THE FEASIBILITY STUDY REPORT
ON
THE ESTABLISHMENT OF A PHOSPHATE FERTILIZER PLANT
IN
THE REPUBLIC OF PARAGUAY

(SUMMARY)

MARCH, 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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PARAGUAY
Bolivia
Chaco
Nueva Asunción
Alto Paraguay
Brazil
Paraguay River
Boquerón
Concepción
Pedro Juan Caballero
Amambay
Verde River
Pezo Colorado
Montelindo River
Presidente Hayes
Argentina
Pilcomayo River
San Pedro
San Pedro
Canendiyu
Alto Parana
Cordillera
Caaguazú
Asución
Caacupé
Coronel Oviedo
Pto. Pte. Stroessner
PLANT SITE
Central
La Colmeva
Villarrica
Guaira
Paraguari
L. Verá
Coaprecu
San Juan
Bautista
Itapúa
Alto Parana River
Paraguay River
Neembucú
Misiones
Fram
Pilapo
Hohenan
Encarnación
Paraguay
Pacific Ocean
Atlantic Ocean
Bituminous Surfaced Roads
Gravel/earth Surfaced Roads
Railroads
Department Boudaries
International Boundaries
Rivers
0 40 80 120 160
KILOMETERS

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CHAPTER I INTRODUCTION

1.1 Background

Agriculture is the most important industry in Paraguay, accounting for over 30% of the GDP. As a result of traditional extensive farming practices, however, agricultural productivity has decreased because of soil deterioration. In recent years the shift to intensive cropping with active fertilization has been encouraged, but as there is no domestic fertilizer plant, all fertilizer must be imported. This situation results not only in loss of foreign exchange credits, but in an unstable supply of fertilizer as well.

On the other hand, Itaipu power station (12.6 million kW), a cooperative project between Paraguay and Brazil, is expected to be completed in the early 1990's. In 1982, the Japan International Cooperation Agency implemented preliminary research to determine how to put this large quantity of electricity to good use in power-intensive industry. As the results of research, the production of fertilizer using this large quantity of electricity was listed as one of possible projects in Paraguay. The Government of Paraguay, then, made a request to the Government of Japan to conduct a feasibility study on the establishment of a phosphate fertilizer plant. Upon receiving the request, the Japan International Cooperation Agency dispatched a pre-survey team in February 1986 and a scope of work for the feasibility study was agreed.

The field survey was conducted from June 16 to July 17, 1986 based on the scope of work. This report has been worked out as the results of the field survey in Paraguay and home study in Japan.

1.2 Purpose of Study

The purpose of this study is to assist the Government of Paraguay in its plans to develop a domestic fertilizer industry by analyzing the market, technical, financial and economic aspects in Paraguay.

1.3 National Development Plans

Economic development in Paraguay is planned according to two to five year "National Economic and Social Development Plans", which are devised by the Secretaria Tecnica de Planificacion (STP), located directly under the President. The project offices in STP supervise the projects enacted under these plans.

Although three such national plans were implemented in the 1960's, the first serious development projects came under the plan which lasted from 1971 until 1975. During this period a goal was set at 6% annual growth in GDP, and the actual result was a 6.6% growth. During the next planning period, from 1977 to 1981, a goal of 7.6% growth annually was more than matched by an actual figure of 10.9%.

Between 1980 and 1984, however, total domestic production grew at an average rate of only 1.9% annually, and production in the agricultural sector at the rate of 3.4%.

The five-year national plan currently being constructed, like its predecessors, contains mostly agricultural development projects. The four fundamental directions of the plan are; aid to the small farmer, greater production of export crops, substitution of domestic crops for imports (mostly wheat), and protection of the environment. This plan has not yet been approved by the government, so details such as projected total growth in domestic production have not been made public.

The Paraguayan Ministry of Agriculture and Livestock recognizes the importance of fertilization for increasing production of food resources and for promoting regional recovery and development; and is thus solidly in favor of constructing a domestic fertilizer plant.

1.4 Project Outline

The products earmarked for manufacture under this project are phosphate fertilizers suitable for the Paraguayan agricultural industry, and are presently being imported. The processes to be employed in this study require large amounts of electric power, which will be supplied directly from Itaipu power station.

Phosphate rock, the major raw material, will be imported from Brazil, and used to produce DAP (29,000 ton/yr), TSP (5,000 ton/yr), NPK 6-30-10 (32,000 ton/yr) and NPK 15-15-15 (4,000 ton/yr) fertilizers. In addition to these water soluble phosphate fertilizers, the production of FMP (15,000 ton/yr), which is soluble in citric acid, is studied. Taking into consideration such factors as supply of electric power, transportation of raw materials and marketing of the products, Hernandarias City, close to Itaipu Dam, was chosen as the location for the plant.

CHAPTER II WORLDWIDE SUPPLY AND DEMAND AND PRICE TRENDS FOR PHOSPHATE FERTILIZERS

2.1 World Supply and Demand for Phosphate Fertilizers

Table 2-1-1 shows yearly production and consumption for phosphate fertilizers. Between 1980/81 and 1981/82, production fell 8.2% from 3.45 million ton P_2O_5 to 3.17 million ton P_2O_5. Afterwards, however, production recovered, and by 1983/84 regained the 1980/81 level with a total of 3.49 million ton P_2O_5.

World consumption fell in 1981/82 and 1982/83, but then rose again in 1983/84, reaching a level of 3.29 million ton P_2O_5 in that year.

Table 2-1-1 Phosphate Fertilizer Production and Consumption

	Production (million tP_2O_5)					Consumption (million tP_2O_5)				
	1979/80	1980/81	1981/82	1982/83	1983/84	1979/80	1980/81	1981/82	1982/83	1983/84
Developed Market Economies	18.29	18.07	15.08	15.17	16.64	14.27	13.48	12.68	12.00	12.86
	(54.8%)	(53.4%)	(47.6%)	(47.2%)	(47.8%)	(45.9%)	(42.8%)	(41.2%)	(39.2%)	(39.1%)
Developing Market Economies	4.21	5.19	4.73	5.10	5.73	5.94	6.64	6.09	6.41	6.55
	(12.6%)	(15.0%)	(14.9%)	(15.9%)	(16.4%)	(19.1%)	(21.0%)	(19.8%)	(21.0%)	(19.9%)
[inwhich Latin America]	[1.60]	[1.90]	[1.53]	[1.48]	[1.40]	[2.46]	[2.78]	[2.19]	[2.17]	[1.85]
Centrally Planned Economies	10.89	11.25	11.88	11.87	12.48	10.88	11.43	12.03	12.18	13.44
	(32.6%)	(32.6%)	(37.5%)	(36.9%)	(35.8%)	(35.0%)	(36.2%)	(39.0%)	(39.8%)	(41.0%)
World Total	33.39	34.51	31.69	32.14	34.85	31.09	31.56	30.80	30.59	32.86
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)

Source: FAO

2.2 Regional Supply and Demand for Phosphate Fertilizers in Neighboring Countries

2.2.1 Latin America

Table 2-2-1 projects the supply and demand balance for phosphate fertilizers in Latin America.

Table 2-2-1 Latin America: Fertilizer Supply-Demand Balance, 1984/85-1989/90 (forecast)

(Unit: 1,000 tP_2O_5)

	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Potential P_2O_5 Fertilizer Supply	1,580	1,593	1,752	1,975	1,980	2,049
P_2O_5 Fertilizer Consumption	2,490	2,210	2,390	2,580	2,740	2,900
Surplus (deficit)	(910)	(617)	(638)	(605)	(760)	(851)

Source: British Sulfur

Although Fertimex has completed a new phosphoric acid/phosphate fertilizer plant at Lazaro Cardenas in Mexico, the shortage of this fertilizer in Latin America remains unresolved.

Venezuela and Brazil have plans for new phosphate fertilizer plants, but there is little possibility that these projects will be implemented before the early 1990's. Thus the shortage of phosphate fertilizer in Latin America, 600 thousand ton in 1985/86, is expected to reach the 1 million ton mark by 1990. The deficit in supply is made up by imports from places like the U.S. and Morocco.

2.2.2 Brazil

Table 2-2-2 lists supply and demand balance for phosphate fertilizer in Brazil.

Table 2-2-2 Supply and Demand Balance of Phosphate Fertilizer in Brazil

(Unit: tP_2O_5)

	1980/81	1981/82	1982/83	1983/84
Supply				
Production	1,582,478	1,186,600	1,115,200	1,055,200
Import	408,608	135,600	98,100	N.A.
Supply Total	1,991,086	1,322,200	1,213,300	-
Demand				
Consumption	1,988,486	1,318,300	1,210,400	999,700
Export	2,600	3,900	2,900	55,500
Demand Total	1,991,086	1,322,200	1,213,300	1,055,200

Source: FAO

Both production and consumption reached a peak in 1980/81. Since then both have tapered off, and in 1983/84 stood around the million ton P_2O_5 mark. This decline can be contributed to cutbacks in agricultural aid programs due to a downturn in the national economy.

In 1986, however, due to economic recovery measures based on introduction of the new currency system (the Cruzado Plan) in February, and to the new Agricultural Development Plan (1986-1989) which was announced in August and aims to increase crop production, fertilizer consumption is expected to increase by 7-8%.

2.2.3 Argentina

The balance of supply and demand for phosphate fertilizers in Argentina is shown in Table 2-2-3.

Table 2-2-3 Supply and Demand Balance of Phosphate Fertilizer in Argentina

(Unit: tP_2O_5)

	1980/81	1981/82	1982/83	1983/84
Supply				
Production*	500	89	100	-
Import	49,515	42,500	55,914	56,100
Supply Total	50,015	42,589	56,014	56,100
Demand				
Consumption	44,164	40,000	48,400	49,700
Export	405	-	-	-
Demand Total	44,569	40,000	48,400	49,700

* : Basic slag Source: FAO

With the exception of some basic slag, Argentina does not produce phosphate fertilizer, and relies entirely on imports. Consumption decreased in 1981/82, but has recovered since, and stood at 50,000 ton P_2O_5 in 1983/84.

Table 2-2-4 provides estimated consumption of various fertilizers in 1985/86. Figures of 100,000 ton for DAP, 50,000 ton for TSP and 30,000 ton for NPK bring the total for phosphate fertilizers up to 180,000 ton.

Table 2-2-4 1985/86 Forecast of Fertilizer Consumption

(Unit: t)

Crop	Urea	DAP	TSP	Compound	Ammonia	Ammonium Sulphate
Wheat	150,000	80,000	30,000		5,000	-
Corn	20,000	-	-	-	3,000	-
Sugarcane	40,000	-	-	-	-	-
Fruit	10,000	10,000	-	15,000	-	-
Tobacco	-	-	-	10,000	-	-
Other Crops	50,000	10,000	20,000	5,000	-	20,000
Total (est.)	270,000	100,000	50,000	30,000	8,000	20,000

Source: Fertilizer International No.203, 23 May 1985, British Sulfur

2.3 Phosphate Fertilizers Trade and Price on World Market

2.3.1 Phosphate Fertilizer Trade

Annual volumes and growth rates for export and import of phosphate fertilizers are shown in Table 2-3-1. In 1983/84, world export volume was 82 million ton P_2O_5, or 1/4 of total production. Of this, 70% was accounted for by the developed nations, who export to other developed nations, developing nations, and communist bloc nations. For developing nations, however, exports are increasing while imports decrease, reflecting a growing importance of phosphate fertilizers in these countries.

On a regional basis, volumes of exports are accounted for by North America (especially the U.S.), Western Europe and North Africa (especially Morocco and Tunisia), in that order. Western European exports, however, are mostly confined to their own region, and the U.S., Morocco and Tunisia are foremost in exports to other parts of the world.

Imports, on the other hand, are concentrated in Asia, with China, India and Iran importing large volumes of phosphate fertilizers.

Table 2-3-1 Exports and Imports of Phosphate Fertilizer

	Exports (1,000 tP_2O_5)					Imports (1,000 tP_2O_5)				
	1979/80	1980/81	1981/82	1982/83	1983/84	1979/80	1980/81	1981/82	1982/83	1983/84
Developed Market Economies	5,442 (80.0%)	6,033 (80.3%)	5,108 (79.2%)	5,372 (76.1%)	6,017 (73.4%)	2,474 (42.4%)	2,323 (35.2%)	2,247 (40.8%)	2,444 (39.5%)	2,604 (38.2%)
North America	3,790	4,217	3,565	3,649	4,042	392	359	313	283	260
Western Europe	1,570	1,721	1,453	1,591	1,798	1,956	1,797	1,717	1,814	1,955
Oceania	3	5	1	0	0	26	50	61	148	203
Others	78	90	89	132	176	101	117	156	199	186
Developing Market Economies	872 (12.8%)	973 (13.0%)	875 (13.6%)	1,182 (16.7%)	1,610 (19.6%)	2,731 (46.8%)	3,361 (51.0%)	2,306 (41.8%)	2,446 (39.5%)	3,458 (36.1%)
Africa	377	431	584	671	896	205	284	293	230	321
Latin America	71	42	21	15	71	973	960	705	713	543
Near East	100	121	100	208	339	667	855	482	562	752
Far East	283	344	142	262	282	881	1,357	820	936	837
Others	40	36	28	27	22	5	5	6	4	4
Centrally Planned Economies	488 (7.2%)	500 (6.7%)	467 (7.2%)	509 (7.2%)	576 (7.0%)	632 (10.8%)	911 (13.8%)	959 (17.4%)	1,298 (21.0%)	1,742 (25.6%)
Asia	2	N.A.	N.A.	1	N.A.	176	378	374	633	1,023
Europe/U.S.S.R.	486	500	467	509	576	456	533	585	665	718
World Total	6,802 (100%)	7,506 (100%)	6,450 (100%)	7,064 (100%)	8,202 (100%)	5,837 (100%)	6,595 (100%)	5,512 (100%)	6,188 (100%)	6,804 (100%)

Source: FAO

2.3.2 Price Trends for Phosphate Fertilizers on the World Market

Almost half of the exports of phosphate fertilizers originate in the U.S., and it is safe to conclude that the world market prices for phosphate fertilizers are based on U.S. standards.

Numerous types of phosphate fertilizers are produced, but DAP, TSP and NPK are most important on the world market. NPK fertilizers are available under a variety of product names with different nutrient ratios, but this discussion will focus on 15-15-15, which is most common on the international market. Figure 2-3-1 charts export price trends for DAP, TSP and 15-15-15 fertilizers.

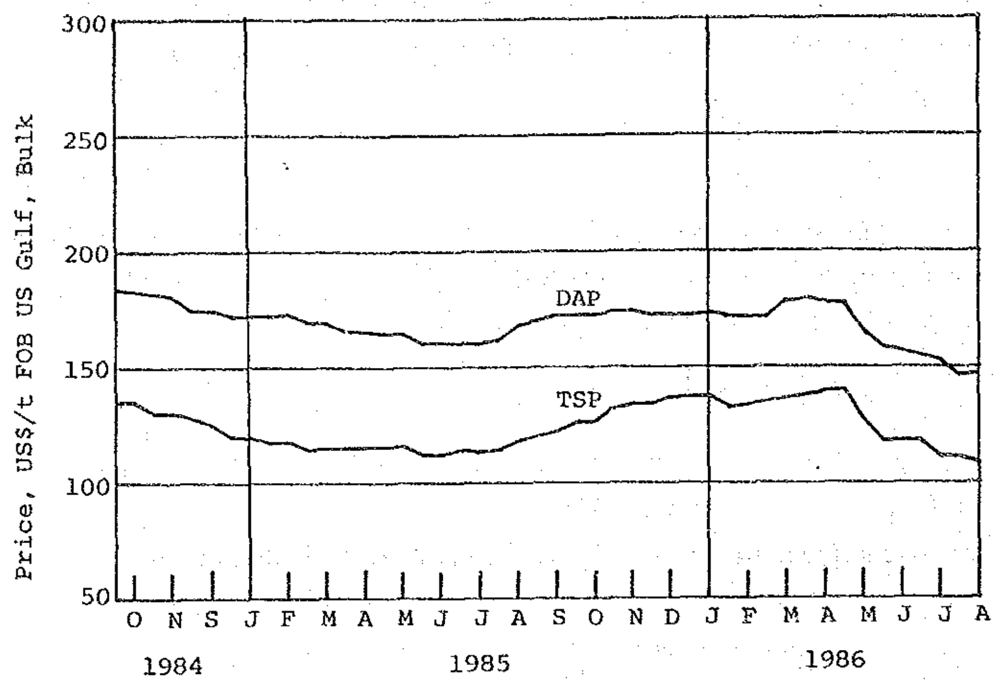
In July of 1986, the export price for DAP dropped to $149-155/ton FOB bulk U.S. Gulf, the lowest since the oil shock of 1978/79. Prices for bagged fertilizer are a bit higher, ranging from $180 to $190/ton FOB exporting country. These price levels are exceptionally low, and the U.S. estimates that an FOB bulk U.S. Gulf price of $200/ton is necessary to turn a profit.

The reason for these low prices is a stagnation in demand. Grain surpluses in countries like the U.S. contribute to the decline in demand for fertilizer. In addition, oil exporting nations like Mexico, Iran and Indonesia are strapped for foreign reserves because of falling oil prices, and are thus less able to purchase fertilizer from abroad.

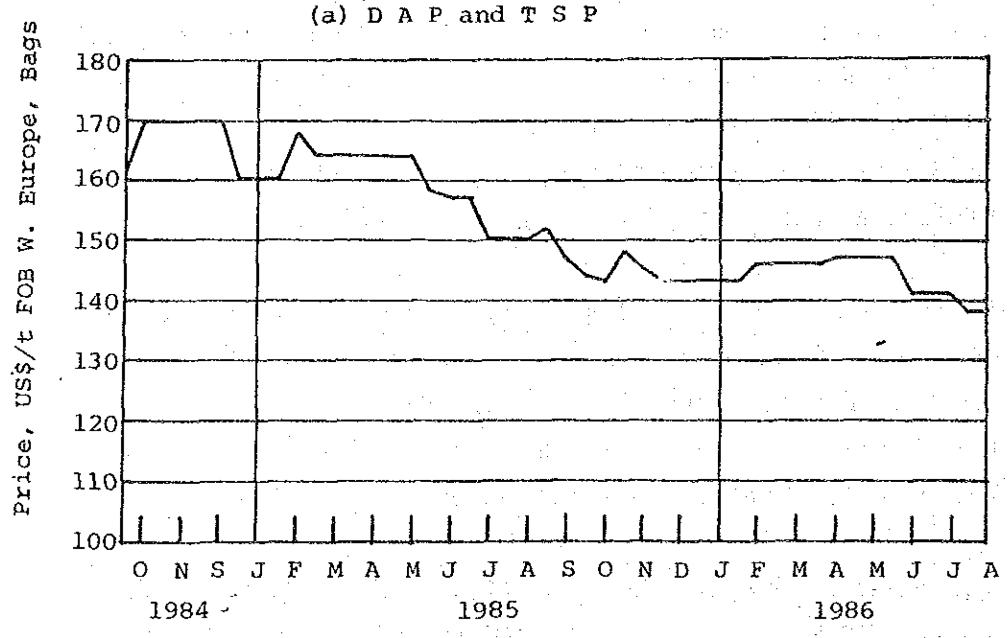
Under these difficult conditions, U.S. fertilizer plants are said to be operating at an average of 52-55% of capacity. Construction of new plants can only add to this gap between supply and demand, which shows no signs of dissolving. The recent prices, however, are unusually low, and over the long run, can be expected to recover and fluctuate between $180 and $200/ton bulk.

TSP prices are linked to those of DAP, and thus market trends are approximately similar. FOB U.S. Gulf prices for TSP are now around $109-112/ton for bulk, and $143-168/ton for bagged fertilizer. In the long run, however, if bulk DAP prices return to the $180-200/ton range, TSP can be expected to fluctuate between $140 and $150/ton bulk.

Prices for 15-15-15 fertilizer have not dropped as sharply as those for TSP and DAP, and now stand at $135-140/ton FOB Western Europe for bagged fertilizer.



(a) D A P and T S P



(b) 15 - 15 - 15

Figure 2-3-1 Export Price Trends

CHAPTER III PARAGUAYAN AGRICULTURE

3.1 Introduction to Agriculture in Paraguay

Paraguay occupies a total area of 406,752 km^2. The Rio Paraguay flows from north to south through the center of the country, dividing it into two regions with distinctive geographical features.

The west side of the river is formerly known as the "Chaco" region. Although this region has a flat topography, for reasons of climate and soil conditions, agricultural development has been slow, and the population density remains at a low level.

Of greatest importance in agriculture is the area east of the river, where almost all crops such as soybeans, wheat, cotton, maize and vegetables are cultivated.

22 million ha, which amounts to 54% of the national area, is considered as agricultural land. Almost half of this figure, however, is devoted to permanent pasture, and extensive forests remain as well. Thus only 2.8 million ha is left as "arable" land, of which a further 1.2 million ha is used for temporary crops.

Table 3-1-1 shows the cultivated area and production of major crops.

Table 3-1-1 Cultivated Area and Production of Major Crops (1984)

Crop	Cultivated Area (1,000 ha)	Production (1,000 t)	Yield (kg/ha)
Soybean	746.8	1,172.5	1,631
Wheat	134.4	184.6	1,477
Maize	481.5	800.8	1,702
Cotton	400.7	469.3	1,216
Sugarcane	56.0	2,726.5	49,000
Cassava	202.2	2,633.3	14,154

3.2 Role of Fertilizer in Paraguayan Agriculture

Paraguayan agriculture is concentrated mainly in the central part of the Eastern Region, where soils derived from arenite prevail, and in the terra-roxa soils of the Parana Highlands. Wheat and soybeans, which are the most fertilized crops, are grown primarily in the Parana Highlands.

The terra-roxa soils are known to be highly fertile soils containing abundant amounts of many nutrients; but after reclamation, nutrients leach down below the reach of the roots of cropped plants. In addition, nutrients tend to be depleted by the crops, reducing the fertility of the soil.

Strong rains are also capable of eroding and washing away the soil, and in some places the subsoil, inferior in physical and chemical properties, is exposed, with a resultant loss in fertility. Many farmers are fully aware of the decline of soil fertility in their lands.

Compared to the natural yield of soybeans, yield after fertilization with three nutrients shows a substantial increase, indicating that the natural fertility has been depleted. In particular, use of P_2O_5 fertilizer is most instrumental in increasing yields. It indicates that the terra-roxa soils are poor in supplement of natural phosphorus.

Experiments conducted in the colonized regions of Yguazu in Alto Parana Department confirm the fact that levels of available phosphate in the soils are low, and that fertilization of soybeans and wheat with phosphate results in substantial yield increases.

From the above, the terra-roxa soils, which have been previously accepted as highly fertile, can be seen as clearly lacking in some nutrients. Thus if the present production levels are to be increased or even maintained, artificial replenishment of the nutrients for the soil will be necessary. Although top priority must be given to resupply of phosphate, which is most noticeable lacking in the natural content, nitrogen and potassium must also be given due consideration. Even though the natural content of K_2O is relatively high, there is a limit to the soil's natural ability to continuously supply this nutrient, especially under heavy cultivation of crops like soybeans that require large amounts of potassium.

Nutritional needs vary from crop to crop, and fertilizer use must be adapted to these individual requirements. In the past, different fertilizers were supplied in individual units and used as needed to meet the requirements at hand. Recently, however, compound fertilizers designed for specific crops have come into wide use. Such compound fertilizers should play an especially heavy role in large scale Paraguayan agriculture.

The Paraguayan fertilizer plant can be expected to eventually produce compound fertilizers that are precisely suited to the needs of Paraguayan agriculture. At present, however, much experimental research still remains to be done in determining the best combinations for actual fertilization. Thus for the time being, the plant should concentrate on producing the most valuable and effective of the presently used fertilizers.

Concerning the types of fertilizers presently used in Paraguay with soybeans and wheat, an NPK fertilizer of 4-30-10 (or 5-30-10) would probably be best for soybeans. For wheat, which requires more nitrogen than soybeans, DAP (18-48-0) would be suitable. For vegetables and irrigated rice, although the cultivated area of these crops is relatively small, 12-12-17-2 NPK fertilizer should be supplied.

In addition, Paraguayan soils being basically deficient in phosphorus, a single element fertilizer of phosphate will also be needed. TSP (0-46-0), used widely at present, will suffice for this purpose, but the possibilities of using fused magnesium phosphate (FMP) in its place should also be investigated.

The advantage of fused magnesium phosphate is that the phosphorus contained within does not dissolve in water, and is not easily absorbed to the soil or leached away. The disadvantage is that the fertilization effect thus occurs on a delayed reaction basis, and is therefore not suitable for single year plantings. In addition, the percentage of phosphate is low, so large quantities must be applied. These are most likely the reasons why FMP has not yet been considered for use in Paraguay.

At present, however, virtually no detailed research on fused magnesium phosphate has been accomplished in Paraguay, and people are not fully aware of the possibilities of using this fertilizer. Only one set of experimental results comparing various types of phosphate fertilizers is available,which shows that FMP has approximately the same effect on crop yield as TSP or super phosphate (Estacion Experimental Agropecuaria en Paraguay 1985). Fused magneisum phosphate enjoys several advantages over other phosphate fertilizers. Detailed experiments should be conducted to see if these advantages can be put to use in Paraguayan agriculture.

CHAPTER IV MARKET STUDY

4.1 Supply and Demand of Fertilizers

All fertilizers required in Paraguay are imported, of which about 80% comes from Brazil. Official exchange rate (240 Gs/US$) is applied to the fertilizers with government permission for import. There is other inflow of fertilizers that is not shown in trade statistics, it is delt with a free exchange rate (ca. 700 Gs/US$). This amount is estimated to be 30% of the official importation. The statistics of fertilizer trade in Paraguay is not accurate. Estimation of fertilizer supply and demand for the past five years, however, is summarized in Table 4-1-1.

Table 4-1-1 Supply and Demand of Fertilizer

(Unit: t)

	1981	1982	1983	1984	1985
Demand					
Phosphate Fertilizers	16,000	19,000	22,000	25,000	31,500
N, K-Fertilizers*	3,000	3,000	3,000	3,000	3,500
Total	19,000	22,000	25,000	28,000	35,000
Supply (Import)					
Phosphate Fertilizers	16,000	19,000	22,000	25,000	31,500
N, K-Fertilizers*	3,000	3,000	3,000	3,000	3,500
Total	19,000	22,000	25,000	28,000	35,000

*: urea, KCl, etc.

Changes in fertilizer consumption for individual crops are difficult to estimate, because of lack of data on the level and extent of fertilizer use. For 1985, however, an estimate of fertilizer consumption for individual crops can be obtained from statistics and interview research. These estimates are presented in Table 4-1-2. A wide variety of fertilizers are in use in Paraguay. Table 4-1-2, however, groups these into related categories and reports the types used most frequently by farmers on a regular basis.

Table 4-1-2 Fertilizer Use by Crop (1985)

(Unit: t)

	Soybean	Wheat	Tomato	Others	Total
P, NP, NPK					
TSP(0-46-0)	900	1,500			2,400
DAP(18-46-0)		13,800			13,800
5-30-10	12,600				12,600
12-12-17-2			1,800		1,800
15-15-15				900	900
Sub Total	13,500	15,300	1,800	900	31,500
N (Urea etc.)					2,600
K (KCl etc.)					900
Total					35,000

As can be seen, most of the fertilizer is used with wheat and soybeans, and only smaller amounts with tomato, and other crops and vegetables. Production of wheat and soybeans concentrates in the Itapua and Alto-Parana Departments, and tomatoes in Central, Caaguazu and Alto-Parana. Thus the geographical distribution of fertilizer use centers on these regions.

4.2 Fertilizer and Crop Value

All fertilizer used in Paraguay is imported, with ca. 80% origination in neighboring Brazil. Using Brazilian imports as an example, the final price of fertilizer to a Paraguay farmer will usually include the following costs which raise the price:

- FOB price
- Truck freight and insurance costs to the national border (Foz do Iguacu)
- Truck transshipment costs (Brazilian carrier to Paraguaian carrier)
- Custom clearance fees (20% of CIF price)
- Bank charge (10.5% of CIF price)
- Domestic shipping costs
- Commission of agricultural cooperatives or agricultural pharmaceuticals/ fertilizers trading firm

Table 4-2-1 compares the FOB prices for fertilizer exported to Paraguay and the international maket prices.

Table 4-2-1 Comparison of FOB Prices (1985)

(Unit: US$/t)

	FOB Brazil for Paraguay (Bag) (Av. during Jan./Oct., 1985)	International Market	
		FOB	Place
DAP	341	165-175	US Gulf, bulk
TSP	250	120-135	US Gulf, bulk
Urea	226	110-130	W. Europe, bags
KCl	180	78- 82	Vancouver

Source: CACEX (FOB Brazil)
British Sulfur Corp. (International Market)

The high FOB price for Brazilian fertilizer is related to that country's policy of protecting its domestic fertilizer producers. An official limit on imports of basic fertilizers such as TSP isolates domestic prices from the influence of the world market and keeps them high. Furthermore, Paraguay imports only limited quantities, and there is no competitive supplier to force prices down.

Crop prices have been increasing. However, they are still at a low level in comparison with the fertilizer prices. As shown in Table 4-2-2, the ratio of crop price to fertilizer price is below one. The economic value of fertilizer use as evaluated by this ratio is not very promising.

Table 4-2-2 Crop Price vs. Fertilizer Price for 1985

	Crop Price (A) (Gs/kg)	Fertilizer Price (B) (Gs/kg)		A/B
Soybean	92.0	119	(5-30-10)	0.77
Wheat	64.9	126	(DAP)	0.52

4.3 Fertilization and Crop Yields

The overall economic efficiency of fertilization can not be derived simply from the amount of additional yield produced by the fertilizer. The price of the crop and the cost of the fertilizer must also be taken into consideration. As a measure of overall economic efficiency, the Value Cost Ratio (VCR) compares the cost of fertilization with the value (not just quantity) of the yield. In this calculation, fertilizer cost does not include manpower costs or machinery operating costs incurred during the actual process of fertilization. In general, the economic value of fertilizer use can be justified when VCR is above two.

Based on the experimental results at Paraguay research institutes, VCR is calculated with the prices of fertilizers and crops. Soybeans give ca. 3 of VCR at 30 kg P_2O_5/ha and wheat, ca. 3 at 30-70 kg P_2P_5, showing the most economical dosage levels.

4.4 Fertilizer Demand Projection

At present, fertilizer use in Paraguay centers on the soybean and wheat crops. Research and experiments concentrate on these two crops, and results are eventually known among the farmers. Little research on fertilization of crops other than wheat and soybeans is being conducted, and the government is not actively promoting such fertilization among the farmers. Furthermore, farmers lacking previous experience with fertilizers do not adopt the practice in the absence of sufficient technical assistance and advice.

When considering demand for fertilizer over the next ten years, there is little expectation that the government will actively promote fertilization of crops other than soybeans and wheat. Thus fertilizer demand for such crops, with the exception of vegetables and a part of paddy and sugarcane now being fertilized, can be essentially ignored.

The analysis of future demand, therefore, will center on wheat and soybeans, with allocations for paddy, sugarcane and tomatoes.

Analysis of future demand, estimated for the ten year period from 1985/86 until 1995/96, is based on predicted trends in standard dosage, cultivated area and fertilized area for individual crops. As the average fertilizer dosages now implemented by Japanese-Paraguayan soybean and wheat producers compare closely with the recommended dosages set by the maximum VCR, these will be used as the standards.

The price of fertilizer in Paraguay is high, and farmers depend on agricultural credit for their purchases. Thus it is highly unlikely that the level of fertilizer dosages will rise in the near future; and the following analysis of future demand will assume that the dosage standards will remain fixed throughout the 10-year prediction period.

Table 4-4-1 summarizes the projection basis.

Table 4-4-1 Summary of Projection Basis

Crop	Recommended Dosage		Cultivated Area (1,000 ha)		Fertilizer Area (1,000 ha)	
	Product kg/ha	kg P_2O_5/ha	1985/86	1995/96	1985/86	1995/96
Soybeans	90 (5-30-10)	27.0	780	1,000	156	400
Wheat	140 (DAP)	64.5	155	255	109	230
Tomato	700 (12-12-17-2)	84.0	2.5	3.5	2.5	3.5
Paddy	133 (15-15-15)	20.0	22.0	22.0	2.2	4.4
Sugarcane	250 (15-15-15)	37.5	57.0	67.0	2.3	5.4
Total	-	-	1,016.5	1,347.5	272.0	643.3

With regard to fused magnesium phoshate fertilizer (FMP), systematic experiments are not being conducted, and analysis of future demand will involve only those Japanese-Paraguayan farmers that already have some experience with FMP, and farmers of UNIDAS Cooperative.

The total demand for phosphate fertilizers is shown in Table 4-4-2.

Table 4-4-2 Summary of Projected Fertilizer Needs by Crop

(Unit: t P_2O_5)

Year	Soybean	Wheat	Tomato	Paddy	Sugarcane	Total
1985/86	4,212	7,031	210	44	86	11,583
1986/87	4,806	7,676	218	48	96	12,844
1987/88	5,454	8,385	227	52	105	14,223
1988/89	6,102	9,095	235	58	116	15,606
1989/90	6,804	9,804	244	62	128	17,042
1990/91	7,533	10,578	252	66	139	18,568
1991/92	8,289	11,352	260	70	150	20,121
1992/93	9,099	12,191	269	74	165	21,798
1993/94	9,720	13,029	277	80	176	23,282
1994/95	10,260	13,932	286	84	188	24,750
1995/96	10,800	14,835	294	88	203	26,220
Av. Growth (% p.a.)	9.9	7.8	3.4	7.2	9.0	8.5

The demand for phosphate fertilizers is calculated to increase at the annual rate of 8.5%, and reach 26,200 tons of P_2O_5, which amounts to 2.3 times the present figure, by 1995/96. Of this total demand, 98% will be generated by the soybean and wheat crops (57% for wheat and 41% for soybeans).

The demand structure for individual types of phosphate fertilizers is estimated as follows:

- DAP: 90% of wheat
- TSP: 10% each of wheat and soybeans
- NPK (5-30-10): 90% of soybeans
- NPK (12-12-17-2): tomatoes
- NPK (15-15-15): paddy and sugarcane

The actual projected demand for each type of fertilizer is listed in Table 4-4-3. In 1995/96, the demand for DAP, TSP, NP and NPK fertilizers is estimated to be around 71,400 tons, about 2.3 times the present level. DAP and NPK (5-30-10) will account for 86% of the total demand.

Table 4-4-3 Summary of Projected Fertilizer Needs by Type

(Unit: t)

Year	TSP	DAP	5-30-10	12-12-17-2	15-15-15	Total
1985/86	2,400	13,800	12,600	1,800	900	31,500
1986/87	2,700	15,000	14,400	1,800	1,000	34,900
1987/88	3,000	16,400	16,400	1,900	1,000	38,700
1988/89	3,300	17,800	18,300	2,000	1,200	42,600
1989/90	3,600	19,200	20,400	2,000	1,300	46,500
1990/91	3,900	20,700	22,600	2,100	1,400	50,700
1991/92	4,300	22,200	24,900	2,200	1,500	55,100
1992/93	4,600	23,900	27,300	2,200	1,600	59,600
1993/94	4,900	25,500	29,200	2,300	1,700	63,600
1994/95	5,300	27,300	30,800	2,400	1,800	67,600
1995/96	5,600	29,000	32,400	2,500	1,900	71,400

Japanese-Paraguayan farmers were experimenting with fused magnesium phosphate fertilizer (FMP) several years ago, but nowadays use of FMP has almost totally dissappeared because of difficulty of availability etc.

However, farmers who have tried FMP claim that it works well in restoring old, acidic soils, indicating that it could be useful as soil restoratives. Many of these farmers seem eager to use FMP if they could obtain a reliable supply at a reasonable price.

On the other hand, no systematic experiments are being conducted on the soil restorative powers of FMP. At least several years of solid research and experimentation are necessary before FMP can be systematically introduced into Paraguay's agriculture. Under such conditions, a projection for future demand of FMP is difficult to arrive at. Based on the following three premises, however, Table 4-4-4 attempts to estimate demand for FMP over the next ten years:

- The analysis assumes that the necessary research and experiments will be carried out, the soil restorative properties of FMP verified, and proper spreading techniques developed.
- In the absense of data from the above research, the analysis assumes a temporary standard dosage of 300 kg/ha.
- For the regions where FMP may possibly be introduced, the analysis is restricted to areas of the Japanese-Paraguayan Agricultural Cooperatives and the UNIDAS Agricultural Cooperative (total cultivated area of 120,000 ha).

Table 4-4-4 Projection of FMP Consumption

Year	FMP Consumption (t)
1985/86	-
1986/87	-
1987/88	-
1988/89	-
1989/90	5,000
1990/91	6,000
1991/92	7,000
1992/93	9,000
1993/94	11,000
1994/95	13,000
1995/96	15,000

4.5 Estimated Product Mix and Fertilizer Supply

Enough fertilizer to almost completely meet the projected 1995/96 demand could be produced in the planned fertilizer plant. The 12-12-17-2 fertilizer used variously in Paraguay could be covered by 15-15-15 fertilizer. With the manufacturing process employed in this project, 6-30-10 could be produced in lieu of 5-30-10.

Product mix for the fertilizer plant is outlined in Table 4-5-1.

Table 4-5-1 Product Mix

(Unit: t/y)

Fertilizer	Product Mix
DAP (18-46-0)	29,000
TSP (0-46-0)	5,000
NPK (6-30-10)	32,000
NPK (15-15-15)	4,000
Total	70,000

Production capacity of the plant is set at 70,000 tons. The individual fertilizer types shown in Table 4-5-1 are representative product mixes. If experimental results at the Estacions or elsewhere, however, show a different component of NPK fertilizers to be the most suitable, the product mix could be altered to produce such fertilizers, although there would be some process restrictions.

The FMP plant will have the capacity to produce 15,000 tons of fused magnesium phosphate fertilizer per year.

Table 4-5-2 lists the projected fertilizer supply for the next ten years. The fertilizer plant is expected to begin operation in 1992, and should be able to fill the entire demand from then until 1994/95.

Table 4-5-2 Supply and Demand Projection

(Unit:t)

	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
Supply											
Import											
DAP	13,800	15,000	16,400	17,800	19,200	20,700	10,600	-	-	-	-
TSP	2,400	2,700	3,000	3,300	3,600	3,900	2,300	-	-	-	-
5-30-10	12,600	14,400	16,400	18,300	20,400	22,600	12,100	-	-	-	-
12-12-17-2	1,800	1,800	1,900	2,000	2,000	2,100	0	-	-	-	-
15-15-15	900	1,000	1,000	1,200	1,300	1,400	1,600	-	-	-	-
Sub-total	31,500	34,900	38,700	42,600	46,500	50,700	0	-	-	-	-
Production											
DAP	0	0	0	0	0	0	11,600	24,650	27,550	29,000	29,000
TSP	0	0	0	0	0	0	2,000	4,250	4,750	5,000	5,000
6-30-10	0	0	0	0	0	0	12,800	27,200	30,400	32,000	32,000
15-15-15	0	0	0	0	0	0	1,600	3,400	3,800	4,000	4,000
Sub-total	0	0	0	0	0	0	28,000	59,500	66,500	70,000	70,000
Supply total	31,500	34,900	38,700	42,600	46,500	50,700	54,600	59,500	66,500	70,000	70,000
Demand											
DAP	13,800	15,000	16,400	17,800	19,200	20,700	22,200	23,900	25,500	27,300	29,000
TSP	2,400	2,700	3,000	3,300	3,600	3,900	4,300	4,600	4,900	5,300	5,600
5(6)-30-10	12,600	14,400	16,400	18,300	20,400	22,600	24,900	27,300	29,200	30,800	32,400
12-12-17-2	1,800	1,800	1,900	2,000	2,000	2,100	0	0	0	0	0
15-15-15	900	1,000	1,000	1,200	1,300	1,400	3,200	3,400	3,600	3,700	3,900
Demand total	31,500	34,900	38,700	42,600	46,500	50,700	54,600	59,200	63,200	67,100	70,900
Balance (Supply-Demand)	0	0	0	0	0	0	0	300	3,300	2,900	(-)900

4.6 Agricultural Credits

Agricultural credits in 1985 totaled 77 billion Gs. which accounted for ca. 20% of total credits.

Agricultural credits are provided by the Banco Central del Paraguay (BCP), Banco Nacional del Fomento (BNF), Credito Agricola de Habilitacion (CAH), and Fondo Ganadero (FG), as well as by privately owned banks. Short term loans for purchase of fertilizer, seed and agricultural pharmaceuticals, however, are provided only by BNF, CAH and the private banks. BNF plays the most important role in agricultural credits.

BNF requires mortgage with conditions of 12% annual interest rate, 1.75% stamp duty and other charges. The final interest rate for farmers is equivalent to ca. 19% p.a. with a borrowing term of seven months.

CAH provides credits for small-scale farmers. Although the amount provided in each case is usually small, CAH services cover a wide area and reach a large number of small farmers. Loans are extended to members of small farmer cooperative groups called AUCA (regional credit associations). A land title deed is not usually required to be eligible for CAH loans, which reach 5,450 small farmers in 228 AUCA organizations served by 22 CAH regional branch offices.

4.7 Research and Extension Work

At the level of national government in Paraguay, two research and experimental organizations, IAN (Instituto Agronomico Nacional) and CRIA (Centro Regional de Investigacion Agricola), exist under the supervision of MAG's Bureau of Agriculture and Forestry Research Extension.

IAN conducts a variety of experiments with important crops, and also basic research and experiments with soils, crop diseases and harmful insects. CRIA experiments concentrate on improving varieties of dry field crops such as soybeans, wheat and corn.

JICA's research and experimental facilities, the Estacion Experimental Agropecuaria en Paraguay, are located at Yguazu in the Department of Alto Parana. The main objectives of the Estacion are to promote and stabilize farm management among the Japanese-Paraguayan farmers, to help improve regional farm management in Paraguay, and to advance international cooperation.

The government of Paraguay is actively involved in agricultural extension services through the Servicio de Extension Agricola-Ganadero (SEAG). SEAG now has 434 extension workers in 125 regional offices spread all over the country.

The activities of the regional offices concentrate on small farmers who cultivate 20 ha or less. Each office has one to three resident extension workers that provide on-the-farm guidance to individual farmers.

In addition to the above-mentioned government agencies, private fertilizer trading companies also provide advice and guidance to their customers. Generally speaking, however, extension activities provided by SEAG, IAN and CRIA are still insufficient, and should be upgraded in the future.

4.8 Fertilizer Distribution System

Agricultural cooperatives or fertilizer and agricultural pharmaceuticals trading companies that wish to import must file an application with the Banco Central del Paraguay (BCP).

The problem with this system is the length of time required between initial application and final approval, which in recent years has prevented farmers from obtaining the right type of fertilizer at the proper time. The reason for this delay in processing the application is insufficient foreign exchange capital, which must be carefully allotted among many potential user groups. In this connection, a policy which gives priority to importation of agricultural materials is a necessary step in correcting the problem.

Fertilizer and agricultural pharmaceuticals trading companies participate either directly or indirectly in fertilizer import. They either import the fertilizer themselves and sell direct to the consumers; or import under consignment from agricultural cooperatives that have obtained an import permit.

Fertilizer that is received by grant from abroad (such as The Second KR from Japan) is handled by MAG or the Credito Agricola de Habilitacion (CAH), and is sold below market price mainly to small farmers through the AUCA system, but also to some extent to agricultural cooperatives. In addition, there is also the fertilizer that is not shown in trade statistics. Although the system for the inflow is not clearly understood, in some cases the consumers journey directly to Brazil to make their own purchases, and in other cases dealers bring the fertilizer in and sell it.

Within Paraguay, fertilizer is transported almost entirely by truck, and delivered directly to the farmers and agricultural cooperatives that use it. The transportation agents have no facilities for storing or wharehousing the fertilizer.

A major problem with the present distribution system is that Paraguay is a landlocked nation with poor rail transportation. Long distance transport depends entirely on trucks, and is thus very expensive.

CHAPTER V PRODUCT MIX AND CAPACITY

In this feasibility study, the product mix to be adopted for this project is chosen from the six fertilizer types listed below. Evaluation is based on comparison of the required raw materials and production processes, fertilization characteristics, and analysis of market demand.

1. TSP (Triple Super Phosphate)
2. FMP (Fused Magnesium Phosphate)
3. MAP (Monoammonium Phosphate)
4. DAP (Diammonium Phosphate)
5. APP (Ammonium Poly Phosphate)
6. NPK (NPK Compound Fertilizer)

Of these six potential products, APP, although similar to DAP in fertilization effect, tends to work on a delayed basis. In addition, this fertilizer has never been used in Paraguay, and is outside the mainstream of international trade. APP is thus eliminated from consideration. The following discussions present the product mix and capacity determined for Scenarios 1 through 3.

(1) Scenario 1

Table 5-1-1 lists the product mix and plant capacity of Scenario 1. All of these fertilizers will be produced from phosphoric acid using the dry process (electric furnace), and could thus be manufactured economically using the same set of facilities. In Scenario 1, the necessary ammonia will be imported.

Table 5-1-1 Production Capacity

(Unit: t/y)

Fertilizers	Product Mix
DAP (18-46-0)	29,000
TSP (0-46-0)	5,000
NPK (6-30-10)	32,000
NPK (15-15-15)	4,000
Total	70,000

(2) Scenario 2

The product mix and capacity for Scenario 2 will be the same as those for Scenario 1. Although the process for manufacturing fertilizers from phosphoric acid will be the same, the ammonia will be produced at the plant using hydrogen obtained by water electrolysis and nitrogen separated from air, rather than imported.

(3) Scenario 3

This Scenario is completely different from Scenario 1 and 2. 15,000 ton/yr of FMP will be produced.

CHAPTER VI ELECTRIC POWER AND RAW MATERIALS

6.1 Electric Power

(1) Supply

Electric power in Paraguay is supplied mainly from Acaray hydroelectric station (194MW), and Itaipu hydroelectric station which is now being constructed by Itaipu Bi-national.

The Itaipu Dam will harness the tremendous hydropower of the Rio Parana, which flows along the border between Paraguay and Brazil. The project was begun in 1973 with a 50/50 equity ratio between these two countries, and is expected to be completed in the early 1990's. The generating capacity of this station will be huge, with 18 generators capable of 700 MW each, for a total of 12,600 MW. At present, three of these generators are already operating on a commercial basis, and a fourth is in the testing stage. Paraguay has the right to receive 50% of the power generated at Itaipu, but as this is far more than national needs, will sell the surplus to Brazil.

In 1986, ANDE, Paraguay's public electric corporation, was in a position to supply 1,400 MW of power, but national demand was only 285 MW. In addition, other large scale electric power projects, such as the Yacyreta and Corpus power stations, are being planned; and construction of the Yacyreta station (4,500 MW), a joint project with Argentina, is under consideration.

(2) Demand forecast

ANDE is in the process of expanding the electric power delivery network in Paraguay, and future demand can be forecasted as shown in Table 6-1-1.

Table 6-1-1 Demand Forecast of Electricity

(Unit: MW)

Year	Forecast of Demand
1986	285
1987	350
1988	380
1989	415
1990	450

(3) Price

If this project were to be implemented, an approximate 25,000-30,000 kW of power would be required. For Paraguay, this is a relatively high level of consumption; but as was explained earlier, supply will present no problems. One precondition for successful operation of the fertilizer plant, however, is low power costs. Thus the plant should receive power directly from nearby Itaipu station, in which case the cost would be same as that paid by ANDE to Itaipu Bi-national.

(a) Power contract

A schedule of power use must be drawn up two years in advance and submitted to Itaipu Bi-national. The contract will be on an annual basis, but specific power requirements must be requested for each month. There will be no minimum or maximum levels set.

(b) Cost

At present, ANDE is purchasing power from Itaipu Bi-national at US$10/kW-month. This rate, however, is current only through 1986, and is expected to rise to US$14.06 in 1987. Calculating on the basis of US$10/kW-month, and assuming that actual power use will average 95% of contracted power, the actual cost of electric power to the plant would be around 1.46 cents/kWh.

6.2 Phosphate Rock

Phosphate rock is the most important raw material for the Paraguayan fertilizer project. Sub-surface mineral resources in Paraguay have not yet to be fully explored; but even the best domestic phosphate rock discovered to date has too low a content of P_2O_5 to be used in manufacture of phosphate fertilizers. The necessary phosphate rock, therefore, must be imported. The most likely source is neighboring Brazil, where the Goiasfertil company is in a position to supply the required amounts and quality.

The Goias phosphate rock is of igneous origin, and the 38% of P_2O_5 qualifies it as high commercial quality. The physical properties differ somewhat from Florida and Moroccan phosphate rock, but these differences should present no problems in terms of fertilizer manufacture. Transport from Catalao City in Brazil to the plant site would be overland by truck. Fortunately, a first class paved national highway is available, so trucking should run smoothly.

Looking at the worldwide patterns of production and supply of phosphate rock, the Paraguayan fertilizer plant could also obtain this raw material from either Florida or Morocco. From the standpoint of cost delivered to the plant, however, the Goias rock enjoys a favorable position, and is thus the best choice. The cost of this phosphate rock is estimated at US$66.7/ton transported to the border of Paraguay neighboring to the site.

6.3 Phosphoric Acid as Raw Material for Fertilizer Production

Phosphoric acid for fertilizer manufacture, produced by the "wet" process, is traded on the international market. If the Paraguayan project wished to import phosphoric acid instead of phosphate rock, world supply and demand conditions indicate that either Florida or Morocco would be possible sources. This project, however, plans to make good use of the abundant and relatively inexpensive electric power to produce phosphoric acid as an intermediate product using the "dry" (electric furnace) process.

6.4 Ammonia

Ammonia will be necessary in the Paraguayan plant as a source of nitrogen for manufacture of NPK and DAP. The world production capacity for ammonia was estimated at 114.5 million ton N in 1984/85, and this figure is expected to exceed 122 million ton N in 1988/89. In addition, special tankers capable of transporting ammonia have been developed, and this substance is now traded widely all over the world. In 1984 the volume of trade reached 7.44 million ton N.

The Paraguayan fertilizer plant would be capable of producing ammonia, but as the requirements are only 30 ton/day, the capacity of the plant would be very small compared to the 1,000 ton/day plants that are now standard in most areas. These large scale plants enjoy great benefit from merit of scale.

The possibilities of producing ammonia in situ using hydrogen made by hydroelectrolysis are examined in Scenario 2. Ammonia production, howevr, is a basic chemical industry. Before Paraguay decides to invest in a small scale ammonia plant, careful consideration should be given to the total level of domestic demand for ammonia, and a hydrogen source with lower cost.

Scenario 1 will import the necessary ammonia from Brazil. The cost transported to the border of Paraguay can be estimated at US$180/ton.

6.5 Potash

Potassium chloride is used as a source of potassium in NPK fertilizers. On a worldwide basis, there is a tendency, which can be expected to continue for the next several years, of excess supply. From the standpoints of geographic proximity and ability to supply, either the US or Canada would be likely sources to import potassium chloride from. North American potassium chloride would be purchased in bulk, offloaded at Paranagua Port in Brazil, then trucked to the plant. The cost at the border of Paraguay neighboring to the plant site would be about US$140/ton.

6.6 Silica Gravel

For production of yellow phosphorus by the electric furnace process, phosphate rock is melted by electric power then reduced using coke. Silica is necessary as a fluxing agent in this process. For this purpose, more than 90% concentration of SiO_2 is required, and silica which can be obtained locally around the plant site can be used. This silica will cost an estimated 4,000 Gs/ton delivered to the plant.

6.7 Coke

Coke is necessary as a reducing agent in an electric furnace for producing yellow phosphorus. The possibility of using charcoal for this purpose has been considered. Charcoal, however, lacks the necessary strength, and thus coke should be used. Coke can be imported from either Brazil or Argentina, and should cost around US$130/ton at the border of Paraguay neighboring to the plant site.

6.8 Serpentine

Serpentine is required as a source of magnesium for production of fused magnesium phosphate fertilizer. An MgO content of over 35% is required. Reserves of serpentine are known to exist east of Asuncion, but details on their size and quality will have to await results of future mineral resource surveys. If Scenario 3 were implemented, these reserves would be tapped as the source for serpentine.

6.9 Fuel

A part of the fuel requirements for the Paraguayan fertilizer plant will be met by carbon monoxide gas generated as a by-product during production of yellow phosphorus. The remainder will be fuel oil (heavy oil) purchased from PETROPAR. This oil will be delivered to plant by lorry for cost of 75 Gs/l.

6.10 Packaging Materials

The finished fertilizer products will be bagged in 50 kg polypropylene or polyethylene woven bags to be produced domestically. Woven bags already produced for storing seed of crops like soybeans will be used, but these should be reinforced and laminated on the inside for fertilizer use. Their cost will be around 300 Gs/bag delivered to the plant.

6.11 Electrodes

Commercially available man-made black graphite electrodes will be used in the electric furnace. Models such as those produced in the US by UCC should be considered, and can be expected to cost approximately US$3,000/ton at the border of Paraguay neighboring to the plant site.

6.12 Urea

If 15-15-15 NPK fertilizer is produced at a rate of 4,000 ton/yr, about 890 ton/yr of urea would be required as one of the raw materials. 50 kg bags, imported from Brazil and stored at the site, would cost an estimated US$175/ton transported to the border of Paraguay neighboring to the plant site.

6.13 Coating Agents

NPK fertilizer granules have a tendency to cake together during storage, which diminishes their value. In order to prevent this, a micro-fine coating of anti-caking agents must be applied to the fertilizer. Suitable materials are talc, clay or diatomaceous earth and should be obtainable domestically. Their costs will be around 80,000 Gs/ton delivered to the site.

CHAPTER VII BASIC PLAN OF FERTILIZER PROJECT

7.1 Basic Plan

Based on the product mix selection presented in Chapter V, three alternative scenarios have been considered for the Paraguayan fertilizer plant. These are flow charted in Figures 7-1-1, 7-1-2 and 7-1-3.

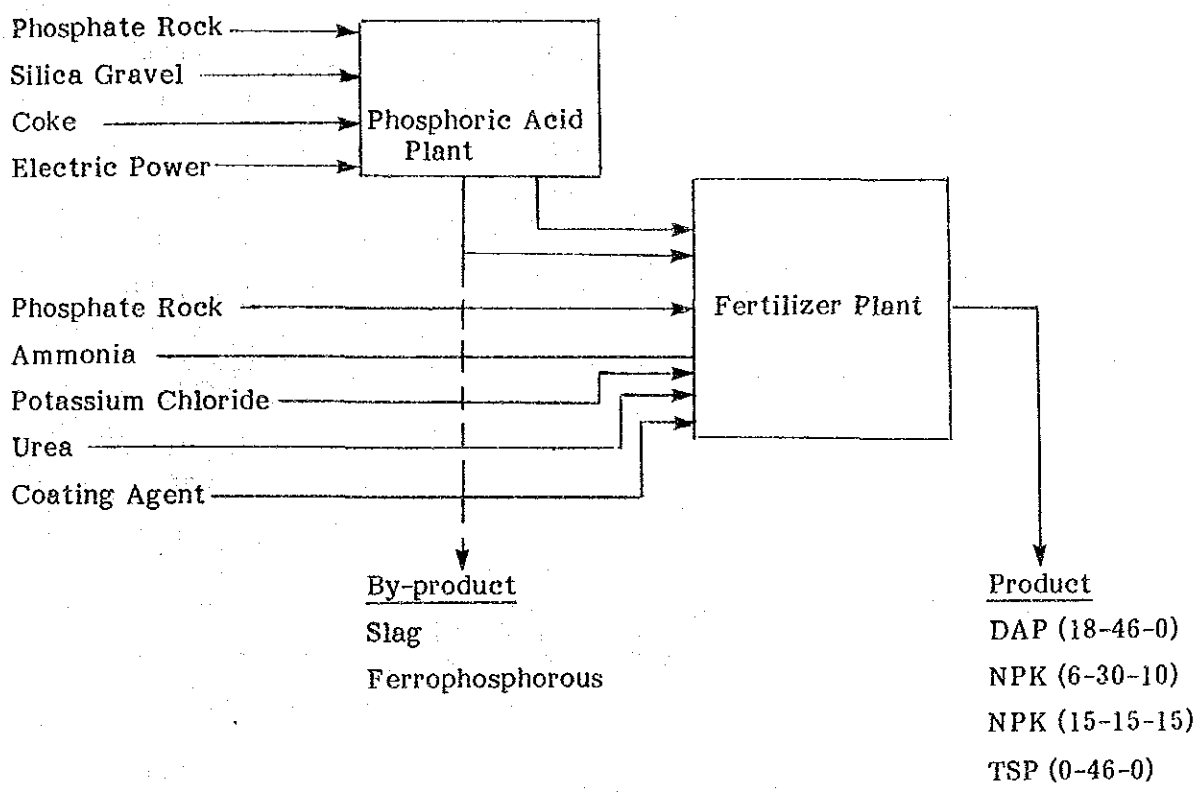


Figure 7-1-1 Flow of Scenario 1

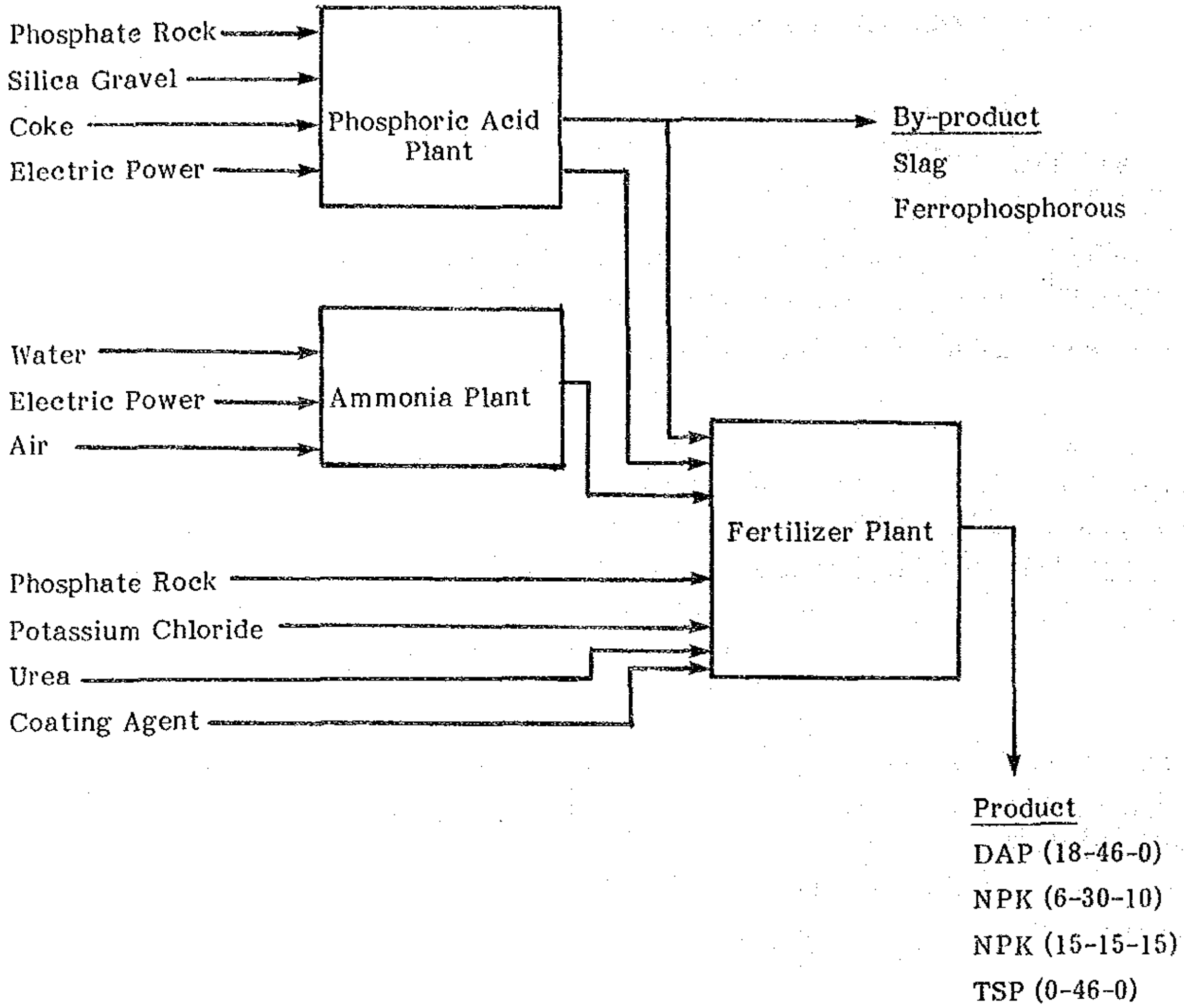


Figure 7-1-2 Flow of Scenario 2

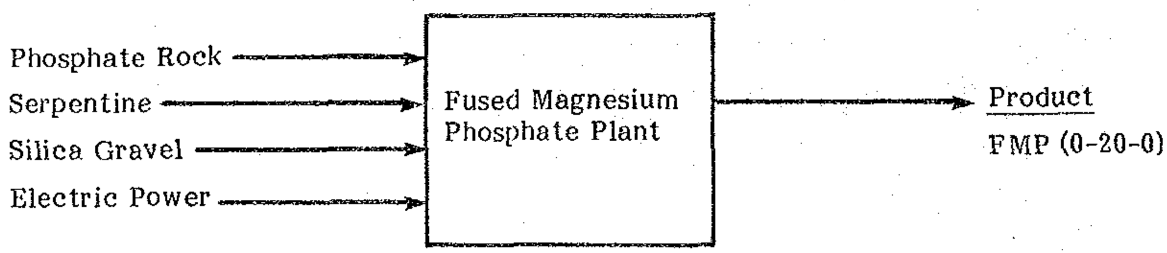


Figure 7-1-3 Flow of Scenario 3

7.2 Outline of Production Process

(1) Phosphoric acid plant

Both the "wet" process and the "dry" process (electric furnace) are available for production of phosphoric acid. The wet process, bacause of its lower energy costs, is usually employed in producing phosphoric acid for fertilizer manufacture. In Paraguay, however, sulfur, one of the main raw materials of the wet process, is difficult to obtain, and there is no domestic sulfuric acid plant. Electric power, on the other hand, is abundant and relatively inexpensive. The fertilizer plant should therefore take advantage of local conditions and choose the electric furnace process.

In the phosphoric acid plant, phosphate rock is reduced in the electric furnace. The resultant gaseous phosphorus is cooled to form yellow phosphorus, which is then burned and to make the phosphoric acid. The phosphoric acid obtained through this process is exceptionally pure and concentrated. The Paraguayan plant will be capable of producing 25, 380 ton P_2O_5/yr.

(2) Fertilizer plant

The Paraguayan plant will employ the slurry process developed by TVA. The flexibility of this process will allow the plant to respond efficiently to Paraguayan demand by producing DAP, NPK and TSP fertilizers in the same plant. Production capacity, broken down in Table 7-2-1, will total 70,000 ton/yr.

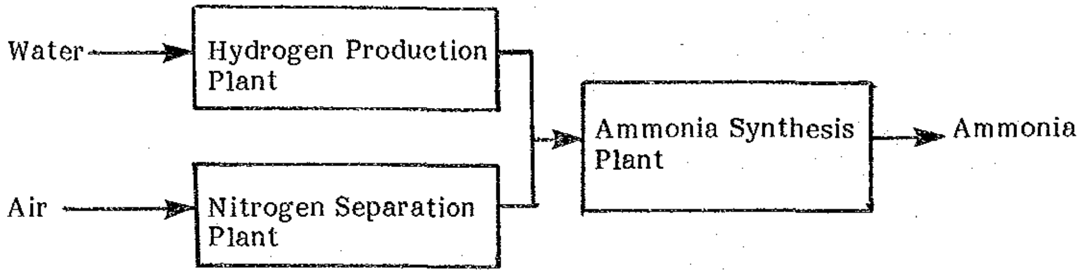
Table 7-2-1 Production Capacity

(Unit: t/y)

Fertilizers	Capacity
DAP (18-46-0)	29,000
NPK (6-30-10)	32,000
NPK (15-15-15)	4,000
TSP (0-46-0)	5,000
Total	70,000

(3) **Ammonia plant**

Scenario 2 discusses the case of ammonia production in the plant. The process would be composed of a hydrogen production plant, a nitrogen separation plant and an ammonia synthesis plant. At present, ammonia plants commonly use hydrocarbon sources such as natural gas, naphtha or fuel oil to produce hydrogen gas. The Paraguayan plant, however, would use the abundantly available electric power to produce hydrogen from water. This hydrogen would then be reacted with nitrogen obtained from air by the cryogenic process to produce ammonia. This process is diagrammed below. The capacity of the Paraguayan plant would be 9,030 ton/yr.



(4) **Fused magnesium phosphate (FMP) plant**

Fused magnesium phosphate fertilizer was developed in Japan. The active nutrient, P_2O_5, is soluble not in water, but in citric acid. This fertilizer thus has a slow-acting charactor. FMP, however, also contains Calcium (CaO), magnesium (MgO) and silica (SiO_2), and is thus useful as soil restoratives.

For producing FMP, the phosphate rock is mixed with serpentine, then melted in an open hearth or electric furnace. The resultant melt is quenched with water. In the Paraguayan project, the FMP plant would employ the electric furnace process, and would be capable of producing 15,000 ton/yr.

7.3 Use of By-products and Anti-pollution Measures

(1) **Treatment of by-products**

73,590 ton/yr of slag, 1,670 ton/yr of ferrophosphorous and 2.3 x 10^7 Nm^3/yr of carbon monoxide will be produced as by-products in the phosphoric acid plant.

(a) Carbon monoxide gas

The carbon monoxide gas generated in the electric furnace will be used as fuel for making briquets from powder phosphate rock.

(b) Slag

The main component of the slag produced in the electric furnace is calcium silicate which is formed of calcium and silica. Some of this slag will be used as filler of fertilizer, and 29,295 ton/yr will be packaged in 50 kg bags and sold as a calcium silicate fertilizer to the domestic market. The remaining 29,300 t/yr will be disposed of.

(c) Ferrophosphorous

In Japan, ferrophosphorous produced in electric furnaces is used in ferro-alloy. In Paraguay, however, there is no present use for this by-product. The ferrophosphorous will thus be stored outside near the plant until a use arises.

(2) Anti-pollution measures

Measures to prevent atmospheric and water pollution are important considerations for the Paraguayan fertilizer plant. This report designs the following measures.

(a) Air pollution

The harmful agents likely to be present in the plant exhaust gases include fluorine compounds, sulfur dioxide, ammonia and dust. Based on both Paraguayan temporary standards and Japanese existing standards, facilities are designed to treat these gases before releasing them into the atmosphere.

(b) Water pollution

The plant is designed to treat harmful substances before discharging them into the river based on the existing Japanese standards.

7.4 Outline of Plant

(1) Plant site

Taking into consideration a broad range of important factors; such as a convenient supply of electric power and industrial water, delivery of raw materials and shipping of product fertilizer, easy access for installation and transportation of construction and plant equipment, and proximity to the main fertilizer consuming regions; Hernandarias City, located in the Alto Parana Department above the Itaipu Dam, was chosen as the most suitable site for the Paraguayan fertilizer plant.

Outline of Helnandarias City

Population: 50,000 (30,000 in the city, 20,000 in surrounding agricultural district)

Educational Facilities: 8 junior high schools

Main agriculture and Industries:

- Main Crop: soybeans
- Agricultural Product Silos: 23
- Timber Factories and Workshops: 20

(2) Plant layout

The plant layout for Scenario 1 is illustrated in Figure 7-4-1.

(3) Plant operation and management

(a) Production schedule

Table 7-4-1 shows scheduled operation load and production once the plant is completed and into commercial operation status.

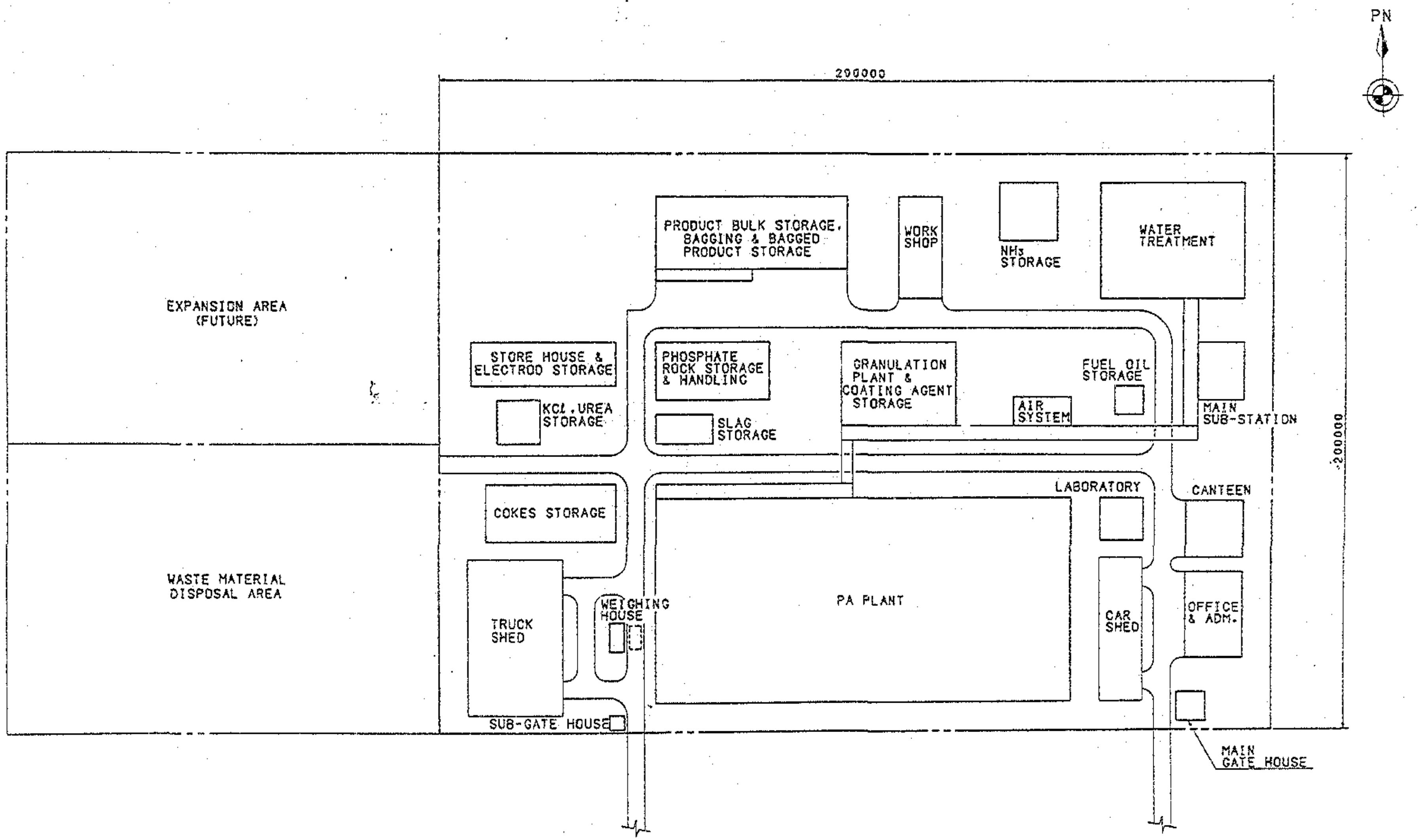


Figure 7-4-1 Overall Plot Plan (Scenario 1)

Table 7-4-1 Production Schedule

Year	Scheduled Operation Load (%)	Scheduled Production (t/y)
1 (1992)	80	56,000
2 (1993)	90	63,000
3 (1994) and onward	100	70,000

(b) Plant management

The fertilizer project is the first of its kind in Paraguay, and represents an important basic industry. Construction and management should thus be carefully planned in advance. To be successful, the plant will have to operate efficiently and effectively to produce the needed fertilizers at the right time and for the right price. With this in mind, a new public corporation had better be created to manage the fertilizer plant. The estimated manpower need for the three alternative Scenarios are as follows:

Scenario 1 (phosphoric acid and granulation plants)	287 people
Scenerio 2 (phosphoric acid, ammonia and granulation plants)	348 people
Scenario 3 (FMP fertilizer plant)	244 people

CHAPTER VIII PLANT CONSTRUCTION COSTS

8.1 Plant Construction

If the contract is into effect in 1989, the plant can be in operation in 1992. Plant personnel must be trained while construction is in progress. Managers, technicians and maintenance personnel, 3 or 4 representatives from each section, should be trained abroad for one and a half months at operating fertilizer plants. These people should then return to the plant and train the operators and other workers according to a plan worked out with the contractors.

8.2 Plant Construction Costs

The estimate of plant construction costs is based on the middle of 1986 constant price basis. The formal exchange rate as of July, 1986 is as follows:

US$1 = 240 Gs

The estimated plant construction costs for scenarios are shown in Table 8-2-1, 8-2-2 and 8-2-3.

Table 8-2-1 Plant Construction Cost

- Scenario 1 -

F: Foreign Currency (Unit: million US$)
L: Local Currendy (Unit: million Gs)

YEAR	-3		-2		-1		Sub Total	
CURRENCY	F	L	F	L	F	L	F	L
1. Land Acquisition & Preparation	-	198.0	-	-	-	-	-	198.0
2. Machinery & Equipment	10.07	-	7.62	-	0.68	-	18.37	-
3. Civil & Building	2.08	210.7	0.96	96.2	0.16	21.1	3.2	328.0
4. Erection	0.23	34.9	3.27	238.2	1.06	67.6	4.56	340.7
5. Transportation (Ocean & Inland)	0.46	22.8	0.26	33.9	0.04	4.3	0.76	61.0
6. Engineering & Consultant Fee	2.66	-	-	-	-	-	2.66	-
7. Supervising Fee, etc.	-	-	1.12	28.6	1.91	45.3	3.03	73.9
8. Contingencies	0.78	13.4	0.66	19.9	0.19	6.9	1.63	40.2
Total	16.28	479.8	13.89	416.8	4.04	145.2	34.21	1,041.8

Excluding plant related costs such as access road, electric cable construction and water intake piping works

Table 8-2-2 Plant Construction Cost

- Scenario 2 -

F: Foreign Currency (Unit: million US$)
L: Local Currency (Unit: million Gs)

YEAR	-3		-2		-1		Sub Total	
CURRENCY	F	L	F	L	F	L	F	L
1. Land Acquisition & Preparation	-	205.5	-	-	-	-	-	205.5
2. Machinery & Equipment	13.69	-	10.17	-	1.44	-	25.3	-
3. Civil & Building	2.45	242.7	1.14	112.2	0.21	29.1	3.8	384.0
4. Erection	0.27	73.9	3.72	313.9	1.15	83.3	5.14	471.1
5. Transportation (Ocean & Inland)	0.57	46.2	0.4	64.4	0.07	9.6	1.04	120.2
6. Engineering & Consultant Fee	3.33	-	-	-	-	-	3.33	-
7. Supervising Fee, etc.	-	-	1.75	72.4	2.89	110.6	4.64	183.0
8. Contingencies	1.01	18.1	0.86	28.1	0.29	11.7	2.16	57.9
Total	21.32	586.4	18.04	591.0	6.05	244.3	45.41	1,421.7

Excluding plant related costs such as access road, electric cable construction and water intake piping works

Table 8-2-3 Plant Construction Cost

- Scenario 3 -

F: Foreign Currency (Unit: million US$)
L: Local Currency (Unit: million Gs)

YEAR	-3		-2		-1		Sub Total	
CURRENCY	F	L	F	L	F	L	F	L
1. Land Acquisition & Preparation	-	138.0	-	-	-	-	-	138.0
2. Machinery & Equipment	1.44	-	1.79	-	0.22	-	3.45	-
3. Civil & Building	0.9	77.8	0.42	34.8	0.08	7.3	1.4	119.9
4. Erection	0.03	1.2	0.57	48.1	0.15	11.5	0.75	60.8
5. Transportation (Ocean & Inland)	0.07	2.0	0.05	3.8	0.02	1.5	0.14	7.3
6. Engineering & Consultant Fee	0.84	-	-	-	-	-	0.84	-
7. Supervising Fee, etc.	-	-	0.14	12.0	0.66	18.4	0.8	30.4
8. Contingencies	0.16	4.1	0.15	4.9	0.06	1.9	0.37	10.9
Total	3.44	223.1	3.12	103.6	1.19	40.6	7.75	367.3

Excluding plant related costs such as access road, electric cable construction and water intake piping works

CHAPTER IX TOTAL CAPITAL REQUIREMENTS

9.1 General

Total capital requirements, which include the various costs outlined below, are the sum of all investments necessary to bring the fertilizer plant into operating condition.

- Total Capital Requirements
  - Plant Construction Cost
    - Land Acquisition and Preparation Cost
    - Plant Construction Cost
    - Plant Related Cost
  - Pre-operating Cost
    - Training Cost
    - Administrative Cost
    - Test Run Cost
  - Working Capital
    - Initial Working Capital
    - Running Working Capital*
  - Interest during Construction

* Required after operation begins

9.2 Major Assumptions

The following are assumed for estimating the total capital requirements.

(1) **Contract method**

A turnkey/lump sum contract

(2) **Procurement method**

Based on competitive biding contract

(3) **Basis of costs**

Constant price base as of middle of 1986, no escalation from the figures available for 1986 up to the time when the actual investments will be made.

(4) **Currency and exchange rates**

Local costs are calculated in guaranies, and foreign costs in US dollar are converted to guaranies. The exchange rates used in the analysis are the following three possibilities:

1) US$1 = 240 Gs (Base Case: Official exchange rate as of July 1986.)
2) US$1 = 400 Gs (Case 1)
3) US$1 = 700 Gs (Case 2)

(5) **Import tax**

Exempt

9.3 Pre-operating Costs

Pre-operating costs include training and administration costs that are required before the plant starts its operation.

9.4 Working Capital

Working capital is required for financial trouble-free running of the plant during normal operation, and is usually divided into initial working capital and running working capital. In this analysis, only initial working capital is included in the total capital requirements calculation. Running working capital is calculated in the financial statements after the start of commercial operation.

9.5 Financial Plan and Interest during Construction

The following assumptions are used in calculating interest during construction.

1) Equity and Debt

The project owner is expected to bear 30% of the total capital requirements excluding the interest during construction as an equity. The total capital requirements not provided by the project owner should be covered by a long term loan.

2) Conditions on the long-term loan

The long-term loans interest and repayment terms are assumed as follows:

Interest:	10% annually
Repayment:	3 year grace period after commercial operation, after which the balance must be repayed in equal amounts once a year for ten years.

9.6 Estimates of Total Capital Requirements

Total capital requirements include all investments necessary before the plant begins operating on a commercial basis. The estimated total capital requirements for Scenario 1, which involves import of ammonia, is listed in Table 9-6-1; that for Scenario 2, in which ammonia would be produced at the plant, in Table 9-6-2; and that for Scenario 3, in which FMP would be produced, in Table 9-6-3. Tables give alternative figures based on three possible guaranies to US dollar exchange rates.

Table 9-6-1 Total Capital Requirement of Scenario 1
(Import of Ammonia)
- Middle of 1986 Constant Price Base -

(Unit: Million Gs)

	Base Case (Gs 240/US$)	Case 1 (Gs 400/US$)	Case 2 (Gs 700/US$)
Land Cost	198.0	198.0	198.0
Plant Construction Cost including Plant Related Facilities	9,362.2	14,835.8	25,098.8
Pre-operating Cost	458.9	474.9	504.9
Initial Working Capital	196.3	196.3	196.3
Interest During Construction	938.2	1,476.6	2,486.3
Total	11,153.6	17,181.6	28,484.3

Table 9-6-2 Total Capital Requirement of Scenario 2
(Production of Ammonia)
- Middle of 1986 Constant Price Base -

(Unit: Million Gs)

	Base Case (Gs 240/US$)	Case 1 (Gs 400/US$)	Case 2 (Gs 700/US$)
Land Cost	205.5	205.5	205.5
Plant Construction Cost including Plant Related Facilities	12,422.6	19,688.2	33,311.2
Pre-operating Cost	458.9	474.9	504.9
Initial Working Capital	251.2	251.2	251.2
Interest During Construction	1,213.5	1,917.1	3,236.1
Total	14,551.7	22,536.9	37,508.9

Table 9-6-3 Total Capital Requirement of Scenario 3
(Production of FMP)
- Middle of 1986 Constant Price Base -

(Unit: Million Gs)

	Base Case (Gs 240/US$)	Case 1 (Gs 400/US$)	Case 2 (Gs 700/US$)
Land Cost	138.0	138.0	138.0
Plant Construction Cost including Plant Related Facilities	2,397.3	3,637.3	5,962.3
Pre-operating Cost	427.0	443.0	473.0
Initial Working Capital	127.1	127.1	127.1
Interest During Construction	244.6	360.4	577.1
Total	3,334.0	4,705.8	7,278.1

CHAPTER X FINANCIAL ANALYSIS

10.1 General

This financial analysis applies the analytical method commonly used in industrial investment projects to evaluate the financial soundness of the Paraguayan fertilizer plant project. It means that financial statements are drawn up based on the total capital requirements, total cost for production of fertilizers, and expected income from product sales. From financial statements the financial internal rate of return (FIRR) is calculated and used to appraise the project from a financial standpoint. This chapter presents analyses of Scenario 1, in which ammonia is imported, and Scenario 2, which includes production of ammonia in situ. Scenario 3, which is FMP fertilizer production, is shown in 10.6 of this chapter.

10.2 Major Assumptions

The major assumptions used in these financial analyses are as follows:

1) Project period for financial analysis

Construction period :	3 years
Operation period :	15 years

2) Currency

In Guranie

3) Cost standards

Based on prices in the middle of 1986 without escalation

4) Operation load

First year:	80%
Second year:	90%
Third year and after:	100%

5) Short term loans

Once operation has begun, temporary shortages of funds will be met by short term loan with the following terms:

Interest rate	:	25% p.a.
Repayment	:	Yearly repayment

6) Corporate tax

Corporation, limited liability companies and other commercial enterprises which are dominant in the country are subject to income tax as follows:

Taxation

Taxable Income in Guaranies			Tax	
			Base Amount	Percent on Excess Over Base Amount
From 1	to	500,000		25%
500,001	to	1,000,000	125,000	26%
1,000,001	to	2,000,000	255,000	27%
2,000,001	to	3,500,000	525,000	28%
3,500,001	to	5,000,000	945,000	29%
5,000,001		plus	1,380,000	

A preferential clause, however, exempts 50% of the assessable tax for 5 years following the first taxable income statement.

7) Administration cost

Equivalent to 50% of direct labor cost

8) Sales cost

Equivalent to 10% of direct labor cost

10.3 Cost of Production and Cost of Goods Sold

10.3.1 Electricity

This financial analysis is analyzed based on purchase of electric power directly from Itaipu Bi-National. The rate is the same as ANDE now pays to Itaipu, but the power would have to be contracted for on a predetermined monthly amount at least two years in advance.

The present rate payed by ANDE is US$ 10/kW·M, but this rate is current only through 1986. In addition, a power cable will have to be laid from the Itaipu power station to the plant site, and the cost of this is included in plant construction costs. The yearly power requirements of the fertilizer plant, based on an annual production figure of 70,000 ton phosphate fertilizers, are listed below.

Contracted Power Requirement

	Scenario 1	Scenario 2
For 10 months	26,449 kW	42,334 kW
For 1 month	1,432 kW	1,432 kW
For 1 month	700 kW	700 kW

10.3.2 Raw Materials and Other Raw Materials

Primary raw materials are phosphate rock and ammonia, and their requirements and price are discussed below, followed by those for other raw materials.

1) Phosphate Rock

Price of Phosphate Rock

	Foreign Currency Portion	Domestic Currency Portion
FOB Goias	US$31.7/ton	
Transportation Cost	US$35.0/ton	
Import Charges		8% of foreign currency portion

The plant requires approximately 77,240 ton of phosphate rock annually.

2) Ammonia

In the case of Scenario 1, ammonia will not be produced but would be imported instead.

Price of Ammonia

	Foreign Currency Portion	Domestic Currency Portion
CIF Price	US$180/ton	--
Import Charges	--	8% of foreign currency portion

The plant requires 9,025 ton of ammonia annually.

3) Other Raw Materials

Other raw materials needed for the productions of phosphate fertilizers are potassium, silica, coke, urea, electrodes and coating agent.

10.3.3 Utilities and Chemicals

Utilities and chemicals purchased from outside are fuel oil, lime, hydrogen chloride, caustic sode, oxygen and nitrogen.

10.3.4 Other Costs

1)	Packaging Costs	:	300 Gs/1 sheet
2)	Direct Labor Costs	:	Operator 1,852 thousand Gs/y. person
			Worker 1,111 thousand Gs/y. person
			Driver 1,111 thousand Gs/y. person
3)	Maintenance Costs	:	3% of Plant construction cost
4)	Insurance Costs	:	0.6% of Plant construction cost
5)	Plant Overhead Costs	:	50% of direct labor cost
6)	Plant Consumables Costs	:	10% of direct labor cost
7)	Depreciation	:	Plant and equipment: 6%/p.a., straight line
		:	Building: 3%/p.a., straight line

10.3.5 Cost of Goods Sold

Cost of goods sold is calculated by adding the value of the inventory at the beginning of the year to the annual production costs, then subtracting the value of the inventory at the end of the year. Both inventories are expected to be 0.5 month's worth. Assuming 100% operation load, the cost of goods sold for Scenario 1 and Scenario 2 are calculated in Tables 10-3-1 and 10-3-2 respectively.

Table 10-3-1 Cost of Goods Sold (Scenario 1)

(For 5th year of operation)

	(million Gs)	(Gs/kg of Phosphate Fertilizer)
Variable Costs		
Initial Inventory of Raw Materials	123.5	
Raw materials Purchased	2,962.8	
Final Inventory of Raw Materials	123.5	
Raw Materials Consumed	2,962.8	42.3
Electricity	639.9	9.1
Utilities & Chemicals	516.4	7.3
Bag	420.0	6.0
Sub-total	4,539.1	64.8
Fixed Costs		
Direct Labor	196.3	2.8
Maintenance	280.9	4.0
Insurance	46.8	0.7
Plant Consumables	19.6	0.3
Plant Overhead	98.2	1.4
Sub-total	641.8	9.2
Total Operating Costs	5,180.8	74.0
Depreciation	519.6	7.4
Amortization	83.8	1.1
Cost of Production	5,784.3	82.6
Initial Inventory of Products	241.0	
Cost of Production	5,784.3	
Final Inventory of Products	241.0	
Cost of Goods Sold	5,784.3	82.6

Table 10-3-2 Cost of Goods Sold (Scenario 2)

(For 5th year of operation)

	(million Gs)	(Gs/kg of Phosphate Fertilizer)
Variable Costs		
Initial Inventory of Raw Materials	108.3	
Raw Materials Purchased	2,598.1	
Final Inventory of Raw Materials	108.3	
Raw Materials Consumed	2,598.1	37.1
Electricity	1,021.1	14.6
Utitities & Chemicals	505.6	7.2
Bag	420.0	6.0
Sub-total	4,544.9	64.9
Fixed Costs		
Direct Labor	251.2	3.6
Maintenence	372.7	5.3
Insurance	62.1	0.9
Plant Consumables	25.1	0.4
Plant Overhead	125.6	1.8
Sub-total	836.7	12.0
Total Operating Costs	5,381.6	76.9
Depreciation	697.2	10.0
Amortization	100.3	1.4
Cost of Production	6,179.2	88.3
Initial Inventory of Products	257.5	
Cost of Production	6,179.2	
Final Inventory of Products	257.5	
Cost of Goods Sold	6,179.2	88.3

10.4 Sales Planning and Amounts

80% operation load is expected during the first year of commercial operation, 90% during the second, and 100% from the third onward. All of the fertilizer produced is expected to be sold.

The sales amount for each fertilizer type can be calculated by multiplying the yearly capacity by the operation load and the sales prices. The sum of all these is the total annual sales. Table 10-4-1 shows yearly production capacity and sales amounts.

Every year, however, inventory will be adjusted by selling 0.5 month's worth. In addition, the calcium silicate slag produced as a by-product of yellow phosphorus will be sold for use in soil restoration and as a silica-lime fertilizer. About half of the excess amount (29,295 ton/yr) assumed to be sold for 12 Gs/kg. Ferrophosphorous will also be produced as a by-product, but as no market is yet available for this material, it can not be calculated as part of sales.

Table 10-4-1 Sales Revenue

	Product Price (Gs/kg)	Sales Volume (t/y)	Sales Revenue (million Gs)
DAP	101.0	29,000	29,290.0
TSP	76.0	5,000	380.0
NPK(6-30-10)	95.0	32,000	3,040.0
NPK(15-15-15)	86.0	4,000	344.0
Total	95.6(Av.)	70,000	6,693.0
By Product (Slag)	12.0	29,250	351.0
Total	-	99,250	7,044.0

10.5 Results of Financial Analysis

10.5.1 Scenario Comparison

Tables 10-5-1 through 10-5-4 in Appendix present results of Cost of Goods Sold and Income Statement of Scenario 1 (ammonia imported) and Scenario 2 (ammonia produced in situ) without sales of by-product (slag) for both scenarios.

Scenario 2 results in higher production costs; and as can be seen from the profit and loss statement (Table 10-5-4), it would leave the plant operating in the red for the entire period of project implementation. These losses could possibly be recovered by raising the price of the product fertilizer; but Scenario 1 would allow the fertilizer to be produced at lower costs and sold at the same price, resulting in continuous profits from the 5th year of operation.

This report thus concludes that ammonia should not be produced in Paraguay until the following two conditions are met:

* The demand for ammonia increases to the point where the plant enjoys profit from economy of scale.
* Electric power costs become competitive with natural gas; or a domestic source such as natural gas or some other inexpensive raw material is developed for ammonia production.

10.5.2 Results of Financial Analyses for Scenario 1

1) Results

Tables 10-5-5 through 10-5-8 in Appendix present results of financial statement for Scenario 1, assuming that half of the excess by-product slag (29,295 ton/yr) is sold.

The financial internal rate of return on investment (FIRR on I) is calculated to be 11.1% before taxes, and 10.2% after taxes.

The ex-plant fertilizer price used in this analysis represents a 20% decrease from the current farm-gate prices. However, this ex-plant price is still relatively high by comparison with international standards.

The financial internal rate of return on equity (FIRR on E) is not a particularly high figure, calculated as 12.8% before taxes and 10.4% after taxes.

2) Sensitivity Analysis

Sensitivity Analyses is used to assess the impact against the project by the variation of factors such as selling price of fertilizers, plant construction costs.

(1) Selected factors

The following factors and amount of change have been settled for sensitivity analysis.

i) Selling price of fertilizers: ±10%
ii) Plant construction costs: ±10%
iii) Electric power costs: $US 14.06/kW·M
iv) Total operating cost: ±10%
v) Operating rate: ±10%
vi) Interest on long-term loan: Decrease from 10% to 5% p.a.

(2) Results

The results of the sensitivity analysis are summarized in Table 10-5-9.

Table 10-5-9 Result of Sensitivity Analysis

		FIRR on I		FIRR on E	
		Before Tax	After Tax	Before Tax	After Tax
Base Case		11.1	10.2	12.8	10.4
Selling Price	+10%	15.9	14.3	24.6	21.4
	-10%	5.3	5.3	-	-
Plant Construction	+10%	9.7	9.0	9.3	7.3
Cost	-10%	12.7	11.5	16.7	14.0
Electric Cost	US$14.06/kW·M	9.0	8.4	7.2	5.4
Total Operation Cost	+10%	6.7	6.7	-	-
	-10%	14.9	13.5	22.2	19.2
Operating Rate	+10%	13.0	11.8	17.4	14.7
	-10%	9.1	8.5	7.6	5.7
Interest	5% p.a.			20.1	17.1

If the exchange rate were to fluctuate from the official rate of 240 Gs/US$ current as of mid-1986, the selling price of fertilizer would be calculated to show a 10% FIRR on I (after taxes). These calculations are presented in Table 10-5-10 below.

Table 10-5-10 Product Price

	Base Case	Case 1 (Gs400/US$)	Case 2 (Gs700/US$)	Additional Case (Gs550/US$)
DAP	101	156	258	207
TSP	76	117	194	156
NPK(6-30-10)	95	146	243	195
NPK(15-15-15)	86	133	220	176
Slag	12	12	12	12

10.6 Financial Analysis for Scenario 3 (FMP)

10.6.1 Major Assumptions

The major assumptions for the financial analysis for Scenario 3 are the same as those for Senarios 1 and 2.

10.6.2 Cost Base

1) Electricity

Electricity requirement is 2,526 kW for 11 months and 450 kW for 1 month. The price of electricity for the calculation is US$ 10/KW·M.

2) Materials and Utilities

The requirements of materials and utilities are as follows;

Phosphate Rock	8,100 t/y *1
Serpentine	6,800 t/y *2
Silica Gravel	885 t/y *1
Electrodes	30 t/y *3
Fuel Oil	150 kl/y *1
Lime	204 t/y *1
NaClO	111 t/y *1

Note: *1 The prices are the same prices applied to the calculation of Scenarios 1 and 2.

*2 The price of serpentine is 20 Gs/kg

*3 The electrodes for FMP production are US$2,500/t and import charges are 8% of US$2,500/t.

3) Others

The other costs required for the production of FMP are the same as applied to the analysis for Senarios 1 and 2 excluding direct labor requirement as shown below:

The direct labor requirement for FMP plant operation is as follow:

Operator	44 persons
Worker	45 persons
Driver	14 persons

The cost for labor is the same applied to the calculation of Senarios 1 and 2.

10.6.3 Evaluation

The FMP price of 89 Gs/kg is calculated based on an after tax FIRR on I of 10%. As the P_2O_5 content of FMP is less than that of TSP, the FMP price should normally be lower. In this case, however, the 89 Gs/kg FMP price is higher than that of TSP. Thus production of FMP in Paraguay can not be expected to be financially feasible.

CHAPTER XI ECONOMIC ANALYSIS

The economic analysis is conducted for Scenario 1 which shows the highest FIRR among three Scenarios.

11.1 Economic Cost and Benefit

The economic cost and benefit expected from this project are summarized in Table 11-1-1.

Table 11-1-1 Economic Cost and Benefit

Benefit	Cost
Fertilizer production Slag production Increase of employment opportunity Development of fertilizer related industry	Investment cost Pre-operation cost Raw material and utility cost Direct labor cost Maintenance cost Plant consumable cost Plant overhead cost Administration cost Sales expense

11.2 Economic Internal Rate of Return (EIRR)

The EIRR of this project shows 10.7%, which is not exceptionally high in comparison with the cut off rate which is normally applied (8-12%).

11.3 Effect on Foreign Currency Balance

The foreign currency savings reach 47.1 million US dollar for the period of 15 years commercial operation under conditions described below.

- The foreign currency portion required during plant construction is met by the entire amount of the long term loan.
- Interest rate is 10% p.a.
- 10 years repayment with 3 years period of grace from the start of commercial operation.

CHAPTER XII CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

Based on the analysis of domestic demand for fertilizers, the plant capacity was decided at 70,000 ton/yr. The recommended fertilizer plant is Scenario 1 consisting of phosphoric acid plant and fertilizer plant without the production of ammonia. Since the recommended production processes have a long history of commercial use worldwide, they present no problems judging from the operational experiences.

Furthermore, in terms of site selection, required infrastructure, and the potential of Paraguay's engineers for the operation of plant, this project is feasible.

There are some problems, however, to be considered for the project: one is the need to rely on Brazilian imports for the large quantities of phosphate rock the main raw material in the production process.

The other is the fertilizer production costs. In a processing industry like this fertilizer project, securing a reliable supply of raw materials is of utmost importance for continuous normal operation. In the Paraguayan case, imports must be relied on not only for phosphate rock, but for other major raw materials as well. To add to this problem, Paraguay is a landlocked country isolated from the producing regions, which means that transportation costs are always high. These high transportation costs are naturally reflected in high production costs.

If the Paraguayan fertilizer plant were to offer its products at the prices currently available on the world market or in eastern Brazil (DAP US$250-300/ton), this project is not feasible in view of financial profitability.

At present, however, individual traders import bagged fertilizers into Paraguay in small quantities over long distances, and prices are thus exceptionally high.

The fertilizer plant, in order to maintain reasonable profits, would have to offer ex-plant prices of products at least at the level of 80% of end user prices with the conditions of ammonia importation for the production of phosphate fertilizers and sales of excess slag.

For an agricultural nation like Paraguay, however, construction of this fertilizer plant would be an important project with significant contributions to social and economic development.

12.1.1 Market Evaluation

Use of fertilizers in the Paraguayan agricultural industry is relatively recent, having a history of only ten years or so. The demand for phosphate fertilizers in 1985 stood at 31,500 ton/yr; and the farm gate price was exceptionally high, about Gs 126/kg for DAP (US$525/ton), calculated at the official exchange rate of Gs 240/US$, current as of mid 1986. Prices for TSP (Gs 76/kg) and 5-30-10 NPK (Gs 95/kg) were equally high, while the prices that farmers received for their crops were comparatively low.

In this unfavorable price environment, farmers are unlikely to increase the per unit area dosages of fertilizer applied to their crops. As the benefits of initial levels of fertilization are substantial, however, farmers who are not presently using fertilizers can be expected to adopt the practice in future years. Thus demand for phosphate, NP and NPK fertilizers is estimated to reach 71,400 ton/yr in 1995. The recommended plant product mix with the capacity of 70,000 ton/yr is based on this estimate.

12.1.2 Raw Materials

In a processing industry such as the Paraguayan fertilizer plant, a reliable supply of raw materials is of prime importance.

For manufacture of phosphate fertilizers, phosphate rock is the crucial raw material. No deposits of acceptable quality phosphate rock, however, have been discovered in Paraguay to date. The project will thus be forced to rely entirely on imported rock. The Goias mine in Brazil is presently producing a large surplus of high quality phosphate rock; and as the price is competitive, this is the most promising source of imports.

Other supplementary raw materials, such as coke and electrodes, must also be imported from abroad. Although high transportation costs, and some operational snags for these materials will be unavoidable, there should be no technical problems in terms of shipping and delivery. In order to insure that these foreign imports can be obtained on a steady basis, however, special arrangements will have to be made to facilitate customs clearance procedures at the border.

12.1.3 Technical Aspects

Sources of phosphorus and nitrogen are necessary for production of phosphate fertilizers such as DAP, TSP and NPK. In Paraguay, there are no sulfur deposits or sulfuric acid plants, but the fertilizer project will have access to abundant electric power from Itaipu power station. Thus the "dry" process, instead of the "wet" process which uses sulfuric acid, will be employed in producing yellow phosphorus to produce phosphoric acid.

Ammonia is required as nitrogen source. As hydrocarbon sources such as natural gas and oil have not been developed in Paraguay, the following two Scenarios are studied:

Scenario 1: Ammonia will be imported.

Scenario 2: Ammonia will be produced by reacting nitrogen separated from air with hydrogen obtained through water electrosis.

According to the financial analysis results Scenario 2 is not viable; and ammonia will thus be imported. The process recommended for production of phosphoric acid has already been completely developed, and has a long history of stable operation and results.

Paraguayan engineers and technicians possess a relatively high potential, and with transfer of the necessary technology, should have no problems in operating and maintaining the plant. Thus the Paraguayan fertilizer project should not expect to be beset by technical difficulties.

12.1.4 Financial and Economic Aspects

At present, however, as fertilizer is imported to Paraguay over long distance in bags rather than in bulk and the amounts handled are rather low, prices are substantially higher than on the world market. For example, the farm gate price for DAP in mid-1986 was Gs 126/kg.

This price, however, includes delivery costs in Paraguay and the commissions taken by the traders and agricultural cooperatives. If those costs amount to 20% of the price, this leaves Gs 101/kg as the ex-plant price. If the Paraguayan plant were to offer fertilizer at this price level, a financial internal rate of return on investment (FIRR on I) of 7.9% could be had after taxes.

In the electric furnace used to produce yellow phosphorus, a calcium silicate slag is produced as a by-product. This slag can be used as a fertilizer capable of supplying crops with the required silica and calcium; and also is very effective when used as a soil restorative to help balance pH. The slag by-product will thus not only be useful to the Paraguayan agriculture; but if half the excess amount is sold at Gs 12/kg, will bring the FIRR on I up from 7.9% to 10.2% as well. In this case, an economic internal rate of return (EIRR) shows 10.7%.

Thus the Paraguayan fertilizer plant, in the absence of a price war instigated by drastic cuts in price of imported fertilizer, should be able to operate on a feasible, financial profitability basis.

12.2 Recommendations

This is the first fertilizer plant to be constructed in Paraguay. Thus the government, when drawing up plans for a national fertilizer production industry, should give due consideration to the following recommendations.

12.2.1 Market

1) Soils in Paraguay are lacking in phosphorus. The government should actively support a fertilization promotion program while considering the possibilities of domestic fertilizer production.

2) If this project were to be implemented at the recommended capacity, a balance between domestic supply and demand would be achieved by 1995/96. From this stage onward, the additional supply would have to be made up either by imports or expansion of plant capacity. These options should be considered while observing the functioning of the plant once it has moved into commercial operating status.

3) The government needs to conduct extensive statistical research on importation of fertilizer. A thorough knowledge of the supply and demand conditions is necessary for drawing up plans for a fertilizer development program. The amount of officially imported fertilizer needs to be accurately verified, and it is equally important to find out more about the inflow not shown in the statistics. The government should take necessary measures for making sufficient quantities and desired types of imported fertilizer available on a timely basis and at a reasonable price.

4) As farmer's production costs in Paraguay are dependent upon agricultural credits, these programs should be expanded. Along with increasing the budget framework of BNF, which is the central financing organ for the industry, the mortgage requirements and interest rates should be softened. These measures will allow the credit system to reach a greater number of farmers. In addition, the government should consider the subsidy to fertilizer itself.

5) Paraguayan farmers have been using fertilizers for only a relatively short time. In the future, experimental research should be carried out at institutes like CRIA and the JICA's Estacion to determine which fertilizer types are best suited to local soils. This research should include the testing of fused magnesium phosphate fertilizer.

6) Until the establishment of the fertilizer plant in Paraguay, the government should institute measures to facilitate application for import permits. In addition, fertilizers should be granted preferential status in terms of foreign exchange quotas.

12.2.2 Raw Materials

1) A stable supply of raw materials, particularly phosphate rock and coke, is essential for smooth operation of this project. To assure such a steady supply, raw materials for fertilizer production should be given preference for foreign exchange allocations. In addition, long term contracts should be signed with suppliers, and smooth transportation and delivery should be assured under the protection of the Paraguayan government.

2) It is especially important that the electricity pricing system for this project should be established in order to reduce the electric power cost, as the phosphoric acid production process to be employed will consume large amount of power. One of the recommendations is that

electric power is purchased directly from Itaipu power station at the level of US$10/kW M. Direct reception will be advantageous from a technical standpoint, and power outages can be reduced. This will help to keep the plant running smoothly. In addition, purchasing power directly from Itaipu will be beneficial from the standpoint of costs.

For the reference, the electric power pricing system in Japan to decrease the price of electricity is as follows:

- The electric power prices for industrial use are cheaper than those for households.
- The electric power prices for night period are cheaper than those for day time.

3) Paraguay retains the right to receive half of the power generated at Itaipu station, but excess power will be contracted to Brazil. Bartering this power for phosphate rock should be investigated as a possible method of securing a stable supply of this most crucial raw material.

4) Although no reserves of phosphate rock of a quality acceptable for fertilizer production have not yet to be discovered in Paraguay, mineral surveys are still in progress. If a domestic reserve were to be located, a major problem, that of relying on imports for the most important raw material, would be solved. Thus efforts to locate such a source should be continued into the future.

5) The option of producing ammonia at the plant has been investigated. The capacity, however, would be only 30 ton/day. In addition, electric power cost, US$ 10/kW·M, would be higher than the energy costs for natural gas experienced in other areas. Thus production costs for ammonia would be high by world standards, and the Paraguayan project should import the necessary amounts.

12.2.3 Technology

1) A great deal of operational know-how is necessary for running the "dry" process phosphoric acid and fertilizer plants. Thus not only should technicians and operators be trained before the plant begins operation, but highly experienced foreign personnel should be stationed at the plant for the first three years or so of operation. These experts will be necessary for effecting the technology transfer, and for training and educating Paraguayan technicians.

2) Coke is necessary as a reducing agent for production of phosphoric acid in the "dry" process. The possibilities of substituting wood charcoal for coke have been investigated. Under the existing technology, however, wood charcoal has been found to lack the necessary strength, and is thus unusable. None the less, as coke is not produced in Paraguay, efforts should be taken to develop a method for using wood charcoal instead.

12.2.4 Financial Aspects

1) If fertilizers produced at the plant were sold at the domestic prices now prevailing in Paraguay, the operation would be financially feasible.

   If the price of imported fertilizer were to drop substantially, however, and the plant were forced to engage in a price war to retain the market, government subsidies would be necessary.

2) The following measures should be implemented to improve the financial feasibility of the project:

   (1) As was recommended in Section 12.2.2, importation of ammonia is financially advantageous.

(2) Numerous fees and charges, such as LC opening fees, custom tariffs and import handling charges, are levied on the import of raw materials. The government should institute a system giving preferential treatment to these raw materials, thus helping to reduce costs.

(3) Research should be conducted on how to sell the by-product slag at a higher value-added price.

3) If the foreign exchange rate were to drop (official rate now pegged at Gs 240/US$), not only production costs, but raw materials costs as well would rise. A sudden increase in the price of fertilizer would invite a decrease in demand, perhaps forcing the plant to reduce its operation load. In this case, the government should consider the possibility of establishing a preferential exchange rate for import of raw materials for the fertilizer plant.

4) Based on the results of market analysis, the plant capacity of FMP is determined to be 15,000 ton/yr. The price of FMP with 18-20% P_2O_5 content should normally be less than that of TSP with 46-48% content. At this capacity, however, the ex-plant price of FMP in Paraguay, based on an after tax FIRR on I for 10%, would be Gs 89/kg, which is higher than that of TSP (Gs 76/kg). Production of FMP at the Paraguayan plant can thus not be expected to be financial feasibility and if this fertilizer is required, it is recommended that the necessary amount be imported.

12.2.5 Others

The decrease of operating rate of the plant will make this project infeasible like other industrial projects. The operating rate of this project is scheduled to be 80% of the rated plant capacity for 1st year, 90% for 2nd year, and 100% for 3rd year and after. This operating rate is equivalent to 70% of the actual production capacity for 1st year, 79% for 2nd year and 88% for 3rd year and after.

In order to achieve the operating rate described above, the following efforts are required.

- Prompt financing arrangement including foreign currency for the importation of raw materials
- Smooth transportation of raw materials
- Appropriate control of raw material inventories
- Training of plant operators
- Excellent maintenance of plant
- Aggressive sales promotion of fertilizers
- Reasonable business administration
- Good quality control

Table 10-5-1 Cost of Goods Sold Table
Scenario 1 without By-product

(Unit : MMGs)

<< Project Year >>	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Variable Operating Cost																			
Initial Inventory of Raw Materials	--	--	--	0.0	98.8	111.1	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	--
Raw Materials Purchased	--	--	--	2,469.0	2,678.9	2,975.1	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	43,676.7
Final Inventory of Raw Materials	--	--	--	98.8	111.1	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	--
Raw Materials Consumed	--	--	--	2,370.2	2,666.5	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	43,553.2
Electricity	--	--	--	511.9	575.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	9,406.4
Utilities & Chemicals	--	--	--	413.1	464.7	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	7,590.8
Bag	--	--	--	336.0	378.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	6,174.0
Sub-total	--	--	--	3,631.3	4,085.2	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	66,724.4
Fixed Operating Cost																			
Direct Labor Cost	--	--	--	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	2,944.5
Maintenance Cost	--	--	--	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	4,213.0
Insurance Cost	--	--	--	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	702.2
Plant Consumables	--	--	--	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	294.5
Plant Overhead	--	--	--	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	1,472.3
Sub-total	--	--	--	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	9,626.4
Total Operating Cost	--	--	--	4,273.0	4,726.9	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	76,350.8
Depreciation	--	--	--	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	7,794.2
Amortization	--	--	--	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	1,257.3
Cost of Production	--	--	--	4,876.5	5,330.4	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	85,402.3
Initial Inventory of Products	--	--	--	0.0	203.2	222.1	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	--
Cost of Production	--	--	--	4,876.5	5,330.4	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	85,402.3
Final Inventory of Products	--	--	--	203.2	222.1	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	--
Costs of Goods Sold	--	--	--	4,673.3	5,311.4	5,765.4	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	85,161.3

Table 10-5-2 Income Statement

Scenario 1 without By-product

(Unit : MMGs)

<< Project Year >>	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Sales Revenue																			
DAP	--	--	--	2,245.6	2,623.9	2,916.8	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	42,934.3
TSP	--	--	--	291.3	340.4	378.4	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	5,570.2
NPK(6-30-10)	--	--	--	2,330.7	2,723.3	3,027.3	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	44,561.3
NPK(15-15-15)	--	--	--	263.7	308.2	342.6	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	5,042.5
By-products	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Revenue	--	--	--	5,131.3	5,995.8	6,665.1	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	98,108.2
Costs of Goods Sold	--	--	--	4,673.3	5,311.4	5,765.4	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	85,161.3
Administration Cost	--	--	--	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	1,472.3
Sales Expense	--	--	--	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	294.5
Cost Total	--	--	--	4,791.0	5,429.2	5,883.1	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	86,928.0
Interest on Long-term Loan	--	--	--	808.9	808.9	808.9	808.9	728.0	647.1	566.2	485.3	404.4	323.6	242.7	161.8	80.9	0.0	0.0	6,875.6
Interest on Short-term Loan	--	--	--	0.0	70.1	16.0	0.0	54.2	101.4	141.0	171.9	192.3	200.0	192.2	175.7	142.1	88.1	0.0	1,544.9
Net Profit before Tax	--	--	--	-468.6	-312.4	-42.9	-17.9	8.8	42.5	83.7	133.7	194.2	267.4	356.0	453.5	567.9	702.8	791.0	2,759.8
Tax	--	--	--	0.0	0.0	0.0	0.0	2.0	7.1	13.3	20.7	29.8	81.6	108.2	137.4	171.8	212.2	238.7	1,022.8
Net Profit after Tax	--	--	--	-468.6	-312.4	-42.9	-17.9	6.8	35.4	70.5	113.0	164.4	185.8	247.9	316.1	396.2	490.6	552.3	1,737.0

Table 10-5-3 Cost of Goods Sold
Scenario 2 without By-product

(Unit : MMGs)

<< Project Year >>	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Variable Operating Cost																			
Initial Inventory of Raw Materials	--	--	--	0.0	87.1	97.7	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	--
Raw Materials Purchased	--	--	--	2,176.9	2,354.6	2,608.7	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	38,317.7
Final Inventory of Raw Materials	--	--	--	87.1	97.7	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	108.3	--
Raw Materials Consumed	--	--	--	2,089.8	2,344.0	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	2,598.1	38,209.5
Electricity	--	--	--	816.9	919.0	1,021.1	1,021.1	1,021.1	1,021.1	1,021.1	1,021.1	1,021.1	1,021.1	1,021.1	1,021.1	1,021.1	1,021.1	1,021.1	15,010.7
Utilities & Chemicals	--	--	--	404.5	455.1	505.6	505.6	505.6	505.6	505.6	505.6	505.6	505.6	505.6	505.6	505.6	505.6	505.6	7,432.7
Bag	--	--	--	336.0	378.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	6,174.0
Sub-total	--	--	--	3,647.2	4,096.0	4,544.9	4,544.9	4,544.9	4,544.9	4,544.9	4,544.9	4,544.9	4,544.9	4,544.9	4,544.9	4,544.9	4,544.9	4,544.9	66,826.8
Fixed Operating Cost																			
Direct Labor Cost	--	--	--	251.2	251.2	251.2	251.2	251.2	251.2	251.2	251.2	251.2	251.2	251.2	251.2	251.2	251.2	251.2	3,768.0
Maintenance Cost	--	--	--	372.7	372.7	372.7	372.7	372.7	372.7	372.7	372.7	372.7	372.7	372.7	372.7	372.7	372.7	372.7	5,590.2
Insurance Cost	--	--	--	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	931.7
Plant Consumables	--	--	--	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	376.8
Plant Overhead	--	--	--	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	1,884.0
Sub-total	--	--	--	836.7	836.7	836.7	836.7	836.7	836.7	836.7	836.7	836.7	836.7	836.7	836.7	836.7	836.7	836.7	12,550.7
Total Operating Cost	--	--	--	4,483.9	4,932.8	5,381.6	5,381.6	5,381.6	5,381.6	5,381.6	5,381.6	5,381.6	5,381.6	5,381.6	5,381.6	5,381.6	5,381.6	5,381.6	79,377.5
Depreciation	--	--	--	697.2	697.2	697.2	697.2	697.2	697.2	697.2	697.2	697.2	697.2	697.2	697.2	697.2	697.2	697.2	10,458.5
Amortization	--	--	--	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	1,505.2
Cost of Production	--	--	--	5,281.5	5,730.3	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	91,341.2
Initial Inventory of Products	--	--	--	0.0	220.1	238.8	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	--
Cost of Production	--	--	--	5,281.5	5,730.3	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	91,341.2
Final Inventory of Products	--	--	--	220.1	238.8	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	257.5	--
Costs of Goos Sold	--	--	--	5,061.4	5,711.6	6,160.5	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	91,083.7

Table 10-5-4 Income Statement
Scenario 2 without By-product

(Unit : MMGs)

<< Project Year >>	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Sales Revenue																			
DAP	--	--	--	2,245.6	2,623.9	2,916.8	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	42,934.3
TSP	--	--	--	291.3	340.4	378.4	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	5,570.2
NPK(6-30-10)	--	--	--	2,330.7	2,723.3	3,027.3	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	44,561.3
NPK(15-15-15)	--	--	--	263.7	308.2	342.6	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	5,042.5
By-products	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Revenue	--	--	--	5,131.3	5,995.8	6,665.1	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	6,693.0	98,108.2
Costs of Goos Sold	--	--	--	5,061.4	5,711.6	6,160.5	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	6,179.2	91,083.7
Administration Cost	--	--	--	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	125.6	1,884.0
Sales Expense	--	--	--	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	376.8
Cost Total	--	--	--	5,212.1	5,862.4	6,311.2	6,329.9	6,329.9	6,329.9	6,329.9	6,329.9	6,329.9	6,329.9	6,329.9	6,329.9	6,329.9	6,329.9	6,329.9	93,344.5
Interest on Long-term Loan	--	--	--	1,055.0	1,055.0	1,055.0	1,055.0	949.5	844.0	738.5	633.0	527.5	422.0	316.5	211.0	105.5	0.0	0.0	8,967.7
Interest on Short-term Loan	--	--	--	0.0	184.6	274.0	328.0	635.2	990.1	1,405.0	1,894.1	2,475.2	3,170.5	4,007.3	5,019.7	6,249.7	7,749.6	9,331.0	43,713.9
Net Profit before Tax	--	--	--	-1,135.9	-1,106.2	-975.1	-1,020.0	-1,221.6	-1,471.1	-1,780.4	-2,164.0	-2,639.6	-3,229.4	-3,960.7	-4,867.6	-5,992.1	-7,386.5	-8,967.9	-47,918.0
Tax	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Profit after Tax	--	--	--	-1,135.9	-1,106.2	-975.1	-1,020.0	-1,221.6	-1,471.1	-1,780.4	-2,164.0	-2,639.6	-3,229.4	-3,960.7	-4,867.6	-5,992.1	-7,386.5	-8,967.9	-47,918.0

Table 10-5-5 Cost of Goods Sold

Scenario 1 without By-product

(Unit : MMGs)

<< Project Year >>	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Variable Operating Cost																			
Initial Inventory of Raw Materials	--	--	--	0.0	98.8	111.1	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	--
Raw Materials Purchased	--	--	--	2,469.0	2,678.9	2,975.1	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	43,676.7
Final Inventory of Raw Materials	--	--	--	98.8	111.1	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	--
Raw Materials Consumed	--	--	--	2,370.2	2,666.5	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	2,962.8	43,553.2
Electricity	--	--	--	511.9	575.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	639.9	9,406.4
Utilities & Chemicals	--	--	--	413.1	464.7	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	516.4	7,590.8
Bag	--	--	--	336.0	378.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	6,174.0
Sub-total	--	--	--	3,631.3	4,085.2	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	4,539.1	66,724.4
Fixed Operating Cost																			
Direct Labor Cost	--	--	--	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	196.3	2,944.5
Maintenance Cost	--	--	--	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	280.9	4,213.0
Insurance Cost	--	--	--	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	46.8	702.2
Plant Consumables	--	--	--	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	294.5
Plant Overhead	--	--	--	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	1,472.3
Sub-total	--	--	--	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	9,626.4
Total Operating Cost	--	--	--	4,273.0	4,726.9	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	76,350.8
Depreciation	--	--	--	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	519.6	7,794.2
Amortization	--	--	--	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	1,257.3
Cost of Production	--	--	--	4,876.5	5,330.4	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	85,402.3
Initial Inventory of Products	--	--	--	0.0	203.2	222.1	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	--
Cost of Production	--	--	--	4,876.5	5,330.4	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	85,402.3
Final Inventory of Products	--	--	--	203.2	222.1	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	--
Costs of Goods Sold	--	--	--	4,673.3	5,311.4	5,765.4	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	85,161.3

Table 10-5-6 Income Statement
Scenario 1 with By-product

(Unit : MMGs)

<< Project Year >>	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Sales Revenue																			
DAP	--	--	--	2,245.6	2,623.9	2,916.8	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	2,929.0	42,934.3
TSP	--	--	--	291.3	340.4	378.4	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	380.0	5,570.2
NPK(6-30-10)	--	--	--	2,330.7	2,723.3	3,027.3	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	3,040.0	44,561.3
NPK(15-15-15)	--	--	--	263.7	308.2	342.6	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	344.0	5,042.5
By-products	--	--	--	269.5	314.9	350.1	351.5	351.5	351.5	351.5	351.5	351.5	351.5	351.5	351.5	351.5	351.5	351.5	5,153.0
Total Revenue	--	--	--	5,400.8	6,310.7	7,015.2	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	103,261.2
Costs of Goods Sold	--	--	--	4,673.3	5,311.4	5,765.4	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	5,784.3	85,161.3
Administration Cost	--	--	--	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	1,472.3
Sales Expense	--	--	--	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	294.5
Cost Total	--	--	--	4,791.0	5,429.2	5,883.1	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	5,902.0	86,928.0
Interest on Long-term Loan	--	--	--	808.9	808.9	808.9	808.9	728.0	647.1	566.2	485.3	404.4	323.6	242.7	161.8	80.9	0.0	0.0	6,875.6
Interest on Short-term Loan	--	--	--	0.0	10.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.8
Net Profit before Tax	--	--	--	-199.1	61.8	323.2	333.6	414.5	495.4	576.3	657.2	738.0	818.9	899.8	980.7	1,061.6	1,142.5	1,142.5	9,446.8
Tax	--	--	--	0.0	10.0	49.2	50.7	62.9	75.0	174.3	198.5	222.8	247.1	271.3	295.6	319.9	344.1	344.1	2,665.4
Net Profit after Tax	--	--	--	-199.1	51.8	274.0	282.9	351.6	420.4	402.0	458.6	515.3	571.9	628.5	685.1	741.7	798.4	798.4	6,781.4

ROI (before Tax) = 11.1%
ROI (after Tax) = 10.2%
ROE (before Tax) = 12.8%
ROE (after Tax) = 10.4%

Table 10-5-7 Fund Flow Statement
Scenario 1 with By-product

(Unit : MMGs)

<< Project Year >>	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sources of Fund																			
Sales Revenue	0.0	0.0	0.0	5,400.8	6,310.7	7,015.2	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	308.2
Equity	1,357.1	1,170.7	536.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long-term Loan	3,166.7	3,048.2	1,874.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Short-term Loan	0.0	0.0	0.0	45.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Increase in Account Payable	0.0	0.0	0.0	302.6	37.8	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-378.3
Total Source	4,523.8	4,218.9	2,410.9	5,748.5	6,348.6	7,053.0	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	7,044.5	-70.1
Applications of Fund																			
Land	198.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-198.0
Plant Investment	4,220.0	3,796.4	1,345.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1,568.0
Pre-operation Cost	105.8	105.8	247.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Initial Working Capital	0.0	0.0	196.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interest during Construction	0.0	316.7	621.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operating Cost	0.0	0.0	0.0	4,273.0	4,726.9	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	5,180.8	0.0
Administration Cost	0.0	0.0	0.0	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	0.0
Sales Expense	0.0	0.0	0.0	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	0.0
Debt Service																			
- Long-term Loan -																			
Principal	0.0	0.0	0.0	0.0	0.0	0.0	808.9	808.9	808.9	808.9	808.9	808.9	808.9	808.9	808.9	808.9	0.0	0.0	0.0
Interest	0.0	0.0	0.0	808.9	808.9	808.9	808.9	728.0	647.1	566.2	485.3	404.4	323.6	242.7	161.8	80.9	0.0	0.0	0.0
- Short-term Loan -																			
Principal	0.0	0.0	0.0	0.0	45.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Interest	0.0	0.0	0.0	0.0	10.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tax Payment	0.0	0.0	0.0	0.0	0.0	10.0	49.2	50.7	62.9	75.0	174.3	198.5	222.8	247.1	271.3	295.6	319.9	344.1	344.1
Increase in Account Recievable	0.0	0.0	0.0	450.1	75.8	58.7	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-587.0
Increase in Raw Material Inventory	0.0	0.0	0.0	98.8	12.3	12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-123.5
Total Application	4,523.8	4,218.9	2,410.9	5,748.5	5,797.7	6,188.5	6,968.0	6,886.2	6,817.5	6,748.7	6,767.1	6,710.5	6,653.9	6,597.2	6,540.6	6,484.0	5,618.5	5,642.7	-2,132.4
Cash Surplus	0.0	0.0	0.0	0.0	550.9	864.5	76.5	158.3	227.1	295.8	277.4	334.1	390.7	447.3	503.9	560.6	1,426.1	1,401.8	2,062.3
Cumlative Cash Surplus	0.0	0.0	0.0	0.0	550.9	1,415.4	1,491.9	1,650.2	1,877.3	2,173.1	2,450.5	2,784.6	3,175.2	3,622.6	4,126.5	4,687.0	6,113.1	7,514.9	9,577.2
Cash Flow (ROI before/Tax)	-4,523.8	-3,902.2	-1,789.4	763.8	1,415.7	1,683.4	1,743.5	1,745.9	1,745.9	1,745.9	1,745.9	1,745.9	1,745.9	1,745.9	1,745.9	1,745.9	1,745.9	1,745.9	2,406.4
Cash Flow (ROI after/Tax)	-4,523.8	-3,902.2	-1,789.4	763.8	1,415.7	1,673.4	1,694.3	1,695.2	1,683.1	1,670.9	1,571.7	1,547.4	1,523.1	1,498.9	1,474.6	1,450.3	1,426.1	1,401.8	2,062.3
Cash Flow (ROE before/Tax)	-1,357.1	-1,170.7	-536.8	0.0	550.9	874.5	125.7	209.0	289.9	370.8	451.7	532.6	613.5	694.4	775.3	856.1	1,745.9	1,745.9	2,406.4
Cash Flow (ROE after/Tax)	-1,357.1	-1,170.7	-536.8	0.0	550.9	864.5	76.5	158.3	227.1	295.8	277.4	334.1	390.7	447.3	503.9	560.6	1,426.1	1,401.8	2,062.3

Table 10-5-8 Balance Sheet

Scenario 1 with By-product

(Unit : M$s)

<< Project Year >>	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Current Assets																			
Cash on Hand	0.0	0.0	196.3	196.3	747.2	1,611.7	1,688.2	1,846.5	2,073.6	2,369.4	2,646.8	2,980.9	3,371.5	3,818.9	4,322.8	4,883.3	6,309.4	7,711.2	9,773.5
Account Recievable	0.0	0.0	0.0	450.1	525.9	584.6	587.0	587.0	587.0	587.0	587.0	587.0	587.0	587.0	587.0	587.0	587.0	587.0	0.0
Raw Material Inventory	0.0	0.0	0.0	98.8	111.1	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	123.5	0.0
Product Inventory	0.0	0.0	0.0	203.2	222.1	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	241.0	0.0
Total Current Assets	0.0	0.0	196.3	948.3	1,606.3	2,560.7	2,639.7	2,798.0	3,025.1	3,320.9	3,598.3	3,932.4	4,323.1	4,770.4	5,274.3	5,834.8	7,260.9	8,662.7	9,773.5
Fixed Assets																			
Land	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	198.0	0.0
Plant	4,220.0	8,016.4	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	9,362.2	7,794.2
Depreciation	0.0	0.0	0.0	519.6	1,039.2	1,558.8	2,078.4	2,598.1	3,117.7	3,637.3	4,156.9	4,676.5	5,196.1	5,715.7	6,235.3	6,755.0	7,274.6	7,794.2	7,794.2
Book Value	4,220.0	8,016.4	9,362.2	8,842.6	8,323.0	7,803.4	7,283.8	6,764.1	6,244.5	5,724.9	5,205.3	4,685.7	4,166.1	3,646.5	3,126.9	2,607.2	2,087.6	1,568.0	0.0
Intangible Asset	105.8	528.3	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1	1,397.1
Amortization	0.0	0.0	0.0	83.8	167.6	251.5	335.3	419.1	502.9	586.8	670.6	754.4	838.2	922.1	1,005.9	1,089.7	1,173.5	1,257.3	1,257.3
Book Value	105.8	528.3	1,397.1	1,313.2	1,229.4	1,145.6	1,061.8	977.9	894.1	810.3	726.5	642.6	558.8	475.0	391.2	307.4	223.5	139.7	139.7
Total Fixed Assets	4,523.8	8,742.7	10,957.3	10,353.8	9,750.4	9,146.9	8,543.5	7,940.1	7,336.6	6,733.2	6,129.8	5,526.3	4,922.9	4,319.5	3,716.0	3,112.6	2,509.2	1,905.7	139.7
Total Assets	4,523.8	8,742.7	11,153.6	11,302.1	11,356.6	11,707.7	11,183.2	10,738.1	10,361.7	10,054.1	9,728.1	9,458.7	9,246.0	9,089.8	8,990.3	8,947.4	9,770.1	10,568.4	9,913.2
Current Liabilities																			
Account Payable	0.0	0.0	0.0	302.6	340.4	378.3	378.3	378.3	378.3	378.3	378.3	378.3	378.3	378.3	378.3	378.3	378.3	378.3	0.0
Short-term Loan	0.0	0.0	0.0	45.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tax Payable	0.0	0.0	0.0	0.0	10.0	49.2	50.7	62.9	75.0	174.3	198.5	222.8	247.1	271.3	295.6	319.9	344.1	344.1	0.0
Total Current Liabilities	0.0	0.0	0.0	347.7	350.4	427.4	429.0	441.1	453.3	552.5	576.8	601.0	625.3	649.6	673.9	698.1	722.4	722.4	0.0
Long-term Liabilities	3,166.7	6,214.9	8,088.9	8,088.9	8,088.9	8,088.9	7,280.0	6,471.1	5,662.3	4,853.4	4,044.5	3,235.6	2,426.7	1,617.8	808.9	0.0	0.0	0.0	0.0
Stockholdres Equity																			
Capital	1,357.1	2,527.8	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6	3,064.6
Retained Earning	0.0	0.0	0.0	-199.1	-147.3	126.7	409.6	761.2	1,181.6	1,583.6	2,042.2	2,557.5	3,129.3	3,757.8	4,443.0	5,184.7	5,983.1	6,781.4	6,848.6
Total Equity	1,357.1	2,527.8	3,064.6	2,865.5	2,917.3	3,191.3	3,474.2	3,825.8	4,246.2	4,648.2	5,106.8	5,622.1	6,194.0	6,822.5	7,507.6	8,249.3	9,047.7	9,846.0	9,913.2
Total Equity & Liabilities	4,523.8	8,742.7	11,153.6	11,302.1	11,356.6	11,707.7	11,183.2	10,738.1	10,361.7	10,054.1	9,728.1	9,458.7	9,246.0	9,089.8	8,990.3	8,947.4	9,770.1	10,568.4	9,913.2

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