials and its all relative matters required for the proposed project

c. Product-mix recommendation for production deemed most suitable for this project

d. Discussions on all technical aspects; necessary equipment and facilities, including infrastructures and effluent disposal

e. Proposed organization and plant operations

f. Capital requirement and financial analyses

g. Economic evaluation

I.2 Analyses on The Worldwide Market of Phosphate Fertilizers and Their Price Trend

(1) The consumption growth rate of phosphate fertilizers is quite low among the advanced countries, while it is quite high in the regions of East Europe, Asia and Latin America. Should it be competitive against imports from mass production countries like USA, the project of manufacturing phosphate fertilizers in Asia is quite reasonable. Therefore, the world market price level of this kind of fertilizers gives very big influence for this project.

(2) Regarding TSP and DAP, USA holds a prevailing share in the worldwide market. Although exports from phosphate rock producing countries like countries in North Africa may assumedly rise up from now on, no mistake will seemingly be resulted in the worldwide marketing reviews and analyses so long as they are based on the USA situation. This study assumed CIF prices to the ASEAN countires from this project based on the annual FOB prices of USA. These CIF prices from this project is set about 5 to 10 US$/T lower than CIF prices from USA, i.e., 132 US$/T for TSP and 172 US$/T for DAP, both in bulk, in December, 1978.

(3) Because NP/NPK fertilizers have a wide variety of grades and tendency to be produced in the consuming countries, they are not internationally big trading goods. Their price fluctuation is, therefore, quite radical, and their normal prices are hard to be caught up. With all these, this study assumed CIF prices in bag to the ASEAN countries from this project as follows:

	Dec. 1978	July 1979
15-15-15	172	215
16-20- 0	142	180

(4) Though phosphoric acid has recently become a international trading goods, its trading still remains limited, because of scarce receiving facilities, and there is seldom found any examples of its prices in the ASEAN countries. With views of high ocean freight cost to each of the ASEAN countries from the existing manufacturers in the world as well as recent rapid price rising of phosphoric acid, this study assumed CIF price to Indonesia which may be offered under this project to be 322 US$/T-$P_2O_5$ in December 1978 and 370 US$/T-$P_2O_5$ in July 1979.

(5) There are not much difference in FOB prices in ammonium sulfate among USA, West Europe and Japan. Further, the supply source of ammonium sulfate to be

exported depends almost upon by-product from caprolactam production. As its production is deeply related with other industrial fields, there is less possibility of rapid increase in supply, while its demand is expected to rise up steadily. Its price also is, therefore, expected to rise up steadily. With all these, the study assumed CIF price to the ASEAN countries from this project to be 107 US$/T in bag in December 1978 and 115 US$/T in July 1979.

(6) Recent tone of sulfur market is rather tight, due to the fact that supplying countries are limited and sulfur production from desulfurization of crude oil in the advanced countries is unexpectedly low and its price may seemingly continue to rise up. There is a strong opinion to give prominence not only to phosphate rock, but also to sources of sulfuric acid, when considering the future phosphate fertilizer industries. With this, this project is obviously told to be quite reasonable.

I.3 Market Analyses of ASEAN Countires

(1) In the Philippines there are two manufacturers of phosphate fertilizers and ammonium sulfate, respectively, but their supply of both ammonium sulfate and NP/NPK fertilizers can not satisfy the full domestic demand. Import of such goods is, therefore, expected to increase year by year, because steady increase of demand for rice cultivation is strongly prospective. A shortage of NPK will assumedly count 100 thousand tons a year in 1985 and reach to 250 thousand tons a year in 1990. Supply from this project is probably expected largely.

(2) Indonesian agriculture is broadly classified into two sectors, i.e. food crops sector with rice-crop and estate crops sector with plantation rubber and coconut. Regarding phosphate fertilizers to be used for cultivation of food crops, the Government of Indonesia has determined a policy to use only a single fertilizer TSP, under which a TSP plant of 330 thousand tons a year capacity with use of imported phosphoric acid as a raw material will soon start operation. There may be an opportunity of supplying phosphoric acid to meet their needs from this project, but they have an idea to produce phosphoric acid by themselves. Wide shortage of ammonium sulfate is now existing, but they have also a plan to produce it.

(3) In Malaysia mixed fertilizers to use phosphate rock itself is popular as phosphate fertilizers, but a fair amount of NPK/NP fertilizers is also imported now. Such import is assumed to be 85 thousand tons a year in 1985 but they are trying to stop

this import by substituting to other kind of fertilizer. Ammonium sulfate is also needed to be imported about 100 thousand tons a year.

(4) Large amount of NP fertilizer especially 16-20-0 is used for rice-crop in Thailand. There is a manufacturer in Thailand to produce about 120 thousand tons a year of complex fertilizers by importing both DAP and ammonium chloride and mixing them. Its production capacity will be further increased to 300 thousand tons a year, and yet NP/NPK fertilizer to be imported amounts to 450 thousand tons in 1985. Import of ammonium sulfate is also anticipated to be quite big. Viewing from either intermediate products or finished products, there is a very deep relationship with this project.

(5) Summarizing all the above, the maximum quantity of chemical fertilizers deemed to be imported by all the ASEAN countries from this project, say in 1985, would be quite large as follows:

Ammonium sulfate	683 thousand tons a year
DAP	300 thousand tons a year (Including intermediate products)
TSP	10 thousand tons a year
NP/NPK	537 thousand tons a year
Phosphoric acid	270 thousand tons a year

It is, therefore, concluded that there is no marketing problems at all for this project in this regard.

I.4 Raw Materials and Their Prices

(1) Phosphate Rock

Morocco and State of Florida, USA, are leading two among all phosphate rock exporting regions in the world, and North Africa, Middle East and Oceanian Islands are following. Oceanian Islands have advantage of very close location to the

Philippines, but their reserves are going to be run out. Philippines' domestic phosphate rocks are existing, but the reserves are not big enough to be considered for this project, when we follow the investigation results made by the Government of the Philippines up to now. Quality of phosphate rock varies depending on their sources, but any phosphate rock is acceptable as raw materials, both economically and technically, so long as the phosphoric acid plant is designed in advance considering the nature of phosphate rocks selected.

Consequently, phosphate rocks available at the cheapest price should be selected, and thus, the lower grade rocks with the lower ocean freight cost should be purchased, because FOB prices for the same grade are almost same for any sources. Import from Jordan is most favorable to the Philippines, because of her short distance, but there is an alternative to import from Morocco or Florida, too, if any uncertainty is felt for import from only a single source. A price of 44 US$/T, CIF, Philippines, in terms of 1978 end price for the grade of 70% BPL can possibly be expected, if a tanker of approx. 50,000 DWT is used. This price is used in Chapter V and 55 US$/T as of July 1979 is used in the other parts of this report.

(2) Sulfuric Acid

Only by-product sulfuric acid from PASAR is considered as a sole source in accordance with the premises of this project, and assumed to be provided to the fertilizer manufacturing party at cost. It is advised that a sulfuric acid plant should be owned by PASAR, in view of the oprational conveniences. The cost price at 1983 is assumed to be 19 US$/T.

(3) Ammonia, Potassium Chloride and Bag

Ammonia may be delivered from Indonesia (East Kalimantan) with a chartered tanker of appxo. 3,000 DWT by shattle services. Expecting a special offer as a member of the ASEAN countries, the price at 1979 is assumed to be 150 US$/T, CIF. Potassium chloride can probably be imported from any countries of the world, whose price at 1979 is assumed to be 82 US$/T, CIF.

The currently existing bag manufacturing capacity in the Philippines is sufficient, and its price at 1979 is assumed to be 3.82 pesos/bag.

I.5 Product-mix Study

With a purpose of studying what kinds of products are most suitable for the manufacture under this project, 20 cases of product combinations to use all quantity of sulfuric acid from the copper smelter are composed from such potential products as will be accepted by the ASEAN countries. They are ammonium sulfate, DAP, TSP, NPK (15-15-15), NP (16-20-0) and phosphoric acid. The internal rate of return is calculated for each case and the results are compared.

The aforementioned December 1978 prices for both finished products and raw materials have basically been applied. Rough raw materials consumption and capital requirements figures are set for each case by assuming manufacturing processes for each product.

As the result, better profitability is expected in the following order of products.

NPK > NP > Ammonium Sulfate > TSP > Phosphoric Acid > DAP

When NP/NPK fertilizers are mainly produced instead of such intermediate products as DAP, TSP and phosphoric acid, this project becomes viable. While, should only NP/NPK be manufactured, its production amount is rather too big in terms of market size. From this reason, it is concluded to manufacture some amount of ammonium sulfate, too. As conclusion, Case 10 with following product combination is recommended. All the products are assumed to be shipped in bag.

	Ammonium sulfate	NPK/NP
Case 10	150,000 T/Y	369,000 T/Y

I.6 Manufacturing Processes

The phosphoric acid manufacturing process can theoretically be classified into four, depending upon the differences of decomposition conditions of phosphate rock. Under the circumstances that the by-product gypsum is utilized even partly and all the phosphate rock are imported like in the Philippines, the hemi-dihydrate process is recommended because good quality of by-product gypsum can be produced and its recovery rate of phosphate from phosphate rock is higher. It should, however, be noted that there is only a little difference in terms of economy among these processes and the hemi-dihydrate process does not hold an absolute advantage.

For granulation process, a process to circulate a large amount of solid materials in a rotary drum using vessel type reactor is recommended.

For an ammonium sulfate manufacturing process, the result seems to have no much differences no matter what type of crystallizer is used.

I.7 By-product Disposal and Environmental Protections

(1) Gypsum

By-product gypsum production is estimated to be 340 thousand tons a year in Case 10. Applications for cement, gypsum board and plaster are only ways to utilize all of this large quantity of by-product gypsum in the Philippines. In respect of application for cement manufacturing, shortage of gypsum is assumed to be only 50 thousand tons a year in 1982. But as the increase of such shortage is obviously foreseenable year by year, it is recommended that a separate plan for construction of a plant to granulate approx. 200 thousand tons a year of by-product gypsum for cement manufacturing use should be undertaken.

Regarding the application for gypsum board manufacturing, as the demand for gypsum board is possibly expected in the future even in the Philippines, market exploitation efforts are suggested to be made.

Meanwhile, surplus by-product gypsum may be disposed of filling upon an open land.

(2) Fluorine Compound

The main use of fluorine compound is to use for aluminium electrolysis as cryolite. As there are plans to have aluminium industry within the ASEAN region, there is possibility to consider sodium silicofluorate production in the future.

For the time being, small amount of sodium silicofluorate may be recovered for drinking water additive, and the rest will be disposed of, after treated against environmental pollution.

(3) Environmental Protections

Major sources of polluting material in gas are cooling system of phosphoric acid manufacturing plant and exhaust air from fertilizer manufacturing plant.

Concentration of fluorine compound, acid mist or ammonia in gases can easily be lowered down below the tolerance volume set by the Government of Philippines by washing them with scrubbing water and neutralizing the water.

All of discharged acidic water chiefly from the phosphoric acid manufacturing plant containing some fluorine compound are gathered in one place, neutralized with lime and solid created are separated. By this way, waste water becomes clean enough to be finally disposed of.

Both surplus gypsum and solid separated at the water treatment facility will be piled up on an open ground, but rain water passing through such deposits will again be collected and treated in the water treatment facility, so that there comes up no problem at all.

I.8 Fundamentals on Plant Construction Planning

This project includes only matters of such direct concerns as manufactuirng, marketing and distribution. Such items as roads, hospitals, schools, houses for general employees and others for public use are excluded. They are left to be carried out by the Leyte Development Committee, one organization of the local government of Leyte Island.

Product line and production scale is previously described in para. I.5, "Product-mix Study".

Specifications on raw materials and finished products are exactly the same as for those now on the market in general, and nothing is particular.

I.9 Details on Plant Construction Planning

There is a premise given by the Philippine government that the plant site should be adjoining to the PASAR copper smelter.

Because there is no necessity to transport sulfuric acid in long distance, there would be no better site than this location.

Since the PASAR is, so heard, now undertaking to site its plant on the top end of peninsula along the east of Dupon Bay at Isabel district in Leyte Island, the locaton of fertilizer manufacturing plant is projected to be sited at mid-west of peninsula. 50 ha. of land is secured for fertilizer plant and 17 ha. of which is to be prepared for plant construction. Because there is a steep cliff of about 15 m height along the coastline, the excess soils produced out of the land preparation above the cliff may be fallen down to the bottom of the cliff to make a land prepared there, too.

Any ground survey to check the soil strength is not performed yet, but this area seems to have a good base. This survey is indispensable in the future.

The manufacturing installations consist of phosphoric acid manufacturing plant, fertilizer granulation plant and ammonium sulfate manufacturing plant. The utility facilities are boilers, water softening facility, substation, emergency electric generator, sea water pump, etc.

Three wells are to be drilled at location of about 2 km away from the planned site as industrial water sources, but no detail investigation is made yet.

Electricity is aniticipated to be supplied to the site upon completion of the geothermal plant construction in Leyte Island and it is expected to be completed by the end of 1981 together with transmission line to the site.

The port facilities consist of one berth (with 450 T/H unloader) available for mooring a phosphate rock vessel of 50,000 DWT, and one berth available for mooring both a vessel of 10,000 DWT and small vessels at the same time, which are to be used for loading finished products and unloading imported ammonia and others. These are now planned for exclusive use for fertilizer plant, but a part of these facilities may probably be allowed for joint use with the copper smelter, when the both projects are concretely materialized. However, there is little possibility to be widely altered.

Warehouses and storage facilities include one warehouse of 80,000 tons for phosphate rock, one ammonia tank of 15,000 tons, sulfuric acid tanks of 20,000 tons, and warehouses of 25,000 tons for finished products, and others.

Road renovation between Palonpon and Isabel is now under way by the local government of Leyte, and transportation of construction equipment and materials can possibly be done through this road at initial stage of plant construction. So, this project includes a part of access road construction.

This project includes only about 50 houses limited to be used by management level personnel.

I.10 Plant Construction and Management

As the contracting pattern of plant construction, turn-key, lump sum base contract with a general contractor is recommended. It is not deemed to be an indispensable requirement for the owner to employ advisory consultants, but it is deemed that the work may be carried out very smoothly, if the owner employs advisory consultants.

The construction period is assumed to be at least thirty (30) months after conclusion of contract, including commissioning term. Back from this, the contract should be concluded before the middle of 1980, if the commencement of commercial operation is aimed to be at January, 1983.

The training for operators and other employees must be provided right after their recruitment which will commence from around March, 1982.

As for the organization and manning of the new company, a total number of permanent employees is planned to be around 400. This figure is rather low because very few personel are considered for sales division on the basis of using existing distribution channels even in the Philippines.

I.11 Total Capital Requirement and Financing Plan

The total capital requirement for this project is estimated as follows:

(In million US dollars)

	Total Requirement	Foreign Currency Portion	Local Currency Portion
Case 10	US$ 124.28	US$ 74.40	US$ 49.88

These figures above are estimated including approx. 10% of physical contingency and 7%/Y of price contingency. Requirement for initial working capital is estimated to be 11.56 million US dollars.

Financing consists of 30% of paid-up capital and 70% of loan. As a matter of fact the loan will be secured from any source, but, to make the matter simple, consolidated average interest rate and repayment (grace period) are introduced in this report.

And for the sake of the theoretical analysis, we took 11-years equal instalment repayment after the grace period of 4 years with annual consolidated average interest rate of 4%, 5% and 6%, as examples of terms and conditions of loan.

I.12 Financial Analyses

Based on the prices for both product and raw material as estimated from the market price of July 1979 and total investment as estimated and mentioned in the previous paras., a variety of financial evaluation indicators are calculated for product-mix of Case 10. Average annual operating rates are assumed to be 60% for the first year, 80% for the second, and 90% for the third and onward. For other detailed conditions, please refer to the text. The results in terms of after-tax basis for base case of Case 10 are as follows:

Total Sales Revenue (after 3rd year) (thousand US$/Year)	93,860
Internal Rate of Return (IRR) (%)	10.41
Average Return on Paid-up Capital (%)	26.20
Pay-out Period (Years)	6.51
Debt Service Coverage Ratio (DSR)	2.25

These resultant figures show that this project is commercially viable in terms of profitability, commerciality and cash flow.

The sensititity analyses are made to see impacts incidental to changes of interest, selling prices, raw material prices, operating rate and construction cost. Slight fluctuation of such factors may affect influence on profitability. Particularly, attention should be taken that the operating rate is very closely related with that of the copper smelter plant.

I.13 Economic Evaluation

For the Philippines, the implementation of this project produces an increased additive value in terms of a good use of both sulfuric acid and manpower resources, and saves foreign currency expenditures.

For all other ASEAN neighbors, it gives a stable and secured supply of cheap fertilizers, provides an additional investment opportunity, and thus, contributes to an economic growth of each countires.

Based on the economic benefits and costs, the economic internal rate of return is calculated with the results of 14.5% for Case 10.

1.14 Set Premises

Should all the premises primarily set in this study be filled up in the favorable ways, the satisfactory profitability is expected and this project is concluded to be feasible.

Main premises set in this study are:

1) The PASAR's sulfuric acid manufacturing plan is carried out as scheduled.

2) No big unbalance happens between market prices of product fertilizer and raw material phosphate rock.

3) The products assumed in this study are accepted by the ASEAN countries.

CHAPTER I I

OUTLINE OF THE STUDY

II. OUTLINE OF THE STUDY

II.1 Background and Purpose of The Study

This study is made on the basis of "Terms of Reference" which has been given from the Government of the Philippines to the Government of Japan in February, 1978.

The contents of this "Terms of Reference" has been discussed in detail between the Philippine authorities and the contact mission sent in July, 1978, by the Japan International Cooperation Agency, and has been agreed in general, though there was some minor corrections. The copy of "Terms of Reference" is attached as Annex II - 1 of this report.

The background of issuing such request from the Government of the Philippines is briefed below.

As generally known, the Philippines are worldwidely famous for her large copper ore resources, and all of copper ore mined is being exported to many countries of the world. Its mining records 800 thousand tons in 1975, resulting in 200 millions US dollars of total export. It is quite natural to consider to manufacture more value added copper products in her country from ore and to export them abroad. Along this idea, Philippine Associated Smelter and Refining Company (PASAR) is established as semi-governmental copper smelting company, and the plant site is decided to be at northern part of Leyte Island. They are planning to construct a copper smelter plant with use of electricity from the geothermal plant now being under way in Leyte Island, and aiming to start the commercial operation in 1982.

This copper smelter project has capacity of 138,000 tons/y of metallic copper. A volume of sulfuric acid to be by-produced from this plant is estimated to be 412,000 tons/y. This volume of sulfuric acid is several times as much as the current consumption in the Philippines. Therefore, unless some measures are taken to consume all this sulfuric acid, the copper smelter construction project itself cannot be materialized.

Among industries which consume large volume of sulfuric acid, only fertilizer manufacturing industry, particularly phosphate fertilizers and ammonium sulfate can be considered realistic in the Philippines today. Looking over the ASEAN neighbors, these fertilizer products are now mostly imported in the forms of intermediate products or finished products.

Should it be profitable, it is a quite reasonable idea to manufacture such fertilizers based on by-product sulfuric acid from the copper smelter.

Another main raw material for phosphate fertilizers is phosphate rock. Should it be secured cheaply, the phosphate fertilizer manufacturing project will be materialized without any problems. With the above aim, the Bureau of Mines in the Philippines is now keenly exploring the reserves of the Philippines' domestic phosphate rock resources, but the reserves sufficiently to satisfy the need of this project is not yet confirmed until now.

As this project will give benefits to all the ASEAN countries, the Government of the Philippines is now proposing this project to the meeting of the ASEAN Economic Ministers for approval as the Philippines' portion of so called ASEAN Complementation Project, for which credit loan from Japan is to be granted.

Should it be adopted as one of the ASEAN Complementation Project, a joint venture company will be established in the Philippines to carry out this project under the joint investment of all ASEAN countries. Judging from other examples capital sharing ratio will be 60% for the Philippines and 10% each for other four countries of the ASEAN members.

Under the conditions to use imported phosphate rocks as a raw material, it is quite marginal whether this project becomes feasible or not. Furthermore, owing to the necessity to given comprehensive understanding of the project among the countries concerned, the Government of the Philippines has decided to request the Government of Japan to conduct a feasibility study on this project, and the Government of Japan has in turn decided to respond to such request. Thus, the Japan International Cooperation Agency has come to conduct this study.

II.2 Scope of The Study

The scope of the study is outlined as follows:

i) Market Study

a) Analyses on the worldwide supply-demand status and the price trend in respect of fertilizer products which are assumed to be produced under this project

b) Current agricultural patterns in each of the ASEAN countries (Major crops, Harvesting areas, Fertilizer consumption, etc.)

c) Reviews on consumption, production and future production plans, in terms of products relating with this project, in each ASEAN country

d) Reviews and analyses on both domestic and import prices, in terms of products relating with this project

ii) Raw Materials

Investigation on securing ways and prices of both primary and secondary raw materials

iii) Product-mix

Case study necessary to determine kinds and types of product combinations which are deemed to be most favorable to this project

iv) Manufacturing Technologies

Study on manufacturing processes and environmental protection

v) Equipment and Facilities Requirements

Studies on plant equipment and facilities, utilities and off-site facilities, and other direct infrastructures. Estimates on construction costs

vi) Construction Work and Plant Operations

Studies on all aspects in terms of construction and operation

vii) Financial Analyses

Studies on financing programs and financial analyses of this project

viii) Economic Evaluations

Economic evaluations on this project

Note:

i) As for the PASAR's copper smelter project which is very closely related with this project, this study will adopt only the information disclosed by the PASAR, but not cover any examinations to inquire the detail of their project.

ii) As for plant site, this study has investigated only one place adjoining to the copper smelter, and no other site was considered.

iii) For infrastructures, the study covers only what is directly concerned with this project, and all other infrastructures such as housings, roads, etc., have been left untouched, because they are deemed to be covered by either the central government of the Philippines or local government.

II.3 Site Investigation

In order to conduct a study with the above-mentioned purposes and scope, a mission consisting of ten (10) members in total led by Mr. Jiro Inoue, Chief of the mission, has visited the ASEAN countries, centering on the Philippines, over a period from 15 October, 1978 to 17 November 1978 and performed site investigations and studies.

Individual names of the mission members with their responsible areas are affixed in Annex II-2, and the sheets of mission itinerary, including time schedule, travelling, study items, interviewed party, etc. are affixed in Annex II-3.

We would like here to express, with all the heart, our sincere appreciation to all of people concerned; they are from; Mr. Vicente T. Paterno, Minister of Industry; Ministry of Industry, the Philippines; Board of Investment, the Philippines; Fertilizer and Pesticide Authority, the Philippines; Other Governmental Agencies in the Philippines; Planters Products Inc.; Atlas Fertilizer Corp.; other Private Firms; a variety of Governmental Authorities and Private Firms in each of the ASEAN countries; Embassy of Japan in the Philippines; Ministry of Foreign Affairs, Japan; Ministry of International Trade and Industry, Japan; and all other related organizations involved; all of which have rendered us extraordinary helps and cooperations on this study.

CHAPTER I I I

WORLDWIDE MARKET OF PHOSPHATE FERTILIZERS AND THEIR PRICE TREND

III. WORLDWIDE MARKET OF PHOSPHATE FERTILIZERS AND THEIR PRICE TREND

III.1 World Consumption Pattern of Phosphate Fertilizers

The world consumption of phosphate fertilizers is assumed to be 29 million tons in 1978 in terms of P_2O_5.

Fig. III-1 shows a trend of world consumption of phosphate fertilizers and its forecast made by ISMA. It is forecasted to be 42 million tons in 1985 in terms of P_2O_5, resulting in the consumption growth rate of 5.2 per cent per annum. Reviewing by regions, high rates of consumption growth lie on such three regions as East Europe, Asia and Latin America, while North America, West Europe and Oceania may be said to have low growth rates.

In accordance with data of ISMA, the consumption pattern of phosphate fertilizers by types and regions in 1975 is as shown in Table III-1.

Table III-1 Consumption Pattern of Phosphate Fertilizers - 1975

(Unit: 1,000 tons)

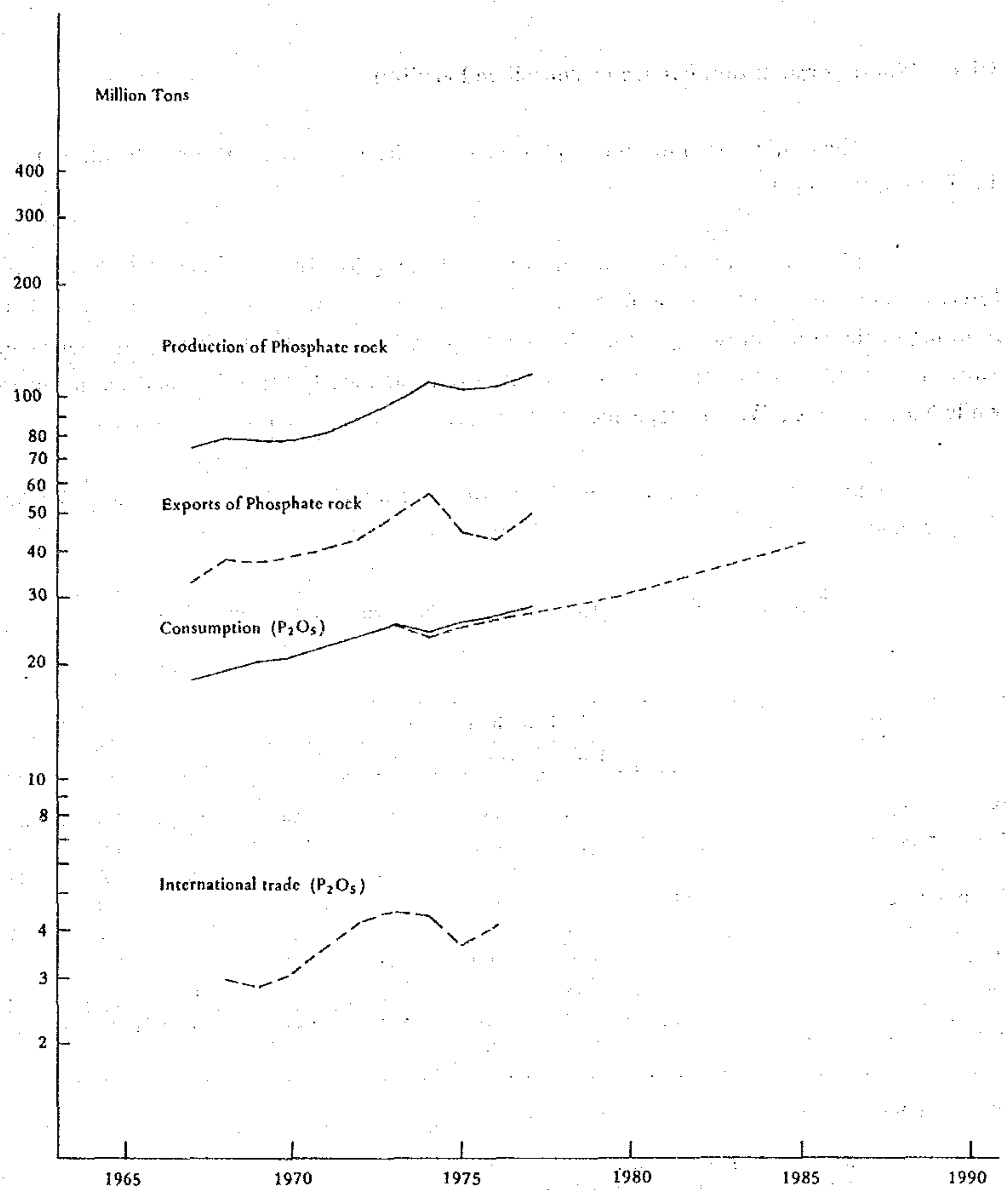
Region	Phosphatic Fertilizers a)						Total	%
	R.P	TSP	DAP	NP	NPK	PK		
West Europe	87	630	356	250	1,584	854	3,761	26
East Europe b)	-	925	187	-	129	68	1,309	9
North America	1	556	2,180	-	2,245	205	5,187	35
Latin America	110	618	455	-	118	-	1,301	9
Africa	23	145	81	16	248	1	514	3
Asia	13	394	500	58	752	-	1,717	12
Oceania	-	804	27	35	9	10	885	6
Total	233	4,072	3,786	359	5,085	1,138	14,674	100
Total %	1	28	26	2	35	8	100	-

(Source) ISMA

a) R.P: Rock phosphate
TSP: Tripple super phosphate
DAP: Diammonium phosphate
NP: Nitrogen Phosphorous compound fertilizers
NPK: Nitrogen phosphorous and potassium compound fertilizers
PK: Phosphrous potassium compound fertilizers

b) excluding U.S.S.R

Fig. III-1 World Phosphate Fertilizer Index



III.2 International Trade Pattern of Phosphate Fertilizers

The international trade of phosphate fertilizers in 1975 recorded 3,650 thousand tons in terms of P_2O_5, resulting in approx. 14 per cent to the total production of 26,200 thousand tons for the same year.

Table III-2 International Trade of Phosphate Fertilizers - 1975

(Unit: 1,000 tons)

Type	P_2O_5 equivalent
Phosphoric acid	963
Diammonium phosphate	1,288
Tripple super phosphate	841
NP/NPK/PK	557
Total	3,649

USA shares in the world export of phosphate fertilizers are remarkably high. They were 61%, 86% and 33% in terms of Tripple Super Phosphate (TPS), Diammonium Phosphate (DAP) and Phosphoric Acid (PA), respectively in 1975 and they were highest in the world. For TSP and DAP, USA exports approx. 35% of her total domestic production.

1. TSP (Triple Super Phosphate)

The world TSP trade in 1975 is shown in Table III-3, which records predominant export from USA of 515 thousand tons in terms of P_2O_5. In 1977 export from USA records 580 thousand tons in terms of P_2O_5.

TSP business in West European countries are mainly made within EC countries, and it will, therefore, not practically affect much influence on the world TSP trade.

Tunisia, Morocco and Spain are also exporting a certain volume to various countries along the Mediterranean Sea. Judging from these facts, it'is quite appropriate to think that USA position in the world TSP trade could be more important than shown in the previously mentioned figure of 61%.

On the other hand, TSP importing countries are Brazil, West European Countries

Table III-3 World TSP Trade (1975)

(a) World TSP Exports -1975-

(P_2O_5 1,000 tons)

USA	515
Tunisia	96
Netherlands	52 *
Morocco	39
Spain	35
Yugoslavia	29 *
West Germany	22 *
Sweden	14 *
Portugal	11
France	10 *
Others	18
Total	841

(b) World TSP Imports -1975-

(P_2O_5 1,000 tons)

Brazil	187
Hungary	121
France	115
Bangladesh	101
South Korea	89
Indonesia	69
Italy	63
West Germany	26 *
Belgium	20
Yugoslavia	19 *
Others	55
Total	865

(France and West Germany) and Hungary.

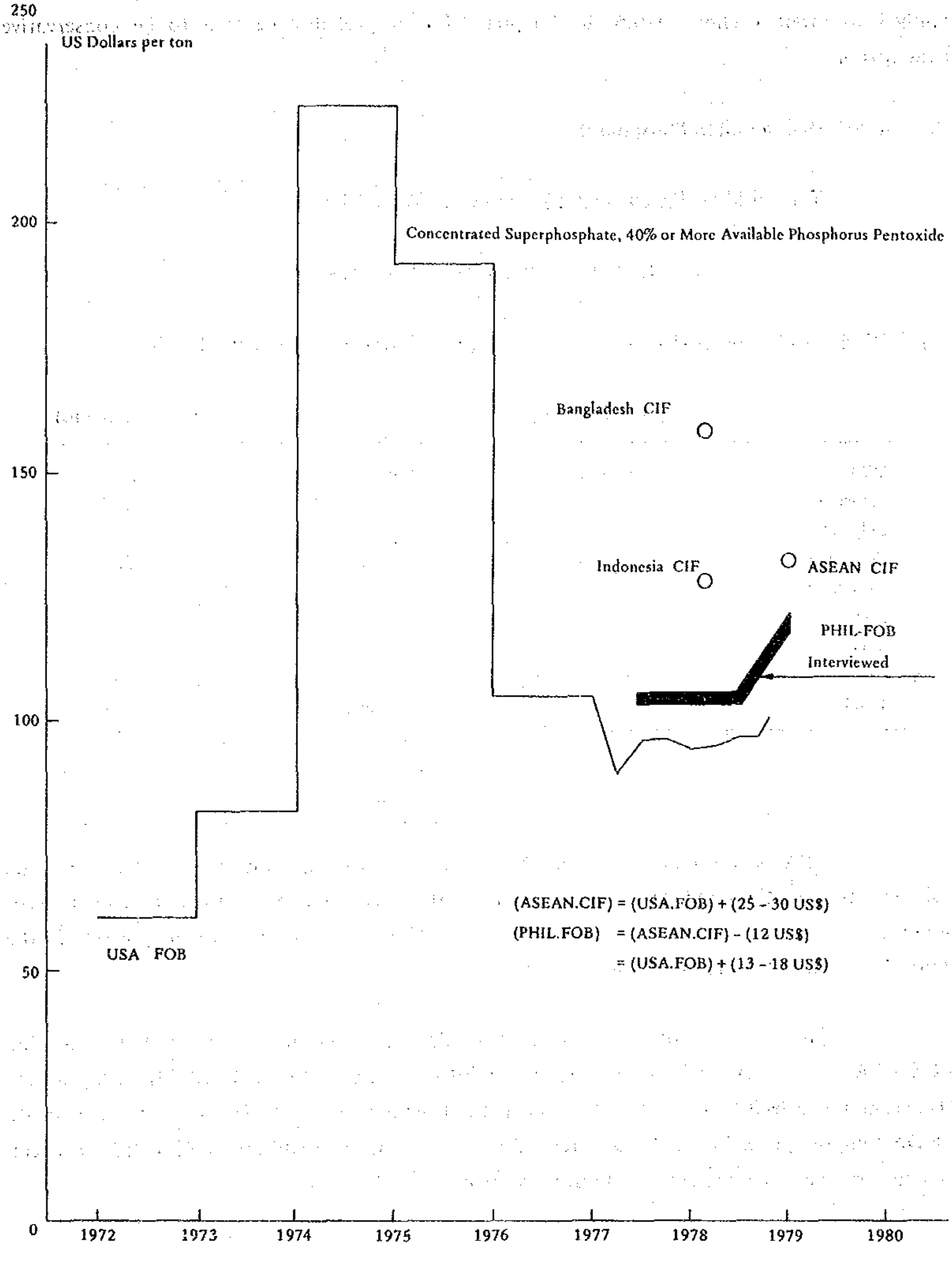
The Asian countries seem to be turning into self-supply from import by nationalization of manufacturing, even though they have been importing much until some time before.

South Korea imported, in 1975, 89 thousand tons of TSP in terms of P_2O_5, but no longer in 1977. This is chiefly attributed to the fact that the chemical fertilizer industry in South Korea has set up its production capacity around 1975 and achieved self supplying. The same has happened in Bangladesh and is going to happen in Indonesia.

TSP prices in the world trade is summarized mainly from FOB USA prices, and some data are added from the information obtained by personal interviews to the traders. (See Fig. III-2)

TSP price has drastically rised up around 1974 and 1975, but it became stagnant in 1976 and thereafter. FOB USA price was as low as around 100 US$/T. While, it again turned upward in mid-1978, and seemed to have recovered more or less up to around 115 US$/T at the end of that year. This corresponds to 145 US$/T CIF ASEAN countries when we consider ocean freight charge between USA and the Philippines. This means that, in order to supply TSP from the Philippines at 145 US$/T CIF ASEAN countries, FOB Philippines price can be assumed to be

Fig. III-2 Price Trend of Triple Super Phosphate



133 US$/T, because ocean freight charge between the Philippines and ASEAN countries are estimated to be 12 US$/T. FOB Philippines price of 120 US$/T, in terms of bulk, which will be applied in product choice study in Chapter VI, can probably be told to be conservative assumption.

2. DAP (Diammonium Phosphate)

The world DAP trade (1975) is shown in Table III-4.

Table III-4 World DAP Trade (1975)

(a) World DAP Exports -1975-

	(P_2O_5 1,000 tons)
USA	1,103
Pakistan	96
Belgium	51
Colombia	15
Netherlands	10
Italy	8
Spain	5
Total	1,288

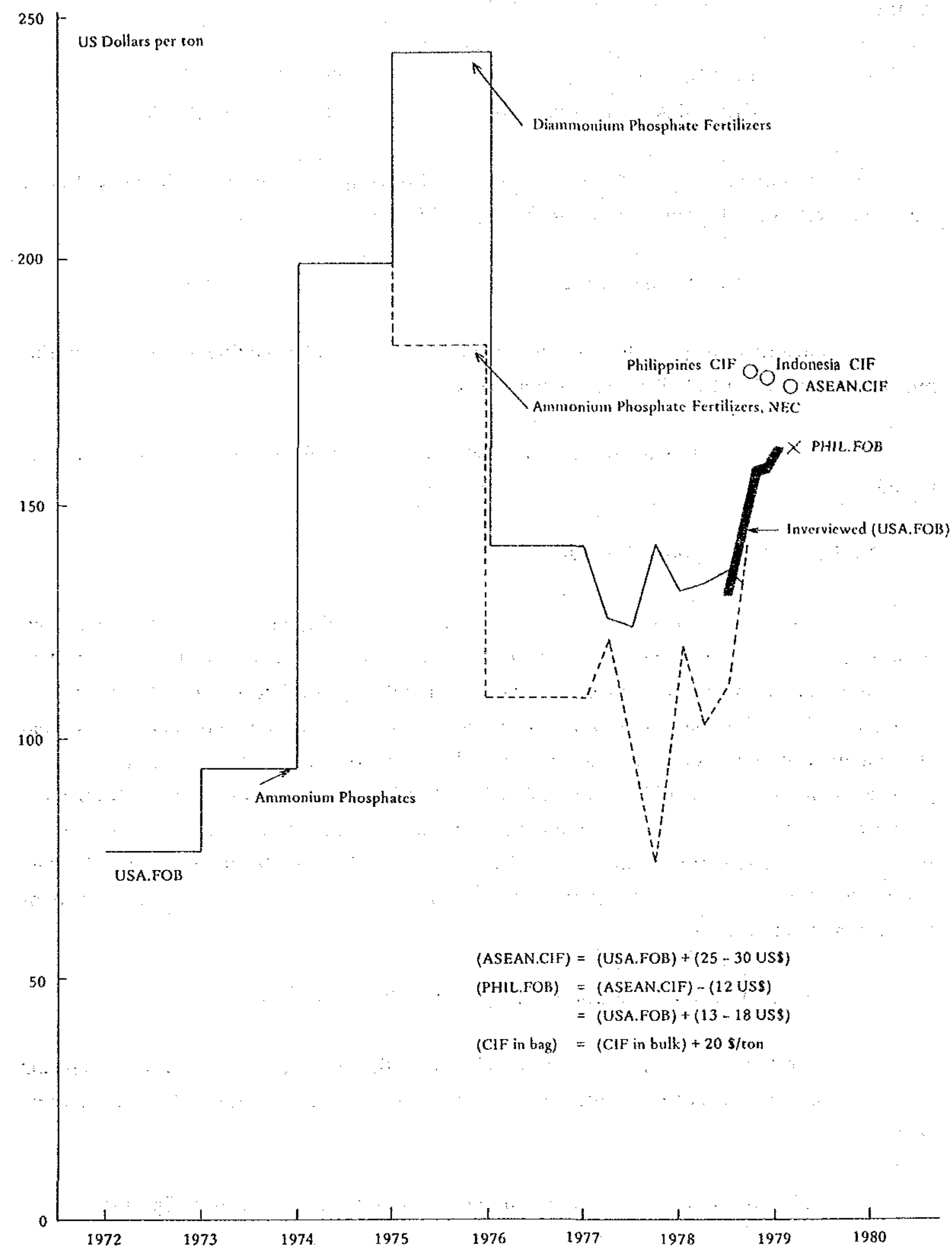
(b) World DAP Imports -1975-

	(P_2O_5 1,000 tons)
Italy	226
India	207
Brazil	205
France	156
USA	132
Iran	86
Japan	31
U.K	25
Thailand	23
Others	53
Total	1,144

USA position in the world DAP trade is also remarkably high, and in 1977, its volume was 1,297 thousand tons in terms of P_2O_5. It seems that some countries may realize self-supply, but none appears to seek for export for a while. USA's predominant position in the world DAP trade may probably last for years.

The follow-up of the world DAP trading prices will be exactly made by checking FOB USA prices. Fig. III-3 shows a trend of FOB USA prices. From this, FOB USA price for DAP is conservatively judged as 150 US$/T at the beginning of 1979. To figure out an estimate of DAP import prices in the ASEAN region, it is said enough to add about 30 US$/T as ocean freight cost and other charges over FOB USA price.

Fig. III-3 Price Trend of Diammonium Phosphate



The price applied in product choice study in Chapter VI is decided in the following manner:

FOB USA price	150 US$/T
CIF ASEAN price from USA	150 + 30 = 180 US$/T

If supplied to ASEAN countries from this project at the same CIF price, freight charge between ASEAN countries and the Philippines 12 US$/T must be deducted.

FOB Philippines price	180 - 12 = 168 US$/T

In order to give advantage for ASEAN countries, FOB Philippines price from this project is taken as 160 US$/T in this study hereafter.

These are prices in bulk and prices in bag are obtained by adding 20 US$/T to prices in bulk.

3. NP/NPK/PK (Compound Fertilizers)

There are a number of types, such as NP, NPK, PK, and so on, in the compound fertilizers. The position of such fertilizers in the world trade is relatively small, although there are a quite number of types. This is seemingly attributable to the facts (1) that the world trade in relation with phosphate fertilizers has primarily been centered in phosphate rocks and manufactured at consuming countries; (2) that the popularization of TSP and DAP has been preceded that of compound fertilizers because of fertilization techniques and the former has occupied a leading position in the international trade, including developing countries; and (3) that the regions consuming compound fertilizers are West Europe, North America and Japan, consuming altogether 85% to the total world production, and are all capable of self-supplying such compound fertilizers.

Table III-5 shows the world compound fertilizers trade (1975).

Easily to see, there shows many of trade within EC market in the world compound fertilizer trade. Based on the EC's trade statistics, the trade within EC shares 60% of the world trade.

The price trend in the world compound fertilizer trade is shown in Fig. III-4.

Table III-5 World Compound Fertilizer Trade - 1975

(Unit: P_2O_5 1,000 tons)

(a) Export

	NP	NPK	PK
Belgium	22	113	17
France	-	69	-
West Germany	7	33	15
Denmark	-	22	51
Italy	8	7	-
Netherlands	-	-	98
Portugal	-	8	-
Yugoslavia	-	23	-
USA	-	34	-
Columbia	-	15	-
Japan	-	15	-
Total	37	339	181

(b) Import

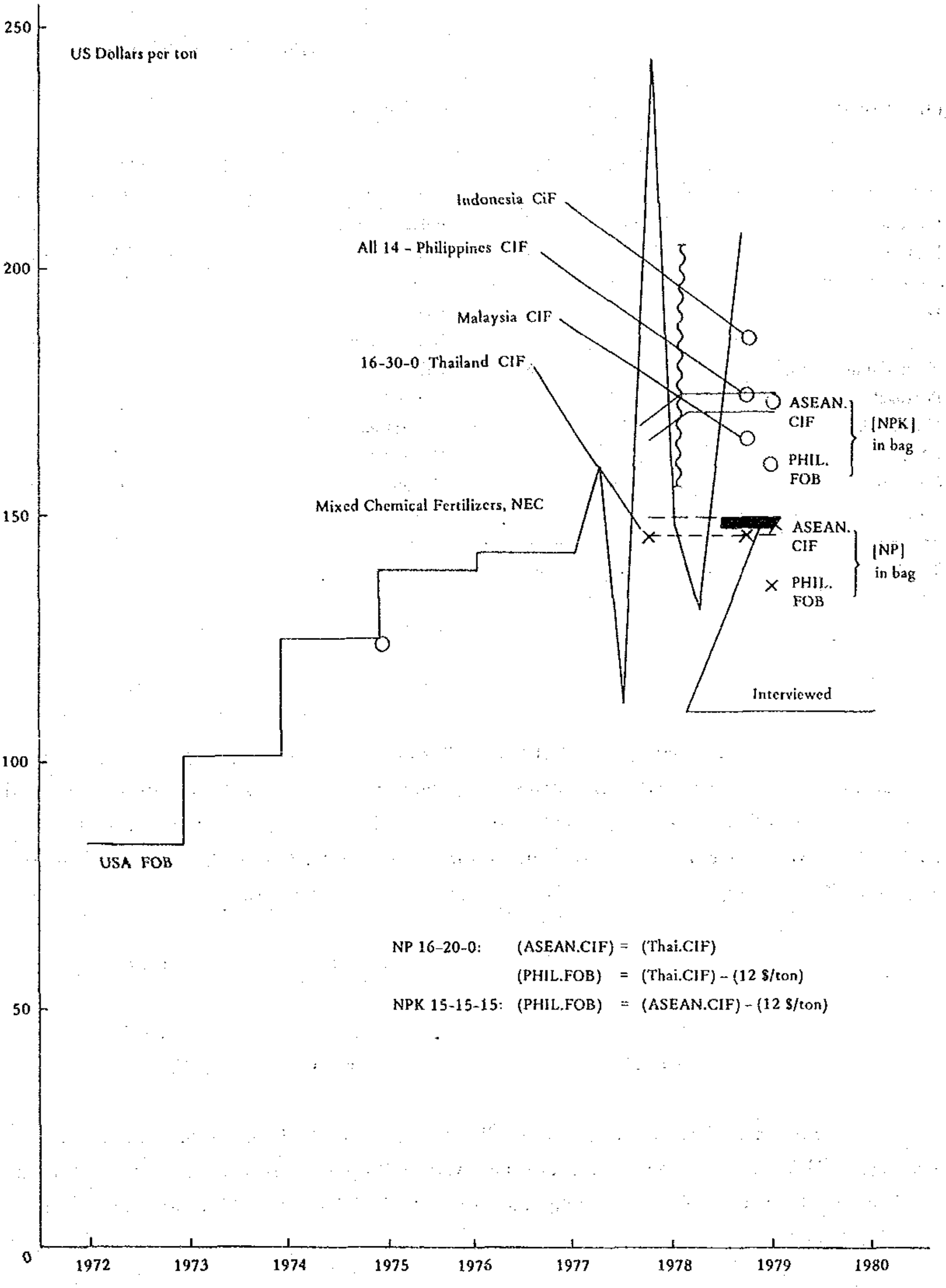
	NP	NPK	PK
Belgium	3	11	1
France	-	117	40
Denmark	-	35	-
Italy	1	10	-
Netherlands	-	-	6
UK	1	16	-
Sweden	-	10	-
Switzerland	-	4	5
Venezuela	-	13	-
Hungary	-	16	14
USA	-	17	-
Ceylon	-	2	-
India	76	45	-
Philippines	-	1	-
Thailand	39	5	-
Total	120	302	66

In the field of compound fertilizers, USA is not always occupying a leading position, but for convenience' sake, FOB USA prices are applied to show the past trend. Recent Thailand importing prices of grade 16-20-0 in NP and ASEAN's importing prices of grade 15-15-15 or 14-14-14 in NPK, have been investigated. From these results, CIF ASEAN prices from this project at the beginning of 1979 and July 1979 can be assumed as follows:

	January 1979	July 1979
16-20-0	147 US$/T	180 US$/T
15-15-15	172 US$/T	215 US$/T

For examples, in fall of 1978, CIF prices for 15-15-15 in Indonesia and Malaysia were 185 US$/T and 165 US$/T, respectively. And, Philippines' CIF price for 14-14-14 in bag was 174 US$/T. In July 1979, CIF Philippines price of 15-15-15 is 230 US$/T and that of 14-14-14 is 225 US$/T.

Fig. III-4 Price Trend of Mixed Chemical Fertilizers



As for 16-20-0, CIF price in Thailand, the largest importing country of this grade, was about 145 US$/T for both 1977 and 1978, but it is about 200 US$/T in July 1979.

FOB price for NP and NPK is fairly fluctuating, depending upon the time and conditions of tender, etc. Even though there was such fluctuation, the past price trend shows consistent upswing.

With these, price-up may be foreseen on a long-term basis, but it is necessary to anticipate possible fluctuation of fair extent on a short-term basis.

4. Phosphoric Acid

The world phosphoric acid trade was originally limited (1) to a regional trade within West Europe and the Mediterranean Sea and (2) to export to a certain specified countries of consuming phosphate fertilizers, such as India and Brazil. But, for these years, particularly after 1974, the world trade pattern is rapidly changing, affected by construction of many export-oriented plants.

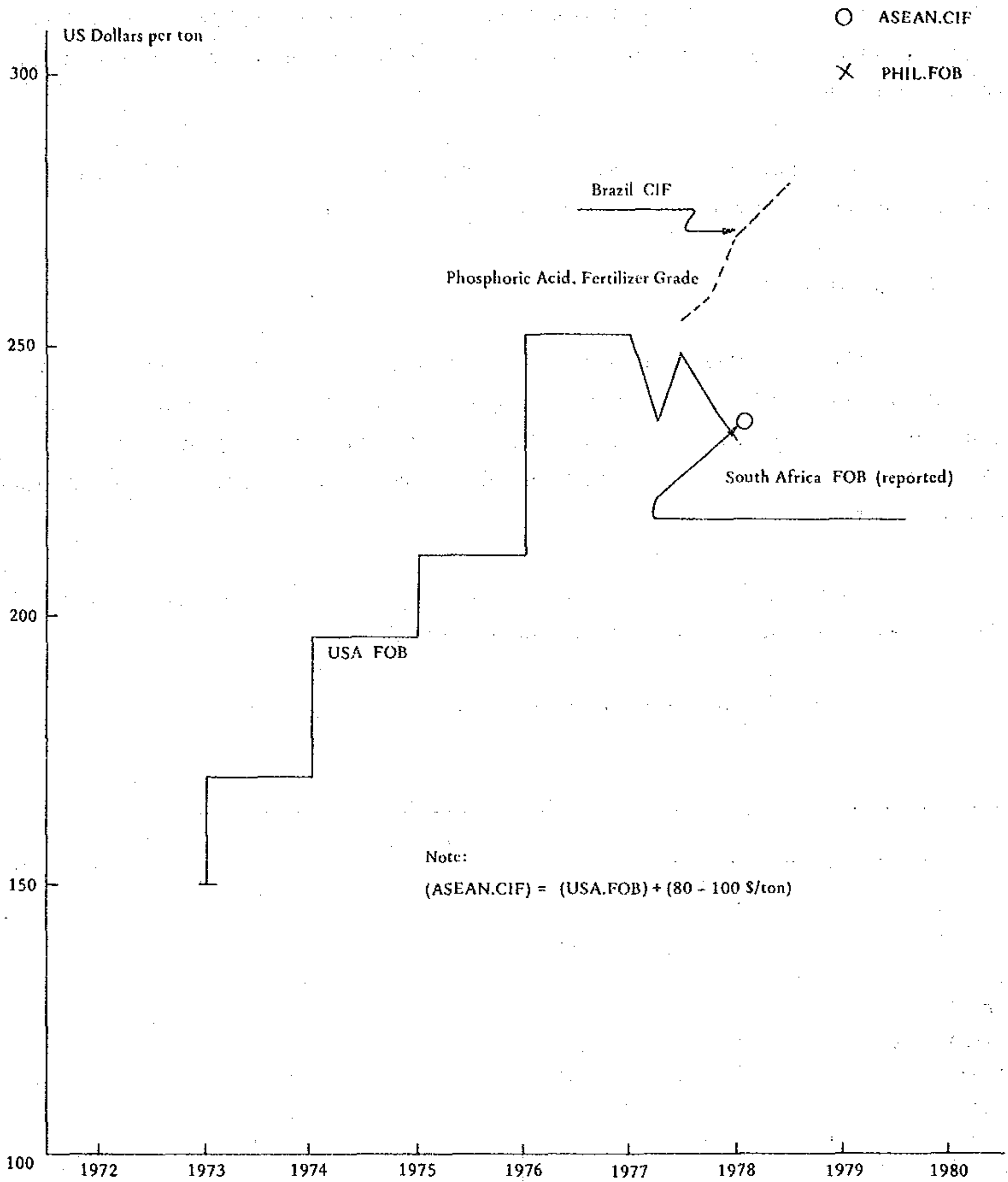
Tunisia, just has started her production in 1972, has added another plant of 132 thousand tons per annum in 1974, doubling up her exporting power.

Table III-6 World Phosphoric Acid Trade - 1977

(Unit: 1,000 tons)

Destination	Exporting countries							Total
	USA	Morocco	Tunisia	Mexico	South Africa	Spain	EC	
India	162	42	17	77		6	11	320
Brazil	185				221		59	465
EC	24	125	136				172	457
Other West Europe				23		47	40	110
East Europe		14	22			30	61	127
Japan	1				26			27
Others	34	39			10	68		151
Total	405	220	175	100	257	151	343	1,657

Fig. III-5 Price Trend of Phosphoric Acid



Morocco has completed first plant in mid 1976 and commenced exporting.

The Union of South Africa has completed a plant of 540 thousand tons per annum capacity in 1976, and achieved export of 257 thousand tons in 1977. It is supposed to have exported more than 400 thousand tons in 1978.

Further, new plant construction projects in Yugoslavia and Jordan are now reported, and export-oriented plant will be constructed.

With these, the world phosphoric acid trade in 1977 is estimated to have exceeded 1,600 thousand tons. (See Table III-6)

Price of phosphoric acid is rising year by year since 1973, but FOB USA price has shown in 1977 a downward trend from severe competition. However, CIF price of Brazil, the biggest importing country of phosphoric acid in the world, was 280 US$/T in mid-1978.

Resulting from personal interviews with people concerned, CIF ASEAN price of approx. 322 US$/T from this project at the beginning of 1979 and 370 US$/T in July 1979 are assumed to be accepted. Deducting approx. 22-25 US$/T of ocean freight cost from the Philippines from these prices, FOB Philippines price of phosphoric acid would be approx. 300 US$/T, for beginning 1979 and 345 US$/T for July 1979.

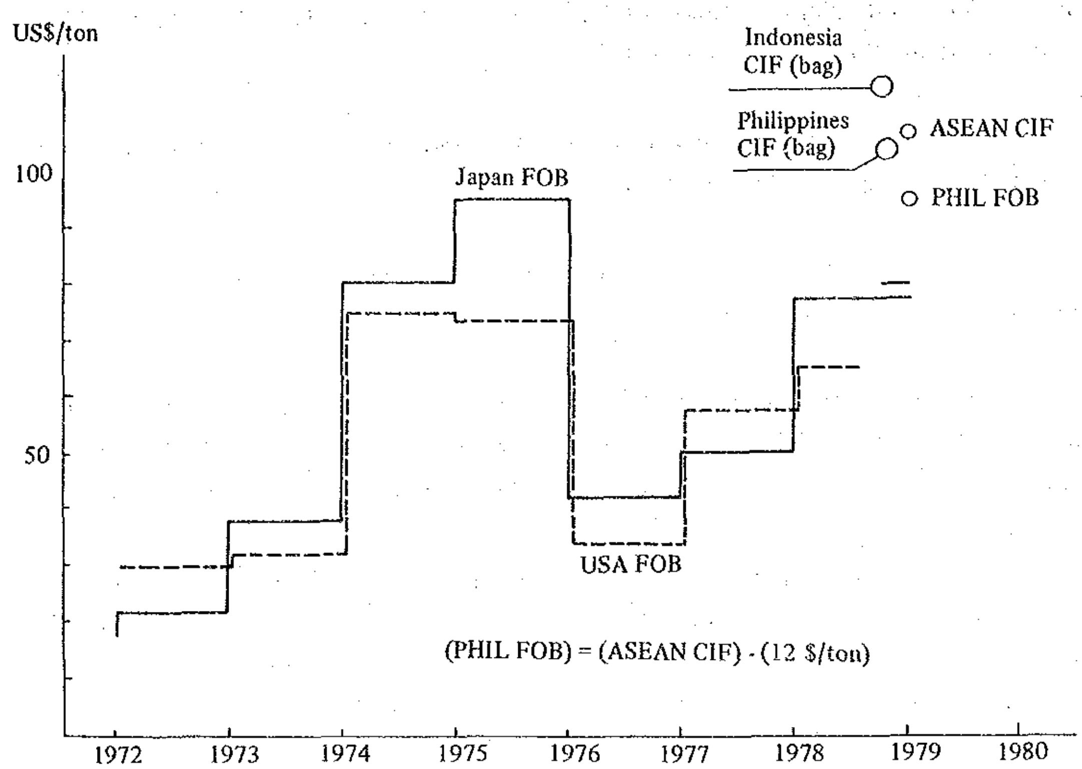
III.3 Price Trend of Ammonium Sulfate

Ammonium sulfate has high reputation as chemical fertilizer for its effectiveness to the tropical agriculture of Southeast Asia. Owing to this, it is assumed to have a steady consumption growth in the ASEAN region.

The price trend of ammonium sulfate is reviewed as shown in Fig. III-6.

The bottom price was observed in 1976 and thereafter price continued gradually going up. FOB prices in Japan, West Europe and USA has recovered up to around 75 US$/T by mid-1978. The price seems to be going up to another step, but we conservatively assumed CIF ASEAN price at the beginning of 1979 to be same with actual price of 1978. Since CIF prices in Indonesia and the Philippines in bag in 1978 were 113 US$/T and 103 US$/T, respectively, CIF ASEAN price from this project is taken to be 107 US$/T in January 1979 and 115 US$/T in July 1979 in bag in this report. From this, FOB Philippines price at the beginning of 1979 is estimated to be 95 US$/T and 100 US$/T in July 1979.

Fig. III-6 Price Trend of Ammonium Sulphate



III.4 Sulfur and Sulfuric Acid

As shown Table III-7, the world sulfuric acid consumption (production) during five years from 1972 to 1977 has kept a growth at an annual rate of about 3.5%. Among free nations in the world, many countries could not avoid a radical drop in consumption at world oil crisis. Resultantly, its growth rate remained at lower level. But there were almost no affects for communist nations, and fairly high growth was observed.

The sulfur source is broadly classified into three, i.e., elemental sulfur, pyrites and others (particularly from smelter gas).

Table III-7 World Sulfuric Acid Production

(Unit: 100% H_2SO_4 1,000 t)

	1972	1973	1974	1975	1976	1977	1972-1977 Growth Rate
Free World	75,985	81,100	85,476	76,184	78,217	84,701	2.2 %
Socialist World	24,791	27,900	30,346	32,242	34,226	34,900	7.1
World Total	100,776	109,000	115,822	108,426	112,443	119,601	3.5

SOURCE: British Sulphur Corp.

The sulfur source for each country varies, depending upon her resources available and others, but the rate of elemental sulfur source is as large as about 53 per cent as worldwide average of 1976.

The consumption is broadly categorized into two groups, i.e., one for fertilizers and another for industrial uses, but its pattern varies depending upon countries.

The sulfuric acid consumption pattern within free nations is shown in Table III-8.

Table III-8 Sulfuric Acid Consumption Pattern – 1976

	Fertilizers	Industrial use	Consumption
USA	54.8%	45.2%	32.1 million tons
Japan	30.7	69.3	6.0
France	43.7	56.3	4.0
West Germany	29.3	70.7	3.8
UK	30.4	69.6	3.6
Spain	68.4	31.6	2.9
Italy	35.7	64.3	2.8
Canada	65.0	35.0	2.5
Belgium	39.3	60.7	2.0
Average	52.8	47.2	80.3

The sulfuric acid for fertilizer manufacturing isused for manufacture of both nitrogenous and phosphate fertilizers, but its use for phosphate fertilizers is prevailing in any countries.

Sulfuric acid is not taken into the world trading as large merchandize from its nature. So the trading volume is not large and unstable.

There has been exported in 1976 no more than 3% or less within free world. And further, approx. 75% of total trade has been within the European countries.

In the communist world, both USSR and Poland occupy exporting position. USSR product is just limited to export within COMECON, mainly to Czechoslovakia, while Poland product is deemed to be exported even into the free world.

The exporting price often shows fluctuation likely in the marketing commodities, corresponding to supply-demand balance of the time of trade.

It is assumed that the growth of sulfuric acid consumption depends greatly upon the increase of phosphate fertilizers production and the demand increase for industrial use both in the communit world and in the developing countries.

It is estiamted among relevant industries that the world consumption will increase at an annual average of 6.8% up to 1980, and at an annual average of 4.6% during 1980 - 1985.

The world sulfur trade has continued downward trend, after it has hit a peak in 1974, but turned to recovering tone since 1976, and reached in 1977 to 11,800 thousand tons which exceeds 1974 level by about 600 thousand tons. Among the top five biggest exporting countries, dull tone is still continued in both USA and Mexico, while exports from Poland, Canada and France have increased, particularly export from Poland has remarkably been extended.

As shown in Table III-9, the export from Canada and Poland occupies approx. 74% of total world trade. Fig. III-7 shows the price trend of sulfur.

The world sulfur supply anddemand is rather in tight tone, even though increase in supply is anticipated, and the world market condition is running at bull feeling. This is chiefly attributable to the fact that the adjustment of freezed stockpiles in Canada, the biggest exporting country in the world, is ill and unstable.

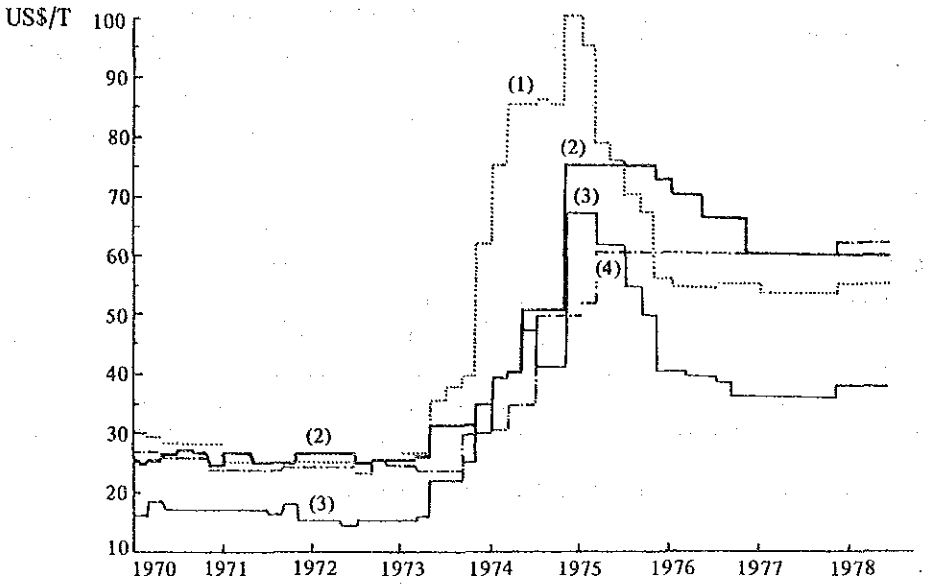
Such an ill and unstable sulfur market condition naturally affect the phosphoric acid industry. Sulfur and its relevance would become one of major factors in setting up phosphoric acid industry.

Table III-9 World Sulfur Trade

Destination	Exporting Countries *				
	USA	Mexico	Canada	France	Poland
West Europe	824	144	727	755	1,799
USA		836	1,150		
Latin America	107	51	517		113
Africa			616	211	564
Oceania	27		609		
East Europe		17	262		1,708
Asia		20	562		85
Total	976	1,068	4,443	966	4,269

* Other exporting countries are USSR, Japan, Iran, Iraq and so on.

Fig. III-7 Price Trend of Sulfur



(Source) British Sulfur Corp. etc.

(1) CIF ASEAN (Flake)

(2) CIF Northeast Europe (Liquid-Terminal base)

(3) FOB Vancouver (Flake)

(4) FOB Gulf (Liquid)

CHAPTER IV

MARKET OF PHOSPHATE FERTILIZERS AND AMMONIUM SULFATE BY ASEAN COUNTRIES

IV. MARKET OF PHOSPHATE FERTILIZERS AND AMMONIUM SULFATE BY ASEAN COUNTRIES

IV.1 Philippines

1. Agricultural Characteristics in the Philippines

Crop area harvested, agricultural production and value of agricultural production in the Philippines by each kind of crops, over a period from 1968 to 1977, are shown in Annex, Tables IV - 1, 2 and 3, respectively.

Through these tables, it can be said that palay (rough rice), corn and coconut are three top ranked crops in terms of crop area harvested, but palay is far exceeding in terms of volume and keeping a stable top rank in terms of value, followed by sugar and coconut, though they show fluctuation depending upon market conditions. With all these, it may be a proper saying that one can understand the agriculture in the Philippines by studying the situation of rice-crop.

As the irrigation system in the Philippines is developed, rice-crop area available for two or three crops a year is greatly expanded, and thus, a current situation allows even some export of rice. However, the Government of the Philippines is strongly promoting a program of rice production increase, named Masagana 99, aiming at the completion of irrigation system now under way, from the reasons that her population growth rate is as high as 3.4%/Y and the rice yield may fluctuate depending on weather conditions and others.

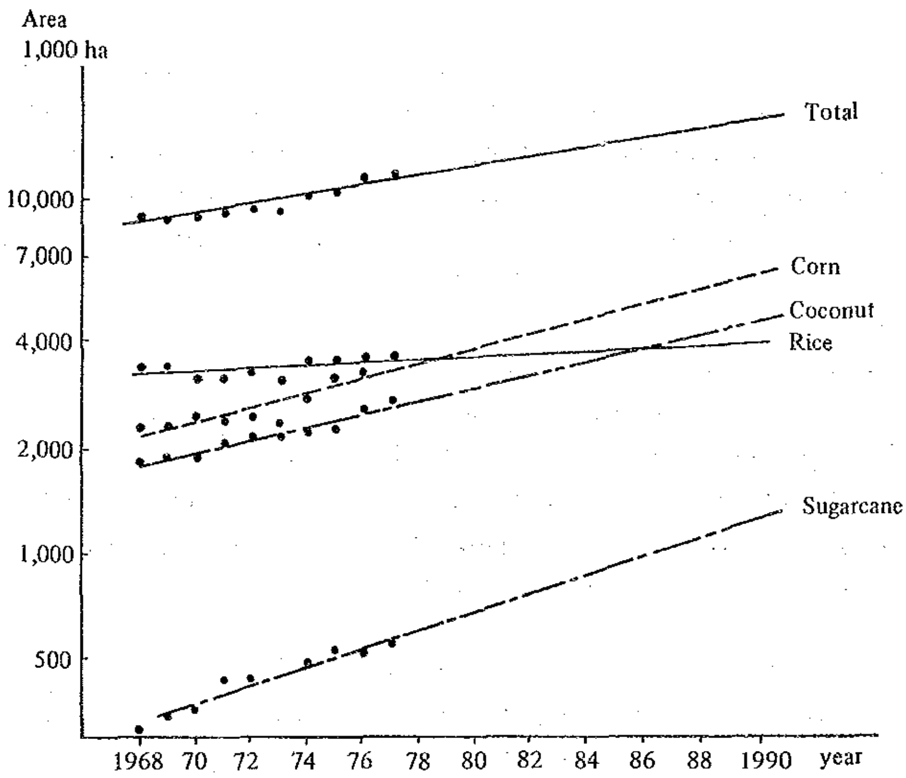
As shown in Fig. IV-1, the growth rate of rice-crop area is steadily increasing, though it is not so large as that of other-crop area, and it is certain that fertilizer demand increase is expected in higher rate than area increase rate.

Among other crops shown in Fig. IV-1, corn consumption has such a various pattern as supplemental crop in case of rice shortage, use for feed and others, and it is not easy to clearly foresee its future. However, corn is possibly deemed to be of a little importance in terms of fertilizer consumption.

Since coconut is exported primarily as copra and one of the most important foreign revenue sources, its crop area will never decrease. But it is rarely fertilized in practice in spite of the government's recommendation for fertilization.

Sugar has less crop area but has large value of production as important export goods. However, it strongly receives the effect of market conditions, and crop area and fertilizer consumption apt to sharply decreased when the market declines. Its fertilizer consumption is also relatively low, as compared with that for rice-crop, so that it seems to affect a little to the fertilizer consumption forecast.

Fig. IV-1 Crop Area, Philippines (Harvested)



2. Current Consumption Pattern of Phosphate Fertilizers in the Philippines

Fertilizer consumption in the Philippines over a period of 1973 and 1977 is shown in Tables IV-1 and 2, below.

Table IV-1 Fertilizer Consumption in the Philippines
(Source: FPA) 1973 - 1977

(1,000 tons of fertilizer products)

	1973	1974	1975	1976	1977
Urea	153	212	144	175	229
Ammosul	210	191	167	185	178
P	4	6	5	7	4
NP	125	125	101	109	102
NPK	116	137	102	108	124
Potash	68	68	59	60	49
Total	677	738	578	644	687

Table IV-2 Fertilizer Consumption in the Philippines
(Source: FPA) 1973 - 1977

(1,000 tons of fertilizer products)

	1973	1974	1975	1976	1977
N	152	177	133	153	174
P_2O_5	51	48	39	38	40
K_2O	5	60	50	51	46
Total	259	285	221	242	261

"P" in these tables means single element phosphate fertilizer. They are single superphosphate and direct application of phosphate rock, and amount as P_2O_5 is rather small. Phosphorus for rice-crop is given in form of NP or NPK fertilizers. NP fertilizer in these tables is mainly 16-20-0 complex fertilizer, and NPK is mainly 14-14-14 with a little amount of 12-12-12.

Further, ammonium sulfate in 1976 and 1977 includes calcium nitrate and ammonium chloride, each quantity of which are 13 and 2 (1,000 tons), and 3 and 11 (1,000 tons), per respective year.

From the table, ammonium sulfate consumption seems to be declining a little. This will be attributable to the trend of shifting to urea, if the price for ammonium sulfate goes up. However, a certain level of ammonium sulfate consumption will be kept in the future, because there is no chance of its complete replacement with urea, even if the price of N in urea is cheaper than N in ammonium sulfate, owing to the fact that effectiveness for crops of "S" element included in ammonium sulfate is apparently and widely recognized.

Further, it is observed in these tables that total fertilizer consumption varies up and down very much. It will be attributable to the fact that farmers' purchasing power declines, when fertilizer prices go up, or at subsequent year of poor yielding.

Consequently, should fertilizer supply depend hereafter largely upon import and should the free world market conditions affect upon the domestic fertilizer prices, such consumption fluctuation may be unavoidable.

On the other hand, fertilization consumption volume per unit crop area is 3.4 kg-P_2O_5/ha. This is calculated by dividing 40,000 tons of P_2O_5 consumption by 11,788 thousand ha of total crop area harvested in 1977. Generally speaking, recommended quantity of fertilization per unit area is subject to nature of land and kind of crops, but examples of recommended rates of fertilization by kind of crops are shown in Table IV-3, below.

Table IV-3 Recommended Rates of Fertilization by Kind of Crops

(kg/hectare)

	N	P_2O_5	K_2O
Palay (rough rice)	60	0-30	0
Corn	56	20	12
Vegetables	90	30	30
Onions	117	15	10
Potato (Irish)	30	30	60
Sugarcane (Centrifugal)	120	72	213
Sugarcane (Others)	80	48	155
Bananas	160	62	125
Pineapple	99	26	21
Coconut	90	26	107
Tobacco	34	14	17

(Source: Fertilizer Industry Authority)

Through this table, the figure of 3.4 kg-P_2O_5/ha is obviously found very small. This means that in the Philippines quite large part of crop area harvested is not fertilized yet, as seen in an example of coconut. As the proportion of exporting crops are rather high, a forecast of fertilizer consumption may be difficult, however the possibility of fertilizer consumption increase seems to exist depending upon the market conditions of products.

3. Fertilizer Manufacturers in the Philippines

There are two major manufacturers of phosphate fertilizers and ammonium sulfate in the Philippines, current status of which are described as follows:

1) Planters Products Inc.

The design capacity and maximum operable capacity with current equipment and facilities of Limay factory are shown as follows:

	Design Capacity	Maximum Operable Capacity
Ammonia	100,000 T/Y	80,000 T/Y
Urea	67,500	55,000
Sulfuric acid	224,400	170,000
Phosphoric acid	63,000	50,000
NP/NPK Fertilizers	294,000	220,000

2) Atlas Fertilizer Corp.

The design capacity and actual annual average production of their Toledo factory over a period of 1972 - 1976 are outlined as follows:

	Design Capacity	Actual Production (Annual average)
Sulfuric acid	75,000 T/Y	42 - 74,000 T/Y
Phosphoric acid	7,500	Ca - 5,000
Single superphosphate	100,000	4 - 5,000
NP/NPK Fertilizers	60 - 90,000	30 - 45,000
Ammonium sulfate	75,000	50 - 86,000

3) Other Manufacturers

Marina Cristina and Chemphil can be described as other manufactures in this line.

Marina Cristina has an ammonium sulfate manufactuirng plant, with which 40,000 T/Y production has once been recorded, but it seems that they are no longer producing.

Chemphil has also an ammonium sulfate manufacturing plant, but the company has kept its operation stopping for these years and it seems that they will no longer restart it.

4. **Fertilizer Supply-Demand Balance**

Table IV-4 is "Fertilizer Supply-Demand Estimate", officially issued by the Government of the Philippines.

It is decided to use all the figures in this table in this feasibility study in relation to Philippines' future consumption of fertilizers, as per request from the Government of the Philippines.

If the mission is allowed to state comments on these estimates, they are:

Firstly, for supply (production), the sum of NP/NPK fertilizers is read from the table to be 310,000 T/Y at maximum production time. In accordance with the data previously given in para. IV-1, subpara. 3, this figure almost accords with the one when both Planters and Atlas perform their full production, thereby so far it falls in a tolerable range, but no allowances at all. Regarding ammonium sulfate, the estimate can not be met, unless Maria Christina makes a fair volume of production.

Secondly, for consumption, please refer to Fig. IV-2, below.

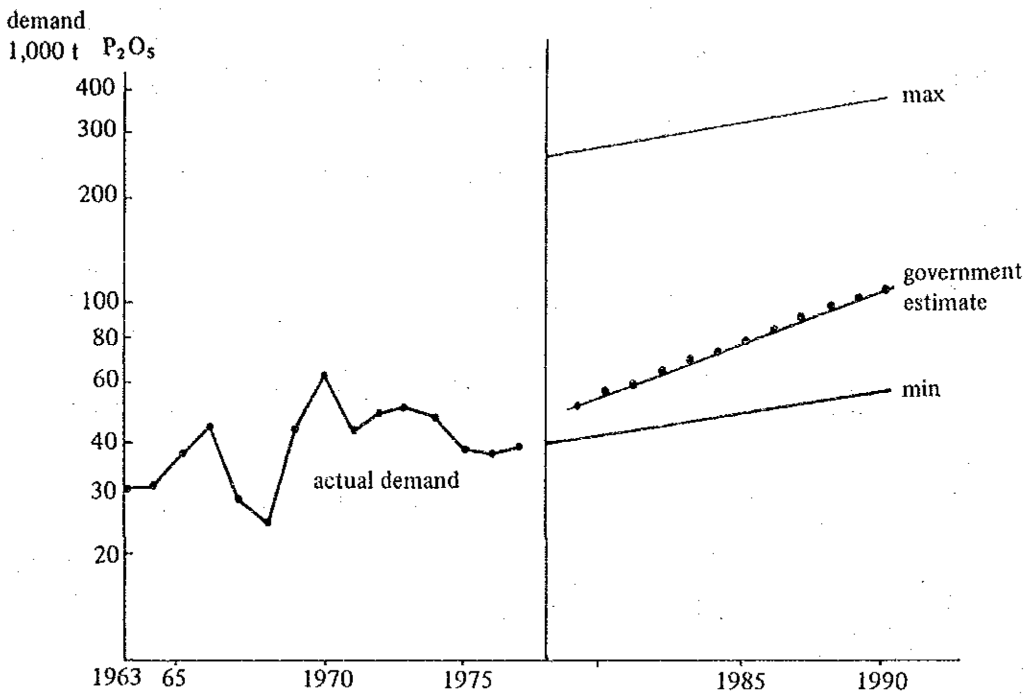
This figure shows the past actual consumption of P_2O_5 in the Philippines, and estimated consumption given in Table IV-4, converted into P_2O_5 equivalent and summed up. Max. and Min. lines on the figure reflect the calculation results of multiplying the sum of crop area estimated from Fig. IV-1 by average of recommended rates of fertilization as shown in Table IV-3 and actual fertilization average rate (3.4 kg/ha). This is based on the idea that the

Table IV-4 Fertilizer Supply-Demand Estimates, Philippines (in 1,000 MT of products) 1979 - 1990

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY/PRODUCTION												
UREA	25	30	35	40	40	40	2780	304	337	337	337	337
AMSUL	78	85	90	180**	180	180	180	180	180	180	180	180
AMCHLOR	-	-	-	-	-	-	-	-	-	-	-	-
P	2.5	2.5	3	3	3	3	3	3	2	2	2	2
18-46-0	-	-	-	-	-	-	-	-	-	-	-	-
16-20-0	109	120	129.5	138.5	147.5	157	167.5	177.5	188	199	210.5	223.5
14-14-14	146	140	150.5	146.5	140	133	127.5	117.5	107	96	84.5	71.5
12-12-12	10	11	12	13	13.5	14	15	15	15	15	15	15
MOP	-	-	-	-	-	-	-	-	-	-	-	-
DEMAND												
UREA	317	349	384	422	490	546	611	656	705	758	815	878
AMSUL	170	179	187	197	207	217	228	239	251	264	277	291
AMCHLOR	17	19	21	23	25	27	30	33	36	40	44	48
P	2.5	2.5	3	3	3	3	3	3	2	2	2	2
18-46-0	19	20	22	23	25	27	29	31	33	35	37	40
16-20-0	110	118	125	134	146	156	167	179	191	203	217	231
14-14-14	138	158	164	177	190	202	217	232	250	268	286	307
12-12-12	16	18.5	20	22	24	26	27	28	30	31	32	32.5
MOP	58	61	64	67	70	74	78	82	86	90	94	99
BALANCE												
UREA	(292)	(319)	(349)	(382)	(450)	(506)	(333)	(352)	(368)	(421)	(478)	(541
AMSUL	(92)	(94)	(97)	(17)	(27)	(37)	(48)	(59)	(71)	(84)	(97)	(111)
AMCHLOR	(17)	(19)	(21)	(23)	(25)	(27)	(30)	(33)	(36)	(40)	(44)	(48)
P	-	-	-	-	-	-	-	-	-	-	-	-
18-46-0	(19)	(20)	(22)	(23)	(25)	(27)	(29)	(31)	(33)	(35)	(37)	(40)
16-20-0	(1)	2	4.5	4.5	1.5	1	0.5	(1.5)	(3)	(4)	(8.5)	(7.5)
14-14-14	8	(13)	(13.5)	(30.5)	(50)	(69)	(89.5)	(114.5)	(148)	(172)	(201.5)	(235.5)
12-12-12	(6)	(7	(8)	(9)	(10.5)	(12)	(12)	(13)	(15)	(18)	(17)	(17.5)
MOP	(58)	(61)	(64)	(67)	(70)	(74)	(78)	(82)	(86)	(90)	(94)	(99)

* Starting 1983, includes demand of 40,000 MT for industrial use.
** Includes planned expansion of Atlas Fertilizer Corporation's ammosul unit to 150,000 MT/annum.

Fig. IV-2 Phosphate Fertilizer Demand Philippines (P_2O_5 basis)



fertilizer consumption is minimized, when the current rate of fertilization per unit area is kept in future, while it is maximized, when the recommended rate is applied.

For averaging the recommended rates of fertilization as shown in Table IV-3, Palay, Corn, Coconut and Sugarcane have been selected as major crops, and those rates are averaged considering the ratio of crop area harvested for each, resulting in 22.8 kg-P_2O_5/ha. This figure is applied in calculating Max. line.

Through Fig. IV-2, a comment is made that all estimates made by the Government of Philippines could be attainable, as its line is far below than maximum line, while its growth rate seems slightly too large, as compared with that of actual line. However, they seems so far agreeable and reasonable.

Lastly, supply-demand balance is concluded to be reasonable, as both supply and demand are estimated at a little bit higher level.

5. Price

Regarding the prices of fertilizers in the Philippines, ex-warehouse prices are fixed as the officially authorized prices by grades and by districts. Prices for major grades at Pasig of Luzon area are exampled as follows:

Table IV-5 Fertilizer Price, Philippines

	Ex-Warehouse price		Imported price (End 1978)
	Pesos/kg	US$/kg	US$/kg
Amsul	936	128.2	103
16-20-0	1,304	178.6	145 (C & F Thailand)
DAP	2,667	365	204
12-12-12	1,034	141.6	167
14-14-14	1,204	164.9	170
15-15-15	1,085	148.6	185 (C & F Europe)

Converted figures at an exchange rate of 7.3 Pesos/US$ are marked in the second column of the table, and example of end 1978 imported prices C & F Philippines in the third just for your reference.

Supposing that such goods are unloaded at Limay, about 15 Pesos/T of barge charge and about 8 Pesos/T of handling charge, totaling in about 23 Pesos/T equal to 3.2 US$/T, are to be added on C & F prices to make ex-warehouse prices at Limay. These prices should theoretically be comparable with those in the second column of Table IV-5.

IV.2 Indonesia

1. Agriculture in Indonesia

Agriculture in Indonesia can broadly be divided into two, i.e. food crops sector and estate crops sector.

Food crops sector includes paddy, maize, cassava, sweet potatoes, peanuts, soybeans, and so on, while among estate crops sector includes export oriented crops of rubber, coconut, coffee, oil palm, tobacco, sugarcane, tea, cloves, peppers and others. Their production volume and crop area are all tabulated in Table IV-6, below.

Table IV-6 Major Crops Harvested Area and Production

	Average 1/		1974		1975		1976	
	Area (x 1000 Ha)	Production (x 1000 tons)	Area	Production	Area	Production	Area	Production
Paddy	8,096	25,732	8,509	29,376	8,495	29,201	8,364	30,211
Maize	2,719	2,734	2,667	3,011	2,444	2,902	2,064	2,512
Cassava	1,430	10,731	1,509	13,030	1,410	12,545	1,356	12,467
Sweet Potatoes	360	2,220	330	2,469	311	2,432	300	2,418
Peanuts	380	281	411	307	475	380	411	332
Soybeans	721	492	768	589	752	590	636	482
Rubber	2,302	811	2,308	822	2,296	793	...	...
Coconut	1,932	1,276	2,108	1,444	2,204	1,505	...	...
Coffee	394	171	384	159	403	172	...	...
Oil Palm	146	329	164	423	171	495	...	...
Tobacco	161	85	171	79	166	81	...	...
Sugarcane	154	1,060	179	1,272	192	1,253	...	...
Tea	98	63	95	64	95	70	...	...
Cloves	117	18	172	15	116	15	...	...
Pepper	48	29	49	28	51	23	...	...

Source: Food Crops: Agricultural Statistics: Production of Food Crops in Indonesia 1976, Jakarta (Central Bureau of Statistics 1977).
Estate crops: Statistical Pocket-book Indonesia 1976

Note 1/ Food crops: 1969 - 1973.
Estate Crops: 1971 - 1973.

Most of food crops are produced by a number of small farmers, while estate crops are produced in large and small, so-called, estates.

Major food in Indonesia is rice, and both maize and cassava are consumed to supplement rice shortage. As seen in Table IV-6 rice production is not increasing since 1974, and its shortage is becoming a serious problem. Because of this, Indonesia must have imported more than one to one and a half million tons of rice every year since 1973.

To cope with such situation, the Government of Indonesia has always put top priority on maneuvering food production increase. Especially, she has determined food production increase to be the most important item in her 5-year National Development Program commencing at 1969, and is now promoting BIMAS/INMAS Programs.

The content of BIMAS/INMAS Programs is to promote food production increase by (1) recommendation of improved plant varieties, (2) strong development work of fertilizers and pesticides, (3) financial help for farmers, and (4) others.

Another way of increasing food producton is exploitation and development of arable land. Generally speaking from Table IV-7, there exists large undeveloped area, and it is possible to develop and exploit more arable land.

Java Isalnds is, however, said that there is scarce land exploitable for farming, so that efforts are now paid to make multi-cropping possible with irrigation systems, to achieve food production increase. Nevertheless, the more irrigated area increases, the more difficult the irrigation becomes. It is, therefore, deemed that the growing rate of crop area in Java Islands cannot be so large hereafter.

Consequently, exploitation of arable land is now being driven in all other Islands than in Java, which necessitates removal of farmers into such Islands from Java. However, population removal incidentally causes a variety of difficulties, so that this plan is also not progressing remarkably.

In order to carry out the plan to increase the food production under such situations, promotion of high yielding variety (HYV) is definitely indispensable. Top priority is especially put on rice-crop, and new kinds of rice like IR5 and IR8, etc., are recommended under BIMAS/INMAS Programs.

Cultivation of high yielding variety must inevitably go together with mass consumption of fertilizers, so that the key point for food production increase is deemed to increase fertilization.

Table IV-7 Land Use in Indonesia (1973)

(x 1000 Ha)

Region	Total Area	Forest Land	Total Land in Agricultural Holdings
Java	13,218	2,891	6,183
Sumatora	47,360	28,420	5,117
Kalimantan	53,946	41,470	1,927
Sulawesi	18,921	9,910	1,651
Bali-Nusa Tonggara	7,361	2,036	1,225
Maluku	7,451	6,000	290
Iriai-goya	42,198	31,500	-
Total	190,457	122,227	16,393

Source: 1973 Agricultural Census, Agriculture: Volume I (Jakarta, Central Bureau of Statistics, 1976)

Table IV-8 Area Under HYV and Total Rice Area (1968 - 1973)

(x 1000 Ha)

	1968	1969	1970	1971	1972	1973
HYV area	18	486	772	1,072	1,433	2,300
Total rice area	8,021	8,014	8,135	8,325	7,984	8,387

Source: International Bank for Reconstruction and Development Indonesia-Appraisal of Second Fertilizer Expansion Project (Washington D.C., 1975)

2. Current Consumption Pattern of Phosphate Fertilizers in Indonesia

Use of fertilizers for food crops was almost not observed in Indonesia until 1959.

Since the Government of Indonesia has established a rice center in 1959 for the purpose of food production increase program and 3-year rice production increase program has taken place, fertilizer consumption for food crops has radically increased. Particularly, the growth rate of fertilizer consumption for food crops over these ten years has reached to annual average of nearly 20% in terms of 3-nutrients with proper efforts by the government, while its rate for estate crops was more or less 13% on the same basis. And, their use for food crops in 1977 occupies 82.8% to total consumption.

Table IV-9 Consumption of Fertilizers in Indonesia

(tons)

	Fertilizer			Nutrient		
	Food crop	Estate crop	Total	Food crop	Estate crop	Total
1968	275,613	57,332	332,945	119,894	25,386	145,280
1969	433,608	111,721	545,329	192,458	35,292	227,750
1970	439,431	150,003	589,434	197,291	50,159	247,450
1971	507,353	88,478	595,831	226,648	26,718	253,366
1972	558,251	290,970	849,221	251,373	76,671	328,044
1973	832,096	122,821	954,917	379,205	38,257	417,462
1974	875,418	186,668	1,060,086	393,319	36,727	430,046
1975	920,551	206,122	1,126,673	422,555	62,171	484,726
1976	914,085	229,550	1,143,635	415,590	69,995	485,585
1977	1,211,306	251,672	1,462,978	557,844	77,272	635,116

Source: 1. 1968-1970: National Fertilizer Study Indonesia (1972).
2. 1971-1977: Directorate General of Agriculture, B.P. BIMAS, Directorate General of Estates.

Further, as seen through Tables IV-10 and 11, fertilizer consumption by farmers under BIMAS Program occupies 85% of total consumption, irrespective of the fact that only 35% of total paddy area and 6.5% of total secondary crops area are covered under the BIMAS program.

Reversely, this means that 65% of total food crops area is fertilized only a little or not at all.

Table IV-10 Food Crop Area Covered by BIMAS Production Loans Bank Rakyat Indonesia (BRI) (1975/1976)

(thousand ha)

	Total Harvest Area 1/	Area covered by BIMAS Credit 2/	As % of total
Paddy	8,495.1	2,994.4	35.2
Secondary food crops	5,392.0	349.8	6.5
Total	13,887.1	3,344.2	24.1

Source: 1/ Central Burau of Statistics
2/ BRI, 23 June 1977

Note: Total harvested area under secondary food crops includes maize, cassava, sweet potatoes, peanuts and soybeans.

Table IV-11 Fertilizer Use in Food Crop Sector

(tons)

Total Fertilizer Use	Fertilizer use under BIMAS	As % of total
914,085	781,897	85.5

Source: B.P. BIMAS

As seen in Table IV-12, phosphate fertilizer consumption for food crops has remarkably increased since the enforcement of second 5-year National Development Program (1973 - 1978). As neither total harvest area nor area under BIMAS program has increased during this period, fertilizer consumption increase is deemed due to adoption of high yielding variety of paddy.

With Table IV-13, phosphate fertilizer consumption ratio for each grade during 1973 - 1977 was computed and the result is shown in Table IV-14.

In terms of total consumed fertilizers, TSP occupies approx. 72%, and NPK, NP and phosphate rocks follows in this order. TSP also occupies approx. 85% in food crops sector. For estate crops use, phosphate rocks and NPK occupy respectively, approx. 40%, and follow NP and TSP in this order, showing clear contrast against those in food crops.

Anyhow, it is a special feature in Indonesia that big amount of TSP is used as P_2O_5 source following the guidance of the government.

Table IV-12 Consumption of P_2O_5 Nutrient

(tons)

	Total P_2O_5 Use	P_2O_5 use for Food Crops	As % of Total	P_2O_5 use for Estate Crops	As % of Total
1967	8,451	5,412	64.0	3,039	36.0
1968	32,463	24,356	75.0	8,107	25.0
1969	42,775	36,264	84.8	6,511	15.2
1970	45,395	31,618	69.7	13,777	30.3
1971	34,949	29,649	84.8	5,300	15.2
1972	33,234	21,393	64.4	11,841	35.6
1973	71,538	65,292	91.3	6,246	8.7
1974	104,285	95,720	91.8	8,565	8.2
1975	119,681	110,216	92.1	9,465	7.9
1976	111,012	99,267	89.4	11,745	10.6
1977	113,023	104,727	92.6	8,296	7.4

Source: 1. 1967-1970: National Fertilizer Study Indonesia (1972)
2. 1971-1977: Directorate General of Agriculture B.P. BIMAS, Directorate General of Estates.

Table IV-13 Consumption of Phosphate Fertilizers

(tons)

	Food crops sector 1/					
	TSP	ROCK	NP	NPK	Others	Total
1967	8,283	-	2,825	1,509	8,230	20,847
1968	49,645	-	3,783	2,107	12,497	68,032
1969	51,746	-	5,985	3,735	3,621	65,087
1970	58,394	27	16,636	7,884	1,387	84,328
1971	55,563	-	11,000	11,102	847	78,512
1972	38,007	-	9,500	13,111	131	60,749
1973	134,467	-	15,349	5,834	41	155,691
1974	193,335	-	11,150	30,375	-	234,860
1975	232,713	-	10,846	6,767	36	250,326
1976	207,389	-	5,785	18,062	138	231,374
1977	189,617	1,000	48,425	8,445	1,220	248,707

Table IV-13 continued

Estate crop sector

1967	50	3,040	-	17,230	-	20,320
1968	5,000	7,000	-	31,207	-	43,207
1969	3,607	838	-	29,871	-	34,316
1970	12,126	8,808	-	39,454	-	60,388
1971	4,074	2,002	6,859	14,133	-	27,068
1972	925	25,115	6,638	25,955	-	58,633
1973	3,164	2,804	10,764	11,241	-	27,973
1974	-	28,168	6,960	16,965	-	52,093
1975	2,121	19,104	2,617	28,193	-	52,035
1976	3,619	15,333	11,778	25,398	-	56,128
1977	80	16,977	6,500	17,351	-	40,908

Source: 1967-1970: National Fertilizer Study Indonesia (1972)
1/ 1971-1977: Directorate General of Agriculture B.P. BIMAS, Directorate General of Estates.

Note: TSP includes SSP and DSP, NP includes DAP.

Table IV-14 Percentage of Average Consumed Fertilizer from 1973 to 1977

(%)

	TSP	ROCK	NP	NPK	Others	Total
Food crop sector	99.1	1.2	70.3	41.8	100	83.2
Estate crop sector	2.1	98.8	29.7	58.2	0	16.8
Total	100	100	100	100	100	100
Food crop sector	85.4	0.1	8.2	6.2	0.1	100
Estate crop sector	4.0	36.3	17.1	47.6	0	100
Total	71.7	6.2	9.7	12.3	0.1	100

Source: Calculated as based on Table-IV-13

3. **Current Supply Status of Phosphate Fertilizers in Indonesia**

Table IV-15 Total Supply of P_2O_5, Indonesia (tons)

	Imported		Domestic	Total
	Food crop	Estate crop		
1967	11,180	3,039	546	14,765
1968	46,209	8,107	376	54,692
1969	55,223	6,511	850	62,584
1970	4,223	13,777	302	18,302
1971	5,667	5,300	44	11,011
1972	20,690	11,841	234	32,765
1973	91,430	6,246	309	97,985
1974	149,747	34,529	1,225	185,501
1975	290,704	9,974	1,570	302,248
1976	315	10,485	1,209	12,009
1977	40,813	8,296	-	49,109

Source: 1967-1970: National Fertilizer Study Indonesia (1972)
1971-1977: Directorate General of Agriculture, B.P. BIMAS, Directorate General of Estates.

The first phosphate fertilizer manufacturing plant is now under construction aiming at the start-up in April, 1979 by Petrokimia Gresik at Slavaya of Java Islands with its capacity of 330,000 T/Y TSP, 50,000 T/Y NPK and 80,000 T/Y DAP.

Phosphoric acid and phosphate rock used in this plant as raw material are all imported, and P_2O_5 imported in a form of phosphoric acid is deemed to count approx. 150 thousand tons per annum.

Further, TSP plant of CELACAP with the capacity of 400,000 T/Y is said to be a concrete project and its start-up is scheduled in 1982, and it is confirmed at the COIME expert meeting of September 1979 that 260,000 T/Y of NPK will be produced in Indonesia from that time.

As for tertilizer prices, consumer prices are fixed by the government for Urea, TSP, DAP and NPK (15-15-15). On the other hand, ex-importer or ex-factory prices are likely fixed as well as retail prices, so that it is well said that distribution cost and commissions are controlled with this policy. All the differences incurred between ex-importer prices and actual import prices, or between ex-factory prices and actual manufacturing costs, are subsidized by the government to importers or manufacturers.

Table IV-16 Projections on Domestic Phosphate Fertilizers Production, 1979 - 1985

(x 1000 tons)

Product / Plant	Design Capacity	1979	1980	1981	1982	1983	1984	1985
1) TSP								
Petrokimia Gresik	330	173	243	260	289	297	297	297
Celacap	400	-	-	-	280	300	320	360
Total	730	173	243	260	569	597	617	657
2) DAP								
Petrokimia Gresik	80	42	59	63	70	72	72	72
3) NPK								
Petrokimia Gresik	50	26	37	39	260	260	260	260

Source: The National Fertilizer and Pesticide Distribution Study, Indonesia (1976).

Note: Assuming maximum of 90% out put of plant design capacity.

Table IV-17 Retail Price of Fertilizers

(Rp/kg) (Ex US$ 1/RP 415)

	UREA	TSP	DAP	15-15-15
1975	60	60	60	60
1976	80	80	120	80
1977	70	70	90	70

Source: Official figures

Table IV-18 Estimate Subsidies for Urea and TSP, 1978

(RP/ton)

		UREA	TSP
(1)	C&F price 1/	62,872.50	56,025.00
(2)	Distribution cost 2/	21,203.98	22,209.07
(3)	Actual cost price (1) + (2)	84,076.48	78,234.07
(4)	Retail price 2/	70,000.00	70,000.00
(5)	Subsidy (3) - (4)	14,076.48	8,234.07

Sources: 1/ Fertilizer International, No. 105 March 1978
2/ Official Figures

4. Outlook on Supply-Demand of Phosphate Fertilizers in Indonesia

The forecast of fertilizer consumption requires at least such variable factors as fertilized area, crop pattern and fertilization rate.

As seen in Table IV-6, the figures for these years show neither any big increase in crop area nor any big changes in crop pattern, so that it is well assumed that this situation may continue, unless the government otherwise takes actions with some particular leading policies.

As previously mentioned, however, food production increase to accomplish self-supply of food is an indispensable requirement from national points of view, so that propagation of high yielding variety and corresponding increase of fertilization are naturally anticipated. It is estimated that pace of such changes is heavily depend how strongly the government pushes forward its policy.

Table IV-19 shows maximum and minimum estimates of P_2O_5 consumption in the future. Maximum figures are computed by multiplying each crop area by respective recommended rate of fertilization, while, for minimum, by actual average rate of fertilization by crop. However, owing to the facts that only 1972 data is available for each crop and its subsequent increase is assumed, rate of fertilization for food crops in 1976 and for estate crops in 1975 are computed based on the data derived from Tables IV-6 and IV-9.

Table IV-19 Assumed P_2O_5 Consumption

(x 1,000 tons)

	Recommended P_2O_5 kg/ha	Maximum P_2O_5 Consumption			
		1976	1980	1985	1990
Paddy	23	195.5	199.4	203.4	207.5
Maize	46	110.4	110.4	110.4	110.4
Cassava	0	-	-	-	-
Sweet Potatoes	0	-	-	-	-
Peanuts	34.5	16.4	16.4	16.4	16.4
Soybean	23	17.3	17.3	17.3	17.3
Vegetables	60	15.4	15.4	15.4	15.4
Sub total		355.0	358.9	362.9	367.0
Rubber	28	64.4	64.4	64.4	64.4
Oil Palm	69	11.8	15.2	17.3	19.3
Sugar Cane	37	7.1	11.1	14.8	18.5
Tea	23	2.1	2.1	2.1	2.1
Tobacco	50	8.3	10.0	12.0	14.0
Sub total		93.4	102.8	110.6	118.3
Total		448.4	461.7	473.5	485.3
	Average P_2O_5 kg/ha	Minimum P_2O_5 Consumption			
Food crops	7.9	110.2	110.6	111.2	113.4
Estate crops	1.7	9.5	10.5	11.5	12.4
Total		119.7	121.1	122.7	125.8

Estimates of phosphate fertilizer consumption made by the Government of Indonesia is shown in Table IV-20.

It is said that the overall satisfaction rate of actual fertilizer consumption against projection rate of actual fertilizer consumption in the second 5-year National Development Program which has ended last year was around 50 - 60%.

Table IV-20 Projected Phosphate Fertilizers Demand

(x 1,000 tons)

	TSP	DAP	NPK (15.15.15)	P_2O_5 1/
1980	393.0	60.0	140.0	229.4
1981	464.0	64.0	155.0	266.1
1982	544.0	72.0	175.0	309.6
1983	-	-	195.0	-
1984	617.0	158.0	220.0	389.5
1985	657.0	215.0	245.0	437.9

Source: Data received from Mr. NIKO KANSIL - Ministry of Industry

Note 1/ Calculated as P_2O_5 contents are TSP 46% DAP 46% NPK 15%.

As shown in Fig. IV-3 a line plotted with figures in Table IV-20 (Line No. 4) looks to be an extrapolation of past 5-year actual consumption, but another extrapolation at 70 - 80% of such estimates (Line No. 5) looks better and closer to forecast of actual consumption. Such results are shown in Table IV-21, and plotted in Fig. IV-3 (Line No. 5).

However, in this report, all the figures in Table IV-20 and extrapolation (Line NO. 4) are used as the supply-demand forecasts of Indonesia, thinking much of the opinion of the Indonesian government.

Table IV-21 Assumed Phosphate Fertilizer Demand

(x 1,000 tons)

	TSP	DAP	NPK (15.15.15)	P_2O_5
1980	295	45	105	172
1985	462	161	184	328
1990	657	215	245	438

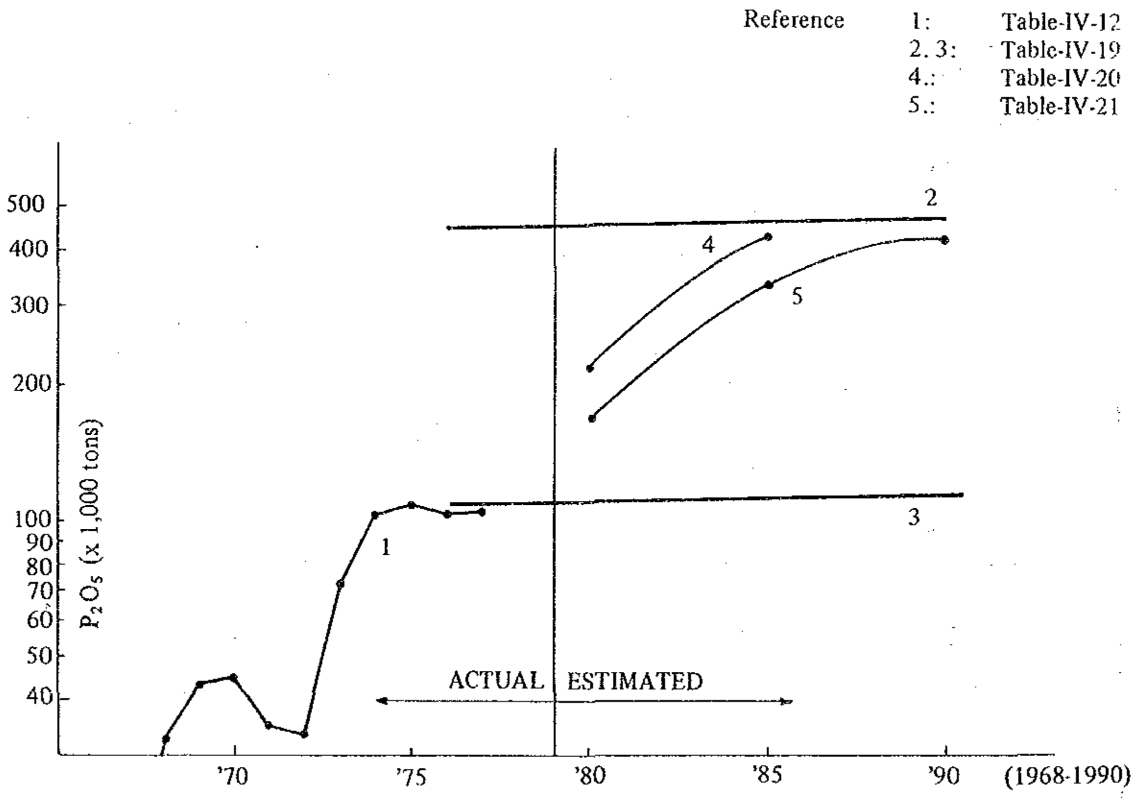
The supply-demand balance estimated based on the figures in Table IV-20 is shown in Table IV-22.

Table IV-22 Estimated Phosphate Fertilizer Demand and Production

(x 1,000 tons)

	Demand	Production	Difference
1980			
TSP	393	243	150
DAP	60	59	1
NPK	140	37	103
1985			
TSP	657	657	0
DAP	215	72	143
NPK	245	45	200
1990			
TSP	820	657	163
DAP	360	72	288
NPK	300	45	255

Fig. IV-3 P_2O_5 Demand



5. Indonesia's Position in Relation with Product-mix of This Project

When we consider the products which can be supplied to Indonesia from this project, TSP must be omitted because all TSP consumed in Indonesia is domestically produced after 1979.

Also DAP and NPK will be almost self sufficient after 1982 and the volume of products to be supplied from this project will be small.

As the raw material for such phosphate fertilizer, Indonesia is to import phosphoric acid at the beginning, but phosphoric acid itself is also planned to be domestically produced in due course.

Consumption of ammonium sulfate is estimated to be 170, 250 and 270 thousand tons in 1980, 1985 and 1990, respectively. The production of ammonium sulfate is as small as 67,000 T/Y today, but they have plans to produce caprolactam and by-produced ammonium sulfate will amount to 135, 270 and 270 thousand tons in 1980, 1985 and 1990, respectively.

All what are mentioned above show that this porject is not closely related with Indonesia in the point of exporting products.

IV.3 Malaysia

1. Agricultural Characteristics of Malaysia

Malaysia's agriculture is featured by estate crops represented by rubber and oil palm.

Exports of rubber and palm oil in 1977 accounted 2,259 and 1,116 million Malaysian dollars, respectively, and it is widely well known that they are the major export goods of Malaysia.

As for rubber, its productivity per unit area has increased due to replacement with high yielding variety, while the planted area has slightly decreased from 1970 to 1975. This reduced area has been transferred chiefly for oil palm area. This trend may change corresponding to the world supply and demand trend of natural rubber and oil palm, but the increase of oil palm area and arrangement of planting area between oil palm and natural rubber, together with conversion into high yielding variety may seemingly continue henceafter, in accordance with Malaysia's third 5-year program and FELDA's land development program.

For rice-crop, Malaysian government is now paying efforts to raise self-sufficing rate up to 100% from the present 90%. Improvement and development of irrigation system and propagation of two-crop a year are the major points to achieve it, and the government aims to raise the productivity per unit area with strong enforcement of these points.

The sight over the current status of Malaysia's agriculture, crop areas and production by major crops are recapitulated in Table IV-23. Additionally, estimates of future changes of crop area up to 1990 are shown in Table IV-24, based on a variety of information.

Table IV-23 Major Crops in Malaysia, 1975

Crop		Production (1,000 tons)	Planted area (1,000 hectares)		
			Mature	Immature	Total
1.	Paddy	2,499	586	-	586
2.	Rubber	2,119	1,522	574	2,096
3.	Palm oil	1,645	477	119	596
4.	Coconut	1,170	258	64	322
5.	Sugar cane	2,117	20	-	20
6.	Fruits	822	57	14	71
7.	Vegetables	575	34	-	34
8.	Pineapples	539	20	-	20
9.	Others	825	87	12	99
10.	Total	12,311	3,061	783	3,844

(Source) ESCAP

As shown in Table 23, rice-crop area is 586 thousand hectares, of which 337 thousand hectares is irrigated. As two-crops a year is possible in this area, total harvesting area is reported to be 835 thousand hectares.

And the item "others" includes tapioca, cocoa, tobacco, pepper, maize, groundnut, coffee, sweet potato, spices, tea, and so on.

The crop area data for 1980 shown in Table IV-24 is the figures published by ESCAP based on informal information of the government, and data for 1985 and 1990 are estimated from governmental programs and other information.

Table IV-24 Actual and Assumed Planted Area by Crops

Crops	Planted area (100 ha)			
	1975	1980	1985	1990
Rubber	2,096	2,203	2,000	1,800
Oil palm	596	819	1,000	1,200
Paddy	586	606	626	642
Coconut	322	351	380	410
Vegetables	34	39	45	50
Fruits	71	81	85	90
Others	132	198	225	250
Total	3,850	4,297	4,361	5,442

2. Current Consumption Pattern of Phosphate Fertilizers in Malaysia

A trend of phosphate fertilizer consumption in Malaysia in terms of P_2O_5 is as shown in Table IV-25.

Table IV-25 P_2O_5 Consumption in Malaysia

Year	A	B		P_2O_5/N	B_2/B_1
		B_1	B_2		
1962	34	34	25	-	0.74
1966	45	49	41	-	0.84
1967	41	45	37	-	0.82
1968	n.a	37	31	-	0.84
1969	32	35	29	0.64	0.83
1970	46	40	32	0.90	0.80
1971	43	44	37	0.81	0.84
1972	47	53	44	0.80	0.83
1973	51	59	51	0.81	0.87
1974	63	59	47	0.83	0.80
1975	66	55	-	0.83	-

(Source) A. ESCAP/Ministry of Agricutlure Malaysia 1977
B. RRDB B_1 Estd P_2O_5 Consumption
B_2 Rock Phosphate Origin P_2O_5

The annual average growth rate of consumption over a period from 1962 to 1972 was 3.3%, while the same over a period from 1966 to 1975 was 3.5%.

An annual fertilizer consumption trend by kind is shown in Table IV-26.

Table IV-26 Fertilizer Consumption in Malaysia

(Unit: 1,000 metric tons)

		1970	1971	1972	1973	1974	1975
Urea		43	40	52	72	104	104
Ammonium sulfate		40	23	25	46	72	57
Diammonium phosphate		-	2	-	-	1	1
Triple superphosphate		6	6	10	13	9	2
Compound fertilizers	NP	-	-	-	-	-	-
	NPK	40	50	55	63	56	21
Natural phosphates		85	100	116	135	130	119
KCℓ & others		160	194	232	282	268	54
Total		374	415	490	621	640	558

Phosphate fertilizer consumption by kind in Malaysia is featured with the direct application of phosphate rocks, namely, approx. 83% of P_2O_5 consumption relys on the direct application.

Another feature in terms of Malaysia's total fertilizer consumption pattern is, although it is not so important in this study, the fact that the consumption of muriate of potash is very high. Both features are closely related with the point that Malaysia's agricultural characteristics are the plantation of rubber and oil palm.

A phosphate fertilizer consumption pattern by crops is as in Table IV-27.

Since factors affecting upon such consumption pattern are crop area and fertilization rate by crops, both are presented in Table IV-24 and -27 respectively for your references. The level of fertilization in Malaysia is also presented in the same table in terms of ratio (B/A), the ratio of actual rate of fertilizer application and recommended rate of fertilizer application.

The ratio (B/A) for coconut is as low as 0.15, while the same for oil palm or rice is kept at a tolerable level.

Table IV-27 Consumption Pattern of Phosphate Fertilizer by Crops: P_2O_5 Equivalent

Crop	1965		1975				
	P_2O_5 1,000 tons	%	P_2O_5 1,000 tons	%	A	B	B/A
Rubber	29	65	30	45	38	15	0.38
Oil palm	7	15	12	18	26	20	0.77
Paddy	4	10	11	17	20	13	0.65
Vegetables	-	-	2	3	90	57	0.63
Coconut	-	-	1	1	20	3	0.15
Fruits	-	-	1	1	26	17	0.65
Others	4	9	10	15	-	-	-
Total	44	100	66	100	-	-	-

Note: A — Recommended rate of fertilizer application (Kg of P_2O_5/ha)
B — Actual rate of fertilizer application (Kg of P_2O_5/ha)
B/A — Ratio of B to A

3. Outlook on Future Consumption of Phosphate Fertilizers in Malaysia

Estimate of phosphate fertilizer consumption up to 1990 are basically computed, based on the forecasts for both fertilization rate by crop and crop area, as follows:

$$\begin{bmatrix}\text{Total estimate of} \\ \text{phosphate fertilizer} \\ \text{consumption at} \\ \text{objective year}\end{bmatrix} = \Sigma\left(\begin{bmatrix}\text{Phosphate fertilizer} \\ \text{application rate by} \\ \text{crops at objective} \\ \text{year}\end{bmatrix} \text{ X } \begin{bmatrix}\text{Total estimate of} \\ \text{crop area by crops} \\ \text{at objective year}\end{bmatrix}\right)$$

Should the recommended rate of fertilizer application be used in the first right term of above equation, instead of realistically most possible rate, the result is the phosphate fertilizer consumption at the level of governmentally recommended fertilizer application. This represents the maximum estimate of consumption under the possible agricultural policy (for crop area). While, should actual annual average rate of 1975 be used, the minimum estimate of consumption is resulted, under the assumption that the propagation of fertilizer application technology will advance henceafter, but never reverses.

In Table IV-28 are summarized and tabulated the computed maximum and minimum estimates of consumption by crops, and they are plotted in relation with those of projection of consumption in Fig. IV-4.

Table IV-28 Maximum and Minimum P_2O_5 Consumption in Malaysia through 1990

Crop	Maximum P_2O_5 Consumption					Minimum P_2O_5 Consumption				
	P_2O_5 kg/ha	P_2O_5 1,000 tons				P_2O_5 kg/ha	P_2O_5 1,000 tons			
		1975	1980	1985	1990		1975	1980	1985	1990
Rubber	38	77	81	73	66	15	30	31	30	27
Oil palm	26	16	22	27	32	20	12	16	20	24
Paddy	20	17	18	18	18	13	11	11	12	12
Coconut	20	1	8	8	9	2	1	1	1	1
Vegetables	90	6	7	8	9	57	1	2	3	3
Fruits	26	2	2	2	3	17	1	1	1	2
Others	-	10	12	14	16	-	10	10	11	12
Total	-	135	150	160	153	-	66	72	78	81

It is explained in the above equation that a forecast of phosphate fertilizer consumption in Malaysia depends upon estimated changes of crop area and increase of fertilizer application level in Malaysia's agriculture.

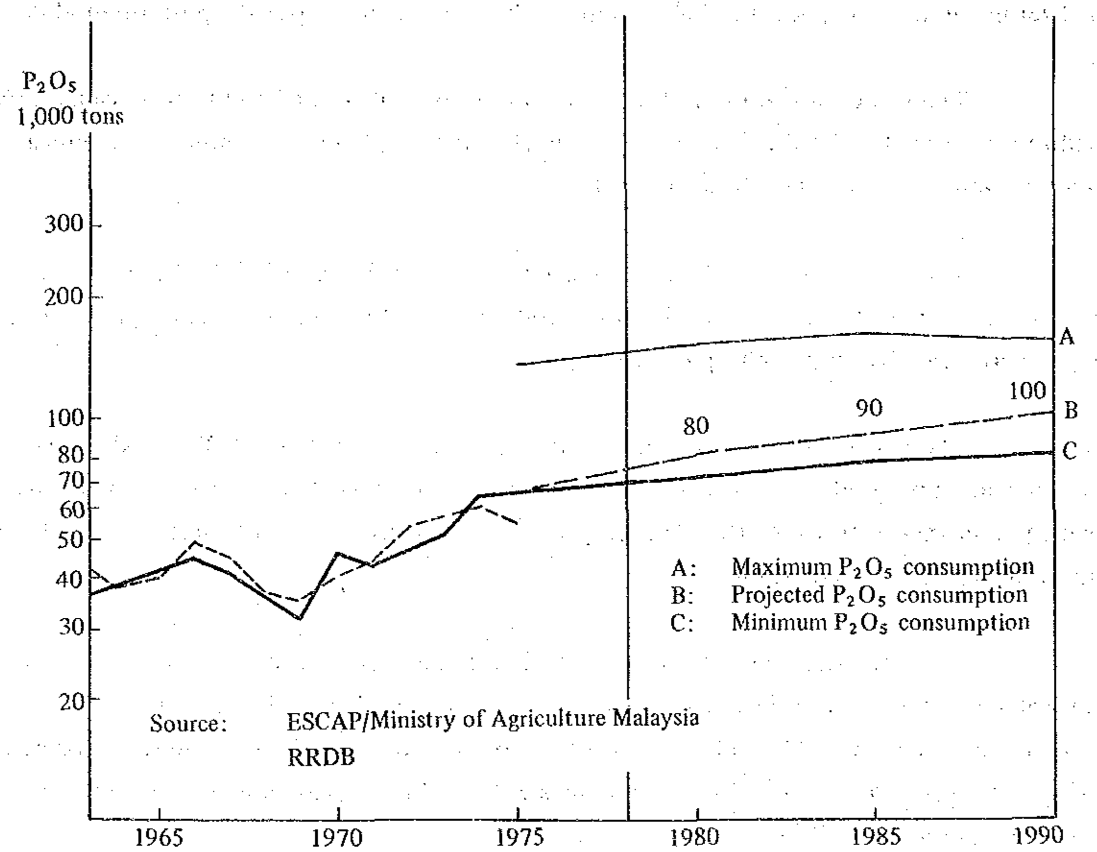
Resulted from the study made on the current status of Malaysia's agricultural movement, governmental programs and agricultural technology level, the trend of such future application rate is rather conservatively assumed in the left half of Table IV-29. Using the most possible crop area given in Table IV-24, consumptions are projected in the right half of Table IV-29.

Table IV-29 Projected P_2O_5 Consumption in Malaysia through 1990

Crop	Assumed P_2O_5 use per hectare				Projected P_2O_5 consumption			
	P_2O_5 kg/ha				P_2O_5 1,000 tons			
	1975*	1980	1985	1990	1975*	1980	1985	1990
Rubber	15	16	18	20	30	30	36	36
Oil palm	20	22	22	22	12	19	23	27
Paddy	13	14	17	18	11	13	15	16
Coconut	2	3	3	4	1	1	1	2
Vegetables	57	60	60	60	1	3	3	3
Fruits	17	-	-	-	1	2	2	3
Others	-	-	-	-	10	11	12	13
Total	-	-	-	-	60	80	90	100

* Actual data origined in ESCAP/Ministry of Agriculture Malaysia

Fig. IV-4 Projected P_2O_5 Consumption in Malaysia through 1990



Namely, phosphate fertilizer consumptions in 1980, 1985 and 1990 are projected to be 80, 90 and 100 thousand tons, respectively. This is equivalent to an annual average growth rate of 3.3% through 1990 in terms of 1976 base year, and reflects the satisfaction rate of 65% against the recommended application rate. For the reference, such satisfaction rate in 1975 was 49%.

Suppose that B_2/B_1 ratio (See Table IV-25) is to be at the range of 0.80 - 0.87, 100 thousand tons P_2O_5 counts around 13 - 20 thousand tons of phosphate fertilizer not based on phosphate rock direct applicaton. This quantity of phosphate fertilizer consumption is what discussed in this project.

With a conservative way of foreseeing the future, a little bit less figure than this is assumed in the product-mix study of this project.

4. Malaysia's Position in Relation with Product-mix Study of This Project

In determining both product items and their production volume in the phosphate fertilizer manufacturing project in the Philippines, here we discuss about the position of Malaysia.

There are groups of manufacturers in Malaysia who are producing so-called mixed fertilizers or granulated NPK fertilizers with imported phosphate rock, muriate of potash and domestic ammonium nitrate, as raw materials.

The production of mixed fertilizers in 1975 is reported to be 167,000 tons. However, to include them in this project as a product of product-mix is not appropriate, because they are produced by mixing phosphate rock.

The phosphate fertilizers discussed in this project are DAP, TSP and NPK fertilizers and they are imported into Malaysia. Among them, both DAP and TSP are very small in quantity, and their future growth in consumption is not foreseen. For NPK fertilizers, Malaysia's import in 1976 was 66,868 tons.

As conclusion, NPK fertilizers which will be imported into Malaysia can be taken into account under this project, and their potential market size is assumed to be 80, 85, 90 thousand tons in 1980, 1985 and 1990, respectively. For conservative estimates, supposing that P_2O_5 concentration is 0.14, they are equivalent to 11.2, 11.6 and 12.6 thousand tons, respectively, in terms of P_2O_5.

But Malaysian government is trying to replace these imported NPK fertilizer to domestically produced mixed fertilizer. Appreciating this effort, we estimate that no NPK fertilizer will be imported to Malaysia in the future.

For ammonium sulfate, which is a candidate product for this project, 75, 119 and 138 thousand tons in 1980, 1985 and 1990, respectively, are estimated to be used.

IV. 4 Thailand

1. Agricultural Characteristics of Thailand

These days, with situations that the industries of manufacturing and commerce are highly growing, an agricultural weight occupying in the industrial structure is relatively getting low (24.6% in 1965, and 18.9% in 1975 in terms of actual basis), but the importance of agriculture's roles in the economy of Thailand will never change, because her foreign revenue relys greatly upon export of agricultural products. The export of agricultural products occupied approx. 65% of total exports in 1976.

Also, in the fourth 5-year Economical and Social Development Program (1977 - 1981), advancement of agricultural product export is one of the major political objectives.

Agricultural production pattern in Thailand is shown in Table IV-30, and their export pattern in Table IV-31. Exports of paddy (rice and rice products), cassava/tapioca, sugar, maize, and rubber are remarkably high in terms of value. Just these five products occupy approx. 87% of total exports of agricultural products.

In the third 5-year program (1972 - 1976), six products including kenaf in addition to these five products above, were the most important crops.

In the fourth 5-year program, diversification of crops, rotation of crops and systematic cultivation are given as the most important strategires. Rubber, tobacco, vegetables and fruits are suggested as items for diversification.

In Table IV-32 are shown the production targets by crops planned in the fourth 5-year program.

The Government of Thailand are expecting high growth on cotton, tobacco, maize, mungbean, soybean and sugarcane. It seems, however, that the targets for cotton, mungbean and soybean are not realistic, as their production levels were very low before the commencement of the fourth 5-year program. (See Table IV-30)

Table IV-30 Planted Area, Production and Exports of Major Crops

	1974					1975					1976				
	Planted Area (1,000 ha)	Production (1,000 t)	Exports		Exp./Prod. (%)	Planted Area (1,000 ha)	Production (1,000 t)	Exports		Exp./Prod. (%)	Planted Area (1,000 ha)	Production (1,000 t)	Exports		Exp./Prod. (%)
			Quantity (1,000 t)	Value (Million Baht)				Quantity (1,000 t)	Value (Million Baht)				Quantity (1,000 t)	Value (Million Baht)	
Paddy	7,982	13,386	1,016	9,810	7.6	8,896	15,300	906	5,581	5.9	8,756	15,068	1,973	8,603	13.1
Rubber	1,406	382	362	5,037	94.8	1,406	349	332	3,473	95.1	1,456	400	374	5,297	93.5
Maize	1,240	2,500	2,260	5,965	90.4	1,312	2,863	2,105	5,705	73.5	1,285	2,675	2,419	5,677	90.4
Cassava/Tapioca	473	6,240	2,392	3,836	38.3	593	8,100	2,385	4,596	29.4	697	10,138	3,721	7,528	36.7
Sugar Cane	310	14,592	–	–	–	391	19,910	–	–	–	449	22,564	–		–
Mung Beans	207	188	53	266	28.2	164	121	42	238	34.7	223	125	57	521	45.6
Coconuts	321	684	0.5	1.1	0.1 >	326	677	2.7	2.9	0.4	332	670	0.6	1.2	0.1 >
Soy Beans	132	110	9	47	8.2	118	114	24	134	21.1	102	114	8	48	7.0
Other Oil Seeds 1)	188	225	45	352	20.0	181	198	35	212	17.7	194	21.5	59	403	27.4
Kenaf	404	384	245	842	63.8	326	307	156	641	50.8	161	183	137	576	74.9
Cotton	52	56	3	21	5.4	30	29	2	21	6.9	25	27	3	41	11.1
Other Fiber Crops 2)	47	106	20	196	18.9	47	106	15	170	14.2	46	107	20	272	18.7
Tobacco	46	37	15	447	40.5	48	42	18	570	37.5	42	41	22	699	53.7
Vegetables 3)	94	387	4	15	1.0	93	388	2	11	0.5	92	382	1	8	0.4
Agricultural Exports				32,815					29,285					39,205	
Total Exports															

Source: AGRICULTURAL STATISTICS OF THILAND

Note: 1) Ground Nuts, Castor Beans and Sesame 2) Kapok and Bombax 3) Chilli-dried, Shallot, Onions and Garlic

Table IV-31 Agricultural Export Pattern (1976)

	Value of Exports (Million Bahts)	Ratio (%)
Paddy (Rice and Rice Product)	8,603	14.2
Cassava/Tapioca	7,528	12.4
Raw and Refined Sugar	6,843	11.3
Maize (includ. Maize meal)	5,677	9.3
Rubber	5,297	8.7
(Sub Total)	(33,948)	(55.9)
Tobacco (Leaf)	699	1.1
Kenaf	576	1.0
Mung Beans	521	0.9
Oil Seeds[1)]	451	0.7
Fiber Crops[2)]	313	0.5
Others[3)]	2,697	4.4
Agricultural Exports[4)]	39,205	64.5
Total Exports	60,797	100.0

Note:
1) Soy beans, Ground nuts, Castor beans and Sesame
2) Cotton raw and Kapok fiber
3) Including Garden crops, Fruits, Animal feeding etc.
4) Excluding Livestock, Livestock products, Forestry products and Fishery products

Table IV-32 Planned Production Targets by Major Crop, 4th 5-year Program

	Production (1,000 t)		Average increase per year (%)
	1977	1981	
Paddy	15,400	16,500	2.3
Rubber	407	466	3.4
Maize	3,500	3,800	9.8
Cassava	9,800	10,800	3.2
Sugar cane	21,900	28,600	7.2
Mung beans	292	390	8.9
Soy beans	310	431	8.3
Kenaf/Jute	220	270	3.3
Cotton	63	205	28.6
Tobacco (Virgia)	45	66	9.9

Source: National Workshop on Improvement of Fertilizer Marketing for Small Farmers in Thailand (ESCAP/FAO REPORT)

In accordance with the governmental policies, diversification of crop may gradually be developed, while the prevailing position of rice-crop in Thailand agriculture will still continue. About two-thirds of total agricultural area is used for rice-crop, and 80% of total population is related with rice cultivation.

Rice is the most important foreign revenue source as well as the major food for people. Thailand ranks in the second rice exporting country after USA in the world, and occupies approx. 20% of total world export. Most of development projects in Thailand are supported by the governmental foreign revenue incurred with her rice export.

2. Current Consumption Pattern of Phosphate Fertilizers in Thailand

In Table IV-33 is shown a trend of chemical fertilizer consumption (production) in Thailand, and in Table IV-34 the trend of consumption by grade of phosphate fertilizers is shown.

Total consumption of chemical fertilizers attained an annual average growth rate of 10% during the period of 1970 - 1975, while it showed a great deal of increase both in 1976 and 1977. In case of 1977, large amount of dashed imports in anticipation of the enforcement of import duty are included, so that it does not always reflect the real demand. However, a big rise in 1976 is almost based on real demand.

Table IV-33 Total Supply of Chemical Fertilizers in Thailand

(Unit: 1,000 t)

	Products			Nutrient			
	Imports	Domestic Production	Total	N	P_2O_5	K_2O	Total
1965	88.9	-	88.9	16	9	6	31
1966	141.4	4.3	145.7	24	16	7	47
1967	217.9	34.4	252.3	44	28	13	85
1968	265.5	26.8	292.3	48	38	14	100
1969	265.6	17.0	282.6	45	42	21	108
1970	249.6	39.7	289.3	49	37	28	114
1971	233.4	38.0	271.4	48	28	23	99
1972	367.2	31.1	398.3	61	42	39	142
1973	352.7	22.6	375.3	50	40	38	128
1974	345.5	29.0	374.5	63	54	18	135
1975	447.1	18.4	465.5	82	66	20	168
1976	662.2	28.6	690.8	126*	76*	21*	223*
1977	915.8*	33.0*	948.8*				

Source: Agricultural Economic Div., MITSUI etc.
* Estimated
** Includes only ammonium sulfate and urea produced by CFC

Demand for chemical fertilizers is surely in expanding tone. As shown in Table IV-34, such big rise as in 1976 and 1977 is chiefly attributable to the increased consumption of phosphate fertilizers, especially NP and NPK.

The chemical fertilizer market in Thailand is featured with the following points:

(1) Originally, this market is based on complex fertilizers. Among them, both 16-20-0 and 18-20-0 used for paddy rice-field are very important, occupying about one-third of total imports.

(2) As the demand for paddy rice-crop is predominant in quantity, fertilization timing concentrates at the period of June to September in the year. Except such season, a little peak appears in the period of January and February.

(3) Among these major nutrients of fertilizer, consumption of "K" is low due to poor

Table IV-34 Consumption of Phosphatic Fertilizer

(Unit: 1,000 t)

	1974			1975			1976			1977		
	Imports	Domestic Production	Total	Imports	Domestic Production	Total	Imports	Domestic Production	Total	Imports	Domestic Production	Total
NP	173.9	–	173.9	190.1	65*	255.1	234.2	92*	326.2	449.1	87*	536.1
NPK	80.6	–	80.6	40.0	22*	62.0	108.1	31*	139.1	159.5	29*	188.5
MAP	–	–	–	31.0	–	31.0	16.6	–	16.6	31.0	–	31.0
DAP	10.7	–	10.7	15.9	–	15.9	20.6	–	20.6	14.9	–	14.9
P**	3.2	–	3.2	1.2	–	1.2	2.2	–	2.2	4.7	–	4.7
Total	268.4			278.2			381.7			659.2		
(cf.) Urea	0.3	5.1	5.4	9.7	2.6	12.3	–	3.4	3.4	–	9.0*	9.0
Ammonium Sulfate	29.2	23.9	53.1	62.8	15.8	78.6	218.7	25.2	243.9	152.0	24.0*	176.0
Ammonium Chloride	9.6	–	9.6	4.2	–	4.2	30.8	–	30.8	47.4	–	47.4

Source: ESCAP/ARSAP Report, MITSUI etc.

Note: * Estimated
** Including Superphosphates and other phosphatic fertilizer

recognition for the effects of K nutrient.

(4) Fertilizer application rate per unit area is rather low, compared with those in other countries in the Southeast Asia. This is presumably due to price unbalance between crops and fertilizers.

3. Chemical Fertilizer Manufacturers in Thailand

Today, there are only two chemical fertilizer manufacturers in Thailand, i.e., The Chemical Fertilizer Co., (CFC) and Thai Central Chemical Co., (TCC).

CFC is substantially a government owned company, 92.8% of whose total paid-up capital is held by the Ministry of Finance, Thailand, manufacturing ammonium sulfate and urea with ammonia produced from lignite and sulfuric acid manufactured from imported sulfur, but nothing of phosphate fertilizers. Its plant capacity is 57.8 thousand tons in terms of ammonium sulfate, and 25.4 thousand tons in terms of urea. Its operating rate is quite low, because of technical problems and high operation cost. Particularly, they cannot replace imported ammonium sulfate which amounts almost 200 thousand tons per annum, though it is their main product.

TCC is a joint venture company between Thailand and Japan, whose total paid-up capital is shared 60% with Thailand investment and 40% with Japanese investment.

Today, this company is manufacturing NP and NPK by mixing ammonium chloride, MAP, DAP and ammonium sulfate, all of which are imported as intermediate materials. (Proudction ratio is 75% for NP and 25% for NPK). It has just started its operation in 1975, but its initial plant capacity was greatly scaled up in 1978.

There are several complex fertilizer manufacturers with small scale of mixing plants other than TCC. However, supply capacity of these manufacturers is deemed to be not more than 12,000 tons.

In Tables IV-35 and 36, the manufacturers and their production status are shown.

There are also plans to expand the production capacity of NP/NPK fertilizers, but these plans are not yet clear. But to neglect these plans may cause big error in balance estimation. So we assumed that in 1990 the production will be twice as big as that in 1985.

Table IV-35 Domestic Producers of Chemical Fertilizers

Company	Product	Capacity (1,000 t/year)	Start	Capital Stock Ratio
The Chemical Fertilizer Co., Ltd., (CFC)	Ammonium Sulfate Urea	57.8 25.4	1966 1967	o Thailand Government 92.8% o Private 7.2%
Thai Central Chemical Co., Ltd. (TCC)	o NP o NPK	120.0 * (Mixing only)	1975	o THAI-JAPANESE JV o CFC 49% o Thai Private 11% o Nissho-Iwai 20% o Central Glass Co. 20%

* Expanded to 360 thousand tons in 1978

Table IV-36 Domestic Production of Chemical Fertilizers

	Ammonium Sulfate (CFC, Production)	Urea (CFC, Production)	NP/NPK (TCC, Mixing only)
1965	-	-	-
1966	4.3	-	-
1967	27.5	6.9	-
1968	19.8	7.0	-
1969	12.0	5.0	-
1970	27.1	12.6	-
1971	27.8	10.2	-
1972	25.6	5.5	-
1973	18.8	3.8	-
1974	23.9	5.1	-
1975	15.8	2.6	87.4
1976	25.2	3.4	123.0
1977	24.0	9.0	116.0

Source: ESCAP/ARSAP Report
* Estimated

4. **Outlook on Future Consumption of Phosphate Fertilizers in Thailand**

Demand estimation was made by summing up the data for each crop. Variable factors required in determining such forecasts are estimates of crop area by crops and fertilizer application rate per unit area.

Yearly estimates of crop area by crops are determined based on the data disclosed in the governmental programs, and the results are shown in Table IV-37.

In estimating the fertilizer application rate per unit area, future growing trend over coming years must be taken into consideration in case of Thailand, because current level is in general low as compared with all other countries in the Southeast Asia.

By taking account of features by crops, current level of application and governmentally recommended standards, etc., trend of possible application rate is assumed, and the results are shown in Table IV-38.

Table IV-37 Assumed Planted Area by Crops

Crop	Assumed planted area (1,000 ha)			
	1975	1980	1985	1990
Paddy	8,896	9,071	9,861	10,651
Maize	1,312	1,439	1,601	1,733
Cassava	593	998	1,336	1,705
Sugar cane	391	648	867	1,107
Coconuts	326	447	544	631
Oil seeds*	299	464	592	720
Rubber	1,406	1,548	1,638	1,711
Others**	589	663	769	892
Total	13,812	15,278	17,208	19,150

* Soy beans, Groundnuts, Castor beans and Sesame

* Mung beans, Principal fiber crops, Vegetables and Tobacco

Table IV-38 Assumed P_2O_5 Use per Hectare

(Unit: P_2O_5 kg/ha)

Crop	Assumed P_2O_5 Use per Hectare				Maximum P_2O_5 Consumption*	Minimum P_2O_5 Consumption**
	1975	1980	1985	1990		
Paddy	5	8	10	12	25	5
Maize	0.2	0.5	2	4	60	0.2
Cassava	5	6	8	10	75	5
Sugar cane	3	4	6	8	38	3
Coconuts	0.6	1	2	5	12	0.6
Oil seeds	0.6	1	3	5	47	0.6
Rubber	7	7	8	8	8	7
Others	10	12	14	16	47	10
Total	31.4	39.5	53	68	312	31.4

* Recommended level
** Present level

Forecast of phosphate fertilizer consumption (P_2O_5 equivalent) through 1990 is projected, taking 1975 as base year and using above mentioned estimation. The results are shown in Table IV-39 and in Fig. IV-5.

P_2O_5 consumption in 1985 and 1990 are assumed to be 147 and 196 thousand tons, respectively, whose levels are equivalent to 2.2 times and 3.0 times, respectively, of consumption at the base year of 1975. Converting into growth rate, an annual average of 8.3% through 1985 (base year 1975) and 6.0% after 1986 through 1990 are attained. With these, it is possible to say that Thailand will have high growth rate, thereby a high potential market.

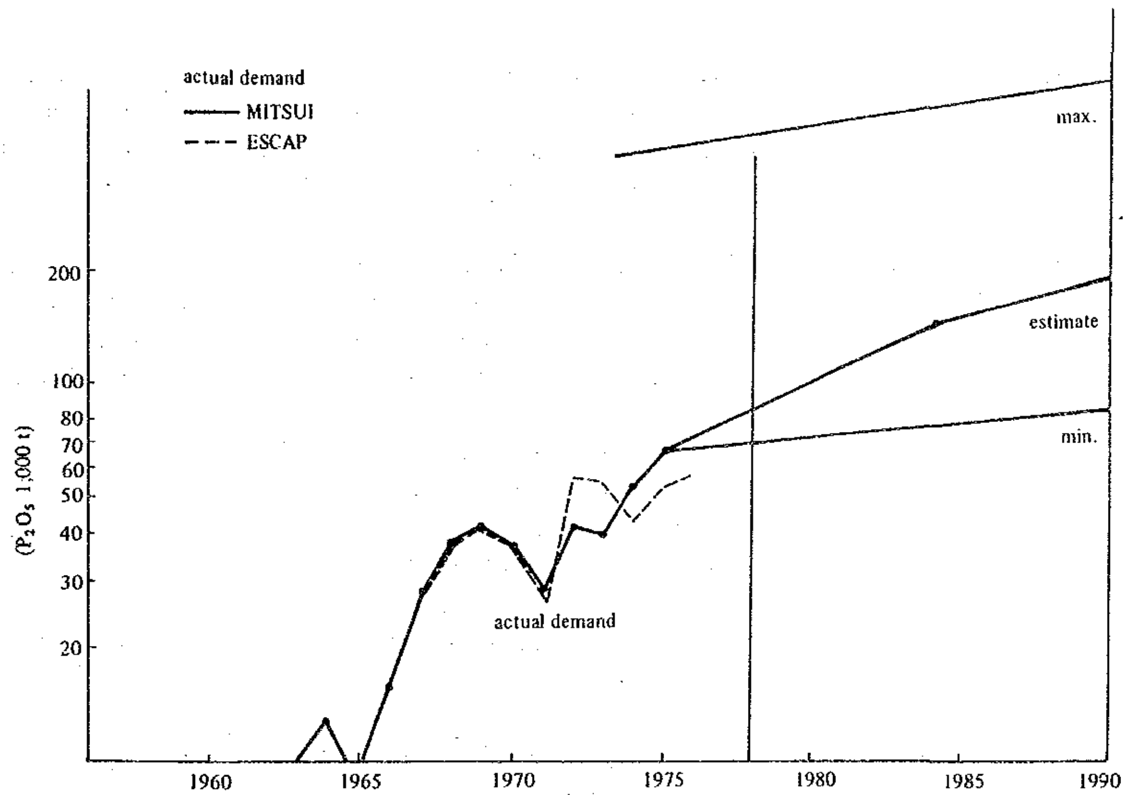
Needless to say, being a big agricultural country in the world, Thailand is really a hopeful market for chemical fertilizers, so that movement of domestic manufacturers are also quite active. Considering such situation, the production of 1990 is taken as twice of 1985 and we are of the opinion that this will be adequate. But there will be severe dumping competition among flooded importers, etc., and market price may be not stable.

Table IV-39 Projected P_2O_5 Consumption in Thailand through 1990

(Unit: P_2O_5 1,000 t)

Crops	1975	1980	1985	1990
Paddy	44	73	99	128
Maize	0.3	0.7	4	7
Cassava	3	6	11	17
Sugar cane	1	3	6	9
Coconuts	0.2	0.4	1	3
Oil seeds	0.2	0.5	2	4
Rubber	10	11	13	14
Others	7	8	11	14
Total	66	104	147	196
NP (as P_2O_5)	55.5	78.5	111.6	148.8
(as Fertilizer)	278	393	558	744
NPK (as P_2O_5)	8.5	21.8	30.1	40.1
(as Fertilizer)	60.6	156	215	286
P	2.0	3.7	5.2	7.1

Fig. IV-5 Projected P_2O_5 Consumption in Thailand through 1990



IV. 5 Singapore

As well known, there is scarecely agricultural activity in Singapore. Only about 3,000 tons per annum of chemical fertilizers are needed to use for street trees, some vegetables and others. Such needed quantity will remain unchanged henceafter, according to the Government of Singapore.

IV.6 Suggestions to the Product-mix Planning in View of ASEAN Market Analyses

A summary of supply-demand patterns of both phosphate fertilizers and ammonium sulfate in each of the ASEAN countries by 1980, 1985 and 1990, is recapitulated in Table IV-40, with results derived from phosphate fertilizer supply-demand trend analyses by ASEAN countries.

Some supplemental descriptions by said countries regarding the preparation of this table are as follows:

(1) Philippines: Supply-demand forecast made by the Government of the Philippines is used.

(2) Indonesia: Supply-demand forecast developed by the Ministry of Industry, Indonesia, received from Mr. Niko Kansil, is used. And this data was modified from the result of discussion at COIME expert meeting in September, 1979.

(3) Malaysia: A supply-demand forecast developed by the study team, based on various data suggested for our use by the Goernment of Malaysia and other bodies concerned is used. However, mixed fertilizers based on phosphate rock are excluded in the forecast.

(4) Thailand: A supply-demand forecast developed by the study team, based on the data of actual value through 1977 provided by the Government of Thailand, is used. Other forecasts made by the Ministry of Agriculture, Thailand and by ESCAP are used as references. DAP, imported to use as raw material for domestic manufacture of chemical fertilizers in Thailand is not included in the table.

(5) Singapore: Demand figure verbally given by the Government of Singapore is straightly used as it is.

Table IV-40 Demand and Supply of Phosphate Fertilizer and Ammonium Sulphate in ASEAN Countries for 1980, 1985 and 1990
(1,000 T/Y as fertilizer product)

*1980

	Philippines			Thailand			Indonesia			Malaysia			Singapore			Balance Total
	Demand	Production	Balance	Demand	Production	Balance	Demand	Production	Balance	Demand	Production	Balance	Demand	Production	Balance	
AMS	179	85	94	342	20	322	170	135	35	75	54	21	0	0	0	472
DAP	20	0	20	0	0	0	60	59	1	1	0	1	0	0	0	22
TSP	0	0	0	3	0	3	393	243	150	7	0	7	0	0	0	160
NP	118	120	(2)	393	324	225	0	0	0	0	0	0	0	0	0	446
NPK	177	140	37	156			140	37	103	80	0	80	3	0	3	

*1985

	Philippines			Thailand			Indonesia			Malaysia			Singapore			Balance Total
	Demand	Production	Balance	Demand	Production	Balance	Demand	Production	Balance	Demand	Production	Balance	Demand	Production	Balance	
AMS	228	180	48	515	20	495	250	270	(20)	119	54	65	0	0	0	683
DAP	29	0	29	0	0	0	215	72	143	2	0	2	0	0	0	174
TSP	0	0	0	4	0	4	657	657	0	8	0	8	0	0	0	12
NP	167	168	(1)	558	324	449	0	0	0	0	0	0	0	0	0	537
NPK	244	143	101	215			245	260	(15)	85	0	85	3	0	3	

*1990

	Philippines			Thailand			Indonesia			Malaysia			Singapore			Balance Total
	Demand	Production	Balance	Demand	Production	Balance	Demand	Production	Balance	Demand	Production	Balance	Demand	Production	Balance	
AMS	291	180	111	550	20	530	270	67	0	138	54	84	0	0	0	725
DAP	40	0	40	0	0	0	360	72	288	2	0	2	0	0	0	330
TSP	0	0	0	6	0	6	820	657	168	9	0	9	0	0	0	178
NP	231	224	7	744	648	382	0	0	0	0	0	0	0	0	0	685
NPK	340	87	253	286			300	260	40	90	90	0	3	0	3	

The differences between demand and supply are the balance values, which are assumed to be the primary potential market for phosphate fertilizer project in the Philippines.

As a rule, production capacity of each country includes planned future expansion only when they are clearly projected except for the NP/NPK production capacity in Thaialnd and 90% of production capacity is taken to be supply (production) volume. This is the way how the supply-demand balance is computed. (See Table IV-41).

Table IV-41 Supply-Demand Balance

(Unit: 1,000 ton/year)

Country	1980					1985					1990				
	AS	DAP	TSP	NP	NPK	AS	DAP	TSP	NP	NPK	AS	DAP	TSP	NP	NPK
Philippines	94	20	0	(2)	37	48	29	0	(1)	101	111	40	0	7	253
Iononesia	35	1	150	0	103	(20)	143	0	0	(15)	0	288	163	0	40
Malaysia	21	1	7	0	80	65	2	8	0	85	84	2	9	0	90
Thailand	322	0	3	225		495	0	4	449		530	0	6	382	
Singapore	0	0	0	0	3	0	0	0	0	3	0	0	0	0	3
Total	472	22	160	446		683	174	12	537		725	330	178	685	

Note: AS: Ammonium Sulfate
DAP: Diammonium Phposphate
TSP: Tripple Super Phosphate
NP: Compound Fertilizers with Nitrogen and Phosphorous Nutrients
NPK: Compound Fertilizers with Nitrogen, Phosphorous and Potash Nutrients

As for Thailand, Thai Central Chemical Co. (TCC), is primarily producing chemical fertilizers based on imported intermediates, whose production capacity may possibly be scaled up. And, a new project to construct a new fertilizer manufacturing plant other than TCC's is also reported. These plans are roughly included in the future capacity.

Further, production volume of NP and NPK in Thailand is not given separately but as sum in one column, because their production ratio in TCC is variable.

These balance values basically suggest maximum possible production quantity under this project. However, considering the case that some fertilizer manufacturing plans may be materialized in some countries or that unforeseenable errors may be found in the forecast, we

Table IV-43 Potential Market Size for This Study, - 1985

(Unit: 1,000 tons)

	Potential Market		Case Study [a]	
	Fundamental	Probable	Case 9	Case 10
AS	683	318	150	150
DAP	174	90	0	0
TSP	12	10	0	0
NP/NPK	537	362	264	370
PA	(270) [b]	(130)	30	0

a: See Table IV-5.

b: Estimated from production volume of TSP, DAP and NPK in Indonesia.

conservatively take the half of balance volume as secondary and probable potential market for this project, though the balance volume for the Philippines is used as it is. Such figures for 1985 is shown in Table IV-43.

What Table IV-43 suggests are the following points:

(1) Ammonium sulfate consumption in the ASEAN region will continue in sound tone. Owing to this, Philippines' sulfuric acid will play an important roll in supplying ammonium sulfate to the ASEAN region where sulfur resources is scarece. Therefore, to put ammonium sulfate into this project, if economically reasonable, is desirous for each of the ASEAN countries. With this reason, our case study for product-mix which is conducted in the following chapter, includes ammonium fulfate as a candidate product. Proposed supply of 150 thous. tons/y of ammonium sulfate from this project as seen in either Case 9 or Case 10 is deemed quite reasonable, as compared with 318 thous. tons/y of probable market in 1985.

(2) Regarding DAP, imported DAP to Thailand for chemical fertilizer manufactuirng use is not included in Table IV-43. If this is included, it seems around 300 thous. tons/y. In the case study, DAP production was also studied, but it gave economically not favorable result.

(3) TSP has a potential market only in Indonesia who is now on a stage to establish self-sufficing situation. Not to compete with this, it is advisable not to include TSP in

this project. Even if such production is planned, there will be no rooms for export in 1985, if limited within the ASEAN region.

(4) NP/NPK have potential market for every ASEAN countries, who are now importing, so that they are most suitable candidate products for this project, even if there are some production plans. And, it is advisable to give careful adjustment in practice, because there are many varieties of grade in NP/NPK fertilizers.

(5) As for phosphoric acid (PA), accompanying with materialization of TSP self-sufficing plan in Indonesia, phosphoric acid is incidentally required as raw material for it. With this, phosphoric acid is also taken up as a candidate product for this project. Theoretically, approx. 270 thous. tons-P_2O_5/y of phosphoric acid is required for Indonesian project. But Indonesia has a plan to make phosphoric acid self-suffice and from this reason we withhold the plan to export phosphoric acid.

It is advised to note that market analyses here are limited to the ASEAN region, and even within the ASEAN region, type of phosphate fertilizers used varies by each country.

Needless to say, allocations of the products from this project for each ASEAN country must wait for the discussion and concent among the ASEAN countries.

Again, note should be taken that all the discussions up to here are for the purpose of studying primary potential market to decide most suitable product-mix.

CHAPTER V

RAW MATERIALS AND THEIR PRICES

V. RAW MATERIALS AND THEIR PRICES

V.1 Phosphate Rock

1. Domestic Phosphate Rock

Many of caves at various places in the Philippines have much deposit of guano or phosphate rock of guano origin. The Bureau of Mines is now carefully exploring the reserves for almost all of such caves. In accordance with the report dated April, 1976, total reserve is about 1.6 million tons, quality of which ranges between about 1 to 30% in terms of P_2O_5 concentration and is unsuitable for phosphoric acid manufacturing. Additionally, gathering such guano spreaded at various places and refining them to acceptable level is practically impossible. Even in quantity wise, it is not enough to satisfy the demand of this project even for one year, so that they are not deserved to be considered.

Marine type phosphate rock, which is normal source of phosphate rock, existed in Negros Islands, but the quantity was little and it was already exhausted, after use of about 35,000 tons by Atlas Fertilizer for these three years.

Another possible reserve of phosphate rocks confirmed is at Isabel district in Leyte Islands. The Bureau of Mines has conducted boring tests of 50 m in depth at 100 m interval in an area of 500 m times 800 m to confirm the reserves. In November of 1978, the test was still on the way and official analyse of samples were not yet completed, so that no clear comments can now be made under such circumstances. It seems, however, that there is a layer of phosphate rock having quality of 10 - 30% of P_2O_5 concentration with 5 - 15 m in thickness at place of 2 - 10 m in depth under the ground. Should it be true to exist exactly as mentioned above, the reserves are estimated to be around 2 - 3 million tons. However, as beneficiation is indispensable for its ununiform quality, possible obtainable beneficiated rock will be around 1 - 1.5 million tons. This will satisfy the demand of this project for only about 4 - 5 years, and it does not deserve exploitation of a new mine.

Should such bed exist in a wider area, it could be deserved for such exploitation. Further exploration results of the Bureau of Mines must be waited to make it sure. So, no further comments can clearly be made here now.

2. Imported Phosphate Rock

2-1 Origin

The world-wide reserves of phosphate rock confirmed is said to be 130,000 million tons and annual consumption is about 120 million tons. It can be said that there are enough reserves world-widely and, as the increase of mining and beneficiation capacity is clearly larger than that of consumption, the supply in phosphate rock is definitely greater than demand (from ISMA report).

In Table V-1, are shown the phosphate rock exports from the major existing countries (lateral columns) to the major importing countries (vertical lines) for a period of January to December, 1978.

As mentioned in the previous para., Philippines' domestic phosphate rock is not expected, so that proper countries must be selected out of exporting countries shown in this table to import phosphate rock for this project.

Here, let's discuss which country's rock is most suitable for use under this project in terms of quality, price, supply stability, etc.

As easily seen through Table V-1, top two of world major exporting countries are Florida, USA and Morocco. Florida has long history as phosphate rock supplier and has dominated over the world market for long, but her top position was replaced by Morocco from lowered quality and higher cost, caused from the fact that easily collectable places are becoming less and less.

Other suppliers are located in the region from North Africa to around the Mediterranean Sea. They are relatively new mining areas, whose stable supply can possibly be expected, if no political problems occur.

Sources close to the Philippines are the South Pacific Islands, such as Ocean, Nauru and Christmas. Rock in Ocean will be exhausted within this year, in Nauru may last for about another 20 years and in Christmas is said for another 10 years time. Rock in Nauru has high quality and is expensive. Rock in Christmas is exclusively imported by Australia and New Zealand. With these circumstances, there are many problems to take account of them as the source for this project.

Table V-1. Western World Phosphate Rock Exports (January – December)

('000 tonnes)

	United States		Sahara		Morocco		Tunisia		Algeria		Togo		Senegal		Jordan		Israel		Banaba		Nauru		Christmas	
	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978
Total	13,967	13,684	25	441	15,791	17,306	1,898	1,667	698	619	2,886	2,849	1,767	1,686	1,777	2,133	933	1,407	419	468	1,146	1,999	1,114	1,225
West Europe	5,169	4,507	11	245	9,615	10,696	1,122	888	275	237	1,784	1,818	1,595	1,353	240	389	735	1,247	–	–	–	–	–	–
Austria	151	33	–	–	10	13	20	4	37	32	–	–	–	–	–	–	43	97	–	–	–	–	–	–
Belgium	498	372	–	–	1,295	1,365	–	10	–	–	164	141	–	–	–	–	31	100	–	–	–	–	–	–
Denmark	26	98	–	–	241	186	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Eire	23	22	–	–	88	76	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Finland	–	35	–	23	–	111	–	–	61	84	–	–	144	141	–	–	–	–	–	–	–	–	–	–
France	1,060	999	–	27	1,621	2,128	551	370	59	60	830	696	562	344	49	27	106	368	–	–	–	–	–	–
West Germany	1,500	1,355	–	53	325	406	26	27	–	–	51	86	155	182	–	–	69	125	–	–	–	–	–	–
Greece	–	–	–	–	165	220	232	206	22	37	–	–	225	201	–	–	54	22	–	–	–	–	–	–
Italy	250	247	–	–	879	883	27	10	89	23	88	169	15	12	49	106	172	249	–	–	–	–	–	–
Netherlands	824	771	–	–	592	899	–	–	–	–	576	613	–	–	–	–	–	145	–	–	–	–	–	–
Norway	154	120	–	–	–	–	–	–	–	–	–	113	–	39	–	–	128	111	–	–	–	–	–	–
Portugal	5	4	–	–	298	442	–	–	–	–	–	–	56	–	–	–	–	–	–	–	–	–	–	–
Spain	151	41	11	141	2,676	2,840	–	30	–	–	9	–	–	–	–	–	–	–	–	–	–	–	–	–
Sweden	120	115	–	–	226	339	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Turkey	–	–	–	–	295	169	187	179	9	–	58	–	14	–	142	256	140	24	–	–	–	–	–	–
United Kingdom	409	478	–	–	895	853	78	52	–	–	10	–	424	435	–	–	–	7	–	–	–	–	–	–
East Europe	1,502	1,291	–	–	3,058	2,940	594	551	381	306	1,061	949	–	71	455	651	99	87	–	–	–	–	–	–
Bulgaria	–	–	–	–	433	467	75	56	–	–	–	–	–	–	26	82	–	–	–	–	–	–	–	–
Czechoslovakia	–	–	–	–	109	224	104	122	144	104	109	–	–	–	35	39	–	–	–	–	–	–	–	–
G.D.R.	–	–	–	–	171	255	120	129	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hungary	–	–	–	–	98	148	–	–	130	89	–	–	–	–	4	–	–	–	–	–	–	–	–	–
Poland	935	893	–	–	835	1,011	286	239	98	77	516	349	–	–	180	166	–	–	–	–	–	–	–	–
Romania	566	398	–	–	774	672	–	–	–	8	103	158	–	–	195	247	64	49	–	–	–	–	–	–
Yugoslavia	–	–	–	–	631	162	9	7	–	–	334	442	–	71	15	118	36	39	–	–	–	–	–	–
Africa	–	–	–	–	–	–	–	–	–	–	16	3	6	9	15	28	–	–	–	–	–	–	–	–
Asia	3,405	3,753	–	159	1,126	1,138	–	–	5	18	24	79	154	242	1,066	1,064	18	25	–	–	127	131	–	–
China	5	–	–	–	165	203	–	–	–	–	–	–	–	12	–	97	–	–	–	–	–	–	–	–
India	249	200	–	–	340	398	–	–	–	–	–	–	78	150	378	386	–	–	–	–	–	–	–	–
Iran	381	478	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Japan	1,480	1,477	–	137	554	446	–	–	5	–	23	9	76	77	218	185	2	5	–	–	85	92	–	–
South Korea	1,165	1,515	–	–	–	10	–	–	–	18	1	–	–	3	–	20	–	–	–	–	42	39	–	–
Lebanon	–	–	–	22	26	–	–	–	–	–	–	45	–	–	89	65	–	–	–	–	–	–	–	–
Taiwan	26	32	–	–	–	–	–	–	–	–	–	–	–	–	245	202	16	19	–	–	–	–	–	–
North America	2,663	3,270	–	–	323	924	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Canada	2,663	3,270	–	–	26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
United States	–	–	–	–	297	924	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Latin America	1,228	862	14	37	1,628	1,567	182	228	37	59	–	–	12	–	–	–	80	48	–	–	–	–	–	–
Brazil	572	347	–	–	715	410	152	202	37	59	–	–	–	–	–	–	80	48	–	–	–	–	–	–
Mexico	567	391	–	–	839	1,089	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Uruguay	–	–	14	37	24	–	18	26	–	–	–	–	12	–	–	–	–	–	–	–	–	–	–	–
Oceania	–	–	–	–	42	42	–	–	–	–	–	–	–	–	–	–	–	–	419	468	1,019	1,868	1,114	1,225
Australia	–	–	–	–	42	42	–	–	–	–	–	–	–	–	–	–	–	–	277	302	660	1,259	540	608
New Zealand	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	141	166	359	609	575	617

It is not cited in this table, but a phosphate rock mine was recently exploited in Australia, but the production was stopped last year, due to dull sales. As this mine is located far from coast line, high transportation charges are required, causing high cost, so that many people think that it won't be reopened, unless market price of phosphate rock becomes far higher. Communist China and Vietnam conceal potential to produce such rock, though they are not yet exploited at all.

2-2 Quality

Quality of phosphate rock varies very much, depending upon their origin. In some cases when phosphate rock is different from originally designed one, production capacity of phosphoric acid broadly comes down, or in an extreme case, production may possibly be stopped completely. Therefore, phosphoric acid manufacturing plant should basically be designed to meet the character of rock to be used, and careful tests should be made in case of changing rock to be used. Below summarizes the features of major phosphate rock.

The process of phosphoric acid manufacture consists of:

1) grinding phosphate rock,
2) digesting the rock with sulfuric acid,
3) separating gypsum and product acid by filtration.

Now, the nature of major phosphate rock is compared, relating to grinding, digestion, filtration, consumption of sulfuric acid, contents of foreign materials and others.

Table V-2, shows the rough characteristics for groups of rocks. These groups are composed by getting together the rocks of similar characteristics.

Should some description be added to this table, column "Digestion" shows degrees how easily rocks are digested with sulfuric acid. For instance, rocks in group III require two times of digestion time until reaching the same decomposition rate than that required for group I. As for filtration, there sometimes happens to exist the difference of more than 50% in terms of volume of slurry to be filtered through unit filtration area in unit time.

Should phosphate fertilizer be manufactured with phosphoric acid containing much of iron and aluminium, its water soluble components become less. The more organic material is contained, the more product fertilizer is colored and the more troubles are observed in filtering and liquid handling.

Table V-2. Comparison of Phosphate Rock Characteristics

Group		Grinding	Digestion	Filter	Sulfuric acid consumption	Fe Al content	Others
I	Nauru Christmas	Δ	◎	O	O	O	
II	Algeria Tunisia Israel Jordan Morocco	O	O	Δ	Δ	O	Contains much MgO High Cl content in some grade
III	Senegal (Taiba) Togo Florida 72 Australia	Δ	Δ	Δ	O	Δ	Contains much organic material
IV	Florida 68	Δ	Δ	X	O	Δ	Contains much organic material

◎ Very good　O Good　Δ Medium　X Bad

With all the above, phosphate rock characteristics vary greatly, depending upon sources. The plant should, therefore, be designed to meet the characteristics of rock to be used. Otherwise, it is possible to happen that production capacity is greatly lower than expected or that recovering rate of P_2O_5 from rock is extremely low. Further, it is also possible to happen that plant construction cost may differ about 10 – 20%, depending upon the kinds of rock to be used.

Additionally, Table V-2 shows only rough classification, and even for the rock from same country, rock characteristics fairly vary by mines. For example, Morocco has mines of Khouribga and Yousoufia, and Jordan has mines of Ruseifa, El Hassa and others, all of which must be considered to be different rocks.

Another thing to be noted is the fact that, even sourced from the same mine, rock characteristics may greatly differ, depending upon difference in their quality (P_2O_5 concentration is shown in terms of % BPL; 72% BPL represents 33% P_2O_5 contents). To take an example, Table V-2 indicates Florida 72 and Florida 68. Among Florida origins, low quality rock like BPL

68% has poor filterability and is hard to handle, which also causes lowered P_2O_5 recovery and production capacity. Recently, high quality rocks are becoming short in supply and their prices are also proportionally getting higher.

Irrespective of proportionally high charge of transportation, use of lower quality rocks is more economical. However, enough care should be taken to such technical questions as mentioned here above.

As will be described later, this report will carry out its planning on the basis of Morocco Khouribga 70/72 BPL. However, the phosphoric acid plant itself is designed so that Florida 70/72 BPL rock can be also accepted attaining same production capacity and same P_2O_5 recovery as the former attains.

As can be seen from Table V-2, Florida rock is inferior to Morocco rock in the point of digestion (= P_2O_5 recovery), but Florida rock has advantage of less sulfuric acid consumption. The economic comparison between Florida rock and Morocco rock is given in Annex V-1, as reference.

2-3 Price

Frankly speaking, it is fairly difficult to know all actual shipping prices of phosphate rock from each country in the world.

In Table V-3, below, are shown the export prices of Florida and Morocco rocks over the period of 1972 - 1978. They are List price, and it is unknown whether actual business is based on the List Price, or not, but it is assumed not to have much differences. Phosphate rock price dashed up radically around 1974, so that price forecast from this table is quite difficult to make.

Further, the following data is presented by Japanese trading firms as informal FOB price estimated at around the end of 1978.

Florida	75	BPL	37.15 – 38.15 US$/T	including 1.15 US$/T
	72		34.15 – 35.15	sales tax
	68		30.15 – 31.15	

Table V-3. Phosphate Rock Export Price

	BPL	July 72	March 73	January 74	July 74	October 74	January 75	January 76	April 76	December 76	July 77	January 78
Florida	77%	12.09	14.27	29.53	46.75	62.00	–	–	–	–	39.00	39.00
(FOB)	75	11.00	12.89	27.07	41.34	55.00	–	47.00	44.00	34.00	37.00	37.00
	72	9.86	11.32	23.62	35.43	48.00	–	41.00	39.00	32.00	34.00	34.00
	70	9.27	10.63	21.65	32.48	43.00	–	37.00	36.00	30.00	32.00	
	68	8.56	9.74	19.68	29.53	39.00	–	33.00	33.00	28.00	30.00	30.00
	66	8.24	9.25	17.72	27.07	36.00	–	30.00	30.00	26.00	28.00	
Morocco	77%	15.75	–	47.25	71.00	–	76.50	51.50	–	41.00	–	
(FAS)	75	14.00	–	42.00	63.00	–	68.00	48.50	–	37.00	–	
	70	13.33	–	40.00	60.00	–	65.00	46.00	–	32.00	–	

Source: USDI and PREA List Price

Morocco	75	BPL	about 36
	70/72		about 33
Spanish Sahara	80		about 42
Nauru	83		about 46
Jordan	73/75		about 36
	70/72		about 33
Togo	80		about 42
Senegal	80		about 42

Viewing through these figures, it can possibly be told that there are almost no differences among international FOB prices on the same BPL rocks.

Regarding a price difference among grades, as seen through Table V-3, it becomes higher by 1 US$/T per 1% BPL rise. Phosphate rock is, when added transportation charge, available at more or less 50 US$/T at a factory near a port, resulting in about 50 ÷ 70 = 0.7 US$ per 1% BPL, so that 1 US$/1% BPL clearly causes higher cost in total, even if transportation cost increase for lower grade is considered.

In case, therefore, that phosphate rocks are directly unloaded off from an ocean vessel into warehouse like in this project, use of possible lowest BPL rocks is economical and lucrative, if technical problems are within tolerable range and same P_2O_5 recovery rate is expected.

2-4 Transportation Cost

The simplest way to obtain cheapest phosphate rock is to purchase it from the nearest places in distance. Sources near to the Philippines are Nauru, Christmas and Australia, but there are problems in stable supply from such sources, and they are to be excluded. Approximate distances from other major sources to the Philippines are as follows:

Florida	–	Philippines	18,700 km
Morocco	–	Philippines	14,400 km
Jordan	–	Philippines	11,300 km

From the above, use of Jordan's is most appropriate.

Another way to lower ocean freight per unit weight of rock is by means of using bigger vessel.

Port Tampa at Florida is limited to maximum 40,000 DWT vessel, while both Casablanca in Morocco and Aqaba in Jordan are available to receive maximum 60,000 DWT vessel.

As an example in 1978, ocean freight cost of phosphate rock was 15.25 US$/T, from Morocco to the Philippines with a vessel of 60,000 DWT, and 19.80 US$/T with 35,000 DWT, showing a fairly large difference. And, there is an another example of 9 US$/T, from Aqaba to the Philippines with a vessel of 60,000 DWT. Therefore, facilities at disembarkation port should be big enough to receive vessels of 50 - 60,000 DWT together with un-loading facilities.

Another way to reduce ocean freight cost is by means of using chartered vessel. The cheapest way is so-called time charter, which is the way to borrow a vessel exclusively for a specified period and use it just for that purpose. In such a case, it won't be beneficial, if nothing is loaded on a return vessel. With this, if there are some bulk commodities constantly exported from the Philippines to the destination or direction where the rock for this project can be loaded, then, ocean freight cost can possibly be lowered, by using one vessel for both purposes.

Among exports from the Philippines, major bulk commodities are metal ore and sugar, and the former is exported neither to North Africa nor to USA.

As for sugar, the Philippines exports only 26,000 T/Y to Algeria, and this volume is too small to be considered. She also exports approx. 700,000 T/Y to North America, so that, in quantity wise, it is possible to use one chartered vessel for both sugar and phosphate rock. However, sugar export is seasonal, about one-third of which is being exported in December and January, and nothing during the period of June – September. It is, therefore, impossible to think of time charter, by combining export from th Philippines and phosphate rock import, so that there is no way but to leave the return cargo to the hand of vessel owner contracting consecutive voyage charter.

2-5 Conclusion on Phosphate Rock

With all the above mentioned, if we judge only from economic point of view, it is recommended in this project to use possible lowest quality rock from grades on the market, importing from Jordan, Tunisia or Morocco. But the raw material source will be decided considering other factors than economy and to design the plant which can treat also Florida rock is advisable. (Note that there are extremely low quality ones which are not on the market, but they are deemed economically not advantageous and also subject to technical problems.)

In this report, Morocco 70/72 is used hereafter as the study basis, with the reason that it is quite popular and there are many data about it, and the phosphoric acid plant is designed to be able to treat either Jordan, Morocco or Florida rock giving same P_2O_5 recovery and production capacity for all rocks mentioned above.

As for the assumed price for the product-mix study in Chapter VI, 44 US$/T for 70/72% BPL as of end 1978 is taken in this study. This price was calculated by adding 11 US$/T of ocean freight between Jordan and the Philippines by 40,000 DWT vessel on top of FOB price of 33 US$/T.

As for the assumed price for the financial analyses and economic evaluation in Chapter XIII and XIV, CIF Philippines 55 US$/T as of July 1979 and 70 US$/T as of early 1983 are taken. These prices will be intermediate price between Jordan rock and Florida rock delivered to the Philippines, as the estimated ocean freight is from Jordan around 15 US$/T and from Florida 25 US$/T both in 40,000 tons lot.

V.2 Sulfuric Acid

The basic premises of this project is to manufacture fertilizer products using all of by-product sulfuric acid from PASAR. In accordance with the plan of PASAR up to now, it is found that quantity of by-product sulfuric acid is 412,000 T/Y, the completion of construction work is around the middle of 1982, the test running is during the second half of 1982, and the commercial operation commences at first quarter of 1983.

As the premises is that PASAR provides all by-product sulfuric acid to the fertilizer project at production cost, PASAR people may have the opinion that the fertilizer project should erect the sulfuric acid plant using the SO_2 containing gas which is supplied by PASAR free of charge. It is, however, our comment that the sulfuric acid manufacturing plant is very closely related with the copper smelter plant and can impossibly be separated each other, i.e. gas is generated at three points of the copper smelter, and some gas sources will be stopped once a day because some part of copper smelter is in batch operation. So it is necessary to manage to secure minimum gas required for operation of sulfuric acid plant, by combining such three gas sources of the copper smelter, in order to carry out continuous operation of the sulfuric acid plant without any troubles. And, it is deemed that there are equipment and facilities which might be operated by by-product steam from the copper smelter, so that relationship between the copper smelter and the sulfuric acid plant is quite close and deep. With all these, the operation of the sulfuric acid plant should be managed by the copper smelter side.

There may be another opinion that the operation of the sulfuric acid plant should be entrusted to the copper smelter and its construction should be executed by the fertilizer project. However, this study still stands on the idea that the sulfuric acid plant should be owned by the copper smelter side. Should the fertilizer manufacturer side own it, many problems relating to plant designing, operation, maintenance, responsibilities of management and control, etc., are anticipated. From these reasons mentioned above, the planning by PASAR is proceeding on the basis that the sulfuric acid plant is owned and operated by PASAR and sulfuric acid is supplied to the fertilizer project.

The price of sulfuric acid supplied to the fertilizer project from PASAR is said to be under negotiation between PASAR and the Philippine government, and it will be 19 US$ for three year from the start-up of the fertilizer plant and the price escalation will be negotiated afterwards. This report assumes 19 US$/T for all the claculation.

V.3 Ammonia

Ammonia is also one of the most important raw materials in this project. The Philippines now imports ammonia mainly from Japan in form of aqueous ammonia, or with small refrigerated vessels, so that they are rather expensive in price. In the last half of 1978, it was imported at about 150 US$/T, but it has seemingly risen up at present to around 170 US$/T. There exists no surplus of ammonia right now in the ASEAN countries, but it is expected that enough volume of ammonia can possibly be supplied from the East Kalimantan Project of Indonesia at the time of materialization of this project.

In such a case, it is expected that fairly low price of ammonia can possibly be expected under special terms and conditions as the business among ASEAN group, if shattle service transportation is carried out with a chartered refrigerated vessel between the Philippines and East Kalimantan. Supposing that enough ammonia is supplied from Indonesia with special terms and conditions, more or less C&F 140 - 150 US$/T is assumed as today's price. The basis of this assumption is that ammonia price FOB Mexico or others is about 110 US$/T, and ocean freight is assumed to be 25 - 28 US$/T with an chartered refrigerated vessel of about 3,000 DWT between the Philippines and East Kalimantan. 140 US$/T for end 1978 and 150 US$/T July 1979 are, therefore, deemed to be sufficiently tolerable. Please refer to Annex V-2 for further descriptions on ocean freight cost.

It is indispensable for this project to secure cheap ammonia and purchasing from East Kalimantan is advisable. But even if ammonia is not supplied from Indonesia, there is a way of securing cheap ammonia from Alaska or Mexico. For the reference, recent ammonia price offered from Alaska is 160 US$/T CIF Philippines.

V.4 Muriate of Potash

Muriate of Potash is a goods having relatively little fluctuation in price, and its major exporting countries are Canada and USSR.

An actual import price in the Philippines in 1978 was 67.25 US$/T, but it is reported that July 1979 price is 82 US$/T. The price of 75 US$/T is assumed for the product-mix study in Chapter VI and 82 US$/T for the financial analyses and economic evaluation in Chapter XIII and XIV.

V.5 Bag

Almost all of fertilizer products in this project will be in bagged form. Specifications of bags are 50 kg content polypropylene woven bag with polyethylene liner inside.

There are a number of bag manufacturers in the Philippines as shown in Annex Table V-3, and total production capacity reaches to 132 million bags per year as seen in the table, while current total bag consumption in the Philippines counts only 91 millions per year.

A total volume of fertilizer products in bag under this project is estimated to be about 520,000 T/Y in the extreme case, which is equivalent to 10.4 million bags, so that all requirements will be sufficed with the currently existing bag manufacturers.

A current bag price varies as follows:

1.75 Pesos/bag	FOB, Manila	(Information from the Ministry of Industry, Philippines)
2.64 Pesos/bag	Ex-Bataan	(Same as above)

2.30 Pesos/bag	Ex-factory	(from a trading firm of Japan)
1.85 Pesos/bag	Ex-factory Toledo	(from Atlas Co.)

In this report, the price of 2.5 Pesos/bag (equivalent to 6.85 US$/T product) is taken for the product-mix study in Chapter VI and 3.82 Pesos/bag (10.3 US$/T product) for the financial analyses and economic evaluation in Chapter XIII and XIV.

CHAPTER VI

PRODUCT-MIX STUDY

VI. PRODUCT-MIX STUDY

Till now, fertilizer supply-demand patterns in the ASEAN countries have been described, mainly for sulfuric acid consuming products, together with status of raw materials required for such products.

From now, this report will discuss about what types of equipment and facilities are necessary and how much capital are required. For this purpose, it must be clarified what kinds of products should be manufactured, before going into such discussions.

Hence, in this Chapter, a number of product combinations which consume 412,000 T/Y of by-product sulfuric acid from PASAR copper smelter are assumed in reference with consumption estimates by the ASEAN countries summarized in Para. IV-6, and the internal rates of return on investment for all combination cases are computed using capital requirement estimated in this chapter, product prices estimated in Chapter IV and raw material prices estimated in Chapter V. From these combinations one product-mix is selected that shows good profitability and is deemed to be fairly adequate from market point of view. For this product-mix case further detailed study is to be conducted in the following chapters.

VI.1 Principal Factors

1. Product Combination

Based on Table IV-40, Demand and Supply of Phosphate Fertilizers and Ammonium Sulfate in the ASEAN Countries for 1980, 1985 and 1990, some product combinations available for this project are proposed. They are shown in the left half columns of Table VI-5. The volume of each products is calculated, based on an assumption that 412,000 T/Y of by-product sulfuric acid is all consumed in producing these products, using the raw material consumption rate given in Table VI-4.

Further, 16-20-0 and 15-15-15 are chosen as representatives of NP and NPK respectively. 14-14-14 of NPK is more popular in the Philippines, and roughly speaking the production capacity in one plant is increased in inverse proportion to the contents of P_2O_5.

2. Price

This product-mix study was carried out based on the raw materials and final products prices of end 1978 which were converted into prices of July 1982 (base year: Operation commencing year). On the other hand, the financial analyses and economic evaluation study given in Chapter XIII and XIV were made based on the prices of July 1979 which were converted into those of early 1983 (base year) only from the reason of the difference in time at which these studies were conducted. Strictly speaking, the product-mix study should be repeated based on the July 1979 prices, but, for the purpose of selecting proper product-mix, it is estimated that there will be no difference in conclusion whichever base prices are taken. From this reason, two groups of base prices are used in this report.

Final products prices are discussed in Chapter IV and raw material prices are discussed in Chapter V. 7% per year escalation rate is taken for all prices judging from worldwide general price increase including phosphate rock price increase and July 1982 or early 1983 prices are calculated using this escalation rate.

End 1978 prices and 1982's prices of raw materials are tabulated in Table VI-1 as follows:

Table VI-1. Assumed Raw Material Price

	End 1978	1982
Phosphate rock 70/72% BPL	44 US$/T	55 US$/T
Sulfuric acid	15 US$/T	19 US$/T
Ammonia	150 US$/T	190 US$/T
Potassium chloride	75 US$/T	95 US$/T
Urea	150 US$/T	190 US$/T
Electricity*	0.036 US$/KWH	0.044 US$/KWH
Fuel heavy oil	110 US$/T	140 US$/T
Antifoaming agent	1,600 US$/T	2,000 US$/T
Anticaking agent	110 US$/T	1,400 US$/T
Bag	6.85 US$/T fertilizer	8.7 US$/T fertilizer

* These figures are given by National Power Cooperation, Philippines.

Estimated FOB prices, Ex-factory, Philippines, of products selected for this project, in terms of end 1978 and July 1982, are tabulated in Table VI-2 as follows:

Table VI-2. Assumed Products Price (US$/T product)

	in bags		bulk	
	Today	1982	Today	1982
Ammonium sulfate	95	120	80	101
15-15-15	160	203	140	177
16-20-0	135	171	115	146
DAP	180	228	160	203
TSP	140	177	120	152
Phosphoric acid (54%)*			300	380

* Price for phosphoric acid is US$/T P_2O_5.

3. Construction Cost and Raw Material Consumption Rates

In Table VI-3, below, is tabulated estimated construction costs to be used for case study to determine suitable product combinations.

Naturally plant capacity differs for each case and 0.6th power rule is applied to estimate plant construction cost per capacity of each case, which is given in the third column from the last (Investment cost) in Table VI-5.

Fertilizer manufacturing plant is designed as multi-purpose plant, with which NPK, NP, DAP and TSP can be produced. Further, about 20 million US$ of working capital is added to the investment cost given in the table.

Additionally, estimated construction costs here are for the purpose of case study, and surely differ from what are used in the later paras., because investment costs used in the later chapters are estimated with further detailed specifications on the proposed plant best suitable to manufacture product combinations selected out of such 20 cases.

Table VI-3. Construction Cost for Case Study

280 T/D phosphoric acid plant (including tank and waste water treatment plant)	19.1 million US$
700 T/D fertilizer plant (including product warehouse)	10.9
500T/D ammonium phosphate plant (including product warehouse)	7.8
180 T/D phosphoric acid concentrating plant (including product tank)	4.6
Utility facilities	4.5
Raw material warehouse, tank and unloader	15.5
Plant service building and facilities	6.0
Pier facilities	5.5
Land acquisition, land preparation, road, etc.	1.7
Housings	0.3

Raw material consumption rates shown in Table VI-4 are used.

Table VI-4. Raw Material Consumption (t/t product)*

	As	15-15-15	16-20-0	DAP	TSP	54% PA
Phosfate rock		0.479	0.634	1.442	1.485	3.107
Sulfuric acid	0.754	0.693	0.922	1.315	0.984	2.834
Ammonia	0.263	0.151	0.202	0.228		
Potassium chloride		0.256				
Urea		0.070				
Electricity KWH/T	33	74.1	84.5	174.9	166.7	247
Fuel heavy oil	0.012	0.044	0.049	0.059	0.048	0.077
Anti-caking agent		0.01	0.01			
Anti-foaming agent g/T		30	30	80	70	170

* For 54% phosforic acid t/t P_2O_5.

4. **Other Factors**

i) Commencement of commercial operation is July, 1982, and construction period is 30 months, including test operation period.

ii) Operating rate is 60% in 1982, 80% in 1983 and 90% onward.

iii) Personnel expenses: Total number of employees is 312. Salary and wage is set by ranks, and fringe benefit, 35% of basic salary, and overtime allowance, 15% of basic salary, are considered. Additionally, 60 daily contract workers are programmed.

iv) Maintenance cost is 3% of total plant cost. (1% for company owned houses)

v) Insurance cost is 1.6% of total remaining value of assets.

vi) Total overhead cost (including expenses at head office) is 3.5% of total manufacturing cost.

vii) Depreciation period: Mostly 12 years; 30 years for company owned houses; and 50 years for port and water intake facilities.

viii) Loan repayment: Interest rate at 4% per annum; 4 years of grace period; and 15 year-equal-instalment-repayment, including 4 years grace period.

ix) Pre-operation cost: 1.44 million US dollars with amortization of 5 years.

x) Corporate income tax: 35%, with exemption for 5 years.

VI.2 Computation Results of Case Study

Using all the conditions mentioned in the previous para., the internal rate of return over 20 cases are computed, the results of which are tabulated in Table VI-5.

With these results, the following items can be pointed out regarding the influence of product combination and shipping pattern over profitability:

i) Comparing each other among Case 1 through Case 4, better profitability is found

Table VI-5. Result of Case Study

Case	Product (1,000 T/Y)						Packing	Investment cost* (million US$)	Internal rate of return (%)	
	Ammonium sulphate	15-15-15	16-20-0	DAP	TSP	Phosphoric acid			before tax	after tax
1	0	100	100	0	0	88.4	In bags	77.1	9.10	7.74
2	100	100	100	0	0	61.8	In bags	78.6	9.57	8.14
3	150	100	100	0	0	48.5	In bags	78.0	10.01	8.56
4	200	100	100	0	0	35.2	In bags	76.9	10.57	9.04
5	150	59.3	59.3	50	0	48.5	In bags	78.2	7.92	6.70
6	150	69.5	69.5	0	50	48.5	In bags	78.5	8.82	7.49
7	150	140	70	0	0	48.5	In bags	78.3	10.87	9.32
8	150	63.6	127.3	0	0	48.5	In bags	77.8	9.21	7.83
9	150	132.4	132.4	0	0	30.0	In bags	77.8	11.43	9.83
10	150	185.1	185.1	0	0	0	In bags	76.0	13.88	12.09
11	100	123	123	0	0	48.5	In bags	78.7	10.52	9.00
12	150	100	100	104	0	0	In bags	76.8	9.75	8.31
13	150	100	100	0	139.6	0	In bags	77.7	10.71	9.17
14	100	100	100	0	38.3	48.5	In bags	79.1	9.66	8.23
15	100	100	100	28.6	0	48.5	In bags	78.9	9.38	7.97
16	100	50	0	0	167.2	48.5	TSP bulk Others in bag	80.5	5.09	4.26
17	100	50	0	125.1	0	48.5	DAP bulk Others in bag	79.3	4.28	3.58
18	150	100	100	0	0	48.5	All products 1/2 in bags 1/2 in bulk	78.0	8.26	6.98
19	150	132.4	132.4	0	0	30.0	All products 1/2 in bags 1/2 in bulk	77.8	9.37	7.96
20	150	185.1	185.1	0	0	0	All products 1/2 in bags 1/2 in bulk	76.0	11.37	9.77

* 20 M US$ of working capital is not included.

in ammonium sulfate than in phosphoric acid.

ii) Comparing each other among Cases 3, 5 and 6, better profitability is found in NP/NPK than in DAP or TSP, both in bag.

iii) Comparing each other between Cases 7 and 8, 15-15-15 has better profitability than 16-20-0 has.

iv) Comparing each other among Cases 3, 9 and 10, NP/NPK is better than phosphoric acid in terms of profitability.

v) Comparing Case 3 with Case 11, NP/NPK has a little bit better profitability than ammonium sulfate has.

vi) Comparing Case 3 with Case 12, phosphoric acid is slightly better in profitability than DAP in bag.

vii) Comparing Case 3 with Case 13, slightly higher profitability of TSP in bag is seen than that of phosphoric acid. However, the differences among TSP in bag, DAP in bag and phosphoric acid are very little.

viii) Comparing each other among Cases 3, 14 and 15, ammonium sulfate is better in profitability than both TSP and DAP.

ix) From comparisons each other between Cases 12 and 13 and between Cases 14 and 15, TSP is found to be better in profitability than DAP.

x) As seen in Cases 16 and 17, producing such intermediate products as DAP, TSP and phosphoric acid and shipping them in bulk show very low profitability.

xi) Through comparisons each other between 3 and 18, 9 and 19, and 10 and 20, it is found that profitability is lowered when bulk shipment ratio incrases.

Summarizing all these above, the order of profitability is as follows:

NPK > NP > Ammonium sulfate > TSP > Phosphoric acid > DAP