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THE LATIN AMERICAN FERTILIZER INDUSTRY

presented by
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The arable land area of Latin America es about 103 million hectares or close to 7½ per cent of the world's total. Its population is about 7 per cent of the world's total. When these factors are considered, Latin America has relatively low fertilizer use. Table 1 shows that in total consumption of the three primary plant nutrients - nitrogen (N), phosphate (P_2O_5), and potash (K_2O) combined - per thousand hectares of arable land, Latin America falls behind all regional groupings except the Near East and Africa. Examining total Latin American consumption of the three plant nutrients, we find that it is roughly one million tons, only about 3.2 per cent of the world's total. Latin America's share of total world production is even less.

In spite of Latin America's very modest position in fertilizers up to the present, we believe crop responses to fertilizers have been sufficiently demonstrated, and food and population pressures are sufficient, so that the rate of growth in fertilizer in Latin America will exceed by a wide margin that of the world as a whole. We also believe there are substantial opportunities for domestic production which will be taken advantage of and that Latin America will become self-suffient in nitrogen.

Table 1

FERTILIZER CONSUMPTION PER THOUSAND HECTARES OF ARABLE LAND - 1960/61

(Metric tons)

	N	P_2O_5	K_2O
World Total[a]	7.86	7.55	6.55
Latin America	4.08	2.62	2.33
North America	12.57	11.37	9.16
Western Europe	30.72	33.94	32.23
Eastern Europe	6.13	5.91	6.65
Far East [a]	6.05	2.70	2.89
Oceania	1.07	28.57	3.57
Near East	3.46	1.15	0.13
Africa	0.58	0.97	0.40

Source: FAO.

a/ Excludes mainland China and North Korea.

/With large

With large volumes of natural gas available in several areas that have only limited nitrogen consumption, such as Venezuela and Tierra del Fuego, we see a potential for joint investment in or integrated development of nitrogen production by producing areas and consuming nations. In the case of phosphates, there is a distinct possibility that Latin America will develop into a major source of phosphate rock for use thorughout the world. Only in potash do we see limited opportunities for internal production.

A few words on fertilizer demand will serve as a useful framework for a discussion on production and resources. As noted in Table 2, Central America represents the largest part of total Latin American nitrogen, but not phosphate, and potash consumption. Clearly, consumption of Mexico dominates that within Central America. In South America, consumption is somewhat more evenly divided between countries, with Brazil, Peru, Chile and Colombia being among the most important. In Table 3, consumption in Central and South America is compared to total estimated world consumption during 1961, the last year for which we have complete information. In that year, Latin America on average accounted for about 3.2 per cent of the total world primary plant nutrient consumption.

Because of the increased importance being attached to fertilizer needs and to production, and because of the resources available within Latin America, we expect its share of world consumption to increase substantially. Total primary plant nutrient consumption in Latin America should amount to well over 5 per cent of world demand by 1970. Furthermore, we estimate that the greatest growth will be experienced in South America rather than Central America.

Up to the present, production of all three plant nutrients has been below actual consumption within Latin America, and the area has represented a market for both European and United States fertilizer producers. This statement holds true even when production of Chilean nitrate of soda, which for the most part is destined for markets outside of Latin America, is included.

Nitrogen

At one time, Latin America dominated world nitrogen production, because of its production of natural nitrate of soda. These deposits were exploited in a major way beginning in the middle of the 19th century. With the growth of synthetic nitrogen capacity, the share of the world nitrogen market for Chilean nitrate of soda has dwindled to less than one per cent. Chilean nitrate of soda has found it increasingly difficult to compete with lower-cost synthetic nitrogen on the world market.

Generally speaking, the nations that are developed furthest toward intensive agriculture and heavy fertilization are also the most industrialized nations. It is these nations which are highly industrialized that have the bulk of synthetic nitrogen capacity. In fact, many of these nations have an excess of capacity over their internal needs and are the principal source of nitrogen fertilizers for the developing countries.

/Table 2

Table 2

LATIN AMERICAN FERTILEZER CONSUMPTION

(Thousand tons nutrient)

	1961			
	N	P_2O_5	K_2O	
Central America				
Mexico	128	66	8	
Costa Rica	6	7	5	
El Salvador	14	3	1	
Guatemala	5	3	1	
Honduras	4	-	-	
Nicaragua	3	2	1	
Jamaica	5	2	5	
Cuba	25	15	26	
Other a/	19	9	25	
	209	107	72	388
South America				
Argentina	10	5	3	
Brazil	57	118	72	
British Guiana	4	2	1	
Chile	14	52	9	
Colombia	23	40	21	
Ecuador	5	2	2	
Peru	53	20	4	
Uruguay	4	17	5	
Venezuela	7	8	8	
Other	<1	<1	<1	
	178	265	126	569
Total Latin America	387	372	198	957

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a/ British Honduras, Dominican Republic, Haiti, Guadeloupe, Martinique and miscellaneous West Indies (less Jamaica).

/Table 3

Table 3

WORLD SUMMARY: PLANT FOOD CONSUMPTION

	1961			
	Thousand tons		Percentage of World	
Nitrogen N				
Central America	209		2.0	
South America	178		1.7	
Latin America		387		3.7
World		10 504		
Phosphate P_2O_5				
Central America	107		1.0	
South America	264		2.5	
Latin America		371		3.5
World		10 600		
Potash K_2O				
Central America	72		0.9	
South America	125		1.5	
Latin America		197		2.4
World		8 424		
Total NPK				
Central America	388		1.3	
South America	567		1.9	
Latin America		955		3.2
World		29 528		

/this situation

This situation is illustrated in Table 4. There is evidence, however, that the developing areas are now turning to domestic production, and that the situation exhibited in the past - with the more industrialized nations dominating nitrogen supply - is changing.

Table 4

PRODUCTION AND CONSUMPTION OF NITROGEN MATERIALS, 1961 [a/]
(Thousand tons nitrogen)

	Production	Consumption	Production Excess
Europe	6 876	5 766	+1 110
Africa	127	389	-262
Asia	1 763	2 089	-326
Oceania	20	35	-15
North America (Canada-United States)	4 404	3 927	+477
Latin America	241	396	-155
	13 431	12 602	

[a/] Includes non-agricultural nitrogen.

The reasons for this change are many. Principal among them is the fact that the technology for the manufacture of synthetic ammonia derivatives is not restricted to any one country or any one firm or organization. Anyone can acquire the necessary technology to erect a synthetic ammonia plant. We should point out in passing, however, that the availability of know-how does not in any way reduce the capital requirements, which are very large for a modern synthetic nitrogen complex.

Technology has advanced to the point where economic units can be based on natural gas, refinery gases, naphtha, or other liquid hydrocarbons. Plants based on coal, lignite, or hydrogen from the electrolysis of water are also technically feasible. While hydrocarbon resources in the form of natural gas or refinery products are not produced in every country of the world, any country that, for example, has access to imported naphtha or has a petroleum refinery of its own has the potential to enter the nitrogen business. Anhydrous ammonia, urea, and ammonium nitrate do not require raw materials other than the basic source of hydrogen or synthesis gas. Derivatives such as ammonium sulphate or mixed fertilizers require a source of sulphur or sulphur values.

/Motivations for

Motivations for domestic production beyond the simple fact of fertilizer need include the desire for local industry and employment, which in some cases may overshadow the economics involved. Thus, some local industries have been established in instances where the cost of imported materials has been lower than the cost of domestic production. On the other hand, even when this is true, a nation frequently can demonstrate foreign exchange savings in producing its own nitrogen fertilizers. It is fair to say that foreign exchange savings often represent a major motivation for establishing a local industry.

Before discussing the nitrogen situation in major Latin American countries, a few comments are in order on the factors affecting the costs of nitrogen production. Hydrocarbon feedstock values are a critical factor. Natural gas, for example, in some areas of the world may run from as low as 5c/million BTU to 60c/million BTU. Assuming a requirement of 31 million BTU/short ton of ammonia, the raw material costs per ton of ammonia would vary from about US$1.55/short ton for 5c gas to about US$18.60/short ton for 60c gas, a difference of US$ 17.05/short ton. Where natural gas is either not available or very high in cost, naphtha might prove to be the preferred raw material. Because of the world-wide naphtha surplus, it is estimated that under long-term contract large volumes of naphtha could be available in any major port in the world for the equivalent of perhaps 5c/gallon or 41-42c/million BTU. However, because of the higher investment and higher BTU consumption when employing naphtha, methane would have a premium for use in synthetic ammonia production of perhaps 12c/million BTU over naphtha.

A second major factor is plant size. The capital investment per ton of anhydrous ammonia decreases with increasing plant size. For example, we estimate that under Gulf Coast conditions in the United States, a one thousand-short-ton-per-day plant would have a capital investment requirement of about US$40/short ton of annual capacity, versus an investment requirement of about US$64/ton for a 200-ton-per-day plant. The manufacturing costs of a 600-ton-per-day plant would be expected to be US$4 to US$5 less than those of a 300-ton-per-day plant, and US$ 11 to US$ 12 less than those of a 150-ton-per-day plant. If an identical percent return-on-investment factor is applied for these various plant sizes, the differentials become even larger.

Other factors which will vary by location include the important electric power input, the cost and size of the labour force, and the area in which the plant is constructed, etc. This brief review of the factors affecting production costs will give us a perspective in viewing the Latin American nitrogen situation.

Estimated nitrogen capacity both in place and under construction in Latin America is over 700 million tons nitrogen. If all these plants were operated at capacity, Latin America could meet its own needs at least through 1967. This substantial capacity is not evenly distributed among the countries. (Not included in this figure is the capacity of W.R. Grace's synthetic ammonia plant on Trinidad, whose output is destined largely for export. We have included in our estimates, however, a provision of 210,000 tons nitrogen from Chilean nitrate operations which are largely for export.) Additional projects planned in Latin America, if carried out, could make the area self-sufficient over the long term.

An example of the progress being made in Latin American nitrogen production is Mexico. Mexico has the largest nitrogen fertilizer consumption within Latin America. Its consumption was about 170,000 tons nitrogen in 1963 and in 1971 should be well over 400,000 tons. Historically, the country has been a net nitrogen importer to satisfy these needs. Mexico is a country with an excellent basic position in hydrocarbons and has entered a programme for indigenous nitrogen production. The earlier synthetic nitrogen plants at Monclova and Cuatitlan are small by world standards. Both are under 30,000 tons nitrogen per year. However, two other plants are now operated, each with a capacity of over 50,000 tons per year nitrogen, and PEMEX has a large unit under construction at Ciudad Camargo. Of particular interest is a one thousand-ton-per-day anhydrous ammonia plant for Coatzacoalcos, which follows the world trend towards much larger-scale units.

We believe it is likely that Mexico, therefore, will have excess nitrogen capacity and will become an exporter. In fact, there are indications that discussions have taken place with regard to long-term exports, possibly, for example, to Ecuador. Mexico is an excellent example of the country which has growing substantial internal nitrogen consumption coupled with a basic position in hydrocarbons and which is capitalizing on these factors.

Agricultural nitrogen consumption in Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua totals less than 50,000 tons per year, and no single one of these countries could erect an economic-sized nitrogen unit solely to satisfy internal consumption. In a move that predated the Central American Common Market, International Petroleum affiliates erected ammonia units at Aruba, Netherlands Antilles, and Cartagena, Colombia, with part of the output of these plants destined for consumption in the Central American area. Part of the scheme involves satellite plants in El Salvador and Costa Rica.

Let us now take a look at the South American picture. Colombia has already achieved self-sufficiency in nitrogen, through production in a fairly large-scale plant at Cartagena and a smaller unit at Barranca. Export of approximately 42,000 tons of ammonia is planned from the Cartagena plant to Central America. Plans exist for at least one more nitrogen venture in the country directed primarily at export markets.

Venezuela is one of the world's major petroleum-producing countries and has important quantities of natural gas which are not utilized, including gas associated with petroleum production which is re-injected. Venezuela now has one synthetic ammonia plant at Moron with a capacity of about 29,000 tons per year of nitrogen. While this plant, if run at capacity, could serve near-term agricultural needs of Venezuela, there have been various proposals to erect large nitrogen facilities directed at the export market. Venezuela is one of those nations where one could visualize joint investment in the producing plant by Venezuela and other consuming nations.

A substantial part of Peruvian nitrogen demand is supplied by guano, but two small synthetic nitrogen plants exist. Demand is increasing in that country, and there are plans for a larger, more economic unit.

The position taken with respect to nitrate of soda will strongly influence the development of the Chilean fertilizer industry. At the moment, imports of synthetic nitrogen for fertilizer purposes are not allowed, and the agricultural needs are met from nitrate of soda produced in northern Chile. While there is little question that for the most part nitrate of soda can meet the nitrogen needs of Chilean agriculture, it is also clear that synthetic nitrogen would probably be a lower-cost form for that country. The potential demand for Chilean agriculture indicates that a synthetic nitrogen plant might prove feasible, but probably only if nitrate of soda were not protected. Chilean natural gas reserves are located in Tierra del Fuego, far removed from the point of nitrogen consumption. Nonetheless, the potential exists for nitrogen production in this area, and it might prove feasible, particularly if other countries either lacking low-cost hydrocarbon reserves or reserves near points of consumption participated in such a venture.

Argentina has small by-product capacity based on coke oven gas, but there are plans for the erection of a large-scale synthetic unit by a consortium of interests. If this plant materializes, production could well be in excess of internal demand.

While Brazil is the largest consumer of synthetic nitrogen in South America, it is a country lacking major hydrocarbon reserves in the main geographic area of agricultural nitrogen use. One plant based on refinery gas exists and a second synthetic ammonia plant is under construction. However, in Brazil, the potential nitrogen demand is large, and it appears that additional nitrogen capacity may be warranted. It is conceivable that joint development of a large scale nitrogen project by Brazil and a country with important low-cost hydrocarbon reserves might be appropriate.

Phosphate

The situation regarding phosphate fertilizers is quite different from the situation in nitrogen fertilizers. While some phosphate values are secured from bones, slag, and guano (from the latter particularly in Chile and Peru), phosphate rock is the main source of phosphate values throughout the world.

/Phosphate rock

Phosphate rock normally must be upgraded before it becomes useful for agricultural purposes; the phosphorus content is made available to plants by treatment with an acid, usually sulfuric acid, or by conversion to elemental phosphorus in an electric furnace and then to derivatives. In some processes, the phosphate is converted directly by thermal means without first being reduced to elemental phosphorus.

In 1962, world production of phosphate rock amounted to about 46 million tons. The United States of America was the largest producer, with Florida alone producing about 14 million tons or 30 per cent of the world total. Morocco was the largest exporter and produced 8 million tons or 17 per cent of the world total. The Soviet Union is a major factor; its total production was between 8 and 9 million tons.

Phosphate rock is produced in more than 25 nations. A breakdown of total world production by major producing areas i shown in Table 5. It should be noted that several new producing areas are of growing importance. For example, Togo and Senegal, two new West African producers, began commercial production only in 1961 and 1960, respectively. There is also potential production in other African countries, and in the United States of America preparations are being made to begin production in North Carolina.

Table 5

BREAKDOWN OF WORLD PHOSPHATE ROCK PRODUCTION IN 1962 BY REGION

	Per cent of World Total
United States of America	41
North Africa (Morocco, Tunisia, Algeria)	23
Pacific and Indian Ocean Islands (Nauru, Ocean and Makatea Islands)	6
Middle East (Egypt, Jordan, Israel)	3
West Africa (Togo, Senegal)	2
South America (principally Brazil and Peru (Guano))	<2

As in the case of many other minerals, there are ample recoverable reserves of phosphate rock. However, high-grade deposits which are close to transportation and cheap to mine and process are limited. Phosphate rock, generally speaking, is a low-cost product, say US$ 10 to US$ 15 or less per ton for rock with a 32 per cent P_2O_5 content. Therefore, location, cost of mining and beneficiation (where the latter is required), and specific properties are the factors which determine whether a deposit is of commercial value or not. In fact, marketable phosphate rock is a cheap material approaching the cost of crushed and sized stone in a few cases.

As Table 5 indicates, Latin America is not now a major source of phosphate rock. It is instead an importer of phosphate rock and upgraded phosphate fertilizer products. Turning to an examination of the phosphate resources of various Latin American nations, we find that Mexico has significant superphosphate production, but little or no phosphate rock production for fertilizer use. Mexico has major phosphate rock potential in the form of phosphate - containing sands off the coast of Baja California. These sands contain only about 3 per cent to 5 per cent P_2O_5 but reportedly can be upgraded to 29 per cent to 31 per cent P_2O_5. The investment and size of operation necessary to carry out commercial production, however, would be extremely large and probably much greater than that required for typical sedimentary deposits elsewhere.

In the Caribbean area, there is little or no production for fertilizar purposes. However, production takes place in the Netherlands Antilles on Curacao; this rock, which is low in fluorine, is sold primarily as an animal feed supplement.

In Venezuela, some production takes place for local superphosphate manufacture, and several deposits are known. Venezuelan deposits may be the basis for Venezuela's recently announced plans for elemental phosphorus production based on low-cost hydro-electric power.

Peru represents a major potential source of phosphate rock and could become one the world's major exporters. The reserves are located in the Sechura Desert of northern Peru. The phosphorite beds which would be mined are relatively low in P_2O_5, perhaps 10 per cent to 12 per cent, but could be upgraded without calcination to about 31 per cent P_2O_5. Further processing might yield higher grades. The rock concentrate product apparently is extremely reactive. The phosphate rock produced would be relatively low-grade by world standards, but quite acceptable for phosphoric acid manufacture. Commercial mining and beneficiation operations, however, may require an investment of close to US$ 20 million. The location of the deposits near the coast and the size and character of the reserves - hundreds of millions of tons in terms of 31 per cent concentrate - leave little question that at some future time these deposits will be exploited on a large scale and may become a major source of phosphate for the world market.

The comments made earlier on the economic scale of ammonia production do not apply to the production of phosphate rock. For example, where extensive beneficiation is not required and where the deposits are on the surface, small-scale mining as practiced by some nations in the Middle East may prove economic.

/It cannot

It cannot be emphasized too strongly that while phosphate resources are known in most areas of the world, deposits which are of high grade and have other suitable properties are restricted to a limited number of areas. Many important consuming areas lack significant phosphate resources of their own. For example, Japan has no phosphate resources of their own and imports over 2 million tons of rock per year. Similarly, India and other areas have no domestic sources. The resources in Oceania - primarily those controlled by Australia and New Zealand - are now being supplemented by imports from other areas. The general area of Asia could well be viewed as a potential market for phosphate rock produced in Peru or Baja California. The former area in particular appears to be capable of developing into a major world source of phosphate and thus of changing Latin America from being a net importer of phosphate rock into being an exporter.

Turning to phosphate fertilizer products, we find that the most common derivatives - normal superphosphate, triple superphosphate, and various compound fertilizers based on these materials or on phosphoric acid - require sulfur in their manufacture. On a cost basis, it sometimes can be argued that phosphate fertilizers are nearly as much a sulfur consumer as a phosphate rock consumer.

As fertilizer demand increases, we can foresee further development of phosphate fertilizer projects in many nations of Latin America. For example, there is discussion of a phosphate fertilizer complex in Chile, which already consumes over 50,000 tons P_2O_5 and which currently has only modest local production.

In the case of elemental phosphorus and its derivatives, electric power and coke are the critical materials required in addition to phosphate rock. The properties of the phosphate rock - its grade and silica content - are less critical for this use than for other uses. With about 10,200 kWh/ton elemental phosphorus required for the operation of the furnace, and with high coke requirements, the cost of the phosphate rock may be less than the cost of power and coke in some instances.

Potash

Potash is similar to phosphate rock in that major commercial resources are located in only a few parts of the world. In 1962, the United States, West Germany, East Germany, France and the Soviet Union accounted for the bulk of world production. Canadian production is expanding rapidly, and Canada will take a place among the leading producing nations. The only significant production of potash in Latin America is as a by-product of nitrate of soda operations. World production by major producing areas is indicated in Table 6.

Potassium minerals are widespread throughout the earth's surface, but production is restricted to relatively few commercial deposits of water-soluble potassium minerals. Most production is of potassium chloride (muriate of potash), with smaller quantitites of potassium sulphate and mixed potassium-magnesium sulphate being produced. The

/Table 6.

Table 6

WORLD POTASH PRODUCTION, 1962

	Thousand tons K_2O		Percentage of World total
United States of America	2 453		
Canada	150		
		2 603 N. America	24
Chile	20		
		20 S. America	-
France	1 898		
West Germany	2 136		
Spain	260		
Italy	149		
		4 443 W. Europe	42
East Germany	1 900		
U.S.S.R.	1 650		
		3 550 E. Europa	33
Israel	100		
		100 Asia	1
Total		10 716	

/typical mineral

typical mineral mined is sylvinite, a mixture of potassium chloride and sodium chloride, although some other minerals such as langbenite, carnallite, and kanite are also mined. In Israel and in the western United States some production of potash takes place from brines. Aside from the brines, most other potash production is mined from underground deposits. Historically, these have been mined using conventional shaft methods, but recently a solution mining process has been initiating in Canada. Conceivably, this approach might prove applicable to other deposits which, because of depth or other reasons, might not prove suitable to conventional mining.

I have indicated there is very little potash production in Latin America. The future for Latin American potash production is difficult to project. To date, there is little evidence of major commercial primary potash resources in Latin America, although new exploration may uncover major deposits. Some production of potash may take place as a by-product or co-product of salt production, such as in Brazil, and there are potash brines, for example, underlying the phosphate deposits in the Sechura Desert of Peru. It appears, however, that at least for the near future, Latin America will be dependent upon imports for its needs. It is certain that demand will increase, and probably supplies from North America, Europe, and the newer deposits which will be exploited in Africa will supply much of the need.

Summary

In reviewing the fertilizer situation throughout Latin America, we can arrive at some general conclusions as to prospects for the future. In only a few areas are there large quantities of natural gas which would support an economic large-scale nitrogen industry. These areas include Mexico, Venezuela and Tierra del Fuego. However, only in the case of Mexico do we have hydrocarbon availability coupled with large-scale domestic consumption. In some other countries hydrocarbons are available in one form or another, including refinery products, but internal consumption cannot justify a scale of production large enough to be fully economic. (This does not necessarily mean, however, that crop response would not justify erection of a plant with relatively high costs). Brazil, on the other hand, has important nitrogen consumption and a potential for greatly increased use of nitrogen, but lacks well located resources for nitrogen production. Chile is dependent upon natural nitrate of soda, although it has substantial reserves of natural gas in the Tierra del Fuego area.

This situation could well provide a basis for large-scale nitrogen production in Venezuela or Tierra del Fuego, for example, based on hydrocarbon availability. From the producing area, anhydrous ammonia in refrigerated vessels or solid derivatives could be moved to consuming areas. These could be countries such as Brazil, or those nations which have markets too small for large-scale, low-cost nitrogen production to be feasible. Integrated development could call for joint investment in a large nitrogen plant by consuming nations or else investment by the producing plant in derivative mixed fertilizer, and distribution facilities in consuming areas. It should be pointed out that with every nation having some capability for nitrogen production, dependence upon the open export market for a major share of the plant's output is risky unless long-term commitments are obtained. The history of successful large-scale nitrogen ventures such as W.R. Grace in Trinidad and International Petroleum has been one of making investment in derivative facilities in consuming areas. However, the idea of integrated development of a large-scale nitrogen venture by several consuming nations should also prove attractive.

As far as phosphate is concerned, we see a continuation of efforts, such as those which have taken place in El Salvador, Costa Rica, Colombia and elsewhere, to erect phosphate fertilizer plants. There is major potential for phosphate rock production in Latin America, particularly in Peru, which could become a large exporter of phosphate rock. Thus, there is potential for Latin America to join those few areas of the world which are major phosphate rock exporters.

One can be optimistic then about development of the Latin American nitrogen industry, about Latin American production of phosphate fertilizers, and about its phosphate rock production on a long-range basis. The evidence is not yet at hand, however, to show that Latin America will develop into a major potash producing area.