FEASIBILITY STUDY REPORT FOR THE ESTABLISHMENT OF A PHOSPHATE FERTILIZER PLANT IN THE ARGENTINE REPUBLIC

AUGUST 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Argentine Republic, the Government of Japan decided to conduct a Feasibility Study on the Project to Establish a Phosphate Fertilizer Plant in the Argentine Republic and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent a survey team headed by Mr. Makoto Kuwabara from May 22 to June 17, 1983 to Argentina.

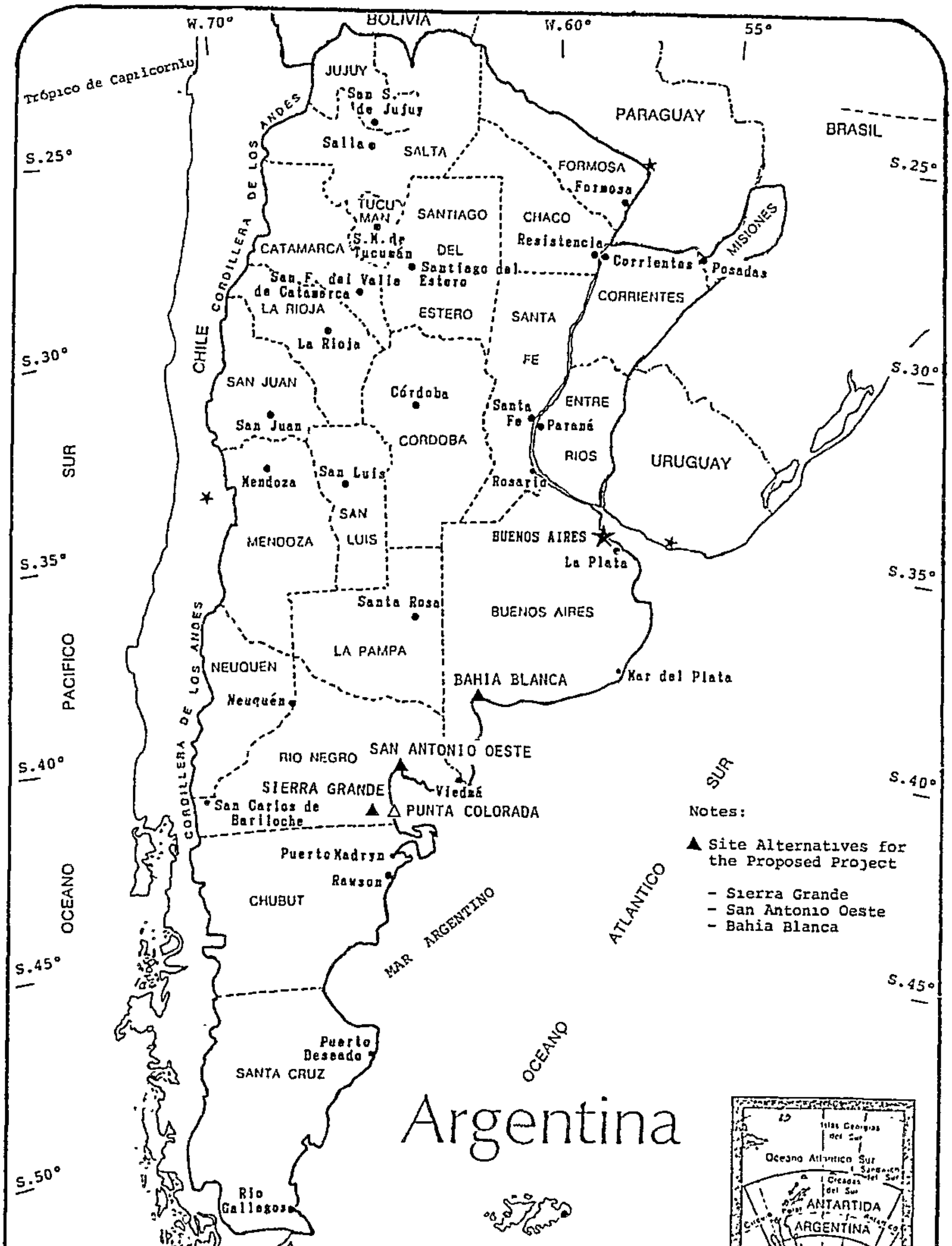
The team exchanged views on the Project with the officials concerned of the Government of Argentina and conducted a field survey in the project related areas including Sierra Grande, San Antonio Oeste and Bahía Blanca. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and also contribute to the promotion of friendly relations between our tow countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Argentine Republic for their close cooperation extended to our team.

August 1984

Keisuke Arita
President
Japan International Cooperation Agency



GENERAL MAP OF ARGENTINE AND SITE FOR PROPOSED PROJECT

ABBREVIATIONS AND CONVERSION FACTORS

for The Feasibility Study on the Establishment of a Phosphate Fertilizer Plant in the Argentine Republic

General

BPC	Base Project Cost which is estimated as of June 1, 1983
C & F	Cost & Freight
CIF	Cost, Insurance and Freight
ERR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
FRR	Financial International Rate of Return
FNPV	Financial Net Present Value
Fiscal Year	From January 1 to December 31 in Argentine
FOB	Free on Board
GDP	Gross Domestic Product
GNP	Gross National Product
IDC	Interest during Construction
IWC	Initial Working Capital
IRR	Internal Rate of Return
NPV	Net Present Value
NA	Not Available
$a	Pesos Argentinos, Currency Unit in Argentine
ROI	Return on Investment
ROE	Return on Equity
S/W	Scope of Work
TCR	Total Capital Required at Commencement Date for Commercial Production
USD	U.S. Dollar
Exchange Rate (Effective June 1, 1983)	USD1.00 = $a 8.86 (Mercado Oficial), USD1.00 = $a 11.30 (Mercado Libre) $a 1.00 = USD 0.1129 (Mercado Oficial), $a 1.00 = USD 0.0885 (Mercado Libre) Denomination of Pesos (Ley 18,188) $10,000 to Pesos Argentinos $a 1.00 has been effected on June 1, 1983

Organization

AAN	Armada Argentina Servicio de Hidrografia Naval
AAT	Armada Argentina Servicio de Transportes Navales
ACINDAR	Acindar SA
AGTF	Administración general de transporte fluvial
JICA	Agencia de Cooperación Internacional del Japón
AyE	Agua y Energía Eléctrica
AGROMAX	Agromax SAIC
ALECY	Alecy SA
BNA	Banco de la Nación Argentina
BGA	Banco Ganadero Argentino
BND	Banco Nacional de Deserrollo Caprolactama SA
CAC	Camara Argentina de la Construccion
CIS	Centro de la Industria Siderurgica
CNT	Centro de Navegación Transatlantica
CTI	Consejo Técnico de Inversiones SA
CIADE	Compaia Italo-Argentina de Electricidad
CF Río Chubut	Corporación de Formento del Rsio Chubut
CF Río Colorada	Corporación de Formento del Río Colorada
CORCEMAR	Corporación Cementera Argentina
DALMINE	Dálmine Siderca SA
DGCEE	Dirección General de Centrales Electricas del Estado
DGFM	Dirección General de Fabricaciones Militares
DNEM	Dirección Nacional de Economic Minera
DNFCA	Dirección Nacional de Fiscalizacion y Comercializatisón Agrícola
DNRO	Direccion Nacional del Registro Oficial de la Secretaria de Informacion Publica de la Presidencia de la Nacion
DOW	Dow Química Argentine
DUPERIAL	Duperial SAIC
EFEA	Empresa de Ferrocarriles Nacionales
EFFDEA	Empresa Flota Fluvial del Estado Argentino
ELMA	Empresa Lineas Maritimas Argentinas
EPEC	Empresa Provincial de Energía de Córdoba
FERTILIZAR	Fertilizar SA
FANF	Flota Argentina de Navegación
GAS DEL ESTADO	Gas del Estado
GURMENDI	Gurmendi SA
HINODE	Hinode Kagaku Kogyo KK, Japan
HIPASAM	Hierro Petagónico de Sierra Grande Sociedad Anónima Minera
IDS	Ingenieria del Suelo SRL
IPAKO	Industrias Petroquímicas Argentinas
IMPAGRO	Industras Petroquímica Palalelagro
INDQUICAS	Industrial Químicas SAIC

IRAM	Instituto Argentino de Racionalización de Materiales
IDEVI	Instituto de Dessarrollo del Valle Interior del Rio Negro
INDEC	Instituto Nacional de Estadistica y Censos
INTA	Instituto Nacional de Tecnologia Agropecuaria
INTI	Instituto Nacional de Tecnologia Industrial
ICC	International Chamber of Commerce
INVAP	INVAP SE
NIKKO	Nippon Mining Co., Ltd., Japan
NISSAN	Nissan Chemical Industries Ltd., Japan
NORSK HYDRO	Norsk Hydro sa, Norway
PASA	Petro Química Argentina SA
PETROSUR	Petrosur SA
PQBB	Petroquímica Bahia Blanca SAIC
MOSCONI	Petroquímica General Mosconi SAIC
HOECHST	Química Hoechst SA
SDM	Subsecretaria de Mineria
SEAGN	Secretaria de Estado de Agricultura y Ganadersia de la Nacıson
SEDI	Secretaría de Estado de Desarrollo Industrial
SEGBA	Servícios Eléctricos del Gran Buenos Aires
STN	Servícios de Transportes Navales
SIDERSUR	Siderurgica del Sur SA
SOMISA	Sociedad Mixta Siderurgia Argentina
SUDAMFOS	Sudamfos SA
SULFACID	Sulfacid SA
YCF	Yacimientos Carboniferos Fiscales
YPF	Yacimientos Petrolíferos Fiscales
ZARATE	Zárate Sulfurico

Units

Acre, A	1.0 Acre = 4,047 m^2
BBL	Barrel, 1.0 BBL = 42.0 US Gallon = 34.97 Imperial Gallons
BSCF, BCF	Billion SCF
BSCFD	Billion SCF per Day
BTU	British Thermal Unit, 1.0 BTU = 0.252 kcal
Bushel	1.0 Bushel = 34.25 Liters
DWT	Dead Weight Ton
EL	Elevation Level
Fanga	Unit of Volume in Argentine 1.0 Fanga = 1.57 US Bushels = 1.52 Imperial Bushels = 55.4 Liter
ha	Hectare, 1.0 ha = 10,000 m^2 = 2,471 Acres (A)
HHV	High Heating Value
Gallon	1.0 US Gallon = 0.003785 m^3
kVA	Kilovolt-Ampere
kW	Kilowatt
kWh	Kilowatt-Hour = 3.413 BTU
LHV	Low Heating Value
MW	Megawatt, Million Watt
MMBTU	Million BTU
MMSCF	Million SCF
MMSCFD	Million SCF per Day
MSCF	Thousand SCF
MSL	Mean Sea Level
Nm^3	Normal Cubic Meter measured at 0°C and 1.0 ata
psi	Pound per Square Inch 1.0 psi = 0.07031 kg/cm^2
Quintal	1.0 Quintal = 100 kg
SCF, CF	Standard Cubic Feet measured at 60°F and 14.7 lb/in^2 1.0 SCF = 0.0283 Nm^3
SCFD, CFD	Standard Cubic Feet per Day
STB	Standard Tankage Barrel 1.0 STB = 159 Litre (60°F)
TSCF, TCF	Trillion SCF
TPH	Ton per Hour
TPD	Ton per Day
TPY	Ton per Year
Ton, ton	Metric Ton

K, K_2O	1.0% K = 1.2046% K_2O
	1.0% K_2O = 0.8302% K
P, P_2O_5, BPL	1.0% P = 2.2914% P_2O_5,
	= 5.0073% BPL
	1.0% P_2O_5, = 0.4364% P
	= 2.1853% BPL
	1.0% BPL = 0.1997% P
	= 0.4576% P_2O_5,
Fe, FeO, Fe_3O_4, Fe_2O_3	1.0% Fe = 1.2865% FeO
	= 1.3820% Fe_3O_4
	= 1.4297% Fe_2O_3

Fertilizer

Apatite	Major Calcium Phosphate Mineral of $Ca_{10}(PO_4, CO_3, OH)_{18}(OH,F,Cl)_2$ in General Formula
AN	Ammonium Nitrate Fertilizer
AP	Ammonium Phosphates (MAP and/or DAP) Fertilizer
AS	Ammonium Sulfate Fertilizer
BPL	Bone Phosphate of Lime in Terms of $Ca_3(PO_4)_2$, BPL/ P_2O_5 = 2.1853
CAN	Calcium Ammonium Nitrate Fertilizer
CN	Calcium Nitrate Fertilizer
DAP	Diammonium Phosphate Fertilizer
FMP	Fused Magnesium Phosphate Fertilizer
GGPR	Granulated Ground Phosphate Rock Fertilizer
K_2O	Potash Nutrient Expressed in Terms of K_2O 1.0% K_2O = 0.8302% K
N	Nitrogen Nutrient Expressed in Terms of N
NP	Nitrophosphate Fertilizer (Specifically Compound Fertilizer by Nitric Acid Decomposition Process)
NP/NPK	Compound Fertilizer or Complex Fertilizer
MAP	Monoammonium Phosphate Fertilizer
MOP	Muriate of Potash, Potassium Chloride Fertilizer
P_2O_5	Phosphate Nutrient Expressed in Terms of P_2O_5, 1.0% P_2O_5 = 0.4364% P
SOP	Sulfate of Potash, Potassium Sulfate Fertilizer
SSP	Single Superphosphate Fertilizer
TCP	Tri-Calcium Phosphate; $Ca_3(PO_4)_2$
TPL	Tri-Phosphate of Lime; $Ca_3(PO_4)_2$
TSP	Triple Superphosphate Fertilizer
Urea	Urea Fertilizer

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CHAPTER 1. OUTLINE OF THE PROJECT

1-1 Outline of the Project

Among the seven product alternatives, the nitrophosphate production project was selected as the most highly technical viable project, but it was found that the product as well as by-product nitrogen fertilizer would lack marketability in the domestic market and the capacity utilization of the plant would be constrained. The financial analysis and economic evaluation led to be the conclusion that the project is not feasible under present conditions.

In the case when a sufficiently high capacity utilization can be assured, it is judged that financially there is marginal feasibility, and therefore the basic nature of the selected project is outlined under such assumption as follows.

A phosphate rock concentration plant to produce phosphate rock (P_2O_5, 35.65% and Fe, 5.80%; production capacity, 100,000 TPY) which would use as raw material non-magnetic tails (P_2O_5, 7.08% and Fe, 27.53%; Supply of 921,620 TPY in 1990) from the iron ore concentration plant in Sierra Grande, Rio Negro would be built in Sierra Grande. The tails is the only commercially available phosphate resource in the Argentine Republic.

The intermediate product phosphate rock would be transported on road from Sierra Grande to Bahia Blanca (528km) where a nitrophosphate fertilizer plant would be built. The final product of nitrophosphate [fertilizer nutrients, (20.80-20.80-0.0); production capacity, 163,677 TPY] would be accompanied by the co-product nitrogen fertilizer [fertilizer nutrients, (26.00-0.0-0.0); production capacity, 139,709 TPY], both of which would be bagged and sold in the domestic market in Argentine.

1-2 Outline of the Project Facility

	Phosphate Fertilizer Plant Project	
	Phosphate Rock Concentration Plant	Phosphate Fertilizer Plant
- Proposed Plant Site :	Sierra Grande, Rio Negro	Bahia Blanca, Buenos Aires
- Raw Material :	Non-Magnetic Tails of HIPASAM	Phosphate Rock, Natural Gas
- Product :	Phosphate Rock	Nitrophosphate, Calcium Ammonium Nitrate
- Plant Capacity :	336.7 TPD 100,000 TPY	1,021.5 TPD 303,385.5 TPY
- Major Process Plant :	Phosphate Rock Concentration (Grinding, flotation, filtration, drying)	Ammonia, Nitrophosphate
- Major Off-Site Facility :	Product Storage, Utility, Plant Management, Maintenance	Raw Material and Product Storage, Utility, Plant Management, Maintenance
- Plant Site Area :	40,000 m^2	135,000 m^2
- Construction Schedule :		
- Construction Start ;	1987	1987
- Construction Completion ;	1989	1989
- Commercial Production ;	1990	1990
- Plant Cost (Excluding duties), Base Project Cost - 1983 :	USD 33.65 MM	USD 180.63 MM
- Total Financing Required - 1990 :	USD 421.79 MM for the Integrated Plant Project	

1-3 Financial Analysis and Economic Evaluation

- Management Entity : Independent management under HIPASAM leadership

- Personnel :

	Executives	6
	Head Office	13
	Plants	640
	Total	659

- Required Capital :

- Foreign Currency Portion ;	USD 193.3 MM	(45.8%)
- Local Currency Portion ;	228.5	(54.2%)
	USD 421.8 MM	(100.0%)

- Financing Plan :

- Equity ;	USD 126.5 MM	(30.0%)
- Long-Term Loan ;	295.3	(70.0%)
	USD 421.8 MM	(100.0%)

- Internal Rate of Return :

	FIRROI-DCF, %		EIRROI-DCF, %
	Before Tax	After Tax	
- Current Price Basis ;	15.7	14.0	9.6
- Real Price Basis ;	8.9	7.4	3.2
(Constant Price - 1987)			

CHAPTER 2. SUMMARY OF THE STUDY RESULTS

2-1 General Features of Agriculture and the Fertilizer Market

The output of the agricultural sector of the Argentine Republic contributed a 13% of the gross domestic production in 1980, while the share of agricultural product and primary commodities in total exports was 75%. Agriculture thus is a key industry of the national economy.

Although the agricultural productivity is high, the long distance to export markets is disadvantageous in terms of competitiveness of exports and the agricultural production is constrained.

It is characteristic of the country's agriculture that there is coexistance of extensivo and intensivo farmings. Extensivo farming is typified grain production such as wheat and maize as export commodity as is mostly observed in the Pampeana region.

The intensivo farming produces vegetables, fruits and other crops in the Mendoza and other regions. Much of the country's fruit and wine export products are obtained from the intensivo farming.

The use of fertilizer was at first introduced for intensivo farming, where the use of fertilizer has reached a high level at present. For extensivo agriculture, the use of fertilizer was begun in recent years and spread particularly among wheat farmers Fertilizer demand fluctuates greatly depending on farm product prices, and as shown in Table 1, the demand has grown from the 1965/75 levels of 40,000 TPY-N of nitrogen, 24,000 TPY-P_2O_5 of phosphate and 6,000 TPY-K_2O of potash fertilizer to the recent levels of 50,000 TPY-N, 50,000 TPY-P_2O_5 and 6,000 TPY-K_2O.

In intensivo farming phosphate is applied together with nitrogen fertilizer, while there is strong tendency in extensivo farming that either phosphate or nitrogen is applied as straight fertilizer.

Demand of phosphate fertilizer is estimated to be 50,000 TPY-P_2O_5 at present time, the consumption by region and by crops is shown in Table 2, from which it is evident that the Pampeana region around Bahia Blanca area is the major consuming of phosphate which accounts for 70% of total demand. It is estimated that 30% of demand is the use for wheat, 25% is for pasture crops, 15% is for vegetables and 10% is for fruits.

The future phosphate fertilizer demand is projected and shown in Table 2 which indicates 78,400 in 1990 and 106,700 TPY-P_2O_5 in 1995. Assumption used to make the projection are as follows.

(1) There will be no rapid change in cultivating area for the most crops, except of the increasing trend observed for the soybean area.

(2) In intensivo farming, in the future there will not be a rapid increase in consumption because already consumption level reached a high level.

(3) In extensivo farming, especially regarding wheat, it is excepted that phosphate consumption will increase in the phosphate deficit soil area in the southern part of Buenos Aires near Bahía Blanca, where the fertilized area rises to 40%. The fertilized area in nation wide is 6% in 1982 and is expected to increase to 14% in the future.

(4) In extensivo farming, regarding maize and pasture crops even in the phosphate deficit soil area, there will be not a rapid increase in fertilizer demand unless the price level for these agricultural products rise substantially.

Regarding the relative evaluation among potential phosphate fertilizer product alternatives from Sierra Grande tails, following judgements have been made mostly from soil and agricultural aspects in the country.

(1) In general, phosphate fertilizer with high water soluble phosphate (W-P_2O_5 and Av-P_2O_5) is the most suitable. Marketability of acid soluble phosphate (C-P_2O_5, F-P_2O_5 and T-P_2O_5) is limited to either for the Mesopotamia region in the north where acidic soils are common or for the pasture crops in general.

(2) Compound fertilizer, and nitrogen and phosphate fertilizer mixed are applied in intensivo farming, while nitrogen or phosphate fertilizer is applied as straight fertilizer in extensivo farming.

(3) Among the alternative phosphate fertilizers, water soluble phosphate such as ammonium phosphate and triple super phosphate are the most suitable. Fused magnesium phosphate and granular ground phosphate rock fertilizer are not suitable because of low water solubility.

(4) The production of monoammonium phosphate from Sierra Grande tails would be able to satisfy only a third of domestic demand in 1990, so that it would still be necessary to import ammonium phosphate continuously.

(5) Although nitrophosphate has not be used widely in Argentine to date, it is judged to be possible that a market can be developed, especially in the intensivo farming sectors. However, judging from the fact that in wheat and potato growing area of Pampeana, farmers have applied phosphate fertilizer as straight fertilizer, there is some doubt for rapid switch could be attained from the traditionally used phosphate to nitrophosphate fertilizer.

(6) Regarding co-product nitrogen fertilizer from the production of nitrophosphate, if the use of nitrogen fertilizer is increased among wheat growers in sourthern Pampeana, it is judged to be possible for a market development to some extent, but since the existing nitrogen fertilizer plant of PETROSUR (Campana, ammonia capacity of 190 TPD, completed in 1968) will continue production, the marketability of such new type nitrogen fertilizer would be limited causing low capacity utilization of the plant during initial years of operation.

(7) For the development of a market for nitrophosphate and its co-product nitrogen fertilizer, it is judged that it would be necessary to undertake promotional efforts as well as premarketing activities using imported products.

2-2 Fertilizer Industry and Raw Materials

Regarding nitrogen fertilizer, the Argentine Republic has ammonia, urea and ammonium sulfate plant of PETROSUR based on natural gas, the DGFM has small scale ammonia, nitric acid and ammonium nitrate plant which products are mostly sold as industrial chemicals as well as an ammonium sulfate plant based on ammonia recovery from the coke oven gas, but their combined output is not sufficient to cover domestic demand for nitrogen fertilizer. As a result it is necessary to rely on imports, primarily of urea. Ample domestic natural gas resources exist and studies are being made regarding possible construction of large export oriented and also small domestic market oriented nitrogen fertilizer plants, but no project has reached the construction stage. Therefore, there is no existing domestic supply potential to provide ammonia and/or nitric acid for use by the phosphate fertilizer plant under consideration in the present study. The ELECTROCLOR has a small ammonia plant for supplying mostly for industrial uses of ammonia.

The phosphate rock resources of commercial scale has not been confirmed. In the past, both Thomas phosphate and hyperphosphate were produced by DGFM and by the AGROMAX, respectively, but such production has been stopped.

Virtually all requirements are being satisfied by imports, mostly of ammonium phosphates. The only known source of phosphate rock in the country is the tails of HIPASAM, Sierra Grande. Potash resources do not exist and a small quantities are being imported.

Compound fertilizer is being produced at PETROSUR, Bahia Blanca, using domestic and imported raw materials, but the production at present is at an extremely low level.

Sulfuric acid is produced using imported sulfur and metal smelting off-gas, but existing plants can not provide enough sulfuric acid to meet the requirement of the studied phosphate fertilizer plant project.

There are adequate resources of serpentine for the production of fused magnesium phosphate.

The qualities of fertilizers in the country are determined according to the IRAM standards and the official analytical methods are also stipulated at the IRAM. In conformity with the quality of the phosphate fertilizer product alternatives, one or two types of five quality guarantees (T-P_2O_5, Av-P_2O_5, C-P_2O_5, F-P_2O_5 and W-P_2O_5 would be applicable. Product quality evaluation of the studied alternatives were made in accordance with the IRAM standards.

2-3 Concentration of Phosphate Rock and Supply

Existence of the commercial scale phosphate rock resources capable of being developed has not been comfirmed in the Argentine Republic. The only possible source would be apatite phosphate rock from tails of the iron ore concentration plant (capacity 2,000,000 TPY) operated by HIPASAM in Sierra Grande, Río Negro.

The iron ore is mostly magnetite having the composition of Fe, 54.8% and P_2O_5, 3.28% and because of its high P_2O_5content, the iron ore should be concentrated to yields an iron ore with the composition of Fe, 68.5% and P_2O_5, 0.32% as steel making raw materials, at a same time non-magnetic tails of Fe, 27.53% and P_2O_5, 7.08% are produced and discarded. The phosphate rock is equivalent to 65,250 TPY-P_2O_5in the non-magnetic tails.

It is reported that there are two plants in Sweden and one small plant in the USA which concentrate phosphate rock from tails of the iron ore concentration plants. Production capacity at the SSAB, Grängesberg and LKAB, Kiruna, both in Sweden are 75,000 and 200,000 TPY, respectively to produce a high quality phosphate rock and a part of the product is exported.

As a part of the study, representative sample of 700kg tails were collected at the HIPASAM in June and October, 1983 and used for laboratory-scale experimental test for the concentration of phosphate rock as well as mineralogical studies and for the production of a 15kg of representative sample of phosphate rock to be used for the evaluation tests and the conceptual design of the seven alternatives of phosphate fetilizer production plant.

Results of the phosphate rock concentration tests were as follows:

(1) Phosphate minerals in the tails are mostly fluorapatite and hydroxyapatite, and apatite crystals are in locked form with iron minerals and chlorite.

(2) Minor phosphate minerals are also identified other than the apatites which are blue colored and brown colored and contain iron as constituent.

(3) There are inclusion of iron minerals in apatite crystals and the iron minerals seem partly fused in the apatite crystals.

(4) A small amount of iron is homogeneously dispersed over the entire surface of the apatite crystals as detected by X-ray observation.

(5) Even if the tails are ground to the average diameter of 0.02mm or less, it is impossible to achieve crystal grain isolation or liberation of iron minerals, chlorite and apatites.

(6) Chlorite which contains iron have similar Zeta potentials to that of apatite, the concentration of phosphate rock from chlorite would be difficult by flotation separation.

(7) As the results of the concentration test, it was found to be possible to produce phosphate rock of P_2O_5, 35.65% and Fe, 5.8% grade with the P_2O_5 recovery of 55.5% in the tails, by grinding the tails, rougher flotation and five stage cleaner flotation.

(8) With the purpose of determining the lower limit of the residual iron in the phosphate rock, HGMS (high gradient magnetic separation) was performed to obtain highly purified phosphate rock of P_2O_5, 39.55% and Fe, 1.84% grade. Although the product grade is improved, the P_2O_5 recovery is only 22.1% and judged to be not suitable for the industrial application.

(9) Phosphate rock concentration would be by flotation but because the specific characteristics of the Sierra Grande ore, the consumption of electric power for extensive grinding and flotation collector are higher, and also the P_2O_5 recovery is lower.

Regarding the conceptual design of the phosphate rock concentration plant based on the study results, it was confirmed that the following design would be rational.

(1)	Phosphate Rock Quality	:	
	- P_2O_5		35.65%
	- Fe		5.80
(2)	Recovery of P_2O_5	:	55.50%
(3)	Concentration Process	:	Grinding, Rougher Flotation, Cleaner Flotation (5 stages), Sedimentation, Filtration and Drying
(4)	Production Capacity		
	- Phosphate Rock		100,000 TPY (336.7TPD × 297DRY)
	- P_2O_5		35,650 TPY - P_2O_5
(5)	Plant Location	:	Sierra Grande, Río Negro

The grade of the P_2O_5in the product phosphate rock is sufficiently high but the residual iron is higher and the recovery of $P_2O_5$is lower compared to the performance in Sweden. Reasons for those differences are believed to be due to the mineralogical nature.

The quality of phosphate rock commonly stipulated for the international trade is of P_2O_5, 30% or higher and Fe, 0.6% or lower, and the total impurities (Fe_2O_3 + Al_2O_3 + MgO), 3.0% or lower. The impurities in the product is exceeding 10.0% and would not be accepted as commercial commodity in general.

Moreover, the production cost would be higher than the imported product price and further the process applicable to the tails of Sierra Grande is not adequately commercially proven.

No precedent exists in the world for the production of phosphate fertilizer from the phosphate rock of this quality, making it necessary to undertake evaluation and trial tests for the seven phosphate fertilizer alternative production, and to prepare the conceptual design of the plant on the basis of the results thereby obtained.

Not only are there technical problems in using the phosphate rock but there are problems in the raw material and utility consumption, product quality and production cost. The process applicable to the phosphate rock for the production of phosphate fertilizer have not been commercial proven to an adequate extent.

The quality of the sample phosphate rock obtained are given in Table 4.

2-4 Technical Study on the Phosphate Concentration Plant and Phosphate Fertilizer Plants

The three site locations were compared to select the best plant location for the phosphate rock concentration and phosphate fertilizer plants, on the basis of comparative study of raw material and ancillary material availability, utility supply, transport costs of raw materials and product to the final fertilizer market and also the available infrastructures.

Site Location Alternatives	Code
- Sierra Grande, Rio Negro	PS-1, SG
- San Antonio Oeste, Rio Negro	PS-2, SAO
- Bahia Blanca, Buenos Aires	PS-3, BB

A summary outline of the site conditions are given in Table 5 and Table 6.

Concerning the alternative phosphate fertilizer products, following seven schemes were studied, especially on the supply conditions of ancillary raw materials and utility, product quality, suitability to the soils and agricultural conditions to select the best alternative process and product.

Phosphate Fertilizer Alternatives	Code
- Granular Ground Phosphate Rock	PF-1, GGPR
- Fused Magnesium Phosphate	PF-2, FMP
- Single Superphosphate	PF-3, SSP
- Triple Superphosphate	PF-4, TSP
- Monoammonium Phosphate	PF-5, MAP
- Nitrophosphate and Calcium Ammonium Nitrate (Ammonia Import)	PF-6, NP/CAN
- Nitrophosphate and Calcium Ammonium Nitrate (Ammonia Production)	PF-7, NP/CAN

The integration scheme of the phosphate rock concentration plant and the phosphate fertilizer plant is shown in Figure 1.

The evaluation test of the phosphate rock and phosphate fertilizer production tests were commissioned at the following firms which have long and extensive experiences for the specific fertilizer process know-how and process research and developments, and based upon the test results the conceptual design were prepared.

- Hinode Kagaku Kogyo K.K. (Japan)
- Nissan Chemical Industries, Ltd. (Japan)
- Norsk Hydro as (Norway)

As the result of the tests, following specific characteristics of the phosphate rock extracted from the non-magnetic tails of Sierra Grande were clarified.

(1) The concentration of P_2O_5 is sufficiently high

(2) Iron content is high in phosphate rock and the product quality of phosphate fertilizer made from it is low, in particular the water solubility of phosphate.

(3) Most of the iron is in ferrous iron, Fe (II).

(4) Although the phosphate rock is of finely ground, the reactivity with acid is very low.

(5) The content of organic matter and carbonate are low and no foaming is observed at acid digestion.

The evaluation result of phosphate fertilizer production is as follows:

Phosphate Fertilizer Alternative	Production Technology	Process Consumption	Product Quality Evaluation
- GGPR, PF-1	Applicable	Applicable	Low, especially low in $C-P_2O_5/T-P_2O_5$ and $F-P_2O_5/T-P_2O_5$
- FMP, PF-2	Applicable	Applicable (Open Hearth Furnace)	Excellent in $C-P_2O_5/_2O_5$
- Phosphoric Acid (P_2O_5), PF-4, and PF-5	Applicable, limited in concentration, Evolution of SO_2	Applicable, H_2SO_4 consumption is high and residual SO_3 is high	High in viscosity and sludge forming, concentration upto 40% of P_2O_5 (in general 54%)
- SSP, PF-3	Not applicable, low reactivity with sulfuric acid	Sulfuric acid consumption is high	Low, low in $Av-P_2O_5/T-P_2O_5$, $W-P_2O_5/T-P_2O_5$, high in free acid
- TSP, PF-4	Not applicable, low reactivity with phosphoric acid	Sulfuric acid consumption is high	Low, low in $Av-P_2O_5/T-P_2O_5$, $W-P_2O_5/T-P_2O_5$, high in free acid
- MAP, PF-5	Applicable, iron is transfered in fertilizer	Applicable	A little low but satisfactory for domestic market, low in $Av-P_2O_5/T-P_2O_5$, $W-P_2O_5/T-P_2O_5$ and W-N/T-N
- NP/CAN, PF-6 and PF-7	Applicable, partially iron is removed	Applicable	Excellent in $Av-P_2O_5/T-P_2O_5$, $W-P_2O_5/T-P_2O_5$

As the comparison study result, it was determined that the site location for the phosphate rock concentration plant is suitable in Sierra Grande and for the phosphate fertilizer plant, in case GGPR and TSP production the site in Sierra Grande is the best and in case FMP, SSP, MAP and NP/CAN the site in Bahia Blanca is the best suited.

The results of technical studies of the seven alternatives, with the production amount, product quality, effective utilization of P_2O_5, availability of ancillary raw material in the country, evaluation comparison is given in Table 7, Table 8, Table 9 and Table 10.

The alternative selected according to the comparative evaluation are monoammonium phosphate (MAP, PF-5) and nitrophosphate (NP/CAN, PF-7). The integrated project of phosphate rock concentration and such phosphate fertilizer plant are illustrated in Figure 2 and Table 11.

Their feasibility as an industrial project was investigated by the financial analysis and economic evaluation method.

2-5 Financial Analysis and Economic Evaluation

The two projects were selected in accordance with the market study and technical study and the projects were analyzed and evaluated in financial and economic feasibility calculations.

The Case I for the production of MAP is not feasible in financial and also in economical evaluation. The reasons for such low feasibility are;

(1) In spite of the high residual iron content in phosphate rock, the production of phosphoric acid is proved technically feasible. However the product quality of monoammonium phosphate as final product is a little less than traditional product in other countries.

(2) The cost for ammonia and sulfur as ancillary raw materials are higher because of a small lot import from overseas.

(3) The production capacity of phosphate rock concentration plant (336.7 TPD) and monoammonium phosphate plant (243.8 TPD) are both small in scale due to the limited availability of non-magnetic tails at Sierra Grande, therefore the fixed cost burden is higher in comparison with the world scale phosphate rock plants (10,000 to 20,000 TPD) and ammonium phosphate plants (1,000 to 2,000 TPD) located in North Africa or in the USA with export oriented nature.

(4) The monoammonium phosphate plant would have limited suppliabity to the domestic market up to a third and importation of phosphate fertilizer should be continued.

The Case II for the production of nitrophosphate has also technical viability and beneficial to rely on only to the domestic resources, however the financial feasibility is found also low because of the low capacity utilization. The major reasons for such low feasibility are as follows,

(1) Nitrogen content is higher in comparison with phosphate nutrients in nitrophosphate, and replacement of traditional phosphate fertilizer (DAP and TSP) by nitrophosphate would not proceed with at a high rate.

(2) A half of nitrogen in nitrophosphate and co-product nitrogen fertilizer is nitrate nitrogen and replacement of traditional nitrogen fertilizer (Urea and Ammonium Sulfate) would not proceed with at a high rate.

(3) The production capacity of an ammonia plant incorporated in the project is a 303 TPD. The scale is rather small but if it is assumed that the existing ammonia plant in Argentine would be continuously operational, the combined nitrogen capacity would be larger than the low growing nitrogen domestic market. The nitrogen fertilizer surplus would not be competitive for export market because there are world scale ammonia plants (1,000 to 1,500 TPD) in natural gas producing countries in export oriented nature.

However, if it is assumed that the capacity utilization is higher in Case II, the project has technical viability, the product quality is in conformity with the IRAM standard and also the marginal feasibility in financial and economic analysis are expected. Therefore the analytical data are presented in the report under such assumption and preconditions, and recommendations of project promotion on fertilizer (phosphate and nitrogen) in Argentine in the future are also presented as reference.

CHAPTER 3. CONCLUSION AND RECOMMENDATIONS

3-1 Conclusion

In connection with the proposed project which would utilize tails from the iron ore concentration plant, HIPASAM in Sierra Grande, Río Negro, which is the only phosphate rock source known to exist in the Argentine Republic, to concentrate the phosphate rock as an intermediate and to produce phosphate fertilizer, a wide range of tests and studies as well as evaluation research were performed for seven phosphate fertilizer alternatives However, the results obtained did not permit the judgement that the plan to construct an integrated phosphate rock concentration plant and phosphate fertilizer plant under present condition is highly feasible.

Reasons for the low feasibility are (1) because of characteristics of the Sierra Grande ore, the cost of concentrating the phosphate rock would be high, (2) product quality would be low (i.e., there would be a high level of impurities especially iron), (3) the product quality of some of the phosphate fertilizer products would be low.

While there would be viable regarding technological aspects of production of monoammonium phosphate fertilizer and also in marketing, the production scale would be small and it would be necessary to rely on imports of ammonia and sulfur, the production cost would be high and inevitably low feasibility would be obtained when the project is subjected to the financial evaluation.

Study was also made for nitrophosphate fertilizer project, utilizing the Argentine Republic's abundant natural gas reserves to produce nitrogen fertilizer which could be combined with phosphate fertilizer production In this case, because domestic demand for the by-product nitrogen fertilizer is low, and also the product would lack export competitiveness, the production scale would be excessive to the domestic market and the utilization of capacity would be low. This project thus would not have high feasibility, too.

A feasibility study was nevertheless performed for this project, because if it is assumed that a satisfactorily high degree of utilization of capacity can be obtained, it would be judged that technologically the project had viability and was marginally feasible. Problems in implementing the project in this case, and the working assumptions, were given. It is suggested hereafter to monitor the trend of the demand of nitrogen and phosphate fertilizer, and the possibility for the improvement of production technology, which could provide an opportunity to restudy the project as an alternatives for production of nitrogen and phosphate fertilizer as integrated project in the Argentine Republic in a future.

3-2 Recommendations

It did not prove possible to conclude that as a result of the study, the project was feasible and therefore preparations should be made to construct the proposed plant. Nevertheless, the following recommendations can be made as a result of the study.

(1) Effort should be continued for the improvements at the iron ore concentration plant as planned, and to obtain the production quantity and quality of tails which is beneficial for phosphate concentration. Moreover, the plan presently being made by HIPASAM to improve the quality of the iron ore should be implemented, as part of the effort to obtain tails quality which is advantageous for phosphate rock concentration.

(2) Tests and studies on concentrating phosphate rock from tails should be continued and improvements should be sought regarding quality, yield, and concentration cost

(3) Study should be made of a phosphate fertilizer project to be integrated with a nitrogen fertilizer project. Consideration should also be given to importation of some phosphate rock in order to attain a higher level of production scale. The nitrogen fertilizer plant should be export oriented to enjoy the economies of scale.

Table 1 FERTILIZER SUPPLY/DEMAND SITUATION IN ARGENTINE

(Unit: TPY)

	Yearly Average			Yearly				
	1964/1966	1969/1971	1974/1976	1978	1979	1980	1981	1982
Nitrogen Fertilizer (N)								
Production (A)	-	-	-	30,652	27,305	30,437	25,124	30,596
Consumption (B)	27,321	40,445	39,043	44,412	60,576	65,355	51,173	50,926
Balance (A)-(B)	-	-	-	-13,760	-33,271	-34,918	-26,049	-20,330
Phosphate Fertilizer (P_2O_5)								
Production (A)	-	-	-	1,121	1,541	498	89	0
Consumption (B)	14,010	24,816	23,068	32,551	64,660	50,013	28,885	45,719
Balance (A)-(B)	-	-	-	-31,430	-63,119	-49,515	-28,796	-45,719
Potash Fertilizer (K_2O)								
Production (A)	0	0	0	0	0	0	0	0
Consumption (B)	6,231	7,687	5,233	5,694	12,261	8,752	5,301	5,660
Balance (A)-(B)	-6,231	-7,687	-5,233	-5,694	-12,261	-8,752	-5,301	-5,660

Table 2 ESTIMATED CONSUMPTION OF PHOSPHATE FERTILIZER IN ARGENTINE

(Unit: TPY-P_2O_5)

	Phosphate Fertilizer Consumption			
	1972 (Estimate)	1982 (Estimate)	1990 (Projection)	1995 (Projection)
By region				
Pampeana	25,600	34,900	59,300	85,600
Andina	5,300	5,300	6,300	7,200
Noroeste	2,900	2,700	2,600	2,700
Mesopotamia	4,600	5,600	6,100	6,500
Patagonia	2,100	2,600	4,100	4,700
Chaquena	0	0	0	0
Total	40,500	51,100	78,400	106,700
By Crop				
Wheat	5,800	15,900	39,900	65,900
Other cereals	800	700	700	700
Pasture	13,300	13,300	13,300	13,300
Fruits	4,600	5,000	6,700	7,500
Vegetables and Potato	8,500	8,100	10,200	11,700
Grapes	3,400	3,400	3,400	3,400
Others	4,100	4,700	4,200	4,200
Total	40,500	51,100	78,400	106,700
Average Annual Growth Rate, %/Year		2.35	5.50	6.36

Table 3 SALES PLAN FOR DOMESTIC MARKET

Phosphate Rock Concentration and Phosphate Fertilizer Plant Project	1990							1995						
	Sales Volume			Total Demand		Sales Potential		Sales Volume			Total Demand		Sales Potential	
	Product ton	N	P_2O_5	'000 N	'000 P_2O_5	'000 N	'000 P_2O_5	Product ton	N	P_2O_5	'000 N	'000 P_2O_5	'000 N	'000 P_2O_5
Case I (PC-1/PF-5)														
MAP														
Pampeana	64,400	6,400	29,000	53.0	59.3	13.1	58.9	66,700	6,700	30,000	68.8	85.6	18.9	85.1
Mesopotamia	1,800	200	800	3.5	6.1	1.2	5.6	1,400	100	650	3.9	6.5	1.3	5.9
Noroeste	1,400	100	650	15.9	2.6	0.5	2.3	1,200	100	550	16.2	2.7	0.5	2.4
Andina	7,900	800	3,550	10.2	6.3	1.3	6.0	6,400	600	2,900	11.2	7.2	1.5	6.8
Patagonia	4,900	500	2,200	6,5	4.1	0.8	3.7	4,700	500	2,100	7.6	5.5	1.1	4.9
Total	80,400	8,000	36,200	89.1	78.4	16.9	76.5	80,400	8,000	36,200	107.7	106.7	23.3	105.1
(Production capacity)	(72,409)	(7,386)	(33,243)					(72,409)	(7,386)	(33,243)				
Case II (PC-1/PF-7)														
NP														
Pampeana	37,000	7,400	7,400	53.0	59.3	11.1	11.1	51,500	10,300	10,300	68.8	85.6	16.0	16.0
Mesopotamia	3,500	700	700	3.5	6.1	3.5	3.5	4,000	800	800	3.9	6.5	3.9	3.9
Noroeste	4,500	900	900	15.9	2.6	2.3	2.3	5,000	1,000	1,000	16.2	2.7	2.4	2.4
Andina	25,000	5,000	5,000	10.2	6.3	6.2	6.2	28,500	5,700	5,700	11.2	7.2	7.1	7.1
Patagonia	16,500	3,300	3,300	6.5	4.1	4.1	4.1	22,000	4,400	4,400	7.6	5.5	5.5	5.5
Total	86,500	17,300	17,300	89.1	78.4	27.2	27.2	111,000	22,200	22,200	107.7	106.7	34.9	34.9
(Production capacity)	(163,677)	(34,045)	(34,045)					(163,677)	(34,045)	(34,045)				
CAN														
Pampeana	17,600	6,000	-			23.7	-	20,000	6,800	-			28.1	-
Mesopotamia	0	0	-			0	-	0	0	-			0	-
Noroeste	0	0	-			13.6	-	0	0	-			13.8	-
Andina	8,200	2,800	-			4.0	-	8,500	2,900	-			4.1	-
Patagonia	5,000	1,700	-			2.4	-	4,400	1,500	-			2.1	-
Total	30,800	10,500	-			43.7	-	32,900	11,200	-			48.1	-
(Production capacity)	(139,709)	(36,324)	(-)					(139,708)	(36,324)	(-)				

Table 4 ANALYSIS OF PHOSPHATE ROCK EXTRACTED FROM IRON ORE CONCENTRATION NON-MAGNETIC TAILS OF HIPASAM, SIERRA GRANDE, ARGENTINE

(1) CHEMICAL ANALYSIS

As Element	Weight Percent	As Oxide	Weight Percent	Equivalency for 100g Samp
P	15.56%	P_2O_5	35.65%	(-) 1.507
C (Carbonate)	0.09	CO_2	0.33	(-) 0.015
F	1.50	F	1.50	(-) 0.079
Cl	0.01	Cl	0.01	(-) 0.0005
OH	-	OH	(3.88)	(-) (0.2285)
S (Total)	-	S and Oxides	-	(-) -
S (Sulfide)	0.48	S	0.48	(-) 0.030
S (Sulfate)	-	SO_3	-	(-) -
Si	1.98	SiO_2	4.24	(-) 0.141
Fe (Total)	5.80	Fe Oxides	7.67	(+) 0.233
Fe (II)	4.36	FeO	(5.61)	(+) (0.156)
Fe (III)	1.44	Fe_2O_3	(2.06)	(+) (0.077)
Al	1.46	Al_2O_3	2.06	(+) 0.162
Mn	-	MnO	-	(+) -
Ca	31.66	CaO	44.30	(+) 1.580
Mg	0.22	MgO	0.36	(+) 0.018
Na	0.15	Na_2O	0.20	(+) 0.006
K	0.07	K_2O	0.08	(+) 0.002
Others	-	Others	-	-
Free Moisture	0.14	Free Moisture	0.14	-
Organics	-	Organics	-	-
Ignition Loss	1.68	Ignition Loss	1.68	
Total	65.95	Sub-total	102.58	(-) 2.001
		Adjustment for F	(-) 0.63	(+) 2.001
		Total	101.95	(+) 0.000

(2) PHYSICAL PROPERTY

Color			Gray
Size Distribution (Tyler Mesh and Millimeter)			
(+) 400	Mesh	(0.0370 mm)	15.9%
(+) 468.4		(0.0316)	18.4
(+) 677.8		(0.0219)	36.1
(+) 993.3		(0.0149)	52.5
(+) 1,309.7		(0.0113)	64.5
(-) 1,309.7		(0.0113)	35.4
			100.0
Density			3.27
Bulk Density	- Packed		1.67
	- Loose		1.27
Angle of Reponse			43.0°
Free Moisture of Filter Cake, %			13.0
Specific Surface Area, cm^2/gr			2,770

(3) FERTILIZER PROPERTY

	Weight Percent	Solubility Percent
Total P_2O_5	35.65%	100.0%
Nitric Acid Soluble P_2O_5	35.60	99.9
Hydrocholoric Acid Soluble P_2O_5	35.11	98.5
Citric Acid Soluble P_2O_5	7.96	22.3
Formic Acid Soluble P_2O_5	5.69	16.0
Ammonium Citrate Soluble (AV) P_2O_5 (Neutral)	0.00	0.0
Water Soluble P_2O_5	0.00	0.0

Notes:
- Sample tails (Fe=27.53%, P_2O_5=7.08%) were taken on October 6, 1983 at HIP and concentration test and analysis were made at NIKKO Consulting and Engineering Co. Ltd., Japan in January, 1984. Recovery of P_2O_5 is 55.5%. Fertilizer property was determined at Nissan Chemical Industries, Ltd., Japan in March, 1984.
- Ignition loss is measured by heating at 900°C for 0.5 hours.
- Free moisture is measured by heating at 105°C for 5.0 hours.
- (OH) is estimated to keep balanced equivalency.

Table 5 (1) SITE CONDITIONS FOR PHOSPHATE ROCK CONCENTRATION AND PHOSPHATE FERTILIZER PLANT PROJECT, HIPASAM, ARGENTINE

Items	Project Site Alternatives		
	(PS-1) Sierra Grande, Río Negro	(PS-2) San Antonio Oeste, Río Negro	(PS-3) Bahía Blanca, Buenos Aires
GENERAL DESCRIPTION	Within the Iron Ore Concentration Plant of HIPASAM	Close to Muell Este-Puerto San Antonio and proposed site for SIDERSUR	Close to the Puertos de Bahia Blanca and Parque Industrial
LOCATION			
Longitude, West, Degree	65°20'	64°45'	62°15'
Latitude, South, Degree	41°30'	40°45'	38°45'
Height, Meter abbove Sea Level	268.0	10.0	10.0
CLIMATIC CONDITIONS			
Temperature, °C			
Absolute Maximum	37.0 (Feb)	41.7 (Jan)	41.9 (Jan)
Absolute Minimum	(-) 5.2 (Jun)	(-) 7.5 (Jun)	(-) 8.5 (Jun)
Average	13.5	-	14.8
Design, Maximum/Minimum	42.0 / (-) 10.0	42.0 / (-) 10.0	42.0 / (-) 10.0
Rain Fall, mm			
Annual	258.0	245.0	604.0
Monthly Maximum	44.7 (Dec)	29.0 (Oct)	88.0 (Mar)
Daily Maximum	54.5	-	-
Design, Daily	60.0	60.0	60.0
Relative Humidity, %			
Monthly Maximum	85.0 (Jun)	-	-
Monthly Maximum	60.0 (Jan)	-	-
Design	75.0 (35°C)	75.0 (35°C)	75.0 (35°C)
Wind			
Velocity, km/hour			
Absolute Maximum	147.0	-	-
Average of Daily Maximum	32.0	28.0	26.0
Design	120.0	120.0	120.0
Direction	SW	NWW	NNE
Atomospheric Pressure, ata	0.968 ± 0.003	1.999 ± 0.003	1.001 ± 0.003
Annual Evaporation, mm	750.0	750.0	750.0

Table 5 (2) SITE CONDITIONS FOR PHOSPHATE ROCK CONCENTRATION AND PHOSPHATE FERTILIZER PLANT PROJECT, HIPASAM, ARGENTINE

Items	Project Site Alternatives		
	(PS-1) Sierra Grande, Río Negro	(PS-2) San Antonio Oeste, Río Negro	(PS-3) Bahía Blanca, Buenos Aires
SOIL CONDITION			
General Conditions	Flat (Not Developed)	Flat (Not Developed)	Flat (Developed)
Soil Structure	Silty (0.5-1.0m) Sand Stone (3.0m-)	Silty Sand	Sandy Soil
Soil Bearing Capacity, Ton/m^2			
Surface	20.0	15.0 (Estimate)	15.0 (Estimate)
Ground Rock	100.0 (3.0m)	-	-
Vegetation	None	None	None
Seismic Zone and Coefficient	0.013 (Zone VI: Minor)	0.013 (Zone VI: Minor)	0.013 (Zone VI: Minor)
UTILITY SUPPLY AND PRICE			
Water, Existing	A Pipeline from Arroyo de los Berros and Arroyo de la Ventana: 486m^3/h(120km)	Canal Pomona (37km) from from Río Negro: 1,100m^3/h	DOSBA
Water, Potential	A Pipeline from Arroyo de los Berros: 79m^3/h(120km)	-	-
Electric Power	AyE: 50 MW, 132 KV, 50 Hz	AyE: 12 MW, US$0.015/kWh 132 KV, 50 Hz	DEBA: 132 KV, 50 Hz
Natural Gas	Gas del Estado: US$0.045/Nm^3, 25 atg, 8 Inch Diameter	Gas del Estado: 2.5 MMm^3/day US$0.045/Nm^3	Gas del Estado: US$0.045/Nm^3
Fuel Oil	Lorry Supply	Lorry Supply	Lorry Supply
Waste Water Treatment	None	Yes: 800m^3/hr	Yes:
INFRASTRUCTURES			
Access Road	Paved Road with 7 meter Width	Paved Road with 7 meter Width	Paved Road with 7 meter Width

Table 5 (3) SITE CONDITIONS FOR PHOSPHATE ROCK CONCENTRATION AND PHOSPHATE FERTILIZER PLANT PROJECT, HIPASAM, ARGENTINE

Items	Project Site Alternatives		
	(PS-1) Sierra Grande, Río Negro	(PS-2) San Antonio Oeste, Río Negro	(PS-3) Bahía Blanca, Buenos Aires
State High Way Connection	A 3km for Ruta 3	A 38km for Ruta 3, Ruta 251, Ruta 308 and Ruta 23	A 5km for Ruta 3, Ruta 33, Ruta 35 and A 35km for Ruta 22
Rail Road Connection	A 134km for San Antonio Oeste of EFEA	A 25km for San Antonio Oeste of EFEA	A 5km for Bahía Blanca of EFEA
Ocean Port Connection, km			
Punta Colorada (27ft, No Crane)	32.0	166.0	528.0
San Antonio Oeste (40ft, 45 Ton Crane)	134.0	2.0	394.0
Puerto Madryn (30ft, 12 Ton Crane)	144.0	278.0	672.0
Bahía Blanca (36ft, 50 Ton Crane)	528.0	394.0	10.0
Buenos Aires (27ft, 150 Ton Crane)	1,213.0	1,079.0	685.0
Air Port Connection, km	A 208km for Trelew	A 160km for Viedma (Heliport at San Antonio Este)	A 10km for Bahía Blanca
ACCOMMODATIONS			
Community	Sierra Grande	San Antonio Oeste	Bahía Blanca
Population	10,000	9,000	180,000
Hotel	Yes	Yes	Yes
School	Yes	Yes	Yes
Hospital	Yes	Yes	Yes
GroceryYes	Yes	Yes	Yes
Telecommunication	Yes	Yes	Yes
Construction Camp	(Yes)	(None)	(Yes)
INVESTMENT INCENTIVES			
Provincial Incentives			
Equity Participation	Yes	Yes	(None)
Loan Financing	Yes	Yes	(None)
Industrial Park	(None)	(None)	Yes
Utility Supply	Yes	Yes	Yes
Training Subsidy	Yes	Yes	Yes
Housing Subsidy	Yes	Yes	(None)
Research Assistance	Yes	Yes	(Yes)
Local Tax, %	-	-	-
Local Tax Holiday, year	-	-	-

Table 6 BRIEF DESIGN CONDITIONS FOR PHOSPHATE ROCK CONCENTRATION AND PHOSPHATE FERTILIZER PLANT, ARGENTINE

	Project Site Alternatives		
	PS-1 Sierra Grande, Rio Negro	PS-2 San Antonio Oeste, Rio Negro	PS-3 Bahia Blanca, Buencs Aires
Location			
Longitude, West/ Latitude, South	65°20'/41°30'	64°45'/40°45'	62°15'/38°45'
Height, Meter above Sea Level	268.0	10.0	10.0
Climatic Conditions			
Temperature, °C			
- Maximum	42.0	42.0	42.0
- Minimum	(-)10.0	(-)10.0	(-)10.0
Humidity, %	75.0	75.0	75.0
(Temperature, °C)	(30.0)	(30.0)	(30.0)
Rainfall, mm			
- Daily Maximum	60.0	60.0	60.0
Wind Velocity, km/hour	120.0	120.0	120.0
(Direction)	(SW)	(NWW)	(NNE)
Atmospheric Pressure, ata	0.968 (±)0.003	0.999 (±)0.003	1.001 (±)0.003
Soil Conditions			
Bearing Capacity, Ton/m^2	20.0	15.0 (Estimate)	15.0 (Estimate)
Seismic Coefficient (Zone, Magnitude)	0.013 (VI, Minor)	0.013 (VI, Minor)	0.013 (VI, Minor)
Utility Supply Conditions			
Raw Water			
- Analysis, ppm			
Total Hardness, $CaCO_3$	125.0	119.0	-
SO_4,	88.0	18.0	-
Cl,	-	23.0	-
pH	-	7.5	-
- Source	Arroyo de los Berros, Arroyo de la Ventana	Canal Pomona from Rio Negro	Pipeline from Rio Colorada
- Supply Location	Battery Limit	Battery Limit	Battery Limit
Electric Power			
- Conditions	132 KV, 50 Hz 3 Phase, 3 Wire	132 KV, 50 Hz 3 Phase, 3 Wire	132 KV, 50 Hz 3 Phase, 3 Wir
- Source	Aye	Aye	Beba
- Supply Location	Battery Limit	Battery Limit	Battery Limit
Natural Gas			
- Heating Value, Cal/Nm^3, LHV/HHV	9,012/9,970	9,012/9,970	9,012/9,990
- Pressure, ata	25.0	25.0	25.0
- Source	Gas del Estado	Gas del Estado	Gas del Estado
- Supply Location	Battery Limit	Battery Limit	Battery Limit

Table 7 ALTERNATIVES OF PHOSPHATE FERTILIZER PRODUCTION IN ARGENTINE

Product	Daily Production	Production Specification, %											Other Major Raw Material and Utility Daily Consumption	
		T-N	A-N	N-N	T-P_2O_5	Av-P_2O_5	C-P_2O_5	F-P_2O_5	W-P_2O_5	W-K_2O	Free Moisture	Free Acid		
	TPD													
PF-1, GGPR, Granular, Bagged	347.4	0.0	0.0	0.0	33.87 (24.0)	0.0	7.60	5.40 (14.4)	0.0	3.00	0.70 (4.0)	0.0	MOP	17.9 TPD
PF-2, FMP, Sandy, Bagged	569.0	0.0	0.0	0.0	20.68	13.40	20.30 (11.9) for Escorias Thomas	9.27	0.0	0.0	0.30	0.0	Serpentine	289.1 TPD
PF-3, SSP, Granular, Bagged	572.0	0.0	0.0	0.0	20.57 (19.5)	16.04	-	-	10.70 (18.0)	0.0	3.00 (4.0)	4.0 (3.7)	Sulfur	66.0 TPD
PF-4, TSP, Granular, Bagged	243.3	0.0	0.0	0.0	47.33 (45.0)	35.50	-	-	31.00 (40.0)	0.0	3.0 (4.0)	7.0 (4.0)	Sulfur	63.3 TPD
PF-5, MAP, Granular, Bagged	243.8	10.20 (11.4)	10.20	0.0	46.80	45.91 (48.0)	-	-	30.42	0.0	0.9	0.0	Ammonia, Sulfur	31.2 TPD 90.2 TPD
PF-6, NP, Granular, Bagged	551.1	20.80 (20.0)	11.40	9.40	21.10	20.80 (19.0)	-	-	15.83	0.0	0.60	0.0	Ammonia,	306.0 TPD
/CAN, Granular, Bagged	470.4	26.00 (20.50)	13.00	13.00	0.0	0.0	-	-	0.0	0.0	0.40	0.0	Natural Gas	2,788 MMBTU -LHV/D
Averaged Total	1,021.5	23.19	12.14	11.05	11.38	11.22	-	-	8.54	0.0	0.51	0.0		
PF-7, NP, Granular, Bagged	551.1	20.80 (20.0)	11.40	9.40	21.10	20.80 (19.0)	-	-	15.83	0.0	0.60	0.0	Natural Gas	10,025 MMBTU -LHV/D
/CAN, Granular, Bagged	470.4	26.00 (20.50)	13.00	13.00	0.0	0.0	0.0	-	0.0	0.0	0.40	0.0		
Averaged Total	1,021.5	23.19	12.14	11.05	11.38	11.22	-	-	8.54	0.0	0.51	0.0		

Notes: 1) Production is designed to consume 336.7 TPD (100,000 TPY/297 DPY) of phosphate rock (P_2O_5; 35.65%, Fe; 5.8%) which is recovered from non-magnetic tails at phosphate rock concentration plant, Sierra Grande, Argentine.

2) Requirement at fertilizer control order in Argentine (IRAM) is referred by underlined analysis and its figure is indicated in parenthesis.

Table 8 PROJECT ALTERNATIVES FOR PHOSPHATE ROCK CONCENTRATION AND PHOSPHATE FERTILIZER PRODUCTION IN ARGENTINE

Project	Plant and Product	Site Location	Daily Production and P_2O_5 Efficiency: Material TPD	Total P_2O_5 TPD (Efficiency, %)	Effective P_2O_5 TPD (Efficiency, %)	Annual Production: Material TPY	N TPY	Effective P_2O_5 TPY	K_2O TPY
Phosphate Rock Concentration Plant									
PC-1, PR	Phosphate Rock Concentration, Bulk	PS-1, Sierra Grande	336.7	120.0 (100.0)	$F-P_2O_5$; 19.2 (16.0)	100,000	0.0	5,690.0	0.0
Phosphate Fertilizer Plant									
PF-1, GGPR	Granular Ground Phosphate Rock, Bagged	PS-3, Bahia Blanca	347.4	117.7 (98.1)	$F-P_2O_5$; 18.8 (15.6)	103,178	0.0	5,571.6	3,095.3
PF-2, FMP	Fused Magnesium Phosphate, Bagged	PS-3, Bahia Blanca	569.0	117.7 (98.1)	$C-P_2O_5$; 115.5 (96.3)	168,993	0.0	34,305.5	0.0
PF-3, SSP	Single Super Phosphate, Bagged	PS-3, Bahia Blanca	572.0	117.7 (98.1)	$W-P_2O_5$; 61.2 (51.0) $T-P_2O_5$; 117.7 (98.1)	169,884	0.0	18,177.6 34,945.1	0.0
PF-4, TSP	Triple Super Phosphate, Bagged	PS-1, Sierra Grande	243.3	115.2 (96.0)	$W-P_2O_5$; 75.4 (62.9) $T-P_2O_5$; 115.2 (96.0)	72,260	0.0	22,400.6 34,200.7	0.0
PF-5, MAP	Monoammonium Phosphate, Bagged	PS-3, Bahia Blanca	243.8	114.1 (95.1)	$Av-P_2O_5$; 111.9 (93.3)	72,409	7,385.7	33,242.8	0.0
PF-6, NP/CAN	Nitrophosphate and Calcium Ammonium Nitrate by Ammonia Import	PS-3, Bahia Blanca	1,021.5	116.2 (96.8)	$Av-P_2O_5$; 114.6 (95.5)	303,386	70,355.1	34,039.9	0.0
PF-7, NP/CAN	Nitrophosphate and Calcium Ammonium Nitrate by Ammonia Production	PS-3, Bahia Blanca	1,021.5	116.2 (96.8)	$Av-P_2O_5$; 114.6 (95.5)	303,386	70,355.1	34,039.9	0.0

Table 9 BASIS FOR FINANCIAL ANALYSIS OF PHOSPHATE FERTILIZER PRODUCTION

Product and Production					Consumption/Ton of Product, Bagged									
Product Sepcification (Fertilizer Nutrients, %)	N	P_2O_5	K_2O	Daily Production (TPD)	Liquid Ammonia	Phos-phate Rock	Potassium Chloride	Sulfur	Ser-pentine	Natural Gas (MMBTU-LHV)	Electric Power (kWh)	Raw Water	Chemicals and Catalysts (USD)	Fertilizer Bag, (Sheet)
PF-1, GGPR	0.0	-33.87(5.40) T- F-	-3.0 W-	347.4	-	0.9692	0.0515	-	-	0.555	55.50	0.25	-	20.20
PF-2, FMP	0.0	-20.30 C-	-0.0	569.0	-	0.5917	-	-	0.5080	6.050	155.50	5.60	1.250	20.20
PF-3, SSP	0.0	-20.57(10.70) T- W-	-0.0	572.0	-	0.5886	-	0.1154	-	-	69.23	4.40	0.275	20.20
PF-4, TSP	0.0	-47.33(31.00) T- W-	-0.0	243.3	-	1.3839	-	0.2602	-	-	139.74	7.37	0.271	20.20
PF-5, MAP	10.2 T-	-45.91 Av-	-0.0	243.8	0.1279	1.3687	-	0.3698	-	-	180.49	7.38	0.373	20.20
PF-6, NP/ CAN	20.80 26.00 23.19 T-	-20.80 - 0.0 -11.20 Av-	-0.0 -0.0 -0.0	551.1 470.4 1,021.5	0.2996	0.3296	-	-	-	2.730	171.1	5.47	0.984	20.20
PF-7, NP/ CAN	20.80 26.00 23.19 T-	-20.80 - 0.0 -11.20 Av-	-0.0 -0.0 -0.0	551.1 470.4 1,021.5	-	0.3296	-	-	-	9.815	419.7	7.06	1.525	20.20

Table 10 EVALUATION AND SELECTION OF ALTERNATIVES FOR PHOSPHATE FERTILIZER PRODUCTION IN ARGENTINE

Alternatives	Evaluation and Selection Items and Criteria								Overall Evaluation
	Raw Materials Availability in Argentine, Foreign Currency Saving	Utility Consumption (Low)	Product P_2O_5 Evaluation in Argentine (IRAM)	Product P_2O_5 Water Solubility (High)	Product Physical Property	Product Market Development	Phosphate Rock Applicability to Conventional Production Process	Plant Investment Costs (Low)	
PF-1, GGPR	B	A	D (Formic)	D	A	C	A	A	C
PF-2, FMP	A	B	A (Citric)	D	B	D	A	A	B
PF-3, SSP	C	A	C (Total/Water)	C	C	C	C	A	C
PF-4, TSP	C	A	C (Total/Water)	C	C	B	C	B	B
PF-5, MAP	D	A	B (Citrate)	B	A	A	B	B	A
PF-6, NP/CAN -Ammonia Import	D	B	A (Citrate)	A	A	A	A	C	B
PF-7, NP/CAN -Ammonia Production	A	B	A (Citrate)	A	A	A	A	C	A

Table 11 SUMMARY OF SELECTED PHOSPHATE ROCK CONCENTRATION AND PHOSPHATE FERTILIZER PLANT PROJECT IN ARGENTINE

Product	Phosphate Rock Concentration Plant	Phosphate Fertilizer Plant		Integrated Plants Project	
				Case I	Case II
	PC-1	PF-5	PF-7	PC-1/PF-5	PC-1/PF-7
	Phospahte Rock, PR	Monoammonium Phosphate, MAP	Nitrophosphate/ Calcium Ammonium Nitrate, NP/CAN	Monoammonium Phosphate, MAP	Nitrophosphate/ Calcium Ammonium Nitrate, NP/CAN
Product Grade, % (T-N, T-P_2O_5(AV-P_2O_5), W-K_2O 23.19-11.38(11.22)-0.0		0.0-35.65(0.0)-0.0	10.20-46.8(45.91)-0.0	23.19-11.38(11.22)-0.0	10.20-46.8(45.91)-0.0
Product, TPD TPY	336.7 100,000	243.8 72,409	1,021.5 303,386	243.8 72,409	1,021.5 303,386
Plant Location	Sierra Grande, PS-1	Bahía Blanca, PS-3	Bahía Blanca, PS-3	Sierra Grande/Bahía Blanca, PS-1/PS-3	Sierra Grande/Bahía Blanca, PS-1/PS-3
Site Area, m^2	40,000	97,500	135,000	137,560	175,000
Production Start Year	1990	1990	1990	1990	1990
Total Number of Employee	238	298	440	517	659
Base Project Cost, USD, MM - 1983, Without Taxes	33.65	46.44	180.63	80.09	214.28
Consumption, TPT of Product					
- Liquid Ammonia	0.00	0.1279	0.00	0.1279	0.00
- Phosphate Rock (P_2O_5; 35.65%)	(1.00)	1.3687	0.3296	0.00	0.00
- Transport of Phos Rock (528km)	0.00	0.00	0.00	USD 10.2653	USD 2.4720
- Sulfur	0.00	0.3698	0.00	0.3698	0.00
- Non-Magnetic Tails (P_2O_5; 7.08%)	9.2163	0.00	0.00	12.614	3.0377
- Natural Gas, MMBTU-LHV	0.55	0.00	9.815	0.7527	9.9963
- Electric Power, kWh	338.58	180.49	419.70	643.90	531.30
- Raw Water,	0.784	7.38	7.06	8.453	7.318
- Chemical and Catalysts	USD 12.50	0.373	1.525	17.482	5.645
- Fertilizer Bag, Sheet	0.00	20.20	20.20	20.20	20.20

Notes; 1) Production of NP/CAN is weighted average for the 551.1 TPD of NP(20.80-20.80-0.0) and 470.4 TPD of CAN(26.0-0.0-0.0).
2) Cost for the transport of phosphate rock and chemicals and catalysts in USD-1983 and taxes are not included.

FIGURE 1 OVERALL FLOW SCHEME FOR PHOSPHATE FERTILIZER PRODUCTION IN ARGENTINE

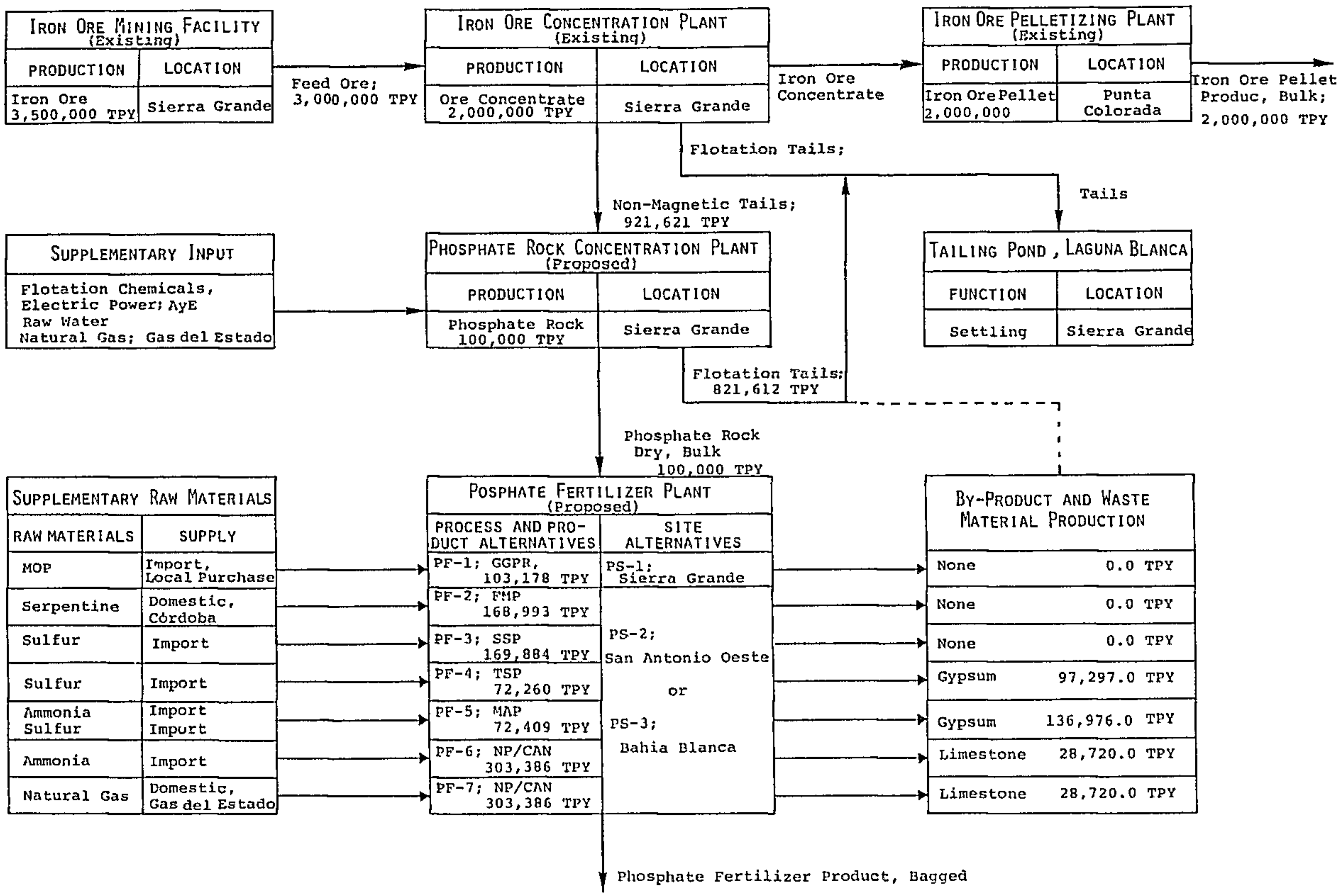
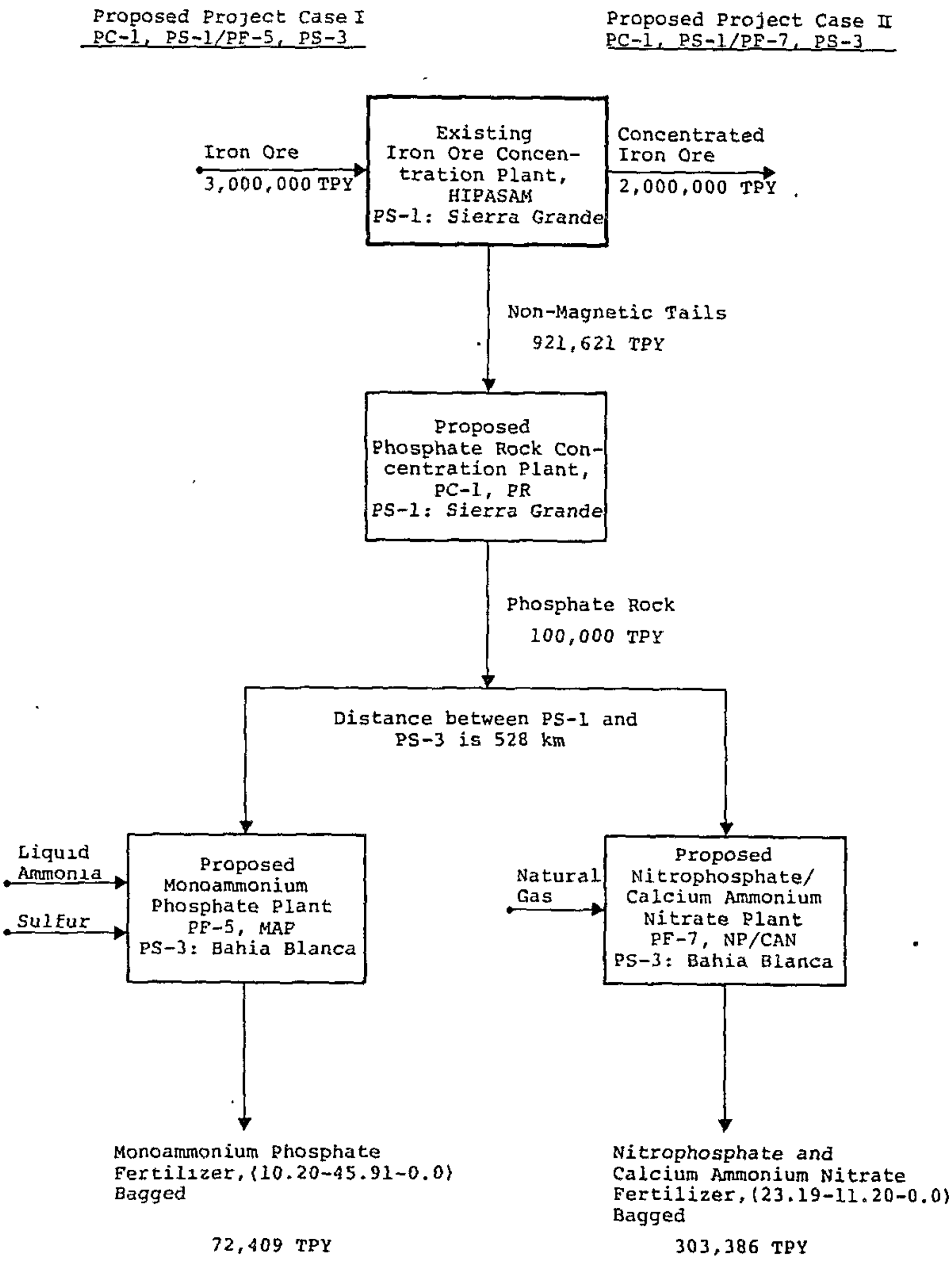


Figure 2 PROPOSED INTEGRATED PROJECTS FOR PHOSPHATE ROCK CONCENTRATION PLANT AND PHOSPHATE FERTILIZER PLANT IN ARGENTINE



PART I

INTRODUCTION

PART I

INTRODUCTION

CHAPTER 1. STUDY OBJECTIVES AND SCOPE

In Argentine Republic, the importance of fertilizer has been recognized since 1960 in view of the modernization of agriculture and the improvements of the productivity of agricultural products, especially the importance of phosphate fertilizer has been stressed because phosphate nutrient are not supplied to soils without chemical fertilizer applications.

Regarding the fertilizer production in Argentine already nitrogen fertilizer from natural gas has been produced in the country but no phosphate fertilizer were produced, except very small amount of Thomas phosphate and hyperphosphate in the past, and all requirements are covered by the importation from overseas. There is no identified phosphate rock reserve for the commercial developments in Argentine, and only one possibility is the apatite minerals in the tails from the iron ore concentration plant of HIPASAM in Sierra Grande, Río Negro

The preliminary studies were undertaken at HIPASAM since 1970 to concentrate phosphate rock from the tails and to produce the most suitable phosphate fertilizer for the soils and agriculture in Argentine by using the phosphate rock extracted as intermediate product.

It has been reported that two plants in Sweden and one small plant in the USA are recovering phosphate rock from the tails of the iron ore concentration plants similar to those of HIPASAM.

Under such circumstances and backgrounds, the Government of Argentine Republic has requested to the Government of Japan to examine the technical and financial feasibility regarding the Establishments of a Phosphate Fertilizer Plant project using the tails of Sierra Grande.

In accordance with the official request from the Argentine Government, the Japanese Government had sent a preliminary survey team in March, 1979 to Argentine, but at that time the pelletizing plant of HIPASAM has not been completed and the consumption of phosphate fertilizer has also been depressed for several years and concluded that the feasibility study should be made after the completion of the whole HIPASAM facility for obtaining the representative samples of tails for the evaluation tests. In 1982, the official request from the Argentine Government was made once again and a preliminary survey team of the Japan International Cooperation Agency, headed by Mr. Kenichi IWAGUCHI had made general survey on the project and concluded the Scope of Work for the study on December 17, 1982 between Japan International Cooperation Agency (JICA), and the DGFM and HIPASAM. A copy of the Scope of Work is attached in Annex I-1 in this report.

The general outline of the study, stipulated in the Scope of Work are cited as below;

(1) Background Study of the Project
(2) Fertilizer Marketing and Distribution Study in Argentine
(3) Fertilizer Raw Material Study
(4) Plant Construction Site Study
(5) Phosphate Fertilizer Alternative Products Study
(6) Conceptual Design of the Phosphate Rock Concentration Plant and Phosphate Fertilizer Plant
(7) Environmental Protection Study
(8) Investment Cost Estimate
(9) Financial Analysis of the Proposed Project
(10) Economic and Social Evaluation of the Propposed Project

In the Scope of Work, the study on the concentration of phosphate rock from the tails in laboratory and pilot plant scale and tests on phosphate fertilizer production in beaker scale are requested to be undertaken during the study.

And it is also requested to confirm the minimum level of the residual iron in the extracted phosphate rock during the study.

CHAPTER 2. STUDY EXECUTION

In due consideration of the importance of the study, the JICA has organized a study team headed by Mr. Makoto KUWABARA and consisting of six other experts to undertake the study The study team visited Argentine for field surveys for about one month from May 23, 1983 and conducted various study on the availability of raw materials and utility, marketing of fertilizer, site conditions and infrastructures and financial and economic conditions for the evaluation of the industrial investment project as well as taken the representative sample tails of 200kg weight at HIPASAM, Sierra Grande, Rio Negro. The member list and study activity of the study team are shown in Annex I-2.

To assist the field survey, a counterpart team was organized under Ing Mil Arnoldo ROLANDO, Coronel Director de Desarrollo of the DGFM with the members consisting of officials or experts nominated from the DGFM and HIPASAM. The member list of the counterpart team is shown in Annex I-3

During the field survey, the study team collected and analyzed necessary data and information by collaboration and discussing in detail with the Argentine counterpart team The list of such information and documents are shown in Annex I-4.

The study team also made investigation on site conditions of the candidated site area in Sierra Grande, San Antonio Oeste and Bahia Blanca and also the present status of the iron ore mining, concentration and pelletizing plant of HIPASAM, Sierra Grande and other related industries to identify underlying problems.

The market study member, through cooperation of governmental agencies, collected necessary data and information, while identifying underlying problems relating to the fertilizer market, distribution, soils and agriculture in Argentine by visiting farm fields in Buenos Aires, Salta, Jujuy and Mendoza

The field study results were summarized in the interim report dated June 16, 1983.

During the course of the experimental test, undertaken in Japan on the concentration of phosphate rock, it was found that the recovery and product quality of the extracted phosphate rock from the sample tails were not high enough in comparison with the targeted levels for the study and such performances were considered due to the specific characteristics of the ore and minerals in Sierra Grande. Therefore, it was discussed and agreed with in accordance with the request of the counterpart team that to take additional sample of tails to make intensive research and study on the concentration of phosphate rock and also to undertake the mineralogical investigation of the tails.

The representative sample of 500kg weight was taken at HIPASAM, Sierra Grande on October 6, 1983 and sent to Japan. Samples at SSAB, Grängesberg, Sweden were also taken to make mineralogical comparison investigation. The references for the revision of the scope and schedule of the study are shown in Annex I-1

The phosphate rock concentration research and experimental test were carried out, in Japan using the representative sample tails, from November, 1983 to February, 1984. The test result shows that the yield and product quality of phosphate rock has been greatly improved by applying the refined concentration process of extensive grinding and rougher and cleaner flotation. Although the P_2O_5 content is high enough as commercial phosphate rock, the residual iron content is higher and the recovery of P_2O_5 is lower than the performances in Sweden.

The mineralogical comparison investigation reveals that the mineral constituents, crystal size and structural complexity of the tails of Sierra Grande is quite different from those of Sweden. However it was concluded that phosphate rock with P_2O_5, 35.6% and Fe, 5.8% quality would be extracted at P_2O_5 recovery of 55.5% to produce a 100,000 TPY of phosphate rock as product. And 15kg representative sample of the phosphate rock was produced in February, 1984.

From February, 1984 to April, 1984, further evaluation tests on the production of phosphate fertilizer with seven different product alternatives were undertaken. Based upon the evaluation tests, it was confirmed that although the iron content is high in phosphate rock, the production of fused magnesium phosphate, phosphoric acid, ammonium phosphates and nitrophosphate are technically viable.

Two project cases were selected as an integrated project scheme of the phosphate rock concentration plant and phosphate fertilizer plant (monoammonium phosphate or nitrophosphate fertilizer) with full considerations of the availability of raw materials, ancillary materials and utility, marketability of the products, as well as the technical aspects of the project.

The two cases were financially and economically examined as feasibility study, and the conclusion and recommendation for the project judgements are presented in the study report.

PART II
MARKET ASPECTS

PART II

MARKET ASPECTS

CHAPTER 1. INTERNATIONAL MARKET OF PHOSPHATE FERTILIZER

1-1 Phosphate Fertilizer

There are ten kinds of plant nutrients, which are required to be supplied in large quantity in the process of growth of plants. Among them, three nutrients are not naturally supplied sufficiently, and these are nitrogen, phosphate, and potassium. Phosphate fertilizer is to supply plants with phosphate nutrient artificially, and therefore, contains phosphate nutrients in the form which the plants are able to absorb. Such phosphate nutrients may be classified into two groups, namely water-soluble phosphate and citrate-soluble phosphate. Many experiments have been conducted to clarify the difference in the absorption mechanisms and the resulting effects on plant growth between these two phosphates. However, since there are many factors which are thought to cause the difference in the effects, no firm theoretical conclusion on this point has reached yet. Therefore, it is recommended to carry out the experiments at the actual field before deciding the suitable products in the market in question.

The phosphate nutrient in the most of phosphate fertilizers is originated from phosphate rock. The production processes of phosphate fertilizers will be described in Part V. The phosphate fertilizers may be classified into two groups depending on the difference in the treatment of phosphate rock in the production process. One is the phosphate fertilizers produced through treatment of phosphate rock by acids, and another is that of treatment by heat. Major phosphate fertilizers are grouped as follows;

1. Acid treatment
   By sulphuric acid .... Single super phosphate (SSP)
   By phosphoric acid .... Triple super phosphate (TSP)
   Ammonium phosphate (MAP/DAP)
2. Heat Treatment .... Fused magnesium phosphate (FMP)
   Calcined phosphate

Besides these phosphate fertilizers, ground phosphate rock is also applied directly in some countries.

The phosphate fertilizers may be also classified into two groups in view of number of contained nutrients. One is the straight phosphate fertilizer which contains phosphate nutrient only, and another is the compound fertilizer which contains nitrogen, potassium or both of them besides phosphate nutrient. The former includes such fertilizers as SSP, TSP, and FMP, whereas the latter includes DAP, which contains nitrogen and phosphate, NP, PK, and NPK fertilizers.

1-2 Demand for Phosphate Fertilizer in the World

Table II-1 shows the demand for phosphate fertilizer in the world by region. Of the total phosphate fertilizer consumed in the world, 35% was consumed in West Europe and North America, while 28% was consumed in East Europe. The ratio of volume of phosphate fertilizer consumption to that of nitrogen fertilizer was around 0.5 in average in the world. It is due to the fact that the effect of nitrogen fertilizer application on crop yield is more easily observed than that of phosphate fertilizer in general, and therefore, the nitrogen fertilizer is firstly introduced at the earlier stage of fertilizer utilization.

Nevertheless, the consumption of phosphate fertilizer is much higher than that of nitrogen fertilizer in some countries in South America and Oceanea, where a large quantity of phosphate fertilizer is applied on pasture on phosphate deficient soils.

Table II-2 gives the outlook of supply/demand balance of phosphate fertilizer in the world, which was projected by Fertilizer Working Group of FAO/UNIDO/World Bank. According to this projection, the world demand for phosphate fertilizer is expected to increase by 3% annually in average in the following 10 years Compared with the annual increase rate of 3.8% in the past 7 years, the demand increase is projected to stagnate slightly in the future. Actually, in the developed countries, the increase in the cropped area may be limited in the future, and, at the same time, the dose level of fertilizer is already high with remaining only little potentiality for further increase in the dose level. Thus, the future increase in the demand for fertilizer will not be large. However, in the developing countries, where the increase in food production is essential, the increase in the demand for phosphate fertilizer is expected to continue. The average annual increase rate in these countries are projected to be 4.1% in Asia, 3.6% in East Europe, and 4.6% in South America.

1-3 Supply of Phosphate Fertilizer in the World

Of the phosphate supplied in the world, 99% has been obtained from phosphate rock, and the remaining 1% was recovered from iron ore. The phosphate rock can be classified into two in view of its origin, namely, live origin and igneous origin. Further, the phosphate rock originated from lives includes two types.

One is continental phosphate rock which is originated from ocean or shell animals, and another is island phosphate rock which is originated from guano. In the case of island phosphate rock, the organic materials is often remained without decomposed sufficiently, and therefore, the phosphate content is low. These are called guano and mined in Chile, Peru and the Philippines, etc.

The live origin phosphate rocks other than guano, namely, well decomposed island rock and continental rock, have no significant difference in view of use of contained phosphate. Most of the phosphate rocks produced at present in the world, including Florida rock and Moroccan rock, belong to the continental rock, and island rock accounts for small portion of world phosphate rock production. The Christmas Island rock belongs to the island rock.

The phosphate rock of igneous origin, which includes such rocks as Kola rock (the U.S.S.R.), Lao Khai rock (Vietnam), Brazilian rock, etc., has the difficulty in decomposition by sulphuric acid in the production process of watersoluble phosphate.

Table II-3 shows the past trend of phosphate rock production in the world by major producing country. Of the world production of phoshate rock in 1980, 73% was produced by the U.S.A , Morocco, and the U.S.S.R. In the second half of 1950s, these three countries accounted for 77% of world production, but this ratio has decreased due to the increase in the production by such countries as Jordan and African countries other than Morocco.

As already stated in 1-2 (Table II-2), the world demand for phosphate fertilizer is expected to increase to 38 million P_2O_5 tons in 1987, and 46 million P_2O_5 tons in 1992.

Adding the industrial demand and distribution/production loss to the above demand, more than 47 million P_2O_5 tons of phosphate rock will be required in 1987.

However, according to the survey carried out by IFA (International Fertilizer Association) in 1987, 62.7 million P_2O_5 tons of phosphate rock production is expected in 1987, and therefore, the oversupply situation is projected in the world phosphate rock market for coming 5 years period.

The phosphate fertilizer is produced from phosphate rock, but as explained in the foregoing section, it is rare for the phosphate rock itself to be applied directly on crops. The phosphate rock is used as a raw material, mainly processed into phosphoric acid (except for the case of SSP production), and further converted to such final products of phosphate fertilizer as AP, TSP and compound fertilizers. The phosphate materials are traded not only as raw materials of final products, but also as intermediate products. Table II-5 shows the world phosphate fertilizer trade by type of material. In 1975, 83% of 17.4 million P_2O_5 tons of world phosphate was traded by phosphate rock, but the ratio has decreased to 69% of 20.6 million P_2O_5 tons in 1982 due to the increase in the trade by phosphoric acid.

In 1950s and the early 1960s, the cheaper ocean freight rates made the trade of phosphate rock viable, and the production facilities of phosphoric acid and phosphate fertilizers were built in the consumer countries in West Europe based on the imported phosphate rock. The producers in these countries vied with others in expanding the production capacities to receive the benefits from scale economies. The residuals of products after absorbed in the domestic market, were reexported in the form of final products. The production capacity of these facilities were further expanded to compete with other exporters when the supply exceeded the demand in the late 1960s. However, since the latter half of 1960s, the producer countries of phosphate rock, especially that of developing countries, started production of phosphoric acid and phosphate fertilizers for export, by large scale production facilities to increase the value added of their phosphate rock. The ocean freight rates and energy costs as well as the price of sulphur, which is one of the major raw materials for phosphoric acid, also increased. As a result, the producing countries in West Europe, whose production was based on the imported phosphate rock, and oriented for export, lost their competitiveness in the export market, and major exporters of phosphate intermediates as well as final products have shifted to the phosphate rock producing countries.

1-4 International Market Price of Phosphate Fertilizer

The main exporter country of phosphate rock in the international market was the U.S.A. in 1950s. The U.S.A. posted the market price and other producers including Morocco followed the price, and thus the international market price was formulated with the U.S.A. regarded as the price leader of the market. However, after the outbreak of first oil crisis in 1973, Morroco and the African/Mideastern producing countries increased the price by 4 to 5 times in order to achieve the leading position in the market, following the OPEC's position in the oil market. The U.S.A. also followed the Morocco's price hike, and the U.S.A.'s position in the market was seemed to be replaced by Morroco.

However, such price increase caused the stagnation in the demand, and Morroco lost its market greatly. Nevertheless, the U.S.A. could keep its market without decline in the shipment, and thus Morocco was forced to ease up their intention to establish their leading position in the market. At present, the price at U.S. Gulf is regarded as the indicative price in international market for phosphate rock, phosphoric acid and phosphate fertilizers.

The price of phosphate rock changes depending on the supply/demand situation and mining costs of phosphate rock. As already mentioned, the supply of phosphate rock is estimated to continue to exceed the demand for the coming 5 years. In such case, the mines, product of which is not competitive in the market, would be forced to stop operation, and the mining projects now under planning would be abandoned if the projects is not feasible in this context. Thus, the market price of phosphate rock will be formulated at the level which is almost equivalent to the supply costs of producers whose cost is marginally high among the suppliers still in the market.

The mining costs of phosphate rock vary depending on the mining conditions. Figure II-2 depicts the estimated distribution and change in the supply ability by mining costs level. Except for the period from 1973 to 1977, when the abrupt fertilizer hike occurred following the oil crisis, the historical price trend has reflected the trend of mining costs, although the estimated cost bias slightly higher side.

According to the demand forecast of FAO/UNIDO/World Bank Group (Table II-2), the demand for phosphate fertilizer in the world is expected to increase to 38.2 million P_2O_5 tons in 1987, and 45.6 million P_2O_5 tons in 1992.

In the case of IFA's projection (Table II-4), the demand in 1987 is estimated 40.0 million P_2O_5 tons for phosphate fertilizer, and the total requirement of phosphate rock including industrial use and losses is estimated 48.4 million P_2O_5 tons. If the industrial use and losses, estimated by IFA, are added to the FAO/UNIDO/World Bank's projection above, the requirement of phosphate rock is 47.0 million P_2O_5 tons in 1987, and 56.6 million P_2O_5 tons in 1992. These are equivalent to 144.6 million tons of phosphate rock in 1987, and 174.2 million tons in 1992, assuming that the P_2O_5 content of phosphate rock is 32.5%. These are almost the same level as low demand level in Figure II-2, and therefore, the mine, the mining cost of which has been the basis of market price formulation, will continue to be so in the future. In other words, the market price of phosphate rock in the future will almost remain unchanged in terms of constant price, although some short term fluctuations are not avoidable.

Table II-6 compares the relationships of prices among phosphate raw materials/intermediates/final products. Since each level of products not only have individual markets, but use different raw materials for their production, each market prices have been fomulated based on supply/demand situation and production costs of individual products.

However, at the same time, these products are competing each other in the market. Therefore, if ratio of prices among these products change greatly, then the demand for the products with higher price will be decreased by being replaced by that of lower price, and as a result, the price of former product will be lowered. Thus, as shown in Table II-6, there have been certain ratioes among prices of products in short term.

CHAPTER 2. AGRICULTURE AND FERTILIZER INDUSTRY IN ARGENTINE

2-1 Agriculture in Argentine

2-1-1 Agriculture in Argentine economy

Of the gross domestic product in Argentine, the product by agricultural sector accounted for 13% in 1980 as shown in Table II-7, with the percentage decreased slightly from 15% in 1970. The percentage has continued to decline relatively in long term from 35.5% in 1900, to 18.8% in 1950 and 16.4% in 1960. Contrary to the agricultural sector, the percentage for manufacturing sector has increased gradually from 18.7% in 1900, to 27.8% in 1950, 31.3% in 1960, and 33.8% in 1980.

The percentage of agricultural products in the total export in Argentine has also declined as shown in Table II-8. Neverthless, the agricultural sector still plays an important role in Argentine economy.

2-1-2 Types of management of agriculture in Argentine

The management types of agriculture in Argentine may be classified into two groups, namely the intensive type and the extensive type. Although the difference in the concepts of these two types are not necessarily definite, the main characteristics are as follows.

The extensive agriculture mainly rely its increase in the production on extension of cropped area, whereas the intensive agriculture use both labor and capital intensively on the production increase. The wheat cultivation area and cattle raising area in Pompeana (Buenos Aires, Santa Fe, Entre Rios, Cordoba, and La Pampa), sugarcane growing area in Tucuman, Salta and Jujuy, viticulture area in Cuyo, these area are characterized by monoculture. Among them, the wheat cultivation area and cattle rasing area in Pampeana are the typical extensive agriculture areas. In the areas other than the above mentioned areas, cereals, such industrial crops as cotton and tobacco, fruits, vegetables, and flowers, etc. are grown, and among these areas, such valley areas as Mendoza and Neuquén as well as the areas in the vicinity of large cities are the typical intensive agricultural areas with intensive labor and capital investment. Before 1952, in the area of 55% of total agricultural land, the cultivation was made by tenants These tenants had farmed a certain land with 3 years-tenant contract, and after finishing the contract period they usually moved to other land. Thus, farmers were discouraged to improve the land, and this was the major factor of impediment to the agricultual development in Argentine. However, according to the official estimate, this situation has been changed, and 73% of farmers are landowner-operaters at present.

2-1-3 Agricultural production in Argentine

The cropped area in Argentine was expanded steadily up to 1935, but after that, due to the worldwide recession and war with decline in the demand in export market, the cropped area was decreased up to 1950 (Figure II-3). Between 1950 and 1970 the cropped area was expanded again, but the expansion has been stagnated since then. The agricultural production in Argentine relys greatly on export market, and therefore, business fluctuation in the export market affects the big influences on the production.

At the same time, the limited supply availability of irrigation water has been the impediment to expansion of arable land. Thus, the expansion of agriculture requires the security of irrigation water, which requires the investment on irrigation facilities, and the improvement in the market would be the essential factoer on the incentive for the investment.

Table II-10 shows the historical trend of agricultural production in Argentine Most of the crops are seperately grown in a specific areas where the climatic condition is favorable for its growth The regional distribution of such crop grown areas are shown in Figures II-4 through II-6.

Table II-11 shows the past trend of yield of major crops in Argentine. The yields of most of crops have showed long-term increase trend. At the same time, the highest yield level reached by most of crops are after 1976. The yield levels of major corps in Argentine are almost the same level as that of the U.S.A.

2-2 Fertilier Industry in Argentine

2-2-1 Fertilizer industry in Argentine

The histrical trend of supply and demand for fertilizer in Argentine is given in Table II-12 The consumption of nitrogen fertilizer in 1982 was around 51,000 N tons, whereas that of phosphate and potassium fertilizers were 46,000 P_2O_5 tons (or 20,000 P tons) and 6,000 K_2O tons respectively. The consumption ratios of phosphate fertilizer and potassium fertilizer to nitrogen fertilizer were around 90 and 10 respectively in terms of nutrient tons with that of nitrogen being 100.

The consumption of these fertilizers per hectare of arable land and permanent crops is shown in Table II-13 compared with that of neighboring countries. The per hectare consumption level in Argentine is fairly lower than that of neighboring countries in South America, but the consumption ratio of phosphate fertilizer to nitrogen fertilizer is fairly high compared with that of world average, while that of potassium fertilizer is low.

The consumption of fertilizer in Argentine had showed the steady increase up to 1972/73, but the consumption declined suddenly in 1974/75, and turned to increase again after that. However, with peak of consumption in 1979/80, the consumption decreased in 1981/82. As already mentioned in the foregoing section, the cultivation types of crop in Argentine may be classified into two groups, namely "Cultivos Intensivos" and "Cultivos Extensivos". It is the significant characteristic of agriculture in Argentine for both types of cultivation that the market is far from the production area, and therefore the reduction of production costs is the essential factor for successful marketing of the products. In the extensive agriculture, the cost reduction is made mainly through expansion of cultivation area, whereas it is through raising the land productivity in the case of intensive agriculture. Thus, the fertilizer had been used mainly on intensive agriculture. However, in recent years, the use of fertilizer has been started on such extensive agricultural crops as wheat, and it has contributed greatly to the increase in the consumption of fertilizer. The demand for fertilizer from intensive crops is stable because the per hectare application level on the intensive crops are already high and fluctuated slightly accordingly with the change in the market situation of the crops.

However, in the case of fertilizer application on the extensive agricultural crops, the applied volume is decreased conspicuously, or sometimes discontinued depending on the market situation of the crops.

Not only the long term trend of increase in the fertilizer consumption has been caused by the expansion of fertilizer application on extensive crops, but the short term fluctuation of consumption has also caused by the change in the application level on extensive crops as explained above.

2-2-2 Fertilizer supply in Argentine

Only the limited amount of fertilizer is produced domestically in Argentine. The nitrogen fertilizer are produced by two companies, PETROSUR and SOMISA. The production capacities of PETROSUR are 195 t.p.d. of ammonia and 300 t.p.d. of urea, and the annual production is in the range of 22,000 to 26,000 N tons per year. SOMISA produces around 4,000 to 7,000 N tons per year of by-product ammonium sulphate using the by-product ammonia obtained from the iron manufacturing process As for the phosphate fertilizers, the sole producer, FM, which produced Thomas phosphate fertlizer, stopped production in 1981, and the supply of phosphate fertilizer is entirely relyed on import. The potassium fertilizer is wholely imported also. With respect to the supply of compound fertilizer, around 20,000 to 25,000 tons of the product are estimated to have been produced domestically, and at the same time, around 2,000 to 9,000 tons of compound fertilizer have been imported. PETROSUR is the sole producer of compound fertilizer in Argentine at present, and the production capacity is 65,000 t.p d. The market size of compound fertilizer used to reach 45,000 t.p.a., but it has shrinked to 25,000 to 30,000 tons.

There are several fertilizer production projects under construction or under planning in Argentine, of which one is to produce compound fertilizer, while others are to produce nitrogen fertilizer. The compound fertilizer production project, which is to produce bulk blending fertilizer, though the production capacity is not disclosed, is under construction by Campaña Quimica at San Nicolas, and expected to start production in 1984. All of the nitrogen fertilizer production projects are to produce urea from ammonia using natural gas which is available domestically. There are five such projects which are to construct the plants at Salta, Santa Fe, Neuquén, Santa Cruz, and Tierra del Fuego, and none of these projects are reached to the final decision for proceeding to construction. Among these projects, the projects at Salta and Neuquén are thought to be the most probable ones, with the production capacity being 200 t.p.d. of ammonia each. All the ammonia produced by these projects are planned to be converted to urea and sold in the local markets. The Santa Fe project was approved already by the government for construction, but no progress has been reported due to some problems

Some phosphate rock reserves have been discovered in Argentine, but no further survey has been conducted and therefore, potentiality for the development of these reserves are not known yet.

2-2-3 Policies on fertilizer promotion, and government offices related to fertilizer industry

The Argentine government does not adopt any specific policy on promotion of fertilizer use. Department of Fertilizers, Secretaria de Estado de Agricultura y Ganaderia is in charge of collecting data and information regarding supply and demand as well as prices of fertilizer, but no action has been taken so far by government on the result thus obtained.

Import duty is revised on the fertilizer which are also produced domestically with the tax rate 25% on C.I.F. value (35% on special fertilizers), but it is exempted on the fertilizers which are not produced domestically. The I.V.A. (value added tax) had been exempted on fertilizer until October, 1981, but it is revied at present at 20% as it is on other commodities.

INTA (Instituto Nacional de Technologia Agropecuria)is responsible for carring out the experiments on fertilizer application and effects of fertilizer on crops. The headquarter of INTA is located in Buenos Aires with more than 30 experimental stations around the country In 1975, INTA collected data and informations on fertilizer use and effects of it on crops from its experimental stations, and summarized the result over the country-wide scale At present, the similar study is under implementation by INTA, but the information is still under processing and no result has disclosed yet so far. Therefore, the conclusion obtained by the last study in 1975 is the latest one over the country-wide scale.

Note: In February, 1984, the Government of Argentine decided to adopt the policy to promote the fertilizer use, especially to promote the nitrogen fertilizer on wheat in order to increase the revenue from export by increasing the wheat export.

The Policy includes the followings;

1 Abolition of import duty on fertilizer
2. Reduction of IVA to 5%
3 Promotion of barter trade of cereas with fertilizer
4 Relax of export control on agricultural product produced by farmers who use fertilizer.
5. Implementation of subsidy for domestic fertilizer producers.

CHAPTER 3. MARKET OF PHOSPHATE FERTILIZER IN ARGENTINE

3-1 Demand for Phosphate Fertilizer

3-1-1 Overview

Table II-12 shows the past trend of fertilizer supply (total of import and domestic production). Since the data on actual consumption are not available, the figure of supply will be regarded as that of apparent consumption in this report. Although the annual supply (or apparent consumption) has fluctuated year by year, it was around 23,000-25,000 P_2O_5 tons in the 1st half of 1970s. The annual supply (or apparent consumption) increased greatly to 65,000 P_2O_5 tons in 1979 and 50,000 P_2O_5 tons in 1980. However, in 1981 it declined to 29,000 P_2O_5 tons and then recovered to 46,000 P_2O_5 level in 1982. (The apparent consumption neglects the change in the inventory, and therefore, the actual consumption is understood to be different from the apparent consumption, although the apparent consumption may be regarded as the indicative figure for the trend of actual consumption.

Table II-14 shows the consumption of phosphate fertilizer by region and by crop in 1972 and 1982. The figure in 1972 was estimated on the basis of INTA Report in 1973, and that of 1982 is based on the Study result. The total consumption of phosphate fertilizer was 41,000 P_2O_5 tons in 1972 and 51,000 P_2O_5 tons in 1982. (As stated before, the apparent consumption was 47,300 P_2O_5 tons in 1972 and 45,700 P_2O_5 tons in 1982, and does not meet to the actual consumption figure estimated by Dept. of Fertilizer.)

Slightly more than 30% of total consumption was consumed by wheat in pampeana, followed by pasture (more than 25%) and potatoe (8%) In these 10 years, the demand for phosphate fertilizer increased by 10,000 P_2O_5 tons, and the most part of the increase was caused by the increase in the consumption by wheat. The fertilizer consumption by other crops has not chagnged greatly in long term with both fertilizerd area and unit area consumption remaining unchanged, although the consumption level has fluctuated accordingly with the change in the price of crops.

3-1-2 Outlook of demand for phosphate fertilizer

There are three major factors which affect the influences directly on the change in consumption volume of fertilizer. These are the changes in:

1. Cultivation area
2. Fertilizerd area ratio to total cultivation area, and
3. Fertilizer application level per unit area.

As shown in Table II-10, wheat, maize, sorghum, sunlower, and soybean are the major crops in view of extension of cultivation area. The cultivation area of soybean has showed increase in recent years, but that of others has remain unchanged. The fertilizerd area ratio of total cultivation areas of these extensive cultivation crops is extremely low except for wheat, and fertilization on these crops are quite rare. In the case of wheat, the fertilized area has showed increasing trend only in recent years. The fertilized area ratio of intensive cultivation crops is estimated to have remained stable.

Nevertheless, in the short term, the fertilized area has changed year by year, and the major factor affecting on such changes was change in the agricultural product prices.

Figure II-8 shows, as an example, the relationship between change in the fertilized area of wheat and change in the price ratio of wheat to fertilizer. The fertilized area of wheat increased conspicuously in 1979-80, declined in 1981, and then, increased again in 1982. Such fluctuation in the fertilized area has almost coincided with the change in the prices of fertilizer and wheat as shown in Figure II-9 (see Table II-15 also). The same situation as above has observed both in the case of wine/fertilizer price ratio to fertilization on grape and in the case of beef/fertilizer price ratio to fertilization on pasture.

The fertilizer application level per hectare of cropped area varies depending on such factors as soil conditions, crops grown, climatic conditions as well as the extent of intensity of farming. The application level has remained unchanged for these ten years according to the informations obtained from INTA people and/or the industry.

In the projection of future demand for phosphate fertilizer, such factors obserbed in the past movement and described above should be taken into consideration. Outlook of change in the factors affecting fertilizer demand may be summarized as follows;

(1) The future cultivation area of crops was projected basically on the basis of past trend, and is not expected to change greatly, except for soybean, according to the projection result. (The projection using past trend includes some steps of projection, and the details of the projection procedure are described in Annex II-2).

(2) The fertilized area ratio of the crops now fertilized except for wheat is not expected to diverge from the present level in the long term. Especially in the case of intensive agricultural crops, the fertilizer has been applied at high dose level so long as it is grown as commercial agriculture, and no or low fertilization may be observed only on selfsustenance agriculture or agriculture on low productivity area. Thus, change in the fertilized area ratio will follow the past trend, although there may be divergence in short term corresponding to the change in crop/fertilizer price ratio, since some farmers discontinue or decrease fertilizer application when the farm management is deteriorated.

(3) The fertilized area ratio of wheat in 1982 was around 6%, and is expected to increase further. In 1990, it is projected to reach 14% of total wheat area in Pampeana, or 40% of wheat area in the phosphate deficit area (see Figure II-10) in the south eastern part of Buenos Aires Province.

(4) In the case of maize, around 23,000 ha of cultivated area is estimated to have been fertilized in Pampeana, and this area is equivalent to 5% of maize cultivated area in the phosphate deficit area mentioned above. Main maize area are distributed from north part of Buenos Aires Province to south part of Santa Fe Province, and these areas are understood to have abandunt supply ability of phosphate nutrient from soil. Although there is no data on phosphate fertilizer response, phosphate fertilizer is not applied in these area. In the case of south part of Buenos Aires province, where the phosphate deficit soil covers, according to the experimental result conducted by the regional station of INTA at Balcarce, around 800-1000 kgs/ha of yield increase can be expected by application of 50-70 kgs/ha of DAP.

However, if various changes and costs for transportation and distribution are subtracted, the net benefit by fertilizer will be less than costs of fertilization (Table II-16). Thus, the increase in the fertilized area ratio of maize is hard to be expected.

(5) In the case of such extensive crops as soybean and sorghum, the cultivated areas on the phosphate deficit area are 110,000 ha and 90,000 ha only respectively, and furthermore, since the area is located far from the market and thus profitability of these crops on the area is not favorable, then the fertilized area is not expected to increase in the future as in the case of maize.

(6) The fertilized area of pasture is estimated 1% or slightly more of total pasture area The pasture includes legume crops, which requires phosphate fertilizer, and grown on phosphate deficit area, and therefore, potentiality to use phosphate fertilizer seems high. However, the pasture is grown on low productivity area with flood and draught, and consumption of phosphate fertilizer has declined greatly due to the decrease in beef price. If the beef price is recovered in the future, the consumption of phosphate fertilizer may also be recovered, but it is hard to expect that the potential demand will be further materialized to actual consumption.

The future demand, projected by taking into account the above factors, is expected increase to 78,400 P_2O_5 tons in 1990, and 106,700 P_2O_5 tons in 1995, as shown in Table II-17.

3-1-3 Outlook of phosphate fertilizer demand by region

Table II-14 shows the demand for phosphate fertilizer by region.Pampeana is the largest consumption region of phosphate fertilizer, and wheat and potato are the major crops on which the phosphate fertilizer is consumed. Non-water-soluble fertilizer has been used on pasture, but the consumption volume has declined due to the stagnant market situation of beef.The largest consumption region next to Pampeana is Andina, mostly used on vegetables and fruits.In Mesopotamia, the third largest consumption region, the phosphate fertilizer is applied on various crops including pasture and soybean.(For further detail on the consumption situation by region, see Annex II-2.) At the southeastern part of Buenos Aires province there is an extensive phosphate deficit area, where the wheat is exclusively grown.This area may be regarded as the most prospective area in view of future potentiality to increase the phosphate fertilizer consumption.The demand for phosphate fertilizer on wheat in Pampeana is expected to increase to 39,900 P_2O_5 tons in 1990 and 65,900 P_2O_5 tons in 1995.

The phosphate fertilizer in other regions is mainly used on intensive agricultural crops in irrigated areas. However, because the available water is limited, the expansion of cropped area with irrigation is hard to expect.As a result, the demand for phosphate fertilizer on these crops will not increase greatly.

3-1-4 Consumption by type of fertilizer and its outlook

Among the several phosphate fertilizers used in Argentine, ground phosphate rock and Thomas phosphate fertilizer are the non-water-soluble phosphate fertilizer. This type of fertilizers have been used in Argentine with the following two objectives.

(1) For the crops grown in the acid soil areas in Misiones province; On the acid soil, the non-water-soluble phosphate may be decomposed by the acid and absorbed by plants, and therefore, this type of fertilizer may be used as cheaper phosphate fertilizer.(Most of acid soils are distributed in mountainous regions in Argentine, and Misiones province is the sole area of acid soil on agricultural area.)

(2) For pastures in Pampeana region; The soil in pasture grown area in Pampeana especially in southeastern part of Buenos Aires province, is not acidulated, and the pH of soil ranges 5.9 through 8.5 instead. Furthermore, according to the experimental results, water-soluble phosphate is more effective than non-water-soluble one on pastures. Nevertheless, since this area is marginal in view of profitability because of unstable production conditions, the non-water-soluble phosphate fertilizer is preferred as the cheaper fertilizer.

However, due to the stagnant market condition of beef, the consumption of this type of fertilizer has declined, with ground phosphate rock decreased from 6,000 - 9,000 P_2O_5 tons in 1973-74 to less than 1,000 P_2O_5 tons 1982, while Thomas phosphate being nil because of discontinuance of domestic production.

Among the water-soluble phosphate fertilizers, DAP and TSP are most popular in Argentine.Especially, DAP consumption has showed the steady increase to 36,800 P_2O_5 tons in 1982, accounting for 80% of total consumption of phosphate fertilizer. However, SSP, which is one of the water-soluble phosphate fertilizers, is not adequate for Argentine market in that the nutrient content of SSP is low with transportation costs high in terms of unit nutrient content. Of the aggregated consumption of DAP and TSP, TSP accounted for 35% in the period of 1972-74, but it decreased to only 6% in the period of 1980-82. Both DAP and TSP can be used as a substitute of the others. Further, the INTA recommends TSP instead of DAP to decrease soil pH. Nevertheless, DAP has been preferred in Argentine, and it may be due to the fact that the price difference between DAP and TSP is so small that DAP is cheaper than TSP if the nitrogen nutrient contained in DAP is taken into consideration. The following table compares the prices of DAP with that of TSP evaluating the price of nitrogen nutrient by urea price. The price of TSP plus urea is higher than that of DAP by 7% in 1981 and 1982, and by 30% in 1983. In the case of wheat, since the protein content of wheat tends to decline in recent years, the application of nitrogen nutrient in addition to phosphate nutrient is recommended, and this is one of the reasons for farmers to prefer DAP rather than TSP.

(Unit : a$/ton)

	DAP (A)	TSP	TSP plus (Urea × 0.39*) (B)	B/A
Average in 1981	2,368	1,696	2,522	1.07
Average in 1982	10,281	8,199	10,985	1.07
Average in 1983	26,100	25,200	34,560	1.32

*Adjusted to equalize N and P_2O_5 nutrients with that of DAP (18-46).

The maximum consumption level of compound fertilizer (excluding DAP) attained in Argentine was 45,000 tons (or around 7,000 P_2O_5 tons-estimated), but it has decreased to 25,000 - 30,000 tons (or 4,000 - 4,500 P_2O_5 tons). These compound fertilizers are used mainly on tobacco and some kinds of fruit trees. Generally, potassium fertilizer is not used in Argentine, and further, nutrient content of compound fertilizer is lower than that of straight fertilizers which are popular in Argentine. Therefore, the high analysis straight fertilizer are usually preferred rather than compound fertilizers. However, if the more suitable and economical type of compound fertilizer to Argentine agriculture with high nutrient contents is introduced, the conversion of demand for straight fertilizer to that of compound fertilizer may be probable.

It is hard to predict the future demand for fertilizer by type without firm information on supply ability and competitiveness of each fertilizers. The type of product to be produced by this Project and its competitiveness in the market will also affect large influences on the type-wise demand in the future. Table 2-18 gives the potential maximum demand for water-soluble and non-water-soluble phosphate fertilizers with the assumption that only one type of phosphate fertilizer is produced domestically, and the fertilizer thus produced is quite competitive with the imported fertilizers. The actual future demand for the product produced by this Project will not exceed the above potential demand.

3-2 Present Situation and Outlook of Supply of Phosphate Fertilizer

3-2-1 Present situation of supply

At present (in 1982), import is the sole supply source of phosphate fertilizer in Argentine. Thomas phosphate fertilizer had been produced by FM, but the production was discontinued due to the conversion of manufacturing process of iron through which Thomas phosphate fertilizer was by-produced. The ground phosphate rock, called Hyper Phosphate, had been also produced domestically by AGROMAX at Bahía Blanca using imported phosphate rock. However, the production was also stopped when the Bahia Blanca factory was taken over by Petrosour. The Hyperphosphate is imported from AGROMAX in Uruguay at present.

3-2-2 Outlook of new projects to produce phosphate fertilizer

At present there is no project to produce phosphate fertilizer in Argentine except for this Project. Several phosphate reserves have been discovered in Argentine (Figure II-7), but no reserves has been firmly proved to be viable so far.

3-3 Marketing and Distribution of Fertilizer in Argentine

3-3-1 Distribution of fertilizer

There are one producer and several importers of fertilizer in Argentine. They have their local branch offices in major cities, and market their products to retailers through these local branch offices. For large scale consumers, they sell the products directly instead of selling through retailers. The retailers generally handle products from more than one producers/importers.

3-3-2 Physical distribution of fertilizer

Most of fertilizers imported in Argentine are unloaded in Buenos Aires with reminder unloaded in Bahia Blanca. The products are transported to the markets mainly by truck from either the producer's factory or warehouses at the unloaded ports. The truck transportation is sufficiently available in Buenos Aires and Bahia Blanca to the agricultural areas as a return cargo, since the agricultural products are shipped from the areas to these cities constantly. In the case of railway transpotation, the railway freight rate is often cheaper than that of truck, nevertheless total transportation costs by railway is more expensive than that of truck when taking into account the additional costs after the railway stations. Besides this, railway transportation requires much time than truck transportation, and because of these reasons fertilizer is transported mainly by truck.

3-3-3 Packaging

Fertilizer is distributed in bag, and no fertilizer is handled in bulk. Either polyethylene bag or polyethylene woven bag are commonly used with 50kgs content per bag.

3-4 Market Price of Fertilizer

3-4-1 Formation of market price of fertilizer in Argentine

Fertilizer is sold at FOB price to users. In other words, fertilizer is sold at ex-factory price in the case of domestically produced fertilizers, while it is at ex-warehouse price at unloaded port in the case of imported fertilizers, and the inland transportation and other handling costs related to movement are charged to the users Nevertheless, since the users may receive bids from more than one distributors, the users can chose the best price offer in terms of delivered price.

The imported fertilizer is levied 25% of import duties in case of the same kind of product is produced domestically. However, other conditions are equal to the domestically produced fertilizers Therefore, the domestic market price of fertilizer is generally formulated on the basis of the import price.

Table II-19 shows the relationship between domestic market prices and import prices The payment term is mostly in cash.

3-4-2 International market price and import price in Argentine

Table II-20 compares import prices of fertilizer in Argentine with the international market prices both in term of FOB US Gulf. In the case of import in Argentine, size of import consignment is generally small (around 500 tons per lot), and therefore, the import price has tended to be higher than the international market price by around 10%.

CHAPTER 4. SALES OF PRODUCT(S) PRODUCED BY THE PROJECT

4-1 Product Mix Selection in View of Marketability

The market size in total as well as by product was analyzed and projected taking into account the characteristics of the market in Argentine in Chapter 2 (2-1-4) and shown in Table 2-18. These points may be summarized as follows;

1. Water-soluble phosphate fertilizer may cover whole demand for phosphate fertilizer. However, if non-water-soluble phosphate fertilizer is cheaper than water-soluble one in terms of unit nutrient price, then a part of demand such as that of pasture and that of acidic soils in Mesopotamia will be met by non-water-soluble phosphate fertilizer.

2. The non-water-soluble phosphate fertilizer may be applicable only on a limited areas or crops.

3. Fertilizer with low nutrient content is not adequate for Argentine market due to the long transportation distance to the market.

4. The potential demand for compound fertilizer is not expected to be large, in that only one nutrient either nitrogen or phosphate, instead of two or three nutrients at once, is applied on extensive agricultural crops depending on the kinds of crops or areas. Both nitrogen and phosphate nutrients are applied together only in the case of intensive agricultural crops.

In conclusion, TSP or DAP is the most suitable type of fertilizer in view of marketability, and assuming that the product can cover whole the potential demand for phosphate fertilizer, the demand for the product is expected to be 78,400 P_2O_5 tons in 1990 and 106,700 P_2O_5 tons in 1995. In the case of such non-water- soluble phosphate fertilizers as ground phosphate rock and fused magnesium phosphate, total demand will not exceed 16,500 P_2O_5 tons per year, and further, since Mesopotamia, one of the major consuming area of non-water-soluble phosphate fertilizer, is far from the probable plant site of the Project, the demand will be only 13,500 P_2O_5 tons per year when excluding that of Mesopotamia. Furthermore, if the unit nutrient price of non-water-soluble phosphate fertilizer is more expensive than that of water-soluble phosphate, as observed in the market at present (by 5-10% higher than that of TSP — Table II-21), the former product will be very hard to find out the adequate market.

4-2 Outlook of Ex-Factory price of the product

4-2-1 Outlook of international market price

As described in Chapter 1 (1-1-4), the international market price of phosphate fertilizer has formulated reflecting the supply/demand situation in the international market as well as production costs level of the product. Such price formulation tendency will not change in the future.

Table II-22 shows the historical trend of market prices of fertilizers and intermediates in both current and constant U.S. dollars. On the basis of price trend, assuming that the price formulation mechanism described above will not change in the future, the future prices of these products are projected and shown in Table II-22. The assumptions and the estimated production cost data are included in Annex II-5 In the case of phosphate rock, the development of new mines will not be required in the near future, as explained in Chapter 1 (1-1-4), and therefore, the mining costs level will not be diverge greatly from the present level. As a result, the price of fertilizers, which are originated from the phosphate rock, will be fairly stable in the future in terms of constant price. However, with respect to ammonia and its derivatives, since the cost of natural gas, the main raw material of ammonia, is expected to increase in constant price, then the price is projected to increase by 3.5% accordingly in annual average. The price of sulphur increased greatly in 1979 through 1981, and as a result, oil producing countries in Mideast have started to supply their sulphur in the international market Thus, the price of sulphur declined. Since these countries have sufficient supply ability of sulphur, the supply will be increased whenever the price level is favorable. These country may play a role of price adjustment in the future, too, and therefore, sulphur price is projected to be stable at constant U.S. dollars.

4-2-2 Outlook of sales price

The sales price of product(s) produced by this Project will also be set in the competition with the imported products. The ex-factory price will vary depending on the destined market of the product due to the difference in the movement costs from the factory to the market. The ex-factory price may be calculated by the following formula;

(Ex-factory price of this Project) = (Market price of imported product) – (Movement costs from the Project location to the market)

The market price of imported products may be calculated by adding such distribution costs to the market as ocean freight, unloading charges, warehousing charges, inland transpotation costs, business fees, etc.

Table II-21 compares unit nutrient price of various fertilizers in the domestic market in Argentine. The price of ammonium sulphate is 1.7 times higher than that of urea in April 1983 in the case of nitrogen fertilizer. Ground phosphate rock price is 1.09 times higher than that of TSP, and DAP price is 0.8 times of that of TSP plus urea. Reflecting such price difference among the different fertilizers, the demand for ammonium sulphate, ground phosphate rock, TSP has declined, whereas that of DAP and urea has increased. Thus, in estimating the future price of products from this Project, it would be necessary to estimate it based on the market price of major import products which may compete with the product, instead of comparing with the market price of same kind of product.

On the basis of above discussion, the prices of products, which are thought to have the potentiality to be produced by the Project, are calculated and shown in Table II-23. According to the calculated prices, such low nutrient fertilizers as phosphate rock, fused magnesium phosphate, single super phosphate, etc. will not be adequate to produce by this Project since the ex-factory price is very low due to high transportation costs.

The prices of products, which were finally selected by the study including technical study, as well as raw materials are shown in Table II-24.

4-3 Sales Plan

The sales plan of the products finally selected through marketing and technical stand point of view is shown in Table II-25. These products are MAP in Case 1 and NP fertilizer with CAN in Case 2. The sales plan was formulated through the following calculation procedure. Namely, sales potential of these products of total demand projected in Chapter 2, is firstly calculated by picking out the demand from the crops and the regions on which these products can be applied in view of application of NP ratio. Out of this sales potential, salable volume is calculated assuming market penetration ratio by these products in the individual regional markets, with taking into account the transportation cost to the market.

The salable volume of MAP in Case 1, thus obtained, is expected to be 49,000 P_2O_5 tons in 1990 and 66,500 P_2O_5 tons in 1995, but the production capacity of the Project is less than the above salable volume, and therefore, sales plan is set at the production capacity level of the Project.

In Case 2, the salable volume of both NP fertilizer and ammonium nitrate (or CAN) is far below the production capacity of these products. The reasons for this are as follows;

1. NP fertilizer may be used on both crops on which NPK fertilizer is applied at present, and crops on which DAP or TSP is applied together with straight nitrogen fertilizers at present. However, for such major phosphate consuming crops as wheat and potato in south Pampeana region, on which DAP is solely applied without additional application of nitrogen fertilizer, further application of nitrogen is not required. Thus, the possibility to replace DAP by NP fertilizer for these crops is quite questionable.

2. With application of DAP becoming more popular, the nitrogen nutrient contained in DAP is also applied on crops together with phosphate nutrient. As a result, a part of demand for nitrogen fertilizer is fulfilled by DAP which is assumed to be imported in Case 2. Furthermore, when subtracting the nitrogen demand met by the above NP fertilizer as well as domestically produced urea and ammonia, from total demand for nitrogen fertilizer, then the demand available for ammonium nitrate (or CAN) from the Project is quite limited.

In conclusion, the market size available for Case 1 is sufficient to the Project, but that of Case 2 is not large enough to justify the Project. The Case 2 is recommended to be restudied when the demand for nitrogen fertilizer is increased to the extent that the market size is sufficient enough to the Project. (Such increase is possible if the nitrogen fertilizer is started to be used on wheat in southeastern Pampeana with the support from the government policy on promotion of nitrogen fertilizer application on wheat, intending to increase in the wheat export. However, such increase possibility is not be included in this sales plan in order to prevent the Project from risk caused by unreliable assumptions in the future.)

Table II-1 FERTILIZER CONSUMPTION IN THE WORLD

(Unit: Nutrient '000 ton)

	1965					1980				
	N	P2O5	(% of total)	K2O	N:P2O5:K2O	N	P2O5	(% of total)	K2O	N:P2O5:K2O
Asia	3,673	1,656	(11)	1,066	1:0.45:0.29	21,256	6,745	(21)	2,446	1:0.32:0.12
E. Europe	4,087	2,948	(20)	3,600	1:0.72:0.88	13,104	8,715	(28)	8,184	1:0.67:0.62
W. Europe	4,648	4,379	(29)	3,931	1:0.94:0.85	9,431	5,396	(17)	5,118	1:0.57:0.54
Africa	559	359	(2)	158	1:0.64:0.28	1,823	1,115	(4)	398	1:0.61:0.22
N. America	5,050	3,856	(26)	3,064	1:0.76:0.61	9,526	5,554	(18)	6,033	1:0.58:0.63
C. America	453	187	(1)	117	1:0.41:0.26	3,475	421	(1)	370	1:0.12:0.11
S. America	276	270	(2)	173	1:0.98:0.63	1,438	2,338	(7)	1,448	1:1.63:1.03
Oceania	82	1,296	(9)	171	1:15.8:2.09	281	1,203	(4)	227	1:4.28:0.81
Total	18,828	14,949	(100)	12,281	1:0.79:0.65	60,336	31,489	(100)	24,264	1:0.52:0.40

Source: FAO

Table II-2 PROJECTION OF PHOSPHATE FERTILIZER CONSUMPTION IN THE WORLD

(P_2O_5 '000 ton)

		1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1992/93
Developed Market Economies								
N. America	Supply	10.52	10.82	10.86	10.85	10.83	10.89	-
	Demand	4.50	4.80	5.30	5.64	5.80	5.96	6.80
	Balance	6.02	6.02	5.56	5.21	5.03	4.93	-
W. Europe	Supply	5.41	5.51	5.57	5.55	5.52	5.48	-
	Demand	5.26	5.55	5.78	5.89	6.01	6.13	6.50
	Balance	0.15	-0.04	-0.21	-0.34	-0.49	-0.65	-
Oceania	Supply	1.34	1.37	1.39	1.39	1.39	1.39	-
	Demand	1.04	1.08	1.13	1.17	1.22	1.28	1.55
	Balance	0.30	0.29	0.26	0.22	0.17	0.11	-
Other DME1/	Supply	1.83	1.83	1.82	1.80	1.79	1.77	-
	Demand	1.23	1.25	1.28	1.30	1.34	1.37	1.52
	Balance	0.60	0.58	0.54	0.50	0.45	0.41	-
Developing Market Economies								
Africa	Supply	1.81	1.99	2.18	2.44	2.75	3.20	-
	Demand	0.50	0.55	0.58	0.62	0.64	0.71	1.00
	Balance	1.31	1.44	1.60	1.82	2.11	2.50	-
L. America	Supply	1.52	1.59	1.65	1.76	1.89	1.96	-
	Demand	2.14	2.29	2.44	2.58	2.84	3.10	4.30
	Balance	-0.62	-0.70	-0.79	-0.82	-0.95	-1.14	-
Near East	Supply	0.89	1.23	1.39	1.45	1.45	1.45	-
	Demand	1.14	1.23	1.33	1.43	1.55	1.68	2.00
	Balance	-0.25	0.00	0.06	0.02	-0.10	-0.23	-
Far East	Supply	1.41	1.41	1.46	1.53	1.69	1.92	-
	Demand	2.50	2.70	2.90	3.10	3.30	3.50	4.30
	Balance	-1.09	1.29	-1.44	-1.57	-1.61	-1.58	-
Centrally Planned Economies								
Asia	Supply	2.85	2.96	3.06	3.17	3.28	3.44	-
	Demand	3.28	3.47	3.58	3.69	3.80	3.92	4.60
	Balance	-0.43	-0.51	-0.52	-0.52	-0.52	-0.48	-
Europe & USSR	Supply	8.10	8.53	8.83	9.11	9.35	9.55	-
	Demand	9.32	9.57	9.82	10.07	10.31	10.55	13.00
	Balance	-1.22	-1.04	-0.99	-0.96	-0.96	-1.00	-
World	Supply	35.67	37.24	38.21	39.05	39.93	41.04	-
	Demand	30.90	32.49	34.13	35.49	36.81	38.19	45.57
	Balance	4.77	4.75	4.08	3.56	3.12	2.85	-

Note: 1/ *Other Developed Market Economies*
Source: FAO/UNIDO/World Bank Working Group on Fertilizers, June 1983.

Table II-3 PRODUCTION OF PHOSPHATE ROCK IN THE WORLD BY MAJOR PRODUCING COUNTRIES

(Unit: '000 tons of Phosphate rock)

	1958 2/	1965 3/	1970 3/	1975 3/	1980 3/
USA	15,117.1 (42.5) 1/	26,745.5 (49.3)	35,143.2 (43.4)	44,284.0 (41.0)	53,363.0 (39.6)
Morocco	6,335.5 (17.8) 1/	9,225.0 (17.0)	11,399.0 (14.1)	14,119.0 (13.1)	18,824.0 (14.0)
Tunisia	2,278.4	3,040.9	3,024.0	3,512.0	4,502.0
Togo	-	812.6	1,508.0	1,100.0	2,933.0
Senegal	-	1,038.3	3,024.0	1,978.0	1,459.0
Jordan	293.9	827.9	891.0	1,353.0	3,911.0
Nauru Is.	1,254.3	1,550.0	2,114.0	1,534.0	2,087.0
Christmas Is.	379.7	1,118.0	1,003.0	1,003.0	1,438.0
USSR	6,004.6 (16.9) 1/	6,700.0 (12.3)	17,920.0 (22.2)	24,150.0 (22.4)	26,100.0 (19.4)
Others	3,896.5	3,241.8	4,873.8	14,892.0	20,235.0
World Total	35,560.0	54,300.0	80,900.0	107,925.0	134,852.0

Note: 1/ Figures in parentheses show the percentage of world total.

Sources: 2/ United Kindgom, Overseas Geological Survey, "Statistical Summary of the Mineral Industry", (London: 1965).
3/ FAO, "Annual Fertilizer Review".

Table II-4 PROJECTED SUPPLY/DEMAND BALANCE OF PHOSPHATE ROCK IN 1987

(P_2O_5 '000 ton)

	Phosphate Fertilizer Consumption (A)	Basic Slag Production (B)	Technical Use of Phosphate rock (C)	Phosphate rock Supply (D)	Balance (E)
W. Europe	5,584	575	1,200	328	-6,502
E. Europe	11,100	60	1,200	11,655	-1,809
N. America	6,420	5	1,300	22,495	+14,009
L. America	3,367	8	280	1,975	-2,028
Africa	1,250	-	230	15,285	+13,657
N. East	1,914	-	45	5,326	+3,171
S. Asia	2,560	-	46	319	-2,548
S. E. Asia	2,466	-	485		-3,246
Soc. Asia	3,950	-	160	4,100	-421
Oceania	1,358	-	110	1,261	-354
World	39,969	648	5,056	62,744	+13,929

Note: (D) - [(A) - (B) + (C)] x 1.1 = (E)
Loss is assumed 10% of total demand.

Source: IFA

Table II-5 TRADE OF PHOSPHATE FERTILIZER BY TYPE OF FERTILIZER

('000 P_2O_5 ton)

	1975					1982				
	P-rock 1/	P-acid	DAP	TSP	Total	P-rock 1/	P-acid	MAP/DAP	TSP	Total
Export										
W. Europe	8	275	99	102	484	-	353	-	183	536
E. Europe	1,906	-	-	-	1,906	1,699	-	221	-	1,920
Africa	6,672	98	-	110	6,880	6,295	1,252	244	355	8,146
N. America	3,715	241 2/	1,333	448	5,737	3,228	907	1,899	490	6,524
C. America	17	215 2/	-	10	242	-	-	-		-
S. America	-	-	-	-	-	-	69	-	-	69
Asia	1,339	-	-	-	1,339	1,758	76	179	105	2,118
Oceania	695	-	-	-	695	-	-	-	-	-
World	14,352	827	1,476 (44) 4/	724 (54) 4/	17,379	14,230 (1,250) 4/	2,657	2,543	1,134	20,564
Import										
W. Europe	6,326	261	339	136	7,062	5,900	695	795	347	7,737
E. Europe	3,182	42	2	97	3,323	3,461	643	56	194	4,354
Africa	16	0	31	12	59	11	0	79	8	98
N. America	1,059	57 2/	219	18	1,353	788	32	292	23	1,135
C. America	418	22 2/	54	9	503	358	38	147	81	624
S. America	339	238	265	210	1,052	110	302	159	66	637
Asia	2,005	200	536	192	2,933	2,548	947	916	374	4,785
Oceania	1,006	3	9	0	1,018	981	0	72	5	1,058
World	14,352	827 (7) 3/	1,476 (22) 3/	724 (50) 3/	17,379	14,230 (74) 3/	2,657	2,543 (27) 3/	1,134 (38) 3/	20,564

Notes: 1/ Calculated as 32.5% P_2O_5.
2/ Including Brazil.
3/ Volume destined to unkonwn countries, and in included in the world total.
4/ Volume exported from unspecified countries, and included in the world total.

Source: IFA

Table II-6 PRICES OF PHOSPHATE FERTILIZER/INTERMEDIATES

(US$/MT; FOB US GULF)

Year	Month	Phosphate rock (75% BPL)	Phosphoric acid (as 100% acid)		DAP		TSP	
		(A)	(B)	(B/A)	(C)	(C/A)	(D)	(D/A)
1978	Jan.	30.00	194.00	(6.5)	133.40	(4.4)	95.80	(3.2)
	Apr	30.00	198.75	(6.6)	131.88	(4.4)	95.25	(3.2)
	Jul.	30.00	203.00	(6.8)	135.67	(4.5)	94.10	(3.1)
	Oct.	30.00	212.50	(7.1)	151.85	(5.1)	104.40	(3.5)
1979	Jan.	30.00	236.00	(7.9)	149.10	(5.0)	104.60	(3.5)
	Apr.	35.70	259.00	(7.3)	163.40	(4.6)	132.50	(3.7)
	Jul.	34.50	300.00	(8.7)	187.80	(5.4)	137.70	(4.0)
	Oct.	34.50	300.00	(8.7)	235.10	(6.8)	163.50	(4.7)
1980	Jan.	44.00	372.50	(8.5)	258.25	(5.9)	193.00	(4.4)
	Apr.	44.00	387.50	(8.8)	238.87	(5.4)	189.90	(4.3)
	Jul.	44.00	387.50	(8.8)	212.50	(4.8)	173.00	(3.9)
	Oct.	44.00	387.50	(8.8)	206.00	(4.7)	162.50	(3.7)
1981	Jan.	50.50	355.00	(7.0)	227.00	(4.5)	202.00	(4.0)
	Apr.	47.50	347.50	(7.3)	192.50	(4.1)	172.50	(3.6)
	Jul.	47.50	347.50	(7.3)	178.50	(3.8)	152.50	(3.2)
	Oct.	47.50	331.50	(7.0)	181.00	(3.8)	134.50	(2.8)
1982	Jan.	47.50	331.50	(7.0)	200.00	(4.2)	140.00	(2.9)
	Apr.	45.00	295.00	(6.6)	177.50	(3.9)	135.50	(3.0)
	Jul.	45.50	294.50	(6.5)	178.50	(3.9)	135.00	(3.0)
	Oct.	45.50	294.50	(6.5)	173.50	(3.8)	134.50	(3.0)

Note: 1/ Figures in the parentheses show the price ratios against the prices of phosphate rock.

Table II-7 GROSS DOMESTIC PRODUCT BY SECTOR, ARGENTINE

(Unit: % of total)

	1900	1935	1970	1980
Primary sector	32.0	28.7	16.6	15.3
Agriculture and fishery	s/d	28.0	14.8	12.9
Mining and quarrying	s/d	0.7	1.8	2.4
Secondary sector	23.0	24.0	40.3	33.0
Industry	s/d	19.2	35.1	25.4
Construction	s/d	4.8	5.2	7.6
Tertiary sector	45.0	47.	43.1	51.7
Commercial	s/d	s/d	s/d	14.0
Transportation and communication	s/d	s/d	s/d	10.9
Banks, insurance and real estates	s/d	s/d	s/d	8.8
Electricity, gas, etc.	s/d	s/d	s/d	3.5
Services and government	s/d	s/d	s/d	14.5
Total	100.0	100.0	100.0	100.0

Note: s/d - Not available

Source: Ministeris de Economia

Table II-8 EXPORT BY PRODUCT IN ARGENTINE

(% of total Export)

	1966	1975
Primary products	75.7	54.7
Agricultural-manufactured products	19.3	24.1
Industrial products	5.0	21.2

Source: "Geografia Politica y Economica de la Republica Argentine", (Editional Kapelusz: Buenos Aires, 1982)

Table II-9 PRODUCTION AND EXPORT OF MAJOR AGRICULTURAL PRODUCTS IN ARGENTINE

('000 ton)

	Average of 1965-69	Average of 1970-74	Average of 1975-78
Wheat			
Production (A)	6,481	6,158	8,243
Export (B)	2,951	1,740	3,649
(B/A: %)	(45.5)	(28.3)	(44.3)
Maize			
Production (A)	7,666	8,618	8,139
Export (B)	4,105	4,598	5,103
(B/A: %)	(53.6)	(53.4)	(62.7)
Soybeans			
Production (A)	7,716	278	2,704
Export (B)	0	0	1,401
(B/A: %)	(0)	(0)	(68.5)

Table II-10 PRODUCTION OF AGRICULTURAL PRODUCTS

('000 ton)

	1975/1976	1976/1977	1977/1978	1978/1979	1979/1980	1980/1981
Wheat	8,570	11,000	5,300	8,100	8,300	7,345
Linseed	377	617	810	600	743	512
Maize	5,855	8,300	9,700	8,700	6,400	13,500
Sorghum	5,060	6,600	7,200	6,200	2,960	6,000
Soybean	695	1,400	2,400	3,700	3,500	3,700
Sunflower	1,085	900	1,600	1,430	1,650	1,200
Tobacco	94	90	63	70	64	s/d
Sugarcane	1,362	1,460	1,579	1,307	1,310	1,625
Rice	309	320	310	312	266	240
Tea	133	140	103	125	153	142
Mate	142	121	127	s/d	s/d	s/d
Cotton	139	160	220	173	160	s/d
Wine	26.5	22.7	19.4	25.9	23.3	s/d

Table II-11 CHANGE IN THE YIELD OF MAJOR AGRICULTURAL PRODUCTS IN ARGENTINE

(Kg/Ha.)

Crop	1966/1967 1/	1973/1974 1/	1979/1980 1/	Maximum 1/ yield level attained (Year attained)	Yield in the 2/ USA in average of 1979-1981
Wheat	1,198	1,657	1,434	1,711 (1976/77)	1,549
Maize	2,466	2,840	2,107	3,647 (1977/78)	3,178
Rice	3,510	3,821	3,236	3,996 (1967/68)	3,260
Soybean	1,186	1,440	2,000	2,346 (1978/79)	2,014
Sunflower	902	815	918	918 (1979/80)	923
Sorghum	1,805	2,534	2,234	3,194 (1977/78)	2,981

Source: 1/ "Geografia Politica y Economica de la Republica Argentina"

2/ FAO, "Production Yearbook"

Table II-12 FERTILIZER SUPPLY/DEMAND SITUATION IN ARGENTINA

	Average of 1964-1966	Average of 1969-1971	Average of 1974-1976	1978	1979	1980	1981	1982
Nitrogen Fertilizer (N tons)								
Production (A)				30,652	27,305	30,437	25,124	30,596
Consumption (B)	27,321	40,445	39,043	44,412	60,576	65,355	51,173	50,926
(A-B)				-13,760	-33,271	-34,918	-26,049	-20,330
Phosphate Fertilizer (P_2O_5 tons)								
Production (A)				1,121	1,541	498	89	-
Consumption (B)	14,010	24,816	23,068	32,551	64,660	50,013	28,885	45,719
(A-B)				-31,430	-63,119	-49,515	-28,796	-45,719
Potash Fertilizer (K_2O tons)								
Consumption	6,231	7,687	5,233	5,694	12,261	8,752	5,301	5,660

Source: Table A-1

Table II-13 CONSUMPTION OF FERTILIZERS PER HA. OF ARABLE LAND AND PERMANENT CROPS

(kg N, P_2O_5, K_2O)

	N		P_2O_5		K_2O	
	1977	1980	1977	1980	1977	1980
Argentine	1.2	1.8	0.8	1.3	0.1	0.2
Brazil	11.5	14.6	25.5	32.1	15.9	21.1
Paraguay	0.2	0.7	0.5	1.8	0.1	0.8
Uruguay	9.3	11.0	22.1	29.4	1.6	1.9
Venezuela	22.9	30.1	14.8	20.7	10.8	13.4
South America	9.8	11.4	14.8	18.6	8.9	11.8
Developed Market Economies	51.1	58.0	33.9	34.3	29.7	31.1
Developing Market Economies	14.5	17.9	7.8	9.8	3.9	5.2
Centrally Planned Economies	52.1	65.5	26.2	29.3	22.5	22.0
World	34.6	41.5	19.8	21.7	15.9	16.7

Source: FAO

Table II-14 ESTIMATED CONSUMPTION OF FERTILIZER IN ARGENTINE, BY PROVINCE AND BY CROP

(Unit: N'000 ton, P_2O_5 '000 ton)

		1972		1982	
		Nitrogen Fertilizer	Phosphate Fertilizer	Nitrogen Fertilizer	Phosphate Fertilizer
Pampeana	Wheat	8.7 (20.3)	5.8 (14.3)	28.2 (43.7)	15.9 (31.3)
	Maize	1.5 (3.5)	0.8 (2.0)	1.3 (2.0)	0.7 (1.4)
	Potato	2.2 (5.1)	4.7 (11.6)	2.1 (3.3)	4.4 (8.7)
	Pasture	1.1 (2.5)	13.3 (32.8)	1.1 (1.7)	13.3 (26.2)
	Others	1.4 (3.3)	1.0 (2.5)	1.0 (1.5)	0.6 (1.2)
	Sub-total	14.9 (34.7)	25.6 (63.2)	33.7 (52.2)	34.9 (68.8)
Andina	Grape	5.2 (12.1)	2.9 (7.2)	5.2 (8.1)	2.9 (5.7)
	Others	3.0 (7.0)	2.4 (5.9)	3.5 (5.4)	2.4 (4.7)
	Sub-total	8.2 (19.1)	5.3 (13.1)	8.7 (13.5)	5.3 (10.4)
Noroeste	Sugarcane	10.9 (25.4)	- (-)	12.8 (19.8)	- (-)
	Others	2.2 (5.1)	2.9 (7.2)	2.0 (3.1)	2.4 (4.7)
	Sub-total	13.1 (30.5)	2.9 (7.2)	14.8 (22.9)	2.4 (4.7)
Mesopotamia	Sub-total	3.5 (8.2)	4.6 (11.4)	3.1 (4.8)	5.6 (11.0)
Pategonia	Sub-total	3.2 (7.5)	2.1 (5.1)	4.3 (6.6)	2.6 (5.1)
Chaguena	Sub-total	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Total		42.9 (100.0)	40.5 (100.0)	64.6 (100.0)	50.8 (100.0)

Note: Figures in parentheses mean the percentage of total.

Table II-15 RATIO1/ OF INCREASE IN THE VALUE OF CROPS BY FERTILIZATION AND FERTILIZER COSTS3/

Year	DAP price4/ (a$1000/ton)	Wheat	Maize	Sorghum	Soybean
1976	79.66	1.02	0.82	0.65	2.18
1977	119.7	1.41	1.53	1.11	3.26
1978	265.2	1.69	1.70	1.14	2.90
1979	552.8	1.57	1.55	1.11	2.61
1980	1,061.0	1.55	1.55	1.25	1.98
1981	2,368.0	1.78	1.48	1.10	2.08
1982	10,281.0	1.39	1.13	0.90	1.88

Notes:
1/ (Increase in the value of crops) / (Fertilizer costs)
2/ Increase in the value of crops was calculated as follows assuming that the transportation costs etc. being 20% of market price.
(Increase in the farmers revenue) = (Market price of crops in Bs. As.) x 0.8
3/ Fertilizer (DAP 1000kg/ha) cost was calculated as follows with the assumption that transportation costs and application costs of fertilizer account for 4% and 35% of fertilizer price respectively.
4/ Retail price in Bs. As.

Table II-16 VALUE/COST RATIO OF FERTILIZATION OF PHOSPHATE

(As of April 1983) (a$'000/ton)

	Wheat		Maize		Soybean		Sorghum	
	N. Pampeana	S. Pampeana	N. Pampeana	S. Pampeana	N. Pampeana	S. Pampeana	N. Pampeana	S. Pampeana
Market price of agricultural product (A)	6,140.0	6,140.0	6,622.0	6/622.0	11,800.0	11,800.0	5,850.0	5,850.0
Marketing costs (B)								
Comission and tax 1/	460.5	460.5	496.7	496.7	885.0	885.0	438.8	438.8
Handling charges 2/	405.5	405.5	405.5	405.5	405.5	405.5	405.5	405.5
Freight 3/	279.6	525.8	279.6	525.8	279.6	525.8	279.6	525.8
Price received by farmers (A-B)	4,994.4	4,748.2	5,440.2	5,194.0	10,229.9	9,983.7	4,726.1	4,479.9
Without fertilization								
Production costs (C) 4/	5,759.4	8,900.9	3,559.2	4,560.2	9,173.9	9,173.9	3,489.0	3,911.9
(Average yield: ton/ha) (Y)	(1.7)	(1.1)	(4.1)	(3.2)	(2.0)	(2.0)	(3.7)	(3.7)
Net revenue/ha (C-(A-B)x(Y) (D)	-1,300.5	-4,568.0	-7,712.1	2,028.2	2,112.0	1,619.6	4,577.3	2,101.6
With fertilization								
Expected increase in yield by application of 60 kgs of P_2O_5/ha : ton/ha	0.4	0.8	0.3	0.6	0.3	0.6	0.3	0.6
Production costs (C') 4/	4,662.4	5,153.1	3,316.5	3,840.2	7,977.3	7,056.9	3,227.3	3,310.1
(Average yield: ton/ha) (Y')	(2.1)	(1.9)	(4.4)	(3.8)	(2.3)	(2.6)	(4.0)	(3.9)
Net revenue/ha (C-(A-B)x(Y') (D')	697.2	-769.3	9,344.3	5,144.4	5,181.0	7,609.7	5,995.2	4,562.2
Value/cost ratio								
Net gain by fertilization (D'-D) (E)	1,997.7	3,798.7	1,632.2	3,116.2	3,069.0	5,990.1	1,417.9	2,460.0
Cost of fertilizer (F) 5/ (100 kgs of DAP/ha)	3,576.8	3,601.4	3,576.8	3,601.4	3,576.8	3,601.4	3,576.8	3,601.4
Value cost ratio (E/F)	0.56	1.05	0.46	0.87	0.86	1.66	0.40	0.68

Notes: 1/ 7.5% of market price.

2/ Loading/unloading costs, transportation costs to the railway station, demurrage, and loss during transportation.

3/ Assuming 100km and 450km for North Pampeana and South Pampeana respectively.

4/ (Per hectare production costs) ÷ (Average yield per hectare)

5/ "Retail price in Buenos Aires" plus railway freight rate is regarded as the retail price at the point.
Retail price in Bs. As: a$25,488,000/ton
Applicaiton cost: a$1,000,000/ha

Sources: (A),(Y), 2/, 3/, 4/, 5/: SNESR, Costos e Insumos, Agropecuarios
1/: Fertilizer Industry

Table II-17 ESTIMATED CONSUMPTION OF PHOSPHATE FERTILIZER IN ARGENTINE

	Phosphate (P_2O_5 '000 ton)			
	1972	1982	1990	1995
By region				
Pampeana	25.6	34.9	59.3	85.6
Andina	5.3	5.3	6.3	7.2
Noroeste	2.9	2.7	2.6	2.7
Mesopotamia	4.6	5.6	6.1	6.5
Patagonia	2.1	2.6	4.1	4.7
Chaquena	-	-	-	-
By Crop				
Wheat	5.8	15.9	39.9	65.9
Other cereals	0.8	0.7	0.7	0.7
Pastures	13.3	13.3	13.3	13.3
Fruits	4.6	5.0	6.7	7.5
Vegetables 1/	8.5	8.1	10.2	11.7
Grapes	3.4	3.4	3.4	3.4
Others	4.1	4.7	4.2	4.2
Total	40.5	51.1	78.4	106.7

Note: 1/ Incl. Potato.

2/ 1972, 1982: Estimated
1990, 1995: Projected

Table II-18 PROJECTION OF POTENTIAL DEMAND FOR PHOSPHATE FERTILIZER BY TYPE IN ARGENTINE

(P_2O_5 ton)

		Total		Water Soluble Phosphate		Non-Water Soluble Phosphate	
		1990	1995	1990	1995	1990	1995
Total		78.4	106.7	78.4	106.7	16.5	16.5
Pampeana	Wheat	39.9	65.9	39.9	65.9	-	-
	Maize	0.7	0.7	0.7	0.7	-	-
	Potatoes	4.8	5.1	4.8	5.1	-	-
	Pasture	13.3	13.3	13.3	13.3	13.3	13.3
	Others	0.6	0.6	0.6	0.6	-	-
Andina	Grape	2.9	2.9	2.9	2.9	-	-
	Others	3.4	4.3	3.4	4.3	-	-
Noroeste		2.6	2.7	2.6	2.7	0.1	0.1
Mesopotamia		6.1	6.5	6.1	6.5	2.9	2.9
Patagonia		4.1	4.7	4.1	4.7	0.2	0.2
Chaquena		0	0	0	0	0	0

Table II-19 IMPORT PRICE AND DOMESTIC MARKET PRICE OF FERTILIZERS IN ARGENTINE

(US$/MT)

Fertilizer	As of:	Imported Price (CIF Bs. As.)	Retailers' Price (At retailers' godown)			
			Bs. As[1]	Santa Fe[2]	Salta	Mendoza[2]
DAP	May 1983	208	336	331	503	387
	Apr. 1983		356		475	
TSP	May 1983		325	261		
	Feb. 1983	173	378			
Phosphate Rock	May 1983					
	Mar. 1983	164	251			
Urea	May 1983		309	379		366
	Mar. 1983	172	316			

Source: 1/ SNESR, Costos e Insumos, Agropecuarios

2/ Departamento de Fertilizantes, MAG.

3/ Industry

Table II-20 COMPARISON OF INTERNATIONAL MARKET PRICE WITH IMPORT PRICE OF PHOSPHATE FERTILIZER IN ARGENTINE

(FOB US Gulf: US$/MT in bulk)

Year/Month:	1981			1982			1983	
	JAN./APR.	MAY/AUG.	SEP./DEC.	JAN./APR.	MAY/AUG.	SEP./DEC.	FEB.	MAY
DAP								
Price trend 1/		172-195	180-199	175-204	176-182	161-181		160-174
Imported price 2/		203	196	199	195	185		186
TSP								
Price trend 1/	167-198		132-142		133-138	130-138	132-138	
Imported price 2/	205		150		138	142	147	

Source: 1/ Green Markets

2/ Secreteria de Agricultura y Ganaderia.

Table II-21 UNIT PRICE DIFFERENCE AMONG THE DIFFERENT FERTILIZERS IN ARGENTINE

	Unit Price (a$)								
	Per ton of: Total Nitrogen			Total P2O5			Available P2O5		
	1981	1982	1983 Apr.	1981	1982	1983 Apr.	1981	1982	1983 Apr.
Urea (A)	46,034	155,304	478,696						
Ammonium Sulphate (B)	63,536	241,619	813,429						
(B/A)	(1.38)	(1.56)	(1.70)						
TSP (C)				36,872	178,240	525,913	59,205	257,021	637,200
Ground Rock Phosphate (D)				38,268	186,866	572,240			
(D/C)				(1.04)	(1.05)	(1.09)			
(A)x18+(C)x46 or 40(E)				2,524,724*/	10,994,512*/	32,808,526*/	3,196,812*/	13,076,312*/	34,104,528*/
DAP Price (US$/ton) (F)				2,368,210	10,280,855	25,488,000	2,368,210	10,280,855	25,488,000
(F/E)				(0.938)	(0.935)	(0.777)	(0.741)	(0.786)	(0.747)

Note: 1. Retailers price in Buenos Aires, including tax. Freight is not included.

2. */ Urea and TSP price of the volume at which nutrient content is equivalent to that of DAP.

Table 2-22 PAST TREND AND PROJECTION OF FERTILIZER PRICE IN THE INTERNATIONAL MARKET

	Current Dollars						1982 Constant Dollars						Price Deflator 3/
	Phosphate Rock 1/	DAP 1/	TSP 1/	Ammonia 1/	Urea 1/	Sulphur 2/	Phosphate Rock	DAP	TSP	Ammonia	Urea	Sulphur	
Actual													
1977	30.0	134.0	98.0	115.0	118.0	40.0	41.8	186.6	136.5	160.2	164.3	55.7	71.8
1978	30.0	139.0	98.0	89.0	128.0	42.0	35.3	163.5	115.3	104.7	150.6	49.4	85.0
1979	34.0	187.0	139.0	122.0	145.0	81.0	34.9	192.2	142.9	125.4	149.0	83.2	97.3
1980	44.0	225.0	179.0	149.0	185.0	124.5	41.0	209.5	166.7	138.7	172.3	115.9	107.4
1981	48.5	193.0	159.0	178.0	185.1	126.0	47.5	189.0	155.7	174.3	181.2	123.4	102.1
1982	47.0	182.5	139.5	143.7	132.1	108.5	47.0	182.5	139.5	143.7	132.1	108.5	100.0
1983	N.A.	180.5	132.0	120.0	127.2	90.0	N.A.	184.4	134.8	122.6	129.9	91.9	97.9
(Average)							(41.3)	(186.8)	(141.6)	(138.5)	(154.2)	(89.7)	
Projected													
1985	42.6	199.6	147.6	162.6	171.4	93.6	40.8	191.2	141.4	155.7	164.2	89.7	104.4
1990	54.2	268.2	187.8	270.8	254.7	118.9	40.9	202.3	141.6	204.2	192.1	89.7	132.6
1995	73.0	368.8	251.9	403.8	364.8	159.2	41.1	207.8	141.9	227.5	205.5	89.7	177.5
2000	98.1	503.3	337.7	580.0	510.9	213.0	41.3	211.9	142.2	244.2	215.1	89.7	237.5

Notes: 1/ FOB UG Gulf, bulk

2/ FOB Vancouver, bulk

3/ Manufacturing Unit Value Index (MUV). Industrial countries' indices of US dollar unit values of manufactured exports to developing countries.

$$\frac{\text{"Current Dollars"}}{\text{"Price Deflator"/100}} = \text{"1982 Constant Dollars"}$$

Source: 3/ Actual - World Bank

Table II-23(1) PROJECTED EX-FACTORY PRICE OF FERTILIZERS (Cont'd)

(AT 1990 CURRENT US DOLLARS)

Product	Market	Price Equivalent to Cost of Imported Products 1/ (A)	Inland Transportation Costs to the Market from Bahia Blanca 2/ (B)	Ex-factory Price (A-B)	Expected Sales Volume 3/ in 1990 ('000 Nutrient ton)
Triple super phosphate (TSP)	Pampeana	211.8	33	178.8	39.5
	Mesopotamia	275.6	126	149.6	1.2
	Noroeste	246.8	133	113.8	1.0
	Andina	252.0	73	179.0	5.0
	Patagonia	275.6	40	235.6	3.3
	(W. Average)			(180.6)	
Mono-ammonium phosphate (MAP)	Pampeana	258.1	33	225.1	39.5
	Mesopotamia	332.5	126	206.5	1.2
	Noroeste	298.9	133	165.9	1.0
	Andina	305.0	73	232.0	5.0
	Patagonia	332.5	40	292.5	3.3
	(W. Average)			(228.6)	
Urea (UR)	Pampeana	309.6	33	276.6	
	Mesopotamia	382.6	126	256.6	
	Noroeste	349.6	133	216.6	
	Andina	355.6	73	282.6	
	Patagonia	382.6	40	342.6	

Table II-23(2) PROJECTED EX-FACTORY PRICE OF FERTILIZERS (Cont'd)

(AT 1990 CURRENT US DOLLARS)

Product	Market	Price Equivalent to Cost of Imported Products 1/ (A)	Inland Transportation Costs to the Market from Bahia Blanca 2/ (B)	Ex-factory Price (A-B)	Expected Sales Volume 3/ in 1990 ('000 Nutrient ton)
Ground phosphate rock (GP)	Pampeana	173.6	33	140.6	10.6
	Mesopotamia	226.0	126	100.0	0.6
	(W. Average)			(138.4)	
Fused Magnesium phsophate (FMP)	Pampeana	105.2	33	72.2	10.6
	Mesopotamia	137.0	126	11.0	0.6
	(W. Average)			(68.9)	
Single super phosphate SSP)	Pampeana	96.8	33	63.8	39.5
	Mesopotamia	126.0	126	0	1.2
	Noroeste	112.8	133	(-20.2)	(1.0)
	Andina	115.2	73	42.2	5.0
	Patagonia	126.0	40	86.0	3.3
	(W. Average)			(63.1)	

Table II-23(3) PROJECTED EX-FACTORY PRICE OF FERTILIZERS (Completed)

(AT 1990 CURRENT US DOLLARS)

Product	Market	Price Equivalent to Cost to Imported Products 1/ (A)	Inland Transportation Costs to the Market from Bahia Blanca 2/ (B)	Ex-factory Price (A-B)	Expected Sales Volume 3/ in 1990 ('000 Nutrient ton)
N-P fertilizer (NP)	Pampeana	194.3	33	161.3	2.3
	Mespotamia	246.1	126	120.1	0.5
	Noroeste	222.7	133	89.7	0.8
	Andina	226.9	73	153.9	1.7
	Patagonia	246.1	40	206.1	2.2
	(W. Average)			(162.4)	
Calcium ammonium nitrate (CAN) (34% N content)	Pampeana	228.8	33	195.8	30.7
	Mesopotamia	282.8	126	156.8	0.2
	Noroeste	258.4	133	125.4	5.6
	Andina	262.8	73	189.8	6.5
	Patagonia	282.8	40	242.8	3.0
	(W. Average)			(189.3)	

Explanatory notes:

1/ Calculated on the basis of costs of urea in the case of nitrogen, and TSP in the case of phosphate. The costs of urea and TSP at the market in question was projected as follows (taxes are not included):

	FOB US GULF Price (A)	Freight to Bs. As. (B)	CIF Bs. As. Price (A+B)x1.01	Market Price				
				Pampeana	Mesopotamia	Noroeste	Andina	Patagonia
Urea	254.7	32.0	289.6	309.6	382.6	349.6	355.6	382.6
TSP	187.8	32.0	222.0	242.0	315.0	282.0	288.0	315.0
(Inland transportation costs from Bs. As. to the market, including unloading costs)				(20)	(93)	(60)	(66)	(93)

The prices equivalent to cost of imported products were calculated by the following formula:

$$(GP) = (TSP) \times \frac{33}{46}$$

$$(FMP) = (TSP) \times \frac{20}{46}$$

$$(SSP) = (TSP) \times \frac{16}{40}$$

$$(\text{Local TSP}) = (\text{TSP}) \times \frac{35}{40}$$

$$(\text{MAP}) = [(\text{TSP}) \times \frac{45}{40} + (\text{UR}) \times \frac{10}{46}] \times 0.76$$

$$(\text{NP}) = [(\text{TSP}) \times \frac{20}{40} + (\text{UR}) \times \frac{20}{46}] \times 0.76$$

$$(\text{CAN}) = (\text{UR}) \times \frac{34}{46}$$

Price difference among different fertilizers in the past is shown in Table 2-21, and based on the price difference trend in the table, the price of binutrient fertilizers are assumed to be 0.76 times that of total price of equivalent TSP and urea.

2/ Actual inland transportation costs vary depending on the availability of cargo from the market to Buenos Aires/Bahia Blanca, because the fertilizer is transported as a back haul cargo. The actual rates obtained from the industry were as follows (as of May 1983):

Buenos Aires —— Noroeste	US$45/ton
Buenos Aires —— Andina	US$50/ton
Bahia Blanca —— Noroeste	US$100/ton
Bahia Blanca —— Andina	US$55/ton

Among the above rates, only the rate from Bahia Blanca to Noroeste is "normal", in that the rate is based on no return cargo, Therefore, to estimate the rate to other markets, following formula was used:

$$(\text{Rate to the market}) = \frac{(\text{Rate from B. Blanca to Noroeste}) - \text{US\$3.0}}{\text{Distance from B. Blanca to Noroeste}} \times (\text{Distance from B. Blanca to the market}) + \text{US\$3.0}$$

Here, US$3.0 means the cost for loading/unloading.
The distances used in the calculation and the rates calculated are:

(km/US$ per ton)

to:	Pampeana	Mesopotamia	Noroeste	Andina	Patagonia
from Buenos Aires	400/15	1,100/70	1,600/45	1,100/50	1,200/70
from Bahia Blanca	450/25	1,800/95	1,900/100	1,100/55	550/30

3/ The market penetration rate against potential demand (see Table 2-17) was assumed as follows:

Pampeana	Wheat	60%
	Other crops	80%
Andina		80%
Noroeste		40%
Mesopotamia		20%
Patagonia		80%

The residuals are assumed to be met either by the imported products or by other types of fertilizer.

4/ Average price weighted by expected sales volume.

Table II-24 SUMMARY OF PROJECTED PRICES OF FERTILIZER AND RAW MATERIALS

(BULK; IN CURRENT US DOLLARS)

	1990			1995			2000		
	w/o taxes 2/	w/taxes 2/		w/o	w/taxes		w/o	w/taxes	
		bef. tax 3/	aft. tax 3/	taxes	bef. tax	aft. tax	taxes	bef. tax	aft. tax
Products									
MAP (Ex-factory)	229	283	229	310	383	310	419	517	419
N-P (Ex-factory)	162	252	207	228	351	290	313	481	398
CAN (Ex-factory) 1/	189	291	243	273	417	349	382	582	488
Raw materials									
Ammonia (CIF Bahia Blanca)	351	351	439	510	510	638	722	722	903
Sulfur (CIF Bahia Blanca)	234	234	257	314	314	345	421	421	463

Notes: 1/ 34% N content.

2/ The case "without tax" assumes that there is no tax institutionally.

3/ The case "before tax" means the case in which the Project does not pay any taxes, while there are taxes institutionally.

4/ The taxes referred here are as follows:
Import duty: urea 25% DAP 0% TSP 0% Ammonia 25% Compound 25% sulfur 10% (or CIF value)
IVA: 20% (on selling price)

Table II-25 SALE PLAN FOR DOMESTIC MARKET

	1990							1995						
	Sales Volume			Total Demand		Sales Potential		Sales Volume			Total Demand		Sales Potential	
	Product ton	N	P_2O_5	'000 N	'000 P_2O_5	'000 N	'000 P_2O_5	Product ton	N	P_2O_5	'000 N	'000 P_2O_5	'000 N	'000 P_2O_5
Case 1														
MAP (10-45-0)														
Pampeana	64,400	6,400	29,000	53.0	59.3	13.1	58.9	66,700	6,700	30,000	68.8	85.6	18.9	85.1
Mesopotamia	1,800	200	800	3.5	6.1	1.2	5.6	1,400	100	650	3.9	6.5	1.3	5.9
Noroeste	1,400	100	650	15.9	2.6	0.5	2.3	1,200	100	550	16.2	2.7	0.5	2.4
Audina	7,900	800	3,550	10.2	6.3	1.3	6.0	6,400	600	2,900	11.2	7.2	1.5	6.8
Patagonia	4,900	500	2,200	6,5	4.1	0.8	3.7	4,700	500	2,100	7.6	5.5	1.1	4.9
Total	80,400	8,000	36,200	89.1	78.4	16.9	76.5	80,400	8,000	36,200	107.7	106.7	23.3	105.1
(Production capacity)	(80,450)	(8,045)	(36,200)					(80,450)	(8,045)	(36,200)				
Case 2														
N-P (20-20-0)														
Pampeana	37,000	7,400	7,400	53.0	59.3	11.1	11.1	51,500	10,300	10,300	68.8	85.6	16.0	16.0
Mesopotamia	3,500	700	700	3.5	6.1	3.5	3.5	4,000	800	800	3.9	6.5	3.9	3.9
Noroeste	4,500	900	900	15.9	2.6	2.3	2.3	5,000	1,000	1,000	16.2	2.7	2.4	2.4
Audina	25,000	5,000	5,000	10.2	6.3	6.2	6.2	28,500	5,700	5,700	11.2	7.2	7.1	7.1
Patagonia	16,500	3,300	3,300	6.5	4.1	4.1	4.1	22,000	4,400	4,400	7.6	5.5	5.5	5.5
Total	86,500	17,300	17,300	89.1	78.4	27.2	27.2	111,000	22,200	22,200	107.7	106.7	34.9	34.9
(Production capacity)	(181,860)	(36,370)	(36,370)					(181,860)	(36,370)	(36,370)				
CAN (34%N)														
Pampeana	17,600	6,000	-			23.7	-	20,000	6,800	-			28.1	-
Mesopotamia	0	0	-			0	-	0	0	-			0	-
Noroeste	0	0	-			13.6	-	0	0	-			13.8	-
Audina	8,200	2,800	-			4.0	-	8,500	2,900	-			4.1	-
Patagonia	5,000	1,700	-			2.4	-	4,400	1,500	-			2.1	-
Total	30,800	10,500	-			43.7	-	32,900	11,200	-			48.1	-
(Production capacity)	(139,709)	(36,324)	(-)					(139,709)	(36,324)	(-)				

Explanatory notes:

1. "Total demand" means the projected total demand for nitrogen fertilizer or phosphate fertilizer.

2. "Sales potential" means the maximum potentital volume by which the fertilizer product in question may be sold competing with the imported/local fertilizers. The "sales potential" was estimated on the basis of following assumptions.

<u>Case 1</u>

MAP: 1) 100% of demand for DAP
2) 100% of demand for straight phosphate fertilizers
3) 80% of demand for compound fertilizer

<u>Case 2</u>

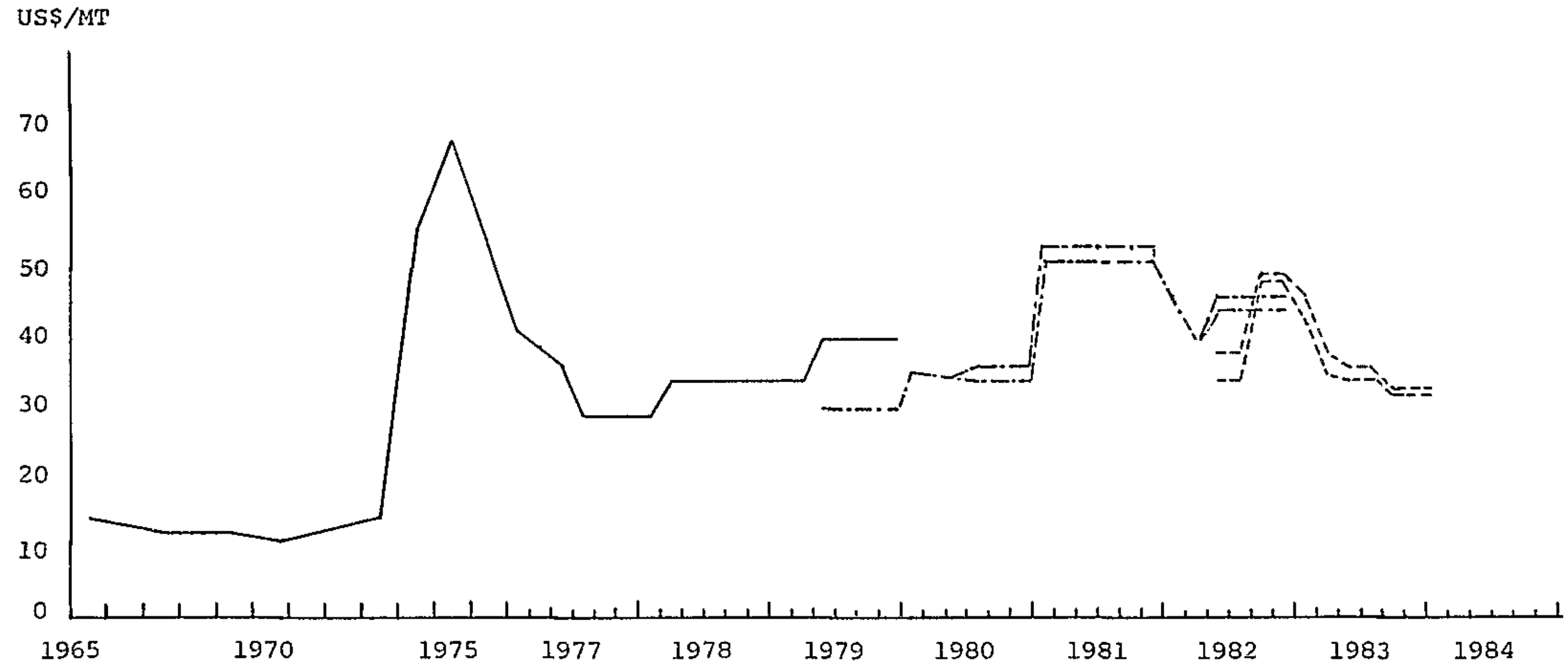
N-P: 1) 100% of demand for DAP in all the regions except for Pampeana, where DAP is mainly used on wheat and potatoes, and therefore, excess nitrogen is not required.
2) 20% of demand for DAP in Pampeana.
3) 100% of demand for compound fertilizer.

can: 100% of demand for straight nitrogen fertilizers

3. "Sales volume" was calculated using the following market penetration rates, which were assumed taking into account the distance to the market and local supply of urea and ammonia. However, when the thus calculated "sales volume exceeds the production capacity, the sales volume was reduced to the production capacity level.

		Market penetration rates		
		MAP	N-P	CAN
Pampeana	Wheat	60%	60%	20%
	Others	80%	80%	70%
Mesopotamia		20%	20%	0%
Andina		80%	80%	70%
Noroeste		40%	40%	0%
Patagonia		80%	80%	70%

Figure II-1 CHANGE IN THE PRICE OF PHOSPHATE ROCK



Note: FAS Casablanca

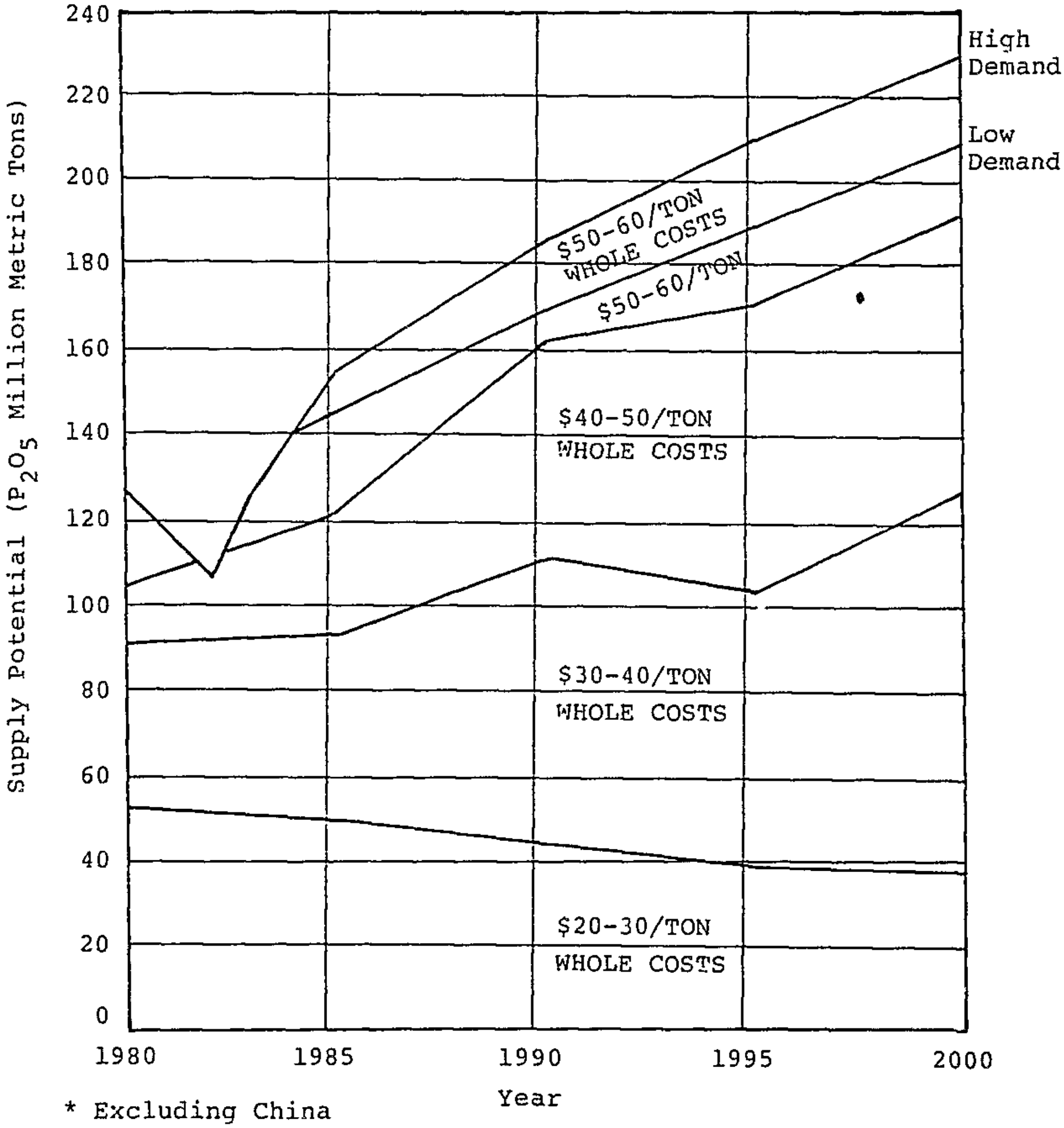
——— 75% BPL

- - - - 70% BPL

—·-— 68% BPL

Source: Various sources

Figure II-2 SUPPLY POTENTIAL OF PHOSPHATE ROCK BY LEVEL OF MINING COSTS



* Excluding China

Source: IFA

Figure II-3 CHANGE IN THE CULTIVATION AREA IN ARGENTINE

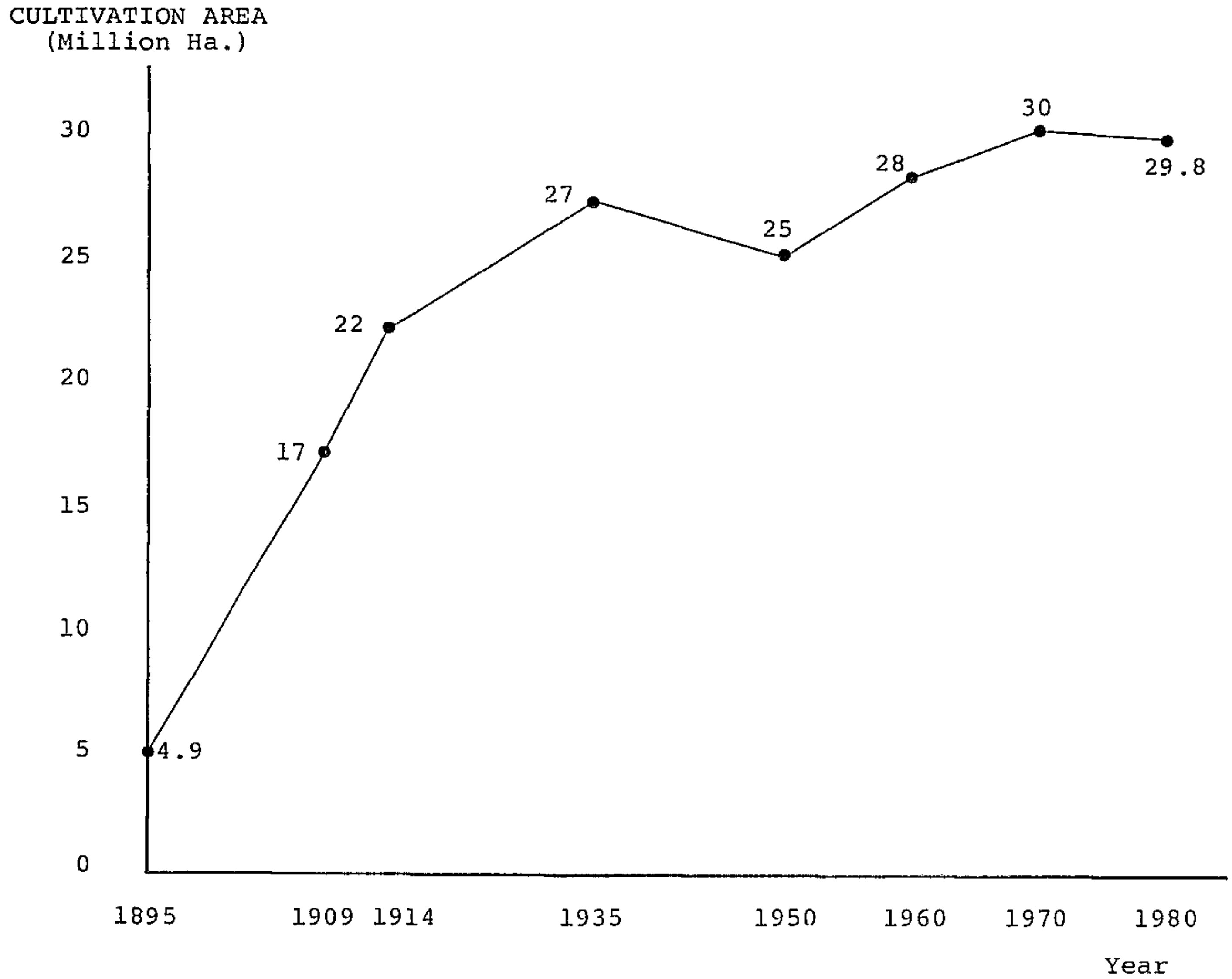


Figure II-4 REGIONAL DISTRIBUTION OF AGRICULTURAL CULTIVATION IN ARGENTINE (1)

- Wheat, Cotton, Sugarcane, and Sunflower -

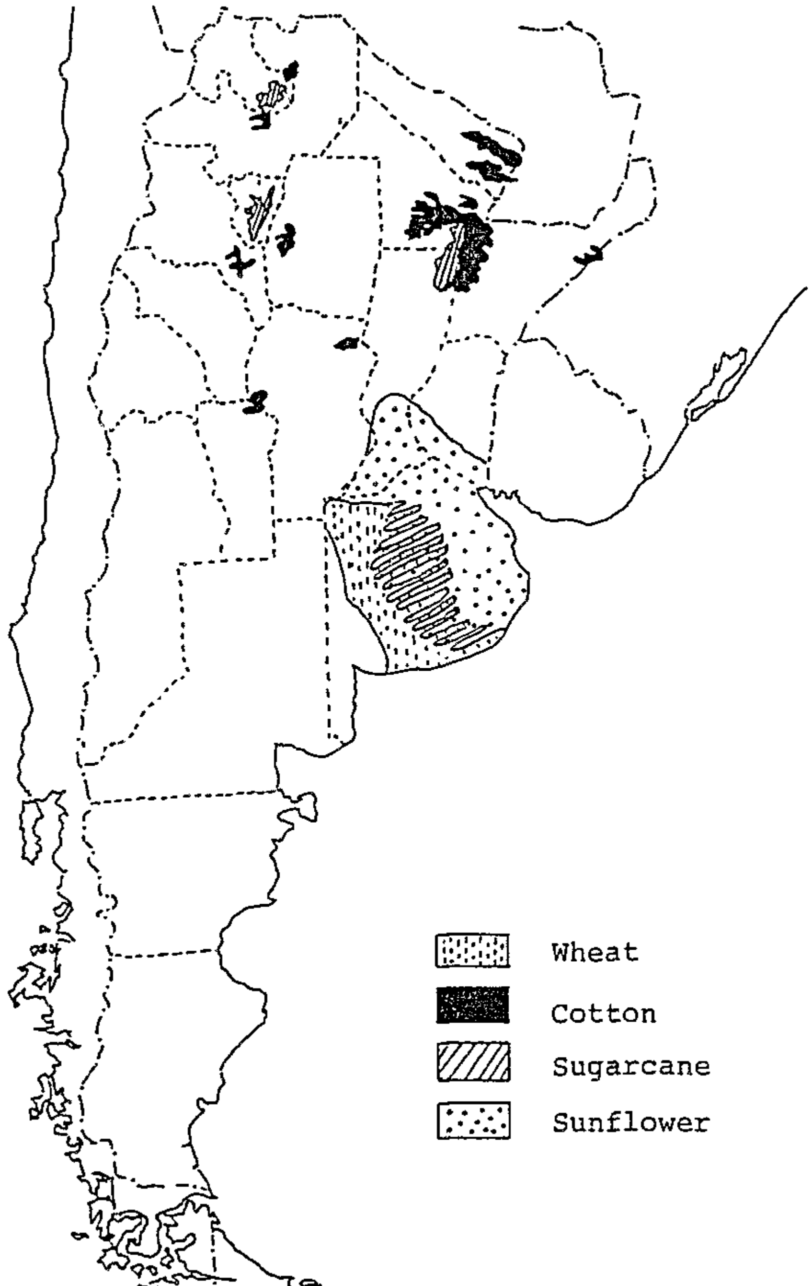


Figure II-5 REGIONAL DISTRIBUTION OF AGRICULTURAL CULTIVATION IN ARGENTINE (2)

- Tobacco, Wine, Maize, and Groundnuts -

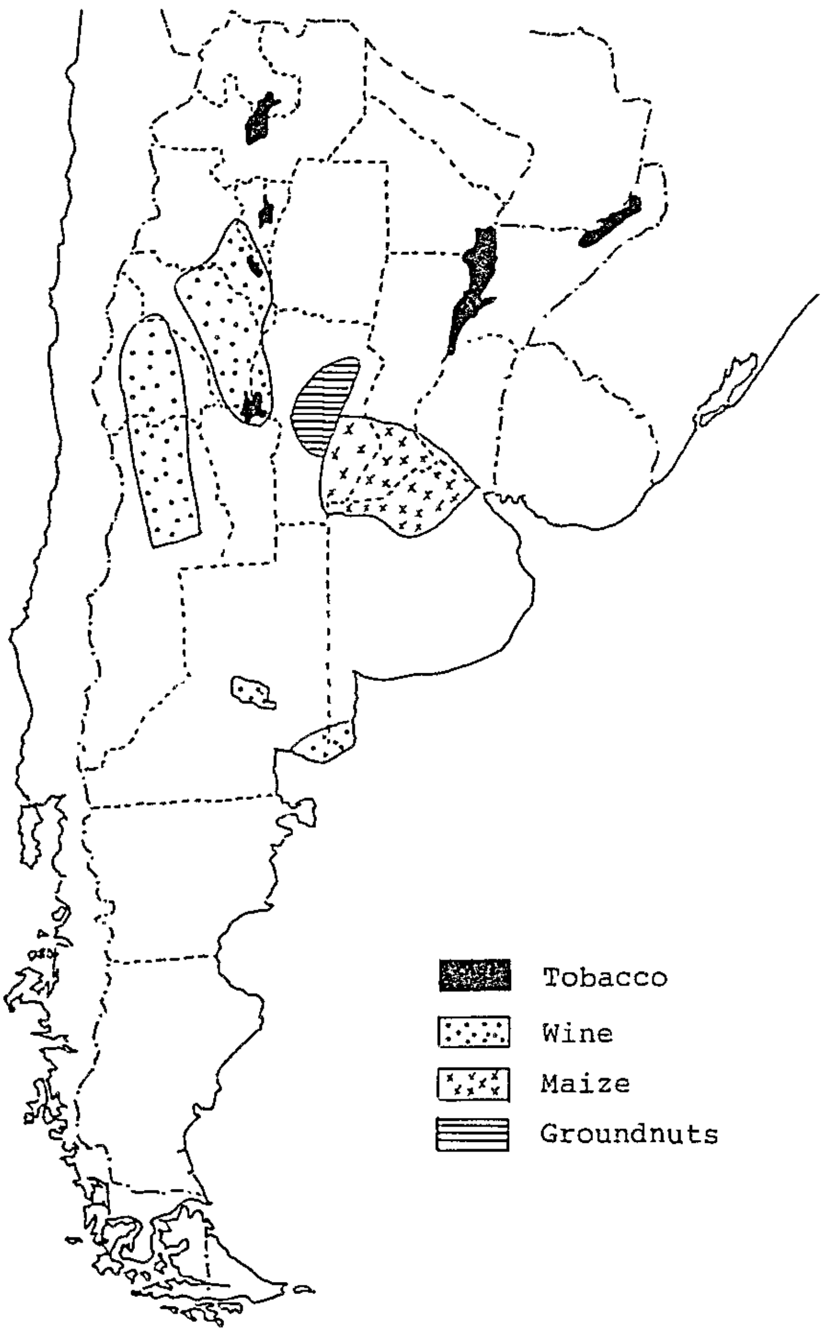


Figure II-6 REGIONAL DISTRIBUTION OF AGRICULTURAL CULTIVATION IN ARGENTINE (3)

- Rice, Alfalfa, and Olives -

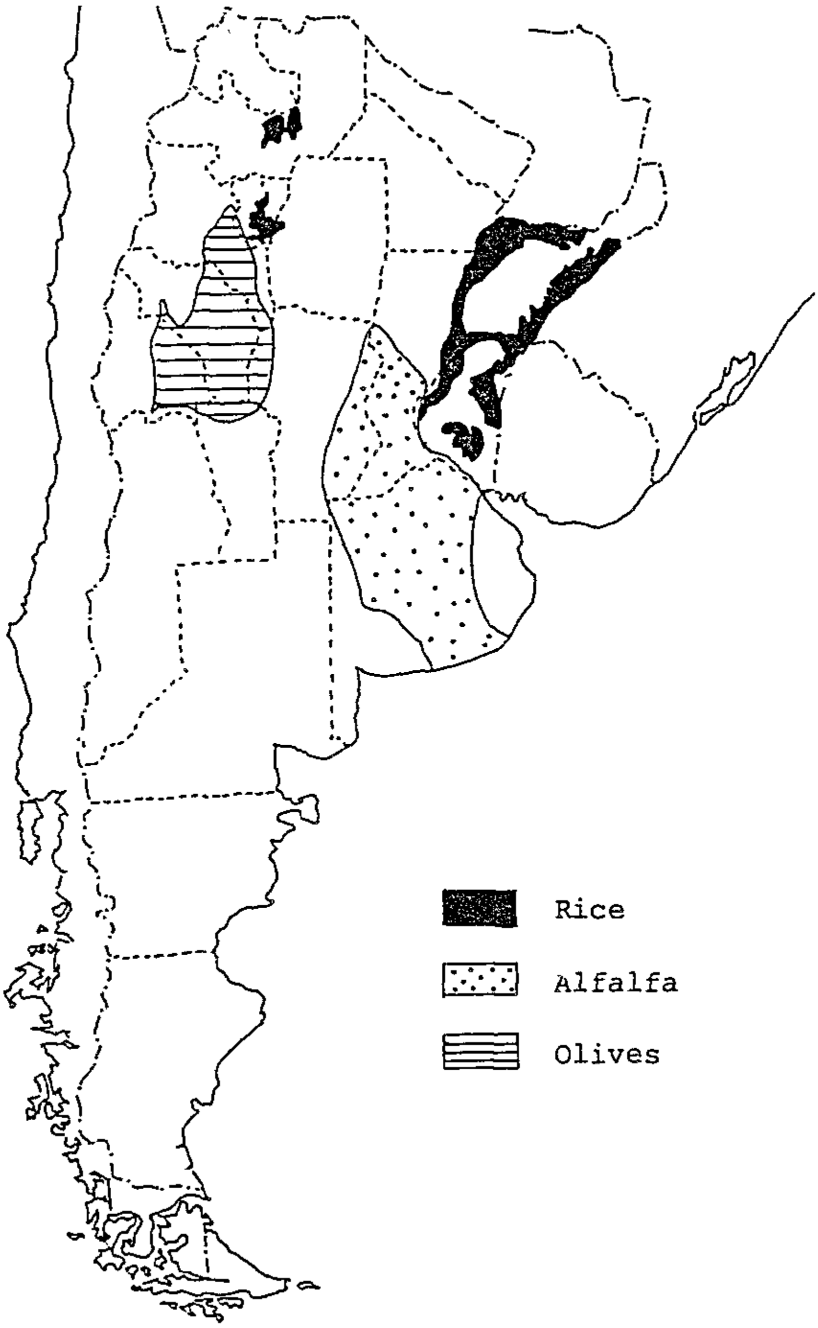
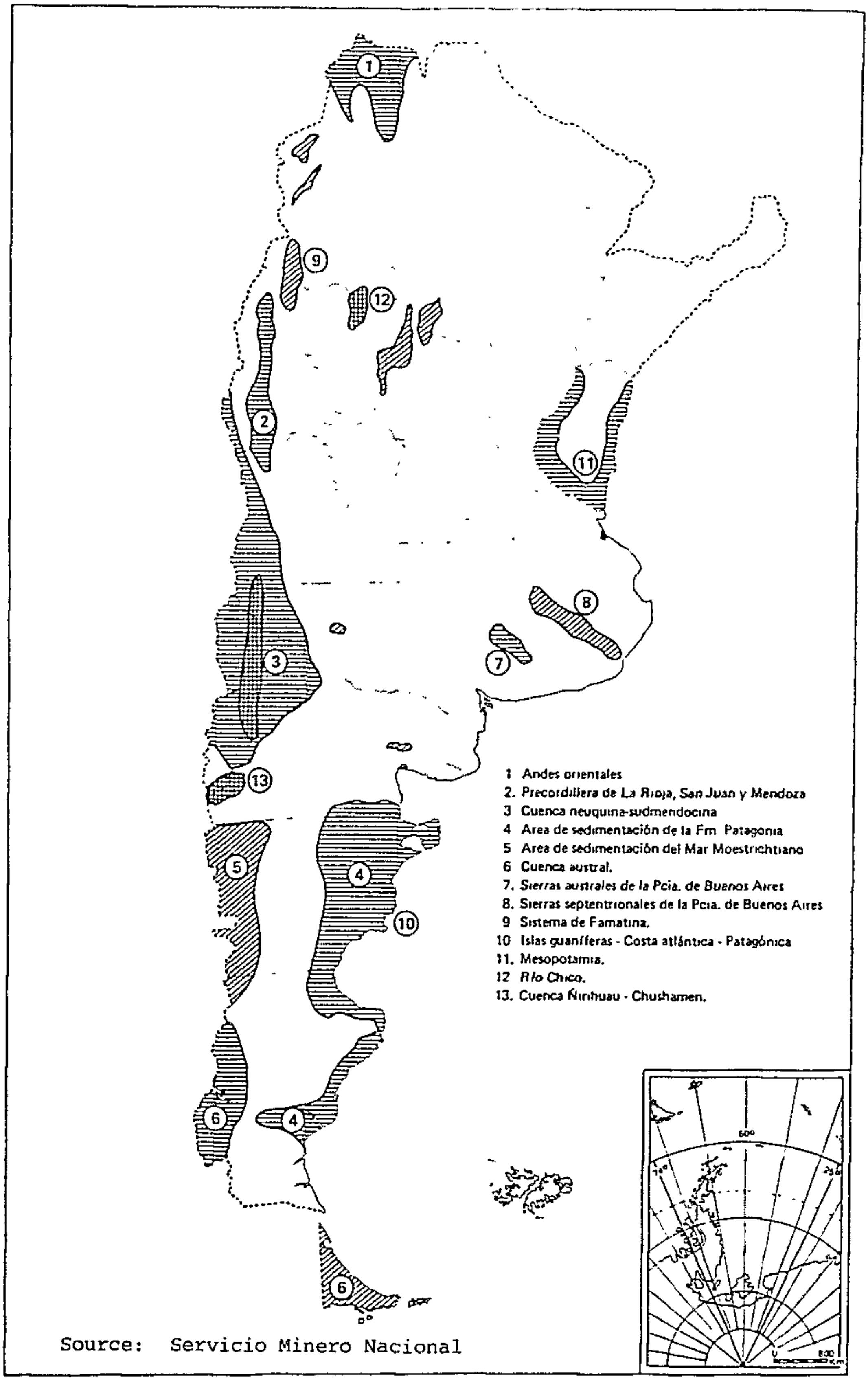


Figure II-7 PHOSPHORITE RESOURCES POSSIBILITY IN ARGENTINE

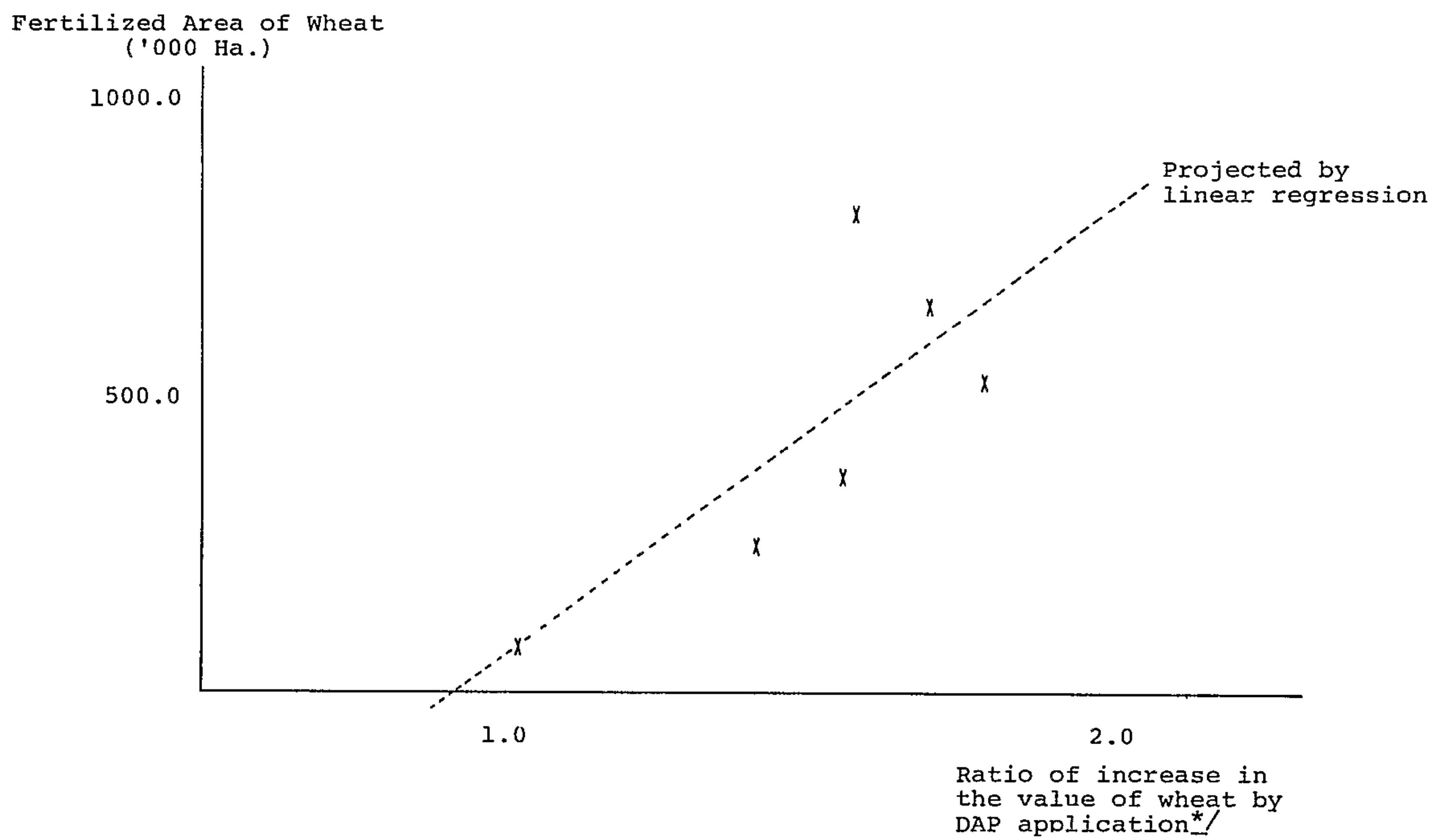


Valley (on Basin) phospected in detail.

Area with preliminary survey.

Manifestation of phosphatic minerals.

Figure II-8 RELATIONSHIP BETWEEN FERTILIZED AREA OF WHEAT AND RATIO OF INCREASE IN THE VALUE OF WHEAT BY FERTILIZATION



Note: */ See Table 2-15

Figure II-9 CHANGE IN THE FERTILIZED AREA OF WHEAT

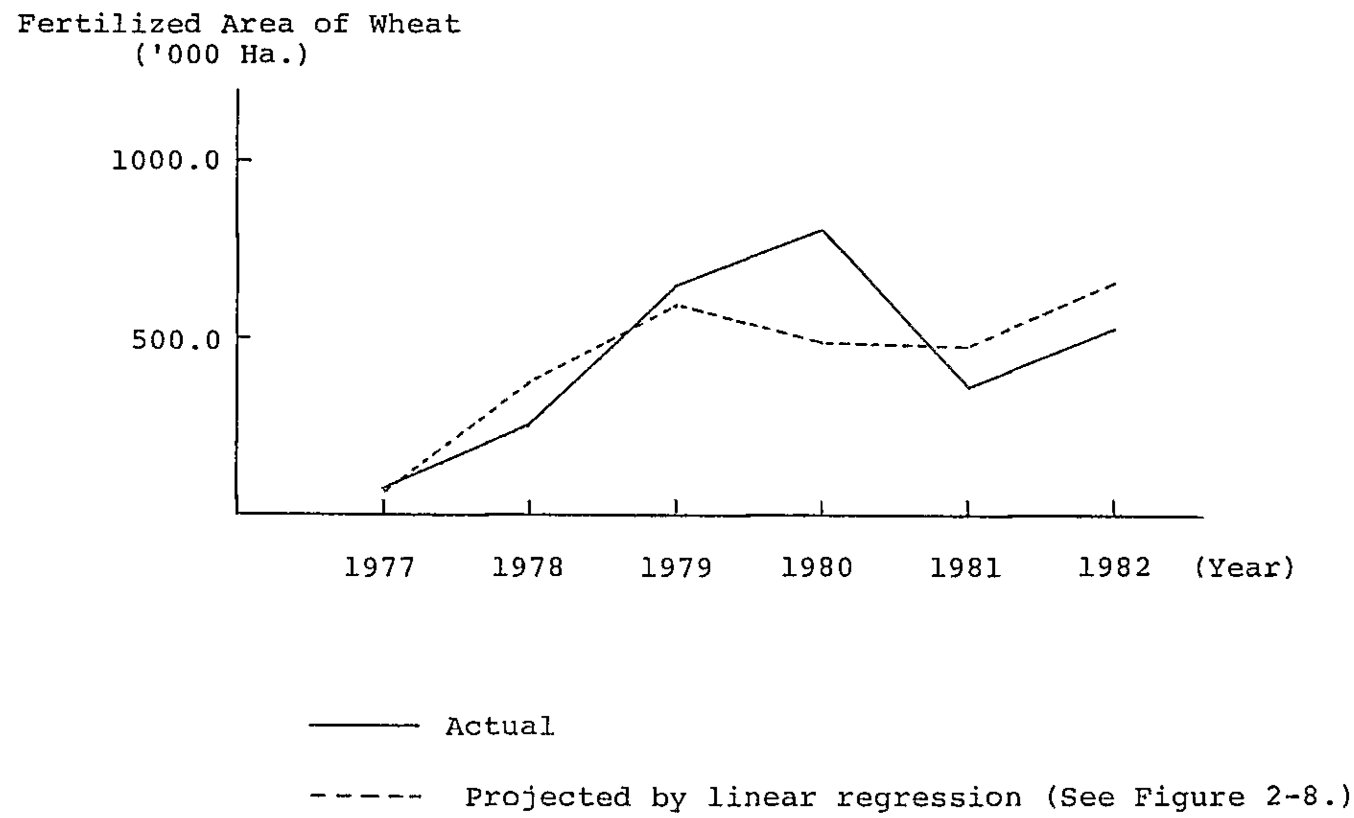
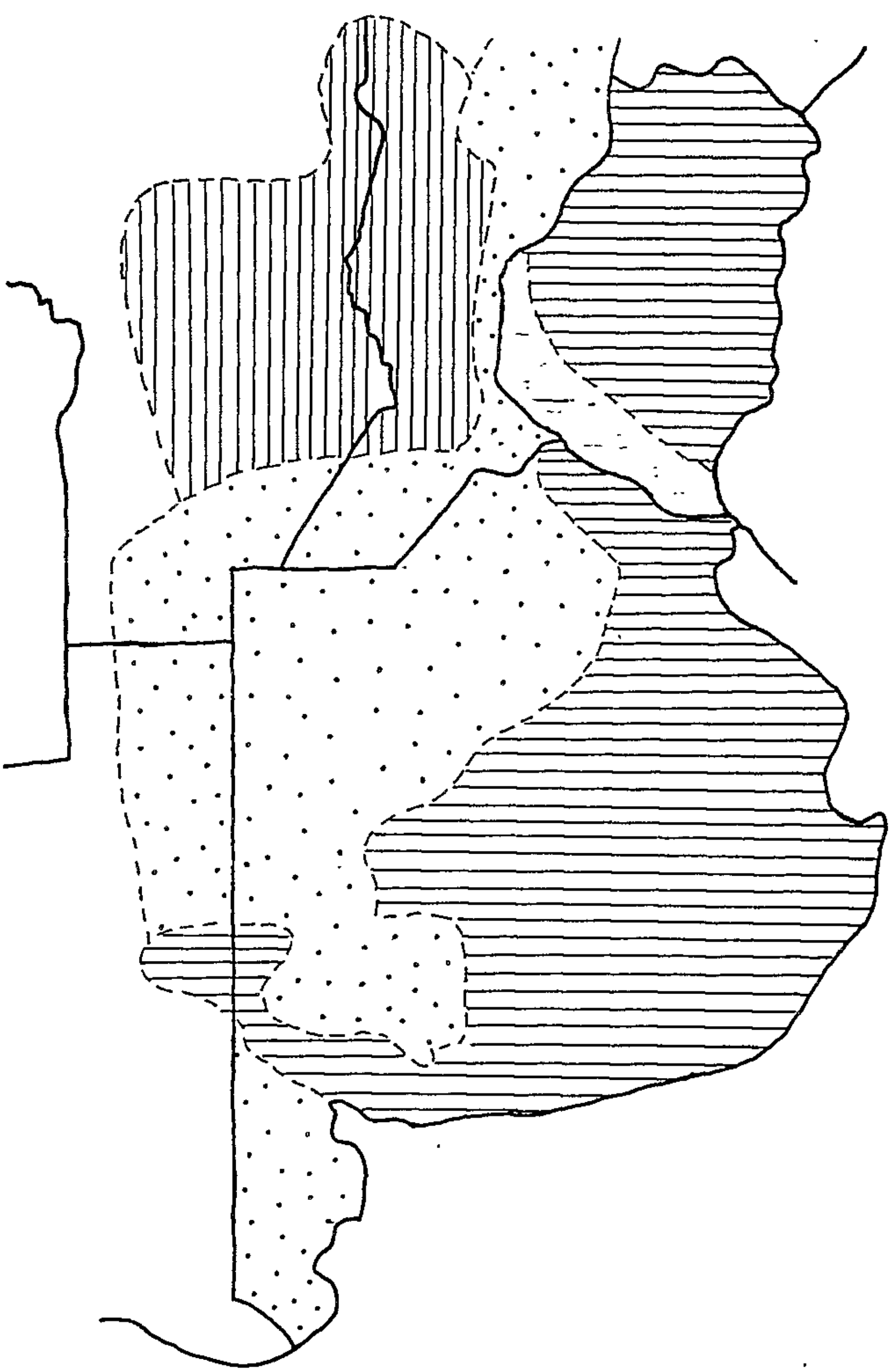


Figure II-10 DISTRIBUTION OF SOILS IN VIEW OF PHOSPHATE AVAILABILITY IN ARGENTINE



Area covered mainly with phosphate deficient soils.

Area covered with soils containing phosphate moderately/ abundantly.

Area covered mainly with phosphate abundant soils.