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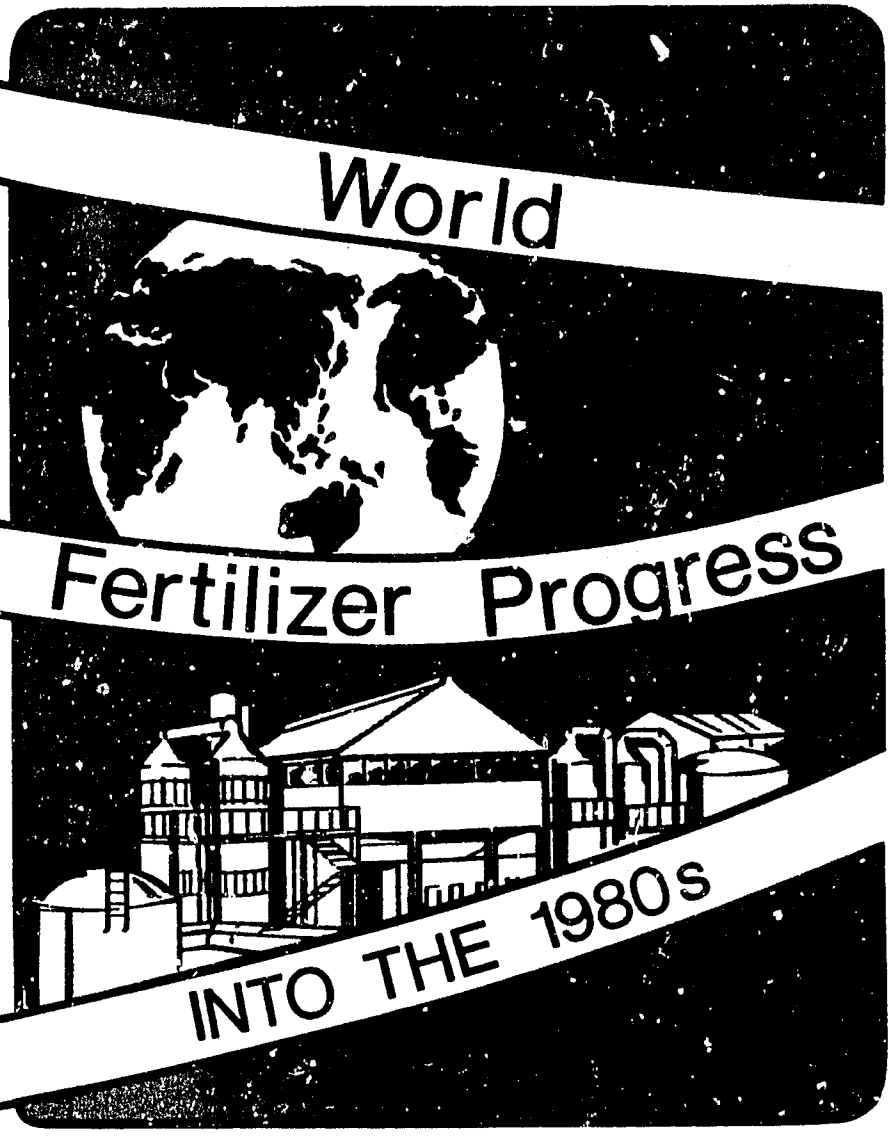
World Fertilizer Progress INTO THE 1980s



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ABSTRACT

The world fertilizer sector is in a process of dynamic expansion in terms of quantities of fertilizers involved and the number of producers. Many countries in the world, and especially in the developing regions, are devoting special efforts to come up with optimum policies with regard to domestic fertilizer production and fertilizer supply. Continuous changes in the nature of the fertilizer sector in light of the crisis of 1973/74 make it much more complicated to be achieved. Fertilizer availability at the right place, the right time, and the right price is one of the major constraints on increasing food production. Acknowledging the increased importance of fertilizers to their crops and food production, most governments had moved fertilizer supply schemes to higher priorities in their long-term planning.

This publication attempts to analyze the changing patterns of world fertilizer production and consumption and underline the major trends in this sector. Based on evaluation of the changes during the 1970s and discussion of the projection made by the FAO/UNIDO/World Bank Working Group on Fertilizers for the first half of the 1980s, this publication attempts to provide useful analysis of fertilizer production, consumption, and trade. Policymakers in the developing countries might find this paper very helpful in their attempts to rationalize their fertilizer supply sector in the 1980s by means of domestic production and imports.

Prepared by

Joseph Lastigzon
Economist
International Fertilizer Development Center

TABLE OF CONTENTS

	Page
Foreword	i
Acknowledgment	i
Summary	ii
Symbols, Acronyms, and Abbreviations	iv
The 1970s in Perspective	1
Summary of Events	1
1969/70-1979/80 Highlights	3
Nitrogen	9
Phosphate	14
Potash	21
Major Trends in the Fertilizer Sector	23
Inflation	23
Balance of Payment Deficits	24
Energy Crisis	25
Research and Development	28
Regional Shifts in International Trade	29
Changing Product Pattern in World Trade	34
Ownership	38
Role of Export Associations	38
World Fertilizer Outlook: 1980/81-1985/86	42
Nitrogen Outlook	45
Phosphate Outlook	49
Potash Outlook	52
Bibliography	56

LIST OF TABLES

Page

1. World Fertilizer Production, 1969/70-1979/80 5
2. World Fertilizer Consumption, 1969/70-1979/80 6
3. Average $N:P_2O_5:K_2O$ Consumption Ratios 6
4. Consumption of Fertilizers Per Hectare of Arable Land, 1979/80 7
5. World Fertilizer Trade, 1969/70-1979/80 9
6. Relative Energy Consumption and Investment Cost for 1,000-mtpd Ammonia Plant by Feedstock 11
7. World Phosphate Rock Trade–1980 18
8. Estimated Structural Change in World Fertilizer P_2O_5 Supply 19
9. Average Annual Rate of Inflation, 1970-78 24
10. Current Account Deficits of Oil-Importing Developing Countries, 1970-80 25
11. Share of N, P_2O_5, and K_2O in Energy Requirements 27
12. Export-Oriented Phosphoric Acid Capacity Expansions 33
13. Market Share of Major Solid Nitrogen Fertilizers 36
14. Estimated Share of Products in World Solid Phosphate Trade, Late 1970s 37

LIST OF FIGURES

Page

1. World Fertilizer Production and Consumption in the 1970s 2
2. Export Price Trends for Some Major Fertilizer Materials (Current Prices) 3
3. Regional Share in Fertilizer Production and Consumption 8
4. World Ammonia Capacity, 1970-80 10
5. Feedstock Share in World Ammonia Capacity 12
6. Percentage Share of World Nitrogen Fertilizer Production Capacity by Major Product, 1970-80 13
7. Regional Variations in Nitrogen Fertilizer Consumption, 1979 15
8. World Capacity for Phosphate Rock Production 16
9. World Wet-Process Phosphoric Acid Capacity 20
10. World Potash Capacity, 1980 22
11. Petroleum Prices, Annual Averages, 1972-80 26
12. India and People's Republic of China–Urea Supply Sources, 1973/74 and 1978/79 32
13. State-Ownership Development, 1970-80, as a Percentage of World Capacity in Major Products 39
14. How Soviet Ammonia Exports Are Expected to Develop 40
15. Role of Export Associations 41
16. Projected Fertilizer Surpluses and Deficits, 1980/81-1985/86 44
17. World Nitrogen Fertilizer Supply Capability and Consumption, 1980/81-1985/86 46
18. World Nitrogen Fertilizer Supply and Consumption by Region, 1985/86 47
19. World Phosphate Available Supply and Consumption, 1980/81-1985/86 50
20. World Phosphate Fertilizer Supply Capabilities and Consumption by Region, 1985/86 51
21. World Potash Fertilizer Available Supply and Consumption, 1980/81-1985/86 53
22. World Potash Fertilizer Supply Capabilities and Consumption by Region, 1985/86 54

FOREWORD

Ten years in the relatively young fertilizer industry is a long and meaningful period of time. The past decade, with its many special events, was dynamic and unusual in many aspects. The beginning of a new decade provides a special opportunity to analyze what has changed in the fertilizer industry and identify those trends that began in the 1970s and are likely to continue during the 1980s. However, with technology becoming more sophisticated, it now takes 4-6 years for new plants to become operational after an investment decision is made. This creates a time lag before the fertilizer sector can adjust to changes in the economic environment. Therefore, many trends that started in the 1970s are likely to be shaped into their final forms only during the decade of the 1980s.

The intent of this publication is to analyze and evaluate the major trends occurring in the 1970s and project the trends for the future. Special attention has been placed on the share and role the developing world may have in these trends. We hope that this analysis will aid policymakers in the developing countries and the agencies involved in those regions to improve their planning and policies for the future.

Complementary reports that will be helpful in reviewing the world fertilizer situation include the annual reports of the FAO/UNIDO/World Bank Working Group on Fertilizers, the *Current Fertilizer Situation and Outlook* published by the FAO Commission on Fertilizers, and *1981 Fertilizer Situation* published by the U.S. Department of Agriculture.

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SUMMARY

The availability of raw materials is likely to be the factor dictating the location of the additional fertilizer capacity needed. This trend started in 1973/74 and is expected to play the major role in investment decisions in the fertilizer sector. The relation between cost of indigenous raw materials and market prices is projected to dictate the location of the new export-oriented facilities.

The world fertilizer sector depends today more than ever on developments of production and consumption in the developing countries and the centrally planned economies of Eastern Europe. Most of the countries in these groups have not yet reached self-sufficiency in food supply, and higher fertilization rates seem to be their best option to increase crop yields and productivity. On the other hand, with relatively cheap raw materials available in their regions, many of those countries are expected to increase production significantly.

It is important to recognize the role of expanding fertilizer production in the developing countries as a de facto push to higher consumption levels. This kind of relationship between domestic production and consumption gives hope for achieving reasonable fertilizer consumption growth rates in those countries. On the other hand, inflation, along with high interest rates, and growing balance of payment deficits are expected to hinder and slow down the rate of growth in fertilizer consumption in many of the developing countries that depend on fertilizer imports.

The developed countries in North America and Western Europe are expected to continue to play a very important role in world fertilizer consumption and production. Important adjustments will be needed in the nitrogen industry in light of these nations' limited supplies of natural gas. However, the phosphate supply in the United States, based on indigenous phosphate rock and sulfur, and the potash supply in Canada are expected to continue their growth, and thus these countries will have a dominant role in those subsectors.

Nitrogen dominates the world fertilizer scene in almost all categories, accounting for more than one-half of world fertilizer production and consumption. The consumption of nitrogen, the dominant plant nutrient, will be influenced heavily by availability and price. The cost of nitrogen consumption is likely to influence phosphate and potash consumption significantly.

The heavy energy input in nitrogen production means that future energy cost plays a very important role in world fertilizer developments. With limited options to reduce energy use and expectations for higher energy prices during the 1980s, research and development efforts should be concentrated on increasing nitrogen efficiency in crop production. Any breakthrough in this aspect is expected to contribute significantly to reduction of fertilization costs and thereby improve the benefit/cost ratio.

According to projections made by the FAO/UNIDO/World Bank Working Group on Fertilizers, the world fertilizer situation is likely to be tight throughout the first half of the 1980s. Nitrogen supply is likely to be the most severe problem with a small deficit to be experienced throughout the near future. Potash supply is expected to improve in the mid-1980s after experiencing deficits in the first 2 years of the decade. There appear to be ample supplies of phosphate.

Shifts in regional supply are expected to continue and thereby increase the role of the developing countries and the centrally planned economies in the world fertilizer trade. More state-owned industries and government involvement in exports as well as imports are likely to result in more bilateral trade agreements. Barter deals might become a more common feature of this trade in the 1980s.

Significant new advances in technological research and development are not expected to b realized in the near future. Having incorporated almost all past technical innovations by th end of the 1970s, the fertilizer industry is now expected to experience the major portion of th impact of energy and raw materials price escalations. There is still room for improvement i the energy efficiency of fertilizer manufacturing plants, but these improvements will entail great investments. Coupled with inflation and low worldwide average utilization rates, fertilizer pric are likely to increase in the future. The question to be answered yet is whether the fast-growin markets of the developing countries will be able to pay these prices and yet maintain reasonab growth rates in terms of fertilizer consumption.

SYMBOLS, ACRONYMS, AND ABBREVIATIONS

Fertilizers

CAN . . . . . calcium ammonium nitrate
DAP . . . . . diammonium phosphate
K_2O . . . . . potash, expressed as potassium oxide
MAP . . . . . monoammonium phosphate
N . . . . . nitrogen
P_2O_5 . . . . . phosphate, expressed as phosphorus pentoxide
SSP . . . . . single superphosphate
TSP . . . . . triple superphosphate

Organizations and Countries

ASEAN . . . . . Association of Southeast Asian Nations
FAO . . . . . Food and Agriculture Organization of the United Nations
FFM . . . . . Fertilizantes Fosfatados Mexicanos, S.A.
Germany D.R. . . . . German Democratic Republic
IFDC . . . . . International Fertilizer Development Center
PCS . . . . . Potash Corporation of Saskatchewan
PHOSCHEM . . . . . Phosphate Chemicals Export Association, Inc.
PHOSROCK . . . . . Phosphate Rock Export Association
TVA . . . . . Tennessee Valley Authority
UNIDO . . . . . United Nations Industrial Development Organization
U.S.S.R. . . . . Union of Soviet Socialist Republics

Measuring Units

ha . . . . . hectare
kg . . . . . kilogram
mt . . . . . metric tons
mtpd . . . . . metric tons per day
mtpy . . . . . metric tons per year

Miscellaneous

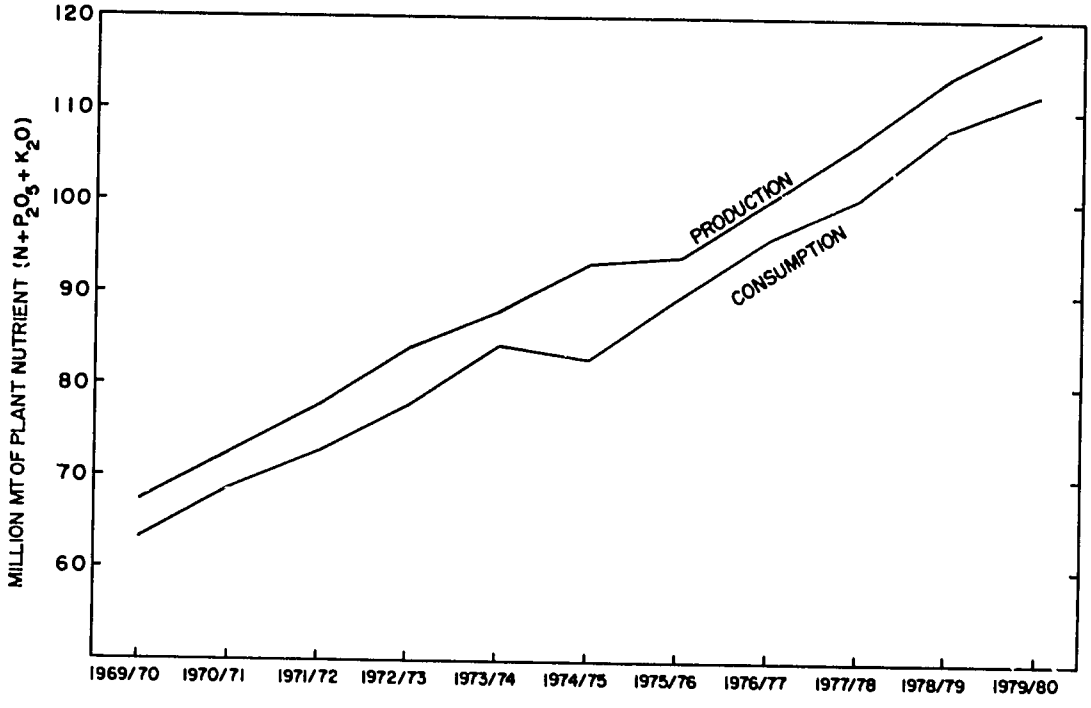
LNG . . . . . liquefied natural gas

THE 1970s IN PERSPECTIVE

Summary of Events

The world fertilizer sector entered the 1980s with much more maturity after experiencing the many wide price swings of the 1970s. The past decade started with surpluses of fertilizers resulting from overcapacity created by large capital investments in the late 1960s (Figure 1). Consumption did not grow as fast as expected in either the developed or the developing countries, and by late 1970, fertilizer prices in the international market were less than half their 1964 level. These depressed prices resulted in poor profits for the producers, and the industry experienced low capacity utilization, the closing of older plants, and the delaying of plans to build new facilities. Subsequently, fertilizer demand exceeded supply. A world food shortage occurred in 1972-74, primarily because of droughts in parts of Europe, Africa, and Asia and a drought and early frost in the United States in 1974. At the same time, the United States had adopted a policy of reducing its food reserves. Food grain prices rose rapidly; thus, the demand for fertilizers was strengthened. The fear of fertilizer shortages soon resulted in record inventories in the marketing chain. At the same time, large increases in petroleum prices occurred. Prices of raw materials and finished fertilizers doubled and redoubled in a few months to reach all-time record highs in late 1974 (Figure 2). But prices of farm products fell as supplies increased. As a result, in 1974/75 world fertilizer consumption declined for the first time in recent history. This negative reaction was experienced mainly in the developed countries while the developing countries increased their consumption. Farmers' cutbacks hit the phosphate industry first and the nitrogen industry shortly after. Potash use declined, although its prices did not change as dramatically as those of the other two major nutrients. In late 1974 the first indication of a softening in export prices began to appear. By mid-1975 prices began a decline which almost mirrored their increase. Finally, in mid-1976 fertilizer prices bottomed out at levels comparable to those in the second half of 1973. With the fall of fertilizer prices, consumption began to recover in 1975/76, and most countries began to reduce their stocks of high-priced fertilizers.

In the latter half of the decade, fertilizer consumption returned to more normal growth rates, and as new plants were coming on stream in 1976 and 1977, fertilizer prices remained fairly stable. In the late 1970s many fertilizer producers suddenly faced a doubling of energy costs and a new cycle of price escalation that resulted from increased production costs rather than tight supplies. International prices of most fertilizers rose steadily during the first half of 1979/80 and reached the highest levels of the previous 5 years. Again the market had to adjust

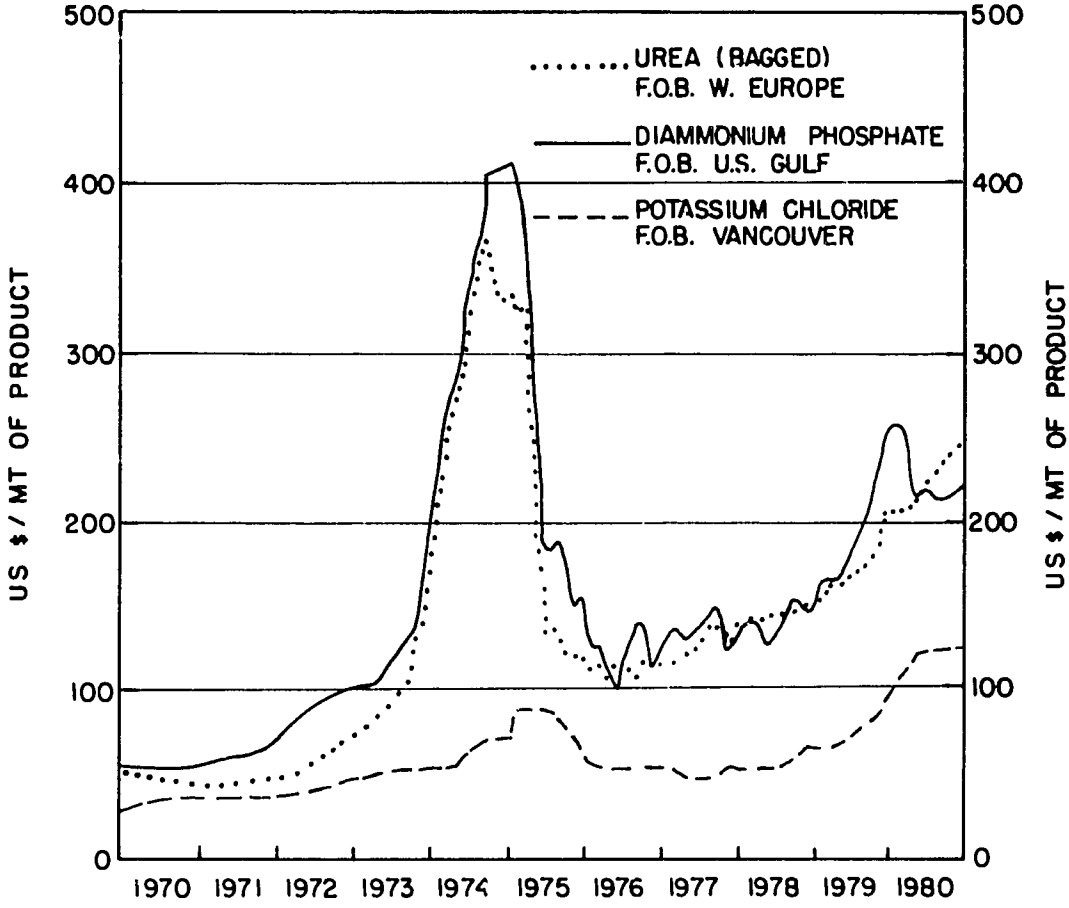


Source: FAO. Various years of the *FAO Fertilizer Yearbook*, Rome, Italy.

Figure 1. World Fertilizer Production and Consumption in the 1970s.

quickly, and as a result, fertilizer consumption in 1979/80 recorded the lowest growth rate since 1974/75. Beginning in early 1980, most fertilizer prices leveled off.

The world fertilizer sector has changed substantially since 1974. After a number of years with fertilizer supplies readily available at relatively low prices, most countries depending on imports found themselves unprepared for the very rapid change in the market. The food shortage and increased prices of food grains, petroleum, and phosphate rock transformed the typical moderate cycle of the fertilizer industry into a rapid change that was a shock for most countries. Acknowledging the increased importance of fertilizers for food production and the availability of high-yielding varieties, most governments moved fertilizer supply schemes to higher priorities in their long-term planning. Having little market intelligence, countries in the past found themselves bidding against one another for available supplies. Because of the acute need for market forecasts for the new projects, market



Source: World Bank data.

Figure 2. Export Price Trends for Some Major Fertilizer Materials (Current Prices).

information, analysis, and projections became readily available during the second half of the 1970s. Today, this kind of information is available to assist planners at all levels in making better decisions which help minimize the cyclical imbalances of fertilizer supply and demand.

1969/70-1979/80 Highlights

On the average, world fertilizer production and consumption during the decade showed an impressive balanced growth at an average rate of almost 6%. While growth of production was

relatively uniform during the 1970s, consumption experienced cycles of fast and slow growth and even 1 year of absolute decline. By the end of the decade, fertilizer production and consumption showed an increase of about 75% over the 1969/70 levels. World fertilizer trade showed an average annual growth rate of 6.6%. By the end of 1979/80, world trade of plant nutrients (N, P_2O_5, and K_2O) increased about 90%; this accounted for nearly 30% of the world fertilizer supply.

Over the past decade, fertilizer production increased from 67.6 to 118.9 million mt of plant nutrients. The developed countries, with an average annual growth rate of 4.5%, accounted for two-thirds of this additional production. As a group they accounted for 80% of world fertilizer production. The developing countries showed a relatively high average annual growth rate of 14.0%; their share of world production increased from 10% to 20%. Compared to the developed economies where the production expansion was more balanced among the nutrients, nitrogen accounted for 75% of the developing countries' additional production. The production gains originating in developing countries have not significantly eased the imbalanced supply/demand situation in the consuming countries, because many expansions took place in countries with relatively low domestic fertilizer use and were intended primarily for export markets. Overall, the gain in world fertilizer production was led by N with an average annual growth rate of 6.8%, followed by P_2O_5 at 5.2%, and K_2O at 4.4% (Table 1).

World fertilizer consumption during the decade increased from 63.7 to 111.7 million mt of plant nutrients (Table 2). The overall $N:P_2O_5:K_2O$ consumption ratio in 1979/80 was 1.00:0.67:0.52 in 1969/70, but by 1979/80 the ratio had declined to 1.00:0.54:0.41. This means that nitrogen use accounts for more than half of total fertilizer consumption. This ratio is highly influenced by the consumption pattern in many of the Asian countries that primarily use nitrogen (notably in the People's Republic of China where the ratio is 1.00:0.19:0.04) and by the relatively slower growth rate of phosphates and potash use in North America and Western Europe. The average consumption ratio in the developed countries is much more balanced than it is in the developing countries (Table 3).

During the 1970s the developed countries, with an average annual growth rate of only 4.1%, accounted for more than half of the increase in world fertilizer consumption. These countries represented about 70% of world fertilizer consumption in 1980. The developing countries showed an impressive average growth rate of 11%/year; their share of world consumption increased from less than 20% at the beginning of the 1970s to slightly over 30% in 1980. Population pressure on land, growing food deficits, and depleted soil fertility contributed to this impressive development.

Table 1. World Fertilizer Production, 1969/70-1979/80

	Production 1969/70	Production 1979/80	Annual Growth Rate 1969/70-1979/80
	(million mt nutrients)		- - - - (%)- - - -
Developed Countries	61.10	94.73	4.5
N	26.36	41.96	4.7
P_2O_5	18.17	27.13	4.1
K_2O	16.57	25.64	4.5
Developing Countries	6.50	24.16	14.0
N	4.49	17.80	14.8
P_2O_5	1.91	6.32	12.6
K_2O	0.10	0.04	-
World Total	67.60	118.89	5.8
N	30.85	59.76	6.8
P_2O_5	20.08	33.45	5.2
K_2O	16.67	25.68	4.4

Source: FAO. Various years of the FAO Fertilizer Yearbook, Rome, Italy.

In many countries, a major constraint on fertilizer use has been the lack of supply. Establishing domestic production has led to increased fertilizer availability at the right place and the right time.

Even with relatively high growth rates, consumption of fertilizer in developing countries is still low in terms of use per hectare of arable land (Table 4). In 1979/80 the developing countries used an average of 44 kg of nutrients per hectare of arable land compared with 118 kg in the developed countries. The most intensive use of fertilizers was found in Western Europe while Africa had by far the lowest fertilizer input per hectare of arable land.

In geographical terms (Figure 3) the Asian region showed the highest rate of growth in fertilizer production and consumption. Even with the relative decline of Japan, the Asian

Table 2. World Fertilizer Consumption, 1969/70-1979/80

	Consumption 1969/70	Consumption 1979/80	Annual Growth Rate 1969/70-1979/80
	(million mt nutrients)		- - - - (%)- - - -
Developed Countries	51.90	77.51	4.1
N	21.15	34.65	5.1
P_2O_5	16.80	22.89	3.2
K_2O	13.95	19.97	3.6
Developing Countries	12.08	34.22	11.0
N	7.88	22.55	11.1
P_2O_5	2.68	8.19	11.7
K_2O	1.22	3.48	11.0
World Total	63.65	111.73	5.8
N	29.03	57.20	7.0
P_2O_5[a]	19.44	31.08	4.8
K_2O	15.18	23.45	4.4

a. Includes ground phosphate rock for direct application.

Source: FAO. Various years of the FAO Fertilizer Yearbook, Rome, Italy.

Table 3. Average $N:P_2O_5:K_2O$ Consumption Ratios (when N = 1.00)

	1969/70	1979/80
Developed Countries	0.79:0.66	0.66:0.58
North America	0.64:0.55	0.50:0.54
Western Europe	0.87:0.73	0.62:0.57
Eastern Europe	0.72:0.70	0.71:0.59
Oceania	6.40:1.04	4.84:0.88
Other developed	0.92:0.72	1.04:0.73
Developing Countries	0.34:0.16	0.36:0.16
Latin America	0.70:0.47	0.93:0.60
Asia	0.26:0.09	0.27:0.09
Africa	0.44:0.21	0.49:0.22
WORLD TOTAL	0.67:0.52	0.54:0.41

Source: FAO. Various years of the FAO Fertilizer Yearbook, Rome, Italy.

Table 4. Consumption of Fertilizers Per Hectare of Arable Land, 1979/80 (kg/ha)

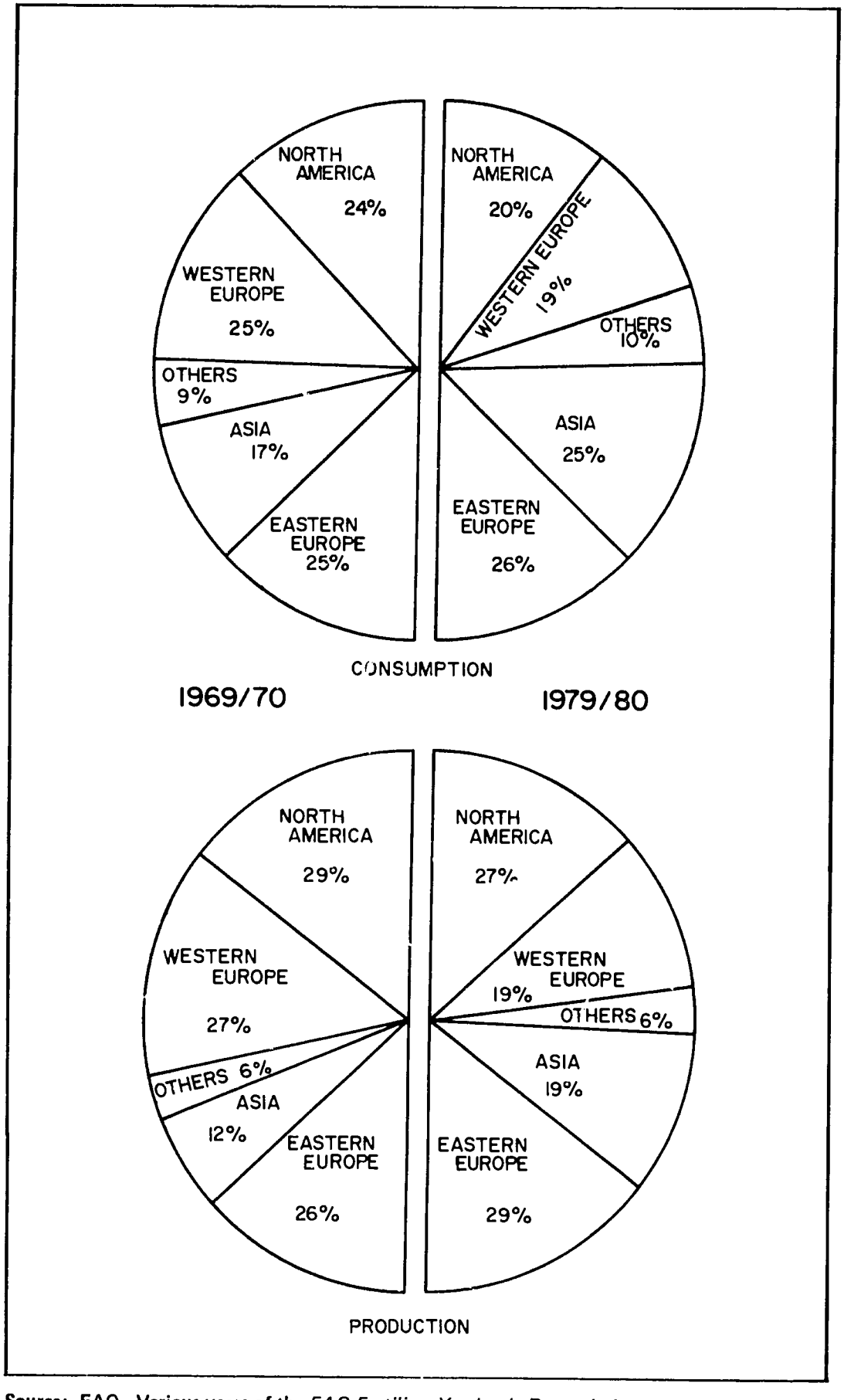
	N	P_2O_5	K_2O	Total[a]
Developed countries	53	35	30	118
Developing countries	29	11	5	44

a. Totals may not add due to rounding.

Source: FAO. Various years of the FAO Fertilizer Yearbook, Rome, Italy.

countries tripled their production and increased their fertilizer consumption by more than 150% during the 1970s. Most of this increase occurred in the nitrogen sector. The Eastern Europe block made substantial gains and became the largest producer and consumer of fertilizers, accounting for 29% of world production and 26% of world consumption at the end of the decade. Western Europe, which was the largest consumer at the beginning of the decade, recorded a relatively low increase and ranked after Eastern Europe, Asia, and North America in terms of production and consumption. The largest supplier in terms of total export availability was North America. Eastern and Western Europe also managed to have surplus production for export while all other regions recorded deficits. Asia imported the largest amount of fertilizer, and both Latin America and Africa have also increased their dependence on imported fertilizers.

World fertilizer trade almost doubled during the past decade to reach 34 million mt of plant nutrients or 30% of world consumption (Table 5). Because of the limited number of producers, potash was the leading plant nutrient in world trade; it accounted for 45% of total trade in 1980. Nitrogen accounted for 35% of total world fertilizer trade primarily in the form of urea. Phosphate fertilizer trade was only 20% of the total but showed the highest rate of growth even with more concentrated products being exported. In spite of the additional capacity and increased production of N and P_2O_5, the developing countries doubled their imports during the 1970s. Indeed, the share of supply that is imported dropped from 55% to 38%, which means relatively less dependence on fertilizer imports, but still the volume of imports



Source: FAO. Various years of the *FAO Fertilizer Yearbook*, Rome, Italy.

Figure 3. Regional Share in Fertilizer Production and Consumption.

in terms of tonnage and prices multiplied their infrastructural and financial problems. The developed countries as a group account for 93% of fertilizer imports as compared with 96% at the beginning of the decade. There was a significant decline in the role of Western Europe and Japan in world trade as the strength of areas with fertilizer raw materials (Eastern Europe and North America) became more important.

Table 5. World Fertilizer Trade, 1969/70-1979/80

	Nitrogen (N)		Phosphate (P_2O_5)		Potash (K_2O)		Total (N, P_2O_5, K_2O)	
	1969/70	1979/80	1969/70	1979/80	1969/70	1979/80	1969/70	1979/80
	(million mt nutrients)							
Imports								
Developed Countries	2.2	5.6	1.5	3.0	7.7	12.0	11.4	20.6
Developing Countries	4.2	6.8	1.1	2.6	1.2	3.4	6.5	13.0
WORLD TOTAL	6.4	12.4	2.6	5.7	8.9	15.4	17.9	33.6
Exports								
Developed Countries	6.1	10.5	2.4	5.9	9.0	15.6	17.5	32.1
Developing Countries	0.4	1.6	0.3	0.8	-	-	0.7	2.4
WORLD TOTAL	6.5	12.1	2.7	6.7	9.0	15.6	18.2	34.5

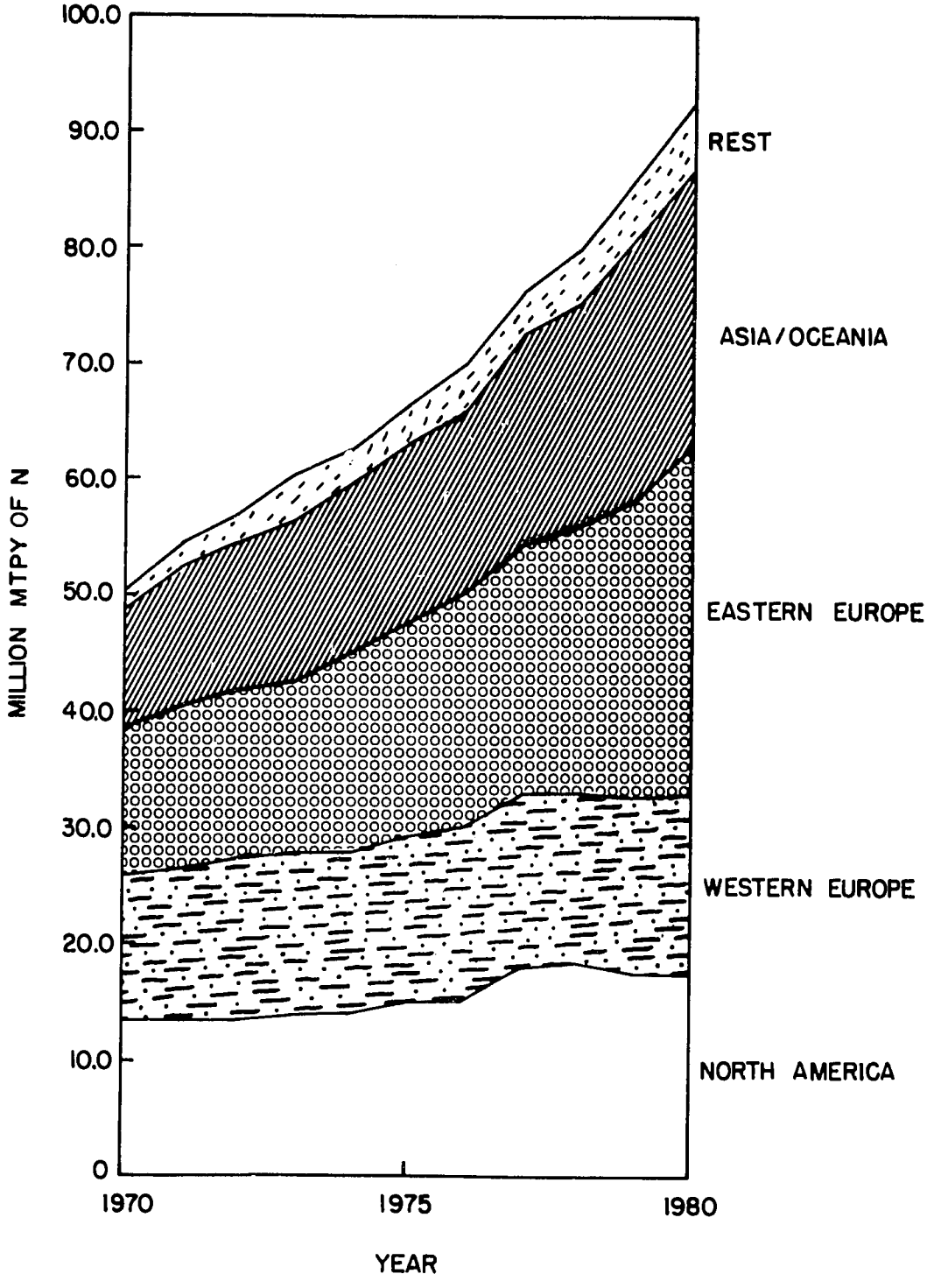
Note: Totals may not add due to rounding.

Source: FAO. Various years of the FAO Fertilizer Yearbook, Rome, Italy.

Nitrogen

Nitrogen is the most widely used fertilizer nutrient and accounts for more than half of the world's fertilizer production and consumption. Produced primarily as ammonia, it can be applied as such or further processed into a variety of solid or liquid nitrogen fertilizers. About 15% of ammonia production is assumed to be used outside the fertilizer sector for explosives, plastics, synthetic fibers, etc. At the end of the past decade, approximately 92 million mt of N capacity was in place in more than 70 countries. Ammonia accounted for 99% of this capacity, which grew from 51 million mtpy in 1970 to 92 million mtpy in 1980 (Figure 4). In 1980 four countries (U.S.S.R., the United States, the People's Republic of China, and India) accounted for more than half of the world's ammonia capacity.

Ammonia is produced from a variety of feedstock sources, mainly natural gas, naphtha, fuel oil, and coal. Natural gas now has technical advantages with respect to energy consumption and



Source: Tennessee Valley Authority. 1981. Unpublished capacity data, Muscle Shoals, Alabama.

Figure 4. World Ammonia Capacity, 1970-80.

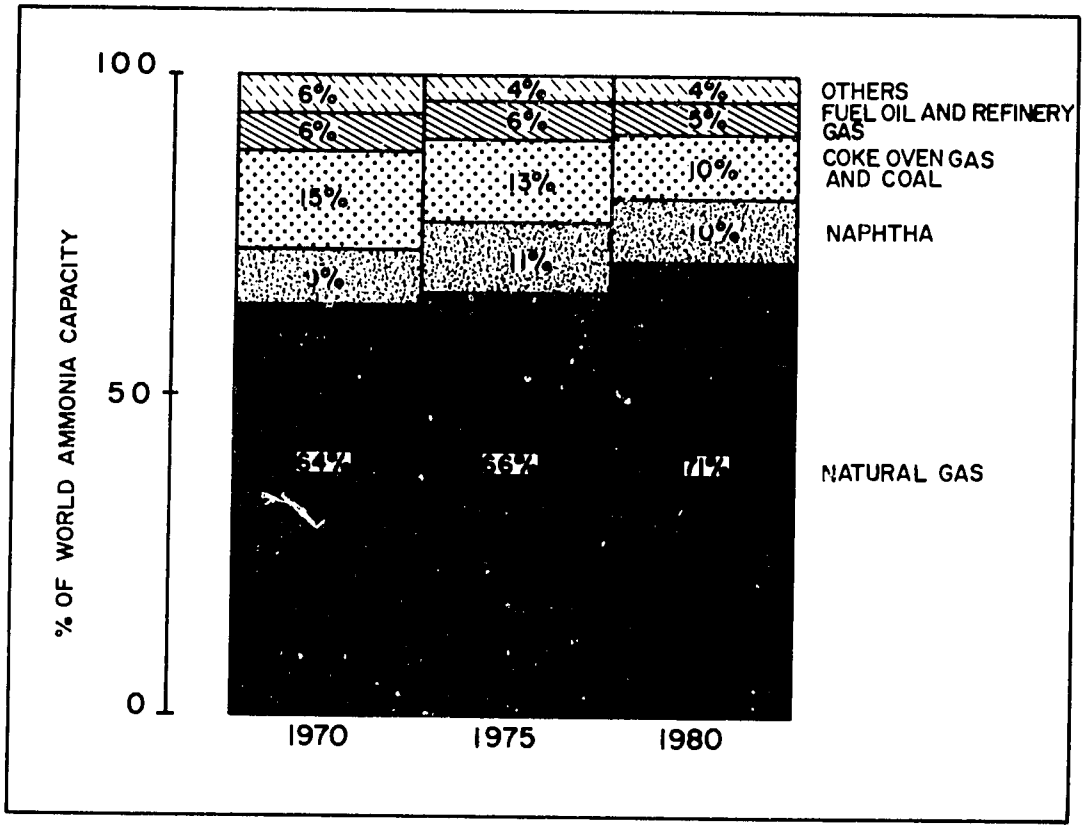
required capital investment to make it the favorable choice (Table 6). This was not the case before 1973 because natural gas sources far from consumption regions were not considered for ammonia production. Since natural gas is not easily transported, many fertilizer companies preferred to produce nitrogen near the consuming areas using naphtha or fuel oil. The energy crisis in 1973 introduced a significant price differentiation between feedstock materials. While naphtha and fuel oil prices skyrocketed during the 1970s, natural gas prices increased at a much slower rate. As a result, natural gas became the chosen feedstock for almost all the new plants built in the 1970s. Today more than 70% of world ammonia production is based on natural gas (Figure 5). The remainder of production is divided between naphtha, coke-oven gas, and other sources.

Table 6. Relative Energy Consumption and Investment Cost for 1,000-mtpd Ammonia Plant by Feedstock (natural gas = 1.00)

Feedstock	Process	Relative Energy Consumption	Relative Investment
Natural gas	Steam reforming	1.00	1.00
Naphtha	Steam reforming	1.09	1.14
Fuel oil	Partial oxidation	1.13	1.60
Coal	Partial oxidation	1.45	2.00

Source: International Fertilizer Development Center. 1979. Fertilizer Manual, pp. 65, 336, IFDC-R-1 (also available from the United Nations Industrial Development Organization, Vienna, Austria), Muscle Shoals, Alabama.

Nitrogen fertilizer production and consumption doubled from 1969/70 to reach 59.8 and 57.2 million mt N, respectively, in 1979/80, an average annual growth rate of about 7%. The developing countries as a group realized an impressive 14.8%/year growth in nitrogen production during the past 10 years. This increase was almost equal to the additional nitrogen production of the developed countries. Led by China's contribution of 8.8 million mt N and new facilities in the Middle East, India, South Korea, and Indonesia, the developing countries increased their share of world nitrogen production from 15% in 1969/70 to 30% in 1979/80. The developed countries were responsible for 13.3 million mt of

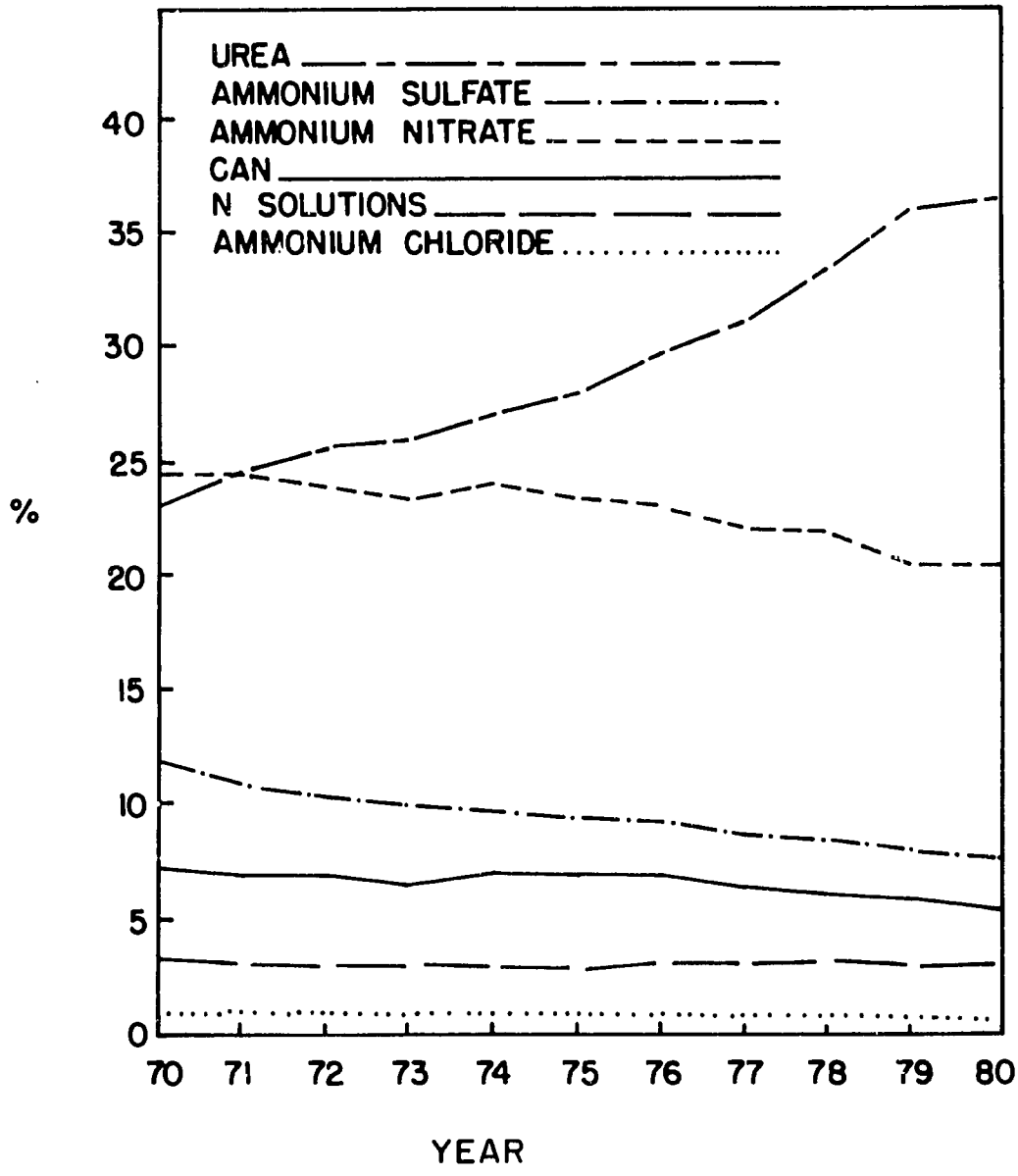


Source: Tennessee Valley Authority. 1981. Unpublished capacity data, Muscle Shoals, Alabama.

Figure 5. Feedstock Share in World Ammonia Capacity.

additional N production. At the end of the decade, Asia emerged as the largest nitrogen producer. Asia accounted for almost 30% of world production; Eastern Europe ranked next and accounted for 26% of the total. North America and Western Europe, which dominated the world nitrogen production at the beginning of the decade with 52% of the total, accounted for only 40% of world supply in 1979/80.

The increased role of Asia and Eastern Europe in world nitrogen production had its impact on the product mix in the nitrogen sector. Urea emerged during the 1970s as the leading solid nitrogen fertilizer and replaced the traditional ammonium nitrate. While ammonium nitrate, ammonium sulfate, and calcium ammonium nitrate (CAN) declined in their share of world nitrogen capacity, urea's share increased from 24% in 1970 to 37% in 1980 (Figure 6).



Source: Chuang, Yao H. "World Fertilizer Situation and Outlook With an Emphasis on Nitrogen Market," Unpublished paper, IFDC, Muscle Shoals, Alabama.

Figure 6. Percentage Share of World Nitrogen Fertilizer Production Capacity by Major Product, 1970-80.

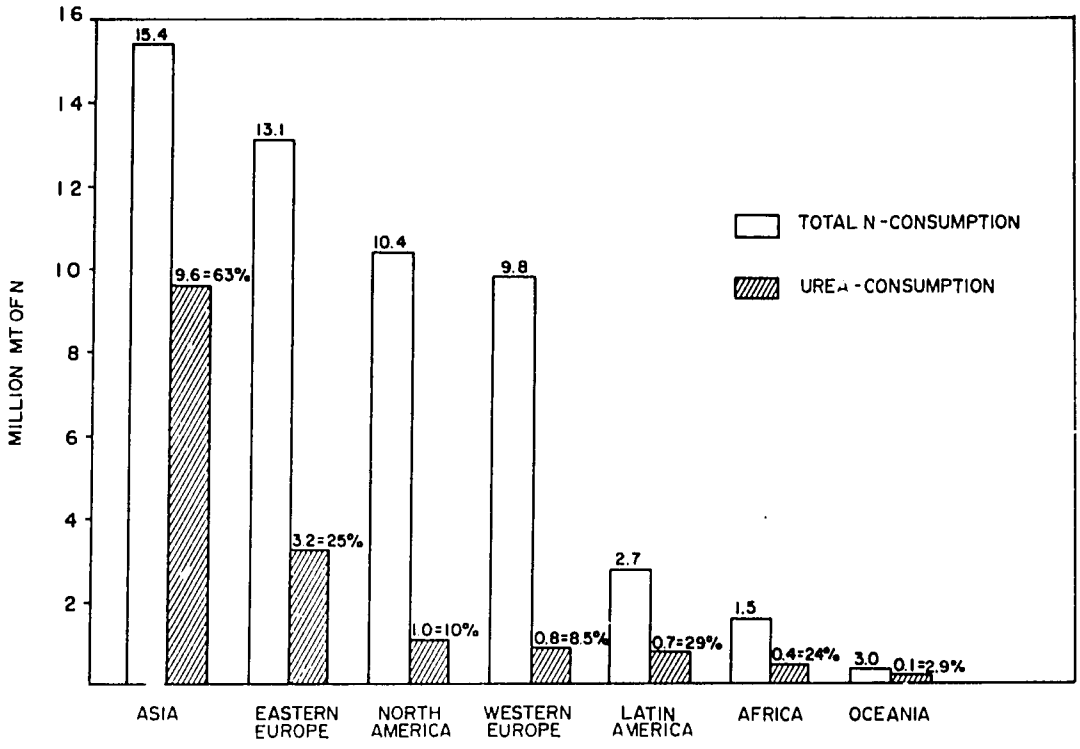
Capacity growth figures are much more impressive than nitrogen production statistics. The world has a theoretical capacity significantly higher than demand figures. During the 1970s ammonia capacity increased much more than the actual

production and, thus, could have led to a significant oversupply situation. However, some of this capacity was idle as a result of an uneconomical situation with feedstock prices. Some capacity may never be operated again or may operate at lower levels than desired. On the other hand, most of the recent additions in capacity were built in centrally planned economies and developing countries where production rates were brought up to rated capacity at a slower pace than anticipated. Most of the problems were related to the infrastructure and in particular to the supply of electricity and raw materials. Availability of trained operators was another major constraint to higher operation rates in those countries.

With an average annual growth rate of 11.1%, the developing countries almost tripled their nitrogen consumption and accounted for 39% of world consumption in 1979/80 as compared with 27% in 1969/70. About 90% of the additional production took place in the consuming regions, and only 10% of new facilities were export oriented. As a result, their dependence on imported nitrogen dropped from 54% of consumption in 1969/70 to 30% in 1979/80. In world trade the leading nitrogen fertilizer was urea; it offered the lowest cost per unit of nutrient. The developed countries showed an average growth rate of 5.1% and added 13.5 million mt N to world consumption. Although urea consumption in the developed countries of North America, Western Europe, and Eastern Europe is less popular and represents only 15% of their nitrogen consumption (Figure 7), they managed to have large surpluses of urea available for export. Their surpluses of about 7 million mt N in 1979/80 were more than sufficient to ensure adequate supplies to developing countries although accompanied with price adjustments. Eastern Europe became the leading exporter replacing the West European countries. Asia continued to be the leading importer with the People's Republic of China and the Indian subcontinent accounting for more than half of world nitrogen imports. Latin America was the second largest nitrogen-importing region and imported about half of its nitrogen consumption.

Phosphate

Globally, phosphates are the second most used fertilizer nutrient. However, in some countries (most notably Brazil, New Zealand, and Australia), phosphate is the dominant fertilizer nutrient. Phosphate rock is the major source for phosphate fertilizers. The fertilizer industry is the major consumer of phosphate rock since about 97% of all phosphate fertilizers are derived from phosphate rock. About 86% of all phosphate rock production is used in the phosphate fertilizer industry. There are some 30 countries involved in phosphate rock production; 20 of these have production in excess of 500,000 mtpy of product. The United

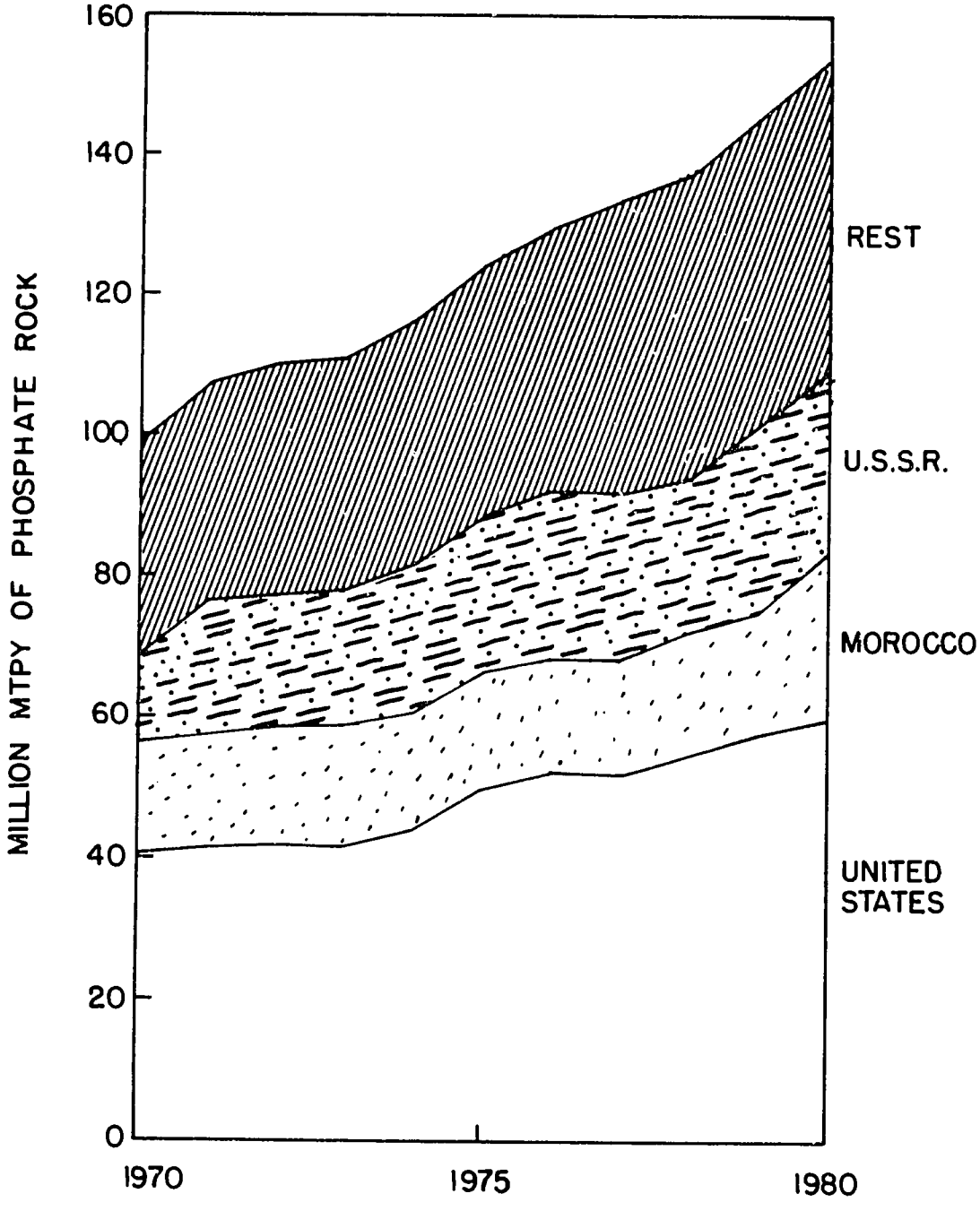


Source: ISMA, Paris, France.

Figure 7. Regional Variations in Nitrogen Fertilizer Consumption, 1979.

States, the U.S.S.R., and Morocco retained their dominance despite sizable increases in phosphate rock production capacity in other countries during the 1970s (Figure 8). In 1980 these three countries accounted for more than 70% of world phosphate rock capacity--about the same share that they held at the beginning of the past decade.

Phosphate fertilizers must undergo significant chemical processing in order to be transformed from the insoluble form in which they are found in nature to the water-soluble form suitable for use as a fertilizer. The traditional structure of the world phosphate industry (with the exception of the United States and the U.S.S.R.) has been to concentrate the phosphate content of the native ore at the mine and then to ship the concentrated phosphate rock to major consuming countries, where the processing steps are undertaken. Therefore, about half of the phosphate rock produced has traditionally been sold in the export market.



Source: Tennessee Valley Authority. 1981. Unpublished capacity data, Muscle Shoals, Alabama.

Figure 8. World Capacity for Phosphate Rock Production.

Phosphate rock registered the highest volumes in tonnage movement of any material in this sector. The share of total production that was exported was very stable until 1974. After the crisis in the phosphate industry, this share dropped to about 40% in 1975, where it has remained since. The main reasons for this development were to maximize the economic benefits to the owners of the raw materials and to establish conversion facilities near the phosphate rock mines. It is more economical to ship the concentrated finished products than to ship finished products (TSP and DAP) or intermediates (phosphoric acid). This concept of vertical integration with conversion plants at the site of phosphate rock mines gained force in the late 1970s with new facilities in north and west Africa, the Near East, and currently in other areas as well. From 37 million mt rock in the beginning of the decade, phosphate rock exports grew to 52 million mt in 1980; Morocco and the United States accounted for 60% of the total. Western and Eastern Europe accounted for about 65% of world imports (Table 7).

This development was stimulated by the unprecedented growth in world demand for high-analysis phosphate fertilizers. This demand was supplied by a massive expansion in the capacity for producing wet-process phosphoric acid and its derivatives. This trend resulted in a steady decline in the relative share of simple low concentrate products like single superphosphate (SSP) and basic slag with a corresponding growth for phosphoric acid-based concentrated products. The rapid increase in the cost of energy and its impact on the cost of production, raw materials, and transportation increased the phosphoric acid-based fertilizer's share of total P_2O_5 fertilizer production to about 60% in 1980 as compared with about 40% in 1970 (Table 8). In 1980 the total capacity of wet-process phosphoric acid plants was 27.6 million mt P_2O_5 as compared with 14.3 million mt P_2O_5 in 1970. At the end of the 1970s, North America represented 38% of the phosphoric acid capacity while Western Europe and Eastern Europe recorded 17% and 22%, respectively (Figure 9).

World production of phosphate fertilizers rose from 20.1 million mt as P_2O_5 in 1969/70 to 33.5 million mt in 1979/80, an average annual growth of 5.2%. Most developing countries sought to diminish their dependence on imported finished P_2O_5 fertilizer products, and the trend was reflected by the continuing buildup of local fertilizer production facilities. Countries where domestic consumption was increasing, such as India, Brazil, and Turkey, led the way in diverting significant volumes of phosphate rock shipments from destinations in the industrial countries to new facilities in the developing regions. Coupled with new production emerging in recent years in those countries where rock deposits exist, the developing countries, as a group, more than tripled their phosphate production, from 1.9 million mt as P_2O_5 in 1969/70 to 6.3 million mt in 1979/80. With an average annual growth rate

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Table 7. World Phosphate Rock Trade--1980

Major Exporters		Major Importers	
Countries	Exports in Million mt	Region/Country	Imports in Million mt
Morocco	16.5	Western Europe	21.8
		France	5.3
United States	14.5	Germany F.R.	2.6
		Spain	2.5
U.S.S.R.	4.5	Netherlands	2.3
		Belgium	2.3
Jordan	3.6	United Kingdom	1.7
		Italy	1.6
Togo	2.9	Others	3.5
Nauru Islands	2.1	Eastern Europe	11.0
		Poland	3.2
Israel	1.9	Romania	2.7
		Yugoslavia	1.4
Christmas Islands	1.6	Germany D.R.	1.3
		Others	2.4
Tunisia	1.4	North America	4.0
		Canada	3.8
Senegal	1.4	Others	0.2
Others	2.0	Latin America	2.0
		Mexico	1.0
		Others	1.0
TOTAL	52.3	Asia	9.4
		Japan	2.6
		Korea, Republic of	1.8
		India	1.4
		Turkey	1.0
		Others	2.6
		Oceania	3.8
		Australia	2.7
		New Zealand	1.1
		Africa	0.3
		TOTAL	52.3

Source: ISMA. 1981. Phosphate Rock Statistics, 1980, Paris, France.

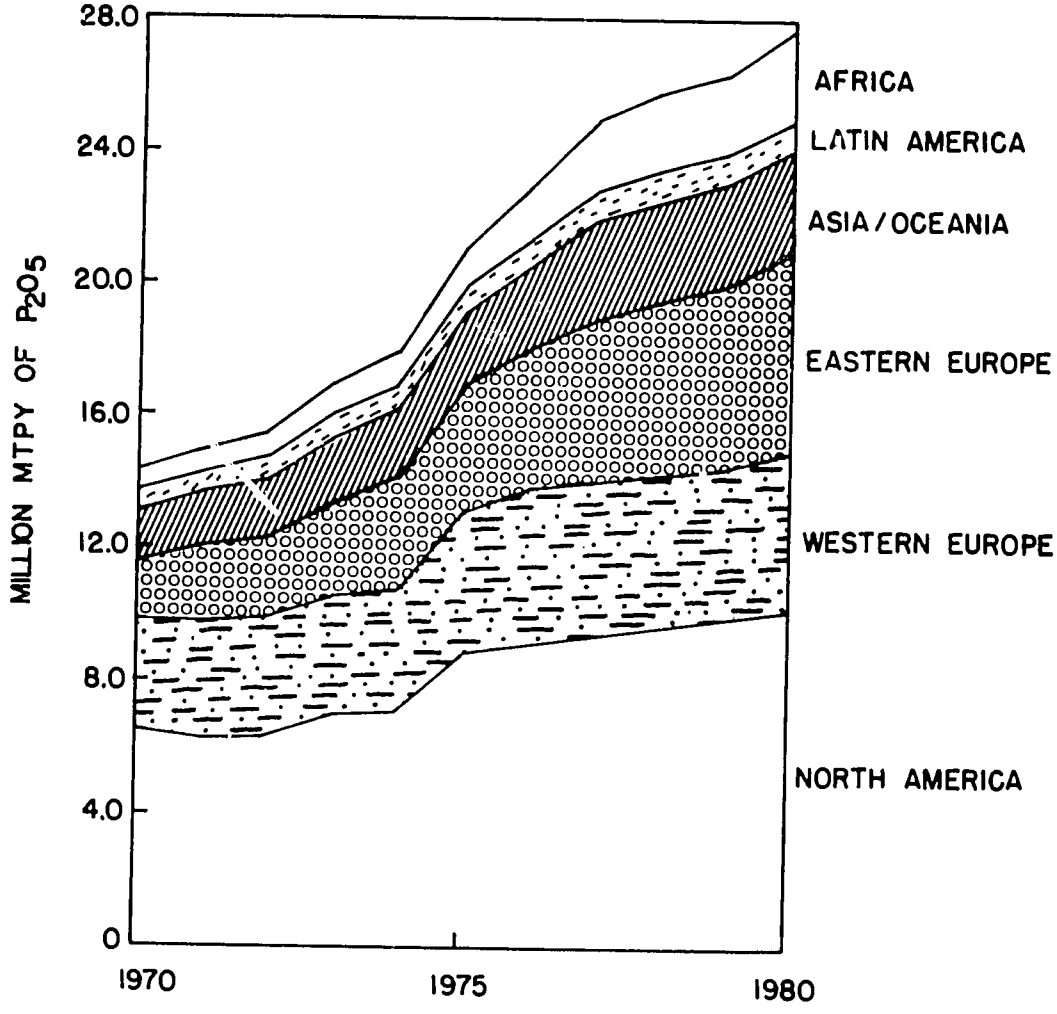
Table 8. Estimated Structural Change in World Fertilizer P_2O_5 Supply (as % of total)

	1960	1969	1980
SSP	55	35	20
Phosphoric acid[a]	20	40	60
Other fertilizers[b]	25	25	20

a. Phosphoric acid derivatives such as DAP, TSP, MAP, etc.
b. Including nitrophosphates, secondary rock for TSP, basic slag, fused phosphates, and ground rock for direct application.

of 12.6%, the developing countries increased their share of world phosphate fertilizer production from 10% to 19% in 10 years. The developed countries increased their production by 9 million mt of P_2O_5, an annual growth of 4.1%. Most of this expansion took place in the first half of the 1970s, when oversupply gave way to acute shortages. The developed countries, with established infrastructure and export markets, were in a position for quick reaction. After the mid-1970s, however, Western Europe and Japan, which are wholly dependent on imported rock, had to switch their industries substantially to meet intraregional demand only. The United States, the U.S.S.R., some other countries in Eastern Europe, and Africa continued the dynamic expansion started in the late 1960s.

On a regional basis, the North American industry, with ample resources of raw materials, a large diversified and well-developed domestic market, and a world market dependent on its exports, had established its leadership with 29% of world production in 1979/80. Western Europe slipped from first to third place during the 1970s; it dropped from 29% to 17% as a result of its poor performance in the second half of the 1970s. With almost no net growth as compared with 1969/70, Western Europe became a net importer in the late 1970s. In Eastern Europe, in line with the strategy of reforming and expanding the agricultural economy, a massive drive to modernize the phosphate industry resulted in this region's becoming the second largest producer of P_2O_5. With an average annual growth rate of 7.8%, Eastern Europe increased its share in world production from 21% to 27%. Asia, with growing



Source: Tennessee Valley Authority. 1981. Unpublished capacity data, Muscle Shoals, Alabama.

Figure 9. World Wet-Process Phosphoric Acid Capacity.

markets in India and Turkey but a depressed export performance in Japan, maintained its position as the largest net importer of P_2O_5. Latin America was the other large phosphate importer with increased Brazilian imports.

Although showing impressive developments, world trade of phosphate fertilizer was much less than that of potash or nitrogen. World P_2O_5 imports more than doubled from 2.6 million mt of P_2O_5 in 1969/70 to 5.6 million mt in 1979/80. The trade in finished

phosphate fertilizer still represented only 24% of all international phosphate trade in 1979/80. Phosphate rock (66%) and phosphoric acid (10%) account for the remainder.

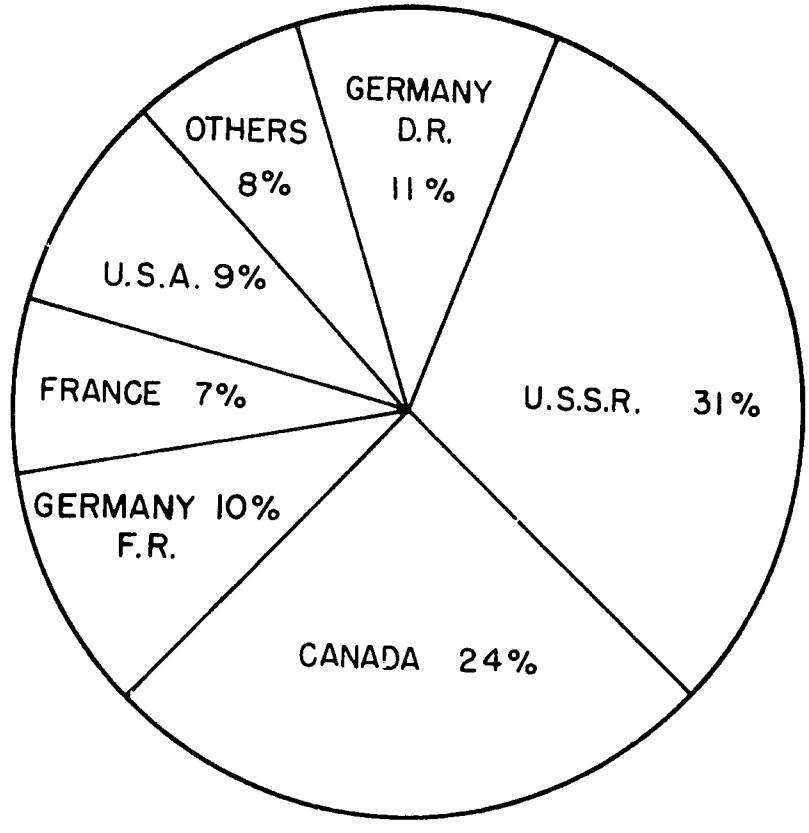
Potash

Potash, the third most widely used fertilizer nutrient, is generally obtained by underground mining of potassium salt from sedimentary rock or recovering of those salts from brines and seawater. About 96% of the world's potash production is used in the fertilizer sector, and the remaining 4% is used in various industrial applications. Potassium chloride dominates the potash sector as a straight fertilizer or as an ingredient in complex fertilizers, while potassium sulfate, potassium nitrate, and other minor potassium salts account for only about 8% of the market. Currently 12 countries have commercial production capacity which in 1980 totaled about 31 million mt of K_2O.

The developed countries dominate the potash supply and six countries (the U.S.S.R., Canada, Germany D.R., Germany F.R., the United States, and France) account for more than 90% of world potash capacity (Figure 10). There is no significant production in the developing countries. Although in the early 1960s potash production facilities were concentrated in Europe and the United States, more recently, capacity of traditional suppliers in those areas has stagnated. New facilities, notably in the U.S.S.R. and Canada, have accounted for most of the incremental output. World potash production increased from 16.7 million mt of K_2O in 1969/70 to 26.2 million mt in 1978/79 and then decreased to 25.7 million mt in 1979/80 as a result of production problems in the U.S.S.R. The average annual growth rate for most of the decade was over 5.0%. However, including 1979/80, the growth rate for the decade was 4.4%/year.

World potash consumption was very similar to the production performance. It increased from 15.2 million mt of K_2O in 1969/70 to 24.4 million mt in 1978/79 and then declined to 23.5 million mt in 1979/80 as the U.S.S.R. consumption dropped by 1.4 million mt. For the first 9 years, world potash consumption increased by an average annual growth rate of 5.4%. However, including 1979/80 data, it averaged 4.4%/year.

Potash fertilizers, like phosphate, are used mainly in the industrialized countries of Europe, North America, Oceania, and Japan, which together account for 85% of world consumption. The developing countries had a much higher growth rate for potash consumption than the developed countries (11.0% versus 3.6%); thus, the developing countries accounted for only 15% of the total used. There are several reasons why potash consumption in developing countries has been small in the past: (1) potash has



Source: Tennessee Valley Authority. 1981. Unpublished capacity data, Muscle Shoals, Alabama.

Figure 10. World Potash Capacity, 1980.

to be imported from the developed countries, (2) potash is mainly used as an ingredient in compound fertilizers that are not used to any significant extent in many developing countries, and (3) the benefits of using potash are not as quickly evident as those of using nitrogen. Therefore, the poor farmer with limited income is inclined to concentrate his fertilizer use on nitrogen and, to a lesser extent, phosphate and potash.

Since potash is produced in only a few locations, its trade in the international markets dominates the fertilizer market. Accounting for almost half of the fertilizer trade (on a plant nutrient basis) potash trade increased from 8.8 million mt to 15.4 million mt of K_2O in the past decade. With a relatively high nutrient content of 60%-62% K_2O, potassium chloride is an ideal material for trade, while other potassium products are limited to markets where crops or soils are affected by chlorine content. About 78% of the trade is in the developed countries. Potash trade is mainly on an intraregional basis. Potash producers are generally also cargo consumers. Demand in Eastern Europe and North America is overwhelmingly being met by their regional producers, and in Western Europe regional producers supply 80% of the needs. The rest of the world depends upon Canada (50%), Western Europe (25%), and Eastern Europe (25%) for the potash supply.

MAJOR TRENDS IN THE FERTILIZER SECTOR

The 1970s were characterized by many special events, some of which contributed to structural changes in the fertilizer industry. The intent of this section is to analyze some of these changes and evaluate their impact.

Inflation

Inflation and its effect on interest rates play a very important role in the cost of investment, cost of production, and farmers' behavior. The average annual rate of inflation in the 1970s was above 10% in most parts of the world, and higher rates occurred in the second half of the decade (Table 9). The fertilizer industry is capital intensive; furthermore, the technical sophistication of its plants tends to lengthen the construction period over 3-5 years. Therefore, high inflation rates and high interest rates significantly increase the cost of producing fertilizer. Fertilizer accounts for a major part of farmers' input costs and often must be purchased with credit; as a result, high interest rates limit application rates. In addition, inflation and interest rates have an impact on exchange rates for the major currencies. Since most fertilizer prices are quoted in U.S. dollars, exchange rates influence fertilizer prices quoted in domestic currencies.

In many countries, and especially in the developing countries, the cost of fertilizer and prices of agricultural produce are controlled by the governments. Frequent changes with respect to agricultural input/output value ratios tend to make it difficult for

Table 9. Average Annual Rate of Inflation, 1970-78[a]

Country Group	%
Low-income countries	10.6
Middle-income countries	13.1
Industrialized countries	9.4
Capital-surplus oil exporters	22.2
Centrally planned economies	NA

a. Median.

Source: The World Bank. 1980. World Development Report, Washington, D.C.

governments to develop policies that encourage proper fertilizer use. It is generally recognized that changes in input/output values have an immediate impact on fertilizer consumption. However, frequent changes also introduce a new element of risk for farmers.

Balance of Payment Deficits

The developing countries entered the 1980s with a general economic slowdown. Increasing balance of payment deficits face most of the developing countries, primarily because of the rising price of oil but also because of inflation in industrial nations, which has boosted the cost of their imports. Further, the recession which started in 1979 in many developed countries has cut the demand for purchases from developing countries and created political pressure for trade restrictions.

According to the World Bank statistics, current deficits of oil-importing countries amounted to US $61.0 billion in 1980 as compared with US $8.3 billion in 1970 (Table 10). The developing nations can deal with payment deficits by (a) slashing imports of oil and other products, which not only reduces economic growth but also makes it difficult to develop export products to generate foreign exchange, or (b) borrowing to finance continued imports while striving to restructure their economies by developing alternative energy sources and new export industries.

Table 10. Current Account Deficits of Oil-Importing Developing Countries, 1970-80[a] (US $ billion)

Country Group	1970	1973	1975	1978	1980
Low income	1.2	2.3	5.4	5.7	10.0
Middle income	7.1	4.4	34.2	21.4	51.0
	8.3	6.7	39.6	27.1	61.0

a. Excluding official transfers.

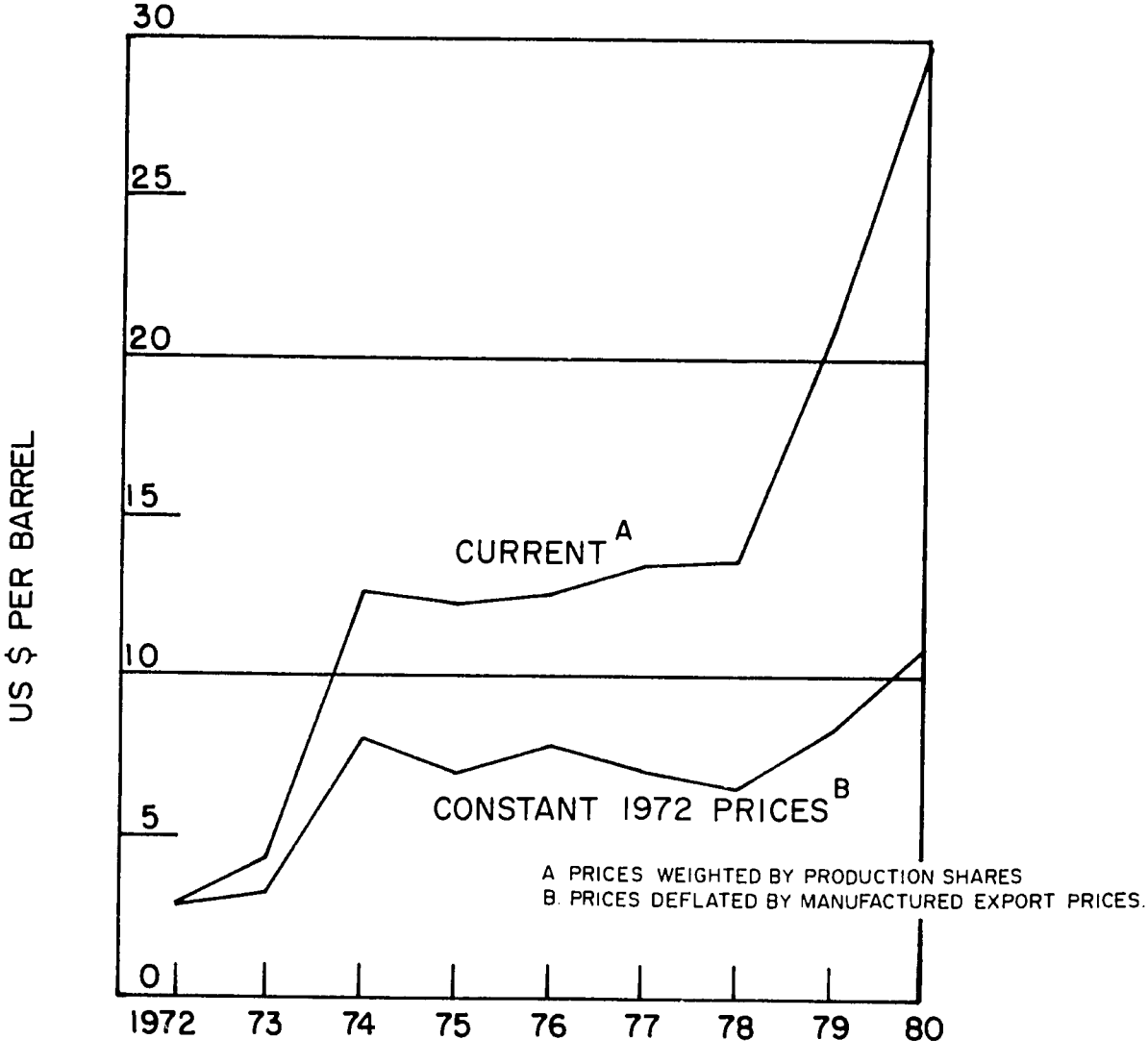
Source: The World Bank. 1980. World Development Report, Washington, D.C.

The fertilizer import bill of the developing countries for 1979/80 was estimated to be about US $6 billion or 10% of their current deficits (not including raw material imports for domestic fertilizer production). Therefore, in developing countries that possess indigenous resources, investments to develop domestic fertilizer production should get high priority to enable them to cut their import bill significantly. In any case, hard currency shortages affect fertilizer imports to some developing nations. Payment problems in major importing countries, such as Brazil, Turkey, and India, have been experienced; if these financing difficulties continue, it could have a tremendous impact on world fertilizer trade.

Energy Crisis

Crude oil prices have increased from about US $2/barrel in 1970 to about US $29 in 1980 (Figure 11). Such a development in a relatively short time has directly affected the energy costs in the fertilizer industry as well as other indirect costs. The major use of energy in the fertilizer industry sector is as a feedstock and fuel for nitrogen production. Aside from nitrogen manufacture, the energy use by the fertilizer industry is relatively small compared with that of other industries. The fertilizer industry accounts for only about 1.5% of world energy consumption. Of the total energy used in fertilizer manufacturing, 90% is consumed by the nitrogen industry, while the phosphate and potash industries account for 6% and 4%, respectively. When the energy used for packaging, distribution, and application is added, the proportion of the total use is 82%, 11%, and 7% for N, P_2O_5, and K_2O,

respectively (Table 11). As we see from those figures, nitrogen fertilizers, which account for more than half of total fertilizer production and consumption, are highly dependent on energy as feedstock and fuel. The fertilizer sector in developing countries, with its higher emphasis on nitrogen and dependence on imports, is more energy intensive than the fertilizer sector in developed countries.



Source: The World Bank. 1980. *World Development Report*, Washington, D.C.

Figure 11. Petroleum Prices, Annual Averages, 1972-80.

Table 11. Share of N, P_2O_5, and K_2O in Energy Requirements (%)

	Share in Energy for Production	Share in Energy for Packaging, Transportation, and Application	Share in Total Energy Required for Fertilizers
N	90	47	82
P_2O_5	6	32	11
K_2O	4	21	7
Total	100	100	100
Share in total energy for fertilizers	81	19	100

Source: Mudahar, M. S., and T. P. Hignett. 1981. Energy and Fertilizer--Policy Implications and Options for Developing Countries (Executive Brief), Technical Bulletin T-19, International Fertilizer Development Center, Muscle Shoals, Alabama.

The greatest opportunity for reducing energy needs for nitrogen fertilizers is to use fertilizers more efficiently so that less nitrogen will be required for the same agricultural production. It has been well documented that no more than 25%-40% of applied nitrogen is recovered by plants while the rest is lost to the environment. Doubling nitrogen efficiency (i.e., improving nitrogen recovery from 30% to 60%) could save roughly 21 million mt N/year with a delivered value of approximately US $11 billion. Other efforts should be directed toward cutting distribution costs. Switching from bagged to bulk fertilizer movement and from low-analysis to higher concentrated materials is very promising. Any other effort to reduce fertilizer energy use should be concentrated primarily on nitrogen manufacture and secondly on marketing. Energy use in nitrogen manufacturing can be reduced, perhaps by as much as one-third, by applying available technology and by operating existing plants at maximum efficiency. Any technological improvement with respect to a saving of energy beyond what is currently used by modern plants, or with respect to feedstock substitution for new facilities, might increase the availability of energy but would mean additional capital expenditure and result in almost no cost saving.

The full impact of energy cost escalation on nitrogen prices has not been felt. Overcapacity in nitrogen production resulting from massive investments in many countries has made the market very competitive. Many of the new exporters of nitrogen are the oil surplus countries and/or the centrally planned economies, which are attempting to secure a share of the market. Many of the new exporters, having no opportunities to sell natural gas at equivalent energy costs, have built export-oriented ammonia/urea complexes and priced their feedstock far below international prices of crude oil or naphtha. With growing trade in natural gas in the form of liquefied natural gas (LNG), which provides opportunity prices for their reserves, and with moves to decontrol natural gas prices in many developed countries, the full impact of energy costs on nitrogen prices is likely to be experienced in the 1980s.

Research and Development

In the past, particularly in the 1960s, the fertilizer sector experienced the introduction of significant new developments in the technology of fertilizer production. Developments of highly concentrated products permitted a significant savings in handling, transportation, and application. Advanced process engineering enabled doubling and redoubling of plant sizes to achieve economies of scale and thus reduce the production cost per ton of fertilizer. These innovations led to the building of larger plants to serve larger consumption regions; thereby, the structure of the fertilizer sector was changed.

At the end of the 1970s these trends seemed to reach maturity. Average nutrient concentration of the products in the late 1970s rose merely 1-2 percentage points, a much slower rate than that experienced in the 1960s and early 1970s. With respect to plant size there seemed to be a recognition of "convenient" sizes for ammonia/urea and sulfuric/phosphoric acid complexes. Further significant increases in plant capacity are technically possible but are not likely.

No significant new advances in research and development are expected to be realized in the near future, with only few exceptions.

1. Technological modification may occur with respect to an energy saving, particularly in nitrogen production. Many of the energy-saving techniques considered today are merely extensions of established technology and are based on replacing energy input by extended capital expenditure.

2. Technological innovations for the use of a wider variety of raw materials might increase their potential use and help

many countries to establish domestic fertilizer industry. It appears that in the near future, competitive processes for the production of ammonia from coal and production of phosphate fertilizers from lower quality phosphate rock might be available to the industry.

3. Improved application methods may achieve higher fertilizer efficiency. Reduction of nitrogen losses, particularly in urea application to rice, could have significant implications on the future of the industry.

In the future, it may be possible to fix atmospheric nitrogen by reproduction or imitation of natural biological nitrogen-fixing pathways of certain organisms. Modern genetic engineering and enzyme chemistry could eventually provide an endless source of fixed nitrogen, but that could be a long way in the future yet.

Regional Shifts in International Trade

The initial expansion phase of the fertilizer industry in the early 1960s took place in North America, Western Europe, and Japan by the established fertilizer producers with their traditional manufacturing skills. This structure was diversified with the emergence of fertilizer production near the growing consumption regions in Eastern Europe, the U.S.S.R., and some of the developing countries, such as India, the People's Republic of China, and Brazil. In the early 1970s, and more obviously in the late 1970s, a new concept of maximizing the economic benefits of raw materials' ownership has become the driving force of the fertilizer industry in the 1980s. Many developing countries have sought to diminish their dependence on imported finished fertilizers by building local production facilities. Thus, highly concentrated materials are increasingly traded; these materials result in efficient domestic production in the importing countries. The best example of the growing interdependence in the fertilizer sector is the trend of the two largest markets and countries with raw material, i.e., the United States and the U.S.S.R., toward larger involvement in export and import markets.

The ability to compete in the world nitrogen market in the 1980s lies in the access to relatively cheap feedstock materials. The new nitrogen exporters of the late 1970s consist mainly of developing countries possessing large reserves of natural gas. Countries in the Middle East, Central America, and Southeast Asia, having flared gas, have chosen to sell energy through nitrogen production. However, the cost of building and operating plants in remote areas of those developing countries has been high, and the cost of transporting ammonia or urea to consuming regions has also been high. In recent years those costs have tended to offset the advantage of lower cost feedstocks. However,

increasing energy costs in other parts of the world, improved capacity utilization, and use of new infrastructure facilities are making these new locations the low-cost production areas. Because it takes 4-5 years after approval of the project to reach startup, the full impact of these locational changes has not been felt yet. At the end of the 1970s, the new exporters accounted for about 10% of world nitrogen trade. As more countries in the developing world establish new nitrogen facilities and because many have small or no domestic nitrogen consumption, their impact on regional trade is expected to be much more significant in the 1980s.

As a result of capacity expansions in earlier years, the East European countries, with the leadership of the U.S.S.R., came to play a vital role in the world market during the late 1970s. Although nitrogen consumption is rising in this region, it seems certain that countries such as the U.S.S.R., Romania, Poland, and Bulgaria have built an export-oriented industry as a means of diversifing their foreign exchange earnings. Those countries, especially the U.S.S.R., having massive resources of natural gas have managed to expand their nitrogen production not only to supply their domestic demand but also to supply users in other countries. At the same time the increases in production capacity of other East European countries have been aimed primarily at augmenting domestic usage. As a result, intraregional trade has become comparatively low, and imports of nitrogen into Eastern Europe from outside the region are negligible. Although Eastern Europe has successfully captured export markets for nitrogen fertilizers, much of the planned increase in nitrogen capacity was completed by the end of the 1970s. So it is still questionable as to whether the East European share of the world market will rise much further in the 1980s, in competition with the new nitrogen exports from oil surplus countries.

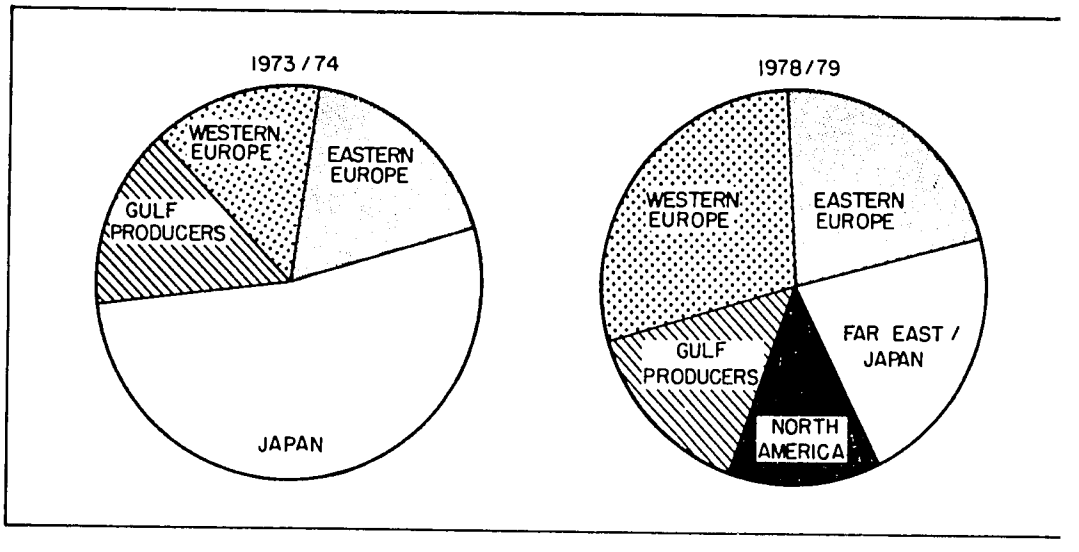
In North America the picture is mixed. Canada, with cheap natural gas, has managed to increase ammonia and urea exports to the United States. The United States, on the other hand, has developed a world-market-oriented industry that takes advantage of import and export opportunities. With a well-established nitrogen industry, the United States has expanded its exports of nitrogen products very significantly by offering the full range of popular fertilizers with special emphasis on NPs. On the other hand, because the United States is the largest single market for nitrogen, increased penetration of relatively cheap ammonia, urea, and nitrogen solutions has started to play a very important role in its nitrogen supply picture. The U.S. nitrogen industry, which is based mainly on natural gas, had to make a difficult transition from 1973, when 74% of the producers were paying less than \$0.50/thousand ft^3 and none were paying more than \$1.00, to 1980, when only 11% were paying under \$.50 and 69% were paying over \$2.00/thousand ft^3. Between 1976 and 1980 about

3.5 million mtpy of ammonia capacity was closed mainly because of high production costs relative to nitrogen prices. And while the existing ammonia plants were operating at 93% of capacity in the first half of 1980, the United States became a net importer of ammonia. Since then approximately one-half of the ammonia capacity, which was temporarily closed, came back into operation. With gas prices scheduled to be decontrolled by January 1, 1985, the U.S. reliance on imported ammonia, both for direct application and processing, is projected to increase in the years ahead. The United States' position as an exporter of nitrogen products might take the shape of upgrading ammonia into higher value fertilizers and particularly emphasizing its distinct advantage in production of ammonium phosphates.

The transition period of the nitrogen industries in Western Europe and Japan has been much shorter and more painful. Almost 100% of ammonia production in Japan and 40% in Western Europe were based on naphtha at the beginning of the 1970s. As leading nitrogen exporters, those countries expanded production in the first half of the 1970s; thus, their position in export markets was strengthened. When nitrogen prices fell in 1975 and naphtha prices kept rising, Japan and many countries in Western Europe faced a decision on closing ammonia plants and trying to restructure the industry. Japan, with no other options, had to reduce production and as a result lost its dominance in the fast-growing Far East markets. Japan's role in the Indian and Chinese urea markets has been eroded by other producers from more than 50% in 1973/74 to about 20% at the end of the decade (Figure 12). The West European countries did not react uniformly; some countries with natural gas resources switched to gas while others closed down some naphtha-based facilities and moved toward higher dependence on ammonia imports. As a result, only 25% of the region's ammonia capacity used naphtha at the end of the 1970s. Ammonia imports were popular in Western Europe because the nitrogen market is based primarily on calcium ammonium nitrate, ammonium nitrate, and ammonium sulfate.

Less than 10% of the nitrogen consumption in the West European countries is in the form of urea. Following the leadership of the Netherlands and Italy, Western Europe has exported increasing quantities of urea. The West European nitrogen industry, so often regarded as a declining industry, has managed to increase significantly its share in the Far East urea markets and is now the largest urea exporter to India and China. As gas price increases in the future and with increased nitrogen supplies from Eastern Europe, the West European export position will likely come under severe pressure. As a result, in the 1980s the West European countries will be more concerned with securing domestic markets.

As with the nitrogen sector, when oversupply gave way to acute shortage in the early 1970s, major expansions of phosphate



Source: The British Sulphur Corporation, Ltd. 1981. *Nitrogen,* **No. 129, London, England.**

Figure 12. India and People's Republic of China—Urea Supply Sources, 1973/74 and 1978/79.

fertilizer capacity were being initiated throughout the world bu especially by export-oriented producers in North America Western Europe, and Japan. In the United States, production c phosphate fertilizers was based on indigenous phosphate rock whereas in Western Europe and Japan imported material was th basis for their manufacture of phosphate products. At that time the major agricultural countries in Asia, Latin America, an Africa were importing phosphate fertilizers from these exporters East European countries and some developing countries, such a India, Brazil, and Turkey, with growing phosphate markets wer continuing their buildup of local phosphate production faciltie based upon phosphate rock imports. Some other countries, sucl as Mexico, Spain, and Sweden, that had sulfur resources als built phosphate industries with export orientations. An importan trend of recent years has been the export of phosphate fron countries where rock phosphate deposits exist; thus, some of th traditional rock exports were replaced.

The trend toward the production and export of upgradec phosphate materials, on the part of phosphate rock producers has developed most rapidly in the United States. In terms o P_2O_5, the United States now exports approximately equa quantities of phosphate rock and phosphate derivatives. U.S

exports now not only dictate the world phosphate outlook but also the U.S. domestic market. Similar trends have developed to a lesser degree in other rock-producing countries with relatively insignificant domestic markets. Countries such as Morocco, Tunisia, Algeria, Jordan, Israel, and South Africa are all developing phosphate export-oriented industries (Table 12).

Table 12. Export-Oriented Phosphoric Acid Capacity Expansions (in countries with small domestic markets)

	1980	1985
	('000 mt P_2O_5)	
Morocco	825	1,485
South Africa	838	963
Algeria	165	330
Tunisia	645	975
Jordan	-	413
Israel	86	206
Syria	-	165
	2,559	4,537

Source: Tennessee Valley Authority. 1981. Unpublished capacity data, Muscle Shoals, Alabama.

The extent of this substitution of product for rock varies widely among the several countries moving in this direction and depends on the motivations of the specific countries. Product exports in Tunisia and South Africa are substantially in excess of rock exports, primarily because of the limited quality of their rock. In the United States the decline in rock quality will enhance the trend toward increased emphasis on product sales with rock exports becoming secondary in importance. This is also likely to be the case for Algeria and Jordan but at a much slower pace. Morocco, while continuing a strong program of construction of phosphate derivative plants, will for many years be exporting the major part of its phosphate as phosphate rock, establishing its leadership in this market.

The emphasis by rock producers on intermediate and finished products poses a problem for traditional phosphate exporters in

Western Europe and Japan. The relative prices which the rock producers assign to rock and to finished products will largely determine the fate of their phosphate industries. Western Europe and Japan had to make structural changes with respect to their phosphate industries. By importing intermediates and decreasing exports, those regions were net importers of phosphate fertilizer in the late 1970s with only intraregional exports. The growing impact of sulfur on the structure of the phosphate industry, with prices doubling and redoubling in a very short period of time, should strengthen the traditional position of Western Europe and Japan as important phosphate fertilizer producers. The cost of sulfur in the production of phosphoric acid today equals the cost of the phosphate rock. Therefore, tight supplies of brimstone, accompanied by high prices, provide advantages to producers in those regions with cheap supplies of sulfuric acid.

Most of the upheavals in the phosphate industry of the 1970s played only a small role in Eastern Europe's phosphate fertilizer development. Engaged with satisfying their growing consumption and modernizing their industry by switching to concentrated products, these countries (with the exception of the U.S.S.R.) limited their involvement in world markets to phosphate rock imports. The U.S.S.R. changed from being one of the most important suppliers of phosphate rock to being a potentially large importer of phosphate products. This country is one of the largest producers of phosphate rock, but its exports to countries outside of Eastern Europe are overshadowed by its expected role as a growing importer of phosphoric acid and triple superphosphate, at least for the next 5 years. The U.S.S.R. has a long-term import contract with Occidental Chemical Company of the United States involving large quantities of superphosphoric acid.

Changing Product Pattern in World Trade

Twenty years ago, international trade consisted largely of the complex fertilizers containing the three essential plant nutrients and to a lesser extent single-nutrient fertilizers. Today urea, anhydrous ammonia, concentrated phosphates, and phosphoric acid are the most traded fertilizer materials. The popularity of these products has contributed to a sharp decline in the share of lower analysis and complex fertilizers in world trade. The above-mentioned products have been the major contributors to world nitrogen and phosphate trade, especially in the 1970s. Their higher concentration provided significant savings in distribution and left options for complementary domestic manufacture of finished fertilizer products.

Ammonia trade has developed very rapidly during the 1970s to become one of the major nitrogen markets. From about 2.4 million mt of ammonia moved internationally in 1969, world trade reached

6.4 million mt in 1980, representing about 30% of total nitrogen trade. The fastest growth occurred in the second half of the 1970s as the U.S.S.R. developed its ammonia exports, establishing itself as the leader in world ammonia trade with 34% of the total. Although shipment of anhydrous ammonia is the least energy-intensive means for shipping nitrogen fertilizers, it requires special ships, barges, railcars, and storage facilities. An adequate supply of suitable oceangoing ships is available, but in many countries, suitable conveyances for inland storage and shipment are not available. Therefore, imported ammonia is often converted into solid nitrogen fertilizers at the port. Unfortunately, urea cannot be produced economically from imported ammonia because pure carbon dioxide (CO_2) is required for its manufacture. The CO_2 is available as a byproduct at no cost at ammonia plants, but it is seldom available elsewhere at a reasonable cost. So, use of imported ammonia is limited to direct application or manufacture of ammonium nitrate, phosphate, sulfate, or some combination of these compounds. As a result most of the ammonia is imported by West European countries and the United States where urea consumption accounts for a very small share of their nitrogen use (less than 10% of total). There is no doubt that these regions will continue to cover part of their ammonia requirements by means of imports from countries with cheap natural gas. However, for political reasons, the imports will not exceed a certain proportion of the requirement of these large fertilizer-consuming countries.

During the 1970s, urea trade approximately tripled to represent more than one-third of world nitrogen trade or about one-half of solid nitrogen fertilizer trade (Table 13). Urea demand increased dramatically during the 1970s as compared with that of other nitrogen fertilizers. Its share of regional nitrogen consumption in Eastern Europe, North America, and Western Europe is relatively low, representing 25%, 10%, and 9% of their total nitrogen consumption, respectively. In Asia, the largest consumer of nitrogen fertilizers, urea accounts for 65% of the nitrogen use. The imbalanced nitrogen supply in Asia was the major reason for the growing urea trade. Asia accounted for about 60% of world urea imports at the end of the 1970s. The centralized purchases by India and the People's Republic of China alone represented roughly 45% of world urea trade. Despite ambitious investment programs India and China will still have to import a substantial part of their urea consumption for many years and will remain important to the world urea market.

Ammonium phosphates and especially diammonium phosphate (DAP) have become an important segment of the nitrogen trade, representing almost 10% of the world's solid nitrogen fertilizer trade. Their growing popularity as major phosphate fertilizers in the 1970s and their very bright prospects for the 1980s make them a very significant nitrogen source for world trade.

Table 13. Market Share of Major Solid Nitrogen Fertilizers (as % of total solid nitrogen trade)

	1968/69[a]	1975/76[a]	1979/80[b]
Urea	36	43	47
Ammonium nitrates	20	15	13
Ammonium sulfate	24	14	10
Compound fertilizers and others	20	28	30
	100	100	100

a. Source: British Sulphur Corporation, various publications, London, England.
b. Estimated.

Ammonium nitrate, ammonium sulfate, other straight nitrogen fertilizers, NPs, and NPK compounds, although representing a significant volume on a product basis, accounted for less than 30% of world nitrogen trade or about 40% of the solid nitrogen fertilizer traded at the end of the 1970s, a significant decline from about 60% in 1969.

Intercontinental bulk shipments of phosphoric acid were initiated in 1969 when Fertilizantes Fosfatados Mexicanos, S.A., (FFM) of Mexico shipped its first cargo from Coatzacoalcos to Rotterdam. Initially, the market for acid was relatively small, amounting to only about 140,000 mt of P_2O_5, with regular shipments between the United States and Colombia, between Lebanon and Turkey, and among northwest European countries. During the 1970s, as more producers of merchant-grade acid began operations, consumers became more confident about ensurance of supply from noncaptive sources. The use of phosphoric acid as an intermediate replacing phosphate rock and sulfur as raw materials developed into a market of 2.5 million mt of P_2O_5. Phosphoric acid has become a key product in the phosphate intermediate trade and equals about half of the solid phosphate fertilizer trade. In the medium term the expected competitive market price of P_2O_5 in phosphoric acid compared with that in phosphate rock points to a steady expansion of phosphoric acid trade. The introduction of superphosphoric acid into the international trade and the developing dependence of the U.S.S.R. on imported phosphoric acid are likely to accelerate the pace of development.

In the solid phosphate fertilizer trade, which reached 6.4 million mt P_2O_5 in 1979/80, concentrated phosphate products represent more than two-thirds of the market (Table 14). Demand for concentrated phosphate products for both direct application and as constituents in compound fertilizers increased rapidly during the 1970s. This was reflected in the upward trend of DAP, monoammonium phosphate (MAP), and triple superphosphate (TSP) movement in the international market. Between 1969 and 1979 ammonium phosphate trade rose from about 0.7 million mt of P_2O_5 to almost 3.0 million mt, and TSP exports rose to 1.2 million mt of P_2O_5. It is likely that in the near future the movement of SSP will be limited, and further declines in compound fertilizer (other than DAP and MAP, which represented 4% and 20% of world trade in 1979, respectively) will occur. The most important trend is the growth in trade of DAP, MAP, and TSP relative to the growth in phosphate rock trade. Rock-producing countries have made major investments in plants producing phosphoric acid and its derivatives. There is a strong incentive in these countries to set prices that will ensure the movement of the upgraded products. In addition, continuing declines in P_2O_5 content of rock in many countries make transportation more expensive and provide an incentive for trade in concentrated products. Therefore, higher growth rates are expected in the concentrated phosphate fertilizer trade than in the phosphate rock trade.

Table 14. Estimated Share of Products in World Solid Phosphate Trade, Late 1970s

	%
SSP	4
Ammonium phosphates	48
TSP	20
Compounds (other NPs, PKs, and NPKs)	20
Others (basic slag, phosphate rock, etc.)	8
TOTAL	100

Developing countries, which depend heavily on fertilizer imports, will likely face increasing difficulties in getting the NPK fertilizer they require at competitive prices. Countries in this situation must be aware of the increasing availability of ammonia,

urea, phosphoric acid, and concentrated phosphates and prepare themselves with options (such as bulk-blending or granulation facilities, port terminals, etc.) to take advantage of the growing competitiveness of these products. Meanwhile, countries which need ammonium sulfate or SSP for agronomic reasons will likely have to cope with limited supplies of such products in world trade.

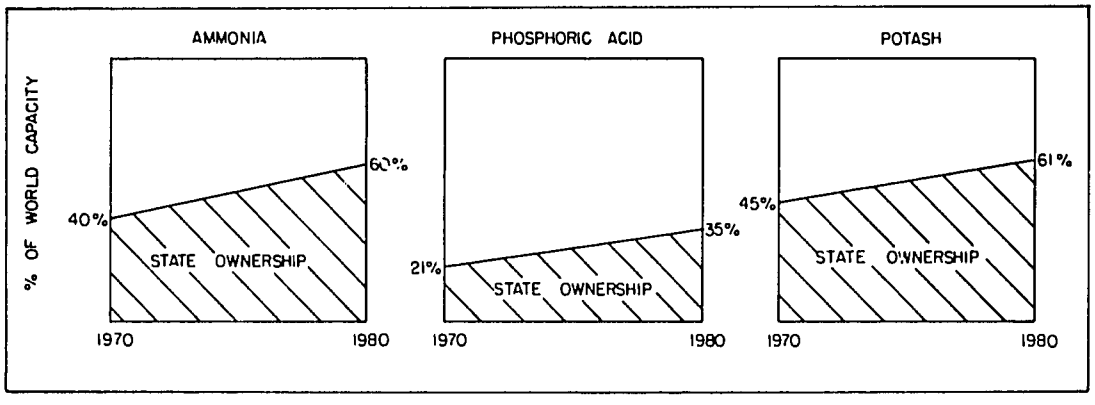
Ownership

The shifts in the regional distribution of the world fertilizer industry are placing more ownership and control in the hands of the public sector. Newer capacities are being built in countries where the government is involved directly in the production and supply of fertilizers. The trend was established in the early 1960s when the developing countries of Asia and the Middle East, Africa, and Latin America and the centrally planned economies of Eastern Europe and Asia announced major expansions in their fertilizer industries. In the case of ammonia, state ownership increased from 44% in 1970 to 60% of world capacity in 1980 (Figure 13). Similarly, state ownership of phosphoric acid capacity rose from 21% to 35%. In the case of potash, the creation of the Potash Corporation of Saskatchewan (PCS) and the growing role of the U.S.S.R. were the main reasons for the rise of non-private sector potash capacity ownership from 45% in 1970 to 61% in 1980. The above figures include many western state-owned companies. However, today many of the state-owned companies are managed as any other privately owned company, with little direct government involvement in the management.

Such shifts toward increased public-sector involvement in fertilizer production reflect the importance that national planners place on fertilizer and the role it plays in food production, political stability, and economic development. This trend of growing government involvement is projected to intensify and is likely to have implications on the nature of the industry. Development for the sake of development is becoming the main drive behind the scene. With many of those countries being export oriented, an immediate impact of the public ownership trend in the international trade is exemplified by the growing popularity of buy-back and barter agreements between governments. As an example, in 1980 only 10%-15% of the U.S.S.R.'s exported ammonia was on a commercial sales basis (Figure 14).

Role of Export Associations

The trend toward increased public-sector control of fertilizer production has been accompanied by a similar trend to coordinate exports in the developed countries through export associations.



Source: Tennessee Valley Authority. 1981. Unpublished capacity data, Muscle Shoals, Alabama.

Figure 13. State-Ownership Development, 1970-80, as a Percentage of World Capacity in Major Products.

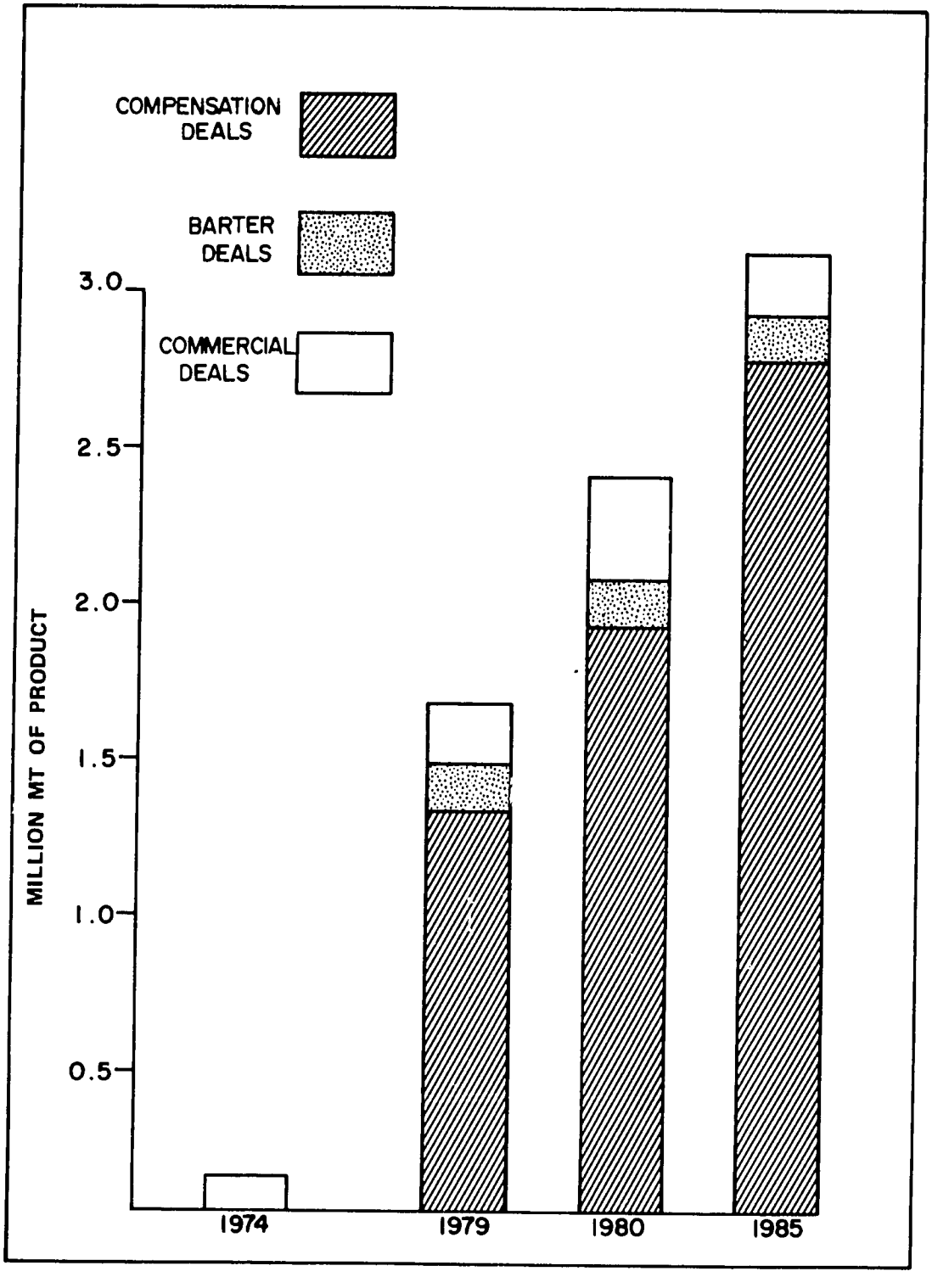
During the 1970s, the role of export associations in world fertilizer trade increased significantly, representing a growing share of supply. For some products, such as phosphate rock, concentrated phosphate fertilizers, urea, sulfur, and potash, the impact of export associations on world trade cannot be ignored.

The major export associations are:

1. Nitrex (Western Europe) and JUASECO (Japan) in the nitrogen market. These associations, representing the nitrogen exports of most West European producers and all Japanese nitrogen producers, had a dominating role in the Asian market during the 1970s.

2. Phosphate Rock Export Association (PHOSROCK) (United States) and Phosphate Chemicals Export Association, Inc., (PHOSCHEM) (United States) in the phosphate market. PHOSROCK members accounted for about two-thirds of U.S. rock exports in 1979 (Figure 15). PHOSCHEM represented the majority of phosphate intermediate exports of the United States. Representing such a high share of the leading country's phosphate exports, these associations had a role in phosphate markets of Latin America, Asia, and Western Europe that was very significant.

3. Kali-Export GmbH (Western Europe) and Canpotex, Ltd., (Canada) in the potash market. Representing more than

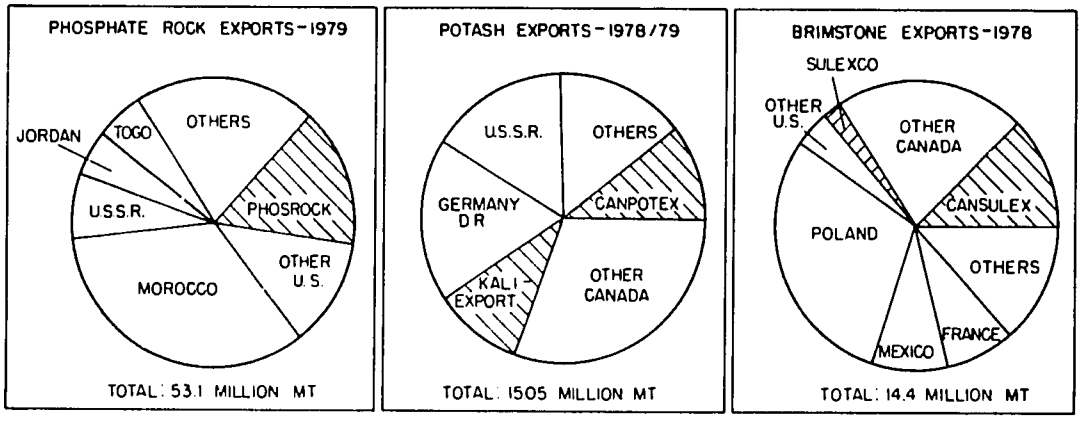


Source: The British Sulphur Corporation, Ltd. 1980. *Nitrogen*, No. 123, London, England.

Figure 14. How Soviet Ammonia Exports Are Expected to Develop.

4 million mt K_2O in the late 1970s, their involvement in the K_2O markets is felt in all importing markets. Kali-Export is the largest exporter of potassium sulfate. Canpotex is expected to develop its potash exports at higher growth rates than many other producers during the 1980s.

4. Cansulex, Ltd., (Canada) and Sulexco (U.S.A.) in the sulfur market. In 1979 Cansulex represented about half of the Canadian offshore sulfur exports or about 15% of the world trade. Sulexco represented, at that time, about one-third of U.S. sulfur exports or about 2% of world trade.



Source: British Sulphur Corporation, Ltd., London, England.

Figure 15. Role of Export Associations.

The main objective of most export associations is to rationalize competition between their members in international trade, especially with respect to negotiations with governments and centralized purchasing organizations of the importing countries. Their main activities are coordination of exports, sales promotion and representation, and in many cases centralized handling logistics, financial arrangements, and legal services.

The significant involvement of export associations in world fertilizer trade has had its impact. The export associations have provided a certain degree of price stability by means of their sales contracts which tend to set the norm for international market prices. Usually, spot sales by brokers and individual producers are at lower prices during periods of ample supply and

higher in periods of short supply. The export associations also have a positive attitude toward supply contracts and emphasize the need for long-term contracts. Long-term contracts, by their nature, tend to reduce the probability of severe imbalances between supply and demand in world fertilizer markets.

WORLD FERTILIZER OUTLOOK: 1980/81-1985/86

World economic conditions have deteriorated since 1979. All oil importers in both developing and developed countries face a major challenge over the next few years in adjusting to the 150% oil price hikes during 1978-80 and the sluggish world trade while minimizing their loss of growth. Overall growth in developing countries that are dependent upon imported oil is likely to be lower in the 1980s than that in the 1970s. However, since fertilizers receive high priority in most countries, because of their link with increased food production, it is likely that this sector will suffer less than others.

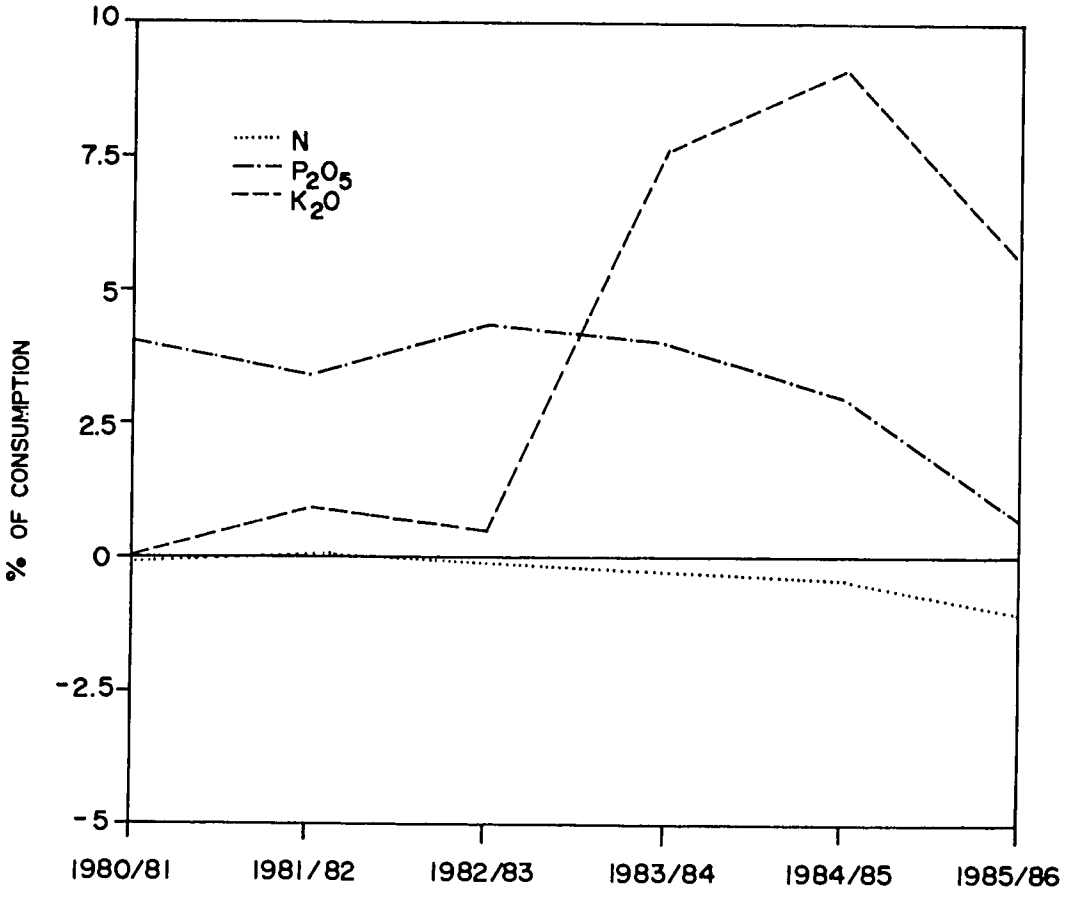
World population is expected to increase to 5.35 billion by 1990 or 1.25 billion higher than in the late 1970s. Most of this growth will occur in the developing countries. Population pressure on land, growing food deficits, and depleted soil fertility emphasize the need for increased fertilizer consumption in the developing regions. On the other hand, low demand for Third-World exports, high inflation and interest rates, constraints on the balance of payments, and growing debt service payment will likely hamper the economies of developing countries and their ability to adequately develop their fertilizer sector.

Based on recent supply/demand projections prepared by the FAO/UNIDO/World Bank Working Group on Fertilizers, world fertilizer consumption is expected to reach 146.9 million mt of plant nutrients in 1985/86, compared with 111.7 million mt in 1979/80. This represents an average annual growth rate of 4.7%, as compared with the 5.8% growth rate of the 1970s. Still, on the average, world fertilizer consumption is projected to increase by about 5.9 million mt of plant nutrients per year, as compared with about 4.8 million mtpy during the past decade. Of the 35.1 million mt of plant nutrients to be added during the 6-year period, about 16.0 million mt or about 45% of it will be used in the developing countries. Thus, their share in world consumption will increase from 31% in 1979/80 to 34% in 1985/86. This increase represents an average annual growth rate of 6.6%, as compared with 11% during the 1970s. In comparison, the growth rate in the developed world is projected to decline to 3.8% from its 4.1% growth during the last decade.

On the basis of the fertilizer consumption projections, the overall $N:P_2O_5:K_2O$ consumption ratio for 1985/86 will be very close to the ratio that prevailed in the late 1970s. Regarding the decline of potash consumption in 1979/80 in Eastern Europe as temporary, the potash consumption ratio will improve slightly over the 1979/80 ratio. The projected ratio of 1.00:0.55:0.43 for 1985/86 is therefore very similar to the 1978/79 consumption ratio.

With the most significant supply expansions expected to come from the centrally planned economies and from the developing countries, each project has to be evaluated and analyzed to identify realistic rates of utilization. In view of the poor production performance of many new plants in these locations, this forecast of fertilizer availability should probably be regarded as close to a maximum. According to the FAO/UNIDO/World Bank Working Group on Fertilizers, world fertilizer production is projected to reach 153.5 million mt of plant nutrients in 1985/86, as compared with 118.9 million mt of 1979/80. Of the 34.6 million mt of plant nutrients to be added during the 6-year period, about 14.3 million mt or about 41% of the new production will occur in the developing countries. This will increase their share of world production from 20% in 1979/80 to 25% in 1985/86. The overall increase in fertilizer production in developing countries represents an average annual growth rate of 8.1% compared with 14.0% during the 1970s. The centrally planned economies of Eastern Europe are expected to increase production by 12.1 million mt of plant nutrients during the same period. The developing countries and the centrally planned economies of Eastern Europe will account for 76% of the projected increase in fertilizer production. As mentioned before, such heavy involvement of countries which still experience many problems of infrastructure development calls for special caution in projecting future production.

Analysis of the supply/demand projections, taking into account conversion and distribution losses to arrive at supply availability, indicates a tight market situation. World fertilizer availability is projected to reach only 148.3 million mt of plant nutrients in 1985/86, as compared with 146.9 million mt to be consumed. Analysis of supply/demand balances indicates a small deficit of nitrogen throughout most of the near future, a tight potash situation during 1980/81-1982/83, and ample supply of phosphate throughout the period (Figure 16). In practice, supply and demand will balance, and any apparent deficit will be reflected in higher prices. However, the forecast suggests that in the case of nitrogen some additional capacity may be needed if an excessive price rise by the mid-1980s is to be avoided. With respect to phosphate, additional capacity will be needed after 1986; in the case of potash, it seems that the industry is well prepared for the longer term, and there is not much that can be done for the near future.



Source: FAO/UNIDO/World Bank Working Group on Fertilizers. 1981. *Current Fertilizer Situation and Outlook,* Rome, Italy.

Figure 16. Projected Fertilizer Surpluses and Deficits, 1980/81-1985/86.

On a geographical basis, Asia and Latin America are expected to continue their heavy dependence on imports of all the three essential plant nutrients. On the other hand, Europe (Eastern and Western) is projected to dominate nitrogen exports, North America and Africa will dominate the phosphate trade, and Eastern Europe and North America the potash supply.

The amount and the timing of fertilizer price movement depend upon several factors including supply availability, consumption growth, food prices, feedstock costs, inflation, etc. Future developments in the world food situation are expected to have a considerable impact on world fertilizer prices. Higher prices for agricultural commodities generally increase the demand

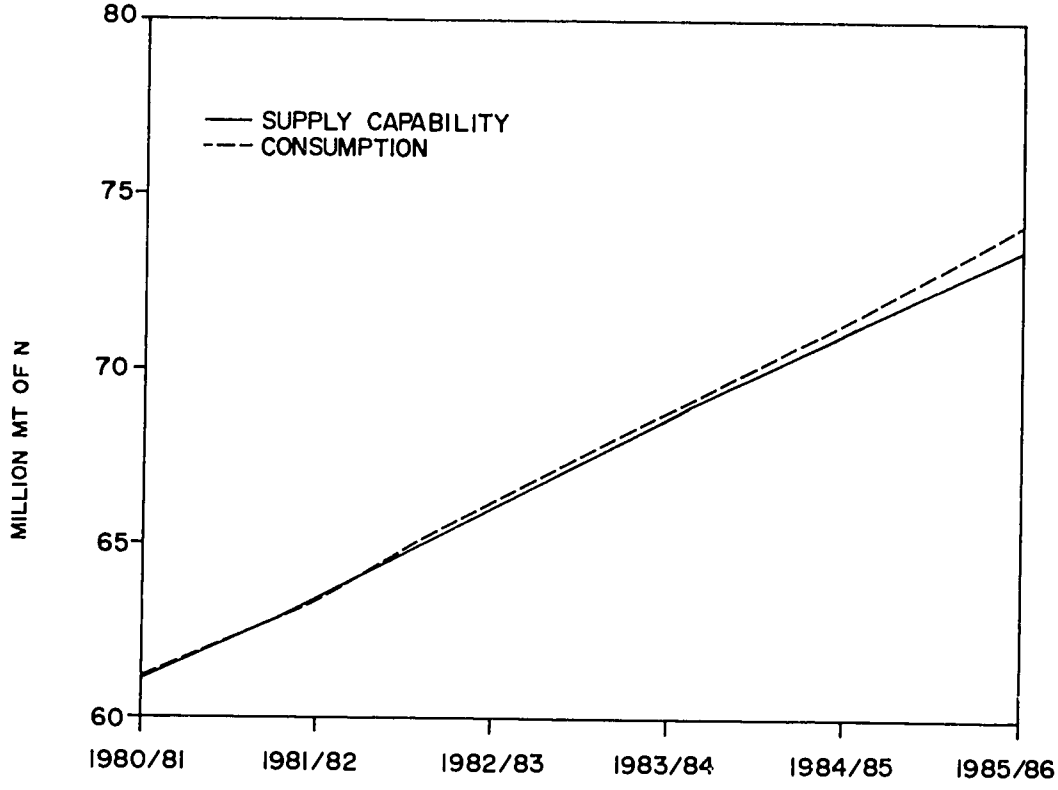
for fertilizers. One of the major factors determining world grain prices is weather, particularly in major crop-producing areas. This relationship between weather and grain and fertilizer prices makes it very difficult to predict future fertilizer consumption levels and prices. There should be a floor on fertilizer prices in the form of the production cost in the exporting countries. However, it is very difficult to determine production cost levels since they vary widely and decisions at some state-owned production facilities are not dictated entirely by economics. Fertilizer prices during the next few years are expected to be affected by the supply/demand situation, energy costs, and inflation unless production costs or prices of agricultural commodities change significantly.

Nitrogen Outlook

Nitrogen consumption is projected to grow at an average annual rate of 4.4% in the first 6 years of the 1980s, significantly lower than the 7.0% growth rate during the 1970s. The 17.0 million mt of N to be added to world nitrogen consumption is about the annual 2½-3 million mt N increase experienced in recent years. The continuing pressure on world food supplies should ensure that additional nitrogen will be used in order to have adequate supplies of grain. More than half (55%) of the increase in consumption is expected in developing countries; this will increase their share of world nitrogen consumption from 39% in 1979/80 to 43% in 1985/86. The Asian region will continue to be the major contributor to this growth. The annual growth rate in nitrogen consumption in the developing countries is expected to decline from its 11.1% in the 1970s to 5.9% for the first 6 years of the 1980s. This growth rate is still higher than the rate projected for the developed countries. The developed countries are expected to increase their nitrogen consumption by only 3.4%, a significantly lower growth rate than their 5.1% rate of the 1970s.

On the supply side, the number of plants coming on stream seems to indicate a significant worldwide surplus of nitrogen. But realistic evaluation of many ammonia capacity figures and deduction of nonfertilizer uses of ammonia and conversion and distribution losses indicate that supply and demand will be closely in balance. Since nitrogen fertilizer availability is almost entirely dependent on ammonia availability, the overall balance of nitrogen is projected to remain tight in the near future and develop a small deficit by 1982 (Figure 17).

On a regional basis there are important differences between ammonia availability and nitrogen fertilizer availability. North America and Western Europe are expected to incur significant ammonia deficits in the period ahead. On the basis of current plans in these regions, less than 3 million mt N of new ammonia



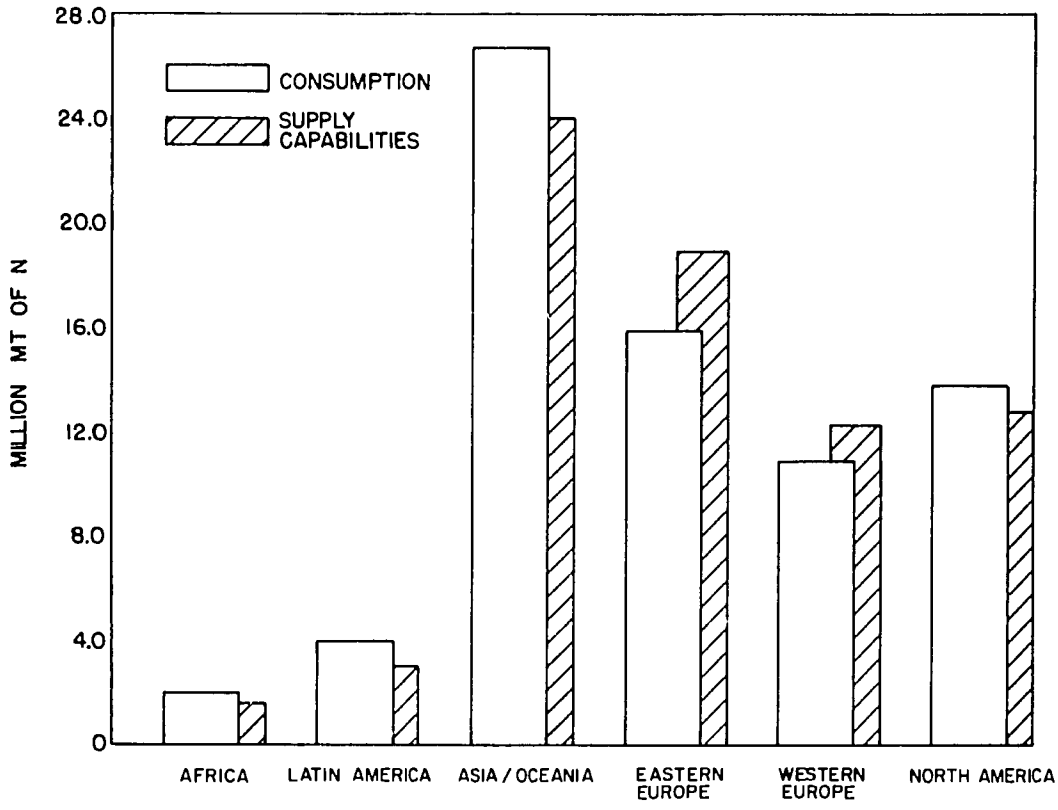
Source: FAO/UNIDO/World Bank Working Group on Fertilizers. 1981. *Current Fertilizer Situation and Outlook,* Rome, Italy.

Figure 17. World Nitrogen Fertilizer Supply Capability and Consumption, 1980/81-1985/86.

capacity will be installed between 1980/81 and 1985/86. Ammonia imports into these regions from the U.S.S.R. and some developing countries will continue to grow rapidly. The ammonia surplus from Eastern Europe (mainly the U.S.S.R.) is projected to peak at 6.0 million mt N by 1983/84 and thereafter to decline as domestic consumption grows. Latin America and the Middle East are projected to move from an ammonia deficit to a surplus position by 1984. The People's Republic of China is expected to double its ammonia deficit by the mid-1980s despite a relatively ambitious construction program. The other regions are projected to maintain their existing balances.

World nitrogen supply is projected to reach 73.5 million mt N in 1985/86, an average annual growth rate of 3.5%. Regionally, the nitrogen supply forecast differs from the ammonia supply picture. While ammonia imports increase, North America and

Western Europe are expected to continue to be major exporters of finished nitrogen fertilizers. Overall, however, North America is expected to be a net importer of nitrogen by 1984/85 (Figure 18). Eastern Europe is expected to dominate world nitrogen trade, with about equal quantities of nitrogen to be exported as ammonia and as finished products. The other regions are projected to continue their dependence on imports although an overall steady reduction in their nitrogen deficits is predicted. The developing countries will increase their share in world nitrogen fertilizer production from 30% in 1979/80 to 37% in 1985/86, accounting for 69% of the increase in world supply during this period.



Source: FAO/UNIDO/World Bank Working Group on Fertilizers. 1981. *Current Fertilizer Situation and Outlook*, Rome, Italy.

Figure 18. World Nitrogen Fertilizer Supply and Consumption by Region, 1985/86.

As a result of projected developments in the world nitrogen fertilizer market, consumption and supply figures indicate a

marginal and growing nitrogen deficit in 1982/83. This development suggests that some additional capacity may be needed if an excessive price rise by the mid-1980s is to be avoided. The equilibrium of the nitrogen market is expected to be so delicately tight that almost any significant event will have an immediate impact on the market. On the other hand, any extraordinarily rapid rise in price could depress demand as it did in 1974/75 and lead to surpluses.

Basically, we should expect an increase in nitrogen fertilizer prices in the 1980s for many fundamental reasons. The adjustment to the dislocation of ammonia plants following the 1974/75 crisis is almost realized. However, this was an expensive process in many respects because it included closure of plants that technically could have continued in operation while huge investments were made in nondeveloped areas where infrastructure was nonexistent. The full impact of this dislocation on nitrogen prices is not known. Fortunately, this reorganization was accompanied with modernization of the supply system; technical breakthroughs of the 1960s with respect to nutrient concentration and production economies of scale were utilized. Today, more than ever, the world depends on nitrogen production in the centrally planned economies of Eastern Europe and the developing countries of the Middle East and Central America. As a result, world ammonia capacity utilization in 1980, which was 73%, will continue at a generally low level.

Developments in the world oil market will continue to play a very important role in determining consumption trends and prices in the nitrogen market. Feedstock for about 10% of the world's total ammonia capacity still costs more than the ammonia produced from that feedstock. Every increase of US $1 in the price per barrel of oil or equivalent change in the price of natural gas raises the cost of urea production by about US $5/mt. In addition, the impact of inflation and high interest rates will continue to contribute to fertilizer price escalation.

The impact of the importing countries on the equilibrium market price is not clear. The United States and Western Europe, accounting for most of the ammonia imports, will influence ammonia market prices. Following the decontrol of natural gas prices in the United States by 1985, the ability of this market to adjust to higher ammonia prices is quite obvious. Sizable cost-induced increases are also in store for gas-based producers in Western Europe to the extent that these values represent an economic relationship with crude oil prices. On the other hand, the urea imports of the Association of Southeast Asian Nations (ASEAN) will influence international urea prices. The big importers, the People's Republic of China and India, will have to continue to import heavily, despite their new plants. These countries will find it difficult to maintain high levels of imported

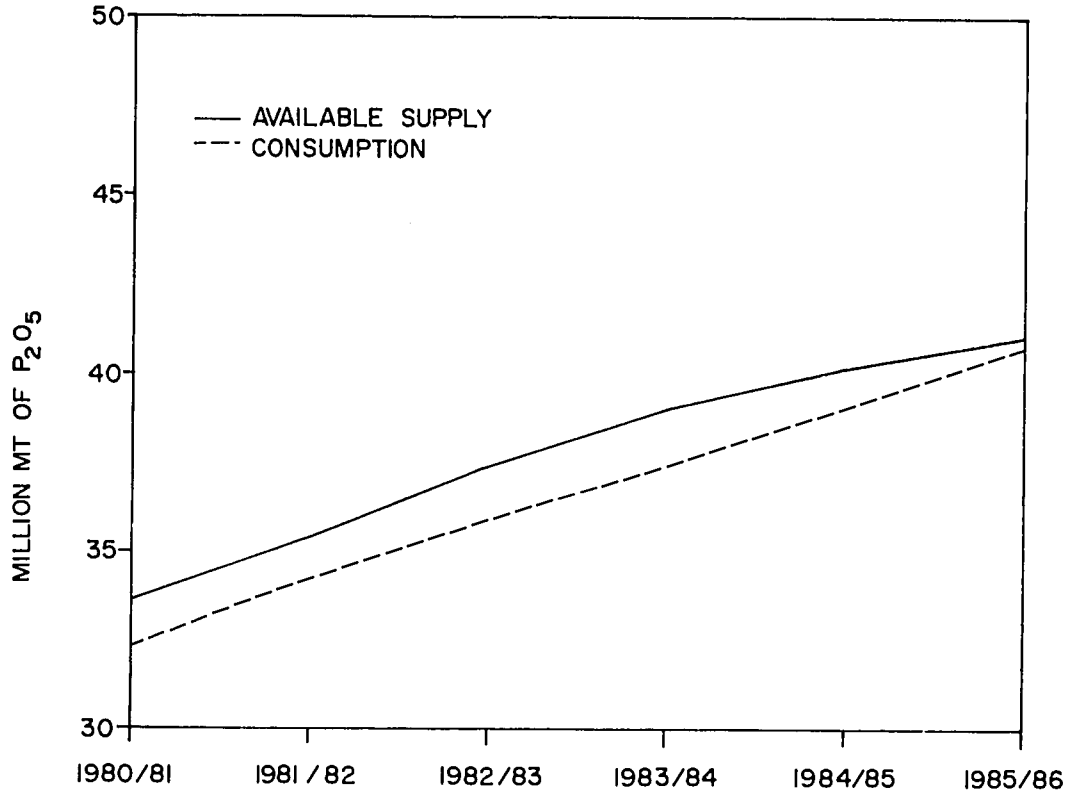
urea if there is any significant price escalation. In addition, the 1980s may exhibit a new wave of uncertainty as demonstrated by the United States-U.S.S.R. trade embargo and the Iraq and Iran war. Any such disturbance in the major countries, such as the U.S.S.R., the United States, China, or India, would have a major market impact. The growing role that the centrally planned economies will have on world nitrogen trade, their pricing mechanism, and the trade and aid arrangements that the centrally planned countries will give the developing countries will also have major market impacts.

Phosphate Outlook

The FAO/UNIDO/World Bank Working Group on Fertilizers indicates that phosphate consumption will reach 40 7 million mt of P_2O_5 in 1985/86 (Figure 19). This represents an average annual growth rate of 4.6% in the first 6 years of the 1980s, down slightly from the 4.8% average of the 1970s. The developing countries, with an average annual growth rate of 7.8%, are expected to increase P_2O_5 consumption by 4.6 million mt and increase their share of world phosphate consumption from 26% in 1979/80 to 31% in 1985/86. The developed countries, with a growth rate very close to that achieved in the 1970s, will increase phosphate consumption by 5.0 million mt of P_2O_5 during the 1980-86 period. Most of the increase in phosphate consumption in the developed world is expected to occur in Eastern Europe (3.5 million mt of P_2O_5).

World phosphate supply is projected to increase rapidly from 1981 to 1984 and slow down thereafter. It is estimated that available phosphate supply will grow by 3.5%/year and reach 41.0 million mt of P_2O_5 in 1985/86. About 52% of the increased production will occur in the developed countries as a result of impressive plant construction plans in North America and Eastern Europe. The developing countries will increase their share of world phosphate production from 19% in 1979/80 to 24% in 1985/86 as a result of new facilities in Africa, the Middle East, and Latin America. The bulk of the increase in phosphate fertilizer production will be in the form of phosphoric acid and its derivatives. The share of phosphoric acid and its derivatives in world phosphate production is projected to increase from 59% in 1979/80 to 63% in 1985/86. With about 60% of wet-process phosphoric acid capacity in 1980 owned by phosphate rock producers, this group is expected to account for most of the expansion in the near future.

Current expectations for the medium term indicate an ample supply of phosphate fertilizers. However, only North America and Africa are projected to have surpluses of supply over regional demand (Figure 20). The United States will remain the world's largest exporter of phosphate fertilizers. The largest increase in

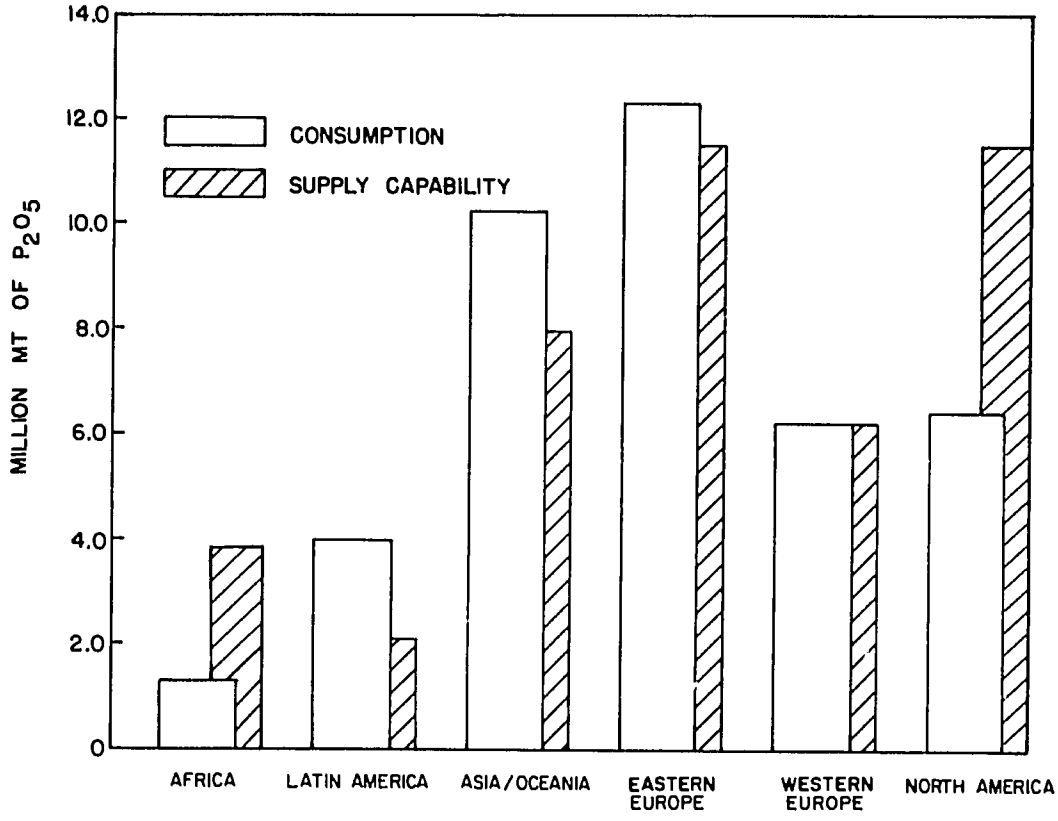


Source: FAO/UNIDO/World Bank Working Group on Fertilizers. 1981. *Current Fertilizer Situation and Outlook,* Rome, Italy.

Figure 19. World Phosphate Available Supply and Consumption, 1980/81-1985/86.

supply capabilities is expected to be in Eastern Europe, particularly in the U.S.S.R. However, because demand is expected to increase faster than supply, Eastern Europe will continue to have a phosphate deficit. Western Europe, with little additional capacity scheduled, will lose its export potential and concentrate on supplying regional demand. Latin America and Asia are expected to account for the largest phosphate fertilizer imports.

The present price structure favors expansion of phosphate fertilizer production at commercially exploited phosphate rock deposits, thus having raw materials available that cost less than the present market price. Current price relationships imply that unless the price of rock on the world market drops or the price of finished phosphates rises significantly future expansions in phosphoric acid will occur primarily in those countries having



Source: FAO/UNIDO/World Bank Working Group on Fertilizers. 1981. *Current Fertilizer Situation and Outlook*, Rome, Italy.

Figure 20. World Phosphate Fertilizer Supply Capabilities and Consumption by Region, 1985/86.

phosphate rock deposits. Toward the end of the 1970s, sulfur prices and availability started to play an increasing role in expansion considerations. World sulfur supply/demand forecasts indicate increasing tightness of the market and high probability of shortages. At the beginning of the 1980s sulfur prices, c.i.f. North Africa or the Middle East, equaled the f.o.b. price of about 3 mt of phosphate rock. On this level, the sulfur used in producing phosphoric acid costs as much as the phosphate rock. Thus, countries with ample phosphate rock supplies but no reliable source of sulfur should reevaluate any ambitious plans for expansion of export-oriented phosphate fertilizer capacity expansion plans. On the other hand, countries with domestic sulfur supply or byproduct sulfuric acid might start planning future phosphate fertilizer expansions. However, such changes are not expected to have any major impact on short-term supply projections.

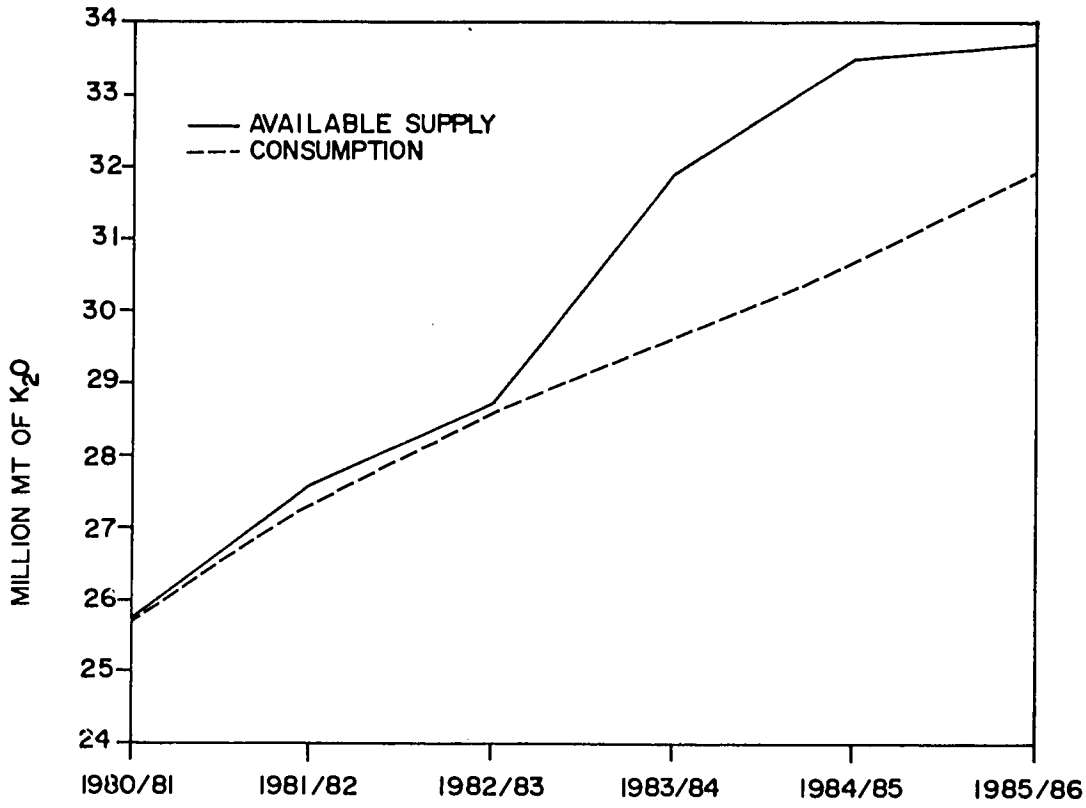
Generally, phosphate fertilizer prices are more cyclical than nitrogen prices. In addition, most of the agricultural soils of the high phosphate-use areas (United States and Western Europe) contain high residual levels of phosphate due to many years of phosphate use. Thus, when prices are very high, farmers, in the short term, can rely on this residual supply and delay using phosphate. However, the dependence of phosphate production on energy is relatively low; therefore, changes in the oil prices should have limited impact on its production costs. On the other hand, the necessity to utilize lower grade phosphate rock, the tight sulfur supply, and the intensive investment involved should put consistent pressure on phosphate fertilizer prices.

The major countries in the phosphate sector are the United States, the U.S.S.R., and Morocco on the supply side and the United States, Brazil, India, and Western Europe on the demand side.

Potash Outlook

Potash consumption is projected to increase by an average of 5.3%/year for the first 6 years of the 1980s to reach 31.9 million mt of K_2O in 1985/86 (Figure 21). This is a much higher growth than the 4.4% growth rate of the 1970s. The main reason for this is the decline in potash consumption that took place in Eastern Europe in 1979/80. This decline is considered temporary, and consumption is expected to rebound to a more favorable level in 1980/81. The developing countries are expected to increase their demand for potash by 2.0 million mt or 7.8%/year to account for 17% of world potash consumption in 1985/86 as compared with 15% in 1979/80. Still, most of the increase in potash consumption is projected to occur in the developed countries (6.5 million mt of K_2O) as a result of their more balanced fertilizer use patterns. According to this forecast, K_2O consumption in the developed countries is expected to grow at an annual rate of 4.8% in the first half of the 1980s as compared with 3.6% in the 1970s.

Current prospects for the world potash situation are for tight supplies, particularly during the 1980-83 period. Beyond 1983, capacity expansions will begin to take effect and allow a small and growing positive supply/demand balance. Overall, available supply is expected to grow by an average 4.6%/year to reach 33.7 million mt of K_2O in 1985/86, allowing for a safe positive balance of 1.8 million mt above 1985/86 consumption. Most of the expected additional supply will come from Canada and Russia. Canada's expansions are centered in the province of Saskatchewan, with its high quality, easily accessible deposits and the opening of a new mine in New Brunswick in 1982/83. Russia is already improving its infrastructure and production performance to reach its planned production targets. In addition, expansions mainly at



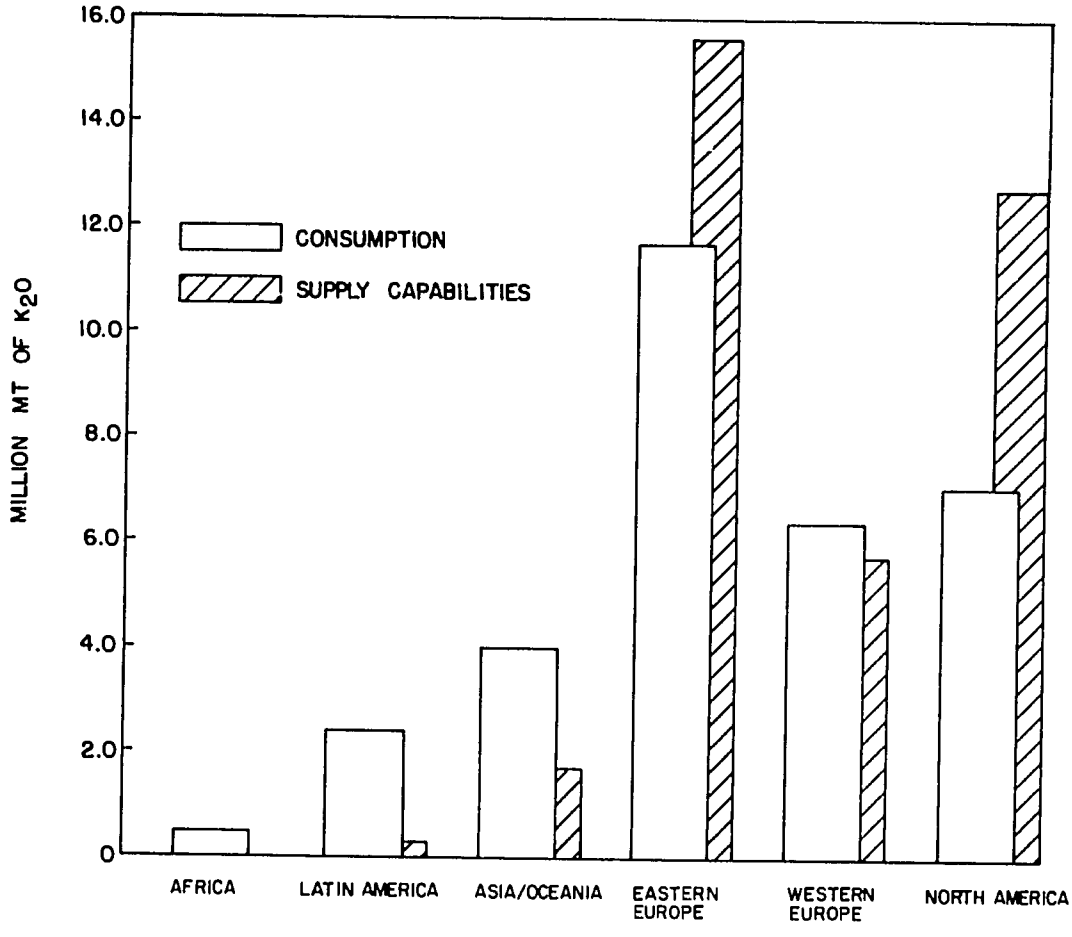
Source: FAO/UNIDO/World Bank Working Group on Fertilizers. 1981. *Current Fertilizer Situation and Outlook*, Rome, Italy.

Figure 21. World Potash Fertilizer Available Supply and Consumption, 1980/81-1985/86.

the Uralkali complex should ensure enough supply for the growing domestic market and exports.

Potash development in North America is highlighted by only moderate expansions in the United States' and Canada's impressive exploitation schedule. Eastern Europe, with the U.S.S.R. and Germany D.R., is expected to be the only other region with exportable surpluses (Figure 22). The export potential of Western Europe will deteriorate as supply remains much the same throughout the period. Latin America and Asia are expected to remain the largest importing regions in spite of moderate capacity developments in Brazil, Israel, and Jordan.

With respect to future prices, potash demand at the farm level is becoming extremely price sensitive. This is due primarily



Source: FAO/UNIDO/World Bank Working Group on Fertilizers. 1981. *Current Fertilizer Situation and Outlook*, Rome, Italy.

Figure 22. World Potash Fertilizer Supply Capabilities and Consumption by Region, 1985/86.

to the residual levels of potassium that have been built up in most of the prime agricultural soils of North America and Western Europe. The high levels of residual potassium could permit cropping with little or no addition of potash without resulting in significant reductions in yield in the short term. On the other hand, it appears that current prices have reached levels sufficient to justify capacity expansions to supply the growing need. Anyhow, developments in the potash market will depend mainly on the general trends of the fertilizer sector and in particular on the nitrogen sector.

The major countries to be watched in this market are Canada and the U.S.S.R. on the supply side and the United States,

Brazil, India, and the People's Republic of China, which has recently entered the market as a large consumer, on the import side.

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