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**MEXICO: THE FERTILIZER INDUSTRY**

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# **MEXICO**

## **THE FERTILIZER**

### **INDUSTRY**



**IFDC**

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER

## ABSTRACT

A rapidly expanding domestic fertilizer market and a desire to capitalize on indigenous raw material deposits have resulted in Mexico's rapid emergence as a major factor in the world fertilizer market. During the past decade, fertilizer use in Mexico has nearly doubled, exceeding 1 million mt of plant nutrients in 1978. Major gains have also been registered in fertilizer production, with total output estimated at over 1.65 million mt of nutrients in 1978 versus only 0.7 million mt in 1970.

The purpose of this report is to draw attention to one country's approach to meeting its farmers' needs for increasing fertilizer needs and to examine the impact Mexico's industry development plans will have on its position in the world fertilizer market.

The report is a joint FERTIMEX/IFDC publication.

Keywords: FERTIMEX, PEMEX, IFDC, fertilizer, capacity.

MEXICO: THE FERTILIZER INDUSTRY

A Joint Publication of IFDC and FERTIMEX

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## FOREWORD

Fertilizer is a cornerstone of modern agricultural production. Plant nutrient consumption in Mexico has doubled in the last decade and is projected to double again in the next five years. To meet this compounding growth rate, a modern fertilizer industry has developed in Mexico. Agronomic research, extension, plant construction, production, marketing, government policy, finance, and education are all intertwined in the development of this modern industry.

This report on the Mexican fertilizer industry describes briefly the many facets of its fertilizer sector and exemplifies one country's solutions to meeting its farmers' needs for increasing amounts of fertilizer in order to expand the national supply of food and fiber and improve the economic well-being of the rural population.

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## TABLE OF CONTENTS

|   | <b>Page</b> |
|---|-------------|
| <b>Abbreviations</b> . . . . .              | iii         |
| <b>Summary</b> . . . . .                    | iv          |
| <b>Introduction</b> . . . . .               | 1           |
| Geography . . . . .                         | 1           |
| Economy . . . . .                           | 1           |
| Agricultural Overview . . . . .             | 5           |
| <b>The Fertilizer Sector</b> . . . . .      | 12          |
| Fertilizer Policy . . . . .                 | 12          |
| Fertilizer Industry . . . . .               | 12          |
| Fertilizer Trade . . . . .                  | 20          |
| Fertilizer Consumption . . . . .            | 20          |
| Fertilizer Production Outlook . . . . .     | 29          |
| Fertilizer Supply-Demand Forecast . . . . . | 35          |
| Raw Materials . . . . .                     | 38          |
| <b>FERTIMEX and Marketing</b> . . . . .     | 40          |
| Channels of Distribution . . . . .          | 42          |
| Fertilizer Prices . . . . .                 | 44          |
| Marketing Costs . . . . .                   | 46          |
| Warehousing and Inventories . . . . .       | 46          |
| Fertilizer Transportation . . . . .         | 50          |
| Fertilizer Research and Extension . . . . . | 51          |
| <b>References</b> . . . . .                 | 54          |

## TABLES

|  | Page |
|--|------|
| 1. Mexico—Ammonia Production Capacity and Nitrogen Fertilizer Supply-Demand Forecast . . . | 14   |
| 2. Nitrogen Fertilizer Capacity and Supply Potential . . . . .                             | 16   |
| 3. Phosphate Fertilizer Capacity and Supply Potential . . . . .                            | 17   |
| 4. Mexico—Phosphoric Acid Capacity and Phosphate Supply-Demand Forecast . . . . .          | 34   |
| 5. Mexico Fertilizer Demand Forecast . . . . .   | 36   |

## FIGURES

|   |    |
|---|----|
| 1. Fertilizer Market Regions . . . . .  | 2  |
| 2. GNP by Economic Sector . . . . .   | 3  |
| 3. Foreign Trade by Economic Sector . . . . .                                   | 4  |
| 4. Topography of Mexico . . . . .   | 6  |
| 5. Climate of Mexico . . . . .  | 6  |
| 6. Expansion in Cropland and Irrigated Area, 1960-77 . . . . .                  | 7  |
| 7. Irrigated Cropland by Region . . . . .                                       | 8  |
| 8. Percentage of Cultivated Land in Each Region that is Irrigated . . . . .     | 8  |
| 9. Major Crops in Mexico . . . . .  | 9  |
| 10. Primary Crop Areas (percentage by total national crop production) . . . . . | 10 |
| 11. Crop Yield in Mexico . . . . .  | 11 |
| 12. Location of FERTIMEX Finished Fertilizer Plants, 1978 . . . . .             | 15 |
| 13. Regional Nitrogen Fertilizer Capacity . . . . .                             | 18 |
| 14. Regional Phosphate Fertilizer Capacity . . . . .                            | 18 |
| 15. Fertilizer Capacity by Product . . . . .                                    | 19 |
| 16. International Fertilizer Trade . . . . .                                    | 25 |
| 17. Fertilizer Consumption Trends . . . . .                                     | 26 |
| 18. Trends in Fertilizer Consumption . . . . .                                  | 26 |
| 19. Regional Fertilizer Consumption (kg/ha) . . . . .                           | 28 |
| 20. 1977 Regional Fertilizer Consumption (percentage total) . . . . .           | 28 |
| 21. 1977 Nutrient Consumption by Product . . . . .                              | 29 |
| 22. Monthly Fertilizer Use . . . . .  | 30 |
| 23. Phosphoric Acid Capacity by Location . . . . .                              | 33 |
| 24. Ammonia Capacity by Location . . . . .                                      | 33 |
| 25. Nitrogen Fertilizer Supply-Demand Outlook . . . . .                         | 37 |
| 26. Phosphate Fertilizer Supply-Demand Outlook . . . . .                        | 38 |
| 27. Natural Gas Reserves of the Western Hemisphere . . . . .                    | 39 |
| 28. FERTIMEX Organizational Chart . . . . .                                     | 41 |
| 29. Channels of Distribution for Fertilizers (1978) . . . . .                   | 43 |
| 30. Retail Fertilizer Prices (product basis) . . . . .                          | 45 |
| 31. Retail Fertilizer Prices, 1978 (nutrient basis) . . . . .                   | 47 |
| 32. Fertilizer Marketing Costs . . . . .  | 47 |
| 33. Fertilizer Distribution Costs (May 1978) . . . . .                          | 48 |
| 34. Fertilizer Storage Capacity in Mexico, 1978 . . . . .                       | 49 |
| 35. Modes of Transportation for Fertilizer Shipment in Mexico, 1977 . . . . .   | 51 |
| 36. INIA Research Stations . . . . .  | 53 |

## ABBREVIATIONS USED IN THIS REPORT

### FERTILIZERS

|                               |            |
|-------------------------------|------------|
| N                             | Nitrogen   |
| P                             | Phosphorus |
| P <sub>2</sub> O <sub>5</sub> | Phosphate  |
| K                             | Potassium  |
| K <sub>2</sub> O              | Potash     |

### Fertilizer Formulas—% of N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O

|                             |          |
|-----------------------------|----------|
| Ammonium Sulfate            | 21-0-0   |
| Anhydrous Ammonia           | 82-0-0   |
| Urea                        | 46-0-0   |
| Ammonium Nitrate            | 33.5-0-0 |
| Diammonium Phosphate (DAP)  | 18-46-0  |
| Single Superphosphate (SSP) | 0-20-0   |
| Triple Superphosphate (TSP) | 0-46-0   |
| Potassium Chloride          | 0-0-60   |
| Potassium Sulfate (SOP)     | 0-0-50   |
| Phosphate Rock (PR)         |          |

### MEASURES

|                |                                    |
|----------------|------------------------------------|
| ha.            | hectare (2.47 acres)               |
| kg.            | kilogram (1 pound = 0.454 kg)      |
| km.            | kilometer (1 mile = 1.61 km)       |
| m.             | meter (3.281 feet = 1 meter)       |
| mt             | metric ton (1.1 short tons = 1 mt) |
| mtpy.          | metric tons per year               |
| m <sup>3</sup> | cubic meters                       |

### ECONOMIC AND MONETARY

|                |                                       |
|----------------|---------------------------------------|
| Mexican pesos. | approximately Mexican \$22.6 = US \$1 |
| GNP            | Gross National Product                |

### ACRONYMS

|          |  |
|----------|--|
| ASARCO   | manufacturer of byproduct ammonium sulfate from caprolactam production |
| CIMMYT   | International Maize and Wheat Improvement Center                       |
| FERTIMEX | Fertilizantes de Mexico  |
| GUANOMEX | Guanos y Fertilizantes de Mexico                                       |
| IFDC     | International Fertilizer Development Center                            |
| INIA     | National Institute of Agricultural Investigation                       |
| PEMEX    | Petroleos Mexicanos, S.A.  |
| ROFOMEX  | Roca Fosforica Mexicana, S.A.  |
| TVA      | Tennessee Valley Authority   |
| UNIVEX   | manufacturer of byproduct ammonium sulfate from caprolactam production |

## SUMMARY

- The population of Mexico is estimated at 66 million, the eleventh largest in the world. With a 3.5% per annum population growth rate, the agriculture sector will be under increased pressure to meet domestic food requirements.
- The major sectors of the Mexican economy are commerce and trade, manufacturing, and agriculture. As a result of relatively slow growth in the agriculture sector, its share of the GNP has declined from approximately 20% in 1950 to 9.0% in 1975.
- Fertilizer consumption in Mexico almost doubled during the past decade; it is forecast to double again by 1985.
- Mexico's position as a net importer of nitrogen has been reversed.
- The 1978-85 annual export potential is estimated at 508,000-1,381,000 mt of nitrogen.
- Mexico, currently a net exporter of phosphates, will continue to have an export potential. However, this potential will decline to about 100,000 mtpy of  $P_2O_5$  in 1980 and 1981. The export potential will peak in 1983 at over 350,000 mt of  $P_2O_5$ .
- Based on recent new discoveries, Mexico's petroleum resources are estimated to be among the world's largest, thus ensuring nitrogen feedstock availability.
- Four phosphate rock deposits in Baja California are being investigated. Exploitation of the San Juan and Santo Domingo deposits is to begin in the early 1980's.
- Mexico's impressive fertilizer industry development plans include two projects involving the production of potash. By the mid-1980's, a large share of its domestic demand should be met by indigenous production.
- The government policy in Mexico is to make fertilizers readily available to farmers at the lowest possible price. In recent years, the farm-level price of fertilizers in Mexico has been considerably less than prices paid by farmers in countries such as the United States and India.
- The fertilizer marketing system in Mexico is well coordinated. Thorough planning in this area suggests Mexico will continue to meet its rapidly expanding needs efficiently.

## INTRODUCTION

Mexico's population in 1978 was estimated at over 66 million, the eleventh largest population in the world. With a population growth rate of 3.5% per annum, increasing pressure will be placed on the agriculture sector to meet Mexico's rapidly expanding food requirements. Increased fertilizer use is one means which Mexico has available to increase food production and combat the country's growing food problem. Major progress has been made in the fertilizer sector toward ensuring that fertilizer is not a limiting factor in agricultural production.

The purpose of this report is twofold: first, to emphasize the progress Mexico has made in reducing its vulnerability to one of the factors which limits food production--inadequate fertilizer supplies; and second, to identify expected developments in the fertilizer sector and assess their impact on the future supply-demand situation in Mexico.

### Geography

Mexico is bordered by the United States on the north, Guatemala and Belize to the south, the Pacific Ocean on the west, and the Gulf of Mexico on the east. The land area of Mexico totals 200 million ha or an area about the size of Western Europe. The most prominent physical features of the country are two mountain ranges, one of which extends to the south as the Andes and the other to the north as the Rocky Mountains. The two mountain ranges run north to south through Mexico with an elevation ranging from 1,525 to 2,440 m. Between the ranges lies the central plateau where the major population centers, including Mexico City, are located.

Administratively, the country is divided into 31 states and a "Federal District" in which Mexico City is located. Economic, social, and other important data are often published on a five-region basis. However, in this report, an eight-region system is used to divide the country; this is the system used by the fertilizer industry in Mexico (figure 1).

### Economy

Mexico has a diversified and progressive economy. From 1960 to 1976 the per capita GNP in constant dollars increased at an annual rate of 3.0%--a high rate and even more impressive



**States in the Eight Regions of Mexico**

| <u>Northwest (NW)</u>   | <u>North (N)</u>   | <u>Northeast (NE)</u>                | <u>Bajío (B)</u>  |
|---|--|--------------------------------------|---|
| Baja California, North<br>Baja California, South<br>Sinaloa<br>Sonora | Chihuahua<br>Durango   | Coahuila<br>Nuevo Leon<br>Tamaulipas | Aguascalientes<br>Guanajuato<br>Queretaro<br>San Luis Potosi<br>Zacatecas |
| <u>West (W)</u>   | <u>Central (C)</u>   | <u>East (E)</u>                      | <u>South (S)</u>  |
| Culima<br>Jalisco<br>Michoacan<br>Nayarit                             | Distrito Federal<br>Guerrero<br>Hidalgo<br>Mexico<br>Morelos | Puebla<br>Tlaxcala<br>Veracruz       | Campeche<br>Chiapas<br>Oaxaca<br>Quintanaroo<br>Tabasco<br>Yucatan        |

**Figure 1. Fertilizer Market Regions.**

when considered in light of the country's 3.5% per annum population growth. However, the impact of Mexico's growing population is reflected by the per capita GNP which has been increasing, but at a decreasing rate, in recent years. The rate of growth in the real per capita GNP was 1.7% for the 1970-76 period. In the most recent year (1977) for which data are available, the GNP (in current U.S. dollars) was \$71 million or a per capita GNP of US \$1,110.

The importance of the various sectors to the national economy is indicated by figure 2. Commerce and trade, manufacturing, and agriculture have historically been the major contributors to the GNP. The value of the GNP, in constant dollars, has increased since 1950 by 350%, while the value of the agricultural sector has increased by only 140%. Thus, the relative contribution of the agricultural sector has declined from approximately 20% of the GNP in 1950 to only about 9% of the GNP in 1975.

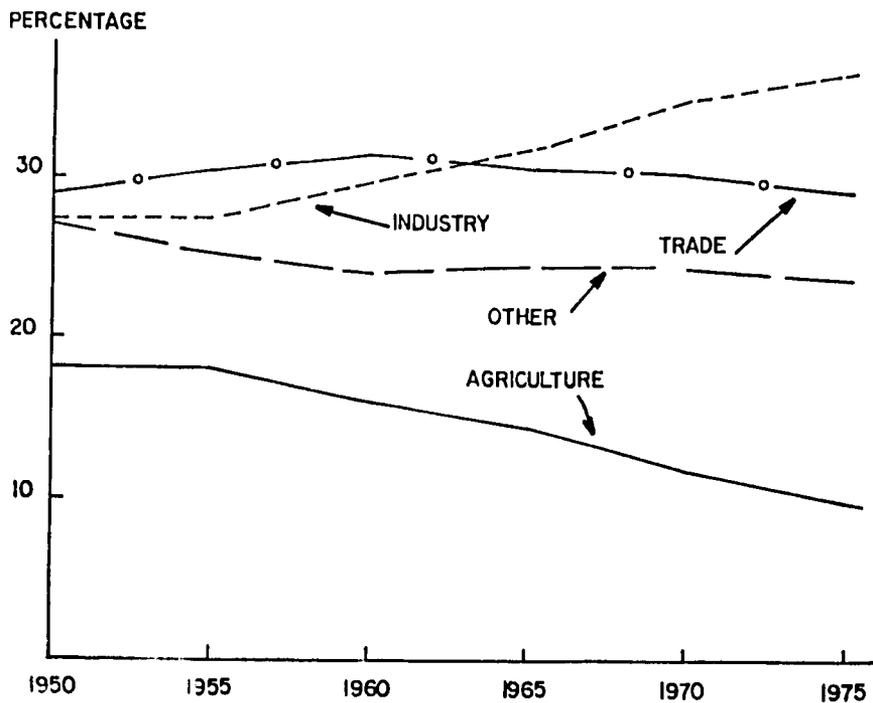


Figure 2. GNP by Economic Sector.

Along with its sustained economic growth, Mexico has rapidly increased its foreign trade and trade deficit. From 1970 to 1976 the total value of foreign trade increased by over 50%. The current market value of imports alone increased from US \$2.3 billion in 1970 to over US \$6 billion in 1976. At the same time, the current market value of exports, while up significantly, was not adequate to offset the higher import level. Exports rose from US \$1.4 billion to US \$3.3 billion during this period.

As shown in figure 3, agricultural products are a major source of foreign exchange. However, with the rapid growth in other sectors of the economy in recent years and increasing domestic consumption, agriculture's share of exports has declined from 52% in 1960 to 35% in 1975. With further development of Mexico's petroleum resources and manufacture of downstream products, the relative contribution of agriculture to total exports is expected to continue to decline in the near future. On the other side of the coin, shortfalls in food production have necessitated large-scale imports. In 1976 the total value of

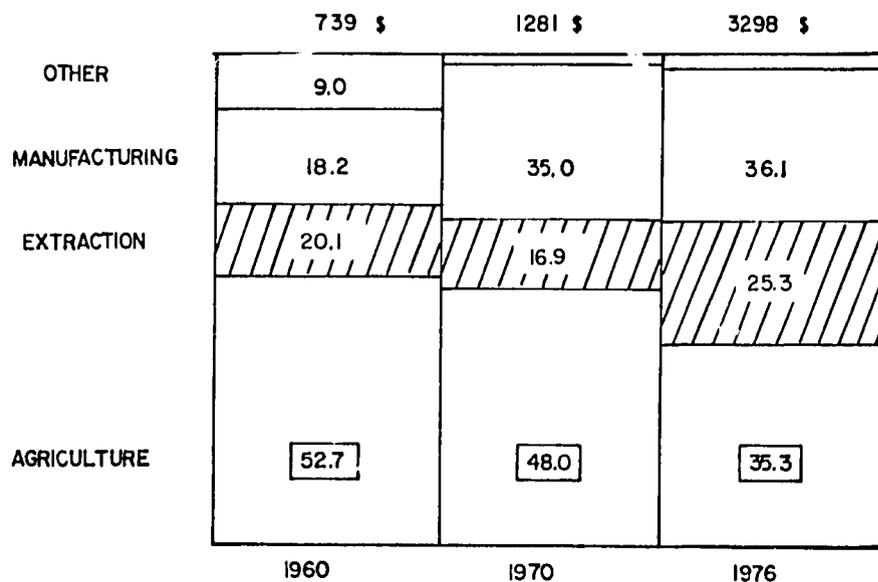


Figure 3. Foreign Trade by Economic Sector.

agricultural imports was US \$362 million, with corn, beans, and wheat being the major products imported (1). In view of these trends, the government of Mexico has placed increased emphasis on moving the country's agriculture toward: (1) meeting a larger percent of food requirements through domestic production and (2) increasing agricultural exports.

The economy of Mexico is highly centralized, with operation of private concerns (local and foreign) constrained within certain fairly well-defined limits. The government's economic policy is aimed at increasing industrialization of Mexico, diversification of the economy, and keeping major economic activities such as fertilizers and petroleum under public control. The government has extended its influence in the economy to regulation of imports to protect the domestic industry.

### Agricultural Overview

Mountainous topography and low rainfall, as shown in figures 4 and 5, limit arable land in Mexico to approximately 24 million ha or 12% of the total land area. Currently, about two-thirds of the arable land is being cropped, and the balance is either in pasture or fallow. Of the 75% of the soils in Mexico which have been classified as of 1977, 36% of the land is arid and semiarid; 43% is comprised of black, chestnut, and prairie soils; and about 10% is made up of tropical and subtropical soils. Soils whose characteristics have been influenced by such factors as parent limestone materials or poor drainage account for the balance (2).

From 1960 to 1975, total cropland increased by 4.0 million ha and, of this amount, 1.8 million ha was irrigated (figure 6). Today, 25% of the total area cultivated is irrigated; most of this is in the western and northern part of the country (figure 7). In the future, water resource development projects will continue to be a major component of government programs aimed at promoting agricultural production.

The 1970 farm census classified 70% of all farms in Mexico as subsistence-type farms. The major crops of subsistence farms, corn and beans, are grown under traditional practices, i.e., labor intensive and with little use of modern inputs. Farms of this type are primarily located in central and southern Mexico.

The balance of the country's cultivated areas (30%) is classified as commercial-type farms. Commercial farms in Mexico employ modern production techniques, i.e., most are highly mechanized and employ essential inputs such as fertilizers and

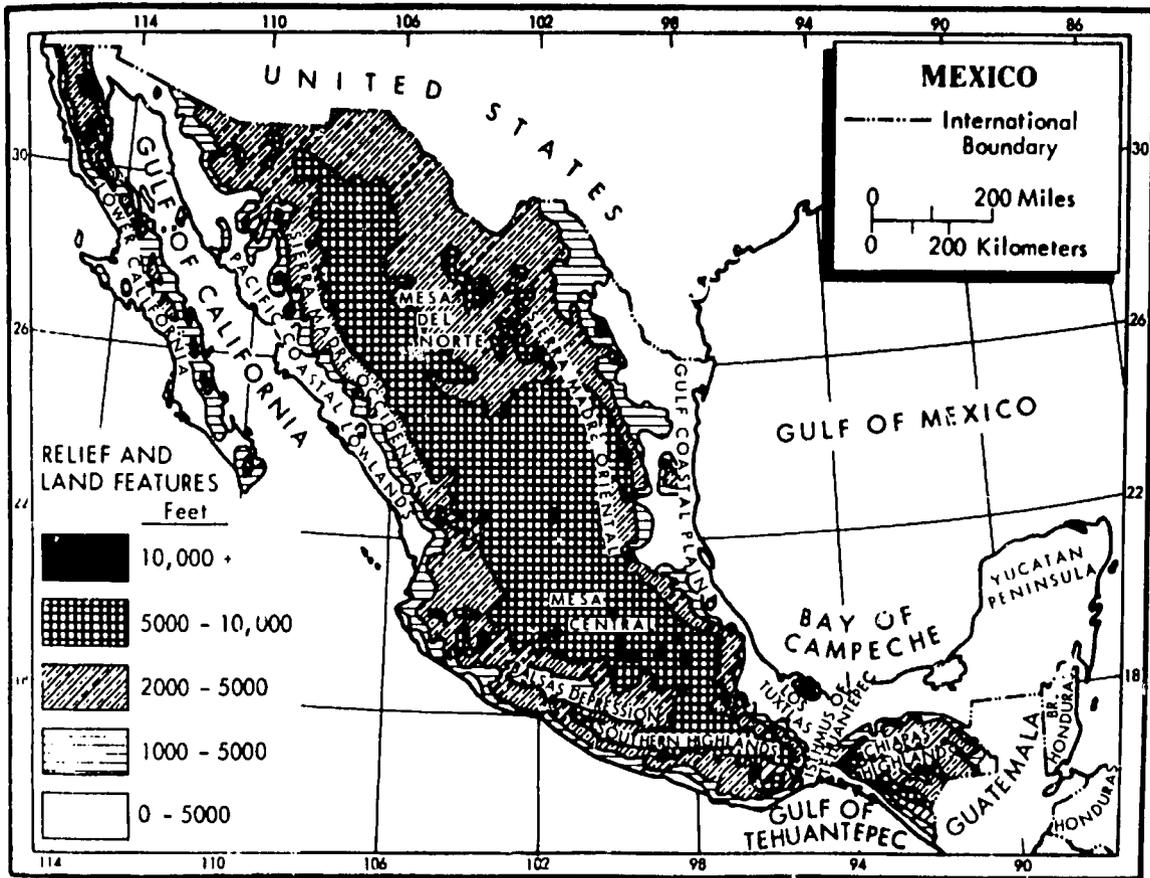


Figure 4. Topography of Mexico.

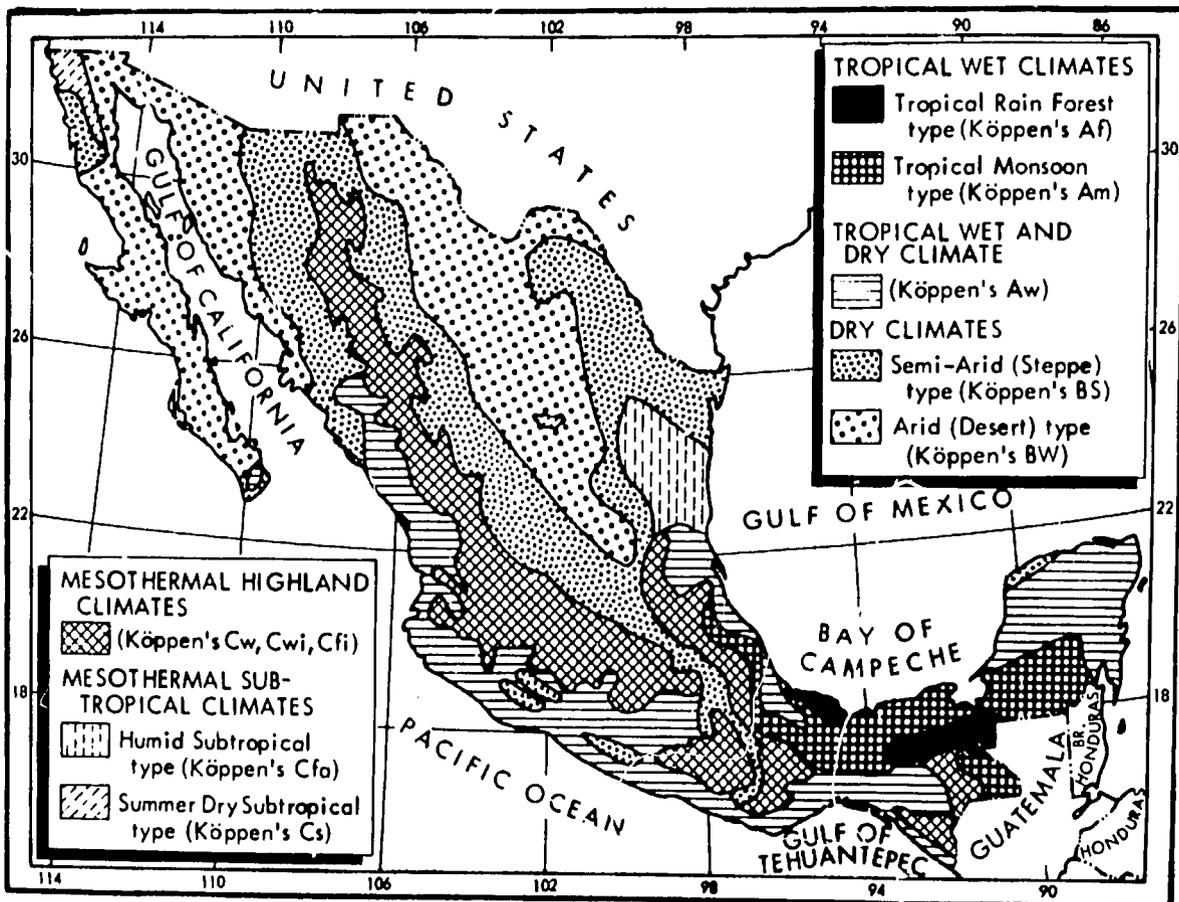


Figure 5. Climate of Mexico.

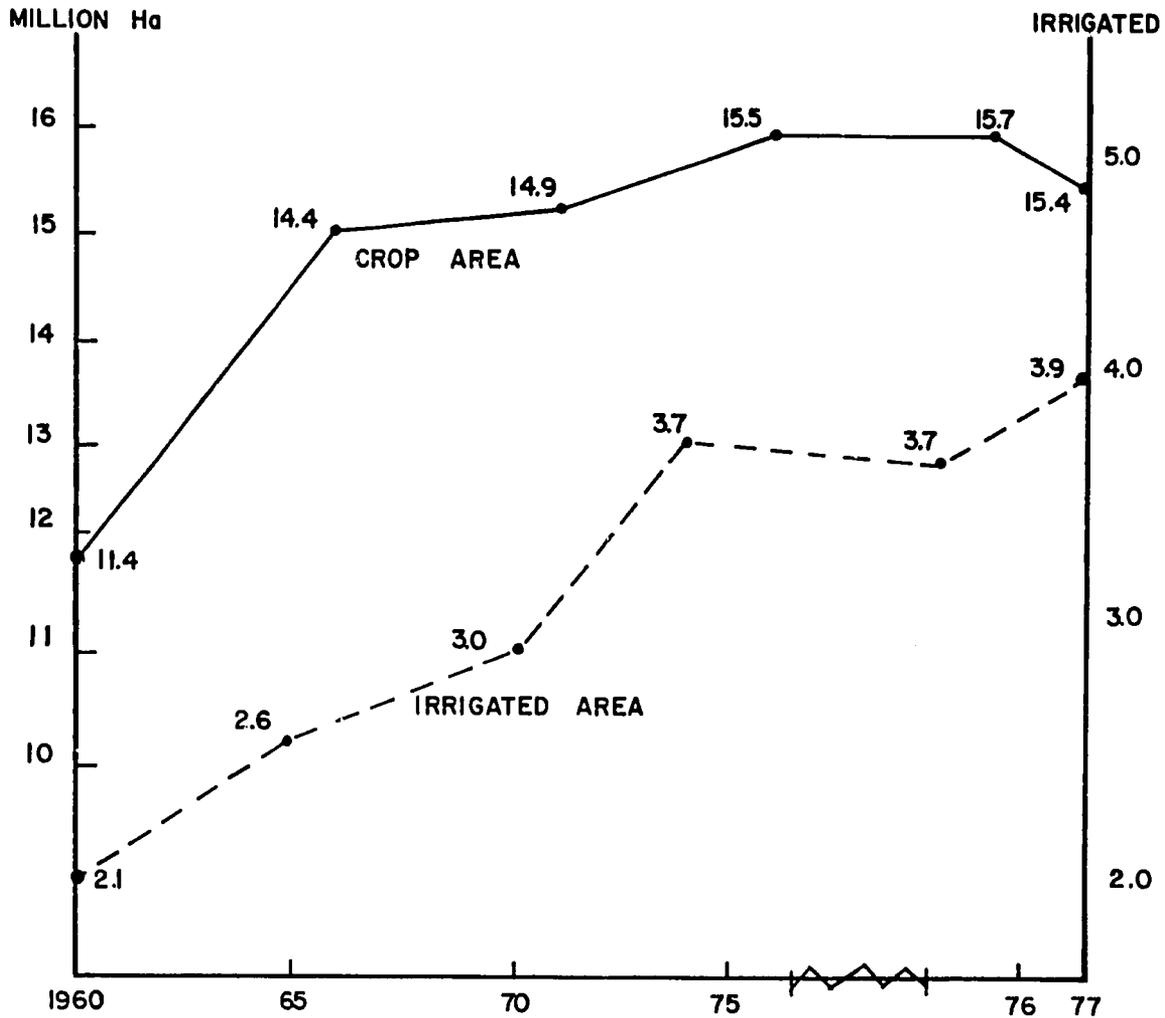


Figure 6. Expansion in Cropland and Irrigated Area, 1960-77.

pesticides. The commercial farms are concentrated in the northern arid zones and, thus, are the principal irrigated areas (figures 7 and 8). The size and output of farms vary as evidenced by the fact that, in 1975, 15% of the total number of farms were responsible for 75% of the value of crop production.

The major crops grown in Mexico are indicated by figure 9. In 1977 44% of the cultivated land was planted to corn, followed by beans, 9%; sorghum, 8%; and wheat, 6%. From 1960 to 1976, the relative importance of each crop (excluding sorghum and cotton) on the basis of cropped area has been fairly stable. Sorghum accounted for 8% of the cultivated area in 1976 as opposed to only 1% in 1960. Conversely, cotton accounted for

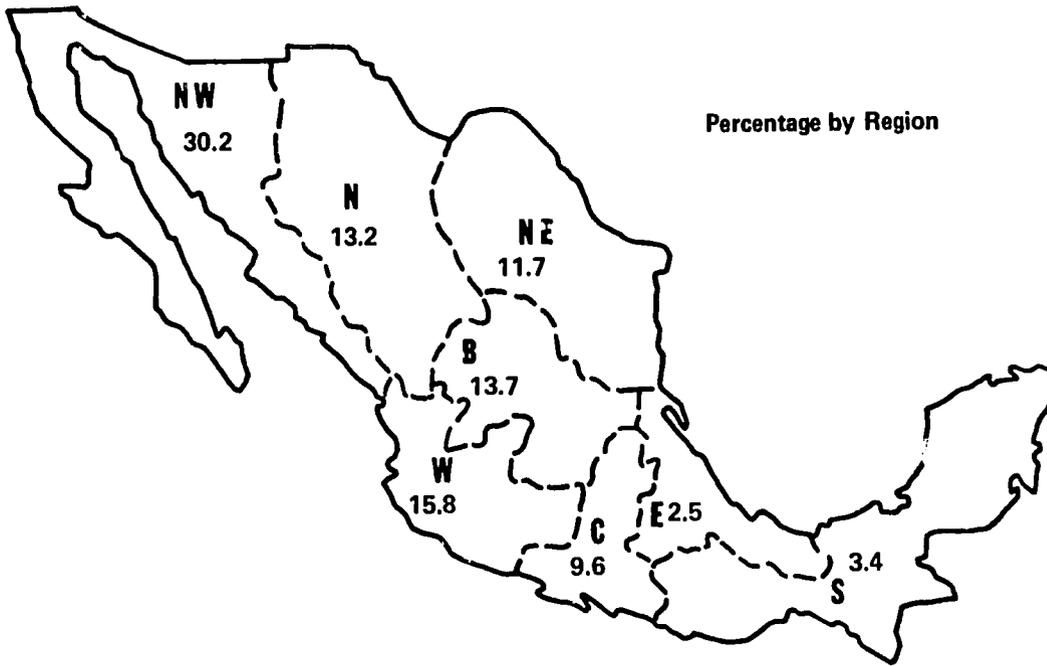


Figure 7. Irrigated Cropland by Region.

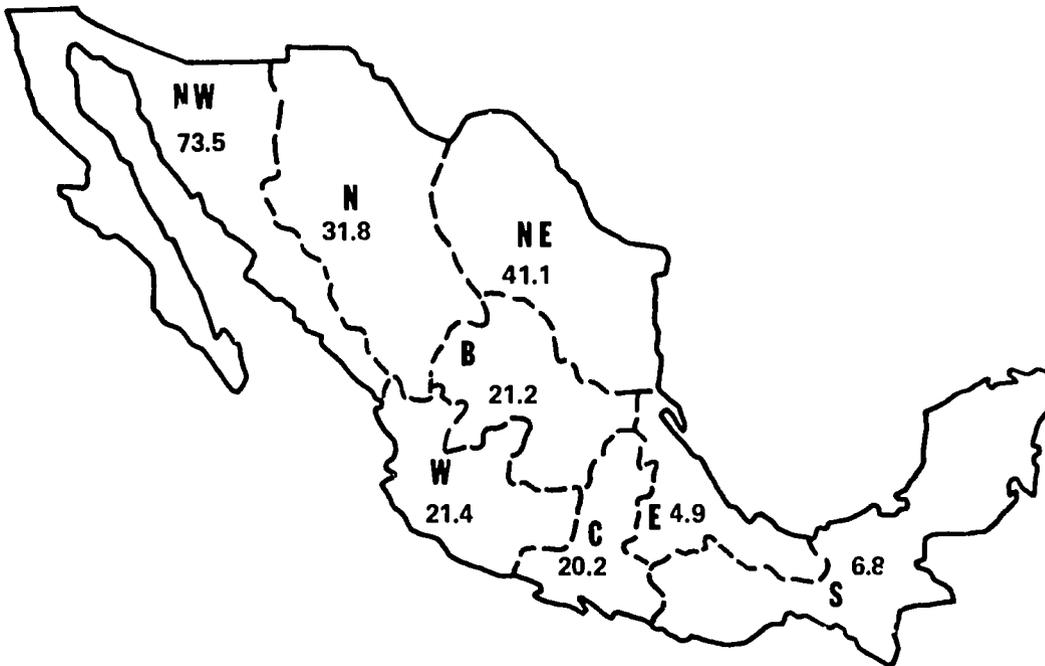


Figure 8. Percentage of Cultivated Land in Each Region that is Irrigated.

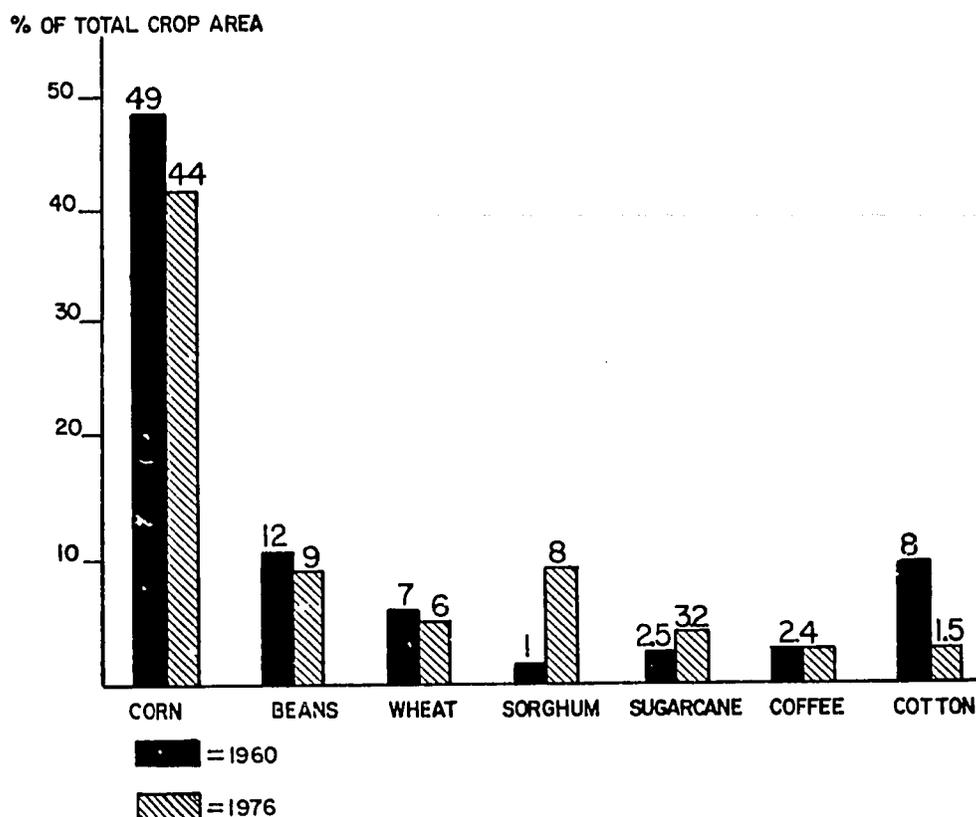


Figure 9. Major Crops in Mexico.

only 1.5% of the cropped area in 1976 versus 8.0% in 1960. These shifts in cropping patterns are due to the low profit from cotton and the attractiveness of sorghum as a cash crop.

The primary cropped areas are shown in figure 10. Corn and beans are common to all of Mexico. Cotton, wheat, and sorghum are grown only in the western and northern parts of the country. Today, 88% of the wheat and 53% of the sorghum are irrigated. Coffee is grown only in the southern part of the country.

Over the last 10 years, agricultural yields per hectare have increased for all of the important crops grown in Mexico (figure 11). This can largely be attributed to improved farming practices, more efficient use of modern inputs, and improved water management through irrigation. In recent years, yields of

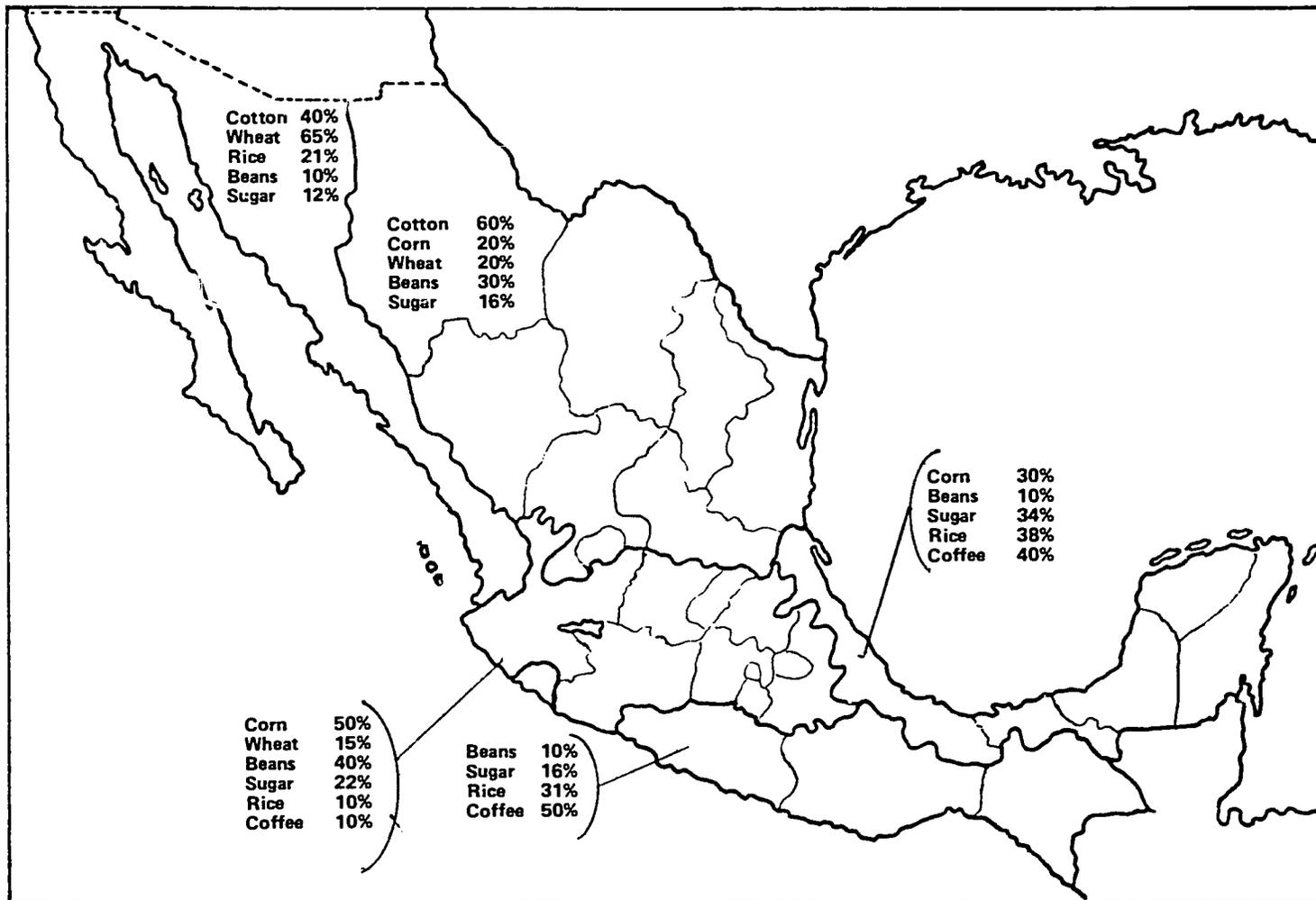


Figure 10. Primary Crop Areas (percentage by total national crop production).

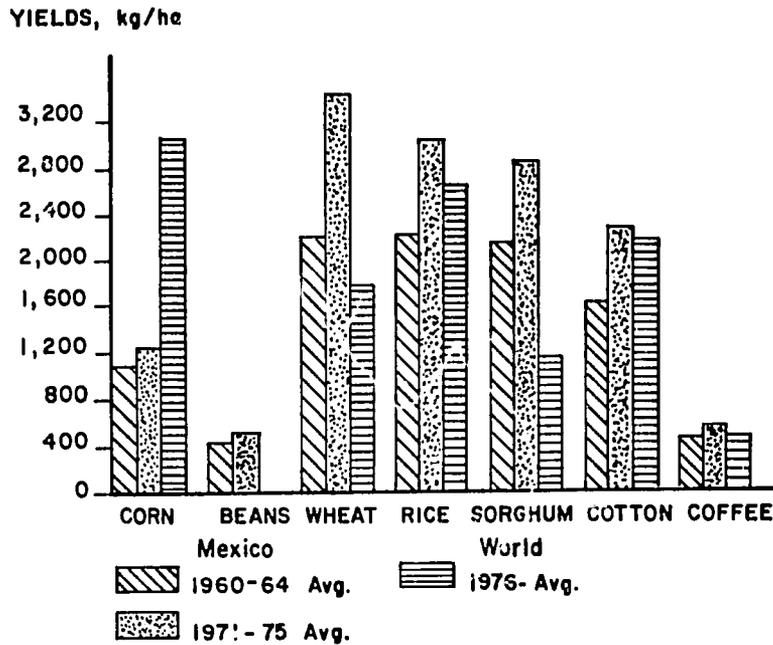


Figure 11. Crop Yield in Mexico.

sorghum, wheat, rice, coffee, and cotton have exceeded the world average. In fact, wheat and sorghum yields are among the highest in the world. Conversely, corn yields which have increased about 20% over the last 10 years remain well below the world average.

Future developments in Mexican agriculture will be strongly influenced by the government's agricultural policy. The Mexican Economic Development Plan (1976-82) calls for an increase in the production of food for local consumption and of agricultural raw materials for industrial purposes. A concerted effort will also be made to raise the levels of agricultural exports. The agricultural development program is based on two strategies, one of which calls for expanding production by increasing the cultivated area and the other which will emphasize increasing yields per hectare with adjustments in cropping patterns. Agricultural pricing policies will likely be instrumental in the government's efforts to achieve crop production goals. Agricultural pricing will be used to assist in the reallocation of land to selected crops and, in some instances, as a method of income redistribution in the agricultural sector.

## THE FERTILIZER SECTOR

### Fertilizer Policy

The fertilizer policy of Mexico is oriented toward national goals. Its primary objectives are:

1. To maintain government ownership of all primary fertilizer and raw material production;
2. To achieve optimum utilization of human, financial technological, and natural resources and attain self-sufficiency in raw materials and finished fertilizers;
3. To maintain government ownership or control of the total distribution system;
4. To provide fertilizers to all farmers in Mexico at favorable prices; and
5. To maintain a fertilizer reserve to allow for unexpected surges in domestic demand and to allow FERTIMEX to participate in the export market.

These policy objectives have been pursued since the mid-1960's and, with the exception of obtaining self-sufficiency in two raw materials (PR and  $K_2O$ ), have been virtually realized in 1978. Modification of these objectives will likely occur in the future as Mexico's fertilizer sector continues to progress.

### Fertilizer Industry

Guanos y Fertilizantes de Mexico, S.A. (GUANOMEX, hereafter referred to as FERTIMEX) and several private companies entered the fertilizer market in the early 1940's.<sup>1</sup> However, the general performance of the Mexican fertilizer industry during these formative years was poor; production facilities were operated inefficiently as was the domestic marketing system, thus stifling the government's efforts to foster fertilizer consumption. It was this general inefficiency of the industry that prompted government action in the mid-1960's which called for a merger of all fertilizer companies with FERTIMEX. By 1970 the industry takeover resulted in the concentration of slightly more than 60% of Mexico's N fertilizer capacity in the hands of FERTIMEX. The

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1. The name of the fertilizer company with government participation in Mexico, Guanos y Fertilizantes de Mexico (GUANOMEX), was changed to Fertilizantes de Mexico (FERTIMEX) in early 1978. FERTIMEX is also engaged in the manufacture and marketing of pesticides and nonagricultural petrochemicals in Mexico.

bulk of the remainder, comprised mostly of anhydrous ammonia units, was controlled by Petroleos Mexicanos, S.A. (PEMEX), a wholly owned government company. In addition, a small quantity of ammonium sulfate was produced as a byproduct by Industrias Quimicas de Mexico, S.A.; ASARCO Mexicana, S.A.; Altos Hornos de Mexico; UNIVEX; Cia Mexicana de Coque; and PEMEX.

The structure of the phosphate fertilizer industry has also developed in the direction of greater government ownership of production facilities. FERTIMEX entered the phosphate market in 1947 with production of single superphosphate (SSP) and later expanded its product mix to include triple superphosphate (TSP). With the arrival of Fertilizantes Fosfatados Mexicanos, S.A. (FFM), a private firm, in 1970 phosphate capacity in Mexico was shared 48% by FERTIMEX and 52% by FFM. At this stage, most of the FFM output was destined for export. Later, with expansion of the domestic market greater quantities of FFM product were channeled through FERTIMEX to Mexican farmers. Finally, in 1977 FFM officially merged with FERTIMEX giving FERTIMEX responsibility for almost all production and marketing activities of all fertilizer materials except ammonia (3).

The other major organization involved in fertilizer production in Mexico is PEMEX. Nationalized by government decree in 1938, PEMEX is the central agency in charge of all petroleum exploration, production, and marketing. This decree was reinforced in 1969 by the National Petroleum Law which afforded PEMEX the exclusive right to produce basic petrochemicals, including ammonia. PEMEX's role in Mexico's fertilizer industry is to supply ammonia and fuels as required in FERTIMEX's fertilizer production plants (4). With the exception of a small plant operated by FERTIMEX, PEMEX is the sole producer of ammonia in Mexico; currently nine ammonia plants with a total capacity of 1,737,000 mtpy of N are operated by PEMEX. The capacity and location of each of these are presented in table 1.

In addition to the two government organizations, a limited number of private concerns are engaged in fertilizer production or processing. These activities are limited to a small amount of ammonium sulfate produced as a byproduct, bulk blending, and the production of liquid fertilizers.

At present, FERTIMEX's fertilizer production facilities are located at 11 sites in Mexico and include 800,300 mtpy and 398,200 mtpy of N and P<sub>2</sub>O<sub>5</sub> capacity, respectively (figure 12 and tables 2 and 3). The bulk of this capacity is located in the east and Bajio regions. A small amount of capacity is located in four other regions, the west, north, central, and northeast (figures 13 and 14).

Table 1. Mexico--Ammonia Production Capacity and Nitrogen Fertilizer Supply-Demand Forecast

| Plant/Year   | 1960 <sup>a</sup>        | 1965 <sup>a</sup> | 1970 <sup>a</sup> | 1971 <sup>a</sup> | 1972 <sup>a</sup> | 1973 <sup>a</sup> | 1974 <sup>a</sup> | 1975 <sup>a</sup> | 1976 <sup>a</sup> | 1977 <sup>a</sup> | 1978 <sup>a</sup> | 1979 <sup>b</sup> | 1980  | 1981  | 1982  | 1983  | 1984  | 1985  |
|--|--------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------|-------|-------|-------|-------|-------|
|  | ----- '000 mt of N ----- |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |       |       |       |       |       |       |
| FERTIMEX:  |                          |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |       |       |       |       |       |       |
| Cuautitlan, Mex.   | 18                       | 18                | 18                | 18                | 18                | 18                | 18                | 18                | 18                | 18                | 18                | 18                | 18    | 18    | 18    | 18    | 18    | 18    |
| Monclova   | -                        | 32                | 32                | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -     | -     | -     | -     | -     | -     |
| PEMEX:   |                          |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |       |       |       |       |       |       |
| Cosoleacaque I   |                          | 49                | 49                | 49                | 49                | 49                | 49                | 49                | 49                | 49                | 49                | 49                | 49    | 49    | 49    | 49    | 49    | 49    |
| Cosoleacaque II  |                          |                   | 246               | 246               | 246               | 246               | 246               | 246               | 246               | 246               | 246               | 246               | 246   | 246   | 246   | 246   | 246   | 246   |
| Cosoleacaque III   |                          |                   |                   |                   |                   |                   | 246               | 246               | 246               | 246               | 246               | 246               | 246   | 246   | 246   | 246   | 246   | 246   |
| Cosoleacaque IV  |                          |                   |                   |                   |                   |                   |                   |                   | 365               | 365               | 365               | 365               | 365   | 365   | 365   | 365   | 365   | 365   |
| Cosoleacaque V   |                          |                   |                   |                   |                   |                   |                   |                   | 365               | 365               | 365               | 365               | 365   | 365   | 365   | 365   | 365   | 365   |
| Cosoleacaque VI  |                          |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   | 365   | 365   | 365   | 365   | 365   | 365   |
| Cosoleacaque VII   |                          |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   | 365   | 365   | 365   | 365   | 365   | 365   |
| Salamanca I  |                          | 75                | 75                | 75                | 75                | 75                | 75                | 75                | 75                | 75                | 75                | 75                | 75    | 75    | 75    | 75    | 75    | 75    |
| Salamanca II   |                          |                   |                   |                   |                   |                   |                   |                   |                   |                   | 246               | 246               | 246   | 246   | 246   | 246   | 246   | 246   |
| Ciudad Camargo   |                          |                   | 127               | 127               | 127               | 127               | 127               | 127               | 127               | 127               | 127               | 127               | 127   | 127   | 127   | 127   | 127   | 127   |
| Project I <sup>c</sup>   |                          |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |       |       | 365   | 365   | 365   | 365   |
| Project II <sup>c</sup>  |                          |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |       |       | 365   | 365   | 365   | 365   |
| Total Capacity   | 18                       | 420               | 547               | 515               | 515               | 515               | 761               | 761               | 761               | 1,491             | 1,737             | 1,737             | 2,467 | 2,467 | 3,977 | 3,197 | 3,197 | 3,197 |
| Potential Supply<br>of Nitrogen <sup>d</sup><br>Fertilizers <sup>d</sup> |                          |                   | 406               | 382               | 415               | 438               | 418               | 645               | 699               | 757               | 1,274             | 1,452             | 1,616 | 2,098 | 2,306 | 2,720 | 2,720 | 2,706 |
| Demand <sup>e</sup>  |                          |                   | 404               | 435               | 485               | 555               | 593               | 733               | 830               | 779               | 731               | 944               | 1,024 | 1,122 | 1,226 | 1,339 | 1,465 | 1,601 |
| Balance <sup>f</sup>   |                          |                   | 2                 | (53)              | (70)              | (117)             | (175)             | (87)              | (131)             | 22                | 543               | 508               | 592   | 976   | 1,080 | 1,381 | 1,255 | 1,105 |

a. Actual.

b. Estimated.

c. Unspecified location.

d. N supply projections are based on 1979 projections by PEMEX. Due to extensive experience in ammonia plant operation in Mexico, a 90% capacity utilization factor is assumed for all plants. Allowances have also been made for nonfertilizer use of ammonia and losses.

e. FERTIMEX, 1978.

f. Potential supply of N for export.

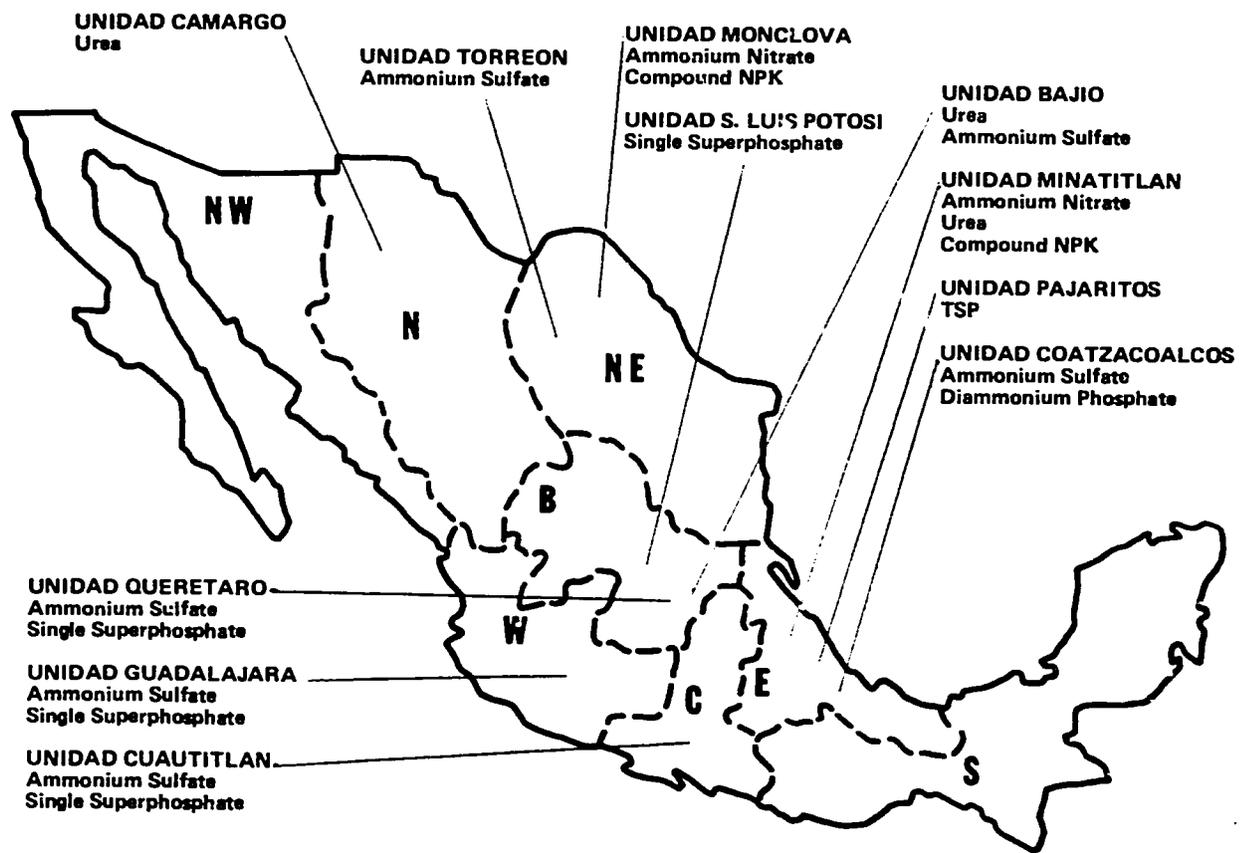


Figure 12. Location of FERTIMEX Finished Fertilizer Plants, 1978.

Table 2. Nitrogen Fertilizer Capacity and Supply Potential

|                                     | 1950 <sup>a</sup> | 1960 <sup>a</sup> | 1970 <sup>a</sup> | 1971 <sup>a</sup> | 1972 <sup>a</sup> | 1973 <sup>a</sup> | 1974 <sup>a</sup> | 1975 <sup>a</sup> | 1976 <sup>a</sup> | 1977 <sup>a</sup> | 1978 <sup>a</sup> | 1979 <sup>b</sup> | 1980 <sup>c</sup> | 1981 <sup>c</sup> | 1982 <sup>c</sup> | 1983 <sup>c</sup> | 1984 <sup>c</sup> | 1985 <sup>c</sup> |
|-------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|                                     | '000 mt of N      |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
|                                     | Ammonium Sulfate  |                   |                   |                   |                   |                   |                   |                   |                   | Urea              |                   |                   |                   |                   |                   |                   |                   |                   |
| Cuautitlan                          | 21.0              | 21.0              | 21.0              | 21.0              | 31.5              | 49.3              | 49.3              | 49.3              | 49.3              | 49.3              | 49.3              | 49.3              | 49.3              | 49.3              | 49.3              | 49.3              | 49.3              | 49.3              |
| Torreón                             | -                 | -                 | 21.0              | 21.0              | 21.0              | 21.0              | 21.0              | 21.9              | 21.9              | 21.9              | 21.9              | 21.9              | 42.0              | 42.0              | 42.0              | 42.0              | 42.0              | 42.0              |
| Coatzacoalcos                       | -                 | -                 | 10.5              | 18.9              | 18.9              | 18.9              | 18.9              | 18.9              | 18.9              | 18.9              | 18.9              | 18.9              | 42.0              | 42.0              | 42.0              | 42.0              | 42.0              | 42.0              |
| Toluquilla, Guadalajara             | -                 | -                 | 26.8              | 26.8              | 26.8              | 26.8              | 26.8              | 26.8              | 26.8              | 26.8              | 26.8              | 26.8              | 58.5              | 58.5              | 58.5              | 58.5              | 58.5              | 58.5              |
| Salamanca                           | -                 | -                 | 12.6              | 12.6              | 12.6              | 12.6              | 12.6              | 12.6              | 12.6              | 12.6              | 12.6              | 12.6              | 33.6              | 33.6              | 33.6              | 33.6              | 33.6              | 33.6              |
| Queretaro                           | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 42.0              | 42.0              | 126.0             | 126.0             | 126.0             | 126.0             |
| Other <sup>d</sup>                  | -                 | -                 | 19.4              | 19.4              | 56.2              | 56.2              | 56.2              | 56.2              | 39.3              | 40.0              | 40.0              | 40.0              | 40.0              | 40.0              | 40.0              | 40.0              | 40.0              | 40.0              |
| Total Capacity                      | 21.0              | 21.0              | 111.3             | 119.7             | 167.0             | 184.8             | 184.8             | 184.8             | 168.8             | 169.5             | 211.5             | 307.4             | 391.4             | 391.4             | 391.4             | 391.4             | 391.4             | 391.4             |
| Expected Production                 | 0.5               | 30.2              | 79.5              | 71.4              | 82.7              | 96.9              | 133.3             | 142.3             | 166.7             | 167.2             | 169.8             | 261.7             | 303.0             | 361.8             | 370.2             | 378.6             | 387.0             | 387.0             |
|                                     | Ammonium Nitrate  |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| Monclova                            | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              | 22.8              |
| Minatitlan                          | -                 | -                 | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              | 33.5              |
| Lazaro Cardenas I                   | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 67.0              | 67.0              | 67.0              | 67.0              | 67.0              | 67.0              |
| Total Capacity                      | 22.8              | 22.8              | 56.3              | 56.3              | 56.3              | 56.3              | 56.3              | 56.3              | 56.3              | 56.3              | 56.3              | 56.3              | 123.3             | 123.3             | 123.3             | 123.3             | 123.3             | 123.3             |
| Expected Production                 | -                 | 18.0              | 50.1              | 52.8              | 50.4              | 50.5              | 49.5              | 51.4              | 49.3              | 51.4              | 36.9              | 44.2              | 44.2              | 55.9              | 98.8              | 105.5             | 112.2             | 118.9             |
|                                     | DAP               |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| Coatzacoalcos                       | -                 | -                 | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              |
| Lazaro Cardenas I                   | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 49.5              | 49.5              | 49.5              | 49.5              | 49.5              |
| Lazaro Cardenas II <sup>e</sup>     | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 51.5              | 51.5              | 51.5              | 51.5              | 51.5              |
| Pajaritos                           | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 34.0              | 34.0              | 34.0              | 34.9              | 34.9              | 34.9              | 34.9              |
| Total Capacity                      | -                 | -                 | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 14.9              | 48.9              | 48.9              | 98.4              | 149.9             | 149.9             | 149.9             | 149.9             |
| Expected Production                 | -                 | -                 | 13.5              | 20.1              | 18.8              | 21.6              | 23.2              | 24.8              | 26.5              | 28.6              | 12.9              | 15.3              | 21.4              | 25.2              | 92.3              | 106.2             | 96.3              | 96.5              |
|                                     | NPK               |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| Minatitlan <sup>g</sup>             | -                 | -                 | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              | 24.8              |
| Monclova <sup>h</sup>               | -                 | -                 | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              | 11.7              |
| Lazaro Cardenas I                   | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 44.3              | 44.3              | 44.3              | 44.3              | 44.3              |
| Total Capacity                      | -                 | -                 | 36.5              | 36.5              | 36.5              | 36.5              | 36.5              | 36.5              | 36.5              | 36.5              | 36.5              | 36.5              | 36.5              | 80.8              | 80.8              | 80.8              | 80.8              | 80.8              |
| Expected Production                 | -                 | -                 | 15.5              | 18.3              | 23.8              | 25.5              | 27.6              | 28.9              | 32.2              | 29.8              | 45.1              | 43.4              | 58.2              | 63.5              | 82.6              | 89.0              | 96.6              | 103.0             |
| Total Solid N <sup>i</sup> Capacity | 43.8              | 43.8              | 304.3             | 426.6             | 473.9             | 491.7             | 491.7             | 491.7             | 475.7             | 476.4             | 518.4             | 800.3             | 1,179.3           | 1,501.1           | 1,552.6           | 1,552.6           | 1,552.6           | 1,552.6           |
| Total Solid N Production            | 0.5               | 48.2              | 231.6             | 261.2             | 333.2             | 361.8             | 388.2             | 402.0             | 435.8             | 456.1             | 420.7             | 566.1             | 867.5             | 1,044.1           | 1,279.6           | 1,369.8           | 1,399.6           | 1,429.9           |

a. Actual.  
 b. Estimated.  
 c. Forecast.  
 d. Other = Byproduct ammonium sulfate.  
 e. 286,000 mtpy of DAP or NPK and 150,000 of TSP (product basis).

f. 189,000 mtpy of DAP or NPK and 150,000 of TSP (product basis).  
 g. 140,000 mtpy of DAP or NPK (product basis).  
 h. 66,000 mtpy of DAP or NPK (product basis).  
 i. In addition to solid nitrogen capacity, in 1981 a 112,000 mtpy liquid nitrogen plant will come on stream in Pajaritos.

Table 3. Phosphate Fertilizer Capacity and Supply Potential

|  | 1950 <sup>a</sup>                                    | 1960 <sup>a</sup> | 1970 <sup>a</sup> | 1971 <sup>a</sup> | 1972 <sup>a</sup> | 1973 <sup>a</sup> | 1974 <sup>a</sup> | 1975 <sup>a</sup> | 1976 <sup>a</sup> | 1977 <sup>a</sup> | 1978 <sup>a</sup> | 1979 <sup>b</sup> | 1980 <sup>c</sup> | 1981 <sup>c</sup> | 1982 <sup>c</sup> | 1983 <sup>c</sup> | 1984 <sup>c</sup> | 1985 <sup>c</sup> |
|--|--|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|  | ----- '000 mt of P <sub>2</sub> O <sub>5</sub> ----- |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
|  | SSP  |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| San Luis P.                                    | 12.5   | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              | 12.5              |
| Cuautitlan                                     | -  | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              | 24.0              |
| Guadalajara <sup>d</sup>                       | -  | -                 | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | -                 | -                 | -                 | -                 | -                 | -                 |
| Queretaro                                      | -  | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 60.0              | 60.0              | 60.0              | 60.0              | 60.0              | 60.0              | 60.0              | 60.0              |
| Total SSP Capacity                             | 12.5   | 36.5              | 54.5              | 54.5              | 54.5              | 54.5              | 54.5              | 54.5              | 54.5              | 54.5              | 114.5             | 114.5             | 96.5              | 96.5              | 96.5              | 96.5              | 96.5              | 96.5              |
| Expected SSP Production                        | 2.3  | 18.8              | 35.0              | 40.4              | 54.1              | 52.6              | 50.8              | 56.4              | 58.0              | 56.7              | 56.4              | 80.0              | 63.2              | 71.8              | 81.2              | 85.4              | 93.4              | 96.5              |
|  | TSP  |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| Pajaritos <sup>e</sup>                         | -  | -                 | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 69.0              | 69.0              | 69.0              | 69.0              | 69.0              | 69.0              |
| Lazaro Cardenas II <sup>f</sup>                | -  | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 69.0              | 69.0              | 69.0              | 69.0              |
| Guadalajara <sup>d</sup>                       | -  | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 18.4              | 18.4              | 18.4              | 18.4              | 18.4              | 18.4              |
| Total TSP Capacity                             | -  | -                 | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 124.2             | 87.4              | 87.4              | 156.4             | 156.4             | 156.4             | 156.4             |
| Expected TSP Production                        | -  | -                 | 88.0              | 91.6              | 85.8              | 105.7             | 117.0             | 111.6             | 99.4              | 125.1             | 102.5             | 124.2             | 93.4              | 103.0             | 137.1             | 151.8             | 168.4             | 185.8             |
|  | DAP  |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| Coatzacoalcos                                  | -  | -                 | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              |
| Lazaro Cardenas I                              | -  | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 126.5             | 126.5             | 126.5             | 126.5             |
| Lazaro Cardenas II <sup>c</sup>                | -  | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 131.6             | 131.6             | 131.6             | 131.6             |
| Pajaritos <sup>e</sup>                         | -  | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 86.9              | 86.9              | 86.9              | 86.9              | 86.9              | 86.9              | 86.9              |
| Total DAP Capacity                             | -  | -                 | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 38.2              | 125.1             | 125.1             | 251.6             | 383.2             | 383.2             | 383.2             | 383.2             |
| Expected DAP Production                        | -  | -                 | 34.3              | 51.5              | 48.0              | 55.2              | 59.2              | 63.4              | 67.8              | 73.2              | 33.1              | 39.1              | 54.7              | 64.4              | 236.0             | 271.4             | 246.1             | 246.6             |
|  | Complex NPK  |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| Minatitlan <sup>g</sup>                        | -  | -                 | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              | 23.4              |
| Monclova <sup>h</sup>                          | -  | -                 | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              | 11.0              |
| Lazaro Cardenas I                              | -  | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 41.8              | 41.8              | 41.8              | 41.8              | 41.8              |
| Total NPK Capacity                             | -  | -                 | 34.4              | 34.4              | 34.4              | 34.4              | 34.4              | 34.4              | 34.4              | 34.4              | 34.4              | 34.4              | 34.4              | 76.2              | 76.2              | 76.2              | 76.2              | 76.2              |
| Expected NPK Production                        | -  | -                 | 15.7              | 15.5              | 19.7              | 26.0              | 26.3              | 25.6              | 28.9              | 27.0              | 35.0              | 40.9              | 54.9              | 59.9              | 78.0              | 84.0              | 91.2              | 97.2              |
| Total P <sub>2</sub> O <sub>5</sub> Capacity   | 12.5   | 36.5              | 251.3             | 251.3             | 251.3             | 251.3             | 251.3             | 251.3             | 251.3             | 251.3             | 311.3             | 398.2             | 343.4             | 511.7             | 712.3             | 712.3             | 712.3             | 712.3             |
| Total P <sub>2</sub> O <sub>5</sub> Production | 2.3  | 18.8              | 173               | 200               | 208               | 240               | 253               | 257               | 254               | 282               | 227               | 284               | 266               | 299               | 532               | 593               | 599               | 626               |

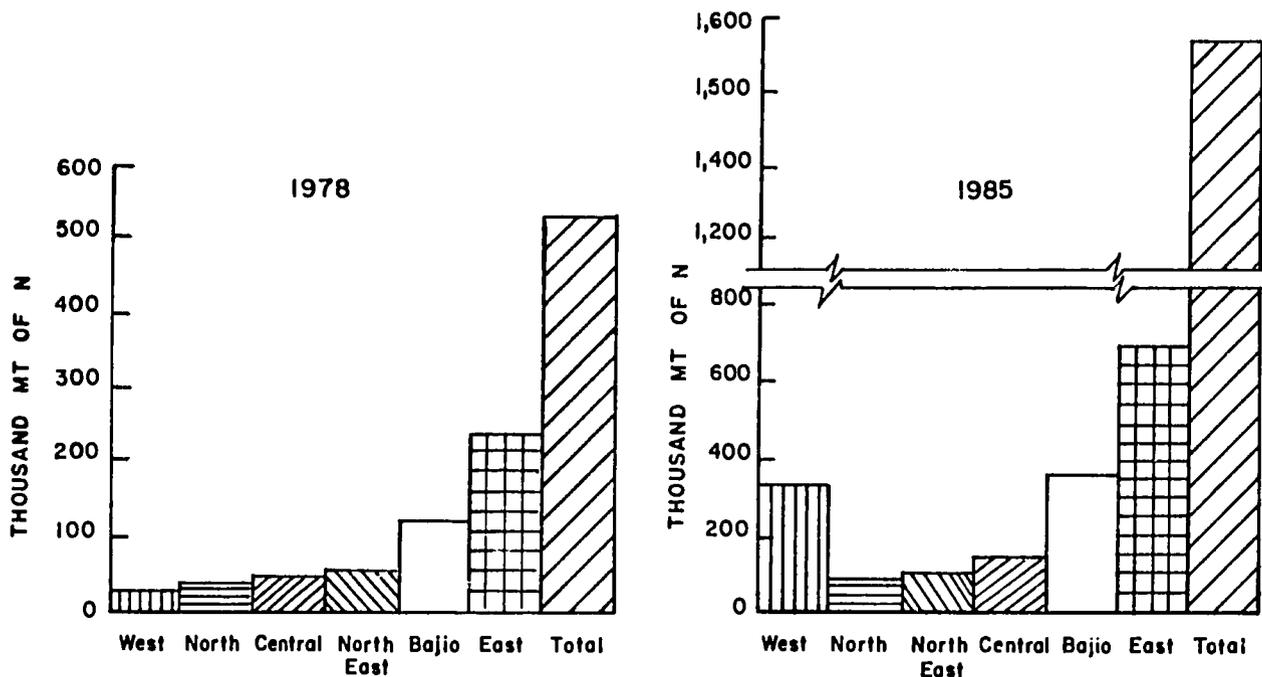


Figure 13. Regional Nitrogen Fertilizer Capacity.

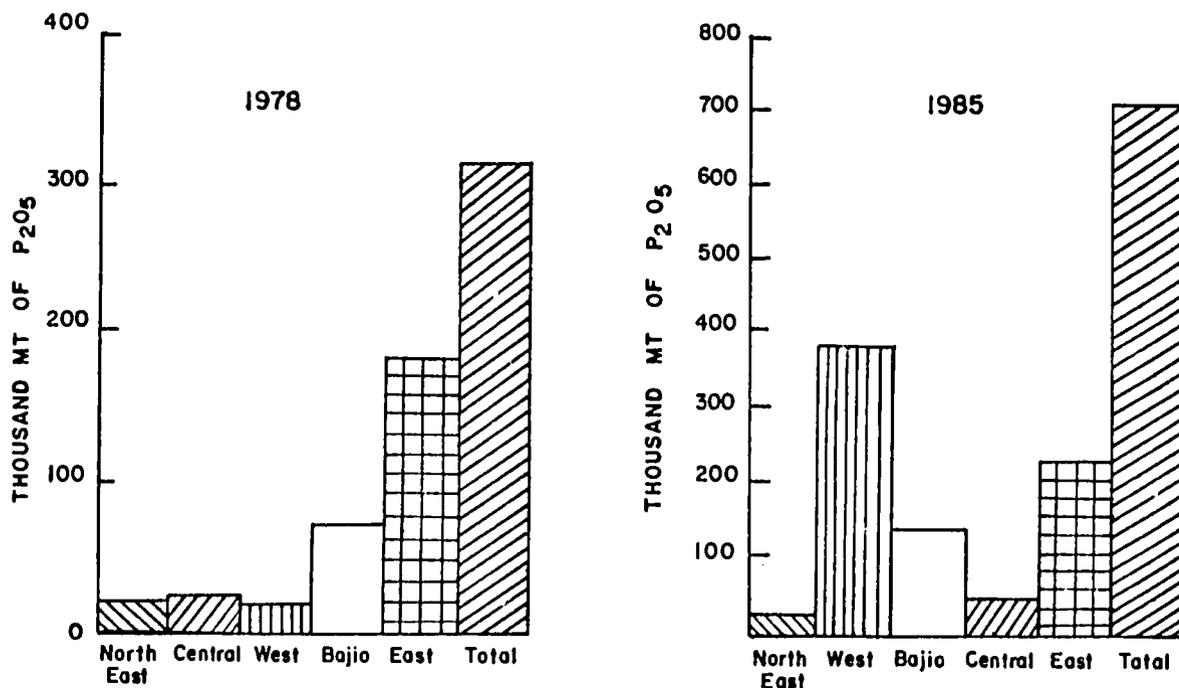


Figure 14. Regional Phosphate Fertilizer Capacity.

As indicated by figure 15, there has been a gradual shift in emphasis in fertilizer production in Mexico toward high-analysis products. For example, urea and ammonium sulfate represented 28% and 37%, respectively, of the dry nitrogen fertilizer capacity in 1970. Conversely, in 1979 urea accounted for 44% of Mexico's nitrogen fertilizer capacity while ammonium sulfate accounted for 38%. The remaining nitrogen capacity, which consists of facilities to manufacture ammonium nitrate (56,300 mtpy of N), diammonium phosphate (DAP) (48,900 mtpy of N), and complex NPK fertilizers (36,500 mtpy of N), continues to account for a small share of the nitrogen market. In the phosphate sector, DAP, TSP, and SSP each account for approximately one-third of the solid phosphate fertilizer capacity. The level of TSP capacity has not changed since 1970. As a result of modification of the phosphate plant at Pajaritos in 1979, DAP capacity has increased threefold since 1970

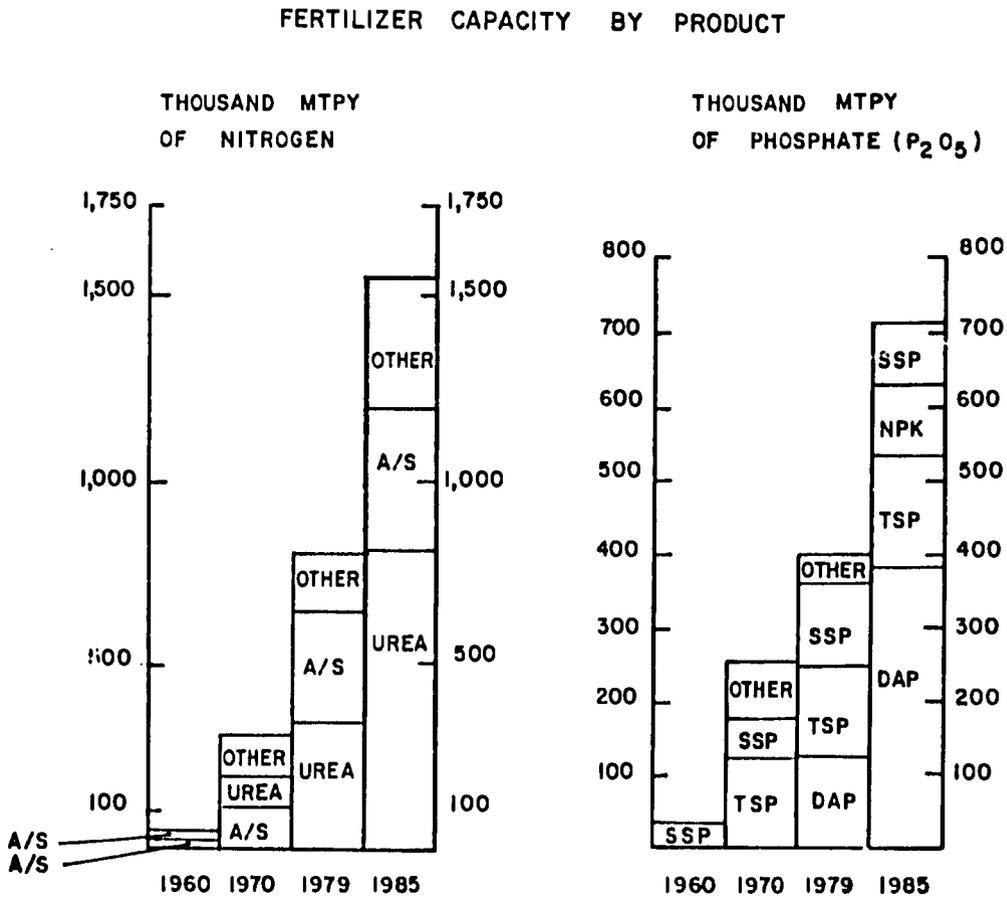


Figure 15. Fertilizer Capacity by Product.

to 125,100 mtpy of  $P_2O_5$ . In addition, the NPK plants at Monclova and Minatitlan also have the capability of producing DAP, thus further increasing Mexico's potential for production of high-analysis fertilizers.<sup>2</sup>

### Fertilizer Trade

International trade plays an important role in the Mexican fertilizer sector. As shown in figure 16, total fertilizer imports have exceeded total exports in almost every year in this decade. On an individual nutrient basis the situation is quite varied. Mexico is totally dependent on imports to meet its  $K_2O$  needs, and prior to 1978 increasingly large tonnages of nitrogen were imported to supplement domestic production. However, with completion of additional ammonia capacity in 1978, Mexico achieved a positive nitrogen-trade balance (539,500 mt of N as ammonia was exported). Currently, due to an absence of downstream facilities, the export potential is primarily in the form of ammonia; thus, imports are required to satisfy a portion of the dry fertilizer demand. However, this situation will change in the future as a result of the projects which are scheduled to come on stream in the next 2 years. A positive net trade balance for phosphates (excluding phosphate rock) has been maintained thus far in the 1970's. Phosphate exports, comprised of TSP and phosphoric acid, peaked in 1973 at 186,000 mt of  $P_2O_5$ .

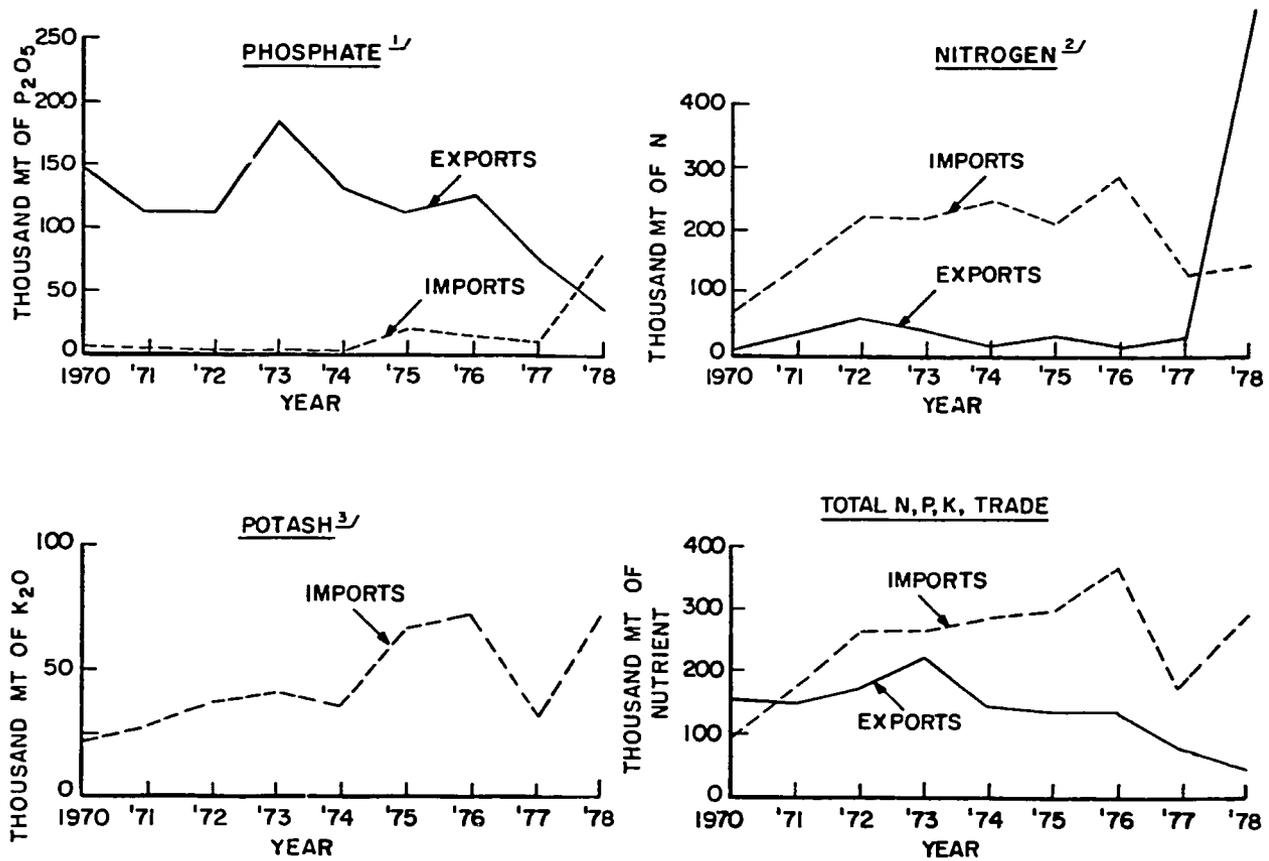
### Fertilizer Consumption

The trend in fertilizer use in Mexico is one of sizeable and sustained growth (figure 17). Fertilizer consumption totaled only 10,000 mt of nutrient in 1950; by 1960 consumption had reached 130,000 mt; by 1970, 537,000 mt; and in 1978 fertilizer nutrient consumption reached an estimated 1,065,000 mt. Since 1960 fertilizer use has increased at an average annual rate of 12.4%.

Nitrogen, the most consumed of the three primary nutrients, accounted for 69% of total nutrient consumption in 1978, followed by phosphate which accounted for 25%. The current high use of nitrogen in relation to phosphate and potash is of concern to Mexican agronomists; this may lead to the promotion of a more balanced ratio of plant nutrient use in the future.

The impressive growth in fertilizer use is due in large part to the increase in application rates on cultivated land (figure 18).

<sup>2</sup> In this study the plant capacities at Monclova and Minatitlan are presented in terms of NPK capacity.



1. Includes phosphate fertilizers and phosphoric acid.
2. Includes nitrogen fertilizers and ammonia.
3. Mexico does not export potash.

Figure 16. International Fertilizer Trade.

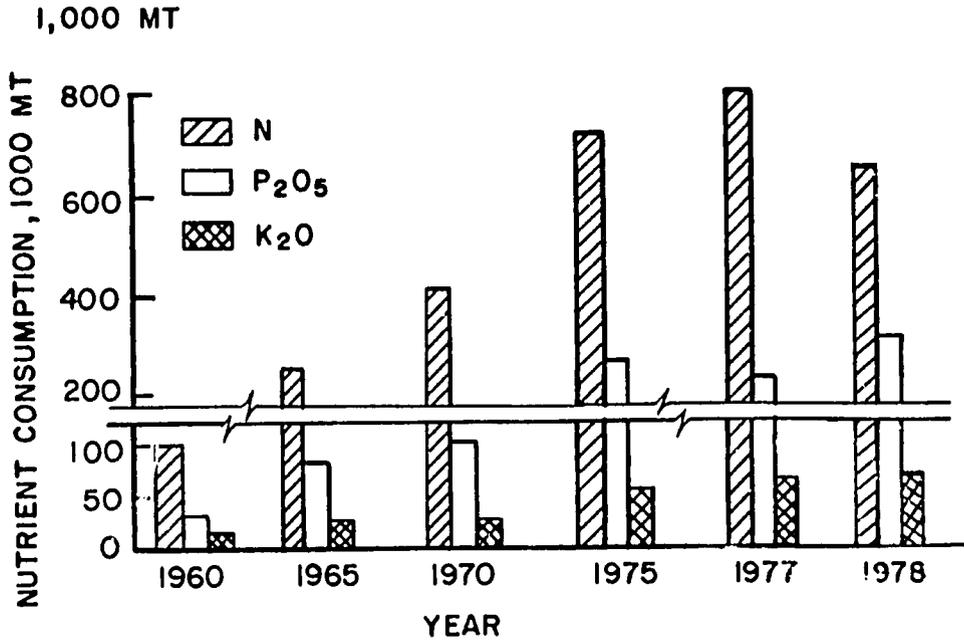


Figure 17. Fertilizer Consumption Trends.

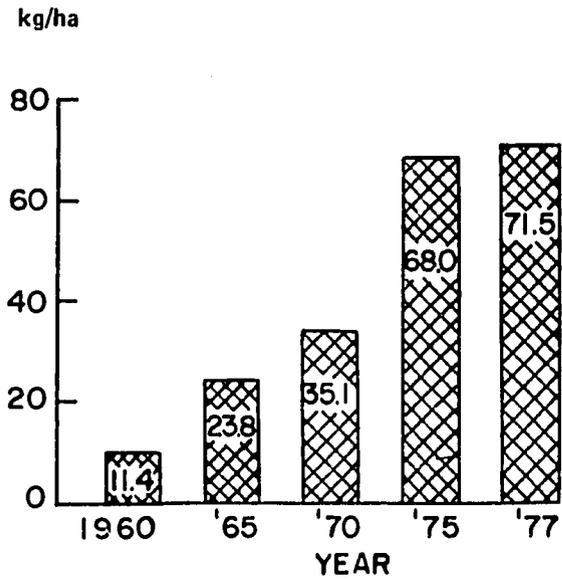
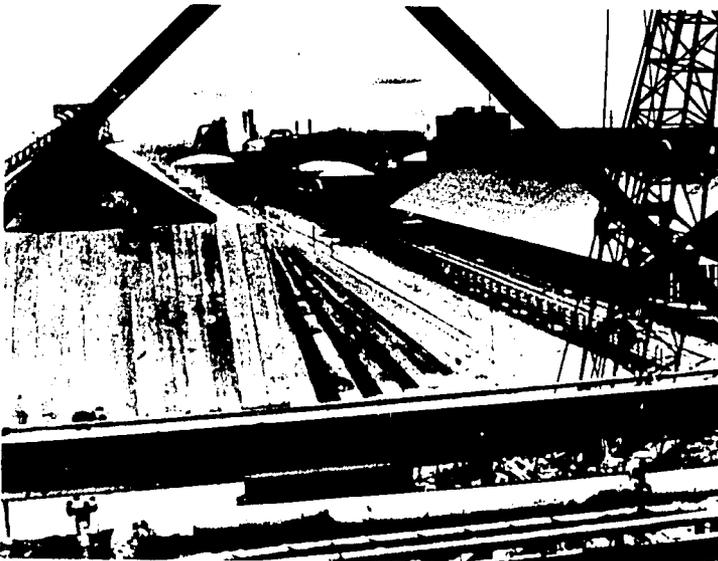


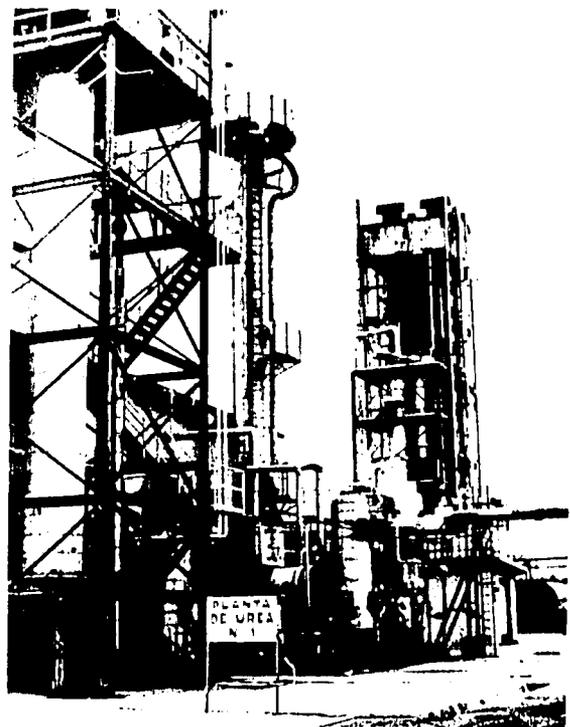
Figure 18. Trends in Fertilizer Consumption.



Minatitlan Unit Urea Storage Warehouse.



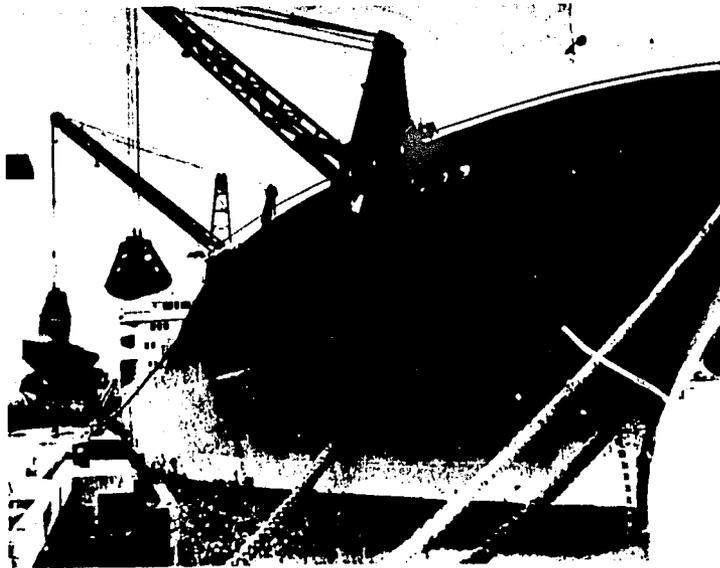
Pajaritos Phosphate Rock Storage Warehouse.



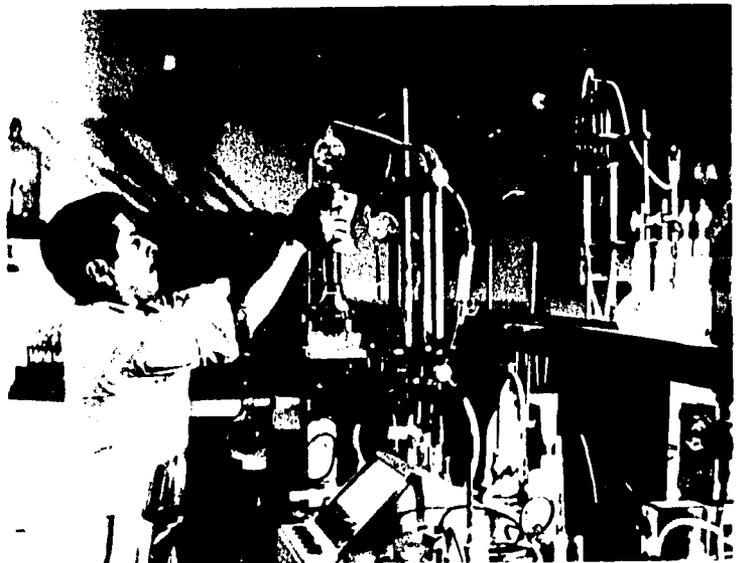
Minatitlan Unit Urea Plant No. 1.



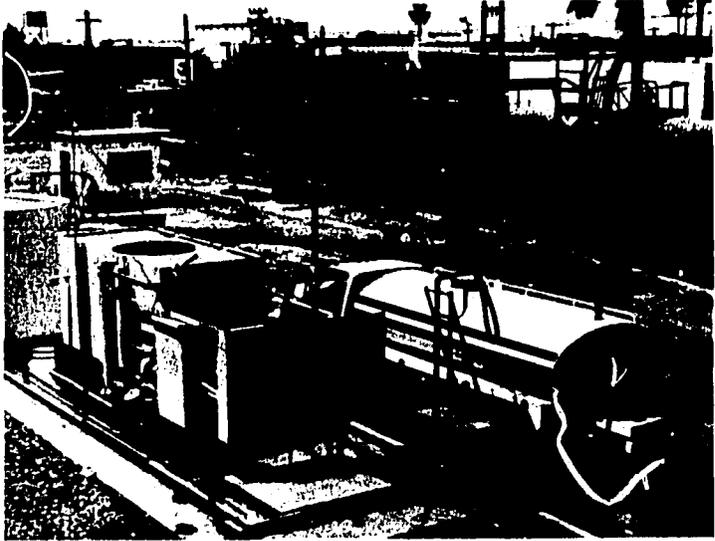
**Nurse Tank for Anhydrous Ammonia at Culiacan, Sinaloa.**



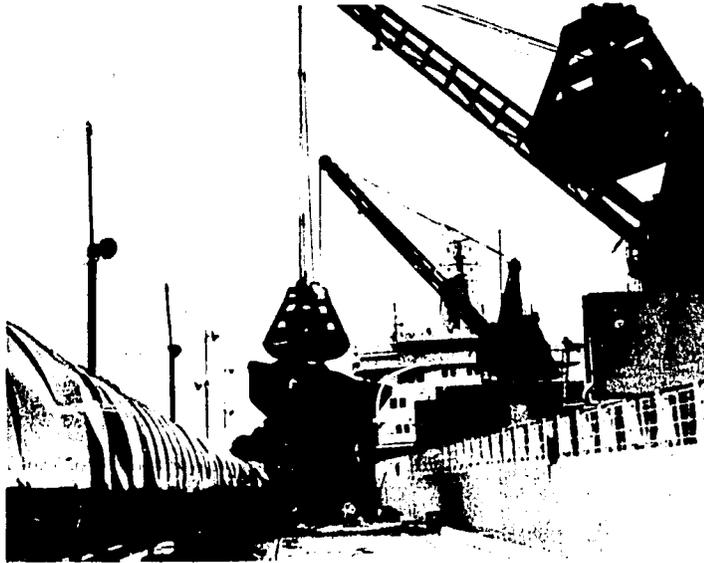
**Discharging Phosphate Rock at Pajaritos.**



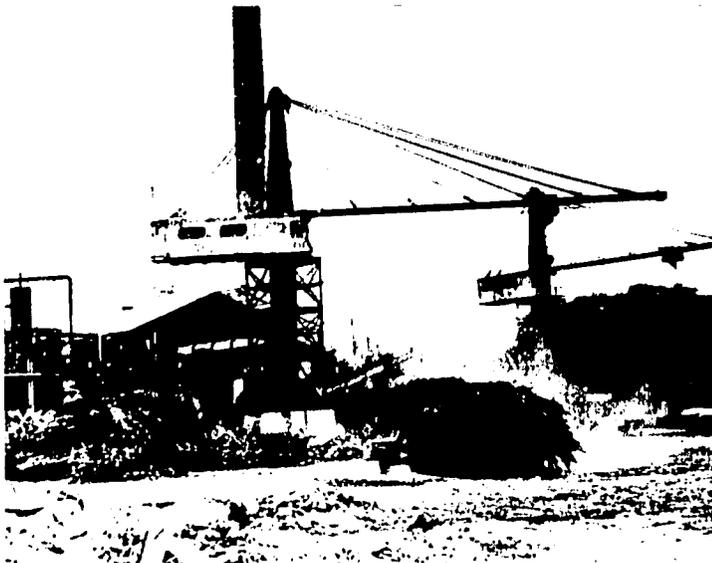
**Quality Control Laboratory at Coatzacoalcos.**



**Fluid Fertilizer Plant at Culiacan, Sinaloa.**



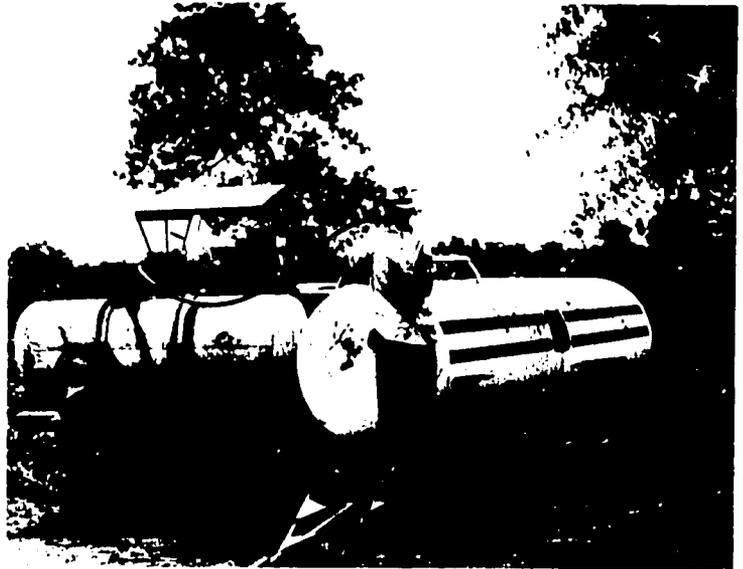
**First Phase of Phosphate Rock Unloading, Pajaritos Unit Pier.**



**Sugar Mill.**



Typical Farmer or Campesino.



Anhydrous Ammonia Applicator and Nurse Tank.



Farmer Signing for Fertilizers Received.

Over the past 17 years, fertilizer nutrient consumption per hectare of cultivated cropland in Mexico increased by 625%. However, usage rates vary from region to region with only two regions, the northwest and central, exceeding the national average of 71.5 kg/ha (figure 19). Fertilizer nutrient use in the northwest and central regions reached 185 kg/ha and 75 kg/ha, respectively, in 1977. The high rate of fertilizer application in the northwest is due to the predominance of commercial farms (i.e., with irrigated fields and modern farm equipment). The lowest level of fertilizer use in 1977, 29 kg/ha of cultivated land, occurred in the southern region.

The wide variation among regions in fertilizer applications is reflected in total regional consumption. Over 26% of all plant nutrients was consumed in the northwest in 1977 while only 5% was used in the south (figure 20). The four regions which span central Mexico accounted for 56% of total fertilizer use in 1977.

The mix of fertilizer products used by Mexican farmers is characterized by three distinct features. The first is the dominance of single and double nutrient fertilizers. In the nitrogen market, three products--anhydrous ammonia, ammonium sulfate, and urea--have historically accounted for approximately 80% of total nitrogen consumption (figure 21). Similarly, TSP, DAP, and SSP account for over 80% of the P consumed. With the exception of 1977, muriate of potash has been the form in which approximately 35% of the  $K_2O$  was consumed. In 1977 compound NPK fertilizers accounted for 59% of the  $K_2O$  supply. The second distinct feature in Mexico's product mix is the trend toward more concentrated forms of solid nitrogenous and phosphatic fertilizers. For example, the ratio of urea to ammonium sulfate consumption on a nutrient basis has shifted from 0.86 in 1970 to 1.14 in 1977, and the ratio of TSP to SSP consumption on a nutrient basis has increased from 0.34 in 1970 to 1.66 in 1977. With the fertilizer capacity development plans of Mexico, this trend toward use of more concentrated fertilizers should continue. A third distinct feature in the mix of fertilizers used is the high use of anhydrous ammonia for direct application. In 1977 directly applied anhydrous ammonia totaled 176,000 mt of N or 25% of the country's total N consumption. With the exception of 1976, in recent years directly applied anhydrous ammonia has been the dominant nitrogen-fertilizer material used in Mexico. In 1976 large tonnages of urea and ammonium sulfate were imported to satisfy a surge in demand for these two products; as a result, urea was the major nitrogen source. Anhydrous ammonia, representing 20%-28% of the total nitrogen supply, is used primarily in irrigated areas on cash crops and is used in all regions except the south.

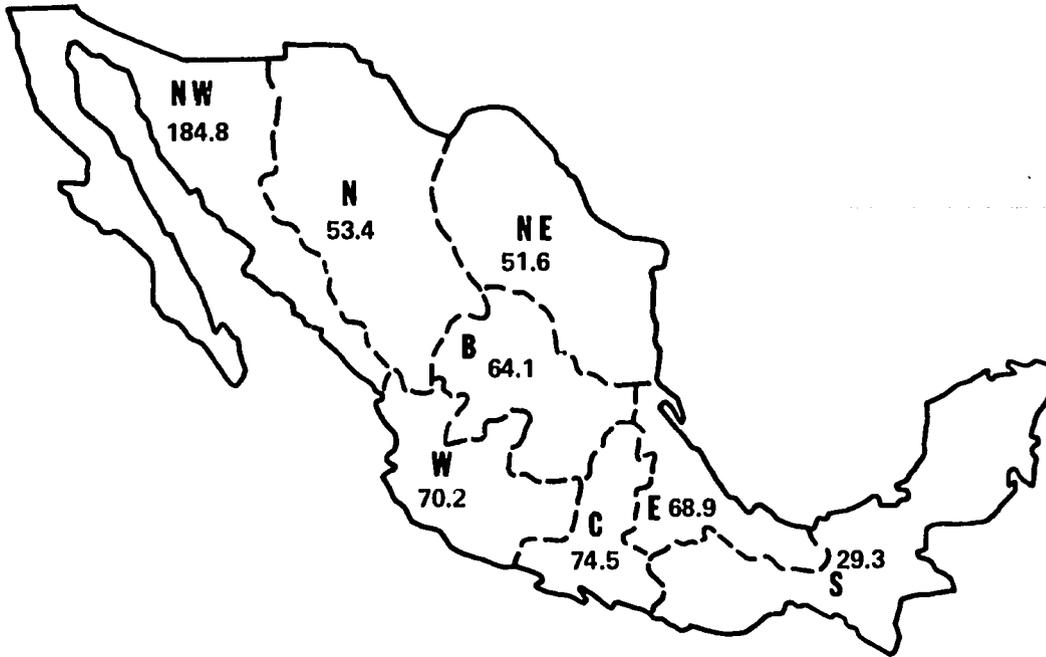


Figure 19. Regional Fertilizer Consumption (kg/ha).

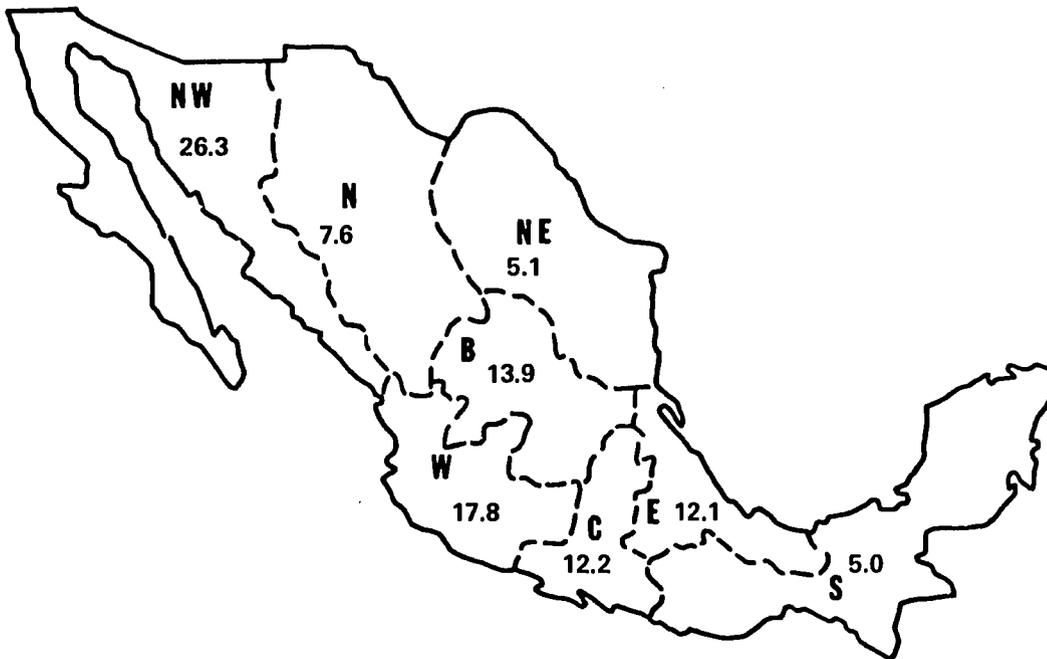


Figure 20. 1977 Regional Fertilizer Consumption (percentage total).

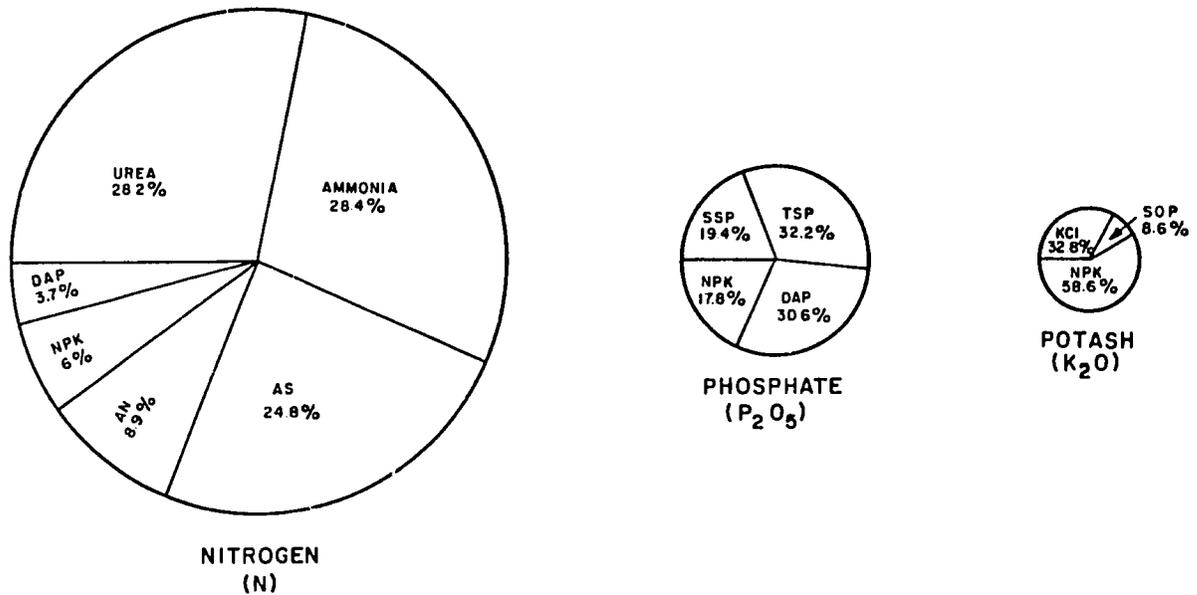


Figure 21. 1977 Nutrient Consumption by Product.

The timing of fertilizer use in Mexico is highly seasonal. There are three major use periods: early spring (February and March), late spring (May and June), and late fall (November) (figure 22). The seasonal use of fertilizer is influenced by the major crops grown in each area and temperature, as influenced by elevation and geographic location of the area.

#### Fertilizer Production Outlook

In looking to the future, the structure of the Mexican fertilizer industry is not expected to change. However, substantial developments in the country's overall capacity will occur. During the next 6 years solid fertilizer capacity is expected to increase from near 1.2 million mtpy of fertilizer nutrients to over 2.5 million mtpy (tables 2 and 3). Included in this major development will be 11 projects (one plant now ready for startup, 8 projects in various stages of construction, and 2 in the planning stage). A description of each of these projects is as follows.

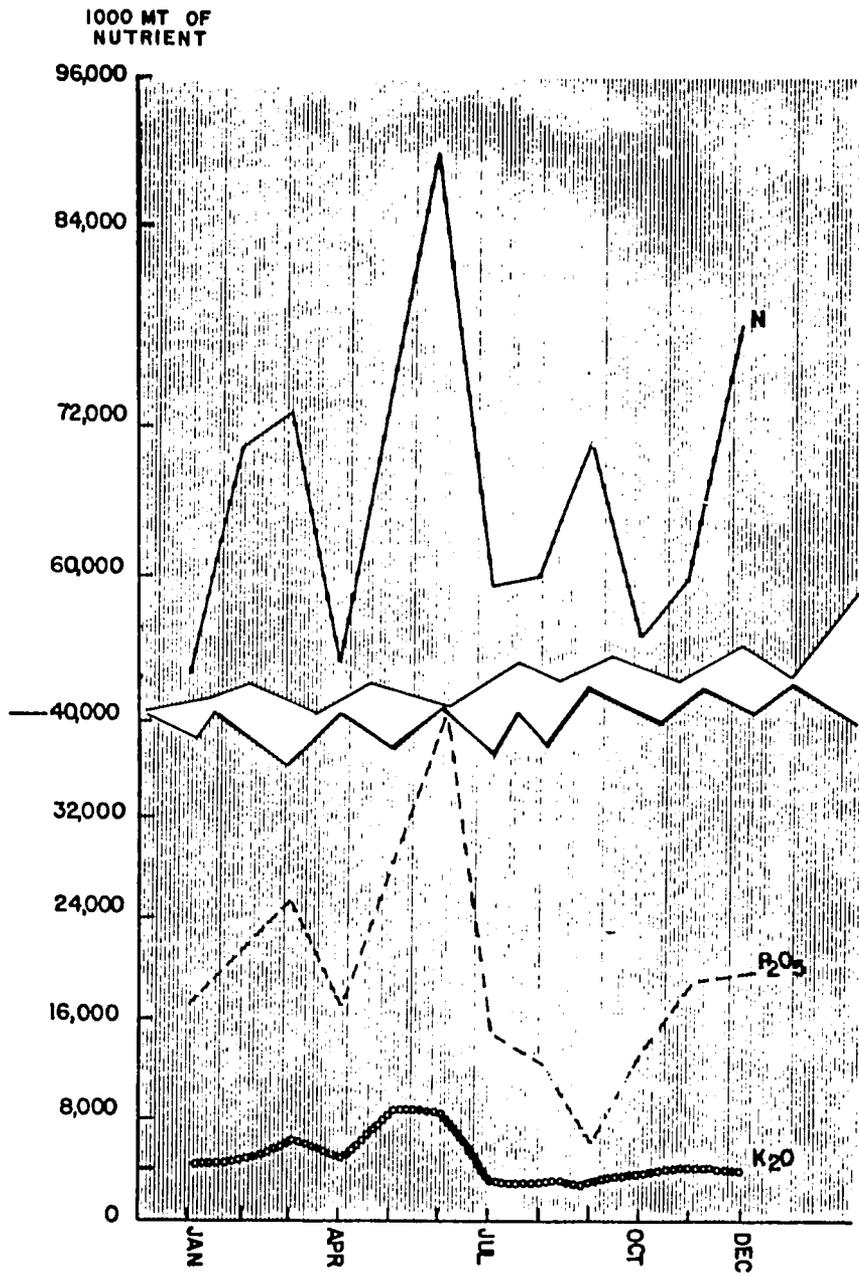


Figure 22. Monthly Fertilizer Use.

1. A 152,000-mt/yr urea plant has recently been completed at Salamanca,
- 2.3. Two large fertilizer complexes are to be built at Lazaro Cardenas on the west coast of Mexico. One of the complexes will be completed in 1981 and will be able to produce ammonium nitrate (67,000 mtpy of N), DAP (49,500 mtpy of N and 126,500 mtpy of  $P_2O_5$ ), and NPK fertilizers (44,300 mtpy of N, 41,800 mtpy of  $P_2O_5$ , and 36,000 mtpy of  $K_2O$ ). The other Lazaro Cardenas project, now in the engineering phase, is scheduled for completion in 1982. It will be able to produce DAP, TSP, or NPK fertilizers. The complex will have a capacity of 94,000 mtpy of N and 241,500 mtpy of  $P_2O_5$  as DAP or 152,000 mtpy of  $P_2O_5$  as TSP.
- 4.5. Two urea plants, each with a capacity of 228,000 mtpy of N, are under construction at Pajaritos; one of the plants will be ready for startup in early 1980 and the other in 1981.
- 6.7. Two additional ammonium sulfate units are under construction at Queretaro. Both of these plants will be completed in 1980, and each will have a capacity of 42,000 mtpy of N.
8. The TSP plant at Pajaritos is being modified to allow production of DAP and NPK fertilizers, as well as TSP. The scheduled completion date for the modification is late 1979.
9. A nitrogen solutions plant, with a capacity of 112,000 mtpy of N, is under construction at Pajaritos. This facility is scheduled for startup in late 1981.
- 10.11. Two potash projects (the first in Mexico) are now in the planning stage. One will involve production of potassium sulfate; this project is scheduled to begin in Mexico in mid-1981 with completion of a sea brines operation located at Guerrero Negro, Baja California. The plant capacity is expected to be 90,000 mtpy of  $K_2O$ . The other is a potassium chloride plant based on brines from geothermal wells. It is to be located at Cerro Prieto, Baja California, and is scheduled for completion in late 1982. It will have an annual capacity of 48,000 mtpy of  $K_2O$ .

The effect of the expected industry developments will be that, by 1985, Mexico will have 1.55<sup>3</sup> million mtpy, 0.71 million mtpy, and 0.14 million mtpy of nitrogen, phosphate, and potassium capacity, respectively. As indicated in figures 13 and 14, approximately 88% of the total nitrogen capacity will be located in the central, Bajio and east regions. These same three regions will harbor 98% of the phosphate capacity in 1985. However, all of the potash capacity will be located in the northwest.

Based on FERTIMEX's 1979-85 capacity plans, no additional types of nitrogenous and phosphatic fertilizers are to be produced in Mexico. In 1985 urea and ammonium sulfate will account for 52% and 25%, respectively, of total solid nitrogen capacity. The remaining nitrogen capacity will be fairly equally apportioned among DAP, ammonium nitrate, and complex NPK fertilizers. In the phosphate sector, DAP capacity will account for 54% of the solid fertilizer capacity; TSP, 26%; and NPKs and SSP, 10% each.

In addition to the solid fertilizer production facilities currently under construction or planned, FERTIMEX plans to construct two new phosphoric acid plants at Lazaro Cardenas. Each plant will have a capacity of 198,000 mtpy of P<sub>2</sub>O<sub>5</sub>, and most of the output will be used in downstream facilities, also to be located at Lazaro Cardenas. No additional phosphoric acid capacity is expected to be constructed at Pajaritos prior to 1985. However, in 1980 the existing plant will be expanded from 345,000 mtpy to 375,000 mtpy of P<sub>2</sub>O<sub>5</sub>. As a result of the developments, in 1985 only 44% of Mexico's phosphoric acid capacity will be located at Pajaritos, as compared to 82% in 1979 (figure 23, table 4).

In the nitrogen sector, PEMEX has plans to build four additional 365,000-mtpy ammonia plants, bringing Mexico's total ammonia capacity to near 3.2 million mtpy of nitrogen. Two of the new units are now under construction at Cosoleacaque and will be ready for startup in 1980. When these two plants are complete, a total of seven ammonia plants or near 80% of Mexico's ammonia capacity will be located in Cosoleacaque (figure 24). The other two ammonia plants are expected to be in operation by late 1982; to date the location of these latter units has not been identified.

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3. In addition, a 112,000 tpy-N nitrogen solutions plant has to be considered in order to have the total capacity of nitrogen.

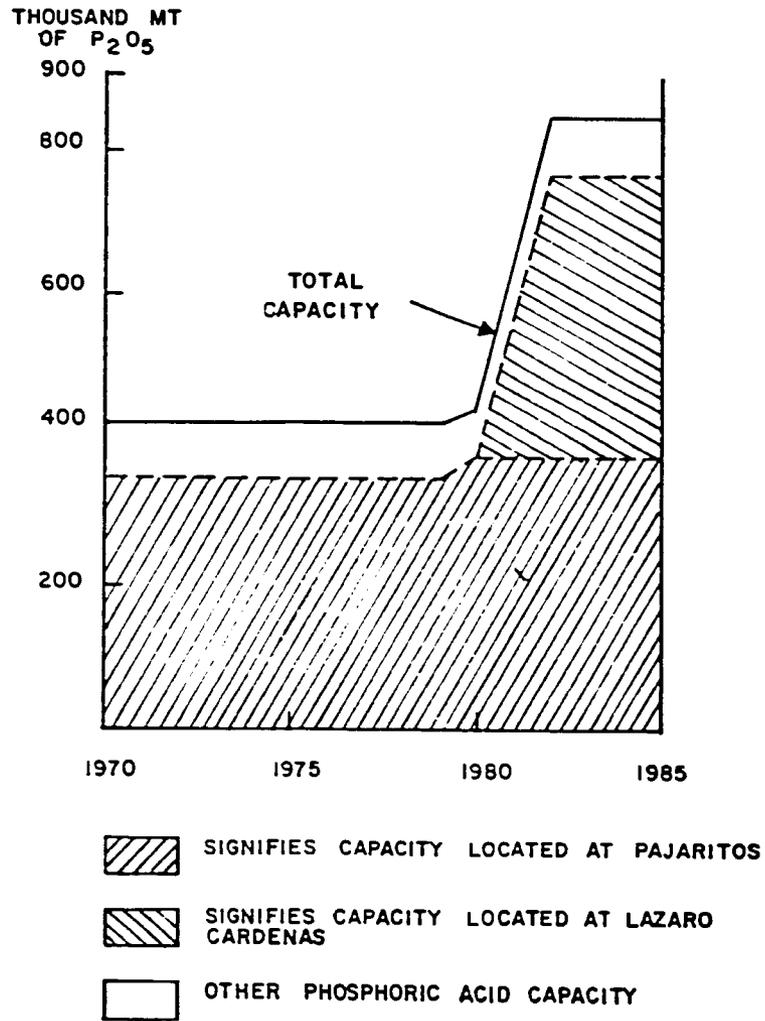


Figure 23. Phosphoric Acid Capacity by Location.

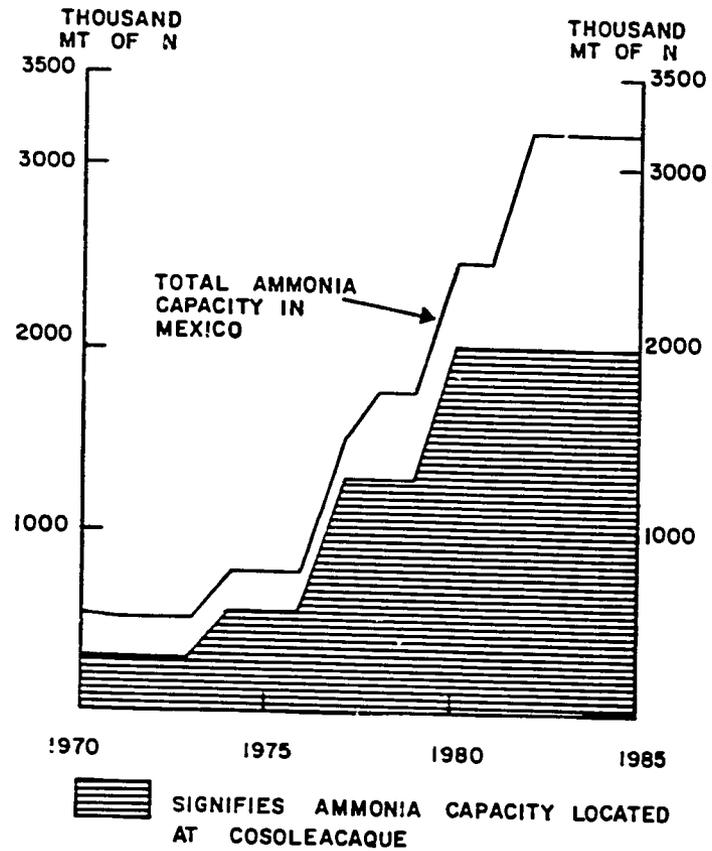


Figure 24. Ammonia Capacity by Location.

Table 4. Mexico--Phosphoric Acid Capacity and Phosphate Supply-Demand Forecast

| Plant/Year                               | 1965  | 1970 <sup>a</sup> | 1971 <sup>a</sup> | 1972 <sup>a</sup> | 1973 <sup>a</sup> | 1974 <sup>a</sup> | 1975 <sup>a</sup> | 1976 <sup>a</sup> | 1977 <sup>a</sup> | 1978 <sup>a</sup> | 1979 <sup>b</sup> | 1980 <sup>c</sup> | 1981 <sup>c</sup> | 1982 <sup>c</sup> | 1983 <sup>c</sup> | 1984 <sup>c</sup> | 1985 <sup>c</sup> |
|--|---|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|  | -'000 mtpy of P <sub>2</sub> O <sub>5</sub> |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| Pajaritos, Ver.                          | -   | 345.0             | 345.0             | 345.0             | 345.0             | 345.0             | 345.0             | 345.0             | 345.0             | 345.0             | 345.0             | 375.0             | 375.0             | 375.0             | 375.0             | 375.0             | 375.0             |
| Coatzacoalcos, Ver.                      | 17.0  | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              | 17.0              |
| Minatitlan, Ver.                         | 19.8  | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              | 39.6              |
| Monclova, Coah.                          | 18.0  | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              | 18.0              |
| Lazaro Cardenas I                        | -   | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 198.0             | 198.0             | 198.0             | 198.0             | 198.0             |
| Lazaro Cardenas II                       | -   | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | -                 | 198.0             | 198.0             | 198.0             | 198.0             |
| Total Capacity                           | 54.8  | 419.6             | 419.6             | 419.6             | 419.6             | 419.6             | 419.6             | 419.6             | 419.6             | 419.6             | 419.6             | 449.6             | 647.6             | 845.6             | 845.6             | 845.6             | 845.6             |
| Potential Supply of Phosphate Fertilizer | 33.7  | 249.7             | 298.9             | 327.8             | 413.8             | 440.8             | 425.6             | 403.7             | 446.9             | 391.6             | 467.0             | 431.0             | 463.0             | 752.0             | 801.0             | 833.0             | 843.0             |
| Demand                                   | 74.0  | 111.0             | 152.7             | 156.5             | 178.0             | 231.0             | 276.4             | 239.0             | 218.0             | 262.3             | 311.0             | 332.0             | 367.0             | 404.0             | 445.0             | 489.0             | 535.0             |
| Balance                                  | (40.3)                                      | 138.7             | 146.2             | 171.3             | 235.8             | 209.8             | 149.2             | 164.7             | 228.9             | 129.3             | 156.0             | 99.0              | 96.0              | 348.0             | 356.0             | 344.0             | 308.0             |

a. Actual.

b. Estimated.

c. Forecast.

d. Potential fertilizer supply includes the P<sub>2</sub>O<sub>5</sub> available from phosphoric acid, single superphosphate, and the contribution of P<sub>2</sub>O<sub>5</sub> from phosphate rock in TSP production. The production of P<sub>2</sub>O<sub>5</sub> from SSP and TSP is based on FERTIMEX's analysis of each plant in the country. The production estimate for phosphoric acid is based on an assumed operating rate of 90% for plants in operation 3 years ago or longer. In addition, an allowance has been made for nonfertilizer uses of phosphoric acid.

e. Fertilizer demand estimates are for solid fertilizers only. The demand for liquid fertilizers is estimated at 22,000 mtpy P<sub>2</sub>O<sub>5</sub> (8).

### Fertilizer Supply-Demand Forecast

With the impressive plant construction schedule of FERTIMEX, fertilizer production in Mexico will increase significantly during the 1979-85 period. Solid fertilizer (nitrogen and phosphate) production is expected to peak in 1985 at 2.06 million mt of nutrients, more than a threefold increase over the level attained in 1978. The greatest increase will occur in the nitrogen sector where additional capacity, predominantly urea and ammonium sulfate, will raise annual production potential for solid fertilizers to 1.43 million mt of N (table 2). The annual production potential for phosphates will also peak in 1985 at 0.63 million mt of  $P_2O_5$ , or approximately triple the 1978 level (table 3). At present, Mexico is not a basic producer of  $K_2O$ . However, based on the two potassium projects scheduled, 1985 production of  $K_2O$  should reach 0.133 million mt.

The anticipated increase in ammonia and phosphoric acid production will more than offset the requirements for these two materials in solid fertilizer manufacture. Ammonia production potential will reach 2.7 million mtpy of N in 1983 or approximately double the actual production in 1978. Meanwhile, potential phosphoric acid production for fertilizers should peak in 1984 at approximately 0.76 million mt of  $P_2O_5$ .

Switching to fertilizer demand, it is expected that by 1985 total plant nutrient consumption in Mexico will approximate 2.2 million mt--more than double the 1978 consumption level (table 5). The projected annual compound growth rates for N,  $P_2O_5$ ,  $K_2O$  over the 1979-85 period are 11.85%, 10.75%, and 5.05%, respectively. If these growth rates materialize, in 1985 fertilizer consumption will total 1.6 million mt of N, 0.5 million mt of  $P_2O_5$ , and 0.1 million mt of  $K_2O$ , respectively. Thus, the current fertilizer ratio (1:0.36:0.1) will drop slightly, reflecting increased emphasis on nitrogen use. To attain the projected consumption levels will require a considerable increase in fertilizer application rates. Assuming the size of the cultivated area in Mexico continues to increase at the 1960-77 rate, in 1985 the country-wide fertilizer nutrient application rate will approximate 139 kg/ha.

Relating potential supply to projected demand, Mexico will continue to be in an export position for both nitrogen and phosphate. The data presented in figure 25 and table 1 suggest that the positive nitrogen trade balance attained in 1978 will be maintained at least through 1985. The magnitude of the projected net export potential ranges from 0.5 million mt of N in 1979 to 1.4 million mt of N in 1983. The export potential will decline by approximately 130,000 mtpy from 1983 through 1985 as agricultural and industrial use of nitrogen in Mexico expands.

Table 5. Mexico Fertilizer Demand Forecast

|  | <u>1970<sup>a</sup></u>         | <u>1976<sup>a</sup></u> | <u>1977<sup>b</sup></u> | <u>1978<sup>c</sup></u> | <u>1979<sup>c</sup></u> | <u>1980<sup>c</sup></u> | <u>1981<sup>c</sup></u> | <u>1982<sup>c</sup></u> | <u>1983<sup>c</sup></u> | <u>1984<sup>c</sup></u> | <u>1985<sup>c</sup></u> |
|--|---------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|  | ----- '000 mt of nutrient ----- |                         |                         |                         |                         |                         |                         |                         |                         |                         |                         |
| Nitrogen (N)                               | 404                             | 830                     | 779                     | 732                     | 944                     | 1,024                   | 1,122                   | 1,226                   | 1,339                   | 1,465                   | 1,601                   |
| Phosphate (P <sub>2</sub> O <sub>5</sub> ) | 111                             | 239                     | 218                     | 262                     | 311                     | 332                     | 367                     | 404                     | 445                     | 489                     | 535                     |
| Potash (K <sub>2</sub> O)                  | <u>22</u>                       | <u>67</u>               | <u>34</u>               | <u>72</u>               | <u>71</u>               | <u>72</u>               | <u>79</u>               | <u>84</u>               | <u>91</u>               | <u>97</u>               | <u>104</u>              |
| TOTAL                                      | 537                             | 1,136                   | 1,031                   | 1,066                   | 1,326                   | 1,428                   | 1,568                   | 1,714                   | 1,875                   | 2,051                   | 2,240                   |

8

|                               | <u>Projected Compound<br/>Growth Rate 1978-85 (%)</u> | <u>Ratio of N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O in Selected Years</u> |                         |                         |                         |                         |                         |                         |
|-------------------------------|---|---|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|                               |   | <u>1960<sup>a</sup></u>   | <u>1965<sup>a</sup></u> | <u>1970<sup>a</sup></u> | <u>1975<sup>a</sup></u> | <u>1978<sup>a</sup></u> | <u>1980<sup>c</sup></u> | <u>1985<sup>c</sup></u> |
| N                             | 11.85   | N   | 1.0                     | 1.0                     | 1.0                     | 1.0                     | 1.0                     | 1.0                     |
| P <sub>2</sub> O <sub>5</sub> | 10.75   | P <sub>2</sub> O <sub>5</sub>   | 0.26                    | 0.3                     | 0.27                    | 0.38                    | 0.36                    | 0.32                    |
| K <sub>2</sub> O              | 5.05  | K <sub>2</sub> O  | 0.07                    | 0.09                    | 0.05                    | 0.08                    | 0.10                    | 0.07                    |

a. Actual.

b. Estimated.

c. All fertilizer consumption forecasts are from FERTIMEX, July 1979.

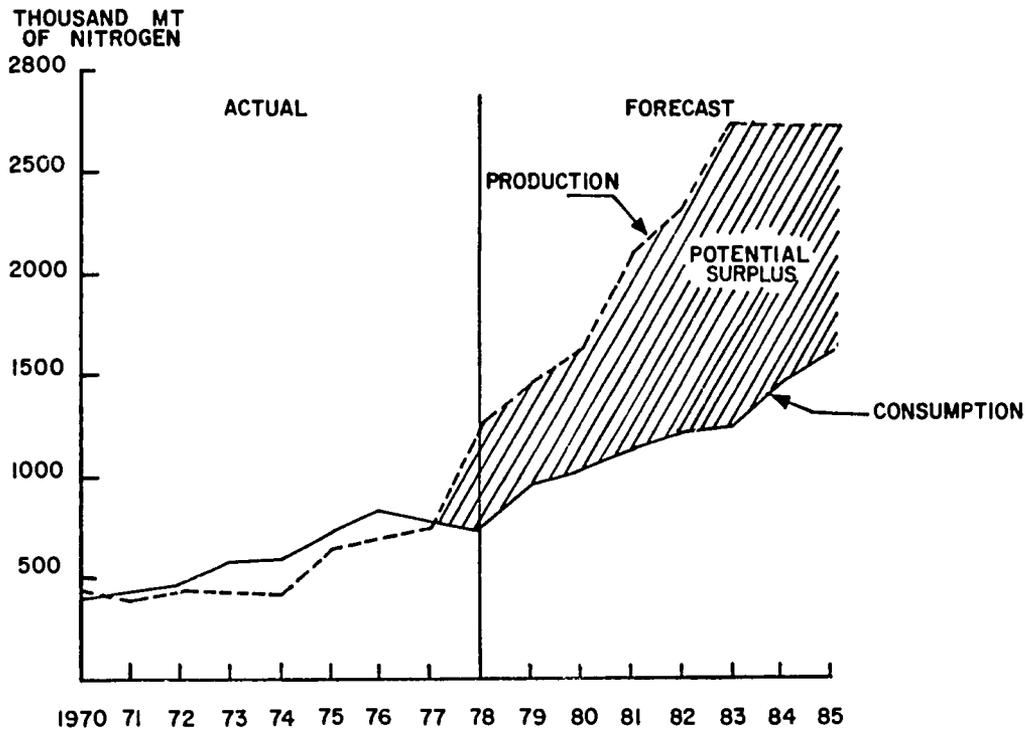


Figure 25. Nitrogen Fertilizer Supply-Demand Outlook.

The current net export position for phosphates will be maintained following completion of FERTIMEX's planned expansion of the phosphate industry (figure 26). Following completion of the Lazaro Cardenas units, the export potential will peak in 1983 at near 350,000 mt of  $P_2O_5$  and then decline to about 300,000 mt of  $P_2O_5$  in 1985.

On a product basis, it appears that ammonia and phosphoric acid will be the forms in which most of the nitrogen and phosphate will be initially exported. Later, a sizable quantity of urea as well as some TSP, DAP, and NPKs will also likely be available for export. An estimation of the tonnage of each individual product to be traded would be subject to considerable variation due to local, as well as world, market conditions.

## PHOSPHATE FERTILIZER SUPPLY - DEMAND OUTLOOK

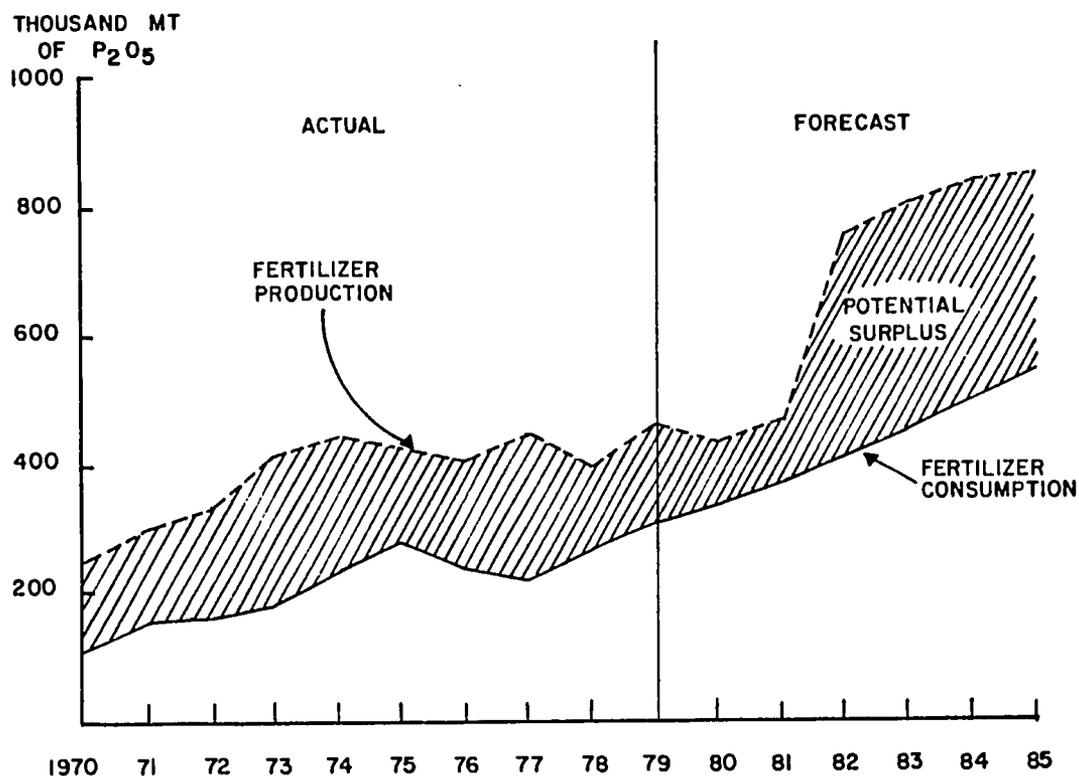


Figure 26. Phosphate Fertilizer Supply-Demand Outlook.

Despite Mexico's forthcoming export potential, a small level of fertilizer importation may continue before the projects under construction come onstream in the next 3 years.

### Raw Materials

Fertilizer raw materials indigenous to Mexico include oil, natural gas, phosphate rock, and sulfur. In addition, sizable quantities of sulfur are available as recovered sulfur from refinery gas and natural gas processing. Indications of sylvite and other potash minerals have been reported; however, extensive exploration of the identified deposits has not been undertaken.

Mexico's proven oil and natural gas reserves as of November 1977 were estimated at 1,507 million mt and 340,000 million m<sup>3</sup>, respectively (figure 27). The government has recently announced additional new fields which are among the most extensive in the Western Hemisphere. Petroleum products have been commercially exploited for a number of years; however, with respect to fertilizers, natural gas is the raw material for all of Mexico's current and planned ammonia production (6).

At present, Mexico's phosphate fertilizer industry utilizes domestically produced sulfur and imported phosphate rock. However, because local phosphate rock production is small (it supplied only 13% of total needs in 1976), large-scale importation,

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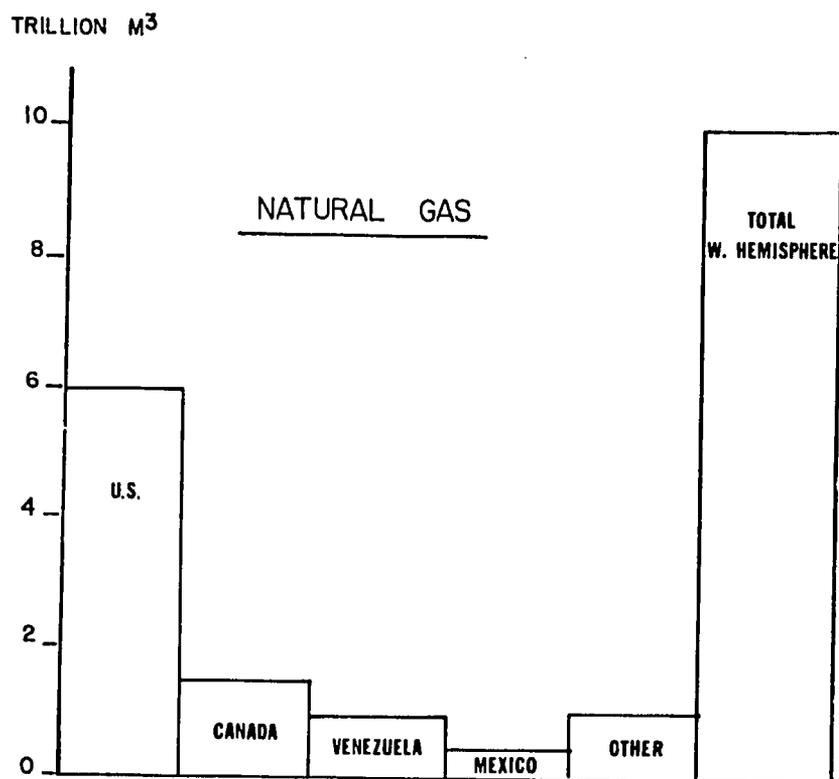


Figure 27. Natural Gas Reserves of the Western Hemisphere.

mainly from Morocco and the United States, is required. Two companies, Minerales Industriales and Fosforitas Mexicanas, are engaged in the production of phosphate rock. The output of these companies is small and, in view of the location of the deposits, their limited life, and/or economics of beneficiation, any expansion of these two operations is considered unlikely.

With regard to future supplies of phosphate rock and with the idea of increasing Mexico's level of self-sufficiency in phosphate rock, a recently (1975) formed government organization, Roca Fosforica Mexicana, S.A. (ROFOMEX), is conducting extensive investigations of four phosphate rock deposits located in Baja California. As a result of these investigations, the San Juan deposit, with reserves estimated at 60 million mt of 20%  $P_2O_5$  rock, is to be exploited in the early 1980's. The planned rate of exploitation will be 750,000 mtpy of 66% BPL rock, and it is assumed that all of the output will be consumed in the new Lazaro Cardenas plants. The Santo Domingo deposit will also be exploited in the early 1980's; although details on the deposit are unavailable, the planned rate of production is 0.5 million mtpy of rock in 1982 and 1.5 million mtpy thereafter. Evaluations of the other two deposits, San Hilario and Santa Rita, are not yet complete; however, preliminary investigations indicate the reserves at each location are extensive but of low-grade ore. Commercialization of these two deposits is not likely to occur prior to 1986 as a result of exploitation of the Santo Domingo and San Juan deposits.

In addition to the potential production of potassium fertilizers from brines, Mexico has potash deposits located near Monterrey and Cuchillo Parado in the State of Coahuila and in the Isthmus of Tehuantepec in the State of Veracruz. Preliminary investigation of these deposits has been undertaken, and indications are that the results are not promising enough to warrant detailed evaluations (7).

## FERTIMEX AND MARKETING

FERTIMEX's organizational structure is presented in figure 28. The Board of Directors of FERTIMEX is appointed by the President of Mexico. The Board determines FERTIMEX's objectives and policies and elects the General Director of FERTIMEX. The General Director has eight General Managers reporting to him, each responsible for a specific area within FERTIMEX. These major areas are finance, operations (which involves

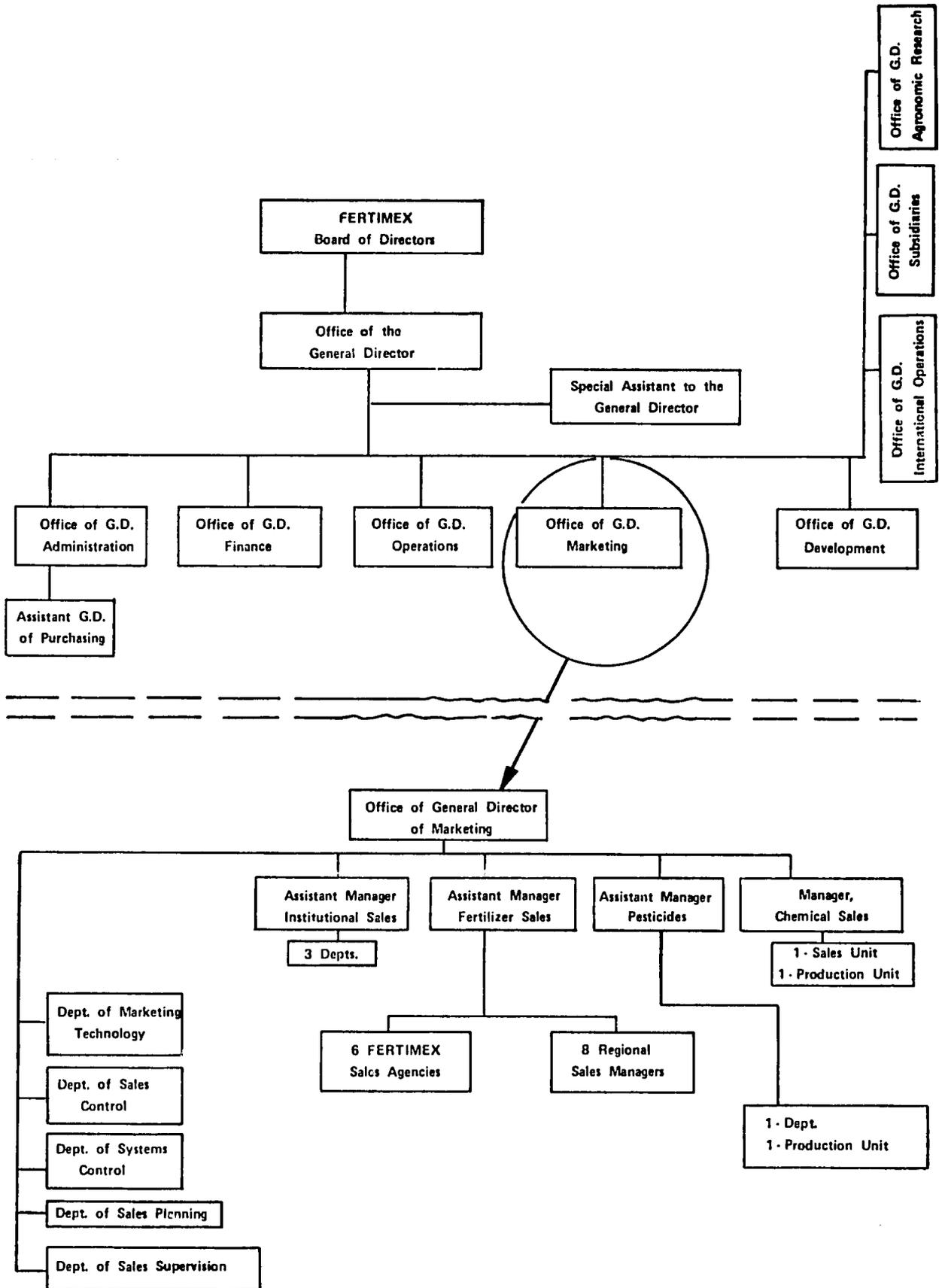


Figure 28. FERTIMEX Organizational Chart.

operation of all FERTIMEX fertilizer plants and terminals), sales, administration, development (planning, engineering, and construction of new plants), international operations, subsidiaries and agricultural research. In addition, the General Director has a group of special assistants who provide day-to-day program coordination and special program assistance.

The eight General Managers each have areas of vital responsibility in the FERTIMEX organization, and their coordinated efforts have contributed to the dramatic increase in fertilizer usage by Mexican farmers. The office of General Manager of Marketing has the responsibility of meeting farmer fertilizer needs in order to ensure that the nation's crop production goals are met. This requires close working relations with the other FERTIMEX General Managers as well as the Ministry of Agriculture and Hydraulic Resources, the National Institute of Agricultural Investigation (INIA), producer associations, farmer groups, and state agricultural authorities.

The General Manager of Marketing is assisted by 4 managers, 11 department heads, and 8 regional sales managers. The current organizational structure gives the General Manager of Marketing responsibility for the marketing of fertilizers, pesticides, and commercial chemicals.

### Channels of Distribution

To meet the objective of keeping retail fertilizer prices as low as possible in Mexico, FERTIMEX is moving to streamline its distribution system. In 1978 43% of the fertilizer sold in Mexico was sold either directly to farmers or channeled through only one middleman (figure 29). This system consists of sales through commission agents and direct sales by FERTIMEX and FERTIMEX agencies to certain large farmers and industrial users. The commission agents act as warehouse and sales agents for FERTIMEX. They warehouse the product, bag bulk shipments of fertilizers, and make sales in FERTIMEX's name. A number of commission agents have also been involved in bulk blending for their own account and make sales of this product under private labels to farmers and farmer organizations.

A second channel of distribution employed by FERTIMEX consists of sales by FERTIMEX to organizations such as Boruconsa (a government-owned retail organization), Banco Nacional de Credito Rural (Rural Bank), and Organizaciones Agricolas (agricultural organizations). These organizations buy products directly from FERTIMEX's plants or from service agents

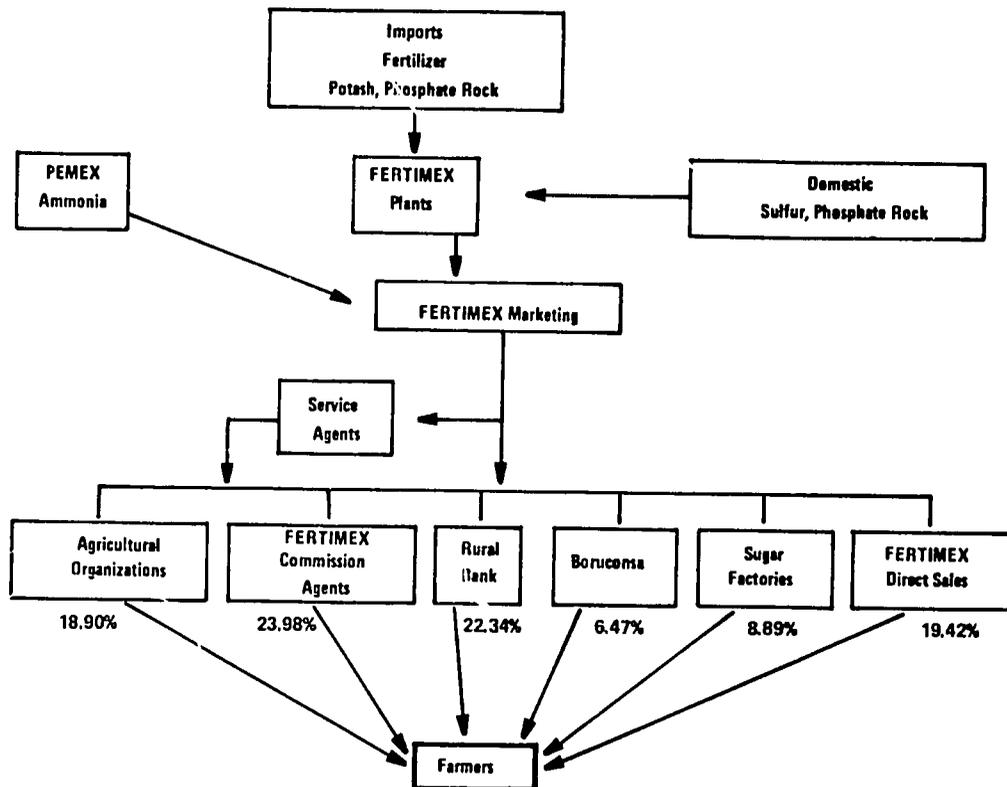


Figure 29. Channels of Distribution for Fertilizers (1978).

(Prestador de Servicios) who provide warehousing and trucking on a contractual basis with FERTIMEX. In 1978 there were 1,231 points of retail fertilizer sale. Small private village retailers who sell sundry goods to farmers have been excluded from the distribution system.

In assessing the overall efficiency of the distribution system, large farmers or farmers who can pool their needs and purchase a truck load or more of fertilizer are well served by the distribution system.

FERTIMEX, in order to supply the needs of the small farmer, has embarked on an expansion of its distribution system as follows:

1. Mobile units that sell directly to the small farmer through scheduled visits to the weekly market place;
2. Sales directly to the public from manufacturing facilities that are on a limited volume basis of from a 50-kg bag to 3 mt;
3. Product sales from FERTIMEX plants are now made directly to newly formed state companies that are composed of directors from state government, agricultural banks, agricultural organizations, cooperatives, and private investors. These state companies have been formed in 13 of the 32 states of Mexico and are dedicated to improving fertilizer distribution in each of their respective states.

### Fertilizer Prices

The real cost of fertilizer to farmers, in terms of kilograms of crop needed to pay for a kilogram of fertilizer, has dropped significantly. In 1962 the farmer paid the equivalent of 18.6 kg of corn for 10.0 kg of urea compared to only 9.6 kg of corn in 1978. This 48% drop in cost for a nitrogen fertilizer product was accompanied by a 10% reduction in the real cost of  $P_2O_5$  from TSP (12.7 kg of corn in 1962 compared to 11.4 kg of corn in 1978 for 10 kg of TSP).

The government's policy of maintaining low fertilizer prices to Mexican farmers has been effective. The current fertilizer pricing system in Mexico consists of an official price at warehouses situated on railway lines in Mexico. From rail points, fertilizer is shipped by truck to other warehouses in the sales area. The cost of trucking is added to the official rail depot price, and this price becomes the official price at that warehouse. Thus, the price to the farmer for fertilizer will depend on where he buys the product. In addition to the official price, farmers must pay a 4% sales tax and a patronage charge of 5 pesos/mt on ammonium sulfate and SSP and 12 pesos/mt on all other fertilizers. FERTIMEX passes this patronage fee on to the Ministry of Agriculture for promotion and technical services.

Fertilizer prices in Mexico, compared with those in other countries (i.e., India and United States), are low in spite of an overall price increase of 10% in September 1976, 25% price increase on March 8, 1977, and 3.34% on November 22, 1978 (figure 30). Retail prices for ammonium sulfate and urea in Mexico were 57% and 35% lower, respectively, than the average price that U.S.

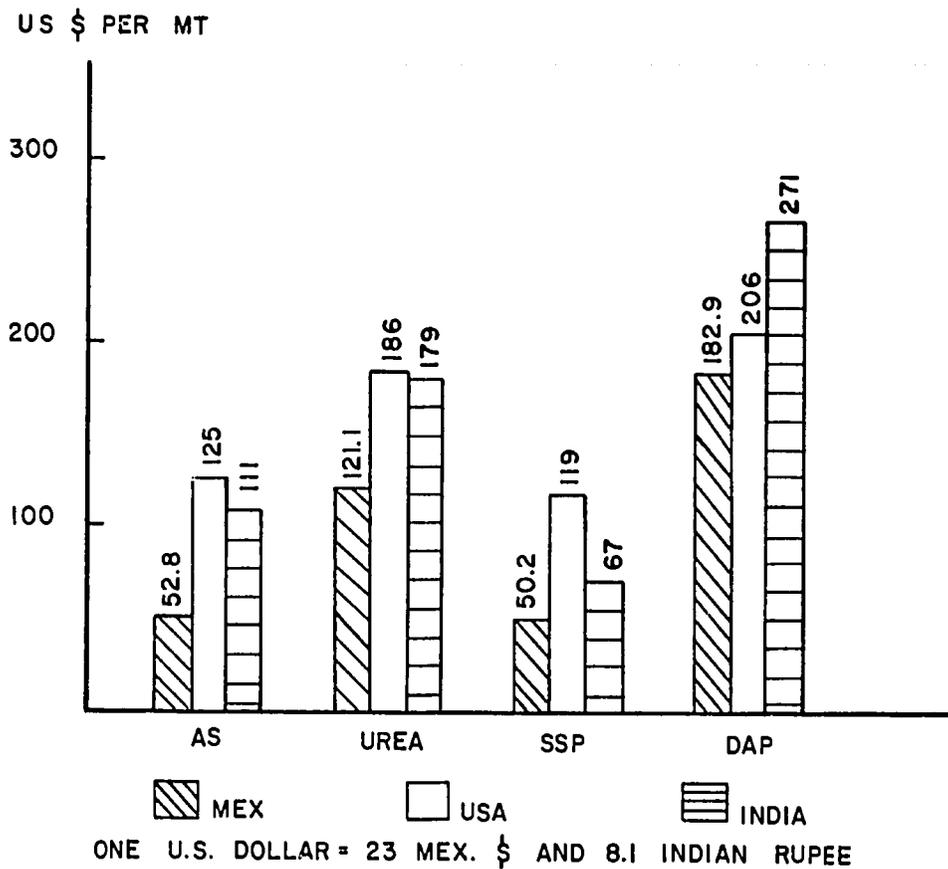


Figure 30. Retail Fertilizer Prices (product basis).

farmers paid in 1978. Indian farmers paid 110% more for ammonium sulfate and 48% more for urea than Mexican farmers paid in 1978. SSP retail prices are 136% lower in Mexico than in the United States. Diammonium phosphate, which is imported in large amounts from the United States, is sold to Mexican farmers at prices that are 11% lower than average retail prices in the United States in 1978.

One possible explanation for the lower prices in Mexico is that rail transportation is subsidized by the government. Another explanation is that FERTIMEX is a government-owned company, having the objectives of rendering social service and supplying the agricultural community with inputs at a reasonable

cost. FERTIMEX receives funds from the government treasury to balance revenues against costs.

Price relationships for fertilizer products were primarily established in the marketplace by companies taken over by FERTIMEX over the last 10 years. These price relationships have not been adjusted to reflect current production costs, distribution costs, or the impact of supply and demand. As a result TSP, which is in long supply and is being exported, has the highest retail price per nutrient metric ton. Conversely, DAP which is imported has the highest retail price per product metric ton but has a lower cost than TSP per ton of nutrient (figure 31). On a nutrient basis TSP is the most expensive fertilizer in Mexico, while SSP is the least expensive of any dry fertilizer. At the retail level, anhydrous ammonia is by far the cheapest source of N on a nutrient basis; it costs approximately 40% less than dry nitrogen products.

### Marketing Costs

The average marketing costs for fertilizers in 1978 totaled Mexican \$515.59/mt (US \$22.81/mt). As shown in figure 32, the single largest cost item is the cost of distribution which accounts for 50% of the marketing costs. The costs of bags and bagging are included in marketing costs and account for 24.8% of the total. Distributor sales commissions which include an allowance for distributor losses, invested capital, inventory costs, and profit represent 16.9% of the total marketing cost.

Distributor margins are established on a product metric-ton basis. Thus, the higher the cost per product metric ton, the lower the margin on a percentage basis; i.e., ammonium sulfate would have a much higher margin than urea. Distributor margins also vary depending on whether the distributor receives the product in bulk form and performs the bagging services or receives the product already bagged (figure 33). For example, the gross margin on bulk urea totals 11% of the retail price. The sales commission totals 5.07% after the cost of bags, bagging, and product handling. The sales commission must cover all other expenses and provide for a profit incentive. For DAP shipped to distributors in bags, distributor gross margins total 5.8% of the retail price, and the sales commission is 3.4%.

### Warehousing and Inventories

Currently the FERTIMEX distribution system includes 1,231 warehouses and ammonia terminals or sales points with a total

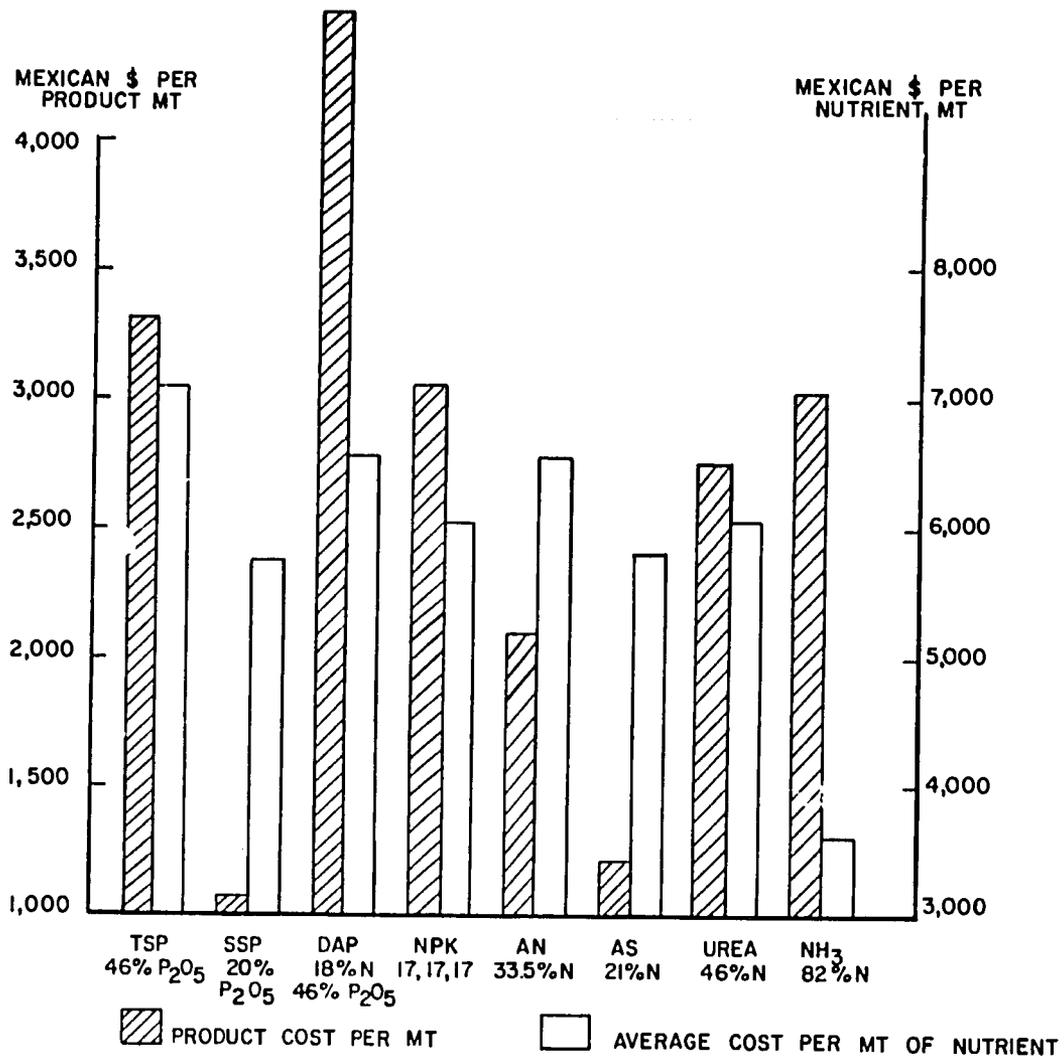


Figure 31. Retail Fertilizer Prices, 1978 (nutrient basis).

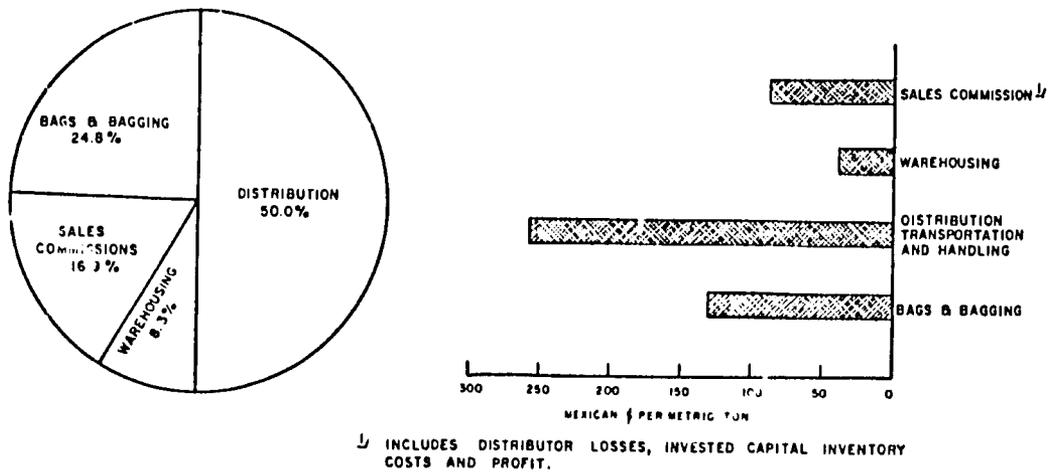


Figure 32. Fertilizer Marketing Costs.

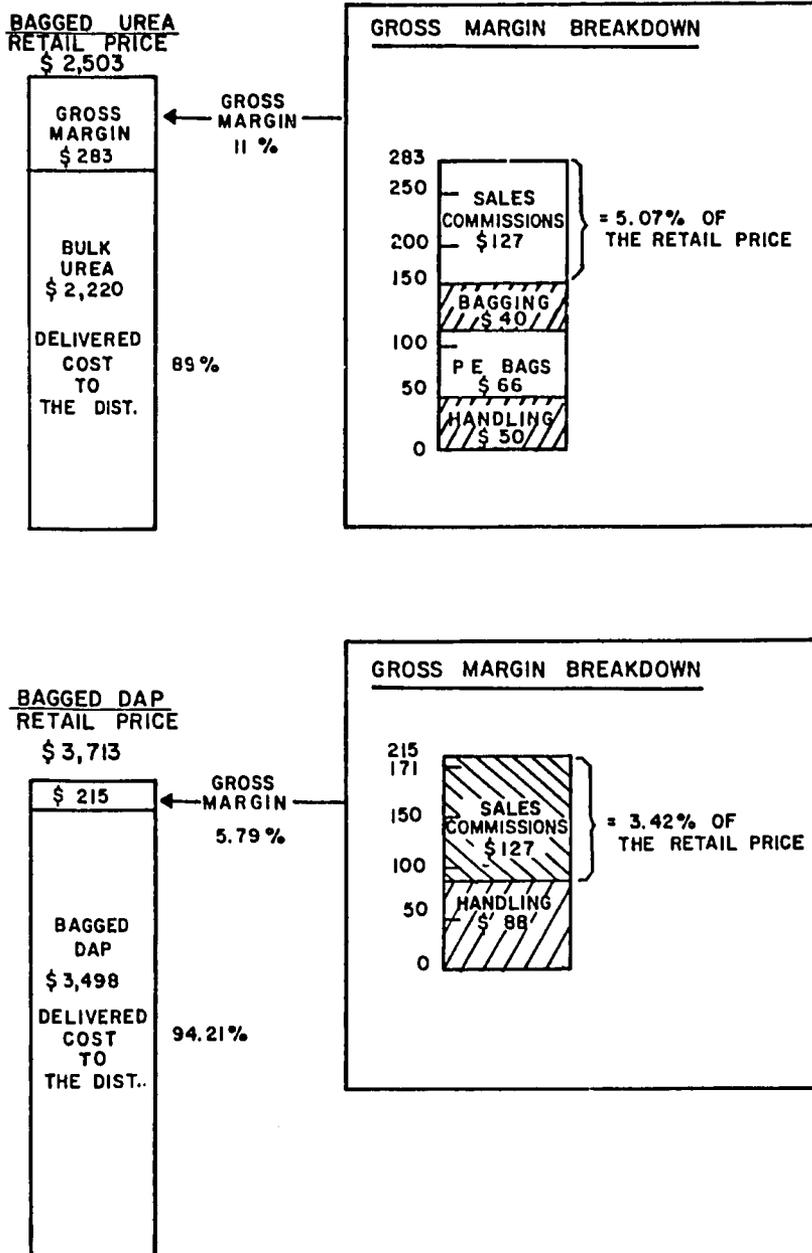
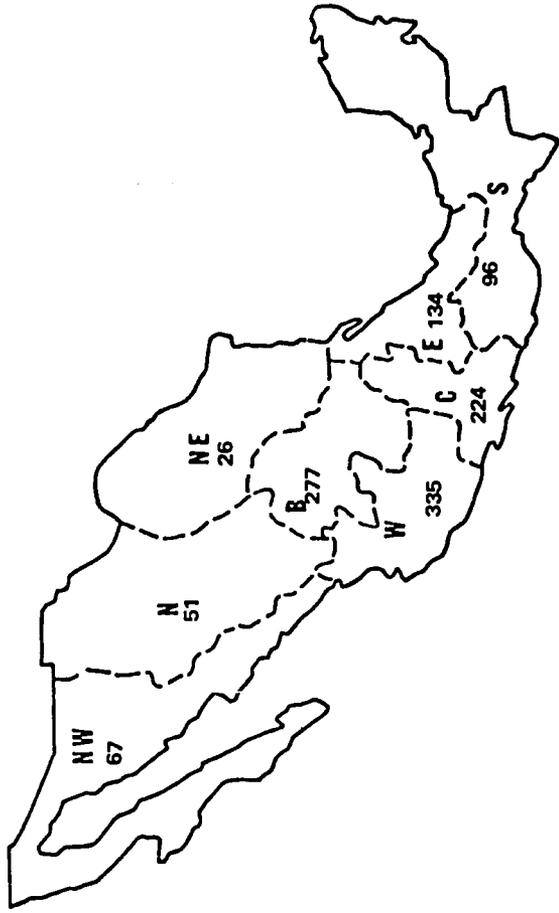
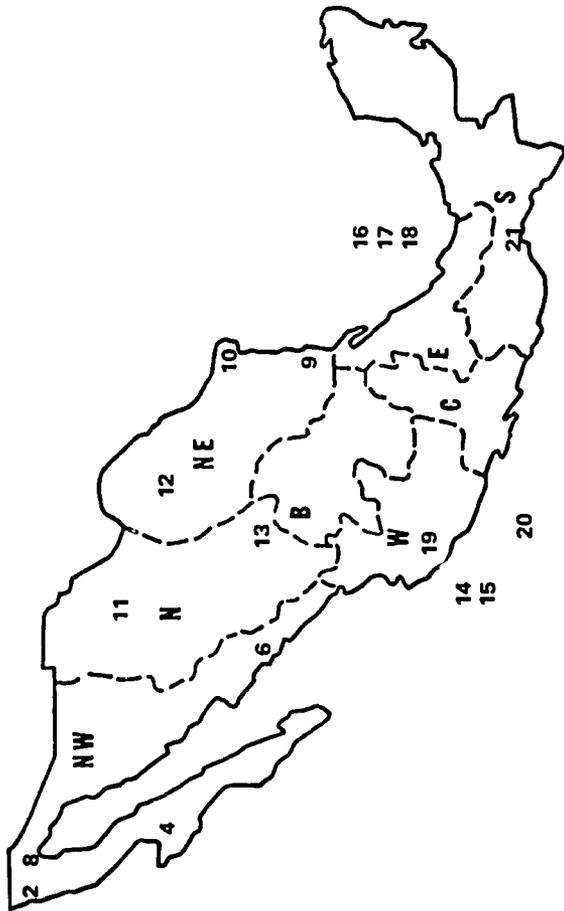


Figure 33. Fertilizer Distribution Costs (May 1978).

storage capacity of 2.0 million mt of product. These are distributed in the eight regions as shown in figure 34. In 1978 FERTIMEX had an annual production capacity of 2.7 million mt of dry product with in-plant warehousing capacity averaging one



Number of Fertilizer Warehouses by Sales Regions



Ammonia Terminals

| Location         | Owner | Capacity (mt) |
|------------------|-------|---------------|
| 1. Guaymas       | PX    | 20,000        |
| 2. Rosarito      | PX    | 20,000        |
| 3. Cd. Obregon   | FX    | 3,000         |
| 4. Sn. Carlos    | FX    | 2,500         |
| 5. Navojoa       | FX    | 1,500         |
| 6. Culiacan      | FX    | 1,500         |
| 7. Caborca       | FX    | 1,300         |
| 8. Mexicali      | FX    | 1,300         |
| 9. Tampico       | PX    | 8,600         |
| 10. Brownsville  | PX    | 7,500         |
| 11. Camargo      | PX    | 5,000         |
| 12. Monclova     | FX    | 1,000         |
| 13. Torreón      | FX    | 500           |
| 14. Salamanca    | FX    | 4,500         |
| 15. Salamanca    | FX    | 500           |
| 16. Minatitlan   | PX    | 20,000        |
| 17. Cosol. 1     | PX    | 2,000         |
| 18. Cosol. 2     | PX    | 2,000         |
| 19. Guadaluajara | FX    | 1,600         |
| 20. Cuautitlan   | FX    | 3,000         |
| 21. Sal. Cruz    | PX    | 20,000        |

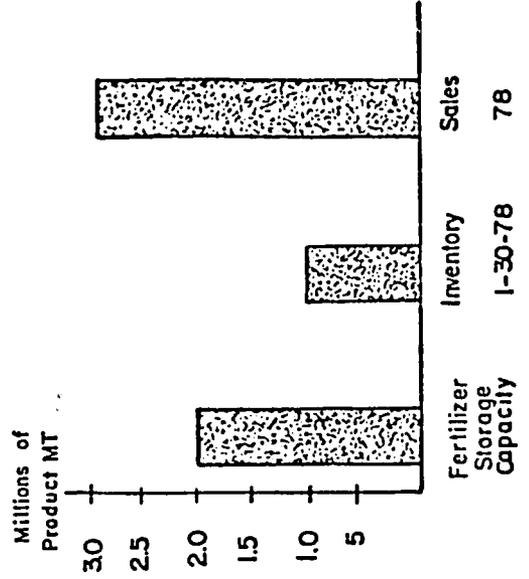


Figure 34. Fertilizer Storage Capacity in Mexico, 1978.

month's production or around 230,000 mt. This, combined with product storage capacity in the distribution system, renders FERTIMEX a total storage capability of 2.2 million mt or an average ratio of dry storage capacity to total sales in 1978 of 0.76:1.0. Distribution storage capacity is short in some sales regions like the northwest, even after allowance for anhydrous ammonia sales totaling 149,000 mt of N in 1978. The major use regions for dry products (west, central, Bajio, and the east) have more than adequate warehouse storage capacities.

Normally, inventory levels in the distribution system are relatively high. For example, inventory levels at the end of January 1978 represented around 35% of real sales for that year. The overall inventory level may appear high for a country which produces around 70% of its finished product needs. This can be attributed to the fact that the demand for fertilizers is coincidental with the time that applications are being carried out on the farms, and FERTIMEX must maintain adequate inventory stocks to ensure deliveries on schedule to the consumers. Certain high-demand products like ammonium nitrate, NPK compounds, DAP, and urea have historically been in tight supply and thus encourage the buffer stock.

#### Fertilizer Transportation

As pointed out earlier the major producing factories in Mexico are centered around Coatzacoalcos in Veracruz with a number of smaller factories distributed in other regions. In order to distribute approximately 3 million product mt of fertilizer consumed annually, FERTIMEX uses rail for around 83% and trucks for 17% of its total product shipments (figure 35). Products shipped in bulk for bagging by distributors accounted for 36% of the total product tons shipped in 1977. Current plans are for all products to be bagged at ports of importation in Mexico or at FERTIMEX factories or warehouses, thus ensuring control of quality and net bag weight.

Ammonia produced by PEMEX is primarily shipped by vessels to terminals on the east and west coasts of Mexico. Two ammonia pipelines also extend from Cosoleacaque on the east coast to Salina Cruz on the west coast for supplying ammonia to the west; one of these lines has a diameter of 6 in and the other 10 in. With the growing demand for fertilizers in the west, additional ammonia terminals, rather than ammonia plants, will be built at Salina Cruz, Topolobampo, and Lazaro Cardenas on the west coast. Two terminals will also be built in Pajaritos (east coast) and Salamanca (central region). FERTIMEX inland terminals and

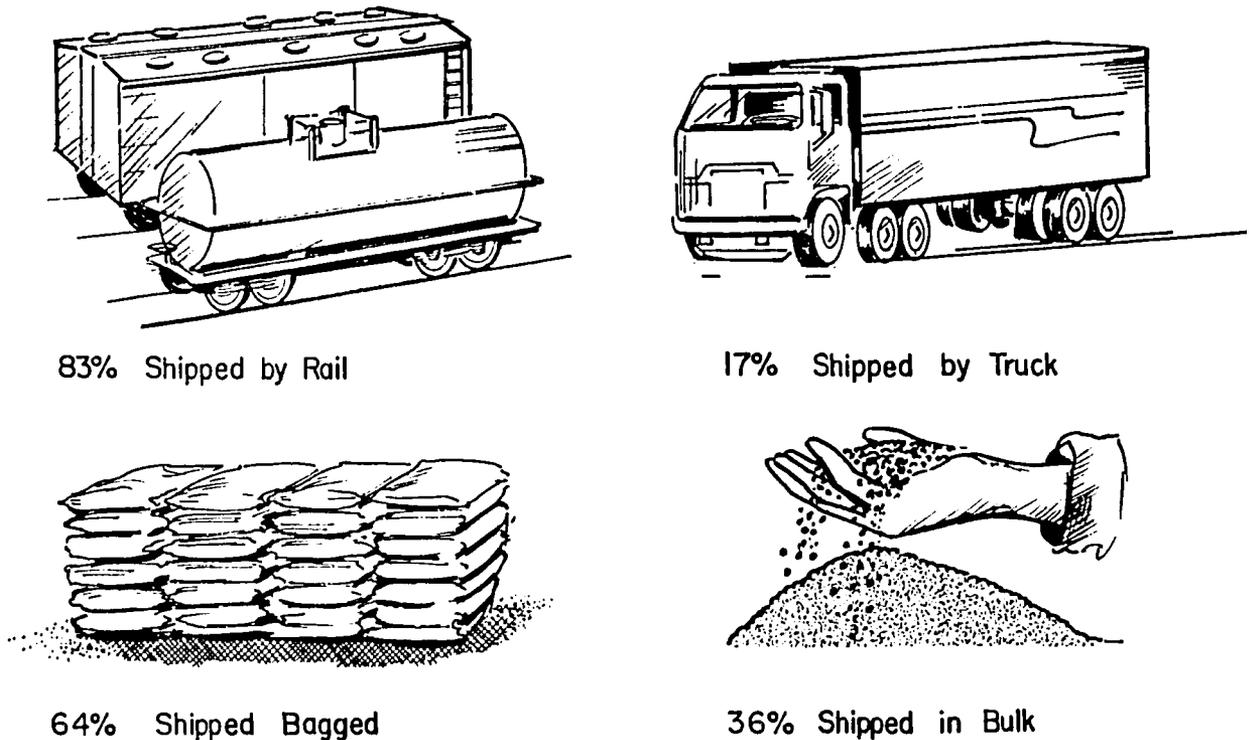


Figure 35. Modes of Transportation for Fertilizer Shipment in Mexico, 1977.

factories are, in turn, served by the seacoast ammonia terminals and, in some instances, by direct rail shipments from PEMEX.

#### Fertilizer Research and Extension

A National Fertilizer Committee was established in 1975 by presidential decree to determine a national policy on rational fertilizer use and to promote the development and financing of technical assistance, research, and use of fertilizers in line with national agricultural policy and goals. In addition, the committee was directed to coordinate fertilizer activity of INIA, extension service of the Ministry of Agriculture and Livestock, and FERTIMEX. Representatives from each of these organizations

were appointed to the Committee in addition to certain Presidential appointments. The locations of INIA stations in Mexico are indicated by figure 36.

The decree also established State Fertilizer Committees (Patronatos) with members drawn from state and national organizations involved in fertilizer activities within each state. The state patronatos are directed to work with the National Fertilizer Committee to ensure that the State and National objectives, goals, and implementation plans are in harmony.

Within each state, districts with similar rainfall and growing conditions are grouped together. This new system called the "Distritos de Temporal" has permitted about 280 agricultural areas to be formed. This approach brings farmer groups with similar problems together with research and extension and permits development of coordinated programs to meet needs under local farming conditions.

Fertilizer research work, soil testing, field trials, and demonstrations are carried out in varying degrees by organizations other than INIA such as FERTIMEX, extension service, grower associations, agricultural universities, and the International Maize and Wheat Improvement Center (CIMMYT). These activities are generally for specific purposes germane to the organization's function. CIMMYT, for example, carries out fertilizer work in relation to cereal breeding programs. Data from its findings are willingly shared with other researchers and agronomists in Mexico.

Overall, progress is being made in coordinating fertilizer research and extension-related activities at the national and state levels. This has resulted in better utilization of fertilizer and other inputs to achieve a continued increase in crop production.

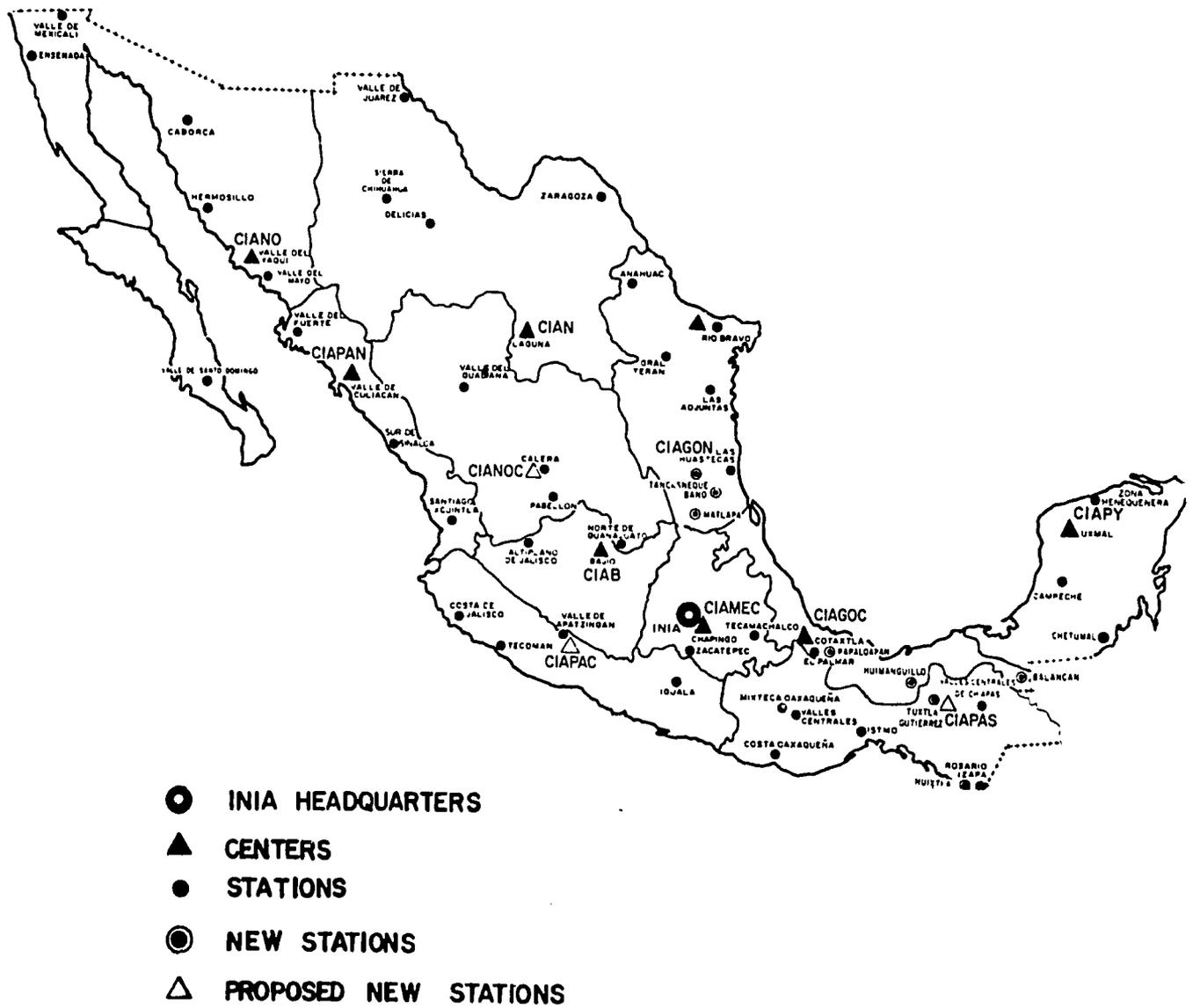


Figure 36. INIA Research Stations.

## REFERENCES

1. Nacional Financiera, S.A. 1977. Statistics on the Mexican Economy, Mexico, D.F.
2. Caballero, Lic. G. Martha Anguiano, Ing. Jose Genaro Pena Arroyo, C. Ana Maria Valenzuela Oliva, Ing. Cuauhtemoc Salazar Rangel. 1977. "Estadística Agrícola de los Distritos de Riego, Ciclo 1975-76," Mexico D.F.
3. Ahrens, C. L., and J. T. Shields. 1973. The Fertilizer Marketing System in Mexico, TVA Bulletin Y-65, National Fertilizer Development Center, Muscle Shoals, Alabama 35660.
4. Petroleos Mexicanos. 1977. Memoria de Labores 1976, Mexico 13, D.F.
5. Fertilizantes Mexicanos, S.A. 1979. Plan De Desarrollo En La Fabricacion De Fertilizantes, unpublished planning document.
6. The Petroleum Publishing Co. 1977. International Petroleum Encyclopedia, Vol. 10.
7. The British Sulphur Corp., Ltd. 1975. World Survey of Potash Resources, Second Edition, London, England.
8. Harris, G. T., and E. A. Harre. 1979. World Fertilizer Situation and Outlook--1978-85, IFDC Bulletin T-13, International Fertilizer Development Center/Tennessee Valley Authority, Muscle Shoals, Alabama 35660.

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