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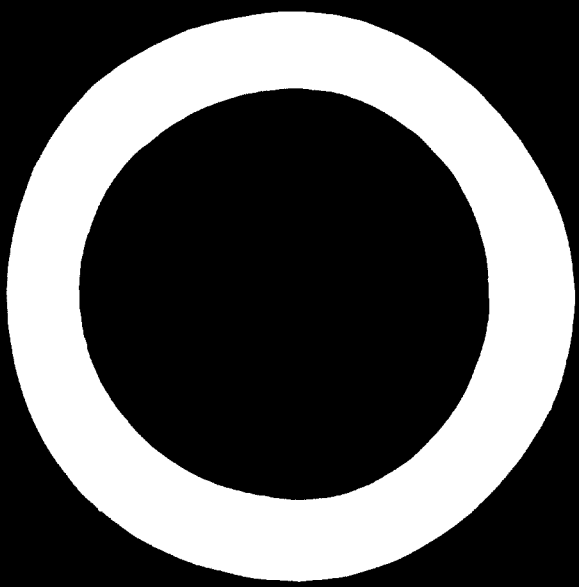
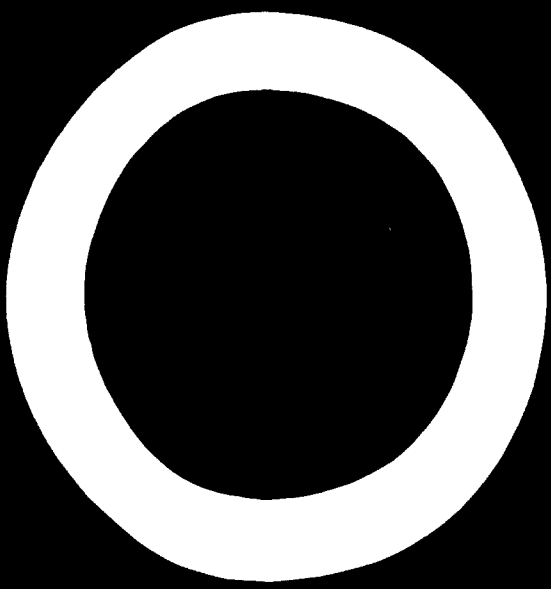
# Fertilizer Demand and Supply Projections to 1980 for South America, Mexico and Central America





UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA

*Fertilizer Industry Series*

*Monograph No. 6*

# FERTILIZER DEMAND AND SUPPLY PROJECTIONS TO 1980 FOR SOUTH AMERICA, MEXICO AND CENTRAL AMERICA

UNITED NATIONS
New York, 1971

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# Foreword

This is the sixth in a series of monographs on the fertilizer industry to be published by UNIDO.

The increasingly acute shortage of food that has resulted from rapid population growth on the one hand, and from rising living standards on the other, confronts the world with the pressing problem of increasing agricultural production quickly and efficiently. To this end, the expansion of the fertilizer industry and the rational use of fertilizers, particularly in the developing countries, must be encouraged by every possible means.

It is the purpose of this series of monographs to assist the developing countries by providing them with the most recent technical and economic information on this subject and on the steps that must be taken to establish a fertilizer industry.

The present monograph was prepared by Christopher J. Pratt of Mobil Chemical Company, New York, serving as consultant to UNIDO. The data are based on information available at the end of 1968. The views and opinions are those of the consultant and do not necessarily reflect the views of the secretariat of UNIDO.

## EXPLANATORY NOTES

The following symbols have been used throughout the report:

A slash (/) indicates a one-year period encompassing two calendar years, as in a crop year or a financial year, thus: 1965/1966.

Use of a hyphen (–) between years signifies the full period involved, including the beginning and end years, thus: 1963–1966.

Three dots (. . .) indicate that data are not available or are not separately reported.

References to tons are to metric tons unless otherwise stated.
References to dollars are to United States dollars unless otherwise stated.

The following abbreviations have been used:

| | |
|---|---|
| AID | United States Agency for International Development |
| DAP | Diammonium phosphate |
| FAO | Food and Agriculture Organization of the United Nations |
| GNP | Gross national product |
| IBRD | International Bank for Reconstruction and Development |
| IDB | Inter-American Development Bank |
| INTA | Instituto Nacional de Tecnología Agropecuario |
| IPEA | Instituto de Pesquisas a Experimentaçao Agropecuario |
| IQB | Industrias Quimicas Básicas |
| IVP | Instituto Vanazoiano de Petroquimica |
| YPFB | Yacimientos Petrolíferos Fiscales Bolivianos |

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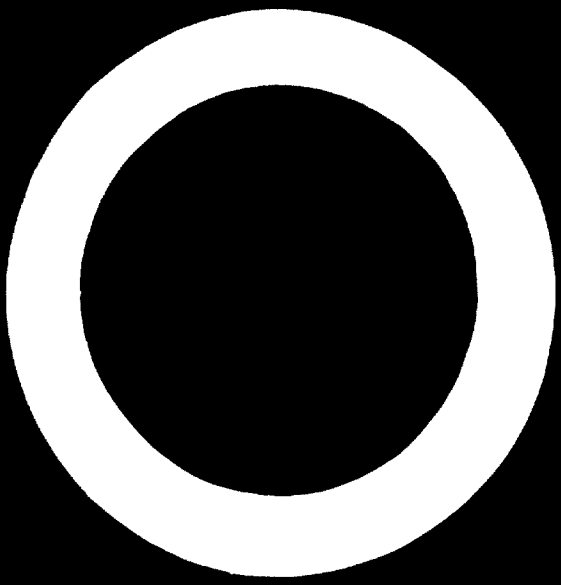

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# Introduction

This monograph contains a description of the agricultural sectors of the major countries of South and Central America, as well as Mexico, with special reference to past fertilizer demand and supply and projections to 1980.

Several comprehensive reports on this subject have been prepared previously by the United Nations, various government agencies and other groups. Some of these have been abstracted to furnish background data and figures for projection purposes. Supplementary information from commercial sources has also been used, whenever possible, to give additional guidance regarding envisaged projects and trading patterns.

In virtually every case examined, the current and projected demand for fertilizer nutrients falls short of the estimated need based on desirable dietary levels *per capita* and maximum export potentials for food products [5] [1]. The latter are especially important to countries such as Uruguay and those of Central America where agricultural products are the principal source of the foreign exchange needed not only to buy industrial goods, but also to pay for fertilizers and other farm inputs. Except in Argentina and Uruguay the annual population increase in the countries studied is 3 per cent or higher, and dietary deficiencies are prevalent in many rural areas. There is therefore a growing need for additional food supplies and more extensive use of fertilizers.

The use of fertilizers has been limited in the past by a number of factors: supplies have not been readily available; the value of

[1] Numerals in square brackets refer to references listed at the end of this publication.

fertilizers has not been generally recognized, particularly by farmers; purchasing power has been low; there have been few marketing facilities for above-subsistence crops; and, in some cases, there has been an unfavourable relationship between crop prices and fertilizer costs. Ample fertilizer materials are now becoming available owing to rapid advances in technology, but other limitations still remain and will take time to overcome, although determined efforts are being made, particularly in Brazil, Mexico and several Central American countries. Accordingly, no sudden transitions from very low to optimum fertilizer application rates can be expected. Instead, the continuation of more recent upward trends in demand is likely, and the projections shown have been made on this basis, in conjunction with other known factors likely to influence consumption.

In order to define probable nutrient demands more accurately, efforts have been made to use available computer models based on information dating from the early 1950s. Least-square linear and non-linear fittings, with and without exponential smoothing, have been tried, but in most cases the input data available are too scattered or inadequate to give indicative results. Consequently compound, manual projections have been made, modified by appropriate local considerations whenever necessary.

A new factor in fertilizer supply is the growing availability, through bulk shipments, of competitively priced liquid ammonia, phosphoric acid and potash from various sources. It is suggested in several instances that the use of these commodities be studied as an alternative to proposed local production on less than economic scales until such time as a growing demand can justify large domestic fertilizer complexes.

In some countries, the forthcoming supply situation is extremely difficult to estimate owing to the multiplicity of plans and aspirations announced by national and international groups concerning new fertilizer projects. In order to maintain a realistic perspective, therefore, further reviews are recommended every two or three years.

The descriptions that follow cover the agricultural sectors of ten South American countries and Mexico under the following headings:

General information
Identified fertilizer raw materials
Farming patterns
Land and economic policies
Fertilizer use
Fertilizer supply
Balance of demand and supply

For the five Central American countries and Panama the descriptions are somewhat more condensed and are combined for the Zone.

# Argentina

## General information

| | |
|---|---|
| *Population (1968)* | Total: approximately 24 million; annual growth rate: 1.8 per cent; density: 10 per square kilometre |
| *Land (hectares)* | Total: 274 million; potential farmland: 126 million; cultivated: 28 million; irrigated: 810,000 |
| *Annual rainfall (inches)* | East: 39; west: 20 |
| *Resources* | Commercial reserves of petroleum, gas, non ferrous metals and iron ore; potential hydroelectric power |
| Per capita *annual income* | $ 700 in 1966 |
| *Average annual growth of GNP* | 2.6 per cent in the period 1960—1966 |

## Identified fertilizer raw materials

| | |
|---|---|
| ***Phosphates*** | Appreciable animal carcass residues |
| ***Potash*** | Virtually nil |
| ***Sulphur*** | Some brimstone minerals in the Andes regions |
| ***Hydrocarbons*** | Commercial reserves of oil and gas |
| ***Limestone*** | Large deposits |

## Farming patterns [1 and 17]

Argentina has been called the breadbasket of Latin America. It is endowed with huge tracts of arable land, a temperate climate and adequate rainfall. It raises about one half of the beef and two thirds of the wheat produced in South America. With a relatively small additional investment, and given effective government and technical support, it could more than double its present agricultural output.

Most of the farming takes place in the central *pampas* region, which covers about one quarter of the country. The principal crops are wheat, barley, oats, corn, oilseeds and rye. Cattle and dairy farming are also practised on a large scale. Sheep raising and fruit and vine growing are common in the arid western and southern regions. Sugar and cotton are produced in the north. Cattle raising is spreading north and west, as land fertility in some parts of the *pampas* declines, (see tables 1 and 2).

## Land and economic policies

Early land policy resulted in the consolidation of large holdings in the hands of a few owners who employed casual and tenant labour. In addition, numerous small, uneconomic farmlets were established, which were repeatedly subdivided. Mass migration to the towns in the early 1950s disrupted the agricultural economy and led to reduced crop yields, which in many cases fell below 1930 levels. Meanwhile, domestic consumption increased considerably. As a result, Argentina has changed from a major to a relatively minor food exporter, and the balance of trade has suffered accordingly. Nevertheless, over 90 per cent of Argentina's foreign-exchange earnings are still derived from agricultural products.

The absence of a sound, continuing programme, fluctuating land and fiscal policies, together with unco-ordinated *ad hoc* planning have weakened the agricultural sector. In each of the past ten years, less than 7 per cent of the national budget has been spent on agricultural development. Until appropriate new policies are introduced and vigorously undertaken, agriculture is unlikely to attain its former world-wide importance, despite an abundance of natural resources and potential skills.

On the positive side, determined efforts are being made by the Instituto Nacional de Tecnologia Agropecuario (INTA) to improve farming practices through its field stations and experimental programmes. However, a shortage of trained personnel is a limiting factor at the present time; for example, whereas the ratio of pro-

*Table 1. Argentina—Indexes of cultivated area, yields and total production of selected major grain crops, 1935—1964* [a]

*A. Cash grains*

| | *Wheat* | | | *Corn* | | | *Flax* | | | *Sunflower* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Area* | *Yield* | *Production* | *Area* | *Yield* | *Production* | *Area* | *Yield* | *Production* | *Area* | *Yield* | *Production* |
| 1935—1940 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1941—1943 | 94 | 123 | 103 | 71 | 106 | 81 | 85 | 109 | 97 | 381 | 99 | 253 |
| 1944—1946 | 83 | 101 | 71 | 60 | 95 | 51 | 65 | 106 | 60 | 460 | 83 | 305 |
| 1947—1948 | 76 | 130 | 88 | 43 | 85 | 39 | 45 | 99 | 43 | 468 | 83 | 325 |
| 1950—1952 | 78 | 113 | 51 | 43 | 84 | 34 | 31 | 108 | 31 | 393 | 79 | 255 |
| 1953—1955 | 78 | 137 | 100 | 48 | 93 | 45 | 24 | 102 | 23 | 245 | 81 | 165 |
| 1956—1958 | 77 | 136 | 102 | 44 | 102 | 51 | 45 | 95 | 40 | 406 | 63 | 211 |
| 1959—1961 | 82 | 132 | 82 | 50 | 101 | 58 | 41 | 107 | 48 | 361 | 79 | 268 |
| 1962—1964 | 77 | 168 | 129 | 57 | 96 | 61 | 46 | 107 | 52 | 294 | 74 | 200 |

*B. Dual grains* [b]

| | *Barley* | | | *Oats* | | | *Rye* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Area* | *Yield* | *Production* | *Area* | *Yield* | *Production* | *Area* | *Yield* | *Production* |
| 1935—1940 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1941—1943 | 89 | 122 | 91 | 125 | 100 | 93 | 145 | 109 | 115 |
| 1944—1946 | 135 | 130 | 164 | 120 | 109 | 123 | 158 | 95 | 140 |
| 1947—1948 | 118 | 115 | 115 | 90 | 121 | 100 | 170 | 101 | 142 |
| 1950—1952 | 122 | 126 | 144 | 95 | 128 | 117 | 208 | 119 | 276 |
| 1953—1955 | 145 | 135 | 188 | 98 | 136 | 125 | 234 | 125 | 284 |
| 1956—1958 | 175 | 128 | 218 | 127 | 123 | 143 | 265 | 123 | 314 |
| 1959—1961 | 159 | 116 | 171 | 105 | 127 | 121 | 255 | 125 | 280 |
| 1962—1964 | 131 | 135 | 139 | 83 | 141 | 105 | 210 | 125 | 183 |

*Source:* Ministry of Agriculture.

[a] Based on harvested acreage.

[b] Dual grains are those that are closely related to cattle production, and are either harvested or grazed, depending upon pasture conditions and the economic relationship between cattle prices and grain prices. In many cases dual grains are planted exclusively for winter pasture.

*Table 2. Argentina—Gross value of agricultural production, 1935—1963 (in millions of 1960 pesos)*

| | Crops | | Livestock | | Total, agricultural sector | |
|---|---|---|---|---|---|---|
| | *Average gross annual production* | *Production index* | *Average gross annual production* | *Production index* | *Average gross annual production* | *Production index* |
| 1935—1939 | 64,845 | 100 | 59,724 | 100 | 124,569 | 100 |
| 1940—1944 | 71,573 | 110 | 71,156 | 119 | 142,729 | 115 |
| 1945—1949 | 58,178 | 90 | 75,167 | 126 | 133,345 | 107 |
| 1950—1954 | 55,395 | 85 | 72,920 | 122 | 128,315 | 103 |
| 1955—1959 | 64,722 | 100 | 78,184 | 131 | 142,906 | 115 |
| 1960—1963 | 67,292 | 104 | 78,768 | 125 | 142,060 | 114 |
| Change 1935—1939 to 1960—1963 | +2,447 | +4 | +15,044 | +25 | +17,491 | +14 |
| Average annual change | | +0.15 | | +1.0 | | +0.56 |

*Source:* Consejo Nacional de Desarrollo (CONADE).

fessional agriculturalists to farmers in the United States is about 1 to 500, in Argentina, where the need is relatively greater, it is about 1 to 1,000.

Average *per capita* dietary standards in Argentina are comparable with those of the United States and Western Europe, that is, about 2,700 calories per day and an animal protein content of 70 per cent of the total protein intake. Furthermore, apart from imports of coffee, cocoa and a few fruits, the country is self-sufficient in food. Increased agricultural production is nevertheless needed to provide for future increases in population and to supply foreign exchange. Similarly, greater fertilizer use is imperative to revive declining crop yields and to ensure adequate future food supplies for the domestic and export markets.

A disproportionate amount of the available credit appears to be allocated to short-term loans, to the detriment of any efforts at long-term improvements and changes in the ownership structure. It is also true that long-term financing has been discouraged by inflation. The principal credit sources are the National Bank of Argentina, the Provincial Bank of Buenos Aires, and the agricultural cooperatives, which also handle many of the banking loans. In recent

years, agricultural credits have amounted to approximately 25 per cent of all bank loans.

Depressed prices for crops and import taxes on items such as farm machinery, fertilizer and pesticides have created relatively high input prices and discouraged efficient practices. As a result, there has been an increase in livestock production and land use. More recently, rising crop prices have led to increased crop production, especially for domestic needs. However, a major deterrent to greater farm output has been, and still is, the lack of effective price structures. Net returns to farmers have varied widely owing to erratic price restrictions, output taxes, inflation and various local factors. Farmers have thus found it difficult to operate on an economic basis.

Political stability and various fundamental changes will be needed to restore Argentine agriculture to its previous level and bring about improvements. Among the recommendations [6] that have been made are the following:

A land tax which imposes penalties for under-utilization;

Better distribution of costs and returns between landlords and tenants to encourage greater yields;

Reduced input prices and taxes;

Maintenance of prices for export commodities at levels close to world prices;

Concentrated production programmes for beef and wheat with the help of INTA, together with the establishment of new crops such as soybeans (and perhaps sunflower);

Training of a greater number of agricultural scientists and field specialists;

Major investments and social incentives that will stimulate a return to farming as a rewarding way of life.

## Fertilizer use

A study made in 1964 showed that Argentina used the smallest amount of fertilizer nutrients per cultivated area of any of the 20 countries compared. The amount was 0.5 kg of nitrogen (N), phosphate ($P_2O_5$) and potash ($K_2O$) per hectare in 1961, compared with a world average of 23 kg per hectare. The *per capita* use of fertilizer nutrients is also very low: approximately 2.2 kg in 1966.

Most fertilizers are used for intensively cultivated crops such as sugar cane, vegetables and fruit. There has been little incentive to fertilize grain crops because of low product prices, while pasture has been scarcely fertilized at all owing to the extensive areas in-

volved. Nevertheless, in 1964, after the lifting of some fertilizer import duties in 1963, the use of fertilizers rose promptly to 2.2 kg per cultivated hectare, showing that many farmers realized the usefulness of economically priced fertilizers. However, this increased use was not kept up between 1965 and 1967 owing to a cutback in sugar crops. In 1966, fertilizer use was about 3.4 kg *per capita*.

*Table 3. Argentina—Fertilizer consumption*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | *1957—1959* | *1960—1961* | *1964* | *1966* | *1967—1968* | *1970* | *1975* | *1980* |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 8.4 | 9.7 | 33.2 | 26 | 34 | (high) 54 | 135 | 333 |
| Average annual percentage increase | 5 | 50 | -12 | 14 | | 20 | | |
| Thousands of tons | | | | | | (low) 46 | 93 | 190 |
| Average annual percentage increase | 15 | | | | | 15 | | |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | 5.1 | 4.0 | 10.4 | 13 | 14 | (high) 23 | 46 | 93 |
| Average annual percentage increase | -4 | -37 | 12 | 8 | | 15 | | |
| Thousands of tons | | | | | | (low) 21 | 38 | 69 |
| Average annual percentage increase | 12.5 | | | | | 12.5 | | |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 2.4 | 2.8 | 4.9 | 6.7 | 5.3 | (high) 8.3 | 25 | 63 |
| Average annual percentage increase | 5 | 20 | 17 | -20 | | 25 | | 20 |
| Thousands of tons | | | | | | (low) 7.0 | 14 | 28 |
| Average annual percentage increase | 14 | | | | | 15 | | |

*Source:* Various.

Average annual growth rates for use of nitrogen, phosphate and potash between 1958 and 1966 were 15, 12.5 und 14 per cent respectively, according to data supplied by INTA, the United Nations and other sources. While these rates are impressive, actual tonnages were very small, as shown in table 3.

Because consumption patterns are so largely dependent on national economic and agricultural policies, it is difficult to forecast them accurately. Calculations have been made [5] of various desirable levels, based on *per capita* equivalent nutrient needs, or recommended application rates per cultivated hectare. However, the country imports much of its fertilizer requirements, has a limited production capacity, and is not perilously short of food. It is therefore unlikely that ideal or even desirable application rates will be achieved within a decade.

Table 3 shows estimated future nutrient consumption, as well as past consumption and growth rates. Minimum requirements are not expected to fall below past growth-rate equivalents, and consumption is likely to be somewhat greater.

## Fertilizer supply

Imports in 1965/1966 were 55,000 tons of nitrogen fertilizers (principally ammonium sulphate, urea and sodium nitrate), 5,100 tons of phosphates (mostly triple superphosphate) and 3,400 tons of potassium chloride and nitrate, in nearly equal amounts. In addition, 25,600 tons of nitrogen, phosphate and potash (N-P-K) compounds and 10,500 tons of nitrogen and phosphate (N-P) compounds were purchased from other countries. Total imports amounted to about 100,000 tons.

In 1967, domestic fertilizer production amounted to some 5,000 tons of ammonium sulphate, 7,000 tons of basic phosphate slag from the steel industry and some organic bone material. In 1968, the Petrosur nitrogen fertilizer plant (based on domestic natural gas) came on stream with a total capacity of 68,000 tons per year of ammonia (56,000 tons per year of nitrogen), which will be used to make, annually, approximately 55,000 tons of urea, 45,000 tons of ammonium sulphate and 30,000 tons of mixed fertilizers equivalent to 14—14—14.

In addition, plants have been established with annual capacities of 40,000 tons of sulphuric acid and 50,000 tons of single superphosphate. Plans have been announced to make 100,000 tons per year of ammonia and 100,000 tons per year of derivatives at Bahía Blanca.

## Balance of demand and supply

Present annual domestic nitrogen production capacity is approximately 57,000 tons. This is likely to exceed demand until 1970/1971, based on the higher anticipated demand growth rate, or 1971/1972, based on the lower rate. Because of the time needed for domestic production to supersede imports, 1974 has been suggested as the probable balance year.

It is evident, however, that the anticipated continual increase in nitrogen fertilizer demand will justify another ammonia and derivatives complex between 1975 and 1980. Because of the greater economy achieved by the larger ammonia plants using centrifugal compressors, this type would be normally recommended. A minimum size would be 600 tons per day of ammonia, equivalent to 165,000 tons per year of nitrogen. The optimum size and timing should become apparent within the next three or four years, on the premise that adequate natural gas supplies are available. The feasibility of using low-cost imported ammonia could also be studied as short-range and long-range alternatives.

Phosphates, potash (and most probably sulphur) will have to be imported because no suitable domestic sources are known. The rapidly increasing availability of wet-process phosphoric acid from Mexico and elsewhere may offer a suitable alternative to importing rock, sulphur and high-analysis phosphates to meet expanding future needs.

# Bolivia

## General information

| | |
|---|---|
| *Population* (1968) | Total: approximately 4.5 million; annual growth rate: 2.4 per cent |
| *Land (hectares)* | Total: 110 million; 40 per cent covered by dense forest |
| *Temperature* | Varies from freezing in the highlands to semi-tropical in the eastern lowlands |
| *Resources* | Mining is the most important sector of the economy. Principal crops are sugar, potatoes, barley, corn, wheat and rice. Production of coffee and bananas is increasing. Sheep and cattle farming predominate in husbandry activities |
| Per capita *annual income* | Approximately $150. Non-military foreign aid from the United States, the United Kingdom and other sources exceeded $28 million in 1967 |
| *Average annual growth of GNP* | 33 per cent derived from agriculture ($700 million in 1967), which employs 67 per cent of the working population |

## Agriculture and fertilizer use

Food production is inadequate and dietary deficiencies prevail in some of the rural areas. Annual fertilizer consumption is very low, being confined in the main to a few thousand tons of diammonium phosphate and other materials imported from the United States and Europe and a small quantity of superphosphate produced locally. A small nitrogen fertilizer plant (about 25,000 tons per year of ammonia and 50,000 tons per year of ammonium nitrate) is planned by Yacimientos Petrolíferos Fiscales Bolivianos (YPFB), the State-owned gas and petroleum company, to be operated in conjunction with a domestic petroleum refinery. Part of the output will be used for the manufacture of explosives. Assistance in establishing a fertilizer industry, including farmer education, credit and marketing facilities, is being provided by the United States Government and other sources.

# Brazil

## General information

| | |
|---|---|
| *Population (1968)* | Total: approximately 89 million; annual growth rate: 3 per cent or over; density: approximately 11 per square kilometre |
| *Land (hectares)* | Total: 851 million; arable: 35 million; cultivated: 33 million; irrigated: 150,000 |
| *Rainfall* | Adequate, except in the north-eastern drought areas |
| *Resources* | Limited reserves of coal, oil and gas. Some hydroelectric power, as well as ferrous and non-ferrous ores and timber |
| Per capita *annual income* | $360 in 1963; in the north, $100 |
| *Average annual growth of GNP* | 7 per cent in the period 1957—1961 |

## identified fertilizer raw materials

| | |
|---|---|
| *Phosphates* | Appreciable deposits, mostly near the eastern coastal region |
| *Potash* | Small deposits in the north-east and some brine residues in the south |
| *Sulphur* | Very small deposits |
| *Hydrocarbons* | Limited reserves of gas |
| *Limestone* | Ample reserves |

## Farming patterns

The greater part of this vast country consists of highlands, nearly 60 per cent being plateau land up to 3,000 feet in altitude; about 40 per cent is lowland. The lowlands forming the Amazon river basin are of limited use for agricultural purposes. Farming, industry and population are mainly concentrated in the eastern coastal regions, which account for about 35 per cent of the total land area. The southern part of this territory produces over 50 per cent of the total cultivated crops and almost half of the national income. Many soils are highly leached and low in fertility.

Farming patterns and methods are a mixture of old and new. In the north, primitive ways have tended to prevail, while in the southern and central areas modern techniques have been widely adopted.

A wide variety of crops is grown; coffee is the most important, followed by rice, corn, cotton, beans, sugar cane, manioc, wheat, vegetables and fruits. Cattle, pig, sheep and poultry farming grew rapidly between 1950 and 1960. At present, cattle is the principal livestock. In the 1940s, coffee yielded about 8 per cent of the national income and nearly 75 per cent of foreign exchange earnings. The Government has for some years de-emphasized the predominant role of coffee and encouraged the cultivation of other crops, such as wheat. In recent years over 2 million tons of wheat, or nearly 90 per cent of domestic needs, have been imported annually. Nevertheless, coffee still produces about 50 per cent of the foreign exchange. It is worth mentioning that Brazil is the largest producer and consumer of rice in the western hemisphere, a circumstance which offers additional opportunities for agricultural expansion.

Cultivated areas, which account for about 4 per cent of the total area of the country, vary widely according to region. In the north and in the central western region, only 9 per cent of the land is farmed; in the east and south, about 70 per cent. Much of the farmland is pasture (except in the east and south), and large tracts are still wooded. The farming potential in most areas is considerable; improved transportation and increased use of fertilizers are key factors.

In the north-east, about 65 per cent of the farms are under 10 hectares in area; in the north, they are even smaller. In the central western and southern regions, some 50 per cent of the farms are in the 10 to 100 hectare range. There are some large holdings of over 10,000 hectares in the thinly populated north. In general, about 90 per cent of all farms are under 100 hectares in size; these represent 20 per cent of the total cultivated area. Only 1 per cent

are over 1,000 hectares, yet these account for nearly half of the total area farmed.

## Economic policies [15]

Although Brazil is largely an agrarain society with a growing population, Brazilian higher education has primarily emphasized law, medicine and letters, which in 1960 accounted for nearly 70 per cent of total enrolments. Agriculture attracted only 2.9 per cent. Agricultural extension services have recently been introduced, but appear to be aimed at supplying technical assistance rather than farmer education. The effectiveness of the programme is limited by the vast extent of the country, the small number of specialists and the lack of good research data. One result has been that the agricultural production index has lagged behind that of total GNP.

Agricultural credit is obtainable from the Bank of Brazil, state banks and co-operatives, as well as from several private sources. However, for small farmers who cannot supply collateral in the form of large holdings and crops, borrowing may be difficult. As a considerable proportion of the available credit is extended only on a short-term basis, capital investment in modern facilities and equipment tends to be restricted.

In 1967, a sustained improvement took place in business conditions and continued well into 1968, leading to the belief that the year 1968 1969 would be the "take-off" period for Brazilian industry and economy. Inflation fell from a rate of 46 per cent in 1966 to 25 per cent in 1967/1968.

Although agrarian reform has been widely discussed, it will take time for a comprehensive national programme to be effectively legislated and undertaken. In addition to reducing dependence on coffee, some proposals [15] for expanding Brazilian agriculture and raising its productivity include:

Development of supply sources in conjunction with the industrial sector;

Development of strong research centres;

Increased investment in rural education, as well as in education at the secondary and higher levels, and in extension services;

Improvement of facilities, including transportation, for handling bulk commodities;

Expansion of research facilities aimed at improving both public and private sector resources.

Until these goals are realized, significant changes in agricultural patterns and substantial annual increases in fertilizer use are unlikely to take place.

## Fertilizer use

Except in the arid north-east, Brazilian soils are very acid and of low fertility. Nevertheless, the use of lime and fertilizer has met only a fraction of real needs. These deficiencies must be corrected before crop yields can be increased. Recent fertilizer applications of nitrogen (N), phosphate ($P_2O_5$) and potash ($K_2O$) have averaged some 9 kg per hectare annually, compared with some 23 kg for the world as a whole, 35 kg for the United States and nearly 500 kg each for the Netherlands and New Zealand. Crop yields, as a result, have been from two to four times as large as those of Brazil.

Table 6 shows past nutrient consumption, indicating an over-all annual increase of 7 per cent in the last decade for nitrogen, virtually no over-all increase for phosphates and 5.5 per cent for potash.

Brazil's chemical and fertilizer industries are expanding, although inflation, changing government policies and uncertainties in investment climate have led to erratic growth patterns in recent years. Nevertheless, several new fertilizer plants have been started; others are under construction or at the planning stage. A much larger availability from domestic sources may be expected to lead to greater use. One clue to the future is undoubtedly the sudden jump in imports between 1966 and 1967, equivalent to an increase of 52 per cent for nitrogen, 100 per cent for phosphates and 46 per cent for potash.

Accordingly, it is believed that minimum annual growth rates for nitrogen, phosphates and potash will not be lower than 10 per cent during the next decade.

Furthermore, it is quite possible that, by 1980, over-all annual growth patterns of 15 per cent will have been achieved, as indicated in table 6, assuming sufficient farm credits are made available. Because phosphates and potash are low in most areas, it is postulated that their increased use will approximately keep step with the use of nitrogen. Recent import figures indicate a possible annual growth of 20 per cent by 1970 for phosphates, as shown in the table.

## Fertilizer supply

In 1966, fertilizer imports included 240,000 tons of ammonium sulphate, 112,00 tons of phosphates and phosphate rock and 144,000 tons of potassic fertilizers. Imports have increased sharply in recent years to meet rising demand, as shown below.

| | Tons of materials | Percentage increase |
|---|---|---|
| 1964 | 361,750 | — |
| 1965 | 470,880 | 30 |
| 1966 | 650,000 | 37 |
| 1967 | 1,015,000 | 56 |

Domestic fertilizer production rose from 417,000 tons in 1966 to 553,000 tons in 1967. Included in the latter year were 12,500 tons of ammonium sulphate, 453,000 tons of superphosphates, 3,800 tons of dicalcium phosphate, 2,600 tons of thermophosphate and 55,000 tons of ground phosphate rock. Ammonium nitrate and nitrochalk have also been produced for many years by the government-owned Petrobras concern. In 1968, installed sulphuric acid capacity was given as 570,000 tons per year. A wet-process phosphoric acid unit (Copebras), with a capacity of 17,000 tons per year of $P_2O_5$, supports a superphosphate plant with a capacity of 100,000 tons per year of double superphosphate.

A large nitrogen-fertilizer complex (Ultrafertil) is now under construction in conjunction with Philips Petroleum of the United States. This plant should come on stream in 1969/1970, and will have annual capacities of 160,000 tons of ammonia, 190,000 tons of nitric acid, 210,00 tons of sulphuric acid and 80,000 tons of phosphoric acid. Products will include 10,000 tons of agricultural ammonia, 220,000 tons of ammonium nitrate (plus some solutions) and about 160,000 tons of ammonium phosphate.

Other new projects or planned expansions include an ammonia unit producing 70,000 tons per year, a urea unit (Petrobras) producing 85,000 tons per year and an ammonium sulphate unit (Usiminas) producing 12,000 tons per year.

A project for producing sulphuric acid and cement, based on by-product gypsum from phosphoric acid manufacture, is under study in conjunction with the Chemoleum Corporation of the United States. This would produce about 300,000 tons per year of acid and a similar quantity of cement annually, and it is claimed that it could save Brazil about $16 million in foreign exchange.

In the early 1970s, therefore, annual domestic capacity should be about 200,000 tons of nitrogen and a similar capacity of phosphates ($P_2O_5$) in the form of ground rock, superphosphates and ammonium phosphates. This should encourage greater consumption and lead to a substantial reduction in imports, although some phosphate rock and sulphur from overseas will undoubtedly be used for a long time to come. For the foreseeable future, virtually all potash needs will probably be imported, although the possibility of using some domestic deposits in the north-east, or brine residues in the south, is under consideration.

## Balance of demand and supply

If the use of fertilizers continues to grow within the limits projected in table 6, an additional nitrogen complex would appear to be needed between 1971 and 1973 to minimize imports. A need for substantial additional phosphate facilities is also indicated by 1974. To take advantage of large-scale economies, it may be expedient to meet expanding needs by imports until such time as a phosphoric acid plant producing 500 tons per day or more can be justified. However, because the active growth of the industry could be curbed by factors such as inflation and insufficient farm credits and support programmes, it is not possible at present to predict precisely the timing and capacities of additional facilities. Studies on future demand and supply are therefore advisable every three years. At the same time, the economic viability of using imported ammonia and phosphoric acid should be investigated.

*Table 4. Brazil—Indexes of quantity of food products, 1953—1963*

| | *Vegetable origin* | *Animal origin* | *Total* |
|---|---|---|---|
| 1953 | 100 | 100 | 100 |
| 1954 | 110 | 105 | 103 |
| 1955 | 116 | 108 | 113 |
| 1956 | 114 | 116 | 115 |
| 1957 | 124 | 123 | 124 |
| 1958 | 119 | 131 | 124 |
| 1959 | 127 | 131 | 129 |
| 1960 | 142 | 133 | 138 |
| 1961 | 143 | 138 | 144 |
| 1962 | 157 | 144 | 152 |
| 1963 | 165 | 145 | 158 |

*Source:* Instituto de Pe uisas e Experimentação Agropecuaria (IPEA).

*Table 5. Brazil—Index of quantities of principal agricultural products[a] exclusive of coffee, and indexes of population, 1947—1963*

| | *Index of quantities (1947—1952 = 100)* | *Total population (1,000)* | *Population index (1953 = 100)* | *Population index (1947—1952 = 100)* |
|---|---|---|---|---|
| 1947 | 77 | 43,438 | 85 | 94 |
| 1948 | 84 | 49,590 | 87 | 96 |
| 1949 | 96 | 50,709 | 89 | 98 |
| 1950 | 103 | 51,976 | 92 | 101 |
| 1951 | 103 | 53,496 | 94 | 104 |

*Table 5 (continued)*

| | Index of quantities (1947—1952 = 100) | Total population (1,000) | Population index (1953 = 100) | Population index (1947—1952 = 100) |
|---|---|---|---|---|
| 1952 | 111 | 55,095 | 97 | 107 |
| 1953 | 113 | 56,741 | 100 | 110 |
| 1954 | 121 | 58,437 | 103 | 113 |
| 1955 | 127 | 60,183 | 106 | 117 |
| 1956 | 130 | 61,981 | 109 | 120 |
| 1957 | 137 | 63,833 | 112 | 124 |
| 1958 | 137 | 65,740 | 116 | 128 |
| 1959 | 145 | 67,704 | 119 | 131 |
| 1960 | 156 | 70,967 | 125 | 138 |
| 1961 | 165 | 73,088 | 129 | 142 |
| 1962 | 174 | 75,271 | 133 | 146 |
| 1963 | 179 | 77,521 | 137 | 150 |

*Source:* Instituto de Pesquisas e Experimentação Agropecuara (IPEA).

[a] Rice, corn, wheat, edible beans, potatoes, manioca, oranges, bananas, lard, beef, pork, milk, eggs, fish, peanuts, sugar cane, tobacco, sisal and cotton.

*Table 6. Brazil—Fertilizer consumption*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | 1957—1959 | 1960—1961 | 1964 | 1966 | 1967—1968 | 1970 | 1975 | 1980 |
| ***Nitrogen, N*** | | | | | | | | |
| Thousands of tons | 38 | 57.4 | 51 | 66 | 125 | (high)165 | 335 | 680 |
| Average annual percentage increase | 14 | −3 | 15 | 35 | | — | 15 | — |
| Thousands of tons | | | | | | (low)152 | 248 | 400 |
| Average annual percentage increase | — | — | 12.5 | — | — | — | 10 | — |
| ***Phosphate, $P_2O_5$*** | | | | | | | | |
| Thousands of tons | 129 | 123 | 135 | 90 | 130 [a] | (high)172 | 350 | 710 |
| Average annual percentage increase | −2 | 3 | −18 | 20 | | — | 15 | — |

*Table 6 (continued)*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | 1957–1959 | 1960–1961 | 1964 | 1966 | 1967–1968 | 1970 | 1975 | 1980 |
| Thousands of tons | | | | | | (low)158 | 255 | 415 |
| Average annual percentage increase of tons | | 0 | | | 20 | | 10 | |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 61 | 82 | 70 | 92 | 122[a] (high) | (high)160 | 320 | 650 |
| Average annual percentage increase | 10 | –5 | 14 | | | 15 | | |
| Thousands of tons | | | | | 112[a] (low) | (low)135 | 217 | 350 |
| Average annual percentage increase | | 5 | | | | 10 | | |

*Source:* Various.

[a] Provisional.

# Chile

## General information

| | |
|---|---|
| *Population (1968)* | Total: approximately 9.5 million; annual growth rate: about 2.5 per cent; density: approximately 13 per square kilometre |
| *Land (hectares)* | Total: 74.2 million; arable: 11 million; cultivated: 6 million; pasture: 20 million; forest: 22 million; potential farmland: 2 million; irrigated: 1.5 million |
| *Rainfall (inches)* | From 4 in the north to 40 in the south |
| *Resources* | Non-ferrous ores, coal, sulphur, natural gas, some petroleum, hydroelectric power, sodium nitrate, potash, some phosphate and limestone |
| Per capita *annual income* | Approximately $550 |
| *Average annual growth of GNP* | From 3 to 3.7 per cent in 1967 |

## Identified fertilizer raw materials

| | |
|---|---|
| *Phosphates* | Small reserves of low-quality rock<br>Dwindling supplies of bird guano |
| *Potash* | Sodium and potassium deposits |

| | |
|---|---|
| *Sulphur* | Some medium-grade ores, often found in remote locations |
| *Hydrocarbons* | Petroleum and gas in the south |
| *Limestone* | Ample reserves |

## Farming Patterns

Chile extends over an area approximately 4,000 km from north to south and 170 km from east to west, flanked by the Andes and the Pacific. The northern and southern territories are sparse in agriculture. The richest farmland is in the central area, which accounts for over half the total output. The north-central region is also farmed, as are the south-central and lake areas, which supply nearly half of the cereal and potato crops.

In recent years, crops have accounted for 57 per cent of the total value of agricultural production, and livestock for 43 per cent. The most important commodities are beef, wheat, milk, fruits and wine. In the central regions, the farming environment is ideal, and a potential for expansion exists. Nevertheless, agricultural imports exceed agricultural exports by about $150 million annually. During the last decade, corn production has increased by nearly 200 per cent, sugar beet some twentyfold and rape seed several hundredfold. Poultry and hog raising have also increased, but not sufficiently to meet total needs.

Privately owned land accounts for approximately 90 per cent of farmed areas. Sixty-three per cent of this land is owned by about 3 per cent of the farmers with properties exceeding 33 hectares. Twenty-five per cent is owned by 12 per cent of the farmers with properties between 3 and 33 hectares, while the remaining 12 per cent is worked by 85 per cent of the farmers occupying areas under 3 hectares.

## Economic policies [3]

Increased agricultural production has been of growing concern in Chile because, during the last decade, agricultural output has not kept pace with population growth. Although the importance of research and extension services is recognized, insufficient priority has been accorded to them. It has been suggested, moreover, that attempts to achieve self-sufficiency in wheat, meat and sugar have inhibited the expansion of labour-intensive crops, which could be advantageously raised in Chile for domestic and export consumption.

One aim of the Government's agricultural programme is to change the landownership structure (with appropriate compensation) and to establish small, family-type farms on insufficiently cultivated areas. It has been recognized, moreover, that there has been a lack of co-ordinated agricultural planning, and a wide range of government programmes has been instituted. An annual production growth rate of at least 5.5 to 6 per cent by 1971 has been established as the goal. Public sector investments in agriculture have recently increased from some 9 to 13 per cent. Attempts have been made to improve agricultural marketing by ensuring a better wholesale price structure, less retail fragmentation and more adequate economic and information services.

Although approximately 30 per cent of the active population is engaged in agriculture, this sector contributes only 10 per cent to GNP. Higher agricultural output could help to control inflation and also to improve the balance of trade. National accounts for 1967 indicated an output growth of 3.9 per cent for agriculture (largely due to increased acreage), compared with 2.5 per cent for industry and –0.6 per cent for mining. The agricultural growth is not expected to be sustained, owing to a long and continuing drought.

Chilean agriculture is in a period of transition, following recognition by the Government of the need for several fundamental changes. Among these are the more productive farming or arable areas through changes in ownership, improved wholesale and retail marketing and price structures, sufficient farm credits for supplies and equipment and first-class research and extension programmes.

Because these problems have been identified and corrective measures instituted, the future should be one of optimism and steady, if moderate, growth. However, 1968 and the years immediately following are bound to be seriously affected by the recent lengthy drought, and should not be interpreted as indicators of future progress.

## Fertilizer use

Although the traditional agricultural environment was not conducive to the use of modern farm inputs such as mechanization and fertilizers, extension training, better education and new government policies have contributed to increasing fertilizer use in recent years, as shown in table 8. Recent fertilizer application rates (in the 30 kg *per capita* range) have in fact been higher than in Argentina and Brazil. Nitrogen use has shown annual growth rates of 20 per cent, phosphates 10 per cent and potash about 11 per cent. Recently

increases of fertilizer use and crop output have been hampered by dry weather.

It is anticipated that fertilizer use may grow by at least 10 per cent annually throughout the next decade, with a possible increase to 15 or even 20 per cent after 1970, as shown in table 8, if agricultural credits are made more readily available. Local availability of nitrogen and potassium salts, as well as hydrocarbon feedstocks, should encourage increased use [9].

## Fertilizer supply

Chile is unique in possessing huge reserves of sodium and potassium nitrate minerals. In recent years, production has been in the region of 1 million and 170,000 tons respectively. About 85 per cent of the sodium salt and 50 per cent of the potassium salt is exported. Availability of these forms of nitrogen (currently corresponding to a production of some 140,000 tons of nitrogen) has limited the manufacture of ammonia-based fertilizers. However, a large chemical complex based on natural gas is planned at Punta Arenas; it will include an ammonia unit with a capacity of 270,000 tons per year which will be converted to urea. A small amount of ammonia is recovered from coal carbonization.

Phosphate production includes about 30,000 tons of guano-based mixtures (equivalent to some 11,000 tons of nutrients); 60,000 tons of triple superphosphate; 20,000 tons of single superphosphate; 15,000 tons of Rhenania-type salts (equivalent to about 3,000 tons of $P_2O_5$), and 20,000 tons of Reno hyperphosphate (containing about 6,000 tons of $P_2O_5$). Most of these compounds are made from imported rock and triple superphosphate, as Chile does not have a self-sufficient primary phosphate base. Potash supplies are derived mostly from domestic minerals [9].

## Balance of demand and supply

Because nitrogen fertilizer costs in the form of indigenous nitrates are rising, the production of synthetic ammonia and derivatives from domestic natural gas is becoming increasingly justified. However, the proposed ammonia plant with estimated capacities of 270,000 tons per year (equivalent to 220,000 tons per year of nitrogen) would be in excess of requirements based on projected consumption growth rates until about 1980, unless a vigorous marketing programme were instituted. For example, the achievement of an annual consumption

growth rate of 20 per cent between 1970 and 1975 would accelerate fertilizer demands to about 250,000 tons by 1978. Until a large, modern ammonia plant is built, expanding needs will probably have to be met by a combination of domestic nitrates and imported nitrogen salts. Meanwhile, the economics of using imported ammonia could be investigated.

Because of a lack of good primary phosphate facilities, reliance on imported rock and high-analysis intermediates will have to continue. A study is recommended of the viability of using imported wet-process phosphoric acid to meet future needs.

*Table 7. Chile—Agricultural production, 1965 crop year*

| Product | Area (1,000 ha) | Production (tons) | Percentage of value | |
|---|---|---|---|---|
| | | | Group | Total |
| *Cereals* | 1,150.0 | 1,854,775 | 100.00 | 20.20 |
| Wheat | 849.4 | 1,275,617 | 68.24 | 13.78 |
| Oats | 112.7 | 116,576 | 5.97 | 1.21 |
| Barley | 71.8 | 138,491 | 7.02 | 1.42 |
| Rye | 13.3 | 14,544 | 0.69 | 0.14 |
| Rice | 29.8 | 88,654 | 5.86 | 1.18 |
| Corn | 73.0 | 220,893 | 12.22 | 2.47 |
| *Pulses* | 148.2 | 105,767 | 100.00 | 2.97 |
| Beans | 86.8 | 74,261 | 82.20 | 2.44 |
| Lentils | 33.7 | 13,545 | 9.29 | 0.28 |
| Peas | 15.5 | 9,340 | 1.84 | 0.05 |
| Garbanzos | 12.2 | 8,621 | 6.67 | 0.20 |
| *Potatoes and sugar beets* | 104.3 | 1,444,426 | 100.00 | 7.10 |
| Potatoes | 85.9 | 734,779 | 76.13 | 5.41 |
| Sugar beets | 18.4 | 709,647 | 23.87 | 1.69 |
| *Vegetables* | 59.2 | 1,049,375 | 100.00 | 8.47 |
| Onions | 7.0 | 208,181 | 7.77 | 0.66 |
| Garlic | 1.9 | 9,940 | 5.85 | 0.49 |
| Other | 50.3 | 831,254 | 86.38 | 7.32 |
| *Oil seeds* | 122.8 | 121,492 | 100.00 | 2.31 |
| Sunflower | 41.2 | 46,295 | 37.76 | 0.87 |
| Rape | 81.6 | 75,197 | 62.24 | 1.44 |

*Table 7 (continued)*

| Product | Area (1,000 ha) | Production (tons) | Percentage of value Group | Total |
|---|---|---|---|---|
| *Fibres* | 4.5 | 4,326 | 100.00 | 0.20 |
| Hemp | 3.7 | 3,626 | 98.84 | 0.20 |
| Flax | 0.8 | 700 | 1.16 | 0.002 |
| *Hemp and flax seed* | 7.5 | 6,775 | 100.00 | 0.21 |
| Hemp | 3.7 | 3,180 | 49.72 | 0.10 |
| Flax | 3.8 | 3,595 | 50.28 | 0.11 |
| *Other agricultural products* | 179.9 | | 100.00 | 15.53 |
| Tobacco | 1.6 | 5,851 | 2.67 | 0.42 |
| Fruits | 75.3 | 399,027 | 45.52 | 7.07 |
| Wine | 103.0 | 364,844 [a] | 51.81 | 8.04 |
| *Meat* | | 229,349 | 100.00 | 24.73 |
| Beef | | 137,012 | 62.40 | 15.43 |
| Pork | | 47,430 | 17.39 | 4.30 |
| Lamb | | 20,385 | 8.96 | 2.21 |
| Goat | | 6,722 | 1.12 | 0.28 |
| Poultry | | 17,800 | 10.13 | 2.51 |
| *Other livestock products* | | | 100.00 | 18.04 |
| Milk | | 810,204 [a] | 51.95 | 9.37 |
| Eggs | | 960,000 [b] | 27.56 | 4.97 |
| Wool | | 25,200 | 20.49 | 3.70 |
| *Bee products* | | 7,060 | 100.00 | 0.26 |
| Honey | | 6,500 | 67.90 | 0.18 |
| Wax | | 560 | 32.10 | 0.08 |
| *Total crops* | | | | 56.99 |
| *Total livestock* | | | | 43.01 |

*Source:* Ministry of Agriculture, *Sinopsis de la Agricultura Chilena, 1963—1965* (October 1966).

[a] Thousand litres.
[b] Thousand eggs.

*Table 8. Chile—Fertilizer consumption*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | 1957—1959 | 1960—1961 | 1964 | 1966 | 1967—1968 | 1970 | 1975 | 1980 |
| ***Nitrogen, N*** | | | | | | | | |
| Thousands of tons | 11.6 | 17.8 | 32.7 | 53 | 40 | (high) 58 | 145 | 360 |
| Average annual percentage increase | | 15 | 23 | 27 | | | 20 | |
| Thousands of tons | | | | | | (low) 53 | 108 | 220 |
| Average annual percentage increase | | | 20 | | | | 15 | |
| ***Phosphate, $P_2O_5$*** | | | | | | | | |
| Thousands of tons | 36.7 | 50.3 | 73.2 | 84 | 84 [a] | (high) 105 | 185 | 330 |
| Average annual percentage increase | | 11 | 13 | 7 | | | 12 | |
| Thousands of tons | | | | | | (low) 102 | 165 | 270 |
| Average annual percentage increase | | | 10.5 | | | | 10 | |
| ***Potash, $K_2O$*** | | | | | | | | |
| Thousands of tons | 7.1 | 9.9 | 14.2 | 16.5 | 16.5 [a] | (high) 22 | 44 | 90 |
| Average annual percentage increase | | 12 | 13 | 8 | | | 15 | |
| Thousands of tons | | | | | | (low) 20 | 33 | 53 |
| Average annual percentage increase | | | 11 | | | | 10 | |

*Source:* Various.

[a] Provisional.

# Colombia

## General information

| | |
|---|---|
| *Population (1968)* | Total: approaching 20 million; annual growth rate: about 3.3 per cent |
| *Land (hectares)* | Total: 114 million (70 per cent forest); arable: 4.8 million; cultivated: 3.5 million; irrigated: 0.5 million; pasture: 40 million |
| *Rainfall* | Adequate except in some areas during the dry seasons |
| *Resources* | Petroleum, hydroelectric power, ferrous and non-ferrous metals, precious metals and gems, sulphur, coal and timber |
| Per capita *annual income* | $340 in 1967 |
| *Average annual growth of GNP* | Approximately 3.6 per cent in 1966/1967 |

## Identified fertilizer raw materials

| | |
|---|---|
| *Phosphate rock* | Reserves recently identified. Feasibility study of commercial exploitation under way |
| *Potash* | No significant reserves known |
| *Sulphur* | Volcanic sulphur and pyrites |

| | |
|---|---|
| *Limestone* | Ample reserves |
| *Coal* | Ample deposits |
| *Hydrocarbons* | Appreciable reserves |

## Farming patterns

Colombia comprises three distinct natural regions: the large Magdalena delta on the Caribbean coast, to the north, which is fertile and has good farming potential; sparsely populated plain of grassland and forest to the east and the Andean chain to the west. Ninety-eight per cent of the inhabitants live in 40 per cent of the country, largely in the valleys and the northern region.

Many crops are tropical: for example, coffee, sugar cane, bananas, cotton and plantain. Other products include corn, rice, vegetables, wheat, sesame and fruits. Pasture for beef production covers about 40 million hectares—an area larger than that of all cultivated land. Coffee is the product of principal economic importance and is produced typically on non-mechanized hillside farms under 3 hectares in area. About 60 per cent of the crop is exported. Corn, vegetables and plantain are also produced on small farms, while cotton, rice and cane are grown on larger units. Bananas and tobacco have become important export commodities. Soy bean and poultry production have increased substantially in recent years.

## Land and economic policies [16 and 7]

Three-quarters of the country's 1.3 million farms average only 2.6 hectares and about half the population is rural. Under the traditional pattern of land ownership, vast tracts have been held by a few individuals and left uncultivated. Recent legislation has provided that potentially productive land must be farmed by the owners or transferred to others, but time will be needed to put such reforms into effect. Nevertheless, Colombia has been successful in achieving almost total self-sufficiency in food production as well as sizable exports. Additional output is required to meet the demands of an increasing population and rising living standards, as well as to furnish much needed foreign exchange.

In recent years, considerable attention has been given to agricultural research and extension courses. Some twelve experimental stations and 70 agencies have been established, employing about 150 and 240 professionals respectively, but the results of their separate endeavours have been meagre to date. In addition, there are nine schools of agriculture and various foreign advisory groups.

Coffee sales account for 70 per cent of the country's foreign exchange. Efforts have been in progress for some time to reduce this dependence on a single crop, which is frequently in oversupply on the world market. A number of agricultural commodity prices are often kept above world market levels by means of tariffs, import prohibitions and other support methods. The United States Government,

*Table 9. Colombia—Principal crops, 1965: area, production and trends*

| Crop | Area (1,000 ha) | | Production (1,000 tons) | | Production trend since 1950 |
|---|---|---|---|---|---|
| Coffee | 845 | | 468 | | stable |
| Corn | 800 | (890) | 705 | (965) | slight increase |
| Rice | 332 | (374) | 666 | (672) | strong increase |
| Sugar cane | 337 | (437) | 18,000 | (23,000) | strong increase |
| Plantain | 225 | (284) | 1,200 | (2,308) | steady increase |
| Cotton | 148 | | 201 [a] | | large increase |
| Yuca | 142 | (189) | 800 | (1,400) | not certain |
| Wheat | 120 | | 110 | | decline |
| Sesame | 103 | (53) | 72 | (31) | strong increase |
| Beans (dry) | 76 | (106) | 40 | (65) | stable |
| Potatoes | 65 | (171) | 900 | (1,225) | steady increase |
| Barley | 60 | (73) | 105 | (110) | slight increase |
| Bananas | 58 | (58) | 590 | (382) | slight increase |
| Vegetables | 40 | | 245 | | not certain |
| Cacao | 37 | | 15 | | small increase |
| Fique | 33 | | 26 | | not known |
| Soybeans | 32 | (24) | 65 | (35) | strong increase |
| Tobacco | 22 | (25) | 43 | (40) | |
| Miscellaneous fruit | 160 | | 480 | | |
| Improved pasture | 14,000 | | | | |

*Note:* Unbracketed figures derived from United States Agricultural Attaché's Figures; figures in brackets reported by Caja Agraria in its "Carta Agraria".

[a] Includes both seed and fibre.

FAO and several major foundations have assisted Colombian agriculture at various times by means of preferential purchases, technical guidance and financial aid.

Agricultural credit is furnished by several private and government sources. The Banco Cafetero, a semi-official bank, raises funds through export taxes on coffee and provides 42 per cent of farm loans. Fifty-five per cent of all institutional credit is provided by the Caja de Credito Agrario Industrial y Minero, at 8 per cent interest. Under the law, 15 per cent of all commercial bank loans have to be made to agriculture.

Although the protein content of some domestic diets is understood to have declined in recent years, there seems to be no reason why Colombia should not be able to feed its growing population adequately and also to increase its foreign-exchange earnings by means of expanded food exports, especially in the light of the endeavours being made to reduce dependence on coffee, to farm unused land and to make greater use of modern agricultural techniques.

## Fertilizer use [7]

Although *per capita* use of fertilizer has been low (some 8 to 10 kg), application rates have been high—about 80 kg per hectare in 1966 owing to double or continuous cropping of certain products, as is often possible in tropical zones. Consumption of all three nutrients has grown during the last decade, especially of nitrogen, but phosphate demand has been erratic. Some farmers have not even grown accustomed to using animal manure for fertilizer—an indication of the educational problems involved in promoting the use of chemical fertilizers.

The increasing availability of fertilizer raw materials such as phosphate rock, potash and sulphur at favourable prices in other countries, together with the larger quantities of finished products from domestic sources, can be expected to encourage greater fertilizer use. Educational and extension services, as well as assistance from the United Nations and other organizations, will also promote the cultivation of new crops and the use of fertilizer. Accordingly it is anticipated that, in the next decade, annual growth rates for primary nutrients should be in the range of 10 to 15 per cent, and possibly even higher, initially, for nitrogen, as shown in table 10.

## Fertilizer supply

Nitrogen fertilizers are produced at several locations, the largest being the International Petroleum Corporation plant at Cartagena, which is based on refinery gas. Capacity is about 100,000 tons per year of nitrogen as ammonia, which is converted to some 80,000 tons per year of urea, and 130,000 tons per year of complete fertilizers. Some ammonia is sold to domestic and Caribbean associates. An additional 20,000 tons per year of ammonia is planned. Another plant—Ferticol—at Barranca Bermeja, designed to produce 15,000 tons of nitrogen as ammonia, as well as ammonium nitrate and urea from natural gas, was closed in 1965 owing to production problems, but recent attempts have been made to start up operations again. A

small amount of ammonium sulphate is also produced from domestic coking operations.

Plans have been made for a joint government project between Colombia and Venezuela for the building of a caprolactam and ferti-

*Table 10. Colombia—Fertilizer consumption*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | *1957—1959* | *1960—1961* | *1964* | *1966* | *1967—1968* | *1970* | *1975* | *1980* |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 9.3 | 13.7 | 41 | 45 | 50 | (high) 72 | 180 | 455 |
| Average annual percentage increase | 14 | 44 | 5 | 5 | | 20 | | |
| Thousands of tons | | | | | | (low) 66 | 134 | 275 |
| Average annual percentage increase | | 18 | | | | 15 | | |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | 38 | 42.5 | 29.8 | 56 | 74 [a] (high) | (high) 98 | 195 | 320 |
| Average annual percentage increase | 4 | −11 | −37 | | | 15 | | 10 |
| Thousands of tons | | | | | 68 [a] (low) | (low) 82 | 135 | 220 |
| Average annual percentage increase | | 5 | | | | 10 | | |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 14 | 17.5 | 24.6 | 35 | 46 [a] (high) | (high) 61 | 123 | 250 |
| Average annual percentage increase | 8 | 12 | 19 | | | 15 | | |
| Thousands of tons | | | | | 42 [a] (low) | (low) 51 | 82 | 132 |
| Average annual percentage increase | | 12 | | | | 10 | | |

*Source:* Various.

[a] Provisional.

lizer project at Barranquilla, with a capacity of 300,000 tons per year of ammonia and a similar quantity of nitrophosphate. Another project is planned which would produce 660,000 tons per year of ammonia from Venezuelan gas and a similar quantity of urea, to be shared equally by the two countries. This would give Colombia an additional 260,000 tons per year of nitrogen capacity for domestic use and for export.

Phosphatic fertilizers are also produced at several locations from imported rock and wet-process phosphoric acid. Complete fertilizers made at Cartagena account for some 16,000 tons per year of $P_2O_5$ from rock; single superphosphate produced at Medellin accounts for a few thousand tons per year of $P_2O_5$. A phosphoric acid triple superphosphate plant based on imported rock has a planned capacity of about 35,000 tons per year of $P_2O_5$. A small additional quantity of $P_2O_5$ is also produced domestically as basic slag. Recent imports of wet-process acid have been of the order of 10,000 tons per year, or 5,400 tons per year of $P_2O_5$. An additional triple superphosphate plant is planned which should provide a total domestic capacity of about 90,000 tons per year of $P_2O_5$ in the early 1970s.

Potash salts are imported largely from Europe; some are imported from the United States. Formerly, a large percentage of all fertilizer needs was imported; now only a few special items are imported.

## Balance of demand and supply

As an exporter of ammonia, Colombia has sufficient basic nitrogen fertilizer capacity until at least the early 1970s, with diminishing quantities available for sale overseas. It is quite possible that future intense competition in the ammonia export business may result in greater domestic use; this has been taken into consideration in table 10. The projections indicate that additional nitrogen fertilizer capacity will be needed by 1975, if not sooner. Production from the proposed Barranquilla project would probably meet future needs, at least up to 1980; the surplus could be used for export.

It is clear that additional phosphate tonnage, over and above existing and planned capacities, is needed to keep pace with the anticipated increase in crop production and nitrogen fertilizer use, and a phosphate unit with a capacity of 100,000 tons per year of $P_2O_5$ may well be justified by 1975. Since Colombia was a pioneer in the use of imported phosphoric acid, the forthcoming availability of new, competitive sources may be a viable alternative to installing additional domestic capacity. The additional production of nitrophosphates, based on domestic or Venezuelan ammonia and imported

rock, which has been proposed for Barranquilla, may be another logical alternative. A comparative study of these various alternatives is therefore recommended, if it has not already been undertaken and final decisions made.

The present position regarding the proposed nitrogen fertilizer complexes for Colombia at Barranquilla and El Tablazo in Venezuela is difficult to define. Certainly, if both plants were to be built, the entire output of one of them would have to be exported for many years, unless the plants shared their relatively small domestic markets and exported the greater part of their production.

# Ecuador

## General information

| | |
|---|---|
| *Population (1968)* | Total: approximately 5.8 million; annual growth rate: 3.4 per cent; density: approximately 22 per square kilometre |
| *Land (hectares)* | Total: 27 million arable: 4.5 million; cultivated: 2 million |
| *Rainfall* | Heavy in the north, very low in the south |
| *Resources* | Timber, fishing grounds, petroleum, a few minerals and small deposits of precious metal ores |
| Per capita *annual income* | $225 in 1968 |
| *Annual average growth of GNP* | 4.8 per cent for the period 1963—1967 |

## Identified fertilizer raw material

| | |
|---|---|
| *Phosphates* | Small deposits of guano; no appreciable rock deposits known |
| *Potash* | Insignificant amounts |
| *Sulphur* | Some volcanic deposits |
| *Hydrocarbons* | Some oil in remote localities |
| *Limestone* | Significant deposits |

## Farming patterns

The country may be divided geographically into the Costa, or coastal plain, the Sierra, which includes two Andean ranges, and the Oriente, which comprises the eastern forested slopes of the Andes, together with the area stretching to the Amazon. The three crops—bananas, cacao and coffee—which account for much of the country's economy—are all grown in the coastal areas.

Bananas and coffee are produced for the most part by small independent farmers who also raise vegetables and other local food crops in the Costa and Sierra regions, often on a subsistence basis. Few modern methods are used. Some mechanization has been introduced by the large estate farmers in the Costa, who also use fertilizers. Soil exhaustion and erosion has occurred in the Sierra owing to primitive cropping methods.

## Economic policies

About 50 per cent of the working population is employed in agriculture, which accounts for about one third of the gross national product and 90 per cent of export earnings. The Government is trying to encourage diversification from bananas, coffee, cacao and sugar to rice, cattle, cotton and oil palm, but progress is slow. In 1968, banana exports slumped owing to competition from Central America. The USSR and Eastern European countries are bartering increasing quantities of bananas and cacao for machinery and other goods.

With comparatively little to export except certain premium woods, Ecuador must intensify efforts to produce high-grade food products at competitive prices. Various agricultural development and extension services have been set up, but funding has been limited and the practical impact has not been as great as anticipated. To date, the country has been largely self-sufficient in food, although the dietary standards of much of the population could be improved, especially in protein content.

## Fertilizer use

While fertilizer consumption has risen in recent years, application rates are still low—about 36 kg of plant nutrients per cultivated hectare (which includes land used for double or continuous cropping), or 3.5 kg *per capita*. Direct application of nitrogen fertilizers, especially urea for bananas, has found favour in the Costa,

and the use of mixtures has slowly increased in the Sierra. Many small farmers use no fertilizer at all.

Much greater use of fertilizer will be necessary to support the increasing population and to generate additional foreign exchange

*Table 11. Ecuador—Fertilizer consumption*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | 1957–1959 | 1960–1961 | 1964 | 1966 | 1967–1968 | 1970 | 1975 | 1980 |
| ***Nitrogen, N*** | | | | | | | | |
| Thousands of tons | 2.8 | 3.0 | 5.0 | 7.0 | 10 | (high) 13 | 26 | 53 |
| Average annual percentage increase | | 2.5 | 18 | 20 | 40 | | 15 | |
| Thousands of tons | | | | | | (low) 12.5 | 22 | 39 |
| Average annual percentage increase | | | 14 | | | | 12 | |
| ***Phosphate, $P_2O_5$*** | | | | | | | | |
| Thousands of tons | 1.9 | 2.1 | 5.1 | 7 | 10[a] (high) | (high) 14.5 | 30 | 60 |
| Average annual percentage increase | | 3.0 | 33 | 18 | 20 | | 15 | |
| Thousands of tons | | | | | 9[a] (low) | (low) 12.5 | 20 | 33 |
| Average annual percentage increase | | | 18 | | 15 | | 10 | |
| ***Potash, $K_2O$*** | | | | | | | | |
| Thousands of tons | 1.4 | 1.7 | 3.3 | 5.0 | 7.2[a] (high) | (high) 10.5 | 26 | 53 |
| Average annual percentage increase | | 7 | 25 | 23 | 20 | | | 15 |
| Thousands of tons | | | | | 6.6[a] (low) | (low) 8.8 | 18 | 30 |
| Average annual percentage increase | | | 18 | | 15 | | | 10 |

*Source:* Various.
[a] Provisional.

through agricultural exports. However, the need to import fertilizers or the raw materials for fertilizer production is a deterrent to substantial additional use. Intensive farmer education, technical assistance and more readily available credit are prerequisites. Estimated future annual fertilizer growth rates are given in table 11.

## Balance of demand and supply

Virtually all fertilizer needs are met by importing finished or semi-finished goods from Europe, the United States and suppliers in the Caribbean area. This pattern is likely to be maintained, with future emphasis on supplies from the large nitrogen projects now under construction, or planned, in the northern countries of South America, Mexico and the Caribbean area. Some local mixing and bagging is undertaken and can be expected to increase.

As indicated, almost all fertilizer requirements are supplied from non-domestic sources, and no suitable indigenous sources of raw materials have been found to date. It may therefore be concluded that the present practice of importing basic materials for mixing purposes, as well as some finished materials from the Caribbean area, Europe and the United States, will continue. Plans for establishing basic fertilizer production facilities have been announced from time to time, but even in projections up to 1980 estimated consumption appears too small to support economic domestic operations. However, a small concentrated phosphate plant, including wet-process acid manufacture, is being built at Guayaquil, with an estimated production of about 7,000 tons per year of $P_2O_5$.

# Paraguay

## General information

| | |
|---|---|
| *Population (1968)* | Total: approximately 2.25 million; annual growth rate: 2.9 per cent |
| *Land (hectares)* | Total: 40 million (about 54 per cent forested); the Paraguay and Parana rivers give access to the Atlantic, except during periods of drought |
| *Temperature* | From 35° F in winter to over 100° F in summer |
| *Resources* | Meat products and cattle hides represent 40 per cent of total; other items include vegetable oil, quebracho, cotton, coffee, timber and sugar. Mineral products are limited |
| Per capita *annual income* | $225 |
| *Annual growth of GNP* | 4 per cent |

## Agriculture and fertilizer use

Fertilizer use is low, and virtually nil in some of the rural areas. As the livestock industry expands, pasture fertilization will have to be increasingly undertaken to maintain competitive export standards.

In 1968 the wheat crop was about 20,000 tons, or nearly three

times the 1967 harvest of 7,000 tons. This trend is an exception to the general decline in production as shown in table 12. The Government has instituted a wheat plan to make the country self-sufficient in this commodity; this will create a need for more plant nutrients. Current consumption is about 100,000 tons per year, most of which is imported.

Accurate data on fertilizer use and supply are not available at this time.

*Table 12. Paraguay—Some important food crops*

| Crop | Area (acres) | | Production (tons) | |
|---|---|---|---|---|
| | 1967 | 1968 | 1967 | 1968 |
| Bananas | 20,500 | 21,700 | 152,000 | 115,000 |
| Manioc | 271,920 | 281,694 | 1,542,900 | 1,503,800 |
| Corn | 617,750 | 630,100 | 277,100 | 180,000 |
| Sugar cane | 81,543 | 81,543 | 1,046,300 | 700,000 |
| Sweet potatoes | 30,887 | 32,123 | 122,500 | 85,300 |
| Oranges | 72,400 | 76,601 | 234,000 | 185,000 |

*Source:* United States Department of Agriculture.

# Peru

## General information

| | |
|---|---|
| *Population (1968)* | Total: 12.7 million; annual growth rate: 3.1 per cent; density: 10 per square kilometre |
| *Land (hectares)* | Total: 128.5 million; forest: 70 million; pasture: 28.7 million; cultivated: 2.7 million; irrigated: 2 million |
| *Rainfall* | From 200 inches per year in the Selva (jungle) area to very low in the Costa region |
| *Resources* | Oil, natural gas, timber, fishing grounds, phosphates, copper and other non-ferrous ores and minerals |
| Per capita *income* | $292 in 1967 |
| *Annual average growth of GNP* | 6 per cent in the period 1961—1967 |

## Identified fertilizer raw materials

| | |
|---|---|
| *Phosphate* | Bird guano; considerable reserves of phosphate rock in the Sechura desert |
| *Potash* | Several million tons in the Sechura desert |

| | |
|---|---|
| *Sulphur* | Some volcanic sulphur; pyrites |
| *Hydrocarbons* | Appreciable petroleum reserves |
| *Limestone* | Ample deposits |

## Farming patterns

Peru may be divided geographically into the Costa, or coastal area, the Sierra or Andean ranges, and the Selva, a wet, jungle area. Arable land comprises 24, 62 and 14 per cent of these regions respectively; over 90 per cent of all arable land is near the coast, and is largely irrigated. Much of the Sierra is pasture or undeveloped country. About 83 per cent of the farms are under 5 hectares in size; 12 per cent are in the 5 to 20 hectare range, while about 2 per cent are larger than 100 hectares.

In the Costa, cash crops are grown, such as cotton, sugar, rice, corn and other cereals. Most of the country's cotton and sugar crops are raised in this region, as well as a good deal of the fruit, potatoes and domestic dairy needs. Lower elevations in the Sierra also produce cereals, potatoes and fruit. In the upland Selva areas, coffee, tea, cacao, mango, citrus, banana and local fruits, as well as some tobacco are raised. In the humid lowlands, only a few local food crops are grown.

## Land and economic policies

The food supply situation in Peru deteriorated in the mid-1960s and will deteriorate further unless prompt action is taken. Annual demand has increased at about twice the food-production rate since 1960, increasing the dependence on imports. This situation may be aggravated by the adverse balance of payments and by devaluation. To resolve the food problem, a sharp distinction must be made between raising agricultural productivity and promoting the development of the rural areas on the one hand, and accelerated industrialization on the other. Each objective must be planned separately, with special emphasis on food production.

Growth in the agricultural sector has lagged behind that of other major sectors of the economy, attaining only about 6 per cent per year compared with 13 per cent for construction, 7.5 per cent for manufacturing and 8 per cent for wholesale and retail trade. *Per capita* output of all agricultural production between 1960—1965 also declined by several percentage points, even though total output rose slightly. There is growing dependence on food imports, amounting

to about $100 million in 1966/1967 (approximately 10 per cent of total imports) especially for wheat, dairy produce, meat and canned or bottled consumer items. The target set for an average daily diet is 2,450 calories and 65 grams of protein *per capita*, but parts of the country may not have reached even 50 per cent of those levels.

In order to reverse the deteriorating food supply, ten key-priority measures have been proposed [4]. These include: achieving greater short-term output through yield-increasing techniques such as greater fertilizer use; substituting domestic food crops for export crops; achieving greater income equality through agrarian reform; reorganizing public and private distribution and marketing arrangements; training college students in agricultural science rather than in farming skills only: increased irrigation; colonization of new land areas; intensive farmer education and new land policies encouraging a return to the rural areas.

## Fertilizer use

Traditionally, fertilizer consumption in Peru has been related to the availability of bird guano, which is increasingly subject to variations caused by intensive anchovy fishing and other factors. Most guano used is the fresh "rico" variety containing 10 to 15 per cent nitrogen, 14 to 16 per cent $P_2O_5$, 1 to 2 per cent $K_2O$ and about 8 per cent CaO. Little fossilized "pobre" guano is recovered; this material contains about 3 to 5 per cent of nitrogen and 12 to 14 per cent of $P_2O_5$, and reserves are limited.

In 1956, some 310,000 tons of guano were used, equivalent to 47,000 tons of nitrogen; in 1965, nitrogen from guano amounted to not more than about 23,500 tons. Corresponding annual tonnages of chemical nitrogen rose from 12,000 tons to 40,400 tons. Phosphate from guano fell from 25,500 tons in 1956 to 15,400 tons in 1965, of $P_2O_5$, while phosphate from chemical fertilizer rose from 2,500 to 3,300 tons of $P_2O_5$. A few thousand of potash ($K_2O$) were also contributed by guano. Chemical fertilizer imports rose from 11,000 tons of total nutrients in 1956 to 29,000 tons in 1965, but not in proportion to the diminished use of guano, especially as regards phosphate.

The principal chemical fertilizers used have been superphosphates, ammonium and calcium ammonium nitrates, and relatively large percentages of ammonium sulphate, which is declining in favour of urea imported from Japan and Europe.

As a result of guano availability supplemented by chemical fertilizer, some cultivated areas of Peru, especially in the Costa, attained an application rate of 34 kg per hectare for nitrogen in

1965—perhaps the highest in the Americas. Average *per capita* use, however, is low—about 9 kg.

Costa soils are alkaline, low in organic content and nitrogen. Sierra soils are even more barren and need repeated applications of phosphate; otherwise, nitrogen additions are largely ineffective. In general, potash deficiencies have not yet appeared. Although an approximate 1:1 ratio of nitrogen to $P_2O_5$ has traditionally been applied through guano, it is believed by some that a 3:2 ratio would suffice. It is doubtful, however, that this ratio will be achieved during the next decade unless local phosphate deposits are rapidly developed and used for fertilizer manufacture for export as well as for domestic use. Recent nationalization policies may delay these endeavours. These uncertainties are reflected in the widely varying projected consumption patterns shown in table 15; the higher values are based on successful attempts to attain better nitrogen-to-phosphate ratios. Guano production is not expected, even most optimistically, to exceed some 30,000 and 25,000 tons of equivalent nitrogen and $P_2O_5$, respectively. Demand will have to be met by chemical fertilizers from domestic and overseas sources. The need for increased phosphate imports will grow considerably if plans for domestic production do not materialize quickly.

## Fertilizer supply

Owing to diminishing and erratic supplies, coupled with rapidly increasing needs, reliance on domestic guano can no longer prevail, especially in the high Sierra regions, where it has been the principal material and where it has been sold under subsidy. In 1964, to supplement guano availability, the Government built an ammonium nitrate/calcium ammonium nitrate plant near Cuzco, based on hydroelectric power. The capacity was 40,000 tons per year of ammonium nitrate, but, owing to power problems and the apathy of farmers about chemical fertilizers, only some 50 per cent of planned sales were effected. Another nitrogen fertilizer plant near Lima, installed in 1959 and based on domestic fuel oil, produces approximately 15,000 tons per year of ammonium sulphate and 40,000 tons per year of ammonium nitrate.

Plans for expanded or new plants include a urea unit at Cuzco based on natural gas, having a minimum ammonia capacity of about 100,000 tons per year (82,000 tons per year of nitrogen). Superphosphates are produced from imported rock by three firms: Industrias Químicas Básicas (IQB), Rayón y Celanese Peruana, and Abonos Completos. IQB capacity is about 30,000 tons per year of single superphosphates and 90,000 tons per year of mixtures; Rayón y

Celanese Peruana capacity is about 15,000 tons per year of single superphosphates; and Abonos capacity is approximately 15,000 tons per year of mixtures. Sources of sulphur include by-product acid and smelter gas.

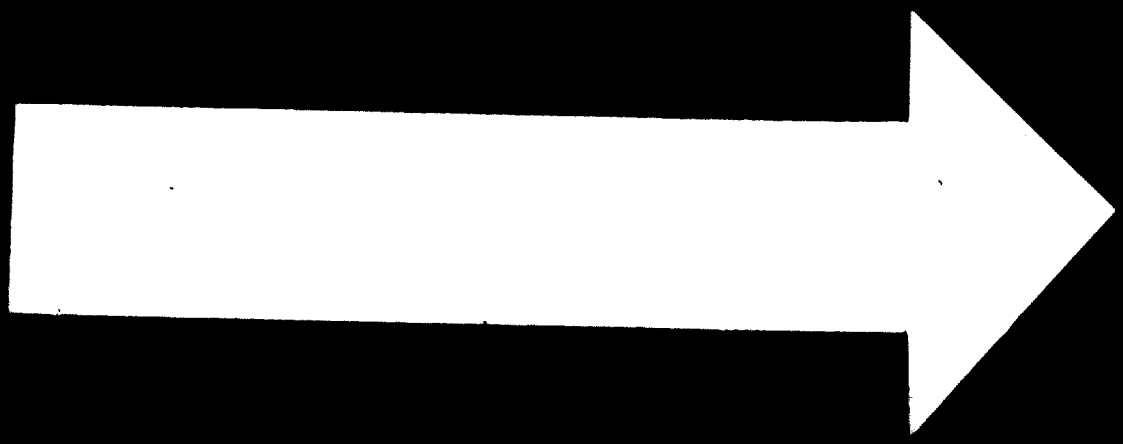
Substantial reserves of phosphate rock (some 500 million tons) exist in the Sechura desert, and for some years plans to mine this material have been discussed between the Government and various foreign consortiums. Also under discussion has been a phosphoric-acid plant with a capacity of 60,000 to 70,000 tons per year which would supply domestic phosphate needs in the form of triple superphosphates and perhaps diammonium phosphate. A small amount of fish meal is also used as fertilizer. Potash needs are partially met by guano and some imported salts and mixtures. Future potash requirements might be supplied from Sechura deposits if sufficient financing became available.

## Balance of demand and supply

Present domestic availability of nitrogen fertilizer includes about 25,000 tons per year of nitrogen from guano, 16,000 tons per year from the Callao plant as ammonium sulphate and nitrate, and about 12,000 tons per year from the Cuzco factory as ammonium nitrate. Total supplies, including a recently announced expansion, are about 60,000 tons per year. Thus there is a deficiency in nitrogen supplies, even on a 100-per-cent-output basis, the balance being provided by imports.

Merely to meet the low projected demand for 1975, 130,000 additional tons of nitrogen will be required, equivalent to about 160,000 tons per year of ammonia or nearly 500 tons per day. By 1980, again on the low projected demand basis, a demand of 308.000 tons per year is indicated, for an additional 118,000 tons per year of nitrogen or 143,000 tons per year of ammonia. This would justify another ammonia unit with the capacity of 500 tons per day. In each case urea might be the preferable major end product, together, perhaps, with some diammonium phosphate. It is realized that one large ammonia plant with a capacity of 1,000 tons per day would suffice, but, in the interests of flexibility, geography and timing, two ammonia plants with capacities of 500 tons per day, plus downstream urea and diammonium phosphate units, would be advisable, in addition to the original Cuzco and Callao facilities. The current status of a number of previously announced plans and studies is not known.

Domestic phosphate availability includes about 15,000 tons per year of $P_2O_5$ from guano, plus 8,000 to 10,000 tons of $P_2O_5$ per year



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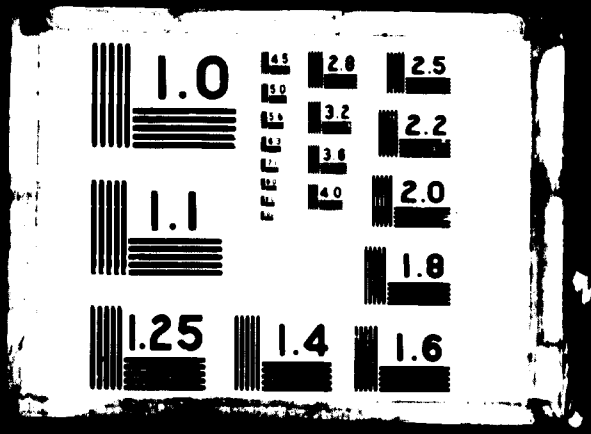

as single superphosphate, making a total of about 25,000 tons of $P_2O_5$ per year. Even at the projected low levels shown in table 15, this availability should be exceeded by 1970, and by 1975 it might be about 30,000 tons per year below demand. If the midpoints between the projected high and low estimates were achieved, 1975 and 1980 needs would be 70,000 tons per year and 162,000 tons per year of $P_2O_5$, respectively. Hence, the proposed phosphoric acid plant, with a capacity of 70,000 tons of $P_2O_5$ per year, although small by some standards, would appear to be justified in terms of partial use by 1975 and full capacity a year or two later. In the meantime, increased imports of phosphate rock and phosphatic intermediates could bridge the gap.

Naturally, if Sechura rock and potash could be mined within the next few years, local phosphate production and use would be encouraged, foreign exchange would be saved and Peru would be on the way to achieving its goal of 1 million extra hectares of cultivated land.

*Table 13. Peru—Food balance for 1963*

| | Consumption, 1963 [a] | | Acceptable diet [b] | Difference between 1963 and acceptable diet | |
|---|---|---|---|---|---|
| | Total (1,000 tons) | Per capita (kg) | Per capita (kg) | (kg) | (percentage) |
| *Food crops* | | | | | |
| Cereals | 1,107 | 99.8 | 84.9 | +14.9 | +17.6 |
| Sugar | 325 | 29.3 | 21.8 | + 7.5 | +34.4 |
| Tubers | 1,696 | 152.7 | 181.2 | −28.5 | −16.2 |
| Fats, oils | 122 | 11.0 | 17.2 | − 6.2 | −36.0 |
| Fruit | 928 | 83.6 | 43.1 | +40.5 | +94.0 |
| Pulses | 105 | 9.5 | 9.3 | + 0.2 | + 2.1 |
| Vegetables | 357 | 32.2 | 103.1 | −69.9 | −59.0 |
| *Animal products* | | | | | |
| Meat | 293 | 26.4 | 36.4 | + 2.3 | + 6.3 |
| Fish | 137 | 12.3 | | | |
| Milk | 554 | 49.9 | 174.9 | −125.0 | −71.4 |
| Eggs | 18 | 1.6 | 5.0 | − 3.4 | −68.0 |

[a] Calculated from data reported in Estadistica Agraria, Peru, 1964, CONESTCAR.

[b] Ideal diet developed by Dr. Collazos, Director of the Peruvian Institute of Nutrition, including 2,447 calories and 65 grams of protein per day as reported in "Some Projections of Dietary Levels and Needs in Peru", Van de Wetering, Cuneo and Montesinos, Special Report 1—219, Iowa Universities Mission to Peru (July 1966), p. 4. At 1966 prices this diet would cost 12.15 soles or less than 50 cents per day.

*Table 14. Peru—Index of agricultural production, 1960—1965 (1957—1959 = 100)*

| | Aggregate output | | | | Per capita output, all agricultural products |
|---|---|---|---|---|---|
| | All agricultural | All crops | Food crops | Livestock products | |
| 1960 | 110 | 111 | 111 | 105 | 105 |
| 1961 | 119 | 122 | 114 | 106 | 111 |
| 1962 | 120 | 122 | 113 | 112 | 109 |
| 1963 | 116 | 117 | 109 | 112 | 102 |
| 1964 | 120 | 121 | 112 | 112 | 103 |
| 1965 | 119 | 120 | 114 | 115 | 99 |

*Source:* United States Department of Agriculture (1966) *Indices of Agricultural Production for the 20 Latin American Countries*, ERS - Foreign No. 44.

*Table 15. Peru—Fertilizer consumption*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | 1957—1959 | 1960—1961 | 1964 | 1966 | 1967—1968 | 1970 | 1975 | 1980 |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 40.8 | 54.2 | 73 | 80 | 100 [a] (high) | (high)125 | 220 | 390 |
| Average annual percentage increase | 10 | 10 | 5 | | | 20 | | |
| Thousands of tons | | | | | 97 [a] (low) | (low)118 | 190 | 310 |
| Average annual percentage increase | | 9 | | | | 10 | | |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | 16.7 | 14.4 | 24.1 | 16 | 23 [a] (high) | (high) 33 | 83 | 205 |
| Average annual percentage increase | −4 | 19 | −17 | | | 20 | | |
| Thousands of tons | | | | | 21 [a] (low) | (low) 28 | 57 | 115 |
| Average annual percentage increase | | 0 | | | | 15 | | |

*Table 15 (continued)*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | 1957—1959 | 1960—1961 | 1964 | 1966 | 1967—1968 | 1970 | 1975 | 1980 |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 5.0 | 3.9 | 6.0 | 8.0 | 10.6[a] (high) | (high) 14 | 28 | 58 |
| Average annual percentage increase | —8 | 15 | 15 | | | 15 | | |
| Thousands of tons | | | | | 9.7[a] (low) | (low) 12 | 20 | 32 |
| Average annual percentage increase | | 6 | | | | 10 | | |

*Source:* Various.
[a] Provisional.

# Uruguay

## General information

| | |
|---|---|
| *Population (1968)* | Total: approximately 3 million; annual growth rate: 1.3 per cent; density: 16 per square kilometre |
| *Land (hectares)* | Total: 18.7 million; arable: 16.6 million; pasture: 14.0 million; crops: 2.5 million; forest: 0.4 million |
| *Rainfall* | Some drought; average, 40 to 50 inches per year |
| *Resources* | Marble, granite, some iron ore, no known oil or gas, some hydroelectric power |
| Per capita *annual income* | Approximately $560 |
| *Average annual growth of GNP* | Very small in recent years |

No significant amounts of fertilizer raw materials have been identified.

## Farming patterns

Uruguay is a land of plains and hills with extensive grasslands which provide forage for cattle and sheep. Livestock accounts for 70 per cent of total farming output value. Beef accounts for about

40 per cent of livestock products, followed by wool and milk. Because of poor feeding practices, disease and inefficient management, livestock production is at only a fraction of full capacity.

The major crops are wheat, corn, sunflower and oil flax. Prior to 1965, cereal grain production had increased by only 18 per cent from the 1935—1940 figure, as against a 51 per cent increase for other crops. However, a marked increase occurred in 1966. About 60 per cent of the cultivated acreage is devoted to cereals.

## Land and economic policies [2]

Although only 20 per cent of the labour force is engaged in farming, this sector of the economy produces over 90 per cent of Uruguay's exports, the major item being wool. Perhaps too much reliance on import substitution for economy building, coupled with outdated agricultural practices, has resulted in a steady aggravation of the country's economic plight, and this in turn tends to jeopardize the existence of a highly developed social system. The fact that beef exports have not risen is a major problem: in 1935—1940, 92 per cent of the beef production was exported, whereas by 1959—1964 only 28 per cent was exported.

The original land-holding patterns established centuries ago still persist: 64 per cent of the farms account for under 5 per cent of the land and less than 2 per cent of the holdings control over 30 per cent of the land. Fifty per cent of the agricultural acreage is operated under rental, share-cropping or other contract terms. Agricultural taxes on exports, imports, land and income provide few incentives to increased output and improved methods. Although an extension service exists, it has been inadequately supported. It is currently being reorganized and expanded.

The major credit source is the Banco de la República Oriental del Uruguay, which grants nearly half of its loan funds to agriculture. It is believed that better availability of credit to small farmers would assist the agricultural sector. Numerous small co-operatives exist, mostly among consumers. Little has been done to resolve domestic and overseas agricultural marketing problems, especially for livestock.

Steps recommended for expanding the agricultural sector on an economic basis include: appropriate fiscal policies to encourage investment in domestic agriculture; intensive agronomic research; recruitment of more trained scientists; increased livestock production and exports; development of idle land and planned encouragement of agriculture and agricultural employment.

## Fertilizer use

The use of chemical fertilizer has grown appreciably in recent years. In 1956—1965, total nutrient consumption rose from under 9,000 tons to over 40,000 tons, yet only about 11 per cent of the crop area and 0.5 per cent of pasture land is currently treated. Fertilizers are used mainly for sugar beets, sugar cane, vegetables and fruits. To encourage greater use, fertilizer subsidies have been introduced and import duties removed; the effort has met with some success. Recent *per capita* use has been moderately high (about 27 kg); the application rate per unit of cultivated cropland has also been moderate (about 32 kg per hectare). However, the rate per hectare of arable land is low (about 5 kg), indicating substantial opportunities for improvement (see table 19).

## Fertilizer supply

All chemical fertilizers are currently based on imported materials. Superphosphates are produced by the Industria Sulfúrica; ground phosphate rock is imported and sold by Agromax; mixtures are prepared and marketed by several firms such as Agroquímica, Fosfato Thomás and Fanaproqui. Typical materials used include urea, ammonium, sulphate, basic slag, potash and potassium sulphate, mostly imported from Europe.

Various plans for a domestic, basic fertilizer complex have been discussed with Japanese, Netherlands and other overseas groups. One of the latest fertilizer manufacturing projects under review (Shell) has been a $20 million plant to make 100,000 tons per year of ammonium phosphate, plus other ammonia derivatives. Basic nitrogen and $P_2C_5$ capacity might be 50,000 tons per year in each case. However, if such proposals are not adopted, the possibilities of importing ammonia and phosphoric acid from the Caribbean and Mexico, or elsewhere, should be studied for viability.

## Balance of demand and supply

Based on future needs and past growth rates, nitrogen demand by 1975 should be at least of the order of 50,000 tons per year, and by 1980 perhaps double that figure. As previously indicated, although a domestic ammonia plant has been considered for some time, projected local consumption does not support the installation of a modern economic unit (with a capacity of at least 500 tons per day or 130,000

*Table 16. Uruguay—Indexes of gross values of production by major crop groups, 1935—1966*

| | *Cereal grains* | *Oil crops* | *Sugar crops* | *Wine grapes* | *Roots and tubers* | *Fruits* [a] | *Vegetables and dry legumes* [a] | *Other* | *Total crops* [b] |
|---|---|---|---|---|---|---|---|---|---|
| 1935—1940 | 100 | 100 | 100 | 100 | 100 | — | — | 100 | 100 |
| 1941—1943 | 81 | 74 | 95 | 121 | 96 | — | — | 102 | 88 |
| 1944—1946 | 79 | 130 | 166 | 114 | 128 | 100 | 100 | 159 | 99 |
| 1947—1949 | 105 | 135 | 189 | 123 | 108 | 101 | 119 | 141 | 115 |
| 1950—1952 | 130 | 182 | 514 | 125 | 172 | 101 | 151 | 231 | 145 |
| 1953—1955 | 192 | 155 | 1,602 | 148 | 205 | 95 | 145 | 310 | 187 |
| 1956—1958 | 188 | 152 | 1,951 | 130 | 218 | 89 | 149 | 349 | 184 |
| 1959—1961 | 107 | 118 | 1,699 | 140 | 230 | 87 | 150 | 341 | 132 |
| 1962—1964 | 118 | 151 | 3,163 | 129 | 271 | 85 | 184 | 336 | 151 |
| 1965—1966 | 171 | 117 | 4,379 | 143 | 339 | 80 | 183 | 330 | 186 |

*Source:* Constructed from data supplied by the Banco de la República Oriental del Uruguay and the Ministry of Livestock and Agriculture. Calculations are in terms of constant 1961 factor prices.

[a] Due to a lack of data for fruits and vegetables for the period 1935—1945, this computation establishes their base year in 1946.

[b] This calculation is exclusive of the contribution of fruits and vegetables.

*Table 17. Uruguay—Indexes of cultivated area, yields and total production of selected major crops, 1935—1966*

| | Wheat | | | Corn | | | Oil flax | | | Sunflower | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Area* | *Production* | *Yield* | *Area* | *Production* | *Yield* | *Area* | *Production* | *Yield* | *Area* | *Production* | *Yield* |
| 1935—1940 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1941—1943 | 85 | 86 | 101 | 96 | 69 | 71 | 80 | 51 | 68 | 525 | 423 | 82 |
| 1944—1946 | 72 | 67 | 95 | 88 | 93 | 100 | 103 | 106 | 106 | 565 | 486 | 101 |
| 1947—1949 | 96 | 107 | 109 | 85 | 82 | 96 | 126 | 99 | 80 | 815 | 611 | 83 |
| 1950—1952 | 110 | 130 | 120 | 122 | 118 | 92 | 103 | 105 | 101 | 1,412 | 1,391 | 108 |
| 1953—1955 | 154 | 204 | 144 | 128 | 149 | 117 | 86 | 81 | 100 | 1,408 | 1,326 | 107 |
| 1956—1958 | 156 | 193 | 125 | 154 | 159 | 103 | 84 | 67 | 80 | 1,631 | 1,486 | 103 |
| 1959—1961 | 104 | 92 | 91 | 130 | 106 | 81 | 69 | 66 | 94 | 1,621 | 920 | 69 |
| 1962—1964 | 82 | 101 | 123 | 102 | 110 | 107 | 88 | 83 | 94 | 1,169 | 1,183 | 120 |
| 1965—1966 | 96 | 171 | 180 | 92 | 89 | 97 | 57 | 56 | 97 | 967 | 1,063 | 124 |

*Source:* Constructed from data provided by the Banco de la República Oriental del Uruguay and the Ministry of Livestock and Agriculture. The very large increase indicated for sunflowers is because this crop started from a very small base in the 1935—1940 period.

tons per year of nitrogen) until about 1980. Use of imported ammonia might therefore be the best alternative for the next few years.

Phosphatic fertilizer demand might reach 50,000 tons of $P_2O_5$ per year soon after 1970, which would justify a domestic phosphoric acid plant of 150 tons per day. However, the possibility of using imported acid until some time between 1975 and 1980, when a larger, more economic unit might be justified, is worth investigating. All potash needs will doubtless have to continue to be met by imports.

*Table 18. Uruguay—Production indexes by product in the livestock sector, 1935—1966*

| | Beef | Lamb and mutton | Pork | All meat | Wool | Milk | Poultry | Total livestock sector |
|---|---|---|---|---|---|---|---|---|
| 1935—1940 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 1941—1943 | 64 | 112 | 99 | 72 | 105 | 117 | 103 | 85 |
| 1944—1946 | 75 | 138 | 105 | 85 | 133 | 128 | 105 | 100 |
| 1947—1949 | 98 | 145 | 105 | 105 | 130 | 155 | 108 | 115 |
| 1950—1952 | 92 | 130 | 121 | 99 | 149 | 217 | 110 | 121 |
| 1953—1955 | 87 | 114 | 141 | 94 | 169 | 255 | 112 | 126 |
| 1956—1958 | 90 | 84 | 119 | 92 | 157 | 285 | 118 | 125 |
| 1959—1961 | 104 | 84 | 123 | 103 | 151 | 311 | 125 | 133 |
| 1962—1964 | 95 | 83 | 136 | 97 | 152 | 336 | 155 | 133 |
| 1965—1966 | 104 | 90 | 143 | 106 | 151 | 323 | – | 131 |

*Source:* Constructed from data provided by the Banco de la República Oriental del Uruguay and the Ministry of Livestock and Agriculture.

*Table 19. Uruguay—Fertilizer consumption*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | 1957—1959 | 1960—1961 | 1964 | 1966 | 1967—1968 | 1970 | 1975 | 1980 |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 2.2 | 4.6 | 10.5 | 15 | 16[a] | (high) 23 | 59 | 150 |
| Average annual percentage increase | 28 | 32 | 20 | 7 | | — 20 — | | |
| Thousands of tons | | | | | | (low) 21.2 | 43 | 86 |
| Average annual percentage increase | — 22 — | | | | | — 15 — | | |

*Table 19 (continued)*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | *1957—1959* | *1960—1961* | *1964* | *1966* | *1967—1968* | *1970* | *1975* | *1980* |
| ***Phosphates, $P_2O_5$*** | | | | | | | | |
| Thousands of tons | 8.0 | 17.2 | 19.7 | 23 | 30 [a] (high) | (high) 40 | 81 | 160 |
| Average annual percentage increase | 30 | 40 | 8 | | | 15 | | |
| Thousands of tons | | | | | 29 [a] (low) | (low) 36.5 | 65 | 110 |
| Average annual percentage increase | | 14 | | | | 12 | | |
| ***Potash, $K_2O$*** | | | | | | | | |
| Thousands of tons | 2.2 | 3.4 | 5.1 | 6.0 | 8.0 [a] (high) | (high) 10.6 | 21.5 | 43 |
| Average annual percentage increase | 16 | 4 | 10 | | | 15 | | |
| Thousands of tons | | | | | 7.6 [a] (low) | (low) 9.5 | 17 | 27 |
| Average annual percentage increase | | 13 | | | | 12 | | |

*Source:* Various.

[a] Provisional.

# Venezuela

## General information

| | |
|---|---|
| *Population* | Total: approximately 9 million; annual growth rate: 3.5 per cent; density: 10 per square kilometre |
| *Land (hectares)* | Total: 91 million; arable: 29 million; cultivated: 2 million; irrigated: 0.3 million |
| *Rainfall (inches)* | 20 in north-west to 100 in south and south-east |
| *Resources* | Oil, gas, iron ore, phosphate, hydro-electric power, timber, some gold, diamonds |
| Per capita *annual income* | About $860 |
| *Average annual growth of GNP* | 6 to 7 per cent in recent years |

## Identified fertilizer materials

| | |
|---|---|
| *Phosphate rock* | Some commercially sized deposits in north-west and west |
| *Potash* | No large reserves |
| *Sulphur* | Some pyrites; some sour gas; little elemental sulphur known |

| | |
|---|---|
| *Hydrocarbons* | Huge reserves of oil and gas in the Lake Maracaibo area and the north-east |
| *Limestone* | Appreciable deposits |

## Farming patterns

Venezuela comprises four main geographical regions: the Maracaibo basin in the north-west; the Andean highlands, extending from Colombia to the Paria peninsula, north of the Orinoco river; the sparsely populated Guiana highlands between the Orinoco and Brazil, and the Llanos (plains) south of the Orinoco. While presently cultivated land in the northern and coastal areas is not of high quality, much fertile territory lying to the east and south of the Andes is largely undeveloped. Agriculture is concentrated in the Andean highlands and the Maracaibo area. Cattle-raising is cencentrated principally in the Llanos.

The main crops by value are coffee, sugar cane, corn, rice, bananas and vegetables. Crops account for 57 per cent of agricultural production; livestock and livestock products for 36 per cent; the balance is accounted for by the products of forestry and fishing. Livestock consists of 66 per cent cattle, 25 per cent poultry and the rest mostly pork. Crop production rose 33 per cent between 1961 and 1965, but forecasts to 1975 indicate rising imports of cereals, dairy products and even beef, the production of which has not kept pace with demand. Coffee exports may decline and, unless changes are made, surpluses of rice and sugar may occur.

Results of a land-reform programme instituted some years ago include the operation of about 500,000 farms by nearly 1 million people. More than 50 per cent of these holdings are unter 50 hectares in area; 25 per cent are from 5 to 50 hectares in area. The balance is worked by squatters and resident labour. Nearly 50 per cent of farmers own their own land and account for most of the cultivated area. While the units created by this programme may be too small to be economic in the aggregate, the programme itself represents a major example of government land reform in Latin America.

## Economic policies [8]

The importance of agriculture in the economy has been overshadowed by the oil industry, which is by far the main source of revenue and foreign exchange. Costs are high, owing to relatively low levels of productivity and limited use of modern farming

methods. Wide income gaps exist and diet deficiencies are prevalent, especially in the rural areas where nearly 40 per cent of the population lives. Nevertheless, determined efforts are being made to increase crop yields (by about 4.5 per cent per year), to expand cultivated acreage (by about 5 per cent per year) and to establish farmers on better land (nearly 120,000 in recent years, under the 1960 Agrarian Reform Act). The average daily diet is estimated to be 2,300 to 2,500 calories, and is deficient in animal protein, fruits and some vegetables. There is thus much room for improved farm production, even without any considerations of increased exports.

Agricultural credit is available only indirectly from the private sector. The major loan source is the government-owned Agricultural and Livestock Bank, which is greatly hampered at present by delinquent loans, and has therefore been assisted by periodic contributions from the United States Agency for International Development (AID) and the Inter-American Development Bank.

National education has received special emphasis; between 1957 and 1960, university enrolments rose by 320 per cent and general educational resources increased by 270 per cent. There are now four university faculties for agricultural studies, as well as numerous practical schools and nearly 200 extension field offices. The United Nations, AID, Shell, the Ford Foundation and other organizations have also given active educational support. Because of uncertain market prices and insufficient processing and storage facilities, especially for perishable goods, farmers and processors tend to limit outputs. The organization and improvement of production, distribution and marketing, however, are hampered by the absence of a regular civil service.

Recommended steps to accelerate agricultural progress include: improved development planning and farmer education; better food processing, storage and marketing facilities; rural higher education facilities; formation of a civil service; increased flexibility for credit and collateral; better use of available farming assets, and a thorough survey of national resources. A greater use of fertilizer is essential in efforts to achieve improved food production and lower costs.

## Fertilizer use

From 1960 to 1965, fertilizer consumption rose from about 70,000 to 116,000 tons per year (an increase of 67 per cent). Application rates rose from 18 to 23 kg of nutrients per hectare of cultivated land. Nevertheless, *per capita* use in 1966 was still low (under 6 kg). Mixed formulas account for about 40 per cent of the total material used and ammonium sulphate accounts for 40 per cent.

The balance comprises urea, triple superphosphate and potash salts.

Much of the fertilizer used has been for rice, sugar and potatoes, mostly by *empresarios* (entrepreneurs), who sell a considerable part of their crops. Many subsistence farmers still use little or no fertilizer.

*Table 20. Venezuela—Area harvested, total production, value of production and yield per hectare in major crops, 1961 and 1965*

| Crop | Area (1,000 ha) | | Production (1,000 tons) | | Value total production Bs. 1,000,000 (1957) | | Yield per hectare (1,000 kg) | |
|---|---|---|---|---|---|---|---|---|
| | 1961 | 1965 | 1961 | 1965 | 1961 | 1965 | 1961 | 1965 |
| Rice | 58 | 105 | 81 | 200 | 37 | 92 | 1.3 | 1.9 |
| Corn | 389 | 462 | 419 | 521 | 88 | 100 | 1.1 | 1.1 |
| Wheat | 2 | 2 | 1 | 1 | 0.5 | 0.6 | 0.5 | 0.5 |
| Black beans | 65 | 65 | 31 | 26 | 23 | 19 | 0.5 | 0.4 |
| Other beans | 25 | 29 | 13 | 16 | 9 | 11 | 0.5 | 0.6 |
| Peas | 7 | 14 | 4 | 7 | 2 | 4 | 0.5 | 0.5 |
| Yams | 5 | 8 | 42 | 71 | 21 | 34 | 8.2 | 8.4 |
| Taro root | 7 | 10 | 52 | 97 | 26 | 48 | 7.7 | 9.1 |
| Potatoes | 9 | 16 | 74 | 135 | 47 | 57 | 7.9 | 8.4 |
| Other roots | 5 | 10 | 32 | 64 | 12 | 31 | 6.6 | 6.5 |
| Sesame | 54 | 87 | 25 | 54 | 23 | 51 | 0.5 | 0.6 |
| Cotton (unginned) | 50 | 46 | 36 | 44 | 32 | 45 | 0.7 | 1.0 |
| Copra | 26 | 25 | 11 | 15 | 9 | 13 | 0.4 | 0.6 |
| Peanuts | 1 | 2 | 1 | 2 | 1 | 2 | 1.0 | 1.0 |
| Sisal | 10 | 11 | 8 | 13 | 4 | 7 | 0.8 | 1.2 |
| Bananas | 47 | 58 | 341 | 418 | 61 | 85 | 7.3 | 7.2 |
| Other Fruit | 6 | 8 | 83 | 106 | 19 | 23 | 12.8 | 13.6 |
| Onions | 2 | 2 | 23 | 34 | 12 | 19 | 13.6 | 17.8 |
| Other vegetables | | | | | 20 | 28 | 24.5 | 25.0 |
| Tomatoes | 4 | 5 | 65 | 72 | 25 | 27 | 15.2 | 15.2 |
| Cocoa | 72 | 70 | 13 | 20 | 42 | 56 | 0.2 | 0.3 |
| Coffee | 316 | 340 | 54 | 54 | 238 | 229 | 0.2 | 0.2 |
| Sugar cane | 51 | 64 | 3,242 | 3,520 | 100 | 134 | 62.8 | 62.8 |
| Plantains | 60 | 100 | 224 | 547 | 24 | 80 | 3.7 | 5.5 |
| Tobacco | 7 | 6 | 10 | 9 | 56 | 50 | 1.4 | 1.4 |

Increased amounts of fertilizer will undoubtedly have to be used for a number of years to come. An increase of as much as 25 per cent per year would be justified by current dietary deficiencies and low application rates; the country would thus have an opportunity of achieving at least self-sufficiency in all foodstuffs. However, owing to inadequate farmer education, poor credit and marketing facilities

and other obstacles, it appears unlikely that annual growth rates higher than 15 per cent will be sustained. The possible availability of large domestic urea supplies may, however, encourage greater fertilizer use. The potential demand situation should therefore be re-examined every few years, as it is not easily predictable under present circumstances, and might exceed the projected high figures.

## Fertilizer supply

With the exception of potash salts, some phosphate and several special compounds, all fertilizers are now produced from domestic sources. The major producer has been the government organization Instituto Venezolano de Petroquímica (IVP), which has annual capacities at Morón for about 26,000 tons of nitrogen as ammonium nitrate, sulphate and urea, plus 40,000 tons of $P_2O_5$ as single and triple superphosphate. An excess of capacity over demand has enabled some exports to be made but this surplus is diminishing. Additional nitrogen capacity is needed now, and extra phosphate production will be needed by 1975, if not sooner, if imports are to be minimized.

The availability of natural gas in the Lake Maracaibo area has aroused interest among various government and overseas groups in the possibilities of fertilizer and petrochemical production on a large scale. One plan is to relocate the Colombian Petroquímica del Atlántico project from Barranquilla to El Tablazo in Venezuela. This unit is expected to produce 300,000 tons per year of ammonia and 400,000 tons per year of urea, for use by Colombia, and will be known as Colombo-Venezolana del Nitrogeno (Covenitro). Under another plan, IVP would build a project producing 200,000 tons per year of ammonia and 250,000 tons per year of urea, as well as 100,000 tons per year of triple superphosphate, 150,000 tons per year of diammonium phosphate, and 115,000 tons per year of mixed fertilizers or 65,000 tons per year of granulated superphosphate.

In the view of the Inter-American Development Bank, one of the lending agencies, the latter project should make Venezuela self-sufficient in fertilizers (except potash) until 1980—1985. This view is supported by the independent projections shown in table 21. However, ample domestic availability, coupled with vigorous educational and selling policies, might cause even the "high" growth rates to be exceeded, in which case additional capacities would be needed, especially for phosphate. In the interim, it is anticipated that surplus production would be exported.

Another El Tablazo project, which is said to be approved, is Nitroven (Nitrógeno de Venezuela), with estimated capacities of 300,000 tons per year of ammonia and 500,000 tons per year of urea.

A possible third project is Petroflex, an IVP/foreign enterprise (40/60 per cent), which would produce 450,000 tons per year of ammonia and 300,000 tons per year of urea. A fourth, involving government and Puerto Rican interests, appears to have been

*Table 21. Venezuela—Fertilizer consumption*

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | *1957–1959* | *1960–1961* | *1964* | *1966* | *1967–1968* | *1970* | *1975* | *1980* |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 5.6 | 7.6 | 13.3 | 25 | 31 [a] | (high) 45 | 110 | 280 |
| Average annual percentage increase | 10 | 20 | 37 | 11 | | | 20 | |
| Thousands of tons | | | | | | (low) 41 | 83 | 170 |
| Average annual percentage increase | | | 19 | | | | 15 | |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | 2.3 | 5.9 | 7.6 | 10 | 14.5 [a] (high) | (high) 21 | 53 | 133 |
| Average annual percentage increase | 30 | 9 | 15 | | | 20 | | |
| Thousands of tons | | | | | 13.3 [a] (low) | (low) 17.6 | 36 | 73 |
| Average annual percentage increase | | 20 | | | | 15 | | |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 3.7 | 7.6 | 11.1 | 10 | 13 [a] (high) | (high) 17.5 | 44 | 110 |
| Average annual percentage increase | 27 | 14 | −5 | | 15 | | 20 | |
| Thousands of tons | | | | | 12.5 [a] (low) | (low) 15.6 | 39 | 97 |
| Average annual percentage increase | | 13 | | | 12 | | 15 | |

*Source:* Various.

[a] Provisional.

postponed. Obviously the output of these additional projects would have to find markets outside Venezuela.

As an alternative to domestic manufacture of phosphates from rock in the Rieceto and Lobotera areas, the use of imported phosphoric acid may be viable. Potash salts may have to be imported because no commercial domestic deposits have been identified to date.

# Mexico

## General information

| | |
|---|---|
| *Population (1968)* | Total: approximately 48 million; annual growth rate: approximately 3.5 per cent; density: 24 per square kilometre. |
| *Land (hectares)* | Total 197 million; arable: approximately 38 million; cultivated: approximately 15 million; irrigated: approximately 4 million |
| *Rainfall* | Central plateau, north-east and north-west, dry; southern area, wet |
| *Resources* | Non-ferrous metals, sulphur, some hydrocarbons, silver, hydroelectric energy |
| Per capita *annual income* | Approximately $550 |
| *Annual growth of GNP* | Diminished from 6 to 4 per cent in recent years |

## Identified fertilizer materials

| | |
|---|---|
| *Phosphate rock* | Some low-grade ore |
| *Sulphur* | Large salt-dome deposits |
| *Hydrocarbons* | Appreciable reserves of oil; some gas and coal |

| | |
|---|---|
| *Potash* | No significant deposits |
| *Limestone* | Ample deposits |

## Land and farming patterns

Mexico is a land of mountains, plateaux and coastal plains. Two mountain ranges—the Sierra Madre Occidental in the west and the Sierra Madre Oriental in the east—are principal features. Two thirds of the country lie at an altitude of over 500 metres. Seventy per cent of the population is concentrated in one half of the territory, at an altitude of over 1,000 metres. There is a dry season extending from October to May and a wet season from June to September. Forty-six per cent of the land is arid, 36 per cent is semi-arid and 16 per cent is humid. Soils are frequently low in nitrogen and phosphates, and are generally alkaline in the north and acid in the south.

Land reform was introduced after the 1910 revolution; the large *haciendas* were transformed into village *ejidos*, averaging 29 hectares, or some 7 hectares of tilled crop land. There are nearly 1 million small holdings and a few large *latifundios*.

In recent years, about 40 per cent of cultivated land has been worked by small farmers who have produced 65 per cent of the agricultural total; the remainder (mostly *ejidos)* produce only 35 per cent of all farm products. Crop production accounts for 67 per cent of the gross agricultural value; livestock accounts for 31 per cent; the balance is in forestry and fishing. Major crops are beans, sugar, coffee, corn and wheat. Annual expansion rates have been well maintained, averaging (between 1950 and 1964) about 9 per cent for wheat and beans, 6 per cent for corn, cotton, sugar and coffee, and more than 4 per cent for all products. Livestock expansion also has been at an annual figure of 4 per cent; herds increased by 70 per cent from 1950 to 1964.

Farm mechanization is common in the north-west and in other areas where sugar, cotton and wheat are grown. Aided by experts from various organizaions and the United Nations, some sections of agriculture have become quite sophisticated; Mexican dwarf wheats, for example, are now world renowned. Double cropping is often undertaken on vines, corn, beans and alfalfa.

## Economic policies [22]

Agricultural expansion has been slower in recent years than that of other sectors of the economy. Farm products, nevertheless,

represented 57 per cent of total exports in 1965, equivalent to some $650 million. Livestock exports rose twentyfold from 1950 to 1965. As a result, Mexico has enjoyed an increasingly favourable balance of trade for agriculture, and is virtually self-sufficient in food needs at present dietary levels.

Approximately 5 million hectares of new land were cultivated between 1950 and 1964—an increase of 57 per cent, which included 1.5 million hectares under irrigation. Other development policies include the introduction of new seeds, increased investment and mechanization, and enlarged credit and educational facilities. Three major government banks provide agricultural credit, as do private banks under a special fund. The United States Government and IBRD have extended about $50 million in agricultural credits since 1962. Although agricultural enrolment has been under 2 per cent of total university intake in the last decade, the Government is making strong efforts to increase the number of professional agriculturists, with some success. Extension services exist, but the ratio of farm families to technicians is about 10,000 : 1 (the ratios in the United States and Japan are 540 and 650, respectively). Many more technologists are needed to maintain planned agricultural expansion.

Price incentives have encouraged farm production for domestic and export purposes. Land reform over the years also appears to have provided better environments and markets, leading to greater farm outputs. In the last fifteen years, about 10 per cent of the federal budget has been allocated to agriculture, much of the funds being used for irrigation projects. Marketing, prices and foreign trade in farm products is controlled by the government agency CONASUPO, which is currently faced with high stocks of corn, wheat and beans.

About 25 per cent of the farmers have adopted modern farm practices, but 15 per cent operate under primitive conditions. The remainder should eventually be able to operate their farms as economic units, given proper help. The *ejidos*, however, are limited in size, and the absence of ownership restricts credit availability. Other factors limiting agricultural growth are shortage of capital, especially in the south, and a scarcity of educational and extension services. Also needed are better planning policies, intensive natural-resources studies, more irrigation and associated research, and improved marketing facilities for surplus production, especially in the rural areas. The Government is said to be aware of these problems and anxious to resolve them. This is a hopeful indication that the rate of progress made in the last decade will at least be maintained.

## Fertilizer use

Fertilizer use has increased very considerably in the last ten years and has recently attained levels of about 11 kg *per capita*, or 60 kg per cultivated hectare — relatively high levels in Latin America. Nitrogen needs have been supplied by domestic ammonium sulphate, nitrate, anhydrous ammonia and urea, as well as mixtures and compound fertilizers. Phosphate requirements have been met by domestic single and triple superphosphate as well as by mixtures and compounds.

Potash needs have been supplied principally as muriate. Nutrient ratios, as shown in table 24, indicate relatively low consumptions for phosphate and potash. It is recognized that some soils of volcanic origin may have high initial potash contents; however, additional potash is likely to be needed for some cash crops within a few years.

To maintain recent agricultural growth rates, a continuation of corresponding increases in fertilizer consumption will be needed. As soil fertility is built up, it may be possible to reduce application rates to some extent, as postulated in table 24. The availability of large quantities of domestic wet-process phosphoric acid from 1969 onwards may encourage phosphate consumption at rates at least as high as the high values shown. If latent soil potassium contents prove inadequate, greater growth in potash than the projected high values may be found necessary, especially after 1975. These uncertainties make it difficult to forecast probable consumption accurately at the present time. Consequently, reviews every few years are recommended.

## Fertilizer supply

Until recently, fertilizers were produced in some thirty plants by some twenty concerns, but consolidation into the government organization Guanos y Fertilizantes has reduced the number of manufacturers. Petroleos Mexicanos operates three ammonia plants at Cosoleacaque, Salamanca and Ciudad Camargo, which will soon have capacities of 300,000, 80,000 and 120,000 tons per year of ammonia respectively, equivalent to about 400,000 tons of nitrogen annually. Additional capacity includes 50,000 tons per year of ammonia (46,000 tons per year of nitrogen) from units at Cuatitlan and Monclova, all except the latter using natural gas. Some urea, ammonium nitrate and ammonia have also been imported, the latter from the United States, for direct application in the north-western states.

Virtually all phosphatic fertilizers produced have been based on phosphate rock imported from the United States and North Africa. Guanos y Fertilizantes have capacities for about 160,000 tons per year of single superphosphate and 50,000 tons per year of triple superphosphate, plus 40,000 tons per year of ammonium phosphate. Total capacity for phosphatic fertilizers up to 1968 has been about 500,000 tons per year, including mixtures, equivalent to 99,000 tons per year of $P_2O_5$. Almost all potash used has been imported (about 25,000 to 30,000 tons of $K_2O$ per year).

The Government's aim is for Mexico to become self-sufficient in fertilizer supplies, based on domestically produced hydrocarbons and hydrogen, together with imported phosphate rock and potash. In addition, it is hoped to build up an export trade in phosphates based on domestic sulphur and imported rock, and also, to the extent permitted by domestic demand, in nitrogen fertilizer. Accordingly, several new plants have been approved, including the expanded ammonia unit at Cosoleacaque, an ammonium sulphate unit at Salamanca with an estimated capacity of 60,000 tons per year, and another unit in Guadalajara with a capacity of 120,000 tons per year. Salamanca and Camargo are also to have additional capacities of 20,000 and 75,000 tons per year of urea, respectively.

A large phosphoric acid-triple superphosphate—diammonium phosphate (DAP) complex has just come on stream at Coatzacoalcos. It has been designed to produce 360,000 tons per year of $P_2O_5$ as acid, part of which will be used to make 410,000 tons per year of triple superphosphate and 92,000 tons per year of DAP, leaving about 160,000 tons per year of acid for domestic and export sales.

One interesting feature of future significance is the expanding use of ammonia for direct application, especially in the north and north-west. This market may attain 200,000 tons per year of nitrogen within a few years.

## Balance of demand and supply

Up to 1968, nitrogen and $P_2O_5$ capacities totalled about 200,000 and 99,000 tons per year, respectively. By 1970, new expanded capacities will be about 490,000 tons per year of nitrogen and 440,000 tons per year of $P_2O_5$. This will result in total capacities of about 560,000 tons per year of nitrogen and over 500,000 tons per year of $P_2O_5$. Assuming that about 100,000 tons per year of $P_2O_5$ can be sold overseas as acid, this will leave a domestic availability of approximately 400,000 tons per year.

On the above basis, the projections in table 25 indicate that additional nitrogen capacity is likely to be needed soon after 1970, amounting perhaps to one unit producing 330,000 tons per year of

ammonia between 1970 and 1975, and another shortly thereafter. The projections also indicate a need for further phosphate capacity between 1975 and 1980; perhaps as much as 300,000 tons per year of $P_2O_5$ may be justified if fertilizer demand continues to grow and acid continues to find export markets. All potash needs will undoubtedly have to be met by imports, as before. Because of the rapid growth and international significance of the Mexican fertilizer industry, as well as its domestic importance, reviews every few years are recommended to define more accurately the changing balances and patterns.

*Table 22. Mexico—Average yields of important crops (100 kg / ha)*

| Crop | 1949—1951 | 1956—1958 | 1962—1964 | Total percentage increase 1949—1951 to 1962—1964 |
|---|---|---|---|---|
| Corn | 7.5 | 8.2 | 9.5 | 26.7 |
| Beans | 2.6 | 3.6 | 3.9 | 50.0 |
| Cotton fibre | 3.5 | 5.1 | 6.4 | 82.9 |
| Wheat | 9.1 | 14.5 | 21.3 | 106.3 |
| Sugar cane | 509.0 | | 565.0 | 11.0 |
| Coffee | 4.0 | 4.3 | 4.4 | 10.0 |
| Potatoes | 45.0 | 49.1 | 73.7 | 63.8 |
| Rice | 17.3 | 20.5 | 22.5 | 30.0 |
| Tobacco | 10.0 | 13.0 | 13.4 | 34.0 |

*Source:* S. A. G., Dirección General de Economía Agricola, for the periods 1949—1951 and 1962—1964; and the *United Nations Statistical Bulletin for Latin America*, (March 1965) Vol. II, No. 1, for the other periods shown.

*Table 23. Mexico—Value of exports*

| Economic sector | 1950 Million dollars | 1950 Per cent of total | 1960 Million dollars | 1960 Per cent of total | 1965 Million dollars | 1965 Per cent of total | 1960—1965 Per cent change |
|---|---|---|---|---|---|---|---|
| Agriculture | 253.1 | 51.3 | 442.1 | 59.8 | 649.8 | 58.5 | 156.7 |
| Crops [a] | 231.4 | 46.9 | 360.4 | 48.8 | 553.1 | 49.8 | 139.0 |
| Fish | 19.2 | 3.9 | 36.3 | 4.9 | 45.4 | 4.1 | 136.5 |
| Mining | 147.2 | 29.8 | 157.6 | 21.3 | 184.5 | 16.6 | 25.3 |
| Manufacturing [a] | 33.3 | 6.7 | 81.9 | 11.1 | 119.0 | 10.7 | 257.4 |
| Other [b] | 59.7 | 12.2 | 57.2 | 7.8 | 157.4 | 14.2 | 163.6 |

*Source:* Nacional Financiera, S. A. (1965) *La Economía Mexicana en Cifras*, Mexico; and Banco de Mexico, *Informe Annual*, 1960 and 1965.

[a] Sugar and molasses included under agriculture rather than manufacturing.

[b] Includes some agricultural and forest products.

Table 24. Mexico—Fertilizer consumption

| | Past | | | | | Projected | | |
|---|---|---|---|---|---|---|---|---|
| | 1957—1959 | 1960—1961 | 1964 | 1966 | 1967—1968 | 1970 | 1975 | 1980 |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 87.3 | 128 | 229 | 320 | 380 | (high)550 | 1,360 | 2,750 |
| Average annual percentage increase | 14 | 21 | 18 | 9 | | 20 | | 15 |
| Thousands of tons | | | | | | (low)500 | 1,000 | 1,600 |
| Average annual percentage increase | 16 | | | | | 15 | | 10 |
| *Phosphate $P_2O_5$* | | | | | | | | |
| Thousands of tons | 32 | 43 | 60 | 98 | 140[a] (high) | (high)200 | 405 | 825 |
| Average annual percentage increase | 10 | 12 | 28 | | 20 | | 15 | |
| Thousands of tons | | | | | 130[a] (low) | (low)172 | 350 | 570 |
| Average annual percentage increase | 15 | | | | | 15 | | 10 |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 12.1 | 14.2 | 12.5 | 22 | 30 | (high) 40 | 81 | 165 |
| Average annual percentage increase | 5 | -4 | 33 | 17 | | 15 | | |
| Thousands of tons | | | | | | (low) 38 | 67 | 120 |
| Average annual percentage increase | 8 | | | | | 12 | | |

*Source:* Various.

[a] Provisional.

# Central America (including Panama)

The North and South American continents are linked by the small but important Central American countries. For reasons of brevity, these will be reviewed together. Individual features of special significance will be mentioned whenever pertinent.

## General information

*Table 25. Central America—Population, 1968*

| Country | Total (millions) | Rate of growth per year (percentage) | Density (per km total land) |
|---|---|---|---|
| Costa Rica | 1.7 | 3.8 | 33 |
| El Salvador | 3.3 | 3.5 | 158 |
| Guatemala | 5.0 | 3.3 | 46 |
| Honduras | 2.5 | 3.1 | 22 |
| Nicaragua | 2.0 | 3.5 | 15 |
| Panama | 3.8 | 3.3 | 51 |
| Total | 18.3 | | |

*Table 26. Central America—Land and climate*

| Country | Total land ($km^2$) | Available land used (percentage) | Climate |
|---|---|---|---|
| Costa Rica | 51,500 | 70 | Hot to temperate, rainy |
| El Salvador | 20,700 | 100 | Hot to temperate, one rainy season |
| Guatemala | 108,500 | 30 | Warm to cool, one rainy season |
| Honduras | 112,000 | 50 | Hot to cool, one rainy season |
| Nicaragua | 138,000 | 30 | Hot to temperate, one rainy season |
| Panama | 74,000 | 25 | Hot to temperate, rainy |

*Table 27. Central America—Economy*

| Country | 1966/1967 GNP growth (percentage) | 1967 income per capita (dollars) | Agricultural labour (percentage of total) |
|---|---|---|---|
| Costa Rica | 8.2 | 426 | 55 |
| El Salvador | 4.0 | 284 | 60 |
| Guatemala | 3.0 | 308 | 64 |
| Honduras | 5.7 | 228 | 70 |
| Nicaragua | 4.2 | 333 | 58 |
| Panama | 9.5 | 533 | 44 |

## Principal resources and fertilizer raw materials

**Costa Rica** — No significant deposits of phosphate, potash. Some volcanic sulphur.

**El Salvador** — No known industrial or fertilizer minerals. Some hydroelectric power.

**Guatemala** — No industrial or fertilizer minerals known. Land not fully surveyed.

**Honduras** — No industrial or fertilizer minerals known.

**Nicaragua** — No industrial or fertilizer minerals known. Land not fully surveyed.

**Panama** — No industrial or fertilizer minerals known.

Most of these countries have appreciable timber resources, fishing industries and limestone deposits.

## Farming patterns

The principal activity of the Central American countries is agriculture, for both domestic consumption and export purposes, the latter being the principal source of foreign exchange. Principal crops are:

| | |
|---|---|
| Costa Rica | Coffee, bananas, cacao, sugar, corn, beans (coffee yields are among the world's highest); |
| El Salvador | Coffee, cotton, corn, beans; |
| Guatemala | Bananas, coffee, cotton, corn, vegetables; |
| Honduras | Bananas, sugar, corn, coffee, tobacco, vegetables; |
| Nicaragua | Rice, cotton, coffee, bananas, sorghum, corn, beans; |
| Panama | Bananas, cocoa, coffee. |

### *Costa Rica*

Most of the land is privately owned and made up of numerous small farms and a few large estates. Small cultivators still apply age-old methods and use little fertilizer, but medium-scale and large-scale operators are adopting modern methods, with increasing use of fertilizers. Progressive farmers have achieved some excellent crop yields through the use of hybrid seeds and nutrients. Government and private sources of credit are available.

### *El Salvador*

Much of the arable land is already under intensive cultivation, and export crops such as cotton and coffee compete with beans and other food crops for the better growing areas. This is the only Central American country which is not a traditional banana exporter owing to limited lowland area. Double cropping is common. Much of the best land is held by a few owners. There are many small, independent farmers, but the rural population consists mainly of tenant farmers and labourers. Adequate government and private credit sources are said to be available.

### *Guatemala*

About half of the land is publicly owned, but most farmland is in large public and private holdings. Much subsistence farming is

practised in the highlands, by primitive methods. Most medium-scale and large-scale farmers are progressive and account for the greater part of agricultural production. Most farm credit is obtained through government sources, but limited credit availability and high interest rates are understood to have inhibited agricultural growth.

### *Honduras*

About half the land is privately owned, the remainder being government property or communally owned. Small-scale farming is undertaken in the interior, and most large-scale operations are situated in the Caribbean lowlands. There is a need for modern farming methods, more irrigation and technical assistance. In the past, commercial credit has been restricted to coffee growers, but the United States and the United Nations have helped small farmers and others with credit and technical assistance through the National Development Bank.

### *Nicaragua*

Agriculture is by far the most important activity, and it includes an increasing amount of processing, packaging and transportation. Livestock production has also expanded considerably and fishing has a good potential. Much of the eastern part of the country is nationally owned and available for purchase or lease. Large companies own big tracts of coffee, sugar, timber and grazing land, which are farmed with hired labour. Many small landowners and farmers also cultivate domestic and export crops.

Credit is mostly available through the national bank and several private banks for both short-term agricultural needs and capital-investment purposes. Although small cultivators have had limited recourse to such credit sources, they frequently borrow from the larger landowners. Nicaragua has made substantial agricultural progress in recent years, especially with regard to crops such as cotton, sugar, coffee and bananas. Good potential exists for rice and livestock.

### *Panama*

The agricultural pattern is similar to that of Costa Rica. Major agricultural exports are bananas, cocoa and coffee. Shrimp and beef are also exported. With only about 25 per cent of arable land in current use, the potential for agricultural growth is promising, as are increased export possibilities in view of Canal traffic.

## Fertilizer use

In terms of *per capita* use, fertilizer applications are moderate to low in Central American countries, as shown below for 1966/1967:

*Table 28. Central America—Approximate* per capita *fertilizer consumption*

| *Country* | $N+P_2O_5+K_2O$ *(kg)* |
|---|---|
| Costa Rica | 40 |
| El Salvador | 24 |
| Guatemala | 7 |
| Honduras | 12 |
| Nicaragua | 25 |
| Panama | 6 |

As previously mentioned, application rates range from high, as in the case of large growers of coffee and cash crops, to low or nil for many small subsistence cultivators. Fertilizers used include increasing amounts of urea, together with ammonium nitrate and sulphate, single and triple superphosphate and potash mixtures and compounds. Relatively more urea is expected to be used in the future, and perhaps urea-ammonium phosphate combinations as well.

Recent growth rates in fertilizer use in most of these countries are encouraging, and it is believed that they will be maintained for the next decade, as shown in tables 26 to 31. This optimism is founded *inter alia* on the rapidly rising birth rate, the increased assistance made available by various large organizations, funds and the United Nations, the gradual spread of education and the increased availability of fertilizer materials such as ammonia, phosphoric acid and potash.

## Fertilizer supply

In the six countries under review virtually all nitrogen, phosphates and potash needs are met by imports, mostly in semi-finished or finished form. In Costa Rica, the Fertica plant produces ammonium nitrate and nitrophosphates from imported ammonia (Colombia) and phosphate rock (Florida). The design capacities are stated to be 50,000 tons per year of ammonium nitrate and 60,000 tons per year of nitrophosphates, to be increased eventually to a total of 165,000

tons per year for sale to domestic and other Central American consumers. Another Fertica plant produces superphosphate and granulated fertilizers in El Salvador. Small mixing plants using imported materials exist in Nicaragua and the other Central American countries.

## Balance of demand and supply

In view of a forthcoming abundance of ammonia and urea from Venezuelan, United States and other sources, there appears little justification for building any basic nitrogen fertilizer plants in the Central American countries—at least not until 1980. Moreover, the combined projected nitrogen needs of these countries by 1980 may scarcely be in the economic plant size range. Similarly, the imminent availability of competitively priced phosphoric acid, DAP and triple superphosphate from the United States and Mexico is likely to prove more economic than small-scale acid production from imported rock and sulphur during the 1970s. However, expanding consumption may well justify more mixing and granulating plants in some of these countries to meet specific local needs. Possibilities of regional integration also exist, as over-all demands increase [20].

*Table 29. Costa Rica—Fertilizer consumption*

| | Past | | | | Projected | | | |
|---|---|---|---|---|---|---|---|---|
| | *1956* | *1961* | *1966* | *1967—1968* | *1969* | *1970* | *1975* | *1980* |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 4.5 | 5.8 | 10 | 11 | ... | 13 | 22 | 35 |
| Average annual percentage increase | | 8 | | | | 10 | | |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | 2.7 | 6.7 | 10 | ... | ... | 15 | 23 | 38 |
| Average annual percentage increase | | 14 | | | | 10 | | |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 3.6 | 5.3 | 10 | ... | ... | 15 | 23 | 38 |
| Average annual percentage increase | | 10 | | | | 10 | | |

*Source:* Various.

*Table 30. El Salvador—Fertilizer consumption*

| | Past | | | | Projected | | | |
|---|---|---|---|---|---|---|---|---|
| | *1956* | *1961* | *1966* | *1967—1968* | *1969* | *1970* | *1975* | *1980* |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 8.1 | 14.1 | 24 | 27 | ... | 34 | 60 | 105 |
| Average annual percentage increase | | 14 | | | | 12 | | |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | 8.3 | 2.9 | 6 | ... | ... | 10 | 15 | 27 |
| Average annual percentage increase | | 0 | | | | 12 | | |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 1.1 | 0.9 | 10 | ... | ... | 15 | 24 | 39 |
| Average annual percentage increase | | 29 | | | | 10 | | |

*Source:* Various.

*Table 31. Guatemala—Fertilizer consumption*

| | Past | | | | Projected | | | |
|---|---|---|---|---|---|---|---|---|
| | *1956* | *1961* | *1966* | *1967—1968* | *1969* | *1970* | *1975* | *1980* |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 1.5 | 5.2 | 9 | 11 | ... | 14 | 28 | 57 |
| Average annual percentage increase | | 18 | | | | 15 | | |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | 1.5 | 2.6 | 4 | ... | ... | 7 | 16 | 27 |
| Average annual percentage increase | | 10 | | | 15 | | | |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 0.5 | 0.7 | 3 | ... | ... | 5 | 11 | 22 |
| Average annual percentage increase | | 20 | | | 15 | | | |

*Source:* Various.

*Table 32. Honduras—Fertilizer consumption*

| | Past | | | | Projected | | | |
|---|---|---|---|---|---|---|---|---|
| | *1956* | *1961* | *1966* | *1967—1968* | *1969* | *1970* | *1975* | *1980* |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 4.4 | 3.6 | 8 | 10 | ... | 12 | 20 | 22 |
| Average annual percentage increase | | 7 | | | 10 | | | |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | 0.3 | 0.2 | 2 | ... | ... | 4 | 8 | 17 |
| Average annual percentage increase | | 20 | | 20 | | 15 | | |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 0.1 | 0.1 | 4.5 | ... | ... | 7 | 13 | 22 |
| Average annual percentage increase | | 45 | | | 12 | | | |

*Source:* Various.

*Table 33. Nicaragua—Fertilizer consumption*

| | Past | | | | Projected | | | |
|---|---|---|---|---|---|---|---|---|
| | *1956* | *1961* | *1966* | *1967—1968* | *1969* | *1970* | *1975* | *1980* |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | 0.4 | 3.2 | 14 | 17 | ... | 24 | 60 | 120 |
| Average annual percentage increase | | 45 | | | | 20 | | 15 |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | 0.7 | 1.6 | 7 | ... | ... | 15 | 36 | 73 |
| Average annual percentage increase | | 26 | | | | 20 | | 15 |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | 0.4 | 1.0 | 4 | ... | ... | 9 | 22 | 45 |
| Average annual percentage increase | | 26 | | | | 20 | | 15 |

*Source:* Various.

*Table 34. Panama—Fertilizer consumption*

| | Past | | | | Projected | | | |
|---|---|---|---|---|---|---|---|---|
| | *1956* | *1961* | *1966* | *1967—1968* | *1969* | *1970* | *1975* | *1980* |
| *Nitrogen, N* | | | | | | | | |
| Thousands of tons | ... | 5 | 9 | 11 | ... | 14 | 25 | 45 |
| Average annual percentage increase | | 12 | | | | 12 | | |
| *Phosphate, $P_2O_5$* | | | | | | | | |
| Thousands of tons | ... | 1 | 1 | 2 | ... | 3 | 7 | 17 |
| Average annual percentage increase | | ... | | | | 20 | | |
| *Potash, $K_2O$* | | | | | | | | |
| Thousands of tons | ... | ... | 1 | 2 | ... | 3 | 7 | 17 |
| Average annual percentage increase | | ... | | | | 20 | | |

*Source:* Various.

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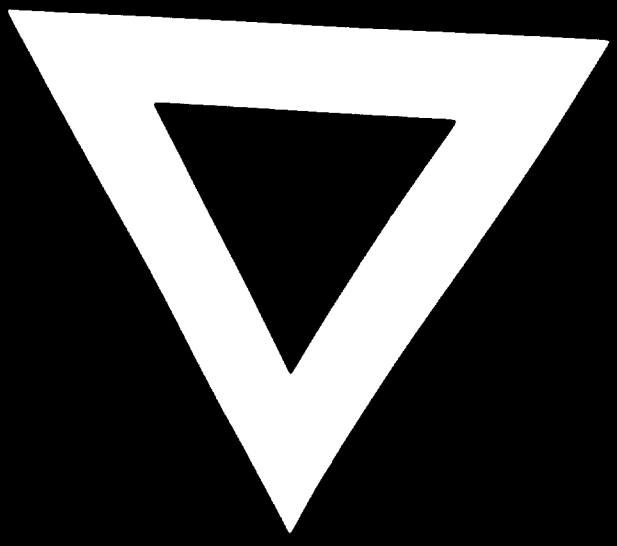

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