Global Fertilizer Perspective, 1960-95

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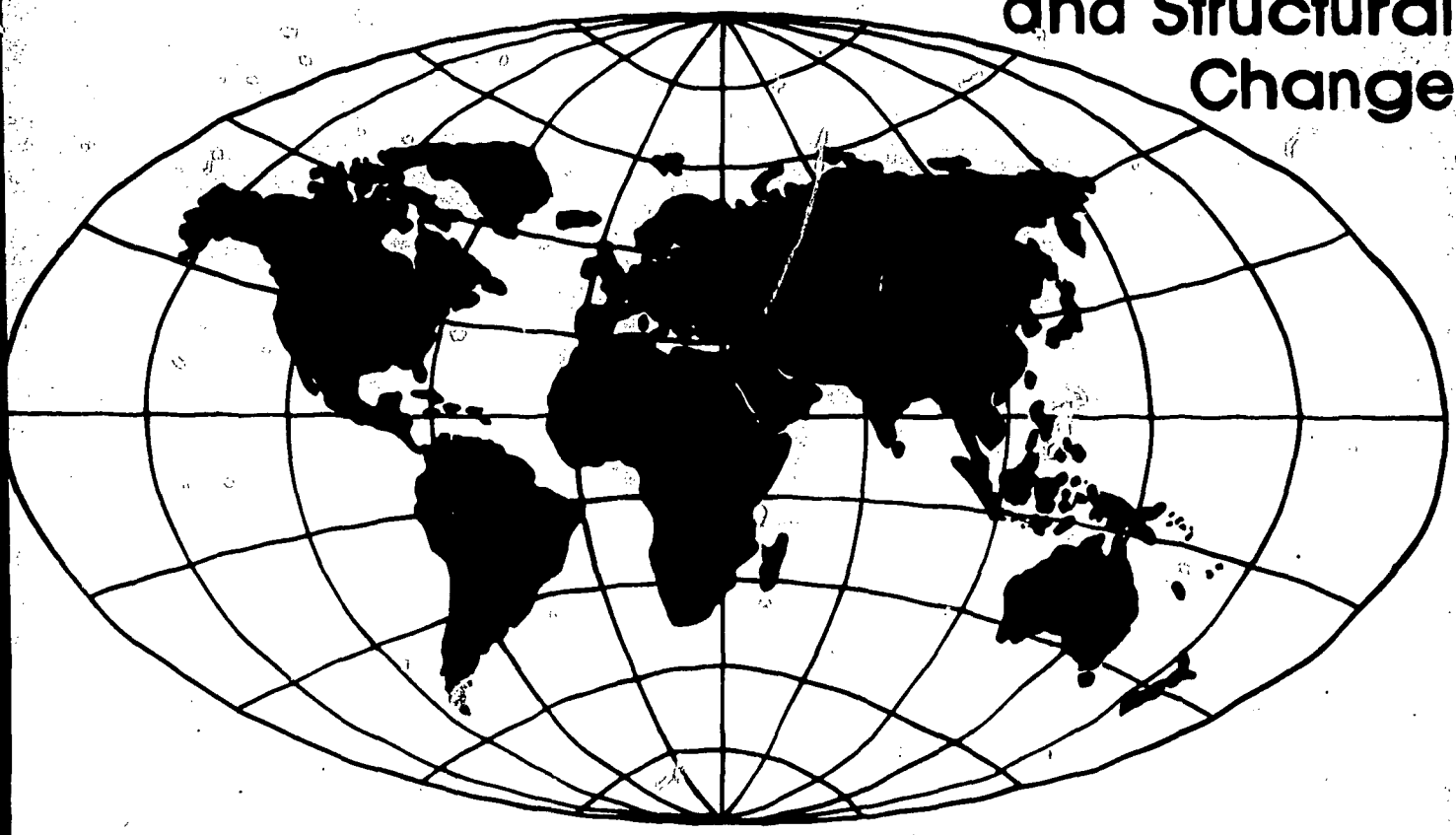
The Dynamics of Growth and Structural Change



International Fertilizer Development Center

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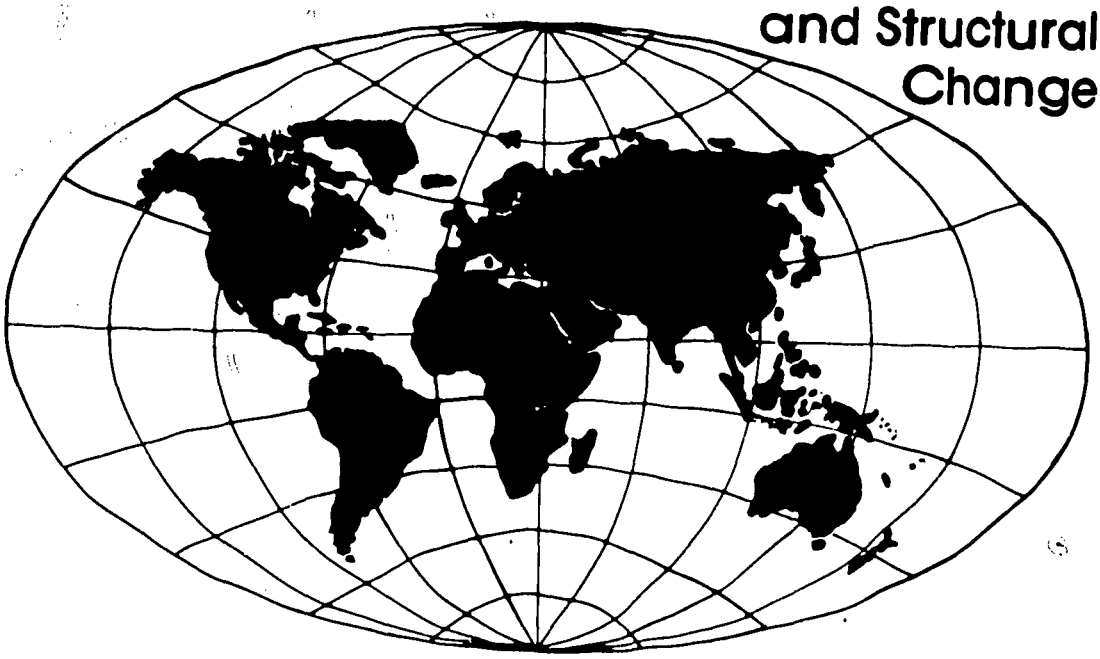

by
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International Fertilizer Development Center

FOREWORD

The United Nations projections indicate that world population will increase from 5.1 billion in 1988 to 6.2 billion in 2000. More than 90% of the projected increase in population will occur in the developing countries of Asia, Africa, and Latin America. Thus, the population of the developing countries will increase from 3.9 billion in 1988 to 4.9 billion in 2000.

This increase in population along with the expected increases in per capita income will accelerate demand for food, feed, and fiber and will put tremendous pressure on world agriculture to produce these agricultural products in the required quantities. With growing population and limited cultivable land, yield-increasing innovations will play an important role in producing the required amount of food, feed, and fiber. And in increasing yields, efficient and increased use of fertilizers must play the crucial role, as it has in the last quarter of a century.

Against this growing need for fertilizer use, the 1980s witnessed a considerable slowdown in fertilizer use growth and near stagnation in per capita fertilizer use. The growth in fertilizer production also slowed down. Because of low and unremunerative prices, many fertilizer plants were closed and several were idled. These changes of the 1980s were inconsistent with the past trends, especially with the changes of the 1970s when both fertilizer use and production increased rapidly in spite of energy crises and high fertilizer prices.

The declining growth of fertilizer use in the face of increasing need for fertilizer has mandated that a comprehensive and long-run analysis of the factors affecting fertilizer use and production at the global and the regional levels be pursued; hence, this study was undertaken.

The study provides an analysis of growth and structural change in the fertilizer sector at the global and regional levels. Specifically, it focuses on how various factors, including the policy environment, have influenced global and regional fertilizer use and production during the last quarter of a century. It also examines how these factors may affect growth in fertilizer use and production during the 1990s. The study includes (1) demand

projections, (2) supply projections, and (3) supply/demand balances for nitrogen, phosphate, and potash, (4) a qualitative assessment of price outlook, and (5) an evaluation of the impact of the projected growth in fertilizer use on food availabilities in the developing countries of Asia, Africa, and Latin America in the 1990s.

The study shows how forces outside the fertilizer sector have significantly influenced fertilizer use; unfavorable macro- and micro-economic and policy environments, in particular, slowed growth in fertilizer use during the 1980s. The study also indicates that substantial investment in new capacity will be required to avoid nitrogen shortages in the mid-1990s. Furthermore, many regions will require a higher than projected growth in fertilizer use to achieve significant improvements in the nutritional levels of their populations in the 1990s.

As the decade of the 1990s approaches, there is an urgent need for programs and policies to promote growth in fertilizer use and food production so that the people of the developing countries can enjoy relatively higher nutritional standards in the year 2000.

IFDC will continue to monitor changes in economic, policy, and other areas and to evaluate their impact on fertilizer use and food production so that policymakers, donors, and those in the fertilizer sector can take appropriate measures to provide relatively greater food security through efficient and increased fertilizer use and production.

Donald L. McCune
Managing Director
INTERNATIONAL FERTILIZER
DEVELOPMENT CENTER

June 26, 1989

PREFACE

In the 1980s, the global fertilizer sector witnessed several structural changes: First, there was a slowdown in fertilizer use growth and consequently, per capita fertilizer use stagnated. Second, fertilizer use fluctuated from one year to another; it decreased on three occasions (1983, 1984, and 1986) during the 1980-87 period as against once (1975) during the 1960-80 period. Third, in spite of low fertilizer prices, fertilizer use decreased. Fourth, because of low and unremunerative prices, many fertilizer plants were closed and several were idled. Fifth, the traditionally dominant users and producers of fertilizers, namely, North America and Western Europe, experienced a decrease in their shares in global fertilizer use and production.

These changes indicate that the structure of the global fertilizer sector was changing rapidly in the 1980s. Hence, a comprehensive and long-run analysis of the factors affecting fertilizer use and production at the global and the regional levels was pursued to unravel the dynamics of growth and structural change. The findings of that analysis were incorporated in developing the future outlook for fertilizer demand, supply, and prices.

As the growth in fertilizer use has played a key role in promoting growth in food production, a stagnation in per capita fertilizer use during the 1980s also necessitated an analysis of the impact of the projected growth in fertilizer use on food security in Asia, Africa, and Latin America.

The detailed results of the analysis in these three areas, namely, historical trends, future outlook, and food security and fertilizer use are contained in this volume and are summarized in the Executive Summary for the benefits of policymakers, donors, researchers, and others dealing with the fertilizer sector at the global and regional levels.

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ABBREVIATIONS, ACRONYMS, AND EXPLANATIONS

Units

c.i.f. ..... cost, insurance, and freight
calories ..... kilocalories
f.o.b. ..... free on board
ha ..... hectare
kg ..... kilogram
ton ..... metric ton (1,000 kilograms, or 2,204.6 pounds)
$ ..... U.S. dollar

Fertilizer Products and Nutrients

AS ..... ammonium sulfate
CAN ..... calcium ammonium nitrate
DAP ..... diammonium phosphate
K_2O ..... potash (expressed as potassium oxide)
MOP ..... muriate of potash
N ..... nitrogen
NPK ..... N + P_2O_5 + K_2O
P_2O_5 ..... phosphate (expressed as phosphorus pentoxide)
PAPR ..... partially acidulated phosphate rock
SSP ..... single superphosphate
TSP ..... triple superphosphate

Institutions/Countries

FAO ..... Food and Agriculture Organization of the United Nations
IFDC ..... International Fertilizer Development Center
IFPRI ..... International Food Policy Research Institute
IRRI ..... International Rice Research Institute
OECD ..... Organization for Economic Cooperation and Development
TVA ..... Tennessee Valley Authority
U.S.A. ..... United States of America
USAID ..... United States Agency for International Development
USBM ..... United States Bureau of Mines
USDA ..... United States Department of Agriculture
U.S.S.R. ..... Union of Soviet Socialist Republics

Others

CU ..... capacity utilization factors
PIK ..... Payment-in-Kind
UCT ..... under construction

Regions

Appendix A and Map 1.1 explains the country composition of the regions used in this study.[a] The following abbreviations are used.

AF.....Africa
AS.....Asia
CA.....Central America
EAS.....East Asia
EE.....Eastern Europe
LA.....Latin America
NA.....North America
NAF.....North Africa
OC.....Oceania
SA.....South America
SAF.....South Africa
SAS.....South Asia
SSA.....Sub-Saharan Africa
SU.....Soviet Union (U.S.S.R.)
WAS.....West Asia
WD.....World
WE.....Western Europe

Explanations

1. All fertilizer quantities, except fertilizer prices, are measured in nutrient tons (unless indicated otherwise).

2. All P_2O_5 data in the study exclude ground rock phosphate for direct application. The P_2O_5 data in Appendix C include ground rock phosphate for direct application.

3. All years used in the study are split years (July-June), although frequently indicated by the latter half of the year. For example, 1990 implies 1989-90.

4. Fertilizer use and fertilizer consumption are used interchangeably.

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a. The regional classification used in Chapter 8 is slightly different from that used in the rest of the study. See Appendix A, Part II for details.

SUMMARY AND CONCLUSIONS

This study has focused on three broad themes, namely, historical trends in fertilizer consumption and production (1960-87); future outlook of demand, supply, and prices (1988-95); and food security and fertilizer use (1988-2000). In each of these themes, several major and minor issues were unearthed and analyzed. The main findings of this study can be summarized as follows.

I. Historical Trends

Consumption

1. Total fertilizer use increased from 27.4 million tons in 1960 to 111.1 million tons in 1980, and 132.3 million tons in 1987. N, P_2O_5, and K_2O use increased from 9.5, 9.8, and 8.1 million tons in 1960 to 57.2, 29.9, and 24.0 million tons in 1980, and 72.4, 33.8, and 26.1 million tons in 1987, respectively. Thus, during the 1960-87 period the $N:P_2O_5:K_2O$ ratio has changed from 1.00:1.02:0.85 in 1960 to 1.00:0.47:0.36 in 1987.
2. There was a considerable slowdown in fertilizer use growth during the 1980s compared with the 1970s and the 1960s. Total fertilizer use grew at 2.6% per annum during the 1980-87 period. This growth rate was less than one-half of the annual growth in the 1970s and less than one-third of that in the 1960s; it was also less than two-thirds of the projected annual growth for the 1980s.
3. Although all three nutrients experienced slowdown in growth, phosphate and potash use experienced sharp declines in their annual growth rates. Compared with more than 4% annual growth in the 1970s, potash and phosphate use grew at less than 2% per annum during the 1980s.
4. Not all regions experienced a slowdown in the growth of fertilizer use. Total fertilizer use grew at more than 5% per annum in Asia and the U.S.S.R., increased at only a marginal rate in Western Europe, and decreased in North America. Other regions experienced modest annual growth in their total fertilizer use. Furthermore, North America, Western Europe, and Oceania experienced 2%-3% annual declines in P_2O_5 use

levels. Thus, Asia and the U.S.S.R. were the main driving forces behind the growth in global fertilizer use in the 1980s.

5. The regional experience of the 1980s is in sharp contrast to that of the 1970s and the 1960s. All regions (except Oceania in P_2O_5 use) experienced significant annual growth in their fertilizer use levels in the 1970s and the 1960s.
6. Over time, if the crop technologies promoted growth in fertilizer use in the 1960s and the fertilizer production technologies (centrifugal compressors and large-scale plants) accelerated the growth in fertilizer use by reducing production costs in the 1970s, then unfavorable economic, climatic, and policy environments slowed growth in fertilizer use in the 1980s.
7. Microeconomic, macroeconomic, climatic, and policy changes played important roles in slowing down the growth in fertilizer use in the 1980s. Notable among these changes are low crop prices in North America, Western Europe, and Oceania; acreage reduction programs in North America; debt crises and foreign exchange shortages in Latin America; and unfavorable weather in Asia.
8. The fertilizer use growth experiences of different regions highlight the role of different factors in sustaining growth in fertilizer use at the regional level. The North American (as well as the West European and the Oceanian) experience indicates that microeconomic factors (crop prices) play an important role in sustaining or slowing down growth in fertilizer use, while the Latin American experience highlights the role of macroeconomic (foreign exchange shortages) factors. The Asian experience indicates that price stability, policy stability, and government commitment are critical in sustaining growth in fertilizer use, whereas sub-Saharan Africa's experience underscores the need for donor support to counteract the negative influence of macroeconomic factors. In addition to these factors, the experiences of many regions indicate that an increased domestic production capacity helps significantly in promoting growth in fertilizer use.
9. Because of the varying growth rates experienced by different regions during the 1960s, the 1970s, and the 1980s, the regional shares in global fertilizer use have changed significantly. If Western Europe dominated the global fertilizer use in the 1960s and North America in the 1970s, then the 1980s belonged to Asia. Asia accounted for about 30% of total

and 40% of N use at the global level in the mid-1980s. In phosphate use also, Asia had a dominant share. However, in potash use, Asia was far behind the U.S.S.R., North America, and Western Europe.

10. The changes in global fertilizer prices per se have very little impact on global fertilizer use for several reasons. First, as fertilizer prices are administered in many regions, not all changes in global prices are reflected in local prices at the regional level. Second, even in those regions where changes in global prices are reflected in farm-level prices (in North America, Western Europe, and Oceania), the impact of changed fertilizer prices is neutralized by changes in crop prices because in these regions the changes in fertilizer prices usually follow the changes in crop prices except when there is an external shock of the kind felt in the mid-1970s. Third, fertilizer use at the regional level also depends on macroeconomic, policy, and ecological changes.

11. Although the changes in global fertilizer prices have very little impact on global fertilizer use, the changes in fertilizer prices play an important role in affecting fertilizer use at the regional and national levels. Unless accompanied by the compensating increases in crop prices, a steep increase in fertilizer prices (resulting from the removal of fertilizer subsidies or some other factors) will reduce fertilizer use. Likewise, a sharp decrease in fertilizer prices will increase fertilizer use significantly.

Production

1. Total fertilizer production increased from 28.1 million tons in 1960 to 117.7 million tons in 1980 and 139.9 million tons in 1987. N, P_2O_5, and K_2O production increased from 9.6, 9.8, and 8.7 million tons in 1960 to 59.6, 32.2, and 25.8 million tons in 1980, and 75.6, 35.6, and 28.8 million tons in 1987.

2. The slowdown in fertilizer use growth in the 1980s also slowed down growth in fertilizer production at the global level. Compared with 9.4% annual growth in the 1960s and 5.5% annual growth in the 1970s, total fertilizer production grew only at 2.6% per annum during the 1980-87 period. Nitrogen production grew at 3.6% per annum and P_2O_5 and K_2O production at 1.5% and 1.6% per annum. The relatively lower growth rates for P_2O_5 and K_2O are reflections of their relatively lower use growth rates.

3. Asia and the U.S.S.R. experienced more than 6% annual growth in production, while North America and Western Europe experienced about 1% annual decline in their fertilizer production in the 1980s. Consequently, most of the increase in global fertilizer production was contributed by Asia and the U.S.S.R.
4. The regional production experience of the 1980s is different from that of the 1970s and the 1960s. In the 1970s and the 1960s, most regions experienced growth in fertilizer production.
5. Because of the varying growth rates experienced by different regions during the 1960s, the 1970s, and the 1980s, the regional shares in global production have changed significantly. The maximum changes were experienced by Asia, the U.S.S.R., North America, and Western Europe. While the shares of Asia and the U.S.S.R. increased, those of North America and Western Europe decreased. For example, in total fertilizer production, Asia and the U.S.S.R. increased their shares from 4% and 10% in 1960 to 25% and 24%, respectively, in 1987. At the same time, the shares of North America and Western Europe decreased from 28% and 42% in 1960 to 21% and 14%, respectively, in 1987. Among different nutrients, Asia dominated N production (34%), North America P_2O_5 production (24%), and the U.S.S.R. K_2O production (36%).
6. Compared with its fertilizer requirement, sub-Saharan Africa had the most narrow production base of all regions and subregions; it accounted for about one-eighth of 1% (0.12%) of global fertilizer production in 1987, and about one-fifth of its domestic requirements.
7. Unlike global fertilizer use, global fertilizer production is sensitive to changes in global fertilizer prices; it is also sensitive to the local availability of feedstock and changes in feedstock prices. Increased fertilizer prices of the 1974-81 period promoted rapid production growth in those regions that had adequate feedstock base while the low prices of the 1980s decelerated production in many regions except those that had adequate feedstock and government involvement in the fertilizer production.

II. Future Outlook

Demand

1. The demand projections of this study indicate that total fertilizer use will grow at 2.6% per annum during the 1987-95 period. Nitrogen use will grow at 2.8% per annum, P_2O_5 use at 2.7%, and K_2O use at 2.1%.
2. In absolute amounts, total fertilizer use will increase from 132.3 million tons in 1987 to 163.5 million tons in 1995. N use will increase from 72.4 million tons in 1987 to 90.5 million tons in 1995, and P_2O_5 and K_2O use will increase from 33.8 and 26.1 million tons in 1987 to 42.2 and 30.9 million tons, respectively, in 1995.
3. Of the projected increases in N use, Asia will contribute 53%, the U.S.S.R. 16%, and North America 12%. Likewise, in the projected increase in P_2O_5 use, these three regions will contribute 48%, 22%, and 20%, respectively. In the projected increase in K_2O use, the U.S.S.R. will contribute 30%, Asia 25%, and North America 18%. Thus, these three regions will account for more than 70% of the projected increases in N, P_2O_5, and K_2O use.

Capacity and Production Potential

1. Ammonia capacity is expected to increase from 113.8 million tons N in 1987 to 129.4 million tons N in 1995. More than one-half of the expected increase is still planned, and another one-fourth is under construction. Asia and the U.S.S.R. will account for more than one-half of the expected increase in ammonia capacity.
2. Phosphoric acid capacity is expected to increase from 37.0 million tons P_2O_5 in 1987 to 39.4 million tons P_2O_5 in 1995. Because of excess capacity and surplus production, relatively modest increases in phosphoric acid capacity are expected. Most of the expected increase in phosphoric acid capacity will occur in North Africa and West Asia.
3. Like phosphoric acid capacity, potash capacity is also expected to increase by about 2 million tons--from 37.0 million tons in 1987 to 39.0 million tons in 1995. Most of this increase in capacity will take place in the U.S.S.R. and West Asia.
4. Nitrogen production potential will increase from 80.3 million tons in 1987 to 91.3 million tons in 1995, and P_2O_5 and K_2O production potentials

from 39.0 and 31.2 million tons in 1987 to 43.4 and 32.9 million tons in 1995.

5. A comparison of the estimated 1987 production potential with actual production reveals that actual fertilizer production in 1987 was lower than the technically obtainable maximum production by 5.9% for N, 8.7% for P_2O_5, and 7.7% for K_2O. This was a result mostly of low and unremunerative fertilizer prices.

Supply-Demand Balances

1. The projected global supply-demand balances indicate that during the 1990-95 period, the nitrogen situation will remain in fragile balance, the phosphate situation in stable balance, and the potash situation will be one of surplus.
2. Under the base case scenario, nitrogen shortages will appear in 1991 and continue thereafter. The magnitude of these shortages will decrease in 1992 but will magnify to about 2.8 million tons in 1995. However, if the capacity utilization rates were higher by one percentage point in all regions (high CU scenario), no nitrogen shortages would appear until 1995. On the other hand, if the capacity utilization rates were lower by one percentage point in all regions (low CU scenario), marginal shortages might occur as early as 1990 and accentuate thereafter. Under this scenario, these shortages will vary between 2 million tons and 4 million tons during the 1991-95 period.
3. Unlike the nitrogen situation, the phosphate situation is less sensitive to changes in capacity utilization. No significant shortages are expected until 1995. Surpluses will dominate the scene until 1993. In 1994, the phosphate situation will be nearly balanced.
4. Like the phosphate situation, the potash situation will also be dominated by surpluses. Even in 1995, the supply potential will exceed the forecast demand by about 500,000 tons.
5. Most of the nitrogen surpluses will be in the U.S.S.R. and Eastern Europe, most of the phosphate surpluses will be in North America and North Africa, and most of the potash surpluses in North America and the U.S.S.R. North Africa, West Asia, and Central America will also have some nitrogen surpluses.

Price Outlook

1. Although the nitrogen shortages will put pressure on urea and other N product prices and restore them to their long-run equilibrium level in the 1990s, it is unlikely that the experience of the mid-1970s will be repeated in the 1990s.
2. The growing demand for P_2O_5 and K_2O will restore phosphate and potash prices to their economically viable levels.

III. Food Security and Fertilizer Use

1. During the mid-1980s, despite mounting food surpluses worldwide, hunger and malnutrition still persisted. By promoting food production in the food deficit countries, fertilizer use can help in resolving this paradox of hunger in the midst of plenty.
2. The world production of cereals and root crops increased from 1,390 million tons in 1961-63 to 2,345 million tons in 1983-85. Although several factors contributed to this increase in food production, a tremendous increase in fertilizer use in both the developed and the developing regions seems to have contributed the most.
3. An analysis of the required increase in fertilizer use for food availabilities and the projected increase in fertilizer use indicates that many developing countries will require more than the projected increases in fertilizer use to make significant improvements in the nutritional levels of their populations.
4. Because the fertilizer use levels in many developing regions are low, there is a considerable scope to increase fertilizer use in these regions by improving physical and institutional infrastructures and marketing systems and by adopting suitable policies and programs. Also, there is scope for improving fertilizer use efficiency so that more crop output can be obtained from the same level of nutrient use.

CHAPTER 1
INTRODUCTION

In the field of food and fertilizers, if the mid-1960s are remembered for projection of global starvation and prescription of triage and the mid-1970s for sky-rocketing prices of food and fertilizers and panic buying of fertilizers, then the mid-1980s should be remembered for two paradoxical phenomena. First, coexistence of low fertilizer prices and decreased fertilizer use and, second, coexistence of hunger and malnutrition and excessive grain stocks. The first paradox was caused by forces outside the fertilizer sector and the second by a geographical imbalance between supply of and demand for food grains.

In the mid-1980s fertilizer prices were very low. For example, urea prices averaged about US $136/ton in 1985 compared with $222/ton in 1980 and $316/ton in 1974 (Figure 1.1). However, in spite of such low prices, global fertilizer use decreased by 1.3% in 1985/86. This decrease in fertilizer use is comparable to the one in 1974/75 when fertilizer prices were an all-time high. This situation was a result of forces operating outside the fertilizer sector. Notable among such forces were low crop prices due to excess grain stocks in North America, Western Europe, and Oceania; acreage reduction programs in North America; and foreign exchange shortages leading to restricted fertilizer imports in Africa and Latin America. In addition to these micro- and macroeconomic and policy changes, unfavorable climatic conditions in many parts of the world, especially in Asia, also produced this situation.

Likewise, the mid-1980s also witnessed the paradox of hunger and malnutrition and mounting food surpluses, or what the 1988 World Food Conference[1] called "hunger in the midst of plenty." In 1985 about 730 million people (more than 3 times the U.S. population) were estimated by the World Bank (1986) to suffer from hunger and malnutrition in Asia, Africa, and Latin America while the world stocks of cereals, mostly in North America and Western Europe, were excessive at 415 million tons. Thus, there was a geographical imbalance between supply of and demand for foodgrains.
Furthermore, the countries of Asia, Africa, and Latin America, where the hunger and malnutrition prevailed, had limited capacity to import food because

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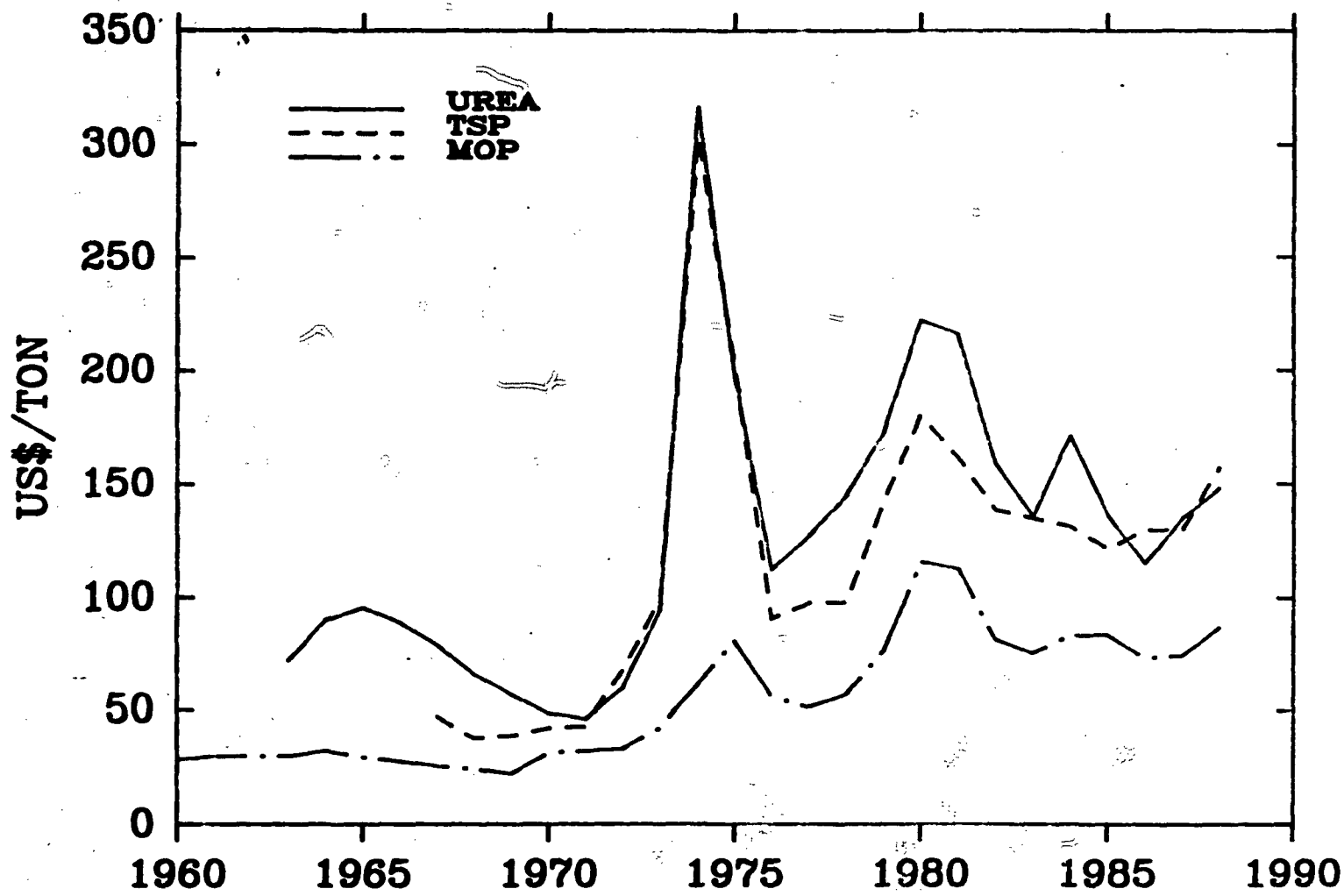
1. Held in Des Moines, Iowa, June 5-9, 1988.

Figure 1.1

GLOBAL FERTILIZER PRICES, 1960–87
(US$/TON)



SOURCE: WORLD BANK/GREEN MARKETS.

of their debt crises and foreign exchange shortages, and even in those countries that had capacity to import food grains, poverty prevented many people from buying the necessary food to maintain healthy and productive lives.

In addition to these paradoxes, the 1980s also witnessed several other disturbing phenomena. First, total fertilizer use at the global level grew slowly; it increased at 2.6%/year during the 1980-87 period. This annual growth was less than half of the actual growth in the 1970s, and less than one-third of that in the 1960s; it was also less than two-thirds of the projected[2] annual growth for the 1980s (Figure 1.2, Panel D). Second, although the slowdown in use growth was experienced by all three nutrients, slowdown was much more significant for P_2O_5 and K_2O than for N (Figure 1.2, Panels A, B, and C). Against the projected and historical annual growth of more than 4%, P_2O_5 and K_2O use only grew at 1.9% and 1.5%/year, respectively, during the 1980-87 period. Economic and policy changes apparently affected their use adversely. Third, the global level of fertilizer use decreased on three occasions during the 1980s (in 1982, 1983, and 1986) as compared with only once in the 1970s.[3] Low crop prices, acreage reduction programs, macroeconomic difficulties (debt crises and foreign exchange shortages), and the removal of fertilizer subsidies seemed to have produced these fluctuations and have slowed growth in global fertilizer use. Unfavorable weather also contributed to these fluctuations. Fourth, the slowdown in fertilizer use growth not only slowed down the growth in capacity and production but also induced low and unremunerative prices, which led to permanent closures and idling of productive capacity. The low fertilizer prices did little to promote growth in fertilizer use for the reasons explained above but did lead to the restructuring of the fertilizer industry in many regions, especially in North America and Western Europe.

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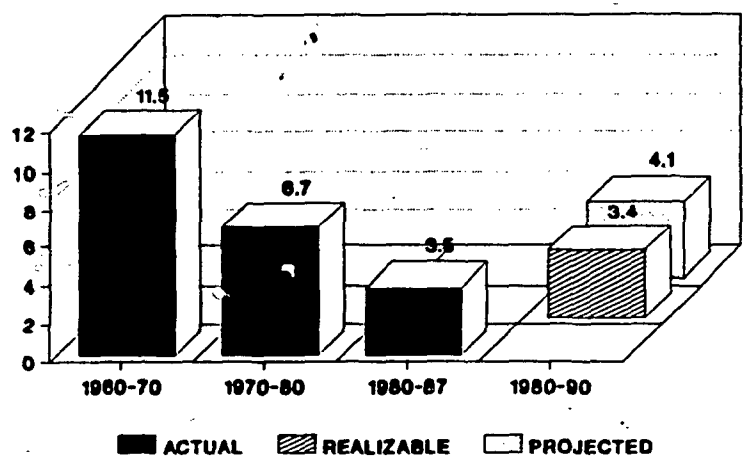
2. Projected by the FAO/UNIDO/World Bank Working Group in May 1980.

3. See Figure 2.1 in Chapter 2 below for details.

Figure 1.2

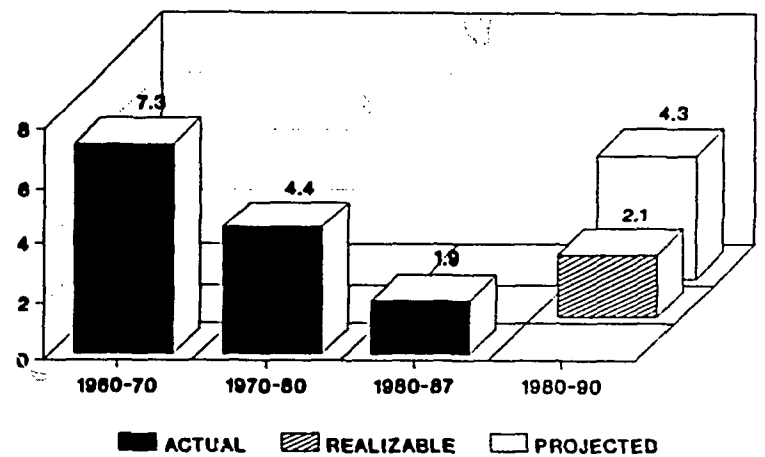
Global Fertilizer Use: Actual and Projected Annual Growth, 1960-90 (Percent)

Nitrogen



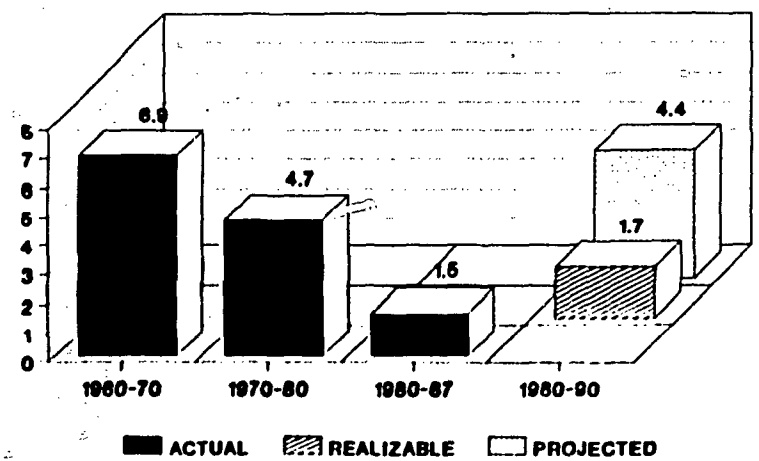
A

Phosphate



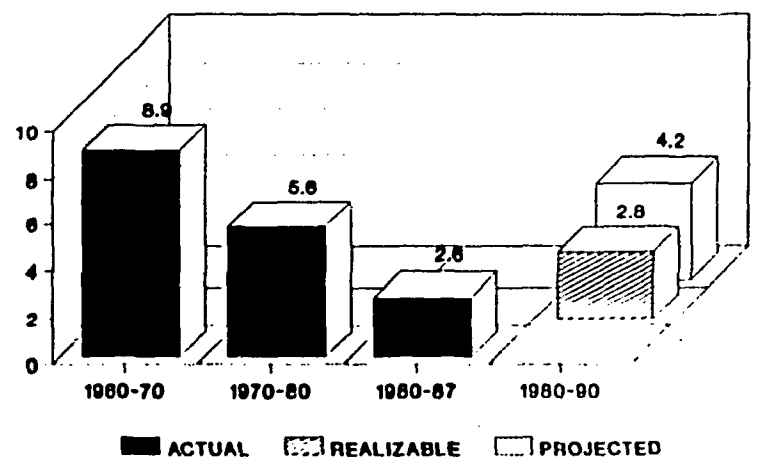
B

Potash



C

Total NPK



D

Nature, Scope and Objectives of the Study

Objectives

The main objectives of the study are:

1. To analyze trends in fertilizer use and production at the global and regional levels, and identify the factors inducing these trends.
2. To project global and regional demand, supply, and supply-demand balances for nitrogen, phosphate, and potash during the 1990s.
3. To provide qualitative assessment of the impact of the projected supply-demand balances on global fertilizer prices.
4. To evaluate the impact of the projected growth in fertilizer use on food availabilities in the developing countries of Asia, Africa, and Latin America.

Nature and Scope

The study uses an empirical or inductive approach for analyzing trends and patterns in fertilizer use and production at the regional and the global levels. Consequently, no hypotheses are proposed and tested; rather the existing body of knowledge and analytical findings are used to explain empirical phenomena. Where the existing knowledge is inadequate in explaining the observed (recorded) phenomena, areas for further research are identified.

Because of the study's focus on global and regional trends in fertilizer use and production during the 1960-95 period, the study provides a macro view of the changes in the fertilizer sector at the global and the regional levels. Consequently, it concentrates more on the factors that affect fertilizer use at the national and regional levels, and less on the factors that affect fertilizer use at the farm level. Because many factors that affect fertilizer use at the farm level also affect fertilizer use at the national and regional levels, they are discussed in the study. The pricing environment and the policy framework are two such factors that affect fertilizer use at both the farm and the national levels. On the other hand, the macroeconomic factors like foreign exchange allocations and debt crisis affect fertilizer use more at the national levels and less at the farm level. However, to the extent that these factors constrain supplies at the national level, they also affect fertilizer use at the farm level.

In projecting fertilizer demand, the study uses a positive concept of effective demand rather than a normative concept of fertilizer

requirements. The normative fertilizer requirements are primarily dependent on population growth and the growth required in food production to feed the growing population; whereas, the effective demand depends on several factors unrelated to population growth. Notable among such factors are the pricing environment, the policy framework, the fertilizer supply system, the agroecological environment, and crop technologies. Thus, depending on the availability and adequacy of these factors, effective demand for fertilizers could be higher or lower than normative fertilizer requirements.

Data, Regional Classification, and Outline of the Study

Data

Data used in this study have come from several different sources. Some of the important sources are FAO (historical data on consumption, and production), British Sulphur and TVA (capacity data), World Bank (global crop, fertilizer, and energy prices), *Green Markets* (fertilizer prices), IFDC (farm-level crop and fertilizer prices in the developing countries), and USDA (farm-level crop and fertilizer prices in the developed countries). In addition to these sources, information was also collected from IFDC collaborators in several developing countries. Because the latest historical data on consumption and production were available for 1986/87 when the study was initiated, 1986/87 has been used as a base for making projections as well as for terminating historical analyses.[4]

However, for estimating production and supply potential, June 1988 (1987/88) has been used as a cutoff point because latest capacity estimates were available for 1987/88.

Regional Classification

The regional classification used in this study is explained in Appendix A, Part I. The world is divided into eight geographical regions. These are: North America (NA), Western Europe (WE), Eastern Europe (EE), the U.S.S.R. (SU), Oceania (OC), Africa (AF), Latin America (LA), and Asia (AS).

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4. The changes in global and regional fertilizer consumption and production in 1987-88 over 1986-87 are analyzed in Appendix D.

Because of the vast size, diversity, and complexity of the last three regions, these regions have been further divided into subregions. In Africa, the subregions are North Africa (NAF), Sub-Saharan Africa (SSA), and South Africa (SAF); in Latin America they are Central America (CA) and South America (SA); and in Asia they are East Asia (EAS), South Asia (SAS), and West Asia (WAS) (Map 1.1).

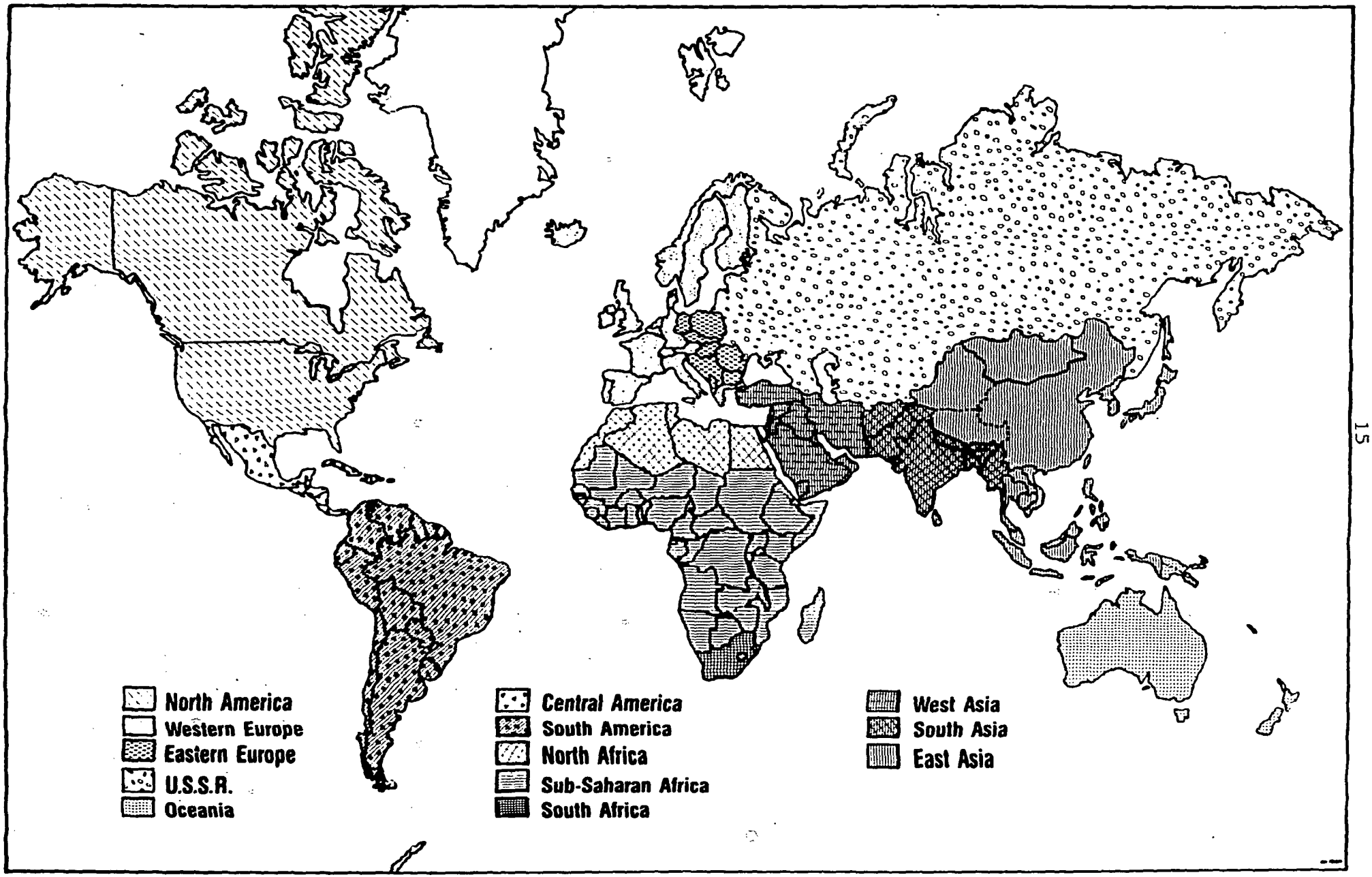
Table 1.1 indicates dominant fertilizer-using countries in each region and subregion.

Outline of the Study

The study focuses on the following major topics:

1. Trends in global and regional fertilizer consumption.
2. Trends in global and regional fertilizer production.
3. Global and regional demand projections.
4. Global and regional supply projections.
5. Global and regional supply/demand balances.
6. Price outlook--a qualitative assessment.
7. Food security and fertilizer use.

Each of these topics along with important issues involved is discussed in a separate chapter. However, these seven chapters are grouped into three parts. Part I consists of two chapters dealing with historical trends in consumption and production. These two chapters not only describe trends in consumption and production but also explain the structural changes that have taken place in the fertilizer sector at the global and regional levels. Technological, institutional, economic, and policy-related factors responsible for causing these structural changes are identified. Thus, these chapters explain the dynamics of growth and structural change in the fertilizer sector at the global and regional levels. Part II contains four chapters dealing with future outlook (demand projections, supply projections, supply/demand balances, and price outlook). A chapter on food security and fertilizer use constitutes Part III.



Map 1.1. Regional Classification.

Table 1.1. Total and Per Hectare Fertilizer Use in Selected Countries, 1985

Region/Country	Total NPK Consumption[a] ('000 nutrient tons)	Country Share in Region/Subregion[b]	Per Hectare (kg)
1. North America	22,067	100	94
U.S.A.	19,668	89	94
2. Western Europe	20,390	100	236
France	5,735	28	301
Germany, F.R.	3,172	16	427
United Kingdom	2,590	13	356
3. Eastern Europe	11,632	100	217
Poland	3,281	28	230
Germany, D.R.	1,556	14	330
Romania	1,506	13	146
4. U.S.S.R.	22,304	100	96
U.S.S.R.	22,304	100	96
5. Oceania	1,771	100	35
Australia	1,230	69	24
6. Africa	3,461	-	20
a. North Africa	1,505	100	59
Egypt	851	57	258
Morocco	249	17	36
b. Sub-Saharan Africa	992	100	7
Nigeria	277	28	11
Zimbabwe	145	15	57
Kenya	79	8	42
c. South Africa	963	100	73
Republic of South Africa	963	100	73

(Continued)

Table 1.1. Total and Per Hectare Fertilizer Use in Selected Countries, 1985 (Continued)

Region/Country	Total NPK Consumption[a] ('000 nutrient tons)	Country Share in Region/Subregion[b]	Per Hectare (kg)
7. Latin America	7,216		41
a. Central America	2,727	100	72
Mexico	1,661	61	69
Cuba	579	21	181
b. South America	4,489	100	25
Brazil	3,290	73	43
Colombia	360	8	20
Venezuela	268	6	108
8. Asia	40,586		74
a. East Asia	27,019	100	100
China	19,350	72	167
Japan	2,105	8	430
Indonesia	1,874	7	95
b. South Asia	10,297	100	47
India	7,974	77	50
Pakistan	1,254	12	74
c. West Asia	3,270	100	57
Turkey	1,541	47	54
Iran	926	28	61
WORLD	129,427		83

a. Excludes ground rock phosphate for direct application.

b. The shares of countries in Africa, Latin America, and Asia are expressed with reference to the corresponding subregions.

Source: FAO Fertilizer Yearbook, 1986.

PART I

HISTORICAL TRENDS

Chapter 2. Trends in Fertilizer Consumption, 1960-87.

Chapter 3. Trends in Fertilizer Production, 1960-87.

CHAPTER 2

TRENDS IN FERTILIZER CONSUMPTION, 1960-87

Trends in fertilizer consumption at the global and the regional levels during the 1960-87 period are analyzed in this chapter. Economic, ecological, technological, and institutional factors producing these trends are also identified. Because of the complexity and the diversity of these factors in producing different regional trends, a comprehensive analysis of regional and subregional trends is pursued here to understand the dynamics of fertilizer use growth in different regions and subregions; only a dynamic analysis of such factors and the resultant growth patterns can help in making plausible demand projections.

The analysis of global and regional trends in fertilizer use reveals several interesting phenomena. First, although the growth in fertilizer use was slowed considerably during the 1980s, not all regions experienced a slowdown in growth in fertilizer use. While North America's fertilizer use decreased and Western Europe's increased at marginal rates, Asia and the U.S.S.R. experienced more than 5% annual growth in their fertilizer use and therefore were the main driving forces behind the growth in global fertilizer use in the 1980s. Second, because of different growth rates experienced by different regions during the 1960-87 period, the regional shares in global fertilizer use have changed significantly. If the 1960s were dominated by Western Europe, and the 1970s by North America, then the 1980s belonged to Asia. In 1985, Asia accounted for 30% of total and 40% of nitrogen consumption at the global level. Third, different factors have influenced fertilizer use growth in different regions, and within the same region, these factors have changed from one period to another. Over time, if the crop technologies (HYVs) promoted growth in fertilizer use in the 1960s, and fertilizer production technologies (centrifugal compressors and large-scale plants) accelerated the growth in fertilizer use in the 1970s, then it was the worsening macroeconomic and microeconomic environment which slowed the growth in fertilizer use in the 1980s. Among different regions, microeconomic (crop prices) and policy changes (acreage reduction programs) in North America, Western Europe, and Oceania and macroeconomic changes in Latin America played important roles in slowing down growth in fertilizer use, whereas in the U.S.S.R. and Asia, policy and price stability, increased domestic production,

and governmental commitment and involvement were instrumental in sustaining high growth in fertilizer use in the 1980s. Sub-Saharan Africa's fertilizer use growth was sustained by donor support. Thus, the regional and temporal experience of over a quarter of a century (1960-87) indicates that with given crop and fertilizer production technologies, the economic and policy environments play an important role in inducing or slowing growth in fertilizer use. Finally, as the role of economic and policy variables changes from one period to another and from one region to another, there is a need for continuous monitoring and analysis of these changes for accurate projections of the short-run fluctuations and the long-run trends in fertilizer use at the global and regional levels.

Global Trends

Because of economic, policy, and climatic changes of the 1980s, global fertilizer use increased at a much slower rate in the 1980s than in the 1970s and the 1960s. For example, total fertilizer use grew at 2.6% per annum during the 1980-87 period compared with 5.6% per annum during the 1970s and 8.9% during the 1960s (Table 2.1). In absolute terms total fertilizer use increased from 111.1 million nutrient tons in 1980 to 132.3 million nutrient tons in 1987--a total increase of 21 million tons during the 7-year period or an annual increase of 3 million tons. Against this, fertilizer use increased at about 5 million tons/annum during the 1970s and 3.5 million tons/annum during the 1960s--from 27.44 million tons in 1960 to 62.11 million tons in 1970 and to 111.08 million tons in 1980. Thus, it is clear that in absolute terms fertilizer use increased at a maximal annual rate during the 1970s. This acceleration in fertilizer use growth in the 1970s was impressive because it occurred in spite of rapid increases in fertilizer prices in 1974/75 and 1978/79. Also, global fertilizer use decreased only once during the 1970s in 1974-75. Against this steady and accelerating growth in fertilizer use in the 1970s, growth in fertilizer use was slow and fluctuating during the 1980s; global fertilizer use decreased three times in the 1980s, namely, in 1982, 1983, and 1986 (Figure 2.1). Although many factors are responsible for these fluctuations, the folliwng four factors played a dominant role in causing slowdown in fertilizer use in the 1980s:

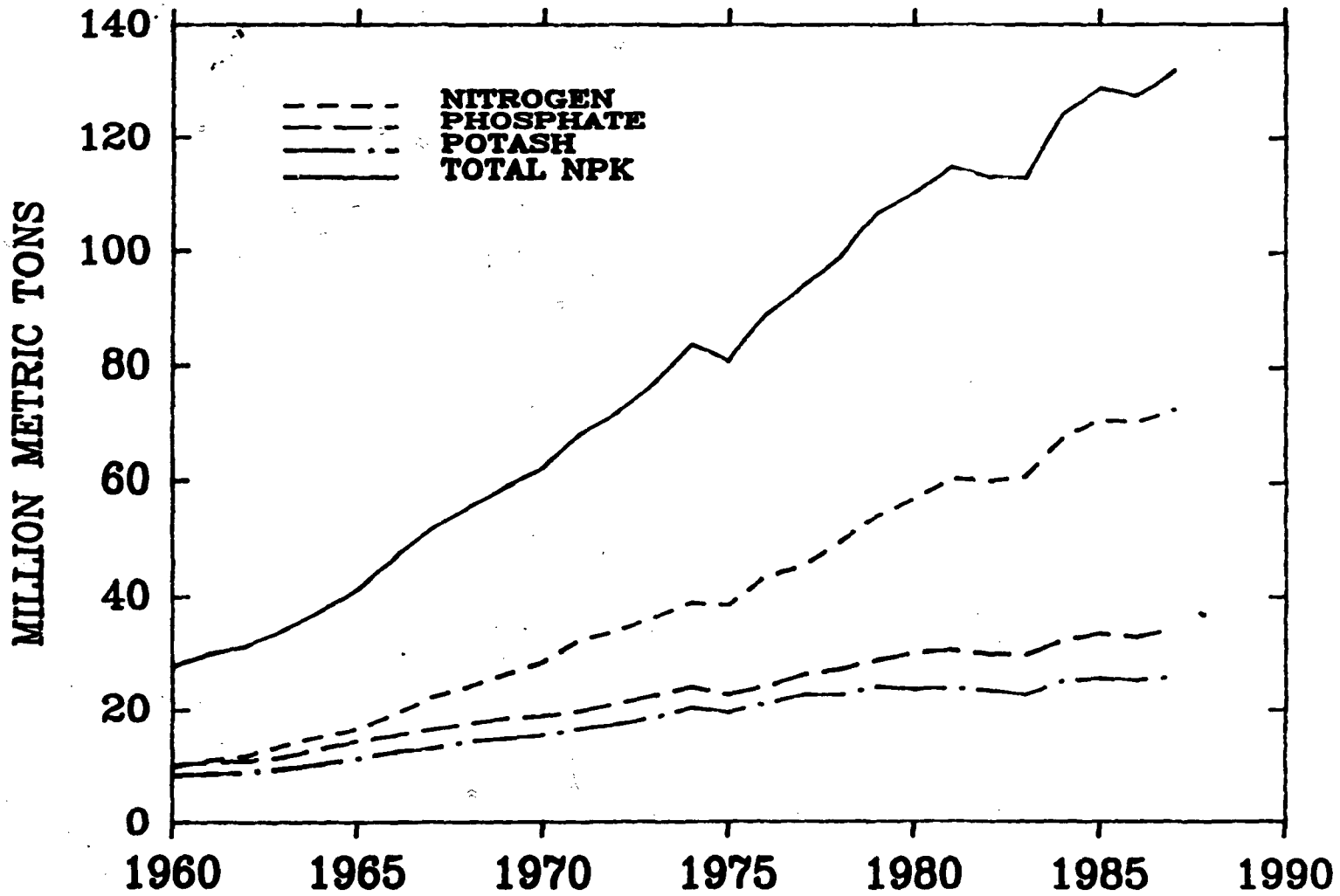
Table 2.1. Global Fertilizer Use: Annual Growth Rates, 1960-87

Nutrient	1960-70	1970-80	1980-87
	(%)		
N	11.5	6.7	3.8
P_2O_5	7.3	4.4	1.9
K_2O	6.9	4.7	1.5
Total	8.9	5.6	2.6

Source: Derived by using log-linear regressions on FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Figure 2.1

WORLD: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK CONSUMPTION, 1960–87



1. Climatic changes--droughts and inadequate rainfall in many parts of the world.
2. Microeconomic changes--low crop prices in North America, Western Europe, and Oceania.
3. Macroeconomic changes--debt crises, foreign exchange shortages, and balance-of-payment difficulties causing many countries to reduce fertilizer imports, and therefore, fertilizer use.
4. Policy changes--acreage reduction programs, especially in North America and subsidy removal programs in many developing countries.

Nutrientwise Growth

Table 2.1 indicates growth rates for nutrient use during the 1960s, 1970s, and 1980s. It is clear from the table that there was a general slowdown for all three nutrients in the 1980s, although the slowdown in fertilizer use growth was maximum for K_2O, followed by P_2O_5 and N. Nitrogen use increased at 3.8% per annum, and P_2O_5 and K_2O use at 1.9% and 1.5%, respectively. These growth rates for P_2O_5 and K_2O are less than half of the growth rates in the 1970s and less than one-third of those in the 1960s. Growth rate for nitrogen use was somewhat more than one-half of the growth rate in the 1970s. Thus, it is obvious that economic changes of the 1980s affected P_2O_5 and K_2O use more adversely than they did nitrogen use, because phosphate and potash uses are more sensitive to economic changes (price changes and foreign exchange allocations) than nitrogen use is.[5]

This relatively higher sensitivity of P_2O_5 and K_2O use levels to economic changes, especially to changes in crop prices, results from the fact that not all of the applied P_2O_5 and K_2O is used in a single crop cycle. Consequently, the soils remain enriched with P_2O_5 and K_2O even when these nutrients are not applied in the following crop cycle. Although no quantifiable information is available on the role of the residual P_2O_5 and K_2O in influencing the current application rates of P_2O_5 and K_2O by the farmers, many agronomists[6] feel that under adverse economic circumstances, the farmers may easily skip application or reduce application levels of P_2O_5 and K_2O without adversely affecting crop yields. Under such circumstances, the

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5. See Annex B for details.

6. Discussions with O. Engelstad (formerly of TVA).

residual phosphate and potash in the soil act as a bank reserve that the farmers use during adverse economic circumstances and replenish when the economic circumstances improve.

In absolute terms, nitrogen use increased from 9.5 million tons in 1960 to 28.2 million tons in 1970, 57.2 million tons in 1980, and 72.4 million tons in 1987. Likewise, P_2O_5 use increased from 9.8 million tons in 1960 to 29.9 million tons in 1980 and 33.8 million tons in 1987, and K_2O use increased from 8.13 million tons in 1960 to 24 million tons in 1980 and 26.1 million tons in 1987 (Table 2.2). Three interesting phenomena are evident in these changes. First, while N use was lower than P_2O_5 use in 1960, it was more than twice the P_2O_5 use in 1987. Second, the $N:P_2O_5:K_2O$ ratio was 1.0:1.02:0.85 in 1960 but changed to 1.0:0.46:0.36 in 1987. Third, while N use increased by 15 million tons during the 1980-87 period, P_2O_5 and K_2O use increased by 4 million and 2 million tons, respectively.

It is clear from this analysis that annual growth rates of use levels of all three nutrients have been decreasing over time; however, in order to understand the dynamics of fertilizer use growth, we further decompose these changes in 5-year periods. Figure 2.2 indicates these changes for N, P_2O_5, and K_2O during the 1960-87 period. What is important to note from this figure is that growth in fertilizer use accelerated during the 1975-80 period. During the 1970-75 period, fertilizer use increased by about 30%, but during the 1975-80 period it increased by 37% (Table 2.3). This acceleration was caused by both improved crop prices and policy changes, especially in the developing countries.

Furthermore, we find that this acceleration in use was only for N and P_2O_5 and not for K_2O. There was little acceleration in growth of K_2O use primarily because the rice crop is less sensitive to K_2O use and also because many developing countries lacked indigenous supplies.

Besides, the percentage change in growth was lower in both the early 1970s and the early 1980s compared with that in the late 1970s. As these slowdowns were caused by macro and microeconomic changes, improved micro and macroeconomic prospects during the late 1980s should result in a higher percentage growth during the 1985-90 period.

Table 2.2. Global Fertilizer Consumption, 1960-87

Year	N	P_2O_5	K_2O	Total
	(million nutrient tons)			
1960	9.54	9.76	8.13	27.44
1965	16.38	14.01	10.93	41.33
1970	28.1[illegible]	18.80	15.14	62.11
1975	38.50	22.86	19.50	80.86
1980	57.19	29.89	24.00	111.08
1985	70.51	33.01	25.90	129.43
1986	69.97	32.38	25.58	127.93
1987	72.37	33.84	26.09	132.31

Source: FAO (1988) and FAO Fertilizer Yearbook (various issues).

Figure 2.2

World: Percentage Change in Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1960-87

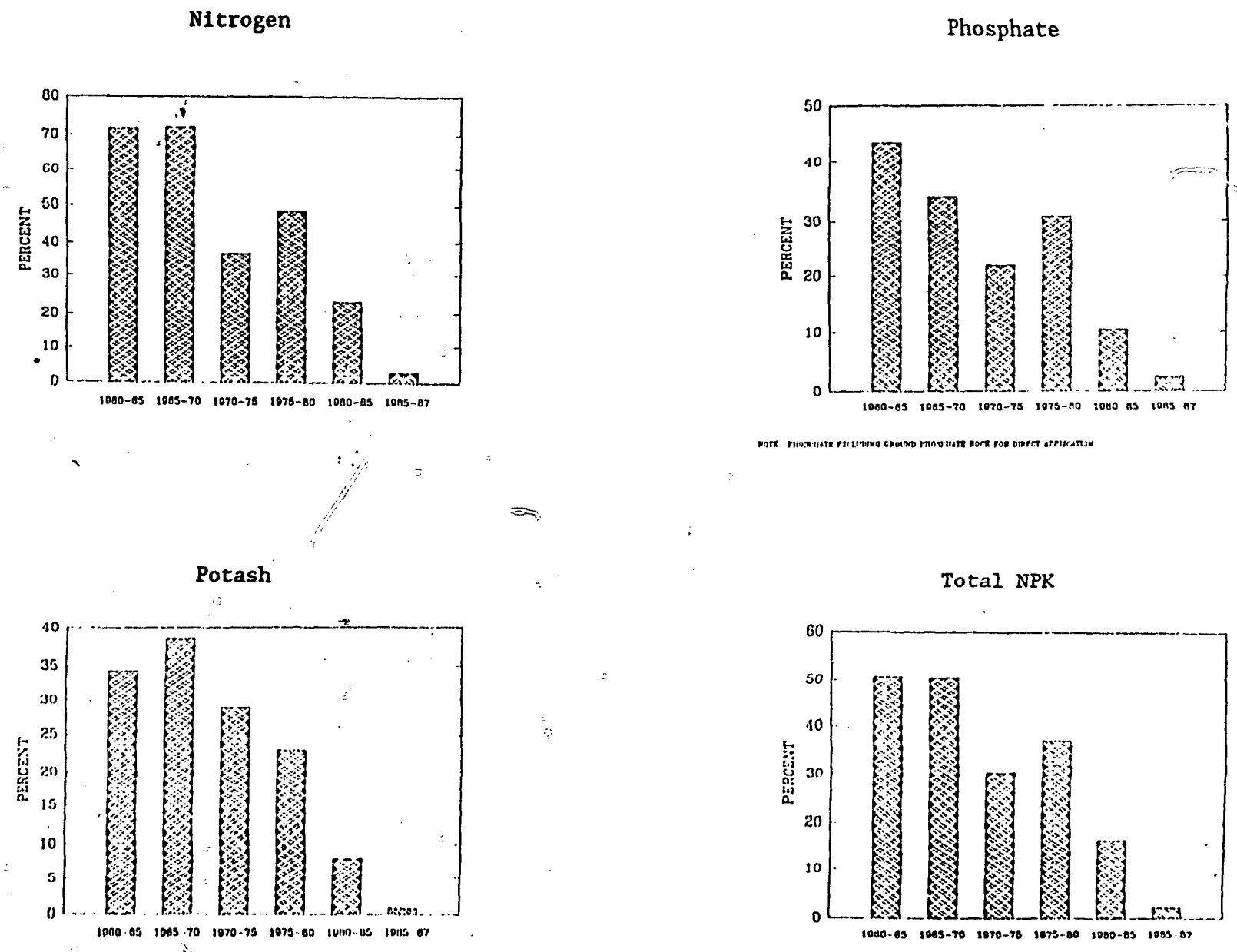

Table 2.3. Percentage Changes in Global Fertilizer Consumption, 1960-87

Year	N	P_2O_5	K_2O	Total
	(%)			
1960-65	72	44	34	51
1965-70	72	34	38	50
1970-75	37	22	29	30
1975-80	49	31	23	37
1980-85	23	10	8	17
1985-87	3	3	1	2

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Regional Variations

Although growth in global fertilizer use was slowed during the 1980s, it did not slow down in all regions. Likewise, the acceleration in use growth in the late 1970s was not uniform to all regions.

Table 2.4 indicates growth rates of nutrient use for different regions during the 1980s. Total fertilizer use grew fastest in the U.S.S.R. (6.4%) and Asia (5.7%). Annual growth rates in Latin America and Africa averaged about 2.7% and 2.5%, respectively. Against this, total fertilizer use decreased in North America, Eastern Europe, and Oceania. Western Europe experienced a marginal increase in total fertilizer use. Thus, positive growth rates of Asia and the U.S.S.R. were partly offset by negative growth rates of North America, Eastern Europe, and Oceania.

Among different nutrients, all regions except North America experienced growth in nitrogen use, although at different rates. Oceania, the U.S.S.R., and Asia had 5.6%-6.2% annual growth in N use; Latin America, Africa, and Western Europe had between 1.7% and 4.5% per annum. North America's small annual decrease is mostly due to low crop prices and acreage reduction programs.

Unlike nitrogen use, phosphate use decreased in several regions. Regions that experienced significant annual declines in P_2O_5 use are North America (-3.29%), Western Europe (-2.12%), Oceania (-2.9%), and Eastern Europe (-0.93%). Economic and policy changes as well as changes in cropping patterns seemed to have caused these decelerations in P_2O_5 use. Also, the residual phosphorus in the soil allowed the farmers in these regions to reduce or skip phosphate applications under adverse economic circumstances of the 1980s. The U.S.S.R. and Asia, however, experienced more than 6% per annum growth in P_2O_5 use, and Africa and Latin America between 1% and 1.8%.

Like phosphate use, potash use also decreased in many regions (North America, Western Europe, Eastern Europe, and Oceania), although the rate of annual decrease is much smaller in all these regions except North America. Again, the U.S.S.R. and Asia were the fastest growing regions in the 1980s.

Against this contrasting regional experience of the 1980s, all regions experienced growth in the 1970s and 1960s (Tables 2.5 and 2.6). Among different nutrients also, all regions (except Oceania for P_2O_5 in the 1970s) experienced growth in both decades. In the 1970s Latin America and Asia were the fastest growing regions. For the U.S.S.R. and Africa, annual growth was between 6% and 8% per annum. Even North America and Eastern Europe, which

Table 2.4. Regional Nitrogen, Phosphate, Potash, and Total NPK Consumption: Annual Growth Rates, 1980-87

Region	Nitrogen	Phosphate	Potash	Total
	(%)			
North America	-0.6	-3.3	-2.9	-1.8
Western Europe	1.7	-2.1	-0.1	0.3
Eastern Europe	0.4	-0.9	-0.3	-0.2
U.S.S.R.	6.1	6.8	6.5	6.4
Oceania	6.2	-2.9	-0.1	-0.7
Africa	2.9	1.8	2.8	2.5
North Africa	4.4	5.0	6.4	4.8
Sub-Saharan Africa	5.4	6.9	3.7	5.5
South Africa	-3.5	-4.9	-1.3	-3.8
Latin America	4.5	1.0	2.1	2.7
Central America	4.8	4.6	3.3	4.5
South America	4.2	0.2	1.8	1.9
Asia	5.6	6.4	4.5	5.7
East Asia	4.0	4.5	3.1	4.0
South Asia	8.9	11.1	7.1	9.3
West Asia	8.0	5.5	11.9	7.1
WORLD	3.5	1.9	1.5	2.6

Source: Derived from FAO data by using log-linear regressions. FAO (1988).

Table 2.5. Regional Nitrogen, Phosphate, Potash, and Total NPK Consumption: Annual Growth Rates, 1970-80

Region	Nitrogen	Phosphate	Potash	Total
	(%)			
North America	4.6	2.3	4.6	4.0
Western Europe	4.2	0.1	1.1	2.1
Eastern Europe	5.1	4.9	3.0	4.4
U.S.S.R.	6.6	9.4	8.7	7.9
Oceania	7.1	-0.7	1.8	0.6
Africa	6.5	6.4	5.1	6.2
North Africa	5.4	8.3	6.3	6.2
Sub-Saharan Africa	5.9	7.3	5.9	6.3
South Africa	9.1	4.8	3.6	6.2
Latin America	8.3	11.1	10.7	9.8
Central America	6.9	4.4	3.0	5.7
South America	10.1	13.4	14.1	12.5
Asia	10.6	7.9	6.8	9.6
East Asia	10.4	5.4	5.8	8.8
South Asia	10.5	13.0	10.8	11.0
West Asia	12.2	13.7	3.7	12.5
WORLD	6.7	4.4	4.7	5.6

Source: Derived from FAO data by using log-linear regressions. FAO (1988).

Table 2.6. Regional Nitrogen, Phosphate, Potash, and Total NPK Consumption: Annual Growth Rates, 1960-70

Region	Nitrogen	Phosphate	Potash	Total
	(%)			
North America	10.6	6.6	7.2	8.4
Western Europe	7.3	4.0	2.8	4.8
Eastern Europe	13.5	10.9	8.6	11.0
U.S.S.R.	18.7	10.0	13.9	14.7
Oceania	16.7	6.1	7.8	6.9
Africa	10.7	7.6	10.2	9.4
North Africa	8.5	4.5	4.5	7.1
Sub-Saharan Africa	13.3	13.5	9.9	12.5
South Africa	13.8	7.7	13.6	10.2
Latin America	13.1	9.7	13.1	11.9
Central America	14.3	18.6	17.8	15.8
South America	11.5	6.4	10.2	8.7
Asia	13.1	13.0	6.9	12.1
East Asia	11.6	11.3	5.4	10.5
South Asia	17.5	20.2	16.1	17.8
West Asia	17.5	19.4	12.8	17.9
WORLD	11.5	7.3	6.9	8.9

Source: Derived from FAO data by using log-linear regressions. FAO (1988) and FAO Fertilizer Yearbook (various issues).

experienced significant declines in their fertilizer use in the 1980s, experienced 2%-4% growth per annum.

Latin America and the U.S.S.R. were the fastest growing regions in phosphate and potash use and Asia and Latin America in nitrogen use. No region experienced less than 4% growth in nitrogen use. However, in P_2O_5 use Oceania had negative growth and Western Europe very marginal growth. Potash use grew between 1.8% (Oceania) and 6.8% per annum among other regions. In North America, Western Europe, and Oceania, potash use grew at a higher rate than phosphate use. However, compared with 3.3% per annum decline in the 1980s, phosphate use increased at 2.3% per annum in the 1970s in North America.

Among the fastest growing regions in the 1960s, we see a pattern very similar to that in the 1980s. The U.S.S.R. and Asia were the fastest growing regions, while other regions experienced growth rates between 4.8% (Western Europe) and 11.9% (Latin America). Many of these high growth rates are because of small base from which fertilizer consumption increased. Similar regional patterns exist among different nutrients (Table 2.6).

Thus compared with positive and significant growth rates for all regions and all nutrients (except P_2O_5 use in Oceania in the 1970s) in the 1970s and 1960s, many regions experienced negative growth rates in the 1980s, and the negative growth rates were highest (in absolute value) for P_2O_5 use. All the regions that experienced negative growth in the 1980s had very little government involvement in the fertilizer sector and had experienced significant changes--both market induced as well as policy induced. On the other hand, the regions that experienced highest growth rates had a high degree of government involvement in the fertilizer sector and a high degree of policy and price stability. These regions also shielded themselves from the volatility of world prices and were less affected by the debt crises and foreign exchange shortages of the 1980s.[7]

Regional Shares

Because of the varying growth rates experienced by different regions during the 1960-87 period, the shares of different regions in total and nutrientwise consumption have changed considerably. The striking changes are for North America and Western Europe, as well as for Asia and the U.S.S.R.

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7. See pp. 59-61 and 64-75 for details.

North America's and Western Europe's shares in total global consumption decreased from 26% and 36% in 1960 to 21% and 19% in 1980, respectively. Because of the declining consumption in the 1980s, their shares further decreased to 15% and 16% in 1987. North America's shares declined sharply in the 1980s and Western Europe's declined in the 1970s. In contrast to the declining shares of North America and Western Europe, the shares of Asia and the U.S.S.R. increased sharply. Asia's share increased from 12% in 1960 to 25% in 1980 and 31% in 1987; the U.S.S.R.'s share increased from 9% in 1960 to 15% in 1980 and 19% in 1987. Other regions experienced small changes in their shares (Figure 2.3 and Table 2.7).

Changes in regional shares for different nutrients are similar to those in total fertilizer consumption, although much sharper in favor of Asia for nitrogen. In 1987, Asia accounted for about 39% of global N consumption and also had the highest share for P_2O_5 (27%). In potash use, the U.S.S.R. had the highest share (26%). North America and Western Europe averaged about 15% each in N use and 13%-14% in P_2O_5 use; their shares in K_2O consumption averaged a little less than 20% each in 1987 (Figures 2.4, 2.5, and 2.6). Because Asia's consumption levels of potash are low, Asia accounted for only 13% of global potash use. In P_2O_5 and K_2O use levels, Latin America experienced about five percentage points increase in its share for both nutrients during the 1960-87 period. Oceania's and Eastern Europe's shares decreased a little while Africa's increased marginally (Tables 2.8, 2.9, and 2.10).

Regional Trends

In this section, the trends in fertilizer use at the regional level are analyzed. Unlike the earlier sections which focused on regional variations in a comparative and global context, this section focuses on long-term trends in fertilizer use for each region separately. Tables 2.11, 2.12, 2.13, and 2.14 indicate data on total nitrogen, phosphate, and potash consumption during the 1960-87 period with 5-year intervals. The percentage changes in fertilizer use during different 5-year periods are presented in Tables 2.15, 2.16, 2.17, and 2.18.

Figure 2.3

Regional Shares of World Total NPK Consumption, 1960-87

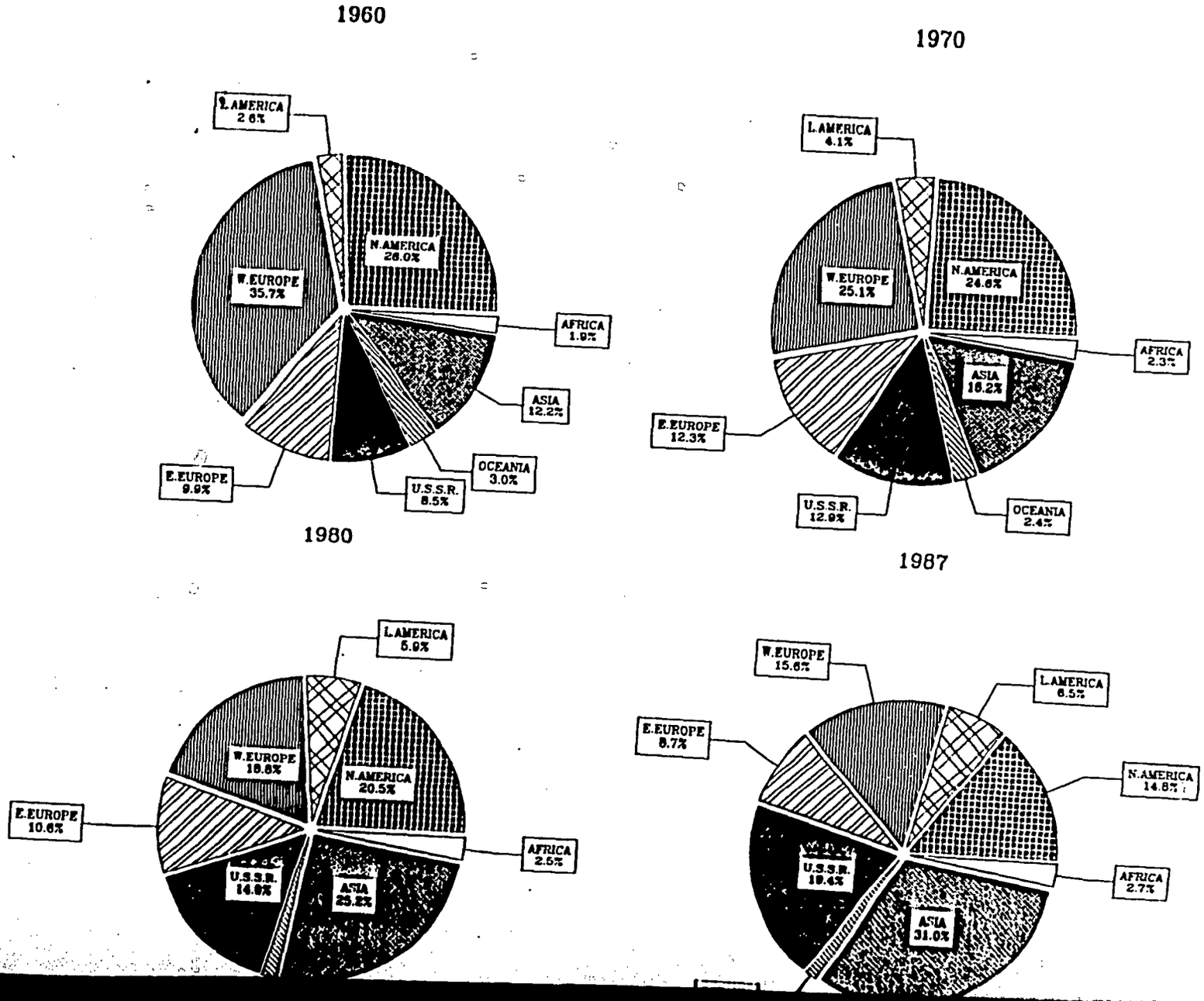


Table 2.7. Global Total NPK Consumption: Regional Shares, 1960-87

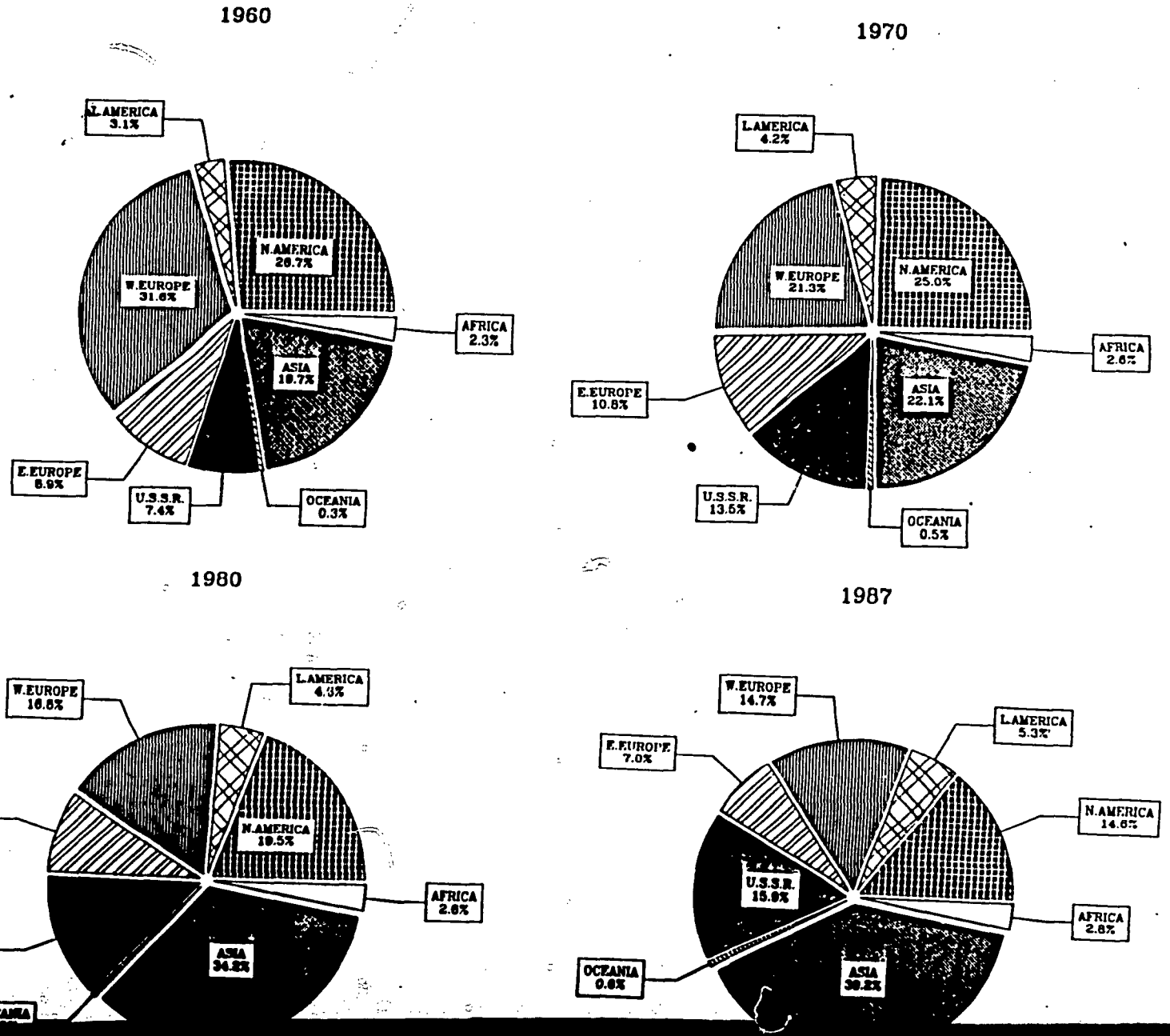
Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	26.0	25.4	24.6	21.2	20.5	17.1	14.8
Western Europe	35.7	30.3	25.1	20.9	18.8	15.8	15.6
Eastern Europe	9.9	10.7	12.3	12.8	10.6	9.0	8.7
U.S.S.R.	8.5	10.8	12.9	17.1	14.9	17.2	19.4
Oceania	3.0	3.5	2.4	1.7	1.6	1.4	1.2
Africa	1.9	2.4	2.3	2.7	2.5	2.7	2.7
North Africa	0.8	1.0	0.9	1.0	1.0	1.2	1.2
Sub-Saharan Africa	0.4	0.6	0.6	0.8	0.7	0.8	0.9
South Africa	0.7	0.8	0.8	0.9	0.9	0.7	0.6
Latin America	2.6	3.4	4.1	5.2	5.9	5.6	6.5
Central America	1.1	1.7	2.2	2.1	1.9	2.1	2.3
South America	1.6	1.7	1.9	3.2	4.1	3.5	4.2
Asia	12.2	13.6	16.2	18.3	25.2	31.4	31.0
East Asia	10.3	11.0	11.9	12.8	17.2	20.9	18.8
South Asia	1.6	2.1	3.2	4.2	6.0	8.0	9.5
West Asia	0.4	0.6	1.1	1.3	2.0	2.5	2.7
WORLD	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

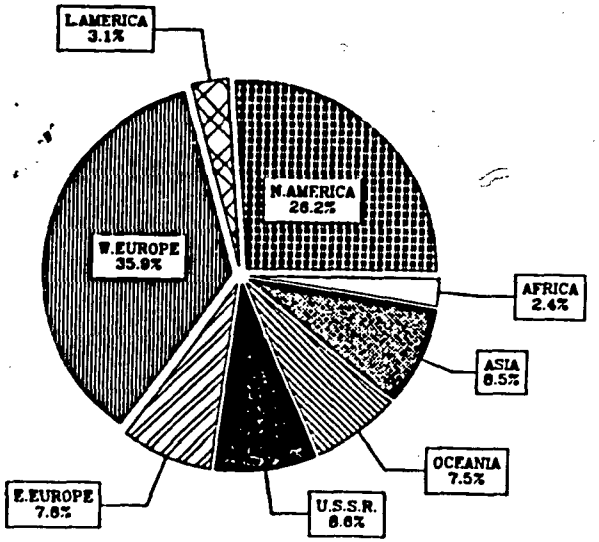
Figure 2.4

Regional Shares of World Nitrogen Consumption, 1960-87

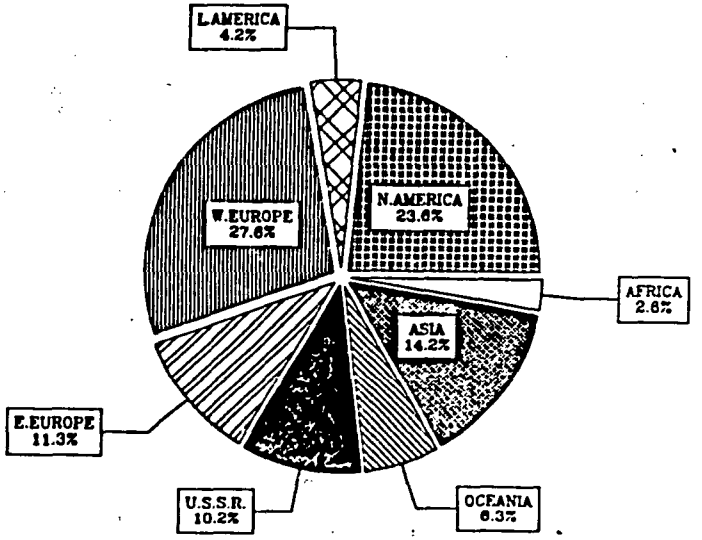


Regional Shares of World Phosphate Consumption, 1960-87

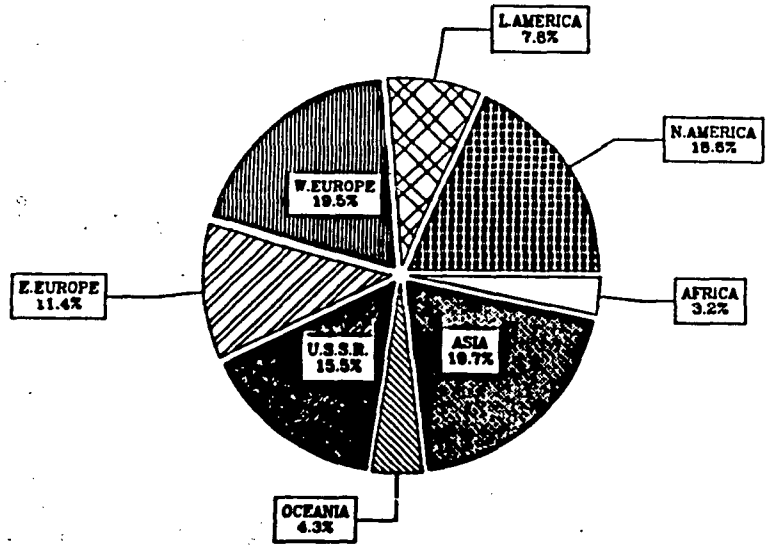
1960



1970



1980



1987

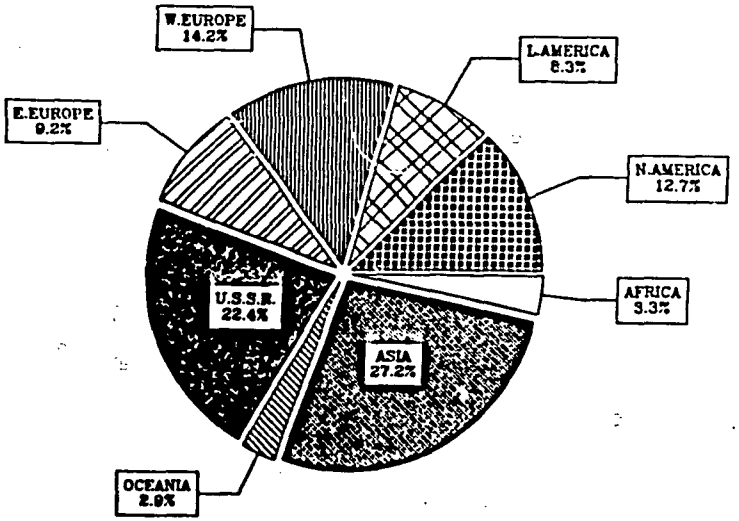


Figure 2.6

Regional Shares of World Potash Consumption, 1960-87

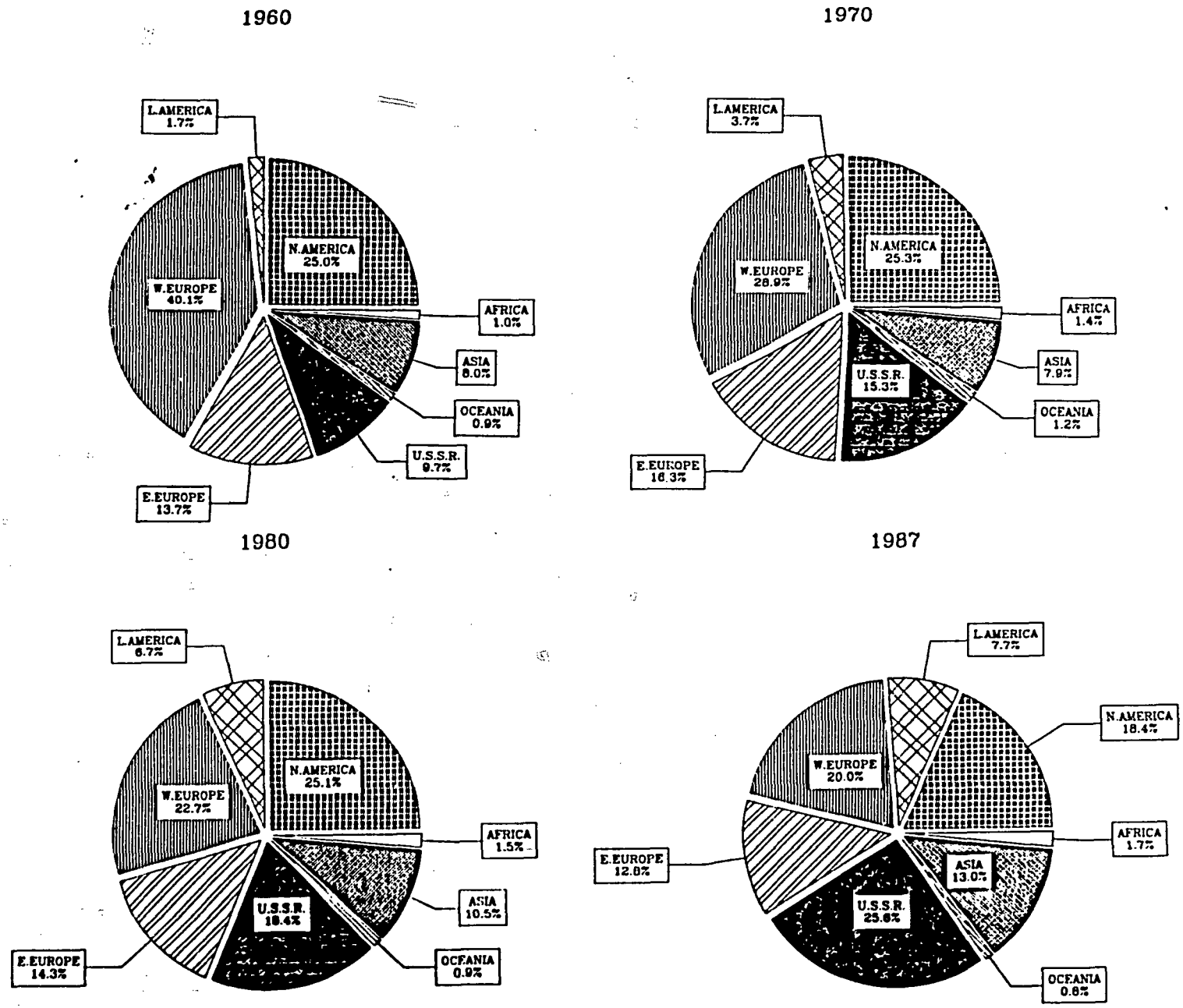


Table 2.8. Global Nitrogen Consumption: Regional Shares, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	26.7	26.7	25.0	21.7	19.5	16.6	14.6
Western Europe	31.6	26.1	21.3	18.8	16.8	14.3	14.7
Eastern Europe	8.9	9.5	10.8	10.6	8.7	7.3	7.0
U.S.S.R.	7.4	10.7	13.5	17.4	13.1	14.6	15.9
Oceania	0.3	0.5	0.5	0.5	0.5	0.5	0.6
Africa	2.3	3.1	2.6	2.8	2.6	2.6	2.8
North Africa	1.3	1.8	1.4	1.4	1.2	1.3	1.4
Sub-Saharan Africa	0.5	0.7	0.7	0.8	0.7	0.7	0.9
South Africa	0.4	0.6	0.5	0.6	0.7	0.6	0.5
Latin America	3.1	4.2	4.2	4.7	4.6	4.5	5.3
Central America	2.1	2.6	2.7	2.5	2.4	2.5	2.8
South America	1.0	1.6	1.5	2.2	2.3	2.0	2.5
Asia	19.7	19.2	22.1	23.5	34.2	39.6	39.2
East Asia	15.9	14.8	15.4	15.7	23.9	27.0	24.4
South Asia	3.1	3.7	5.3	6.3	8.2	9.9	11.9
West Asia	0.6	0.8	1.3	1.6	2.1	2.7	3.0
WORLD	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.9. Global Phosphate Consumption: Regional Shares, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	26.2	24.5	23.6	20.1	18.6	15.0	12.7
Western Europe	35.9	30.9	27.6	22.1	19.5	15.2	14.2
Eastern Europe	7.8	9.5	11.3	12.5	11.4	9.6	9.2
U.S.S.R.	8.6	9.2	10.2	14.3	15.5	17.7	22.4
Oceania	7.5	8.6	6.3	3.8	4.3	3.3	2.9
Africa	2.4	2.3	2.6	3.3	3.2	3.6	3.3
North Africa	0.8	0.7	0.7	1.0	1.1	1.4	1.2
Sub-Saharan Africa	0.2	0.4	0.5	0.8	0.7	0.9	1.1
South Africa	1.4	1.3	1.4	1.5	1.5	1.3	1.0
Latin America	3.1	3.1	4.2	6.6	7.8	7.1	8.3
Central America	0.5	1.1	1.6	1.8	1.3	1.7	1.8
South America	2.6	2.0	2.6	4.8	6.5	5.4	6.5
Asia	8.5	11.8	14.[illegible]	17.3	19.7	28.5	27.2
East Asia	7.4	10.0	11.0	12.8	12.1	17.5	14.9
South Asia	0.8	1.1	1.7	2.7	4.6	7.1	8.5
West Asia	0.4	0.7	1.5	1.9	3.0	3.9	3.8
WORLD	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.10. Global Potash Consumption: Regional Shares, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	25.0	24.6	25.3	21.8	25.1	21.0	18.4
Western Europe	40.1	35.6	28.9	23.6	22.7	20.4	20.0
Eastern Europe	13.7	13.9	16.3	17.6	14.3	12.9	12.8
U.S.S.R.	9.7	13.0	15.3	19.9	18.4	23.8	25.6
Oceania	0.9	1.4	1.2	1.4	0.9	1.1	0.8
Africa	1.0	1.4	1.4	1.8	1.5	1.6	1.7
North Africa	0.3	0.3	0.3	0.4	0.4	0.4	0.5
Sub-Saharan Africa	0.3	0.5	0.5	0.8	0.6	0.7	0.7
South Africa	0.3	0.6	0.6	0.7	0.5	0.5	0.5
Latin America	1.7	2.5	3.7	4.7	6.7	6.5	7.7
Central America	0.6	1.0	1.8	1.4	1.2	1.5	1.7
South America	1.1	1.5	1.9	3.4	5.4	4.9	6.0
Asia	8.0	7.5	7.9	9.2	10.5	12.8	13.0
East Asia	7.2	6.5	6.6	7.1	7.6	8.6	8.6
South Asia	0.7	0.9	1.1	1.9	2.6	3.8	3.9
West Asia	0.1	0.1	0.2	0.2	0.3	0.4	0.6
WORLD	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.11. Regional Total NPK Consumption, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	7,146	10,514	15,301	17,180	22,748	22,067	19,613
Western Europe	9,785	12,504	15,563	16,886	20,850	20,390	20,667
Eastern Europe	2,716	4,402	7,653	10,372	11,813	11,632	11,510
U.S.S.R.	2,335	4,464	8,033	13,856	16,515	22,304	25,719
Oceania	836	1,441	1,498	1,346	1,785	1,771	1,608
Africa	530	996	1,432	2,172	2,811	3,461	3,566
North Africa	230	420	558	820	1,117	1,505	1,547
Sub-Saharan Africa	101	232	373	651	728	992	1,201
South Africa	199	344	501	701	965	964	818
Latin America	726	1,389	2,540	4,242	6,602	7,216	8,634
Central America	293	694	1,341	1,665	2,057	2,727	3,028
South America	433	695	1,199	2,577	4,545	4,489	5,606
Asia	3,361	5,618	10,091	14,807	27,960	40,586	40,993
East Asia	2,819	4,527	7,412	10,332	19,092	27,019	24,887
South Asia	430	860	1,989	3,399	6,669	10,297	12,516
West Asia	112	230	690	1,076	2,198	3,270	3,590
WORLD	27,435	41,327	62,112	80,860	111,083	129,427	132,309

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.12. Regional Nitrogen Consumption, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	2,548	4,379	7,037	8,340	11,179	11,681	10,539
Western Europe	3,018	4,274	6,004	7,236	9,582	10,104	10,656
Eastern Europe	847	1,551	3,057	4,078	4,978	5,133	5,055
U.S.S.R.	710	1,759	3,798	6,696	7,467	10,279	11,475
Oceania	33	76	141	208	280	385	406
Africa	216	510	733	1,073	1,496	1,845	2,010
North Africa	128	296	390	521	711	938	993
Sub-Saharan Africa	52	121	193	322	385	500	655
South Africa	36	93	150	230	400	407	362
Latin America	292	685	1,187	1,817	2,658	3,204	3,831
Central America	199	429	756	987	1,357	1,769	1,995
South America	93	256	431	830	1,301	1,435	1,836
Asia	1,875	3,145	6,218	9,052	19,553	27,884	28,398
East Asia	1,516	2,420	4,345	6,030	13,649	19,023	17,624
South Asia	298	599	1,496	2,418	4,676	6,967	8,630
West Asia	60	126	376	604	1,228	1,894	2,144
WORLD	9,538	16,380	28,175	38,500	57,193	70,514	72,370

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.13. Regional Phosphate Consumption, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	2,560	3,441	4,429	4,594	5,554	4,953	4,283
Western Europe	3,506	4,334	5,188	5,047	5,814	5,014	4,798
Eastern Europe	757	1,328	2,129	2,856	3,409	3,159	3,110
U.S.S.R.	838	1,284	1,916	3,276	4,637	5,858	7,567
Oceania	733	1,212	1,182	867	1,278	1,101	981
Africa	233	329	492	753	960	1,195	1,112
North Africa	78	97	130	229	323	471	418
Sub-Saharan Africa	21	52	101	180	200	308	357
South Africa	135	180	261	344	438	416	337
Latin America	299	435	795	1,507	2,346	2,338	2,796
Central America	45	157	309	414	403	562	599
South America	254	278	486	1,093	1,943	1,776	2,197
Asia	833	1,654	2,670	3,963	5,891	9,396	9,198
East Asia	718	1,402	2,066	2,921	3,615	5,765	5,032
South Asia	75	160	322	617	1,371	2,349	2,865
West Asia	41	91	282	425	905	1,282	1,300
WORLD	9,759	14,017	18,800	22,863	29,890	33,012	33,845

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.14. Regional Potash Consumption, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	2,038	2,694	3,836	4,246	6,014	5,434	4,792
Western Europe	3,261	3,895	4,371	4,602	5,454	5,272	5,213
Eastern Europe	1,113	1,522	2,468	3,438	3,427	3,341	3,345
U.S.S.R.	787	1,421	2,819	3,884	4,411	6,167	6,677
Oceania	70	152	175	271	226	285	221
Africa	80	157	207	346	354	421	445
North Africa	24	28	38	70	84	96	136
Sub-Saharan Africa	28	58	79	149	143	184	189
South Africa	28	71	89	127	127	141	119
Latin America	135	269	559	918	1,598	1,674	2,007
Central America	49	107	277	264	298	396	434
South America	86	161	282	654	1,301	1,278	1,572
Asia	653	819	1,203	1,792	2,516	3,306	3,396
East Asia	584	706	1,000	1,380	1,829	2,231	2,232
South Asia	58	101	171	365	622	982	1,019
West Asia	11	13	32	47	65	94	145
WORLD	8,138	10,930	15,137	19,497	24,001	25,900	26,095

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.15. Percent Changes in Regional Total NPK Consumption, 1960-87

Region	1960-65	1965-70	1970-75	1975-80	1980-85	1985-87
	(%)					
North America	47.1	45.5	12.3	32.4	-3.0	-11.1
Western Europe	27.8	24.5	8.5	23.5	-2.2	1.4
Eastern Europe	62.1	73.9	35.5	13.9	-1.5	-1.0
U.S.S.R.	91.2	80.0	72.5	19.2	35.1	15.3
Oceania	72.3	3.9	-10.1	32.6	-0.8	-9.2
Africa	88.1	43.8	51.7	29.4	23.1	3.0
North Africa	82.8	32.8	46.9	36.3	34.7	2.8
Sub-Saharan Africa	130.6	60.9	74.3	11.9	36.2	21.1
South Africa	72.6	45.6	40.1	37.6	-0.1	-15.1
Latin America	91.2	82.9	67.0	55.6	9.3	19.7
Central America	136.5	93.4	24.1	23.6	32.6	11.1
South America	60.5	72.5	114.9	76.4	-1.2	24.9
Asia	67.2	79.6	46.7	88.8	45.2	1.0
East Asia	60.6	63.7	39.4	84.8	41.5	-7.9
South Asia	99.8	131.3	70.9	96.2	54.4	21.5
West Asia	106.2	199.9	55.9	104.3	48.7	9.8
WORLD	50.6	50.3	30.2	37.4	16.5	2.2

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.16. Percent Changes in Regional Nitrogen Consumption, 1960-87

Region	1960-65	1965-70	1970-75	1975-80	1980-85	1985-87
	(%)					
North America	71.9	60.7	18.5	34.0	4.5	-9.8
Western Europe	41.6	40.5	20.5	32.4	5.4	5.5
Eastern Europe	83.2	97.0	33.4	22.1	3.1	-1.5
U.S.S.R.	147.7	115.9	76.3	11.5	37.7	11.6
Oceania	133.1	84.5	47.5	34.6	37.3	5.6
Africa	136.3	43.7	46.3	39.4	23.3	8.9
North Africa	131.8	31.9	33.5	36.4	32.1	5.9
Sub-Saharan Africa	132.2	59.3	66.6	19.7	29.8	31.0
South Africa	157.8	61.1	53.4	73.9	1.6	-11.1
Latin America	134.4	73.2	53.1	46.3	20.5	19.6
Central America	115.3	76.1	30.7	37.4	30.4	12.8
South America	175.4	68.4	92.5	56.8	10.3	27.9
Asia	67.8	97.7	45.6	116.0	42.6	1.8
East Asia	59.6	79.6	38.8	126.3	39.4	-7.4
South Asia	100.8	149.9	61.6	93.4	49.0	23.9
West Asia	111.4	198.1	60.6	103.1	54.3	13.2
WORLD	71.7	72.0	36.6	48.6	23.3	2.6

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.17. Percent Changes in Regional Phosphate Consumption, 1960-87

Region	1960-65	1965-70	1970-75	1975-80	1980-85	1985-87
	(%)					
North America	34.4	28.7	3.7	20.9	-10.8	-13.5
Western Europe	23.6	19.7	-2.7	15.2	-13.8	-4.3
Eastern Europe	75.6	60.3	34.2	19.4	-7.3	-1.5
U.S.S.R.	53.2	49.2	71.0	41.5	26.3	29.2
Oceania	65.3	-2.5	-26.6	47.5	-13.9	-10.9
Africa	40.9	49.6	53.1	27.5	24.4	-7.0
North Africa	23.8	34.3	76.7	40.8	45.9	-11.3
Sub-Saharan Africa	153.1	92.7	78.4	11.0	54.3	16.0
South Africa	33.5	45.2	31.7	27.3	-5.0	-19.1
Latin America	45.7	82.7	89.6	55.7	-0.3	19.6
Central America	252.7	96.5	34.1	-2.6	39.5	6.6
South America	9.4	74.9	124.8	77.7	-8.6	23.7
Asia	98.4	61.5	48.4	48.7	59.5	-2.1
East Asia	95.3	47.4	41.4	23.8	59.5	-12.7
South Asia	114.8	100.6	91.8	122.3	71.3	22.0
West Asia	123.3	208.9	50.7	113.0	41.6	1.4
WORLD	43.6	34.1	21.6	30.7	10.4	2.5

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 2.18. Percent Changes in Regional Potash Consumption, 1960-87

Region	1960-65	1965-70	1970-75	1975-80	1980-85	1985-87
	(%)					
North America	32.2	42.4	10.7	41.6	-9.7	-11.8
Western Europe	19.4	12.2	5.3	18.5	-3.3	-1.1
Eastern Europe	36.8	62.1	39.3	-0.3	-2.5	0.1
U.S.S.R.	80.6	63.2	67.5	13.6	39.8	8.3
Oceania	118.0	14.7	55.0	-16.5	26.0	-22.7
Africa	95.6	31.8	67.1	2.4	18.9	5.6
North Africa	14.5	38.4	82.6	20.4	14.4	41.3
Sub-Saharan Africa	111.0	35.7	87.7	-3.7	28.3	2.9
South Africa	149.8	26.0	42.2	-0.3	11.3	-15.3
Latin America	98.3	108.0	64.3	74.1	4.7	19.9
Central America	117.4	157.9	-4.9	13.0	33.1	9.7
South America	87.3	74.8	132.3	98.8	-1.7	23.0
Asia	25.4	46.8	49.0	40.4	31.4	2.7
East Asia	20.8	41.7	38.0	32.5	22.0	0.0
South Asia	75.2	69.7	113.4	70.5	57.8	3.8
West Asia	14.3	151.9	46.6	40.3	43.7	55.0
WORLD	34.3	38.5	28.8	23.1	7.9	0.8

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

North America

Total fertilizer consumption increased from 7.15 million tons in 1960 to 15.30 million tons in 1970 and 22.75 million tons in 1980. Between 1980 and 1983 there was a substantial decrease in total fertilizer use. In 1985, there was a significant recovery, but in 1987 it dropped to 19.61 million tons (Figure 2.7).

Nitrogen use increased from 2.54 million tons in 1960 to 11.68 million tons in 1985, and then dropped by 9.8% to 10.54 million tons in 1987. Between 1980 and 1985 also, nitrogen use fluctuated. Phosphate use increased from 2.56 million tons in 1960 to 5.55 million tons in 1980, and then decreased to 4.95 million tons in 1985 and 4.28 million tons in 1987. Thus, unlike nitrogen use which increased by 4.9% during the 1980-85 period, P_2O_5 use decreased by 10.83% during the same period. Furthermore, a 13% decrease was recorded in 1987 over 1985 levels. Like phosphate, potash use also increased from about 2.04 million tons in 1960 to 6.01 million tons in 1980 but then dropped to 5.43 million tons in 1985 and to 4.79 million tons in 1987. Thus, potash use decreased by 9.6% during the 1980-85 period and 11.8% during the 1985-87 period.

An analysis of the percentage changes in total fertilizer consumption during different 5-year periods indicates that after increasing by 45% during 1965-70, percentage increase dropped to 12.3% during 1970-75, but accelerated to 32% in 1975-80 (Figure 2.8). Total fertilizer use dropped by 3% during the early 1980s, and by another 11% in the 1985-87 period. Thus, in North America total fertilizer use reached maximum in 1981. High crop prices and accelerating grain imports by developing and oil-exporting countries seem to have stimulated fertilizer use in North America during the late 1970s. As the world demand for grain imports slackened and food surpluses accumulated leading to low crop prices, fertilizer use decelerated in North America. Acreage reduction programs also reduced fertilizer use considerably.

Like the total fertilizer use, N use also accelerated in North America during the 1975-80 period; it increased by 34% during this period compared with 18.5% in the early 1970s. During the 1970s, P_2O_5 use growth was similar to that of nitrogen use; it increased in the early 1970s but accelerated in the late 1970s, although magnitudes of percentage changes involved are much smaller. The pattern of percentage changes in K_2O use

Figure 2.7

NORTH AMERICA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK CONSUMPTION, 1960–87

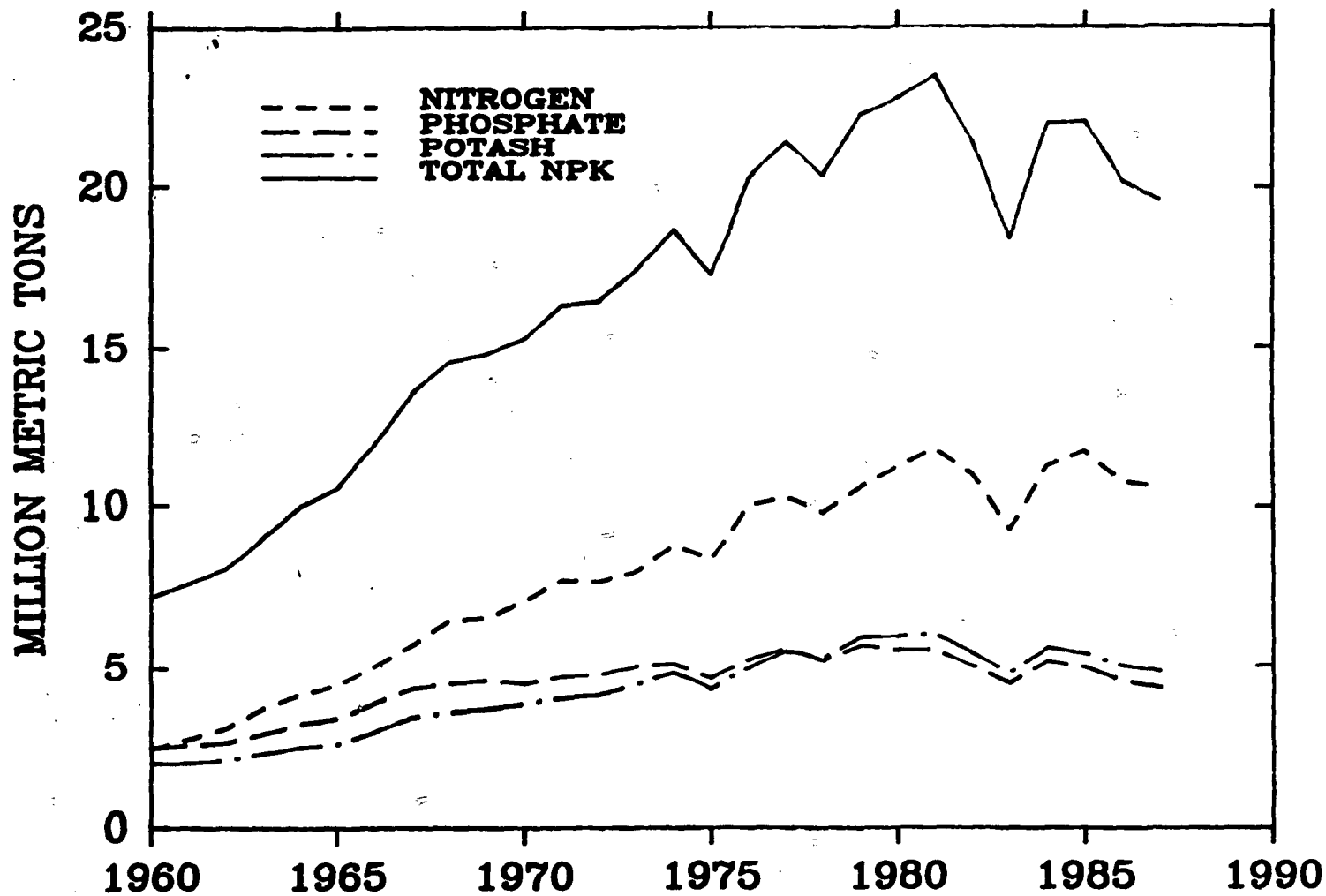
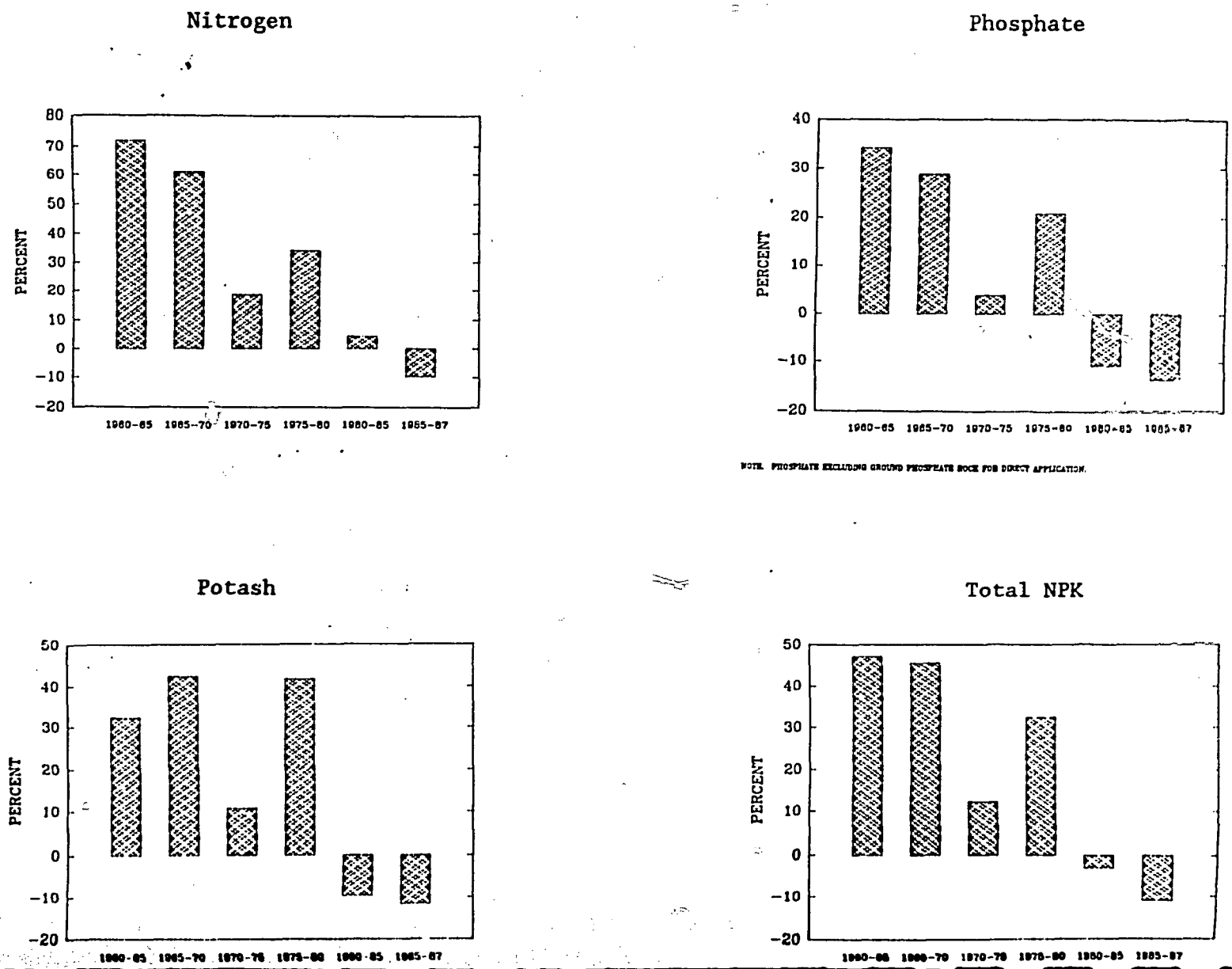


Figure 2.8

North America: Percent Change in Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1960-87



NOTE: PHOSPHATE EXCLUDING GROUND PHOSPHATE ROCK FOR DIRECT APPLICATION.

during the 1970s is no different than that for N and P_2O_5. That is, K_2O use also accelerated during the 1975-80 period, compared with the early 1970s.

Accelerated growth in fertilizer use in North America in the late 1970s followed by deceleration in the early 1980s suggests that microeconomic and policy changes have played an important role in inducing growth in fertilizer use. In North America farmers responded to profitable opportunities created by higher crop prices and increasing world grain imports, and increased fertilizer use. However, when these opportunities diminished and many farmers faced financial losses of the early 1980s along with acreage reduction programs, fertilizer use decreased. This analysis suggests that because crop prices are improving, and world grain imports are expected to increase, fertilizer use may grow again in North America during the late 1980s and the early 1990s.

Western Europe

Total fertilizer use increased from 9.78 million tons in 1960 to 20.85 million tons in 1980. However, after 1980 there was little change in total fertilizer use. In terms of individual nutrients, nitrogen use increased from 3.01 million tons in 1960 to 9.58 million tons in 1980 and to 10.65 million tons in 1987. Phosphate use increased from 3.51 million tons in 1960 to 5.81 million tons in 1980. Unlike N use, which continued to increase in the 1980s, P_2O_5 use decreased substantially after 1980--from 5.81 million tons in 1980 to 4.80 million tons in 1987--a 17% decline. Like P_2O_5 use, potash use also increased from 3.26 million tons in 1960 to 5.45 million tons in 1980 and then started declining. In 1987 K_2O use was 5.21 million tons--0.24 million tons less than the 1980 level (Figure 2.9).

This analysis indicates that unlike nitrogen use, which continued to increase, both P_2O_5 and K_2O use decreased during the 1980s and P_2O_5 use decreased at a faster rate than K_2O use. This pattern of changes in nutrient use suggests that more profitable opportunities continued to exist for N use than for P_2O_5 use. Furthermore, depressed crop prices affected P_2O_5 use much more severely than they did N use or K_2O use because the farmers relied on the residual phosphorus and potassium in the soil.

An analysis of the 5-year percentage changes for total fertilizer use and for all the three nutrients indicates that, as in North America, fertilizer use in Western Europe also accelerated in the late 1970s (Figure 2.10). However, there was one exception. That is, P_2O_5 use in

Figure 2.9

WESTERN EUROPE: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK CONSUMPTION, 1960–87

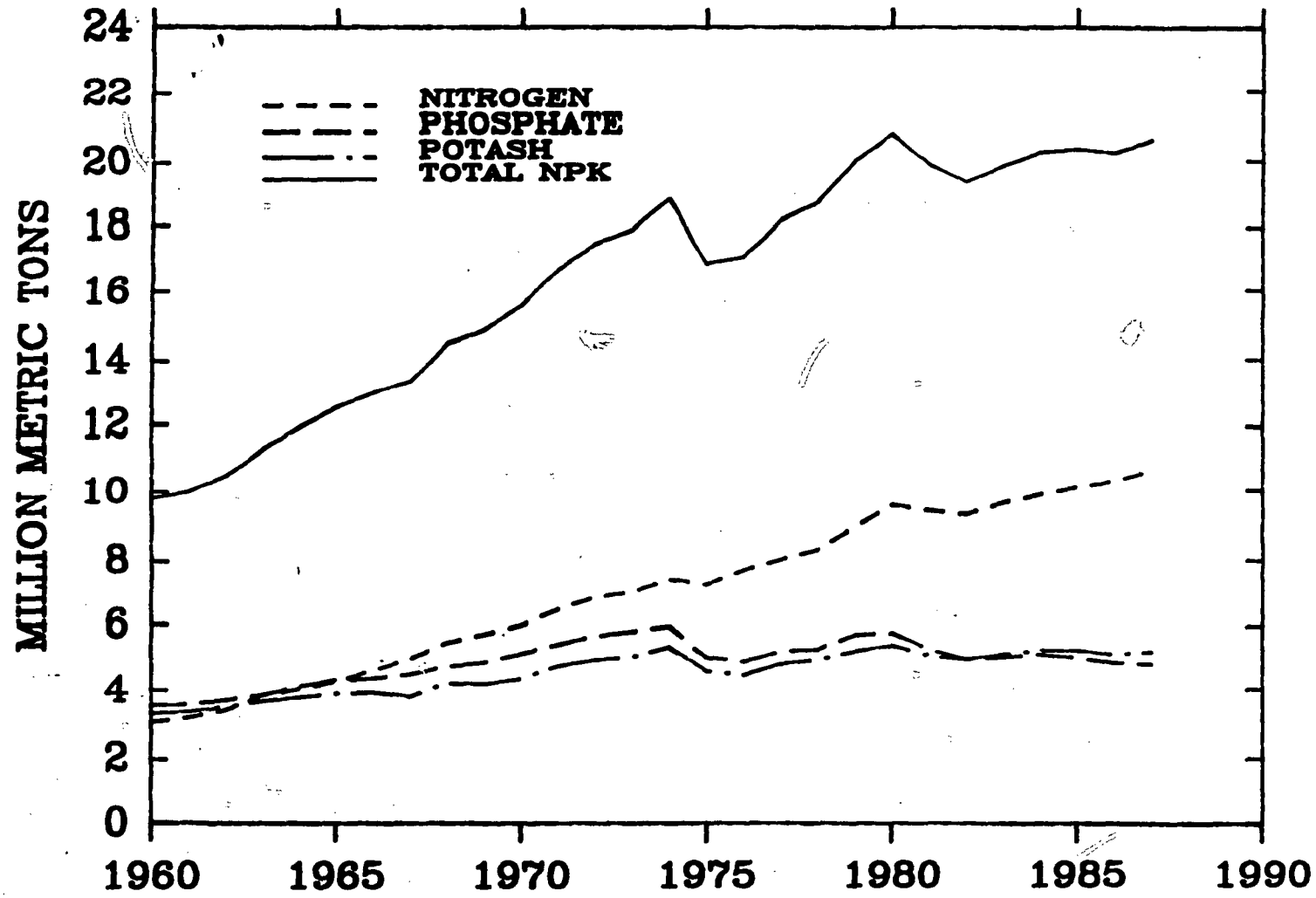
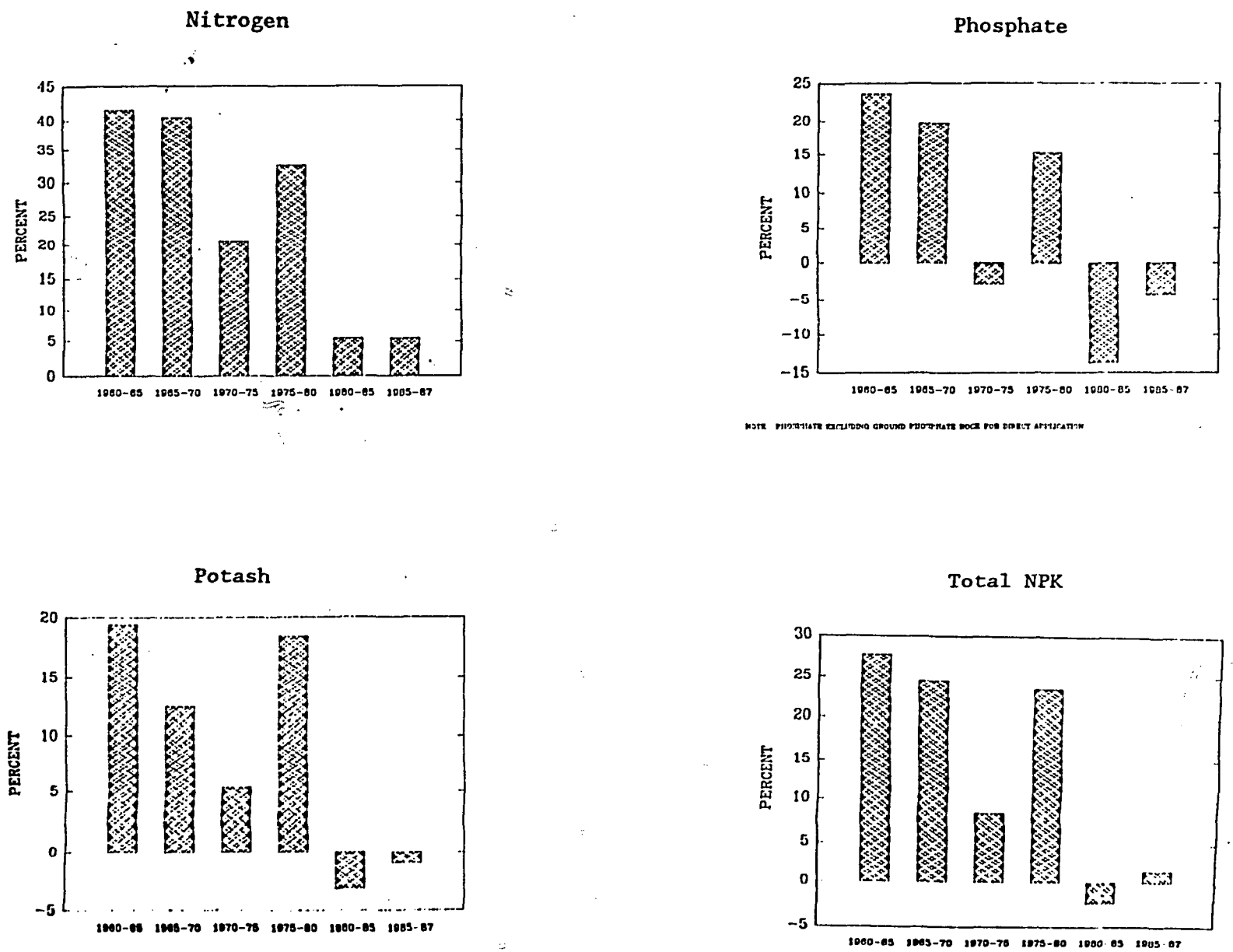


Figure 2.10

Western Europe: Percent Change in Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1960-87



NOTE: PHOSPHATE EXCLUDING GROUND PHOSPHATE ROCK FOR DIRECT APPLICATION

Western Europe declined in the early 1970s and then increased by about 15% in the 1975-80 period. This suggests that P_2O_5 use in Western Europe is much more sensitive to economic changes than it is in North America. The limited feedstock base for P_2O_5 production in Western Europe also makes P_2O_5 use relatively more sensitive to changes in world prices. Nevertheless, fertilizer use increased uninterruptedly in the 1960s.

Eastern Europe

Total fertilizer consumption in Eastern Europe increased from 2.72 million tons in 1960 to 11.81 million tons in 1980 and then decreased to 11.51 million tons in 1987. All three nutrients showed significant growth in the 1960s and 1970s. For example, N use increased from 0.85 million tons in 1960 to 3.06 million tons in 1970 and 4.98 million tons in 1980, while P_2O_5 and K_2O use increased from 0.76 and 1.11 million tons in 1960 to 3.41 million and 3.42 million tons, respectively, in 1980. During the 1980s, however, growth patterns of these nutrients changed. Nitrogen use increased between 1980 and 1985 and then decreased marginally in 1987. Both phosphate and potash use decreased after 1980, although with different intensities (Figure 2.11).

Although Eastern Europe has experienced marginal deceleration in its fertilizer use during the 1980s, its fertilizer use growth pattern is different from that of Western Europe or North America. First, unlike North America and Western Europe where fertilizer use accelerated in the late 1970s, in Eastern Europe, fertilizer use accelerated in the late 1960s. For example, total fertilizer use increased by 73% during the 1965-70 period. Thereafter, it increased with decreased rates until 1980 and then it started decreasing (Figure 2.12). This indicates that fertilizer use in Eastern Europe was mostly geared to domestic food security and crop production needs. Second, pricing environment faced by the farmers was relatively stable; hence the economic factors played little role in enhancing fertilizer use in Eastern Europe.

Different nutrients followed different patterns. Because of its dominant share in total NPK use, nitrogen use followed the same pattern as total fertilizer use. However, P_2O_5 use accelerated in the early 1960s and then started increasing at decreasing but positive rates until 1980 and decreasing thereafter. Potash use accelerated during the 1965-70 period but

Figure 2.11

EASTERN EUROPE: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK CONSUMPTION, 1960–87

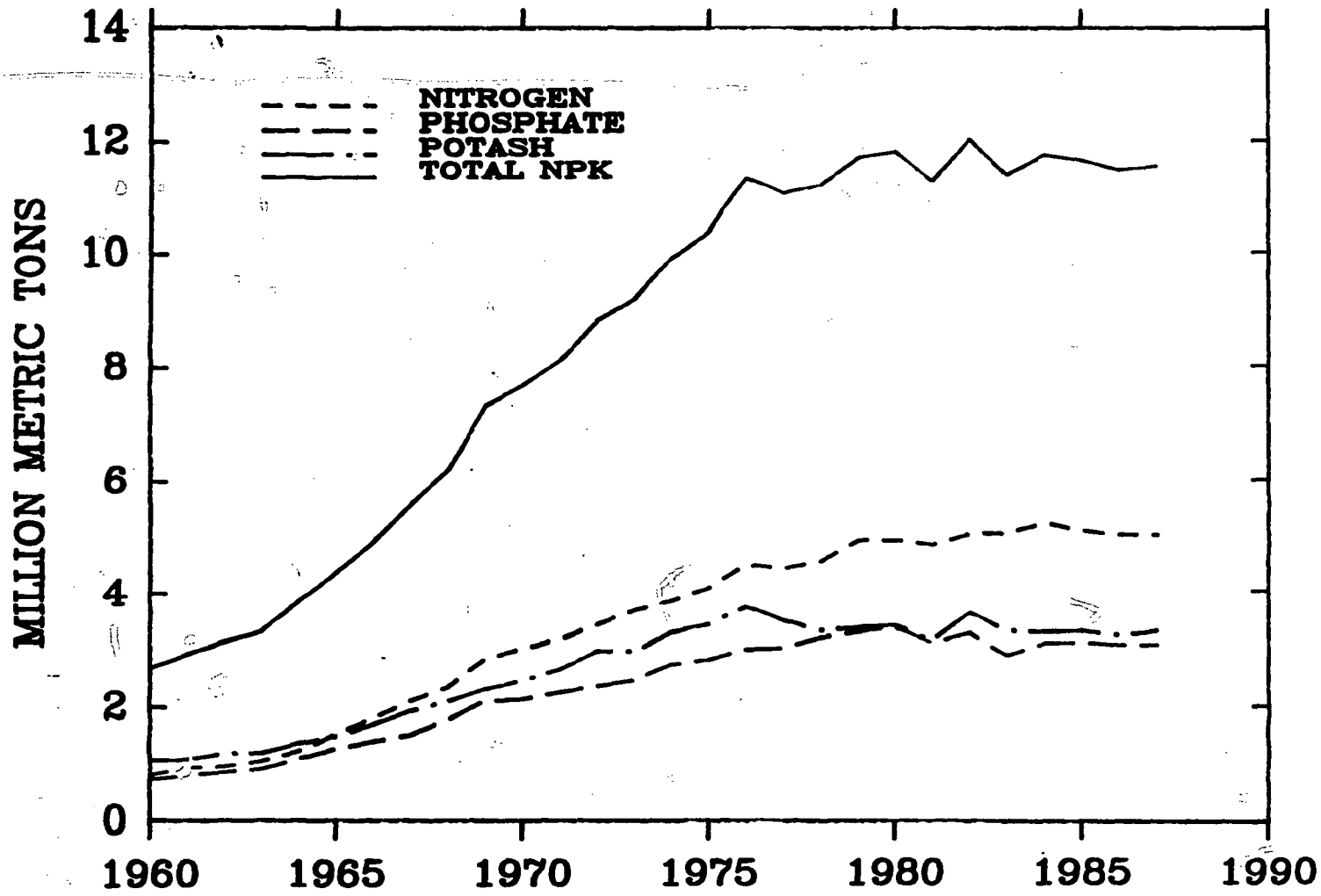
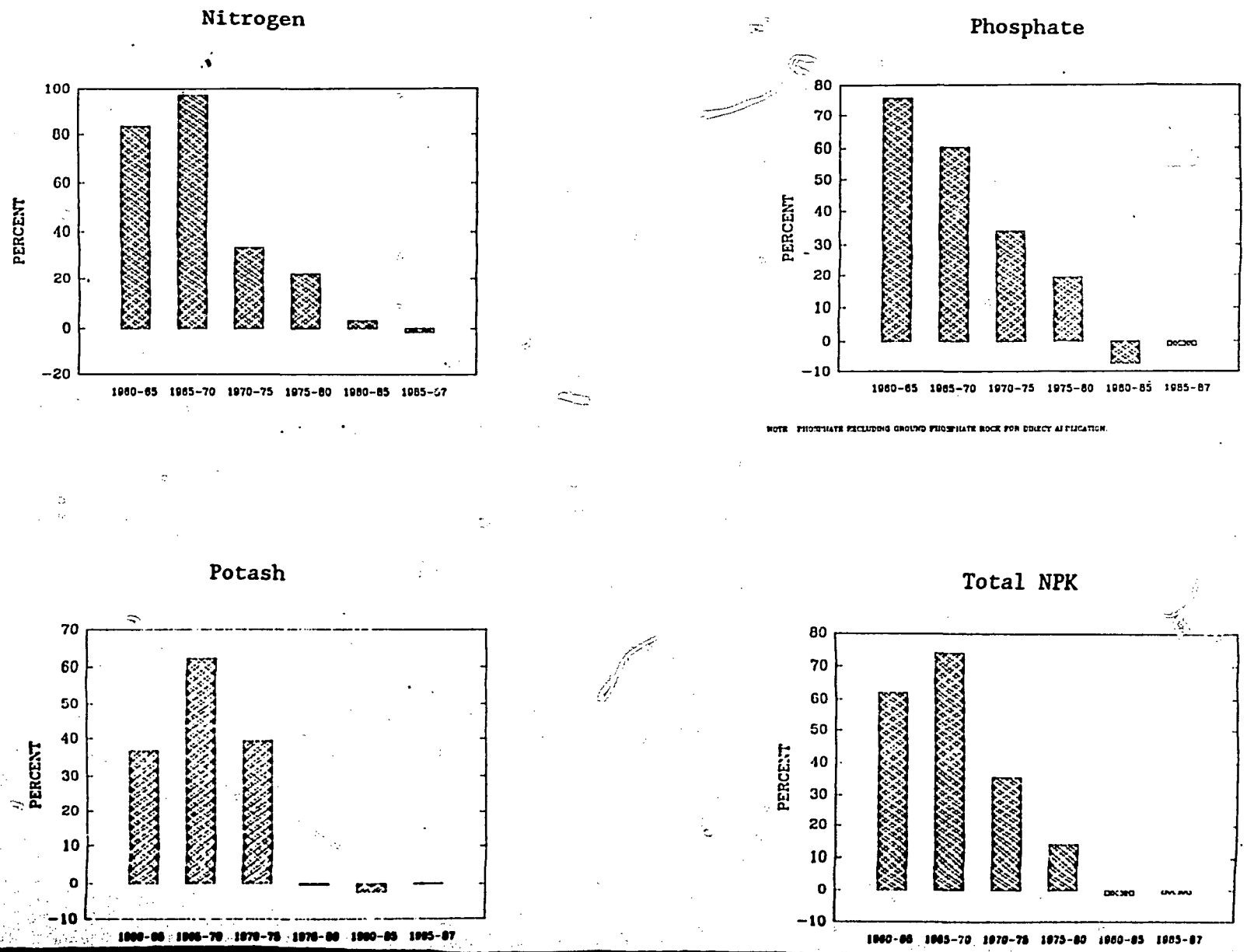


Figure 2.12

Eastern Europe: Percent Change in Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1960-87



NOTE: PHOSPHATE EXCLUDING GROUND PHOSPHATE ROCK FOR DIRECT APPLICATION.

started decreasing in the 1975-80 period, much earlier than both N and P_2O_5 use started decreasing (Figure 2.12).

The U.S.S.R.

The U.S.S.R., like Asia, experienced more than eightfold increase in its fertilizer use during the 1960-80 period and more than 5% annual growth in fertilizer use during the 1980s. Total fertilizer use increased from 2.34 million tons in 1960 to 16.52 million tons in 1980 and to 25.72 million tons in 1987. Unlike North America, Western Europe, and Eastern Europe, which experienced substantial declines in their total fertilizer use, the U.S.S.R. increased its fertilizer use by about 35% during the 1980-85 period and another 15% during 1985-87. As indicated above, it was the U.S.S.R. and Asia that fueled most of the growth in the global fertilizer use in the 1980s.

The use levels of all three nutrients increased significantly. During the 1960-87 period, nitrogen use increased from 0.71 million tons to 11.48 million tons, phosphate use from 0.84 million tons to 7.57 million tons, and potash from 0.79 million tons to 6.68 million tons (Figure 2.13).

Since information about the pricing environment in the U.S.S.R. is limited, one has to make best guesses about the factors responsible for such rapid growth in fertilizer use. Because market forces play a limited role in the U.S.S.R., the farmers face a stable pricing environment. Furthermore, because of its relatively abundant natural gas and potash resource base, the U.S.S.R. has a strong comparative advantage in production of N and K_2O for both domestic use and exports. In fact, its rapid production increase[8] was one of the important factors in stimulating growth in fertilizer use. During the 1980s the U.S.S.R. became a major exporter of N, in addition to K_2O. This rapid increase in production and export capacity of N and K_2O helped the U.S.S.R. in sustaining high levels of P_2O_5 imports. Consequently, the foreign exchange constraint, which affected other countries adversely, did not affect the U.S.S.R. Furthermore, because of government ownership of production facilities, the U.S.S.R. could also afford to sell urea at a price much below what the economists call the "shutdown" cost or the operating cost. Thus, the pricing environment that was becoming adverse for the farmers in North America, Western Europe, and Oceania and the foreign exchange constraint that

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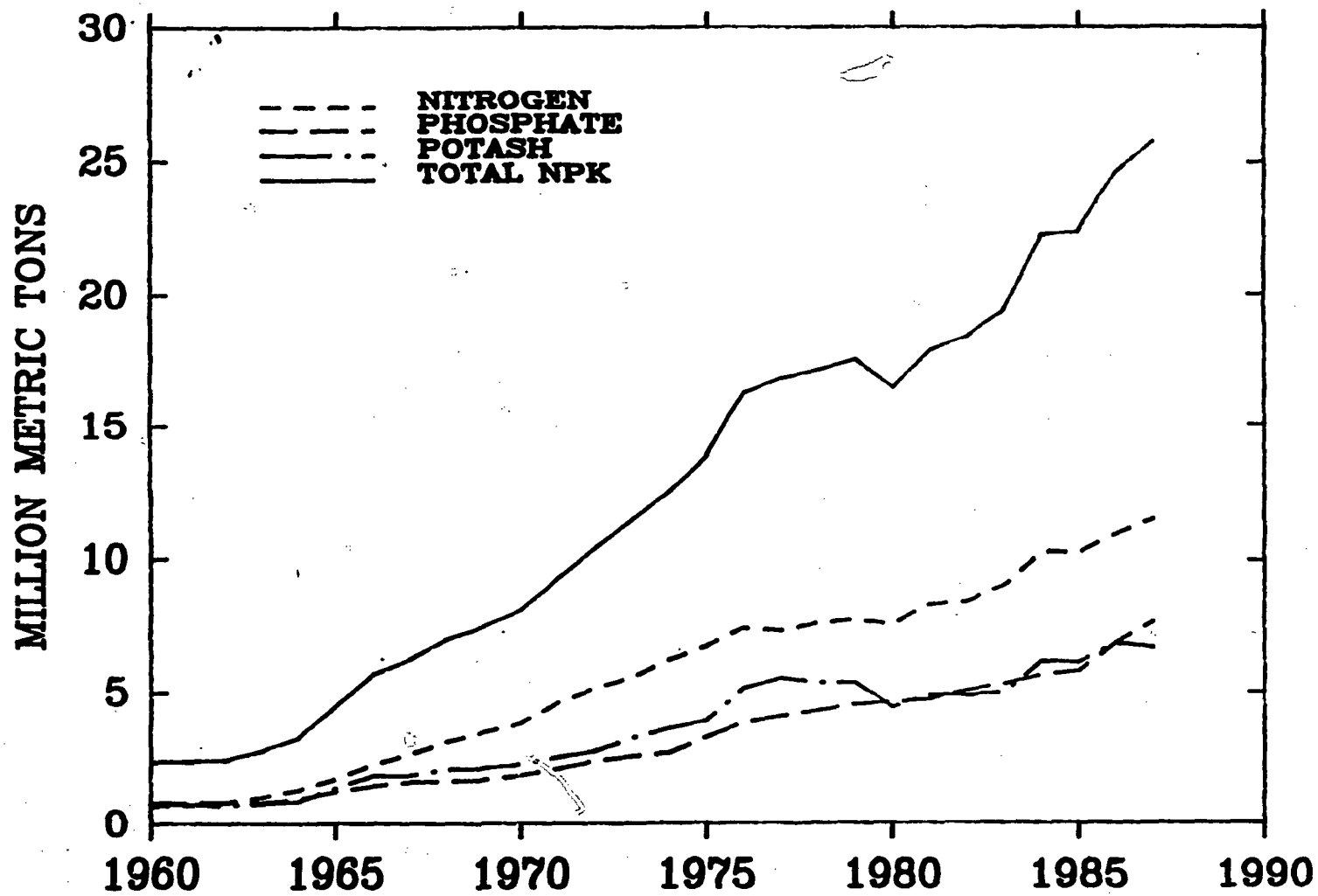
8. See Chapter 3, pp. 119-121 for details.

Figure 2.13

U.S.S.R.: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK CONSUMPTION, 1960–87



was affecting fertilizer imports in Latin America, Africa, and Eastern Europe did not seem to have affected the U.S.S.R.

An analysis of the percentage changes in fertilizer use in the U.S.S.R. during different 5-year periods (Figure 2.14) reveals a strikingly different pattern from those of other regions. During the 1960-80 period, the 5-year percentage changes in total fertilizer use continuously decreased--from 91.2% during the 1960-65 period to 19.9% during the 1975-80 period. Rather than continue to decrease in the 1980s as happened in Eastern Europe, these percentage changes increased to 35% during the 1980-85 period. This turn in percentage changes would indicate that as the U.S.S.R. is still a net importer of food grains, the Russian Government placed a renewed emphasis on increased domestic production of food grains through enhanced fertilizer use, and the increased domestic fertilizer production capacity facilitated this move.

Nitrogen and potash use followed a similar pattern, but phosphate use followed a slightly different pattern (Figure 2.14). The percentage changes in P_2O_5 use accelerated during the 1970-75 period and then continued to decrease until 1985. However, during the 1985-87 period, they accelerated again. This indicates either changes in government commitment to import P_2O_5 or changes in governmental emphasis on different crops in different periods. More research is required.

The U.S.S.R. experience clearly indicates the role that government commitment and domestic production capacity play in accelerating fertilizer use in any country.

Oceania

Compared with other regions, Oceania's fertilizer base is small. Its total nutrient consumption was 1.61 million tons in 1987 dominated by P_2O_5. Oceania used about 0.40 million tons of N, 0.98 million tons of P_2O_5, and 0.22 million tons of K_2O. However, in spite of its small base Oceania experienced significant growth in its fertilizer use in the 1960s and 1970s and deceleration in the 1980s (Figure 2.15). Total fertilizer consumption increased from 0.84 million tons in 1960 to 1.79 million tons in 1980 and then decreased to 1.61 million tons in 1987. Nitrogen use increased from 0.03 million tons in 1960 to 0.28 million tons in 1980 and 0.41 million tons in 1987. Phosphate use increased from 0.73 million tons in 1960 to 1.28 million tons in 1980, and then decreased to 0.98 million tons in 1987. Potash

Figure 2.14

U.S.S.R.: Percent Change in Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1960-87

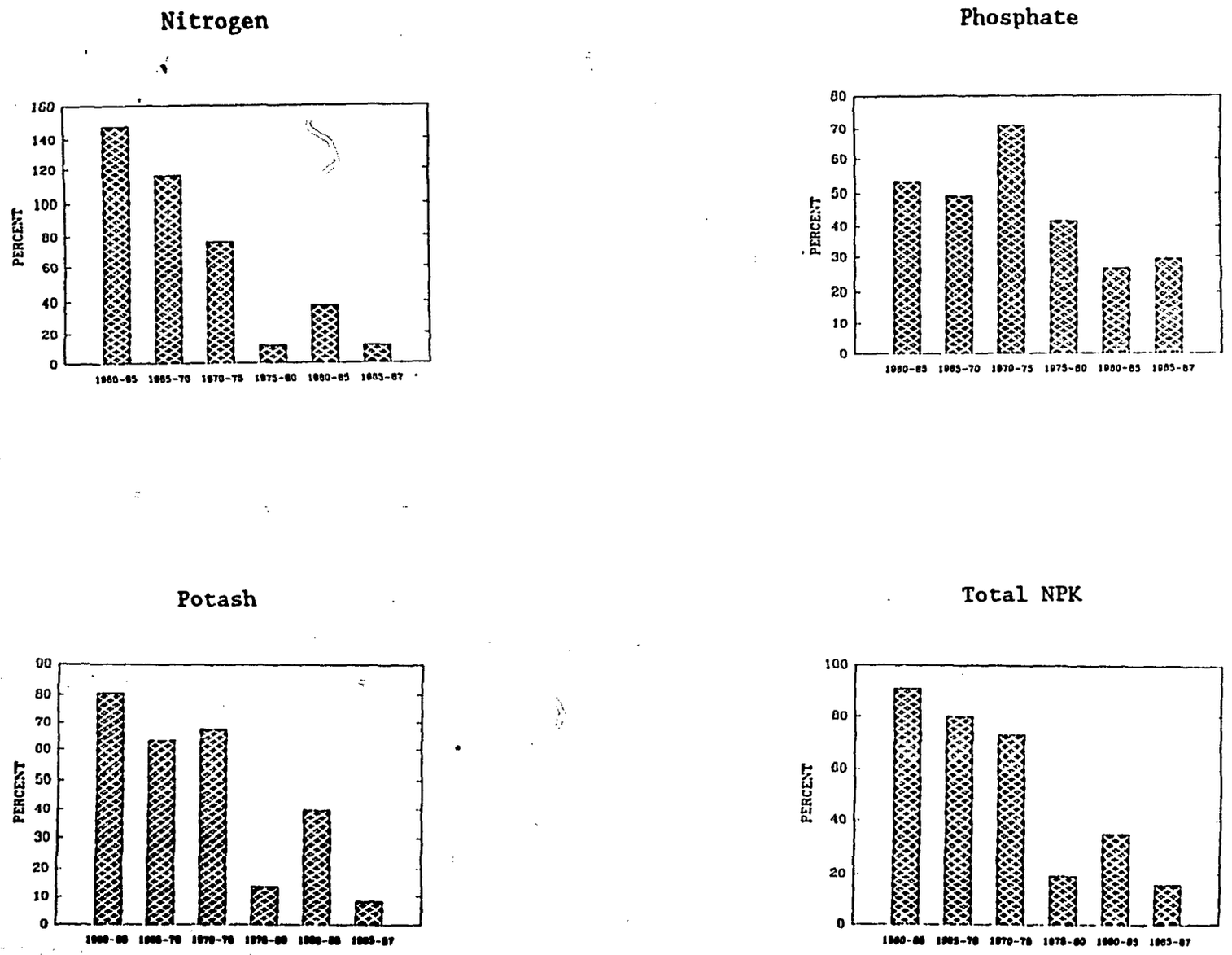
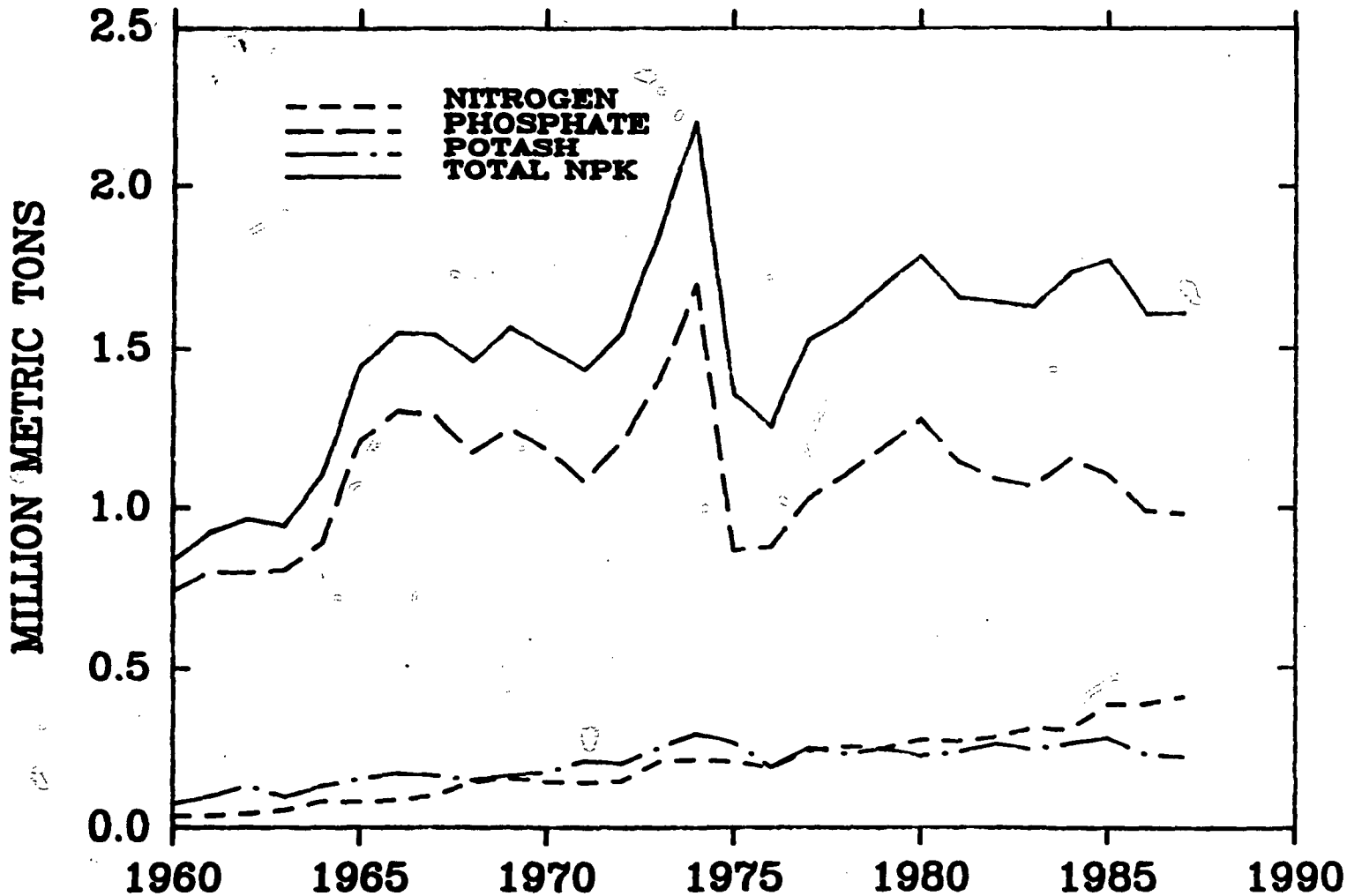


Figure 2.15

OCEANIA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK CONSUMPTION, 1960–87



consumption increased from 70,000 tons in 1960 to 271,000 tons in 1975, and then decreased to 226,000 tons in 1980; it again increased to 285,000 tons in 1985 to be followed by a decrease in 1987 to 221,000 tons.

Because Oceania's fertilizer use is dominated by P_2O_5 and P_2O_5 use is more sensitive to changes in economic policies and cropping patterns, total fertilizer use fluctuates more in Oceania than it does in North America and Western Europe. Oceania's total fertilizer use increased in the 1960s, decreased in the early 1970s, increased in the late 1970s, and decreased again in the 1980s (Figure 2.15). Furthermore, unlike North America and Western Europe, Oceania had significant growth in its nitrogen use in the 1980s; because of the small base, however, it had little impact on the global nitrogen use. Potash use also fluctuated much more in Oceania than in Western Europe and North America.

Two factors seem to have induced these changes in Oceania. First, the increased world demand for grain imports and higher crop prices stimulated wheat and rice production in Australia and therefore accelerated fertilizer use in the late 1970s (Figure 2.16). However, as these opportunities diminished in the 1980s, fertilizer use declined. Second, increased crop production for exports also diverted land from grasslands to crop cultivation. This switch in cultivated areas reduced P_2O_5 use and increased N use.

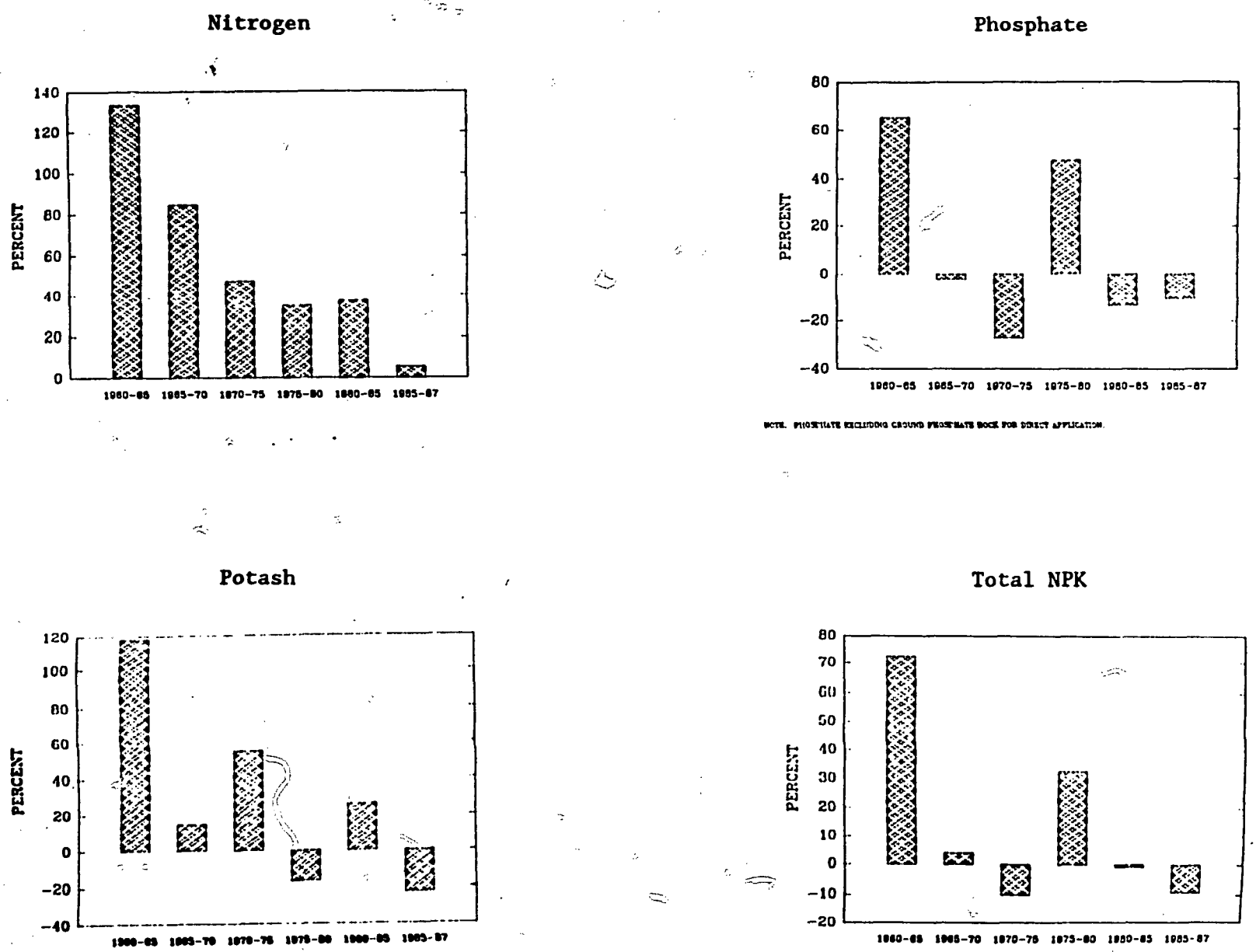
Asia

Before 1980 North America was the leading fertilizer-consuming region of the world. Since then Asia has taken over that role. In 1980 Asia accounted for 25% of the total world fertilizer consumption; by 1985 Asia's share increased to 31%. In the field of nitrogen consumption, Asia's share was about 40% in 1985. Also, Asia, like the U.S.S.R., experienced more than 5% annual growth in its total fertilizer use during the 1980s.

Total fertilizer use in Asia increased from about 28 million tons in 1980 to 41 million tons in 1987. During the previous two decades (1960-80), Asia's total fertilizer consumption increased more than eightfold--from 3.36 million tons in 1960 to 27.95 million tons in 1980. During the same period, consumption of N, P_2O_5, and K_2O increased from 1.87, 0.83, and 0.65 million tons in 1960 to 19.55, 5.89, and 2.52 million tons, respectively, in 1980. From these data, it is obvious that nitrogen use grew much faster than P_2O_5 and K_2O during the 1960-80 period. This trend continued in the

Figure 2.16

Oceania: Percent Change in Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1960-87



NOTE: PHOSPHATE EXCLUDING GROUND PHOSPHATE ROCK FOR DIRECT APPLICATION.

1980s as well. For example, N use increased by 8.85 million tons--from 19.55 million tons in 1980 to 28.40 million tons in 1987. Against this, P_2O_5 use increased by 3.3 million tons and K_2O use by a little less than 1 million tons (Figure 2.17).

Several factors seem to have contributed to this rapid growth in total fertilizer consumption in general and nitrogen consumption in particular. Notable among these are (1) availability and diffusion of fertilizer-intensive high-yielding varieties (HYV) of wheat, rice, and corn; (2) development of irrigation facilities; (3) high degree of government commitment and involvement in the fertilizer sector; (4) rapid increase in domestic nitrogen production capacity; and (5) stable and highly profitable pricing environment created through crop price support programs and fertilizer subsidies.

Because Asia consists of several countries practicing different economic systems ranging from the managed economy of China to the market economy of Japan and the mixed economy of India, Indonesia, and Turkey (these five countries accounted for 80% of total fertilizer use in Asia in 1985-87), its 5-year percentage changes reveal a pattern which is a mixture of both the North American pattern and the U.S.S.R. pattern. To the extent that the mixed economies allow their private sectors to coexist with public and cooperative sectors and allow crop and fertilizer prices to fluctuate in a limited range (avoiding the high volatility of international prices), fertilizer use in Asia responds to both price signals and public support. Also, Asia represents great diversity in ecology ranging from high-rainfall areas of East Asia to semiarid tracts of West Asia and from paddy fields of China to barley-millet farms of the Middle East. In spite of its economic and ecological diversity, Asia achieved and sustained rapid growth in fertilizer use for a quarter of a century (1960-85) because its country governments had a high degree of commitment for promoting food production, in general, and fertilizer use in particular and thereby provided stable policy environment and organizational arrangements. They also provided resources for building physical and institutional infrastructures.

An analysis of 5-year percentage changes in fertilizer use reveals that total fertilizer use accelerated in Asia in both 1965-70 and 1975-80; in these two periods fertilizer use increased by 80% and 89%, respectively compared with 67% and 47% during the preceding periods (Figure 2.18). The

Figure 2.17

ASIA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK CONSUMPTION, 1960–87

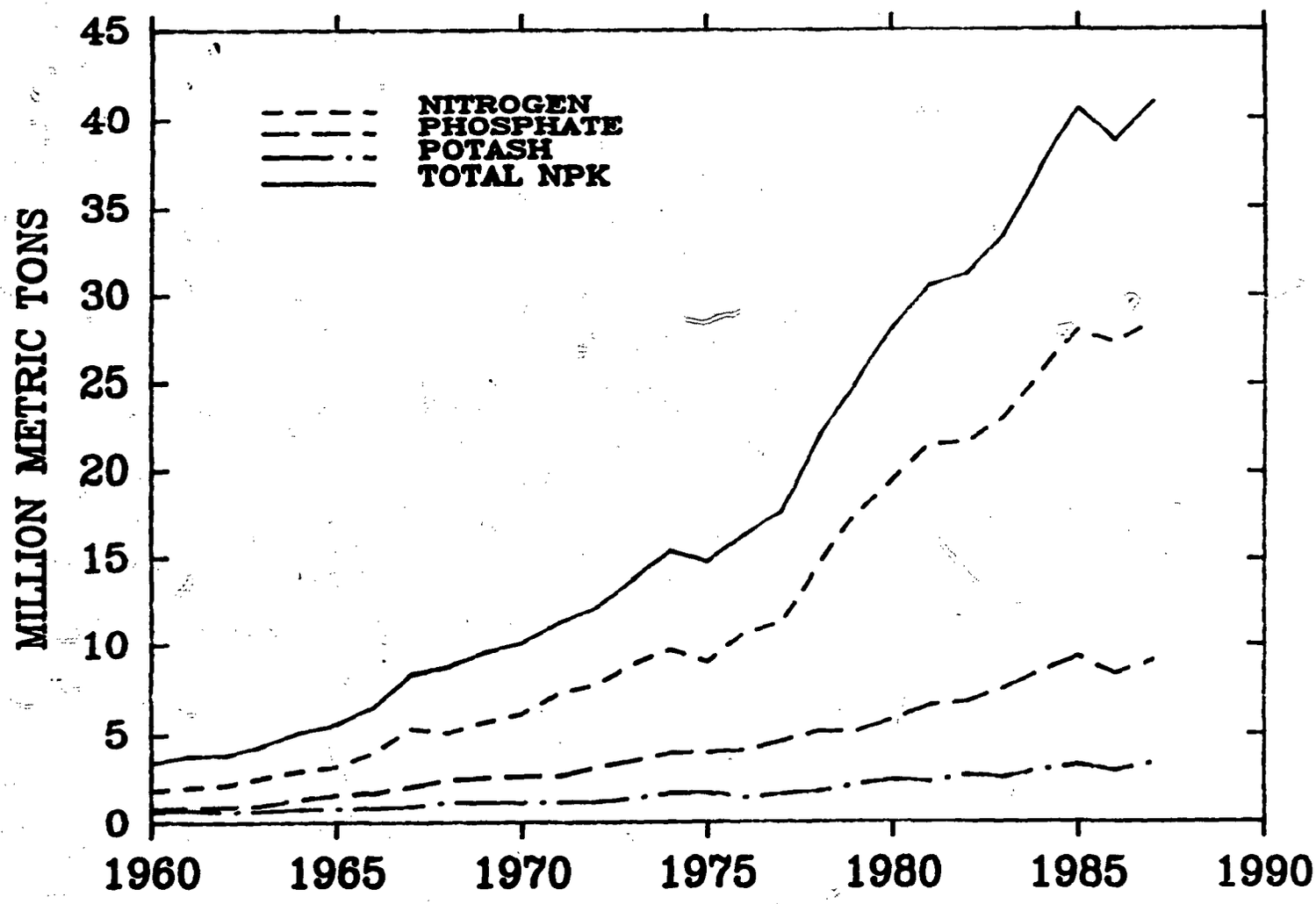
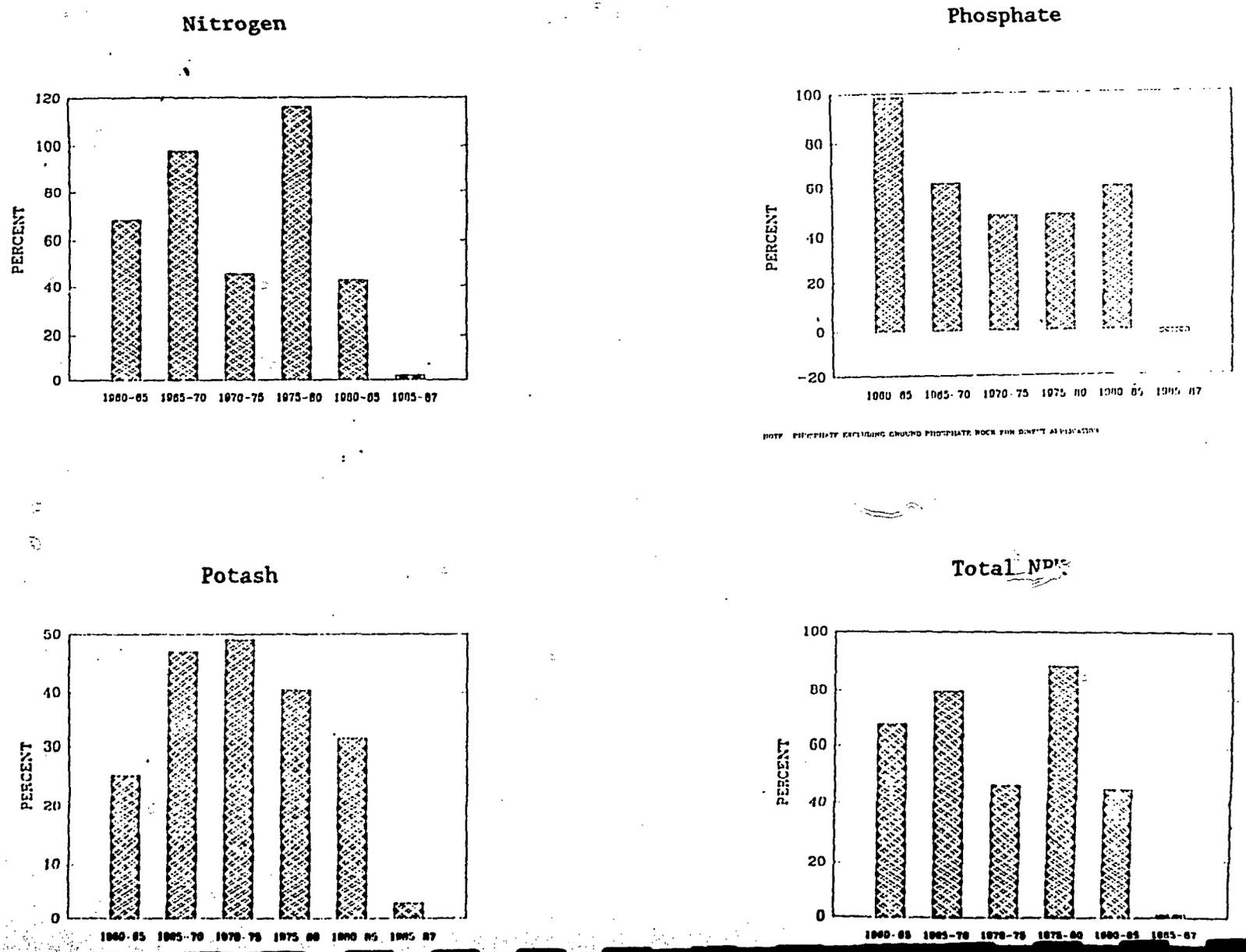


Figure 2.18

Asia: Percent Change in Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1960-87



main reason for the acceleration in the late 1960s was the diffusion of fertilizer-responsive high-yielding varieties of rice and wheat in many Asian countries. Also, low fertilizer prices in the international and domestic markets helped in accelerating fertilizer consumption. This accelerated growth in fertilizer use was slowed down during the 1970-75 period because of a rapid increase in world fertilizer prices, which reduced the profitability of fertilizer use as well as constrained fertilizer imports by many Asian countries. Although some countries enhanced their imports in a panic manner, the high prices of the mid-1970s prompted many Asian countries to invest in large-scale fertilizer plants. China contracted 13 large-scale ammonia-urea plants, and India and Indonesia also invested heavily in fertilizer plants. Decisions taken in the mid-1970s led to rapid increases in fertilizer production in Asia during the 1975-80 period.[9] These increases in domestic production capacity shielded growth in fertilizer use in these countries from the likely negative effect of high world prices and foreign exchange shortages. Consequently, fertilizer consumption increased by 89% from 14.8 million tons in 1975 to 28.0 million tons in 1980. Continued increases in domestic production and a stable policy environment helped in increasing fertilizer consumption by another 45% during the 1980-85 period. No other region experienced such a high increase in fertilizer use in the 1980s and that too from a large base of 28 million tons in 1980. In addition to the enlarged production base, the relatively good economic performance of Asian countries[10] also helped in this growth because their import levels were less constrained by foreign exchange shortages than were the fertilizer imports of the African and Latin American countries.

Because nitrogen use accounts for about 70% of total fertilizer use in Asia, the 5-year percentage changes in nitrogen consumption are similar to those in the total fertilizer consumption (Figure 2.18). A 116% increase in N use in the 1975-80 period further indicates the role played by domestic production capacity in promoting fertilizer use. Because of the limited domestic production of P_2O_5 and K_2O, and also because of limited response of paddy rice to these nutrients, percentage changes in these two nutrients are different. P_2O_5 use increased at decreasing percentage rates until 1980 and

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9. See Chapter 3, pp. 123-125 below.

10. See World Bank (1988a, pp. 224-225) for details.

then accelerated to 59.5% in 1980-85. Increased imports and increased domestic capacity appear to have caused this acceleration. Potash use showed moderate acceleration in the 1970-75 period. Thereafter it increased at decreasing percentages. As the nitrogen use levels increase, as the soil reserves of potash are depleted, and as the cropping pattern shifts in favor of upland crops, K_2O use might accelerate in the late 1980s and early 1990s in Asia. The same may hold for P_2O_5 use as the cropping pattern diversifies, and as China invests in P_2O_5 capacity and India enters into more joint ventures with phosphate rock-producing countries for P_2O_5 production to augment P_2O_5 supplies.

So far we have concentrated on Asia as one region. However, because of its large base and vast size (more than 35 countries), trends in fertilizer consumption in Asia need subregional analysis. For ecological and geographical reasons, we have divided Asia into three subregions; namely East Asia, South Asia, and West Asia. Major fertilizer-consuming countries in each subregion are China, Japan, and Indonesia in East Asia; India, Pakistan, and Bangladesh in South Asia; and Turkey, Iran, and Saudi Arabia in West Asia.

In total consumption East Asia leads the other two. With 27.01 million tons of nutrient consumption in 1985, East Asia accounted for about two-thirds of the total consumption in Asia; South Asia accounted for one-fourth (25%), and West Asia for one-twelfth (8%).

East Asia--Although all three subregions in Asia experienced rapid growth in their fertilizer consumption during the 1960s, 1970s, and 1980s, growth in fertilizer use was slowed down considerably in East Asia in the 1980s. For example, total fertilizer use in East Asia grew at 10.5% and 8.8% per annum during the 1960s and 1970s, respectively, but only at 4.01% per annum during the 1980s (1980-87). This slowdown in growth in East Asia occurred because of the decrease in fertilizer imports in China in 1985/86. Whether this decrease in imports resulted in decreased fertilizer consumption in 1985/86 is debatable.[11] Furthermore, the slowdown occurred in all three nutrients (Table 2.4). However, the slowdown in growth rate was much steeper for nitrogen than for P_2O_5 and K_2O, because nitrogen growth rates dropped from 10.4% per annum during the 1970s to 4.01% during the 1980s. Because most of this slowdown is caused by decreases in apparent nitrogen consumption in China and because accurate information about China is very much lacking, we may have

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11. See Bumb (1988a) for details.

to make some conjectures about the reasons for this slowdown. First, if the Chinese had excessive stocks carried over from 1984 because of bad weather, then the decrease in imports may not necessarily imply a decrease in fertilizer use. However, bad weather did prevent growth in N use in 1985/86. Second, since per hectare nitrogen use is already very high and the imbalance between N:P and N:K is acute in China, there may be a policy shift in favor of promoting phosphate and potash use and slowing down nitrogen growth. To the extent that nitrogen use efficiency is constrained by inadequate availability of phosphate and potash in the soils, this policy shift is desirable and will have a positive impact on P_2O_5 and K_2O use in the short run and on all three nutrients in the long run. Until nutrient balances are restored, nitrogen use growth may be slowed down. Is there a policy shift in favor of P_2O_5 and K_2O in China? Again, the evidence is indirect. From the announced plans about future capacities, this shift in policy is apparent. Third, this slowdown in N use may have been caused by diversion of land from food crops to cash crops under China's new "responsibility system." If so, then the slowdown may be a result of policy change. However, because of stagnation in food-grain production in China during the 1984-88 period,[12] there is a possibility of creating more incentives, or controls, to prevent further declines in the cultivated area under food crops, and to revive this trend in favor of grain crops. If that happens, there may be an increase in nitrogen use.

Of all these factors, the nutrient imbalance factor appears to be a more plausible reason for some slowdown in nitrogen growth rates in China in the long run. Also, as nitrogen use levels are already relatively high, promoting P_2O_5 and K_2O use will definitely increase the efficiency of the existing levels of N. Such a shift also appears economically optimal, because an extra dollar spent on P_2O_5 and K_2O use will provide higher returns. However, the main constraints on P_2O_5 and K_2O use are creation of domestic production capacity and foreign exchange allocations. Both of these factors are a function of governmental commitment. In this context, it is worth mentioning that the World Bank is helping China in building large-scale phosphate complexes. Also, China is increasing K_2O imports. Hence, growth in P_2O_5 and K_2O use may be sustained, or speeded up. However, as the increase in planned N capacity is relatively small, we may expect relatively lower growth in N use.

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12. See Stone (1988) and An (1988).

In addition to the situation in China, the slowdown in growth rates in East Asia was also caused by the almost stagnant fertilizer markets in Japan, South Korea, and Taiwan, all of which had high levels of fertilizer use in the 1970s. Fertilizer price increases in Indonesia also slowed down growth in the 1980s.

In spite of different economic systems in East Asia, one policy is common to all. All of these countries (except Thailand) have kept real costs of fertilizer low--either by keeping crop prices high (Japan, Korea) or by keeping fertilizer prices low (Indonesia, Malaysia) or a combination of the two (China). Consequently, kilograms of paddy rice required to purchase a kilogram of nitrogen are very low in all these countries. For example, in 1985, the Japanese farmers paid only half a kilo of paddy to buy one kilo of nitrogen, whereas the farmers in the world market paid twice as much, and farmers in India and Pakistan paid three to four times as much (Table 2.19).

An analysis of the 5-year percentage changes in fertilizer use growth indicates that, like other regions, East Asia also experienced acceleration in its fertilizer use growth in the 1975-80 period (Table 2.15). New N capacity in China and Indonesia induced this acceleration. In P_2O_5, this acceleration occurred in the 1980s (1980-85), and in K_2O, the highest percentage change was in the 1965-70 period. These percentage changes further reinforce the role of domestic production capacity and foreign exchange allocations in promoting growth in fertilizer use.

South Asia--Not only in Asia but in the whole world, South Asia maintained the highest growth rates in fertilizer use during the 1980s; its total fertilizer consumption grew at 9.3% per annum, and consumption of different nutrients between 7.1% and 11.1%. Such high growth rates were maintained by a high degree of government commitment, a stable and profitable pricing environment, sustainable organizational arrangements, and adequate physical and institutional infrastructure.[13] Although South Asia has not maintained as low a real fertilizer price as East Asia, it has avoided high fluctuations in both crop and fertilizer prices by careful monitoring of these prices.

In absolute terms, South Asia's total fertilizer use increased from 0.43 million tons in 1960 to 1.99 million tons in 1970, 6.67 million tons in 1980, and 12.52 million tons in 1987. Most of this growth was due to a

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13. See Gupta (1989) and Narayan (1988) for details.

Table 2.19. Fertilizer-Rice[a] Price Ratios in Selected Countries, 1970-86 (kg of rice/kg of N)

Year	Bangladesh	India	Indonesia	Japan	South Korea	Thailand	World
1970	0.71	2.26	3.00	0.43	0.87	4.76	0.73
1971	0.95	1.88	2.18	0.42	0.78	7.36	0.78
1972	1.13	1.76	2.25	0.40	0.69	5.79	0.88
1973	0.81	1.55	1.76	0.41	0.70	4.04	0.59
1974	1.36	1.34	1.41	0.38	0.73	4.43	1.27
1975	1.19	1.66	2.55	0.40	0.55	5.01	1.19
1976	0.59	1.86	2.06	0.38	0.60	5.42	0.96
1977	1.18	2.06	1.54	0.34	0.94	3.21	1.02
1978	1.18	1.81	1.44	0.32	0.85	2.29	0.86
1979	1.25	1.76	1.58	0.33	0.73	2.42	1.12
1980	1.37	1.52	0.96	0.36	0.56	2.28	1.11
1981	1.49	1.58	0.88	0.51	0.47	2.57	0.97
1982	1.56	1.78	0.80	0.47	0.67	3.49	1.18
1983	1.59	1.83	0.94	0.46	0.73	3.29	1.06
1984	1.66	1.64	0.92	0.42	0.70	3.03	1.48
1985	1.67	1.48	0.89	0.36	0.72	3.20	1.37
1986	1.55	1.56	1.06	0.35	0.65	2.71	1.10
Average							
1970-79	1.04	1.79	2.0	0.38	0.74	4.47	0.94
1980-87	1.56	1.63	0.92	0.42	0.64	2.48	1.18
1970-87	1.25	1.72	1.54	0.40	0.70	3.65	1.04

a. Milled rice.

Source: Derived from data in IRRI (1988) and World Bank (1986a).

significant increase in nitrogen use, which increased from 0.30 million tons in 1960 to 4.68 million tons in 1980 and 8.63 million tons in 1987. These growth trends suggest that South Asia will be the only region to have doubled its N use in the 1980s. Phosphate and potash use also increased substantially from 1.37 and 0.62 million tons in 1980 to 2.87 and 1.02 million tons, respectively, in 1987. Their growth in the 1960s and the 1970s was significant but not as high as N use growth.

The pattern of 5-year percentage changes in fertilizer use in South Asia is slightly different from that in East Asia. For N and P_2O_5, fertilizer use accelerated in two periods, namely, 1965-70 and 1975-80 (Tables 2.16 and 2.17). High fertilizer prices of 1973-75 affected fertilizer use both at the farm level and at the country level. The high international prices affected imports and, because high import costs were reflected in domestic prices, farm-level use was also affected. It was after the 1975 price increases that India and other countries instituted price stabilization measures and retention price schemes. In the 1975-80 period, two events occurred: one, fertilizer price decreased substantially until 1978, and second, a subsidy was introduced on P_2O_5 use in India in 1977. Besides, domestic production capacity also increased.[14]

West Asia--Unlike South and East Asia which are net oil importers, West Asia consists of many oil-exporting countries. Turkey, Iran, and Saudi Arabia are dominant users in this region.

Because of easy availability of foreign exchange and natural gas, countries in this region (except Turkey) have not experienced the constraints on growth in fertilizer use that some other countries have. Further, this region has become a major exporter of fertilizer products in the 1980s. Although oil-exporting countries were free from foreign exchange constraints, Turkey, which accounted for 47% total fertilizer consumption in 1985, experienced several problems. First, it had severe balance of payment difficulties in the 1980s. Second, because of removal of subsidies, fertilizer prices increased rapidly. Third, it experienced drought conditions. All these factors slowed down growth in fertilizer use in Turkey. However, Turkey's slowdown was offset by rapid growth in fertilizer use in Saudi Arabia and some other countries. Consequently, total fertilizer use increased from 2.20 million tons in 1980 to 3.59 million tons in 1987.

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14. See Chapter 3, pp. 125-127 for details.

Earlier, it increased from 0.11 million tons in 1960 to 2.20 million tons in 1980. Compared with East and South Asia, changes in absolute levels were small, but because these occurred on a small base, West Asia's growth rates were high in the 1980s and the 1970s. The growth rates for total fertilizer use were 7.1% and 12.5% during the 1980s and the 1970s, respectively.

As in South Asia, total fertilizer consumption in West Asia accelerated in the late 1960s as well as in the late 1970s (Table 2.15). Earlier acceleration was associated with the diffusion of HYV wheat in Turkey and some other countries, whereas the latter acceleration is mostly due to expansion in productive capacity and governmental commitment to increase food production through low and subsidized fertilizer prices (Saudi Arabia). The pattern of acceleration was the same for N and P_2O_5 but slightly different for potash. For potash, the highest percentage change was in the late 1960s as well as in the 1980s.

West Asia differs strikingly from other regions and subregions in one feature. Unlike other regions, West Asia experienced high growth in potash consumption; its potash consumption increased by 11.9% per annum during the 1980s, although it must be added that this growth was from a very small base (of 65,000 tons) and therefore had little impact on the global situation. However, by itself, it is worth exploring the factors responsible for this change, because other nutrients, in spite of small base, did not grow as fast. Whether Jordan's potash capacity induced this pattern requires further research.

Latin America

During the 1980s the growth in total fertilizer use was slowed down considerably in Latin America. Compared with 12% and 10% per annum growth in fertilizer use during the 1960s and the 1970s, respectively, total fertilizer use grew only at 2.7% per annum during the 1980s. This slowdown in growth was experienced by both Central America and South America although it was much more severe for the latter than for the former; the annual growth rate for South America dropped from 12.5% per annum during the 1970s to 1.9% per annum in the 1980s, while for Central America the drop in growth rate was from 5.4% to 4.5%. Among different nutrients, P_2O_5 was affected much more adversely than N and K_2O. There was hardly any growth in P_2O_5 use in South America. Some of the factors causing this slowdown in fertilizer use growth are: debt crises, foreign exchange shortages, low export crop prices, high fertilizer

prices resulting from subsidy removal programs in countries like Venezuela and others, and the removal of subsidized credit programs in Brazil. Compared with Asia, which experienced stable policy environment, Latin American countries experienced drastic policy changes and a volatile fertilizer market.[15] Also, because of low production base and high import dependence, especially of South America, many macroeconomic (debt crisis and foreign exchange shortages) factors accentuated the slowdown in fertilizer use growth by reducing imports.

Total fertilizer consumption increased from 0.73 million tons in 1960 to 6.60 million tons in 1980, and 8.63 million tons in 1987. Nitrogen use increased from 0.29 million tons in 1960 to 3.83 million tons in 1987, and P_2O_5 and K_2O use from 0.30 and 0.14 million tons to 2.80 and 2.01 million tons, respectively, during the 1960-87 period (Figure 2.19).

In terms of 5-year percentage changes, Latin America presents a different picture. Unlike North America, Western Europe, and Asia, which experienced acceleration in their fertilizer use growth during the 1975-80 period, Latin America experienced no such acceleration during the 1960-85 period; its total fertilizer consumption increased at decreasing percentage rates (Figure 2.20). After a very low percentage increase (9%) during the 1980-85 period, its total fertilizer use increased by a higher percentage during the 1985-87 period compared with the preceding period (1980-85). This indicates the influence of the improved macroeconomic situation resulting from restructuring of debts and additional foreign exchange available from international organizations like the World Bank and others. The impact of an improved macroeconomic situation on fertilizer use growth is more visible in South America than in Central America, because in South America fertilizer consumption increased by about 25% during 1985-87 compared with a 1% decrease in the 1980-85 period (Table 2.15). Changes in fertilizer use in Brazil and Venezuela mostly induced these changes in fertilizer use in South America.

Another interesting phenomenon about the Latin American experience is that the two subregions experienced offsetting (counter balancing) growth patterns. When one region experienced substantial growth, the other region's growth slowed down and vice versa. In the 1960s, Central America experienced relatively high percentage growth in its total fertilizer consumption, and South America had a similar experience in the 1970s. In Central America,

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15. See Lopes, Guilherme, and Silva (1989) for details.

Figure 2.19

LATIN AMERICA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK CONSUMPTION, 1960–87

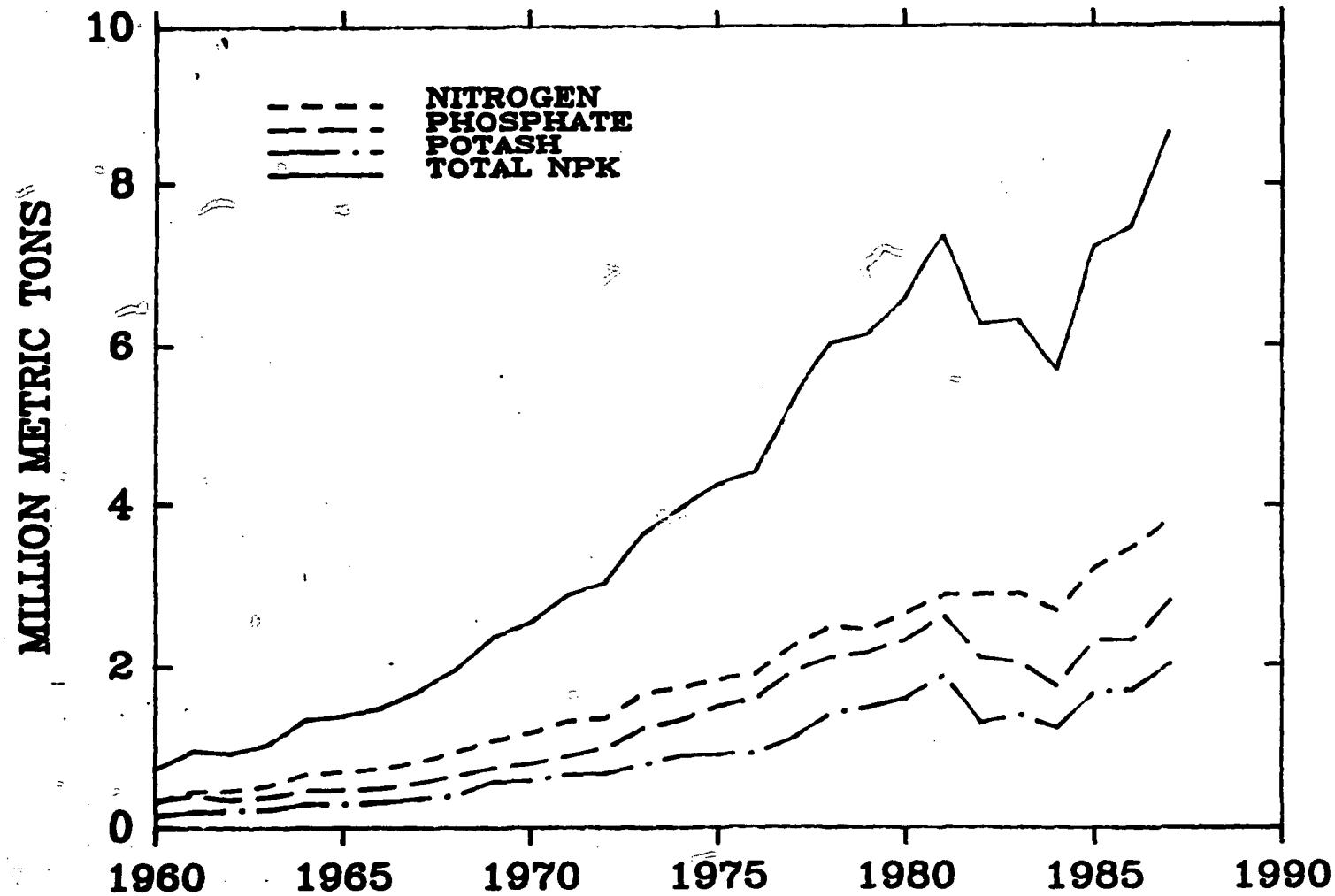
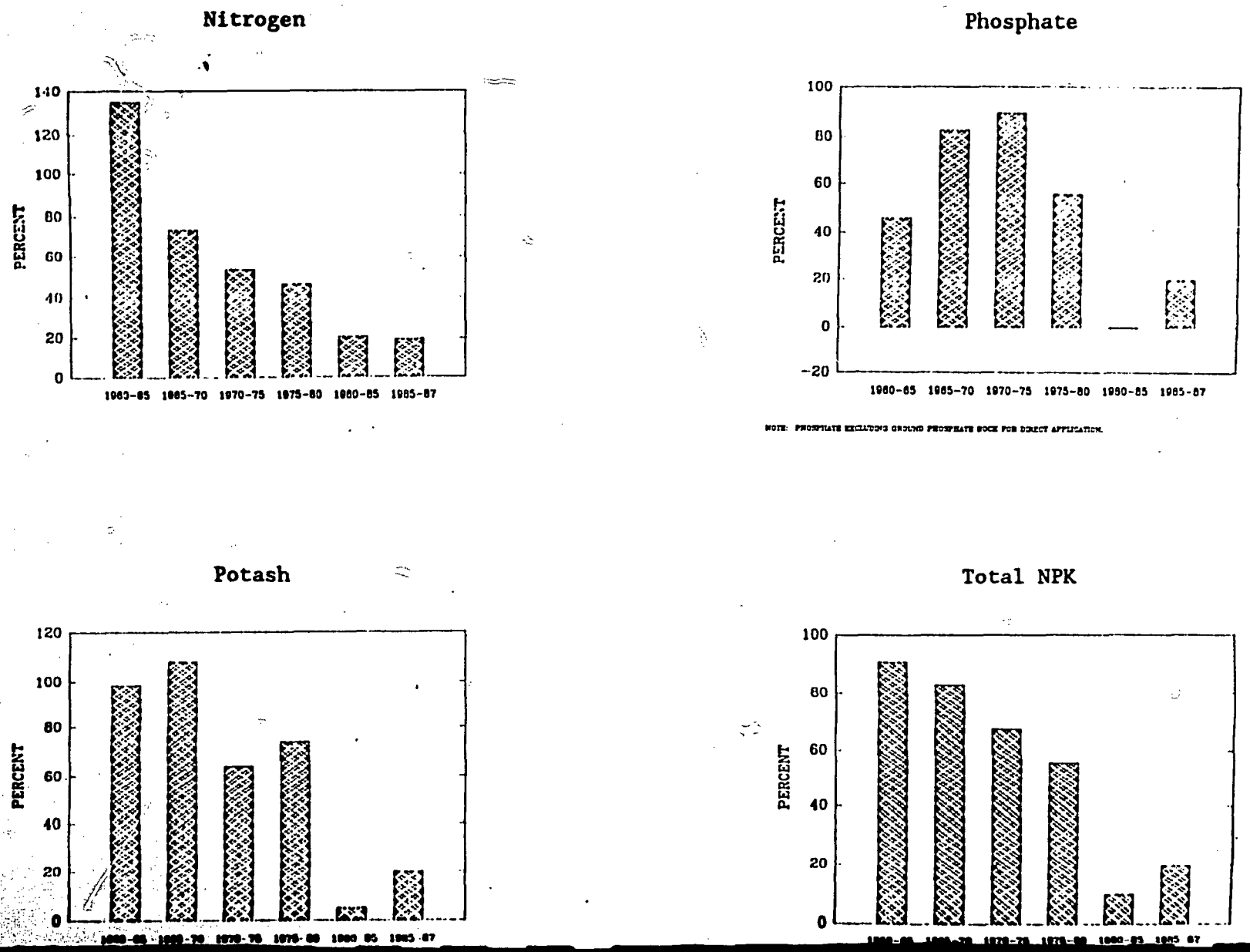


Figure 2.20

Latin America: Percent Change in Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1960-87



total fertilizer use increased by 136% and 93% during the 1960s (1960-65 and 1965-70 periods) and by 24% in each period during the 1970s (1970-75 and 1975-80 periods). Against this, total fertilizer consumption in South America increased by 60% and 72% during the 1960s (1960-65 and 1965-70 periods) and by 115% and 76% during the 1970s (1970-75 and 1975-80 periods) (Table 2.15). The pattern of the 1960s and the 1970s is being repeated in the 1980-85 and 1985-87 period as well. When Central America experienced 32% growth in its fertilizer use during the 1980-85 period, South America's total fertilizer use declined by 1%. Whether this pattern would be repeated in the 1985-90 period is too early to know although because of the expected improvements in macroeconomic prospects, South America may experience higher growth in 1985-90 compared with the 1980-85 period. These counterbalancing growth patterns of South and Central America need more research.

The individual growth experiences of the two subregions in Latin America are as follows.

Central America--Whereas in South America, fertilizer use decreased marginally (by 1%) during the 1980-85 period, in Central America fertilizer use increased by about 33% during the same period. In spite of the debt crisis of Mexico and other countries, fertilizer use in Central America continued to grow because of its vast N production and export base as well as the continued existence of fertilizer subsidies and low fertilizer prices.

Total consumption in Central America increased from 0.29 million tons in 1960 to 3.03 million tons in 1987. Most of this increase was due to an increase in N use. Nitrogen use increased from 0.20 million tons in 1960 to 2.00 million tons in 1987 while P_2O_5 and K_2O use increased from 0.05 and 0.05 million tons to 0.60 and 0.43 million tons during the same period.

As indicated above, Central America's pattern of 5-year percentage changes is quite different from that of South America and Asia. As high-yielding varieties of wheat and corn were first developed and diffused in Mexico, Mexico experienced a rapid growth in its fertilizer use in the 1960s and maintained growth in its total fertilizer use at high levels. After a 24% increase in each subperiod of the 1970s, there was some acceleration in total fertilizer use in the 1980-85 period. This acceleration is mostly due to increase in P_2O_5 use, which decreased by about 3% during the 1975-80 period and increased by 39% during the 1980-85 period.

South America--In 1987, South America accounted for about two-thirds of total fertilizer consumption in Latin America. As was indicated earlier,

in South America, fertilizer use grew rapidly during the 1960s and the 1970s, but slowed down considerably in the 1980s. For example, total fertilizer consumption increased from 0.43 million tons in 1960 to 4.54 million tons in 1980, but there was a small decrease (1%) between 1980 and 1985. After 1985, it increased by 24% in 1987. The slowdown in South America's total fertilizer use was caused mostly by a substantial decrease in P_2O_5 use, which registered a 8.6% decline between 1980 and 1985. Nitrogen and potash use increased marginally during the 1980s.

In terms of 5-year changes, South America's total fertilizer use accelerated in the 1970-75 period, and high growth continued in the 1975-80 period (Table 2.15). Several policies introduced in Brazil in the late 1960s and the early 1970s and high prices for export crops (coffee boom) in the 1970s appear to have contributed towards this acceleration. As Brazil experienced foreign exchange shortages and as prices for its export crops dropped, its capacity to import, especially P_2O_5, decreased. Also changes in credit policies affected fertilizer use. Another factor is a decrease in fertilizer use in Venezuela due to removal of subsidies in March 1981. Total NPK consumption decreased by 50% in 1982 and remained at that level during the next 3 years. Fertilizer use recovered and accelerated in Venezuela only when subsidies were reintroduced in 1984 (Figure 2.21).

Africa

Although Africa consists of more than 45 countries and accounts for about 12% of the world population, it accounted for less than 3% of total world fertilizer consumption in 1987, and about two-thirds of that was concentrated in five countries in North Africa and the Republic of South Africa. Thus, sub-Saharan Africa, with about 40 countries and 9% of the world population, accounted for only one-third of total fertilizer consumption in Africa and about 1% of the global fertilizer consumption in 1987.

In absolute terms, Africa's total fertilizer consumption increased from 0.53 million tons in 1960 to 2.81 million tons in 1980 and 3.57 million tons in 1987. Nitrogen use increased from 0.22 million tons in 1960 to 1.50 million tons in 1980 and 2.01 million tons in 1987. Likewise, P_2O_5 and K_2O use increased from 0.23 million and 0.08 million tons in 1960 to 1.11 and 0.44 million tons, respectively, in 1987 (Figure 2.22).

Like Latin America, Africa also experienced a slowdown in its fertilizer use during the 1980s. Compared with 9.4% per annum growth in the

VENEZUELA: IMPACT OF FERTILIZER SUBSIDIES ON TOTAL NPK CONSUMPTION, 1977–1987

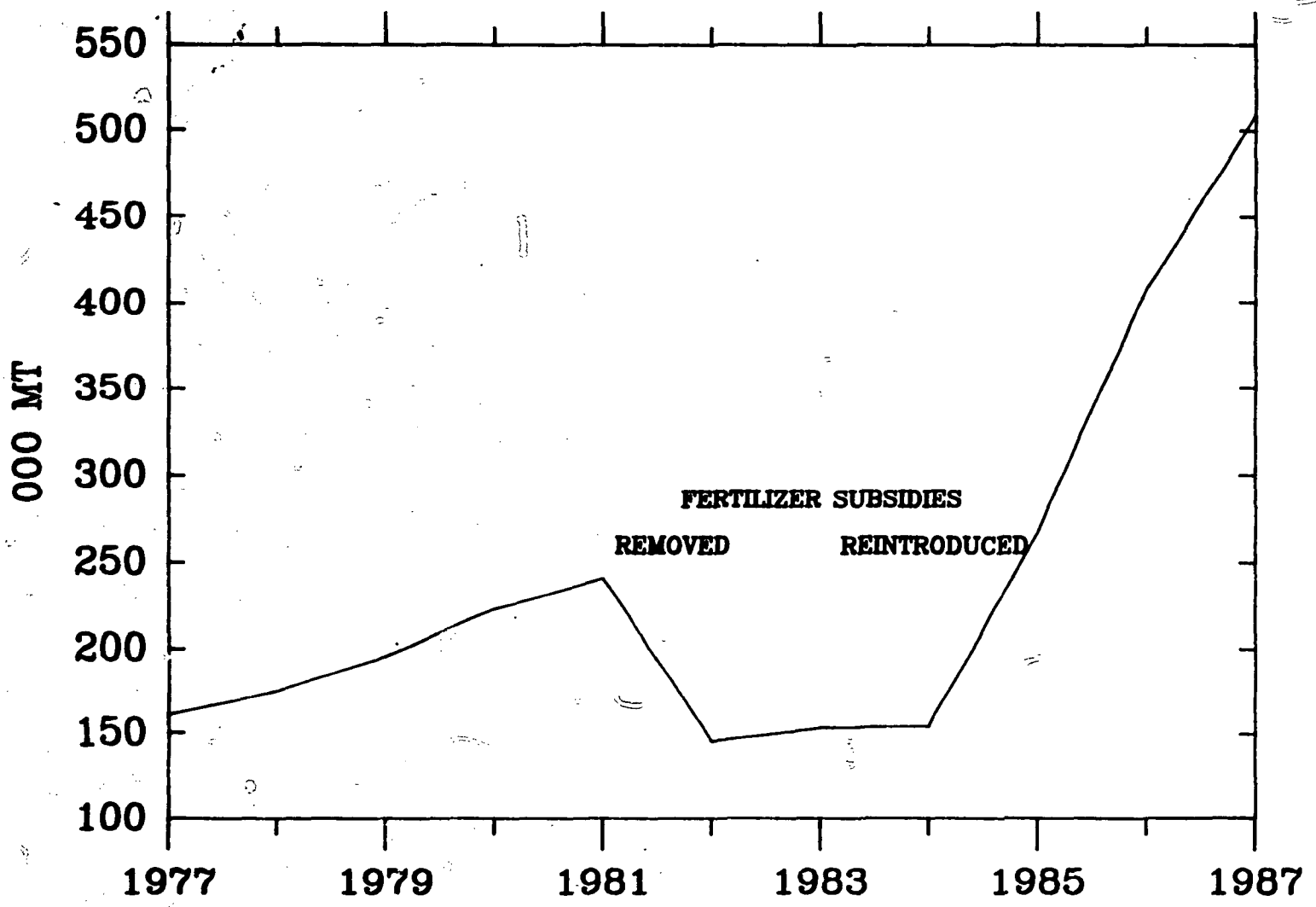
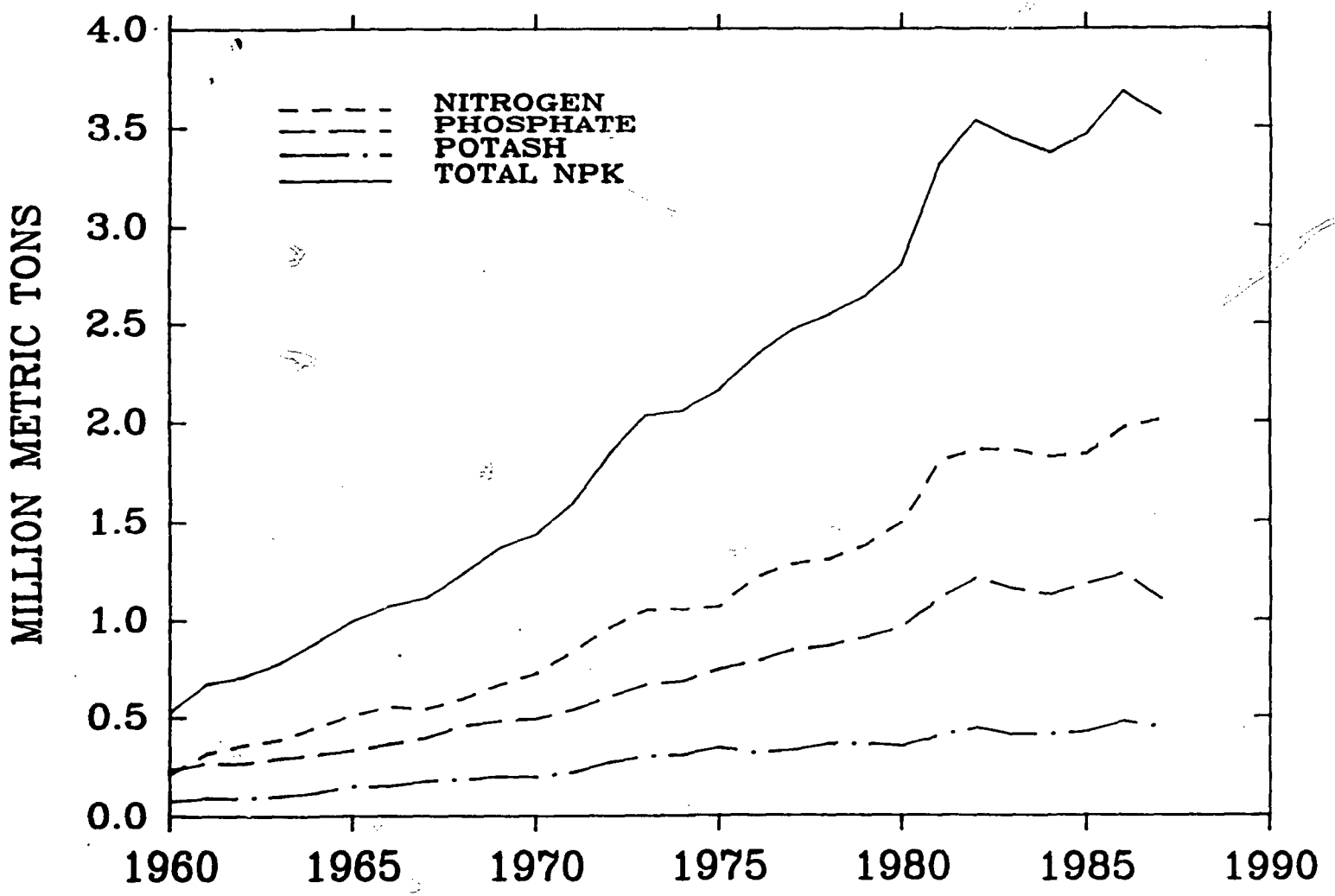


Figure 2.22

AFRICA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK CONSUMPTION, 1960–87



1960s and 6.2% per annum growth in the 1970s, total fertilizer use increased only at about 2.5% per annum in the 1980s. Most of this slowdown was caused by significant declines (3.8% per annum) in total fertilizer use in South Africa. Also, foreign exchange shortages and unfavorable weather conditions in many sub-Saharan African countries contributed to this slowdown. All nutrients experienced the slowdown more or less equally (Table 2.4).

An analysis of the 5-year percentage changes indicates that total fertilizer use accelerated a little in the 1970-75 period in Africa (Figure 2.23). Thereafter, it increased at decreasing percentage rates because the three subregions experienced acceleration in fertilizer use in different periods and because there were large variations in per hectare fertilizer use in different regions.

North Africa--North Africa's total fertilizer consumption increased from 0.23 million tons in 1960 to 1.11 million tons in 1980 and 1.55 million tons in 1987. During the same period N use increased from 0.13 million tons in 1960 to 0.99 million tons in 1987, P_2O_5 use from .08 million tons to 0.42 million tons, and K_2O from 0.02 to 0.14 million tons. In absolute terms, N use increased faster than P_2O_5 and K_2O use.

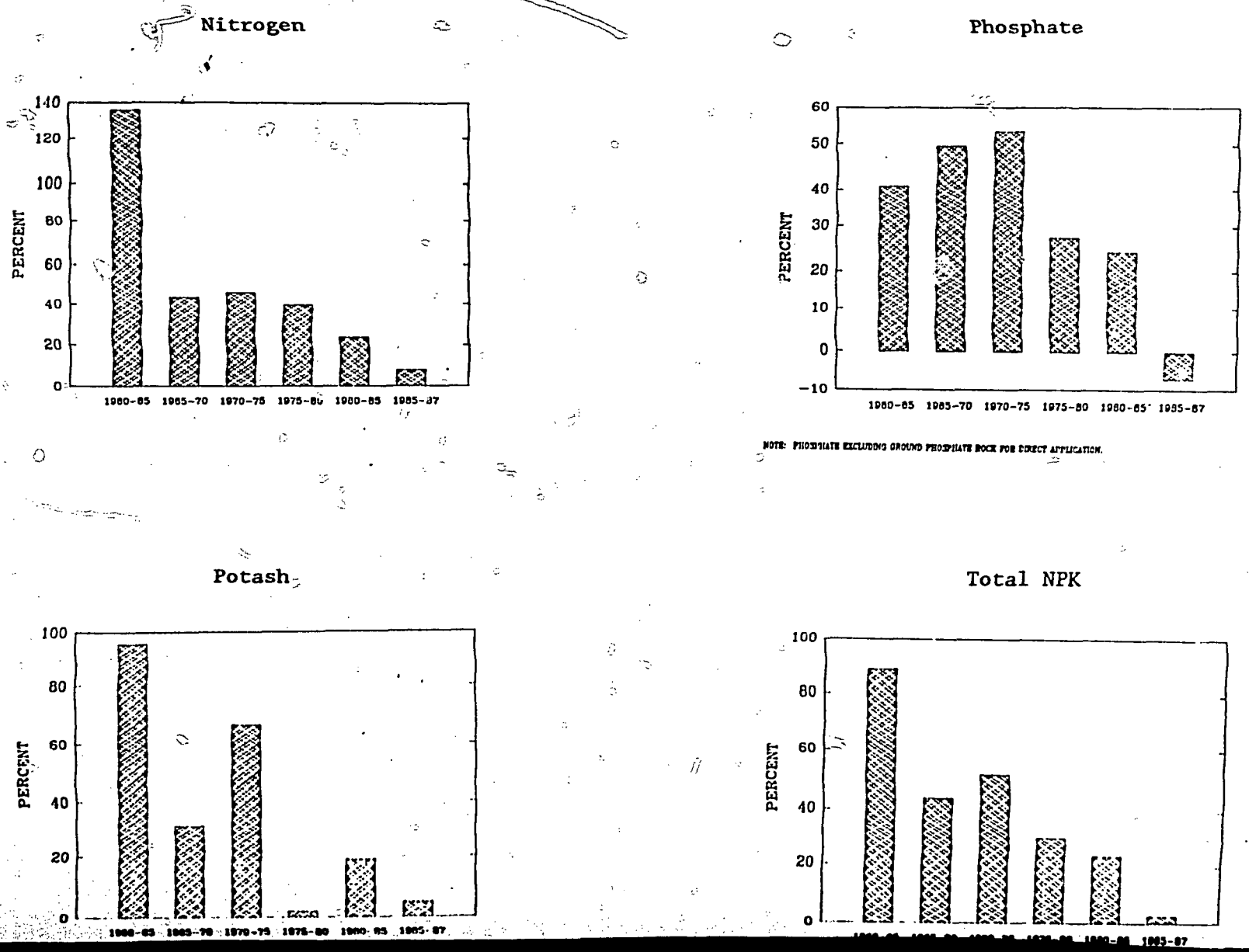
Total fertilizer use grew at 4.8% per annum between 1980 and 1987. In spite of a large production and export base, relatively lower growth rates for North Africa, especially compared with Asia, must be due to ecological constraints as well as the stable high levels of per hectare fertilizer use in Egypt (a dominant user in the region).

North Africa's fertilizer use accelerated a little in 1970-75; thereafter it grew at constant percentages until 1985. This acceleration in total fertilizer use was mostly due to acceleration in P_2O_5 and K_2O uses, because nitrogen use increased by highest percentages during the 1960s.

Sub-Saharan Africa--In spite of the vast size and many countries, absolute as well as per hectare fertilizer use levels are rather low in sub-Saharan Africa. In 1987, sub-Saharan Africa consumed about 1.2 million tons of nutrients. In 1960, total fertilizer consumption was about 0.10 million tons, and in 1980 about 0.73 million tons. Nitrogen use increased from 0.19 million tons in 1970 to 0.65 million tons in 1987, while P_2O_5 and K_2O use changed from 0.10 and 0.08 million tons in 1970 to 0.36 and 0.19 million tons, respectively, in 1987. Although all nutrient use grew at appreciable rates (3.7% to 6.9%), phosphate use grew more rapidly. Relatively higher growth in P_2O_5 use must have occurred for several reasons. First,

Figure 2.23

Africa: Percent Change in Nitrogen, Phosphate, Potash, and Total NPK Consumption, 1960-87



availability of phosphate capacity in Senegal in 1984 must have helped this growth. Second, because many sub-Saharan African countries use more fertilizers on cash and export crops than on grain crops, P_2O_5 use is relatively higher. Third, the dominant fertilizer products are complexes (NPK), which provide more or less equal amounts of all nutrients.

In spite of these appreciable growth rates, fertilizer use in sub-Saharan Africa will have to continue growing at increasingly higher rates because of its fragile food security base.[16]

In terms of 5-year percentage changes, total fertilizer use grew at the lowest rates during the 1975-80 period. Because of heavy import dependence, high fertilizer prices of the mid- and the late-1970s appear to have affected sub-Saharan Africa's fertilizer use. Thus, whereas Asia, North America, and Western Europe, as well as South Africa experienced accelerated growth in their fertilizer consumption, sub-Saharan Africa experienced a slowdown in the 1975-80 period. Foreign exchange shortages seemed to have produced this pattern. Although many countries continued to experience these shortages during 1980-87, several donor-supported programs seemed to have restored recovery in fertilizer use in sub-Saharan Africa.[17] During this period, total fertilizer use increased by 65%.

South Africa--Compared with fertilizer use in sub-Saharan Africa, South Africa's fertilizer use levels are high both in absolute terms and on a per hectare basis. South Africa also achieved higher levels of fertilizer use in the mid-1970s. However, its growth in fertilizer use during the 1970s was mostly grain-export induced, like that of Oceania and North America. Hence, when demand for grain exports slackened and crop prices tumbled, its total fertilizer use decreased at 3.8% per annum during the 1980s. Recent increases in crop prices are reported to have stimulated growth in fertilizer use in South Africa.[18]

South Africa's total fertilizer use increased from about 0.20 million tons in 1960 to 0.97 million tons in 1980 and then decreased to 0.82 million tons in 1987. Nitrogen use increased from 150,000 tons in 1970

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16. See World Bank (1988b) and FAO (1987) for details.

17. See Bumb (1988b) and FAO, Current Fertilizer Situation and Outlook (1986) for details.

18. Discussions with Mr. Ted Stilwell, Development of Southern Africa, Sandton, Republic of South Africa in October 1988.

to 400,000 tons in 1980 and 406,000 in 1985, while phosphate use increased from 261,000 tons in 1970 to 438,000 tons in 1980. However, unlike nitrogen use, phosphate use decreased to 416,000 tons in 1985 and 336,000 tons in 1987. Potash use also increased during the 1980-85 period but registered declines in 1985-87. Again, the pattern which emerges for South Africa is similar to the one we observed earlier for Oceania; that is, fertilizer use is responsive to changes in crop and fertilizer prices, and phosphate use, compared with nitrogen use, is more sensitive to microeconomic changes.

Because of declining fertilizer use during the 1980s, South Africa's fertilizer production capacity was restructured considerably.[19]

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19. See Chapter 3, pp. 130-132 for details.

CHAPTER 3

TRENDS IN FERTILIZER PRODUCTION, 1960-87

In this chapter, trends in fertilizer production at the global and regional levels during the 1960-87 period are analyzed, and the influences of economic and noneconomic factors on global and regional production are identified.

The analysis of global and regional production trends reveals several interesting phenomena. First, the growth in fertilizer production at the global as well as at the regional levels is mostly demand-induced, albeit with a lag. Consequently, a slowdown in demand growth produced a slowdown in fertilizer production in the 1980s. Second, compared with fertilizer use, fertilizer production from the existing capacity is more responsive to changes in fertilizer prices. This is so because fertilizer use is influenced by many factors other than fertilizer prices, such as macroeconomic (foreign exchange shortages and balance of payment difficulties), microeconomic (changes in crop prices and credit allocations), and ecological changes, which have little impact on fertilizer production. Third, in addition to responding to the increased prices of the mid- and late 1970s, fertilizer production in the late 1970s and the early 1980s also responded to food security needs of many food-deficit countries.

Fourth, the regions that experienced maximum annual growth in fertilizer production during the 1980s were the regions that protected their fertilizer sectors from volatile fluctuations in fertilizer prices. These regions had an adequate feedstock base and a high degree of governmental commitment and involvement in their fertilizer sectors and provided a stable policy and pricing environment. On the other hand, the regions that experienced declines in production had little governmental involvement in the fertilizer sector, were mostly market-based economies, and had lost their traditional fertilizer export markets due to limited domestic availability of feedstocks and increased costs of imported raw materials. Also, because of excessive grain stocks, these regions had little need for increased fertilizer use to produce more food grains.

Global Trends

Globally, growth in total fertilizer production, like growth in total fertilizer use, was slowed down considerably during the 1980s. For example, total fertilizer production grew at 2.6% per annum during the 1980-87 period, as against 5.5% per annum during the 1970-80 period (Table 3.1). Likewise N, P_2O_5, and K_2O production increased at 3.6%, 1.5%, and 1.6% per annum, respectively. This slowdown in production was mostly caused by slow growth in fertilizer use, as well as by low and unrenumerative fertilizer prices. In addition to these two factors, a slowdown in capacity buildups also slowed down growth in fertilizer production.

The growth experience of the 1980s is in sharp contrast to that of the 1970s and the 1960s (Figure 3.1). During the 1970s, total fertilizer production grew at 5.5%/year, while N, P_2O_5, and K_2O production grew at 6.5%, 4.5%, and 4.7%/year, respectively. These growth rates were more than twice the growth rates for the 1980s. Higher growth rates for the 1970s are mostly due to high growth in global fertilizer use.

The growth experience of the 1960s is similar to that of the 1970s except that, because of lower base, production of each nutrient increased at a higher rate. In absolute amounts, it nearly doubled.

Total fertilizer production increased from 117.7 million tons in 1980 to 139.9 million tons in 1987, although it dropped in 1982 and 1986 (Table 3.2 and Figure 3.2). During the same period nitrogen production increased from 59.6 million tons to 75.6 million tons, while P_2O_5 and K_2O production from 32.2 and 25.8 million tons to 35.6 and 28.8 million tons, respectively. Thus, more than 70% of the increase in total production was contributed by nitrogen production. This relatively higher contribution of N production was a result of both a higher growth in N production and high capacity creation although the influence of the latter was diminishing as a significant amount of N capacity was permanently closed in many countries, especially in the United States in the mid-1980s. Relatively slower growth in P_2O_5 and K_2O use induced slower growth in their production levels as well.

During the 1970s, total fertilizer production increased from 66.3 million tons in 1970 to 117.6 million tons in 1980: nitrogen production

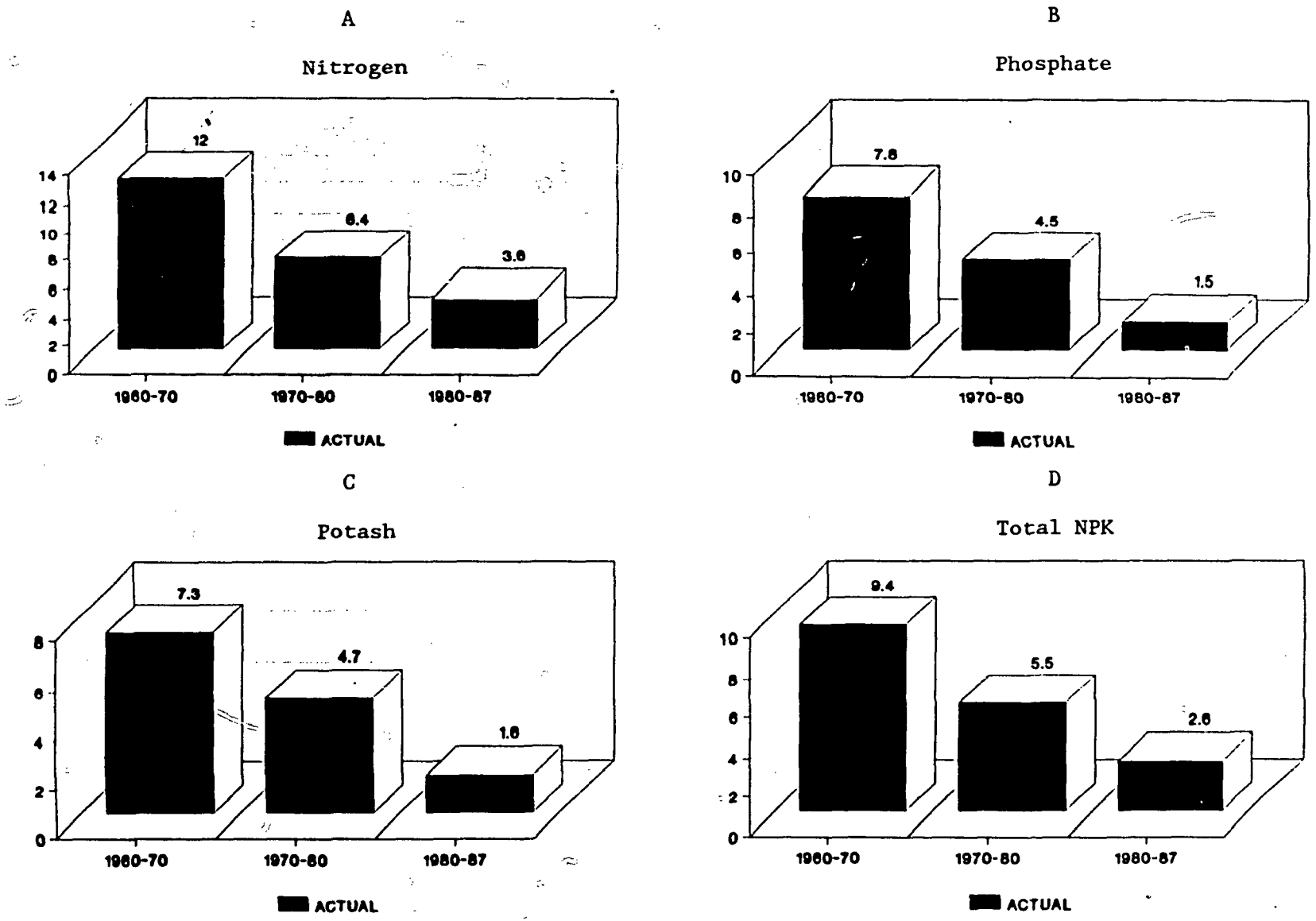
Table 3.1. Global Fertilizer Production: Annual Growth Rates, 1960-87

Nutrient	1960-70	1970-80	1980-87
	- - - - - - - - - - - -	(%) - - - - - - - - - - - -	
N	12.0	6.4	3.6
P_2O_5	7.8	4.5	1.5
K_2O	7.3	4.7	1.6
Total	9.4	5.5	2.6

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Figure 3.1

Global Fertilizer Production Growth Rates, 1960-87



Source: Derived from FAO (1988).

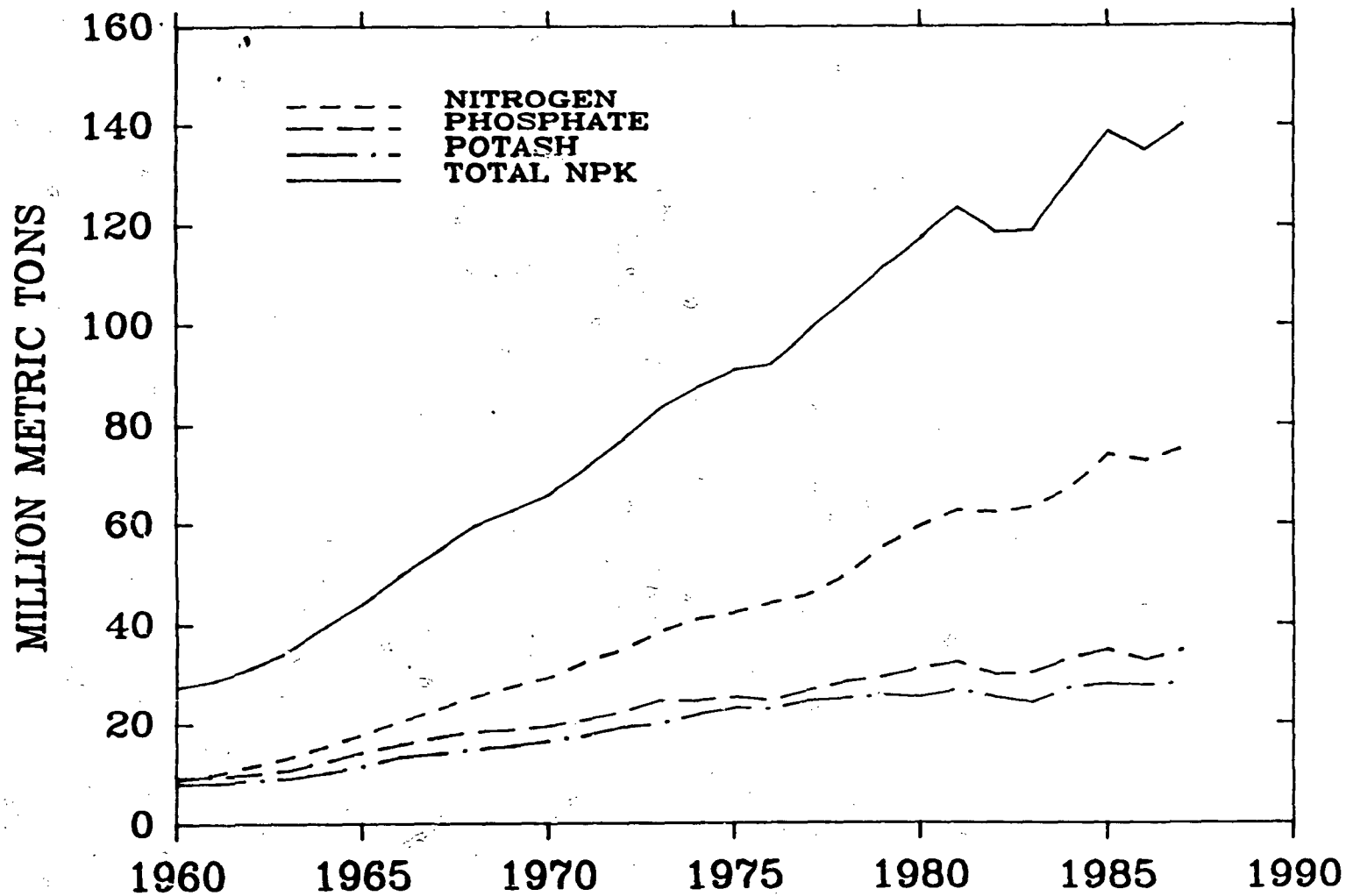
Table 3.2. Global Fertilizer Production, 1960-87

Year	N	P_2O_5	K_2O	Total
	(million tons)			
1960	9.64	9.77	8.71	28.12
1965	17.66	14.60	12.19	44.45
1970	30.22	19.45	16.66	66.33
1975	42.46	25.84	23.40	91.70
1980	59.62	32.22	25.84	117.69
1985	74.52	35.62	28.66	138.80
1987	75.56	35.55	28.79	139.91

Source: FAO (1988) and FAO Fertilizer Yearbook (various issues).

Figure 3.2

WORLD: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK PRODUCTION, 1960–87



increased from 30.2 to 59.6 million tons, P_2O_5 production from 19.5 to 32.2 million tons, and K_2O production from 16.6 to 25.8 million tons. Although increase in N production contributed more than 50% of the increase in total production, significant contributions were also made by increases in P_2O_5 and K_2O production levels.

An analysis of 5-year percentage changes indicate that total fertilizer production increased by the highest percentage points in 1960-65 and by the lowest percentage points in 1980-85. In between, it grew by decreasing percentage points. The same pattern holds for N, P_2O_5, and K_2O (Table 3.3).

This pattern of percentage changes in production is different from that in consumption. While there was an acceleration in fertilizer use during the 1975-80 period, there was no such acceleration in fertilizer production. One explanation is that production fluctuates much less than fertilizer use because it is dependent on installed capacity and fertilizer and raw material prices whereas fertilizer use is influenced by several factors which are external to the fertilizer sector. Second, changes in capacity take a much longer time than changes in use because the construction of fertilizer plants is a time-consuming process. Construction time varies between 24 and 48 months in different countries.

Regional Variations

Although growth in global fertilizer production was slowed down considerably in the 1980s, not all regions experienced the same degree of slowdown in their fertilizer production. Different regions experienced different growth rates. In some regions, total fertilizer production decreased, while in others it increased at high rates (Table 3.4).

In Asia, the U.S.S.R., Africa, and Latin America, fertilizer production grew at more than 6%, whereas in North America and Western Europe it decreased at about 1%/year. Oceania experienced the highest annual decline (5%/year) in its total fertilizer production although the decline was mostly in P_2O_5 production.

Nitrogen production increased at the highest rate in Africa (although from a relatively small base), followed by Latin America, the U.S.S.R., and Asia (5%-10%/year). In North America and Western Europe, it decreased at marginal rates. North America and Western Europe also experienced declines in P_2O_5 and K_2O production.

Table 3.3. Percentage Changes in Global Fertilizer Production, 1960-87

Year	N	P_2O_5	K_2O	Total
1960-65	83	49	40	58
1965-70	71	33	37	49
1970-75	41	33	41	38
1975-80	40	25	10	28
1980-85	25	11	11	18
1985-87	1	-	-	1

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.4. Regional Nitrogen, Phosphate, Potash, and Total NPK Production: Annual Growth Rates, 1980-87

Region	Nitrogen	Phosphate	Potash	Total
	(%)			
North America	-0.7	-1.0	-1.7	-1.1
Western Europe	-0.3	-3.5	-1.4	-1.3
Eastern Europe	2.2	0.0	0.3	1.2
U.S.S.R.	7.0	5.8	5.8	6.3
Oceania	4.2	-6.8	-	-5.0
Africa	10.0	6.6	-	8.3
North Africa	18.5	11.5	-	14.7
Sub-Saharan Africa	-0.3	-0.3	-	-0.2
South Africa	-0.8	-2.3	-	-1.3
Latin America	10.0	2.3	-	6.5
Central America	9.9	3.0	-	8.1
South America	10.0	2.2	-	5.2
Asia	5.7	5.8	13.3	6.0
East Asia	3.5	2.2	5.6	3.2
South Asia	12.5	10.7	-	12.4
West Asia	6.8	15.0	13.4	10.4
WORLD	3.6	1.5	1.6	2.6

Source: Derived from FAO data by using log-linear regressions. FAO (1988).

In P_2O_5 production also, Africa had the highest growth rates (6.65) followed by the U.S.S.R., Asia, and Latin America. Eastern Europe's production was more or less stable. In K_2O production, Asia had the highest growth rate followed by the U.S.S.R. As Asia's K_2O production base is small, its contribution to global K_2O production is also small; Asia accounted for 7% of global K_2O production in 1987.

Compared with the divergent regional experience of the 1980s, the regional experience of the 1970s was more uniform. All regions experienced growth in fertilizer production, although at different rates. Total fertilizer production in North America and Western Europe grew at 4.7% and 1.3%/year, respectively (Table 3.5). Latin America and Asia had about 10% annual increases. Asia had the highest annual growth rate in nitrogen production (11.3%), Latin America in P_2O_5 (15.7%) and the U.S.S.R. in K_2O (8.3%). In North America also, P_2O_5 and K_2O production increased at 5%/year. Western Europe experienced marginal decreases in P_2O_5 production.

Regional variations in growth rates in the 1960s were similar to those in the 1970s, although growth rates were much higher for all the regions in the 1960s than in the 1970s (Table 3.6). Perhaps, this was so because all regions had a relatively small production base.

Regional Contributions

Most of the increase in total fertilizer production at the global level during the 1980s was contributed by increases in production in the U.S.S.R. and Asia where total fertilizer production increased by 12-13 million tons each. Increases in fertilizer production in these regions compensated for decreases of about 2-3 million tons in fertilizer production in North America and Western Europe. Africa, Latin America, and Eastern Europe contributed about 1-2 million tons each.

In nitrogen and phosphate production also, Asia and the U.S.S.R. were the leading contributors and compensated for significant decreases in N and P_2O_5 production in North America and Western Europe. However, in potash production, Asia's contribution was small. Most of the increase in global K_2O production came from increases in K_2O production in the U.S.S.R. In North America and Western Europe, K_2O production levels decreased by about 1 million tons each.

During the 1970s, Asia, North America, and the U.S.S.R. were the leading contributors to the 52 million tons increase in total fertilizer

Table 3.5. Regional Nitrogen, Phosphate, Potash, and Total NPK Production: Annual Growth Rates, 1970-80

Region	Nitrogen	Phosphate	Potash	Total
	(%)			
North America	4.0	5.3	5.0	4.7
Western Europe	3.1	-1.1	0.8	1.3
Eastern Europe	7.2	5.1	4.2	5.8
U.S.S.R.	6.8	8.8	8.3	7.8
Oceania	3.3	0.2	-	1.7
Africa	8.2	3.9	5.4	5.1
North Africa	7.6	4.2	-	5.4
Sub-Saharan Africa	8.9	3.9	5.4[a]	2.6
South Africa	8.7	3.4	-	5.3
Latin America	7.0	15.7	-4.9	10.5
Central America	5.2	4.4	-	5.3
South America	9.8	20.7	-4.9	15.5
Asia	11.3	7.0	4.4	10.0
East Asia	10.6	4.9	14.4	9.1
South Asia	11.9	13.8	-	12.0
West Asia	17.9	15.7	4.3	11.7
WORLD	6.4	4.5	4.7	5.5

a. This growth rate is for the 1970-78 period. In 1978, potash mine in Congo was closed.

Source: Derived from FAO data by using log-linear regressions. FAO (1988).

Table 3.6. Regional Nitrogen, Phosphate, Potash, and Total NPK Production: Annual Growth Rates, 1960-70

Region	Nitrogen	Phosphate	Potash	Total
	(%)			
North America	11.4	8.0	11.1	10.2
Western Europe	7.0	4.5	2.8	5.0
Eastern Europe	14.1	12.0	3.8	9.2
U.S.S.R.	17.6	9.9	13.2	14.1
Oceania	16.8	4.4	-	5.4
Africa	15.2	14.0	-	14.1
North Africa	11.1	17.4	-	12.1
Sub-Saharan Africa	160.4	26.8	-	25.3
South Africa	19.9	10.6	-	12.6
Latin America	9.9	11.1	-2.6	9.8
Central America	27.1	13.0[a]	-	32.6
South America	-0.1	5.3	-2.6	1.4
Asia	22.9	12.6	19.1	18.3
East Asia	23.6	12.4	13.1	18.2
South Asia	19.9	15.2	-	19.6
West Asia	23.9	12.2	19.2	18.8
WORLD	12.0	7.8	7.3	9.4

a. This growth rate is for the 1962-70 period.

Source: Derived from FAO data by using log-linear regressions. FAO (1988) and FAO Fertilizer Yearbook (various issues).

production at the global level. Their respective contributions were 29%, 25%, and 21%. These three regions accounted for about three-fourths of the increase in the production. Compared with the 1980s when North America's fertilizer production decreased, during the 1970s North America contributed nearly a quarter of the increase in global total fertilizer production.

In the 1960s, North America was the leading contributor. It accounted for about 31% of the increase in total global production. The U.S.S.R. and Asia were the next two leading contributors. They contributed about 18% and 17% of the increase in global production. Taken together, these three regions contributed about 65% of the increase in production. Eastern Europe and Western Europe also made appreciable contributions.

Thus, during the 1960-87 period, significant changes occurred. During the 1960s and 1970s, North America contributed between 25% and 30% increase in total fertilizer production. However, during the 1980s its contribution was negative; it has been replaced by Asia, although Asia's contribution was only marginally higher than the U.S.S.R.'s (24.4% versus 23.9%).

Regional Shares

Because of rapid growth experienced by Asia and the U.S.S.R. during the 1970s and the 1980s, their shares in total world production increased sharply. In 1987, Asia accounted for 25% of total world production and the U.S.S.R. for about 24%. Thus, taken together these two regions accounted for about nearly half of the world's total fertilizer production. This is in sharp contrast to their relatively small shares in the mid-1960s, when both of them taken together accounted for about one-fifth of total production (Table 3.7).

While the shares of Asia and the U.S.S.R. increased, those of North America and Western Europe decreased significantly during the 1960-87 period. In 1960, North America and Western Europe together accounted for about 70% of the total production, but in 1987 their share was only about 35%. During this period, Western Europe experienced much sharper declines in its share than North America did. Western Europe's share decreased from 42% in 1960 to 14% in 1987, while North America's share dropped from 27% to 21%. During the 1960-80 period, North America's share was more or less stable.

Table 3.7. Global Total NPK Production: Regional Shares, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	27.8	27.9	29.3	26.5	27.2	23.6	20.6
Western Europe	42.1	34.3	27.5	23.3	19.2	15.6	13.9
Eastern Europe	10.6	9.9	11.3	11.2	11.1	10.0	10.0
U.S.S.R.	10.0	12.1	14.8	19.5	17.7	21.1	23.5
Oceania	2.7	2.6	2.0	1.3	1.3	0.8	0.8
Africa	1.1	1.3	1.8	2.0	1.7	2.4	2.5
North Africa	0.6	0.7	0.8	0.7	0.8	1.6	1.8
Sub-Saharan Africa	0.0	0.0	0.2	0.5	0.2	0.1	0.1
South Africa	0.5	0.5	0.8	0.7	0.7	0.7	0.6
Latin America	1.4	1.7	1.6	2.1	2.6	3.1	3.5
Central America	0.1	0.6	1.0	1.1	0.9	1.2	1.4
South America	1.3	1.1	0.6	1.1	1.6	1.9	2.1
Asia	4.3	10.2	11.7	14.0	19.4	23.3	25.2
East Asia	3.3	8.4	8.9	9.8	13.8	14.9	14.7
South Asia	0.6	1.0	1.7	2.1	3.2	5.0	6.4
West Asia	0.4	0.8	1.1	2.1	2.4	3.4	4.0
WORLD	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

While Africa and Latin America increased their shares a little, Oceania's dropped marginally. Eastern Europe maintained its share at 10% during the 1960-87 period.

Asia's gains were maximum for N production, and the U.S.S.R.'s for K_2O production. North America maintained its dominant position in P_2O_5 production. Thus, during the mid-1980s, Asia was the leading producer of N (34%), North America of P_2O_5 (25%), and the U.S.S.R. of K_2O (35%) (Tables 3.8, 3.9, and 3.10 for details). In P_2O_5 production, Asia and the U.S.S.R. each accounted for about one-fifth of world production, while in K_2O production North America had the second largest share (28%). Western Europe's share averaged between 11% and 16% for these three nutrients during the mid-1980s, as against 42%-45% in the early 1960s. Eastern Europe's share increased marginally in N and P_2O_5 production but dropped in K_2O production.

Latin America and Africa also increased their shares in N and P_2O_5 production by small percentage points.

Regional Trends

Trends in fertilizer production at the regional level are analyzed to identify the factors responsible for inducing changes in fertilizer production in each region. Tables 3.11, 3.12, 3.13, and 3.14 provide data on total, nitrogen, phosphate, and potash production in different regions; Tables 3.15 through 3.18 indicate 5-year percentage changes in total, N, P_2O_5, and K_2O production at the regional level.

North America

After having grown at high rates during the 1960s and the 1970s, total fertilizer production decelerated during the 1980s. During the 1970s, total fertilizer production grew at 4.7%/year, whereas during the 1980s it decreased at 1%/year.

In absolute amounts, total fertilizer production increased from 7.81 million tons in 1960 to 19.45 million tons in 1970 and 33.0 million tons in 1981, and then dropped to 25.8 million tons in 1983. Thereafter, it recovered in 1985 but then dropped again in 1986 (Figure 3.3). Extremely low fertilizer prices of the mid-1980s induced closures and idle capacity

Table 3.8. Global Nitrogen Production: Regional Shares, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	28.8	27.2	27.2	22.1	21.6	18.7	15.9
Western Europe	45.3	33.1	26.1	23.2	19.0	15.2	13.9
Eastern Europe	8.2	7.6	10.8	11.2	10.8	9.8	9.8
U.S.S.R.	9.4	11.9	14.9	18.4	15.2	17.6	19.8
Oceania	0.3	0.1	0.5	0.5	0.4	0.4	0.3
Africa	0.6	1.1	1.2	1.3	1.4	2.4	2.2
North Africa	0.4	0.7	0.5	0.4	0.5	1.6	1.6
Sub-Saharan Africa	-	0.0	0.1	0.2	0.2	0.1	0.1
South Africa	0.2	0.4	0.7	0.6	0.7	0.6	0.5
Latin America	2.9	2.8	2.4	2.8	2.5	3.5	3.9
Central America	0.3	1.1	1.6	1.7	1.5	2.0	2.2
South America	2.7	1.7	0.8	1.0	1.1	1.5	1.7
Asia	4.5	16.1	16.9	20.6	29.1	32.4	34.1
East Asia	3.3	13.9	13.2	15.0	21.6	22.0	21.4
South Asia	1.0	1.8	3.0	3.8	4.9	7.4	9.5
West Asia	0.2	0.4	0.6	1.9	2.7	3.0	3.2
WORLD	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.9. Global Phosphate Production: Regional Shares, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	28.0	27.3	28.0	28.0	30.4	29.0	24.2
Western Europe	39.3	33.1	28.7	24.3	17.3	13.5	11.6
Eastern Europe	5.7	8.3	9.8	10.2	10.0	8.9	8.7
U.S.S.R.	9.0	9.6	10.7	13.6	15.8	17.8	21.6
Oceania	7.5	7.8	5.8	4.0	4.1	2.4	2.3
Africa	2.5	2.6	3.8	3.7	3.4	4.4	5.0
North Africa	1.2	1.2	2.0	1.9	1.8	2.8	3.7
Sub-Saharan Africa	0.0	0.1	0.2	0.4	0.2	0.2	0.2
South Africa	1.3	1.2	1.6	1.4	1.4	1.4	1.0
Latin America	0.9	1.3	1.7	3.0	4.7	4.8	5.4
Central America	-	0.5	0.9	1.0	0.7	0.7	0.7
South America	0.9	0.8	0.8	2.0	3.9	4.1	4.7
Asia	7.2	10.0	11.5	13.3	14.4	19.2	21.1
East Asia	6.3	8.8	9.9	10.2	10.4	11.8	12.4
South Asia	0.6	0.9	1.2	1.4	2.6	4.0	5.1
West Asia	0.3	0.4	0.5	1.8	1.3	3.4	3.6
WORLD	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.10. Global Potash Production: Regional Shares, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	26.4	29.4	34.6	32.9	36.0	29.9	28.7
Western Europe	41.7	37.5	28.7	22.6	22.0	19.1	16.9
Eastern Europe	18.9	15.2	14.1	12.2	13.1	12.1	12.1
U.S.S.R.	11.9	15.5	19.5	28.1	25.7	34.1	35.5
Oceania	-	-	-	-	-	-	-
Africa	-	0.0	0.4	1.2	0.0	0.0	0.0
North Africa	-	-	-	-	-	-	-
Sub-Saharan Africa	-	0.0	0.4	1.2	0.0	0.0	0.0
South Africa	-	-	-	-	-	-	-
Latin America	0.2	0.4	0.1	0.1	0.0	0.0	0.0
Central America	-	-	-	-	-	-	-
South America	0.2	0.4	0.1	0.1	0.0	0.0	0.0
Asia	0.9	1.9	2.6	2.8	3.1	4.8	6.8
East Asia	0.0	0.0	0.0	0.0	0.1	0.1	0.1
South Asia	0.0	-	-	-	-	-	-
West Asia	0.9	1.9	2.6	2.8	3.1	4.6	6.7
WORLD	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.11. Regional Total NPK Production, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	7,811	12,380	19,456	24,296	31,982	32,801	28,883
Western Europe	11,836	15,244	18,231	21,403	22,571	21,646	19,511
Eastern Europe	2,990	4,411	7,505	10,277	13,048	13,927	13,967
U.S.S.R.	2,821	5,400	9,825	17,896	20,792	29,249	32,911
Oceania	756	1,166	1,294	1,227	1,540	1,139	1,085
Africa	303	567	1,176	1,793	1,947	3,378	3,456
North Africa	156	311	522	680	893	2,217	2,506
Sub-Saharan Africa	1	19	137	471	177	179	180
South Africa	146	237	516	642	877	982	770
Latin America	390	735	1,075	1,965	3,024	4,333	4,892
Central America	25	262	654	998	1,108	1,732	1,947
South America	365	473	421	967	1,915	2,601	2,945
Asia	1,212	4,547	7,767	12,840	22,786	32,327	35,202
East Asia	927	3,740	5,916	8,991	16,222	20,616	20,598
South Asia	159	459	1,131	1,952	3,747	6,922	8,955
West Asia	126	349	720	1,897	2,817	4,788	5,649
WORLD	28,120	44,450	66,329	91,698	117,690	138,799	139,907

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.12. Regional Nitrogen Production, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	2,772	4,806	8,234	9,369	12,889	13,913	12,016
Western Europe	4,367	5,847	7,876	9,830	11,314	11,346	10,519
Eastern Europe	793	1,345	3,250	4,773	6,447	7,297	7,385
U.S.S.R.	902	2,099	4,509	7,806	9,074	13,143	14,996
Oceania	28	26	160	198	210	269	255
Africa	59	190	367	552	844	1,805	1,685
North Africa	38	128	138	189	313	1,226	1,174
Sub-Saharan Africa	-	0	25	91	98	97	111
South Africa	21	62	204	271	433	482	400
Latin America	283	500	732	1,183	1,503	2,619	2,960
Central America	25	195	486	738	870	1,473	1,683
South America	258	305	246	445	632	1,145	1,277
Asia	431	2,853	5,092	8,749	17,344	24,132	25,749
East Asia	315	2,458	3,994	6,360	12,853	16,389	16,159
South Asia	99	326	904	1,602	2,901	5,488	7,142
West Asia	17	68	195	787	1,591	2,255	2,447
WORLD	9,635	17,665	30,220	42,459	59,625	74,523	75,565

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.13. Regional Phosphate Production, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	2,736	3,991	5,451	7,229	9,786	10,321	8,613
Western Europe	3,839	4,825	5,579	6,275	5,574	4,812	4,133
Eastern Europe	553	1,209	1,909	2,641	3,207	3,165	3,096
U.S.S.R.	879	1,407	2,072	3,504	5,083	6,330	7,687
Oceania	728	1,140	1,134	1,029	1,330	870	830
Africa	244	377	742	956	1,103	1,573	1,771
North Africa	118	182	384	490	580	991	1,331
Sub-Saharan Africa	1	19	45	95	79	82	69
South Africa	125	175	312	371	444	500	370
Latin America	91	183	328	769	1,510	1,714	1,921
Central America	-	67	169	260	238	258	264
South America	91	115	159	509	1,272	1,456	1,657
Asia	705	1,466	2,237	3,432	4,634	6,832	7,503
East Asia	612	1,281	1,918	2,626	3,354	4,196	4,415
South Asia	59	132	228	351	846	1,434	1,813
West Asia	34	52	91	456	435	1,203	1,275
WORLD	9,774	14,598	19,452	25,836	32,226	35,617	35,554

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.14. Regional Potash Production, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	2,303	3,583	5,771	7,698	9,308	8,567	8,255
Western Europe	3,630	4,572	4,776	5,298	5,683	5,488	4,860
Eastern Europe	1,644	1,857	2,346	2,864	3,395	3,465	3,485
U.S.S.R.	1,040	1,894	3,244	6,586	6,635	9,776	10,228
Africa	-	0	67	285	0	0	0
Sub-Saharan Africa	-	0	67	285	0	0	0
Latin America	16	53	15	14	11	0	11
South America	16	53	15	14	11	0	11
Asia	77	229	438	659	808	1,363	1,951
East Asia	0	1	3	5	16	32	24
South Asia	1	-	-	-	-	-	-
West Asia	76	228	435	654	792	1,331	1,927
WORLD	8,710	12,187	16,657	23,403	25,840	28,658	28,789

Totals may not add due to rounding.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.15. Percent Changes in Regional Total NPK Production, 1960-87

Region	1960-65	1965-70	1970-75	1975-80	1980-85	1985-87
	(%)					
North America	58.5	57.2	24.9	31.6	2.6	-11.9
Western Europe	28.8	19.6	17.4	5.5	-4.1	-9.9
Eastern Europe	47.5	70.2	36.9	27.0	6.7	0.3
U.S.S.R.	91.4	81.9	82.1	16.2	40.7	12.5
Oceania	54.3	10.9	-5.1	25.5	-26.0	-4.7
Africa	86.9	107.5	52.5	8.6	73.4	2.3
North Africa	98.8	68.2	30.1	31.4	148.3	13.0
Sub-Saharan Africa	3,083.3	617.1	244.0	-62.3	0.7	0.8
South Africa	61.8	117.8	24.4	36.6	12.0	-21.6
Latin America	88.3	46.3	82.8	53.8	43.3	12.9
Central America	947.4	149.8	52.6	11.0	56.3	12.4
South America	29.5	-11.0	129.8	98.0	35.8	13.2
Asia	275.1	70.8	65.3	77.5	41.9	8.9
East Asia	303.3	58.2	52.0	80.4	27.1	-0.1
South Asia	189.2	146.6	72.6	91.9	84.8	29.4
West Asia	175.7	106.6	163.4	48.5	70.0	18.0
WORLD	58.1	49.2	38.2	28.3	17.9	0.8

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.16. Percent Changes in Regional Nitrogen Production, 1960-87

Region	1960-65	1965-70	1970-75	1975-80	1980-85	1985-87
	(%)					
North America	73.4	71.3	13.8	37.6	7.9	-13.6
Western Europe	33.9	34.7	24.8	15.1	0.3	-7.3
Eastern Europe	69.5	141.7	46.8	35.1	13.2	1.2
U.S.S.R.	132.7	114.8	73.1	16.2	44.8	14.1
Oceania	-6.2	515.4	23.8	6.0	28.1	-5.2
Africa	221.7	92.9	50.5	53.0	113.7	-6.6
North Africa	236.4	7.7	37.3	65.3	291.5	-4.2
Sub-Saharan Africa	-	-	268.2	7.8	-1.6	14.1
South Africa	194.9	228.9	32.9	59.7	11.4	-17.0
Latin America	76.3	46.5	61.6	27.0	74.3	13.0
Central America	678.8	149.4	52.0	17.9	69.3	14.2
South America	18.0	-19.2	80.5	42.1	81.2	11.5
Asia	562.5	78.5	71.8	98.3	39.1	6.7
East Asia	680.2	62.5	59.2	102.1	27.5	-1.4
South Asia	229.9	176.8	77.3	81.1	89.2	30.1
West Asia	310.6	185.1	304.4	102.2	41.8	8.5
WORLD	83.3	71.1	40.5	40.4	25.0	1.4

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table 3.17. Percent Changes in Regional Phosphate Production, 1960-87

Region	1960-65	1965-70	1970-75	1975-80	1980-85	1985-87
	(%)					
North America	45.9	36.6	32.6	35.4	5.5	-16.5
Western Europe	25.7	15.6	12.5	-11.2	-13.7	-14.1
Eastern Europe	118.9	57.8	38.3	21.4	-1.3	-2.2
U.S.S.R.	60.1	47.3	69.1	45.1	24.5	21.4
Oceania	56.6	40.6	-9.2	29.2	-34.6	-4.6
Africa	54.2	97.0	28.9	15.3	42.6	12.6
North Africa	54.5	110.7	27.6	18.2	70.9	34.4
Sub-Saharan Africa	3,083.3	136.5	109.9	-16.7	3.5	-15.1
South Africa	39.5	78.5	18.9	19.7	12.6	-26.0
Latin America	101.7	79.6	134.4	96.4	13.5	12.1
Central America	-	151.0	54.2	-8.6	8.7	2.2
South America	27.5	38.1	219.2	150.0	14.4	13.9
Asia	107.9	52.6	53.5	35.0	47.4	9.8
East Asia	109.2	49.8	36.9	27.7	25.1	5.2
South Asia	125.5	72.0	53.9	141.1	69.6	26.4
West Asia	54.3	73.1	403.7	-4.7	176.7	6.0
WORLD	49.4	33.3	32.8	24.7	10.5	-0.2

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

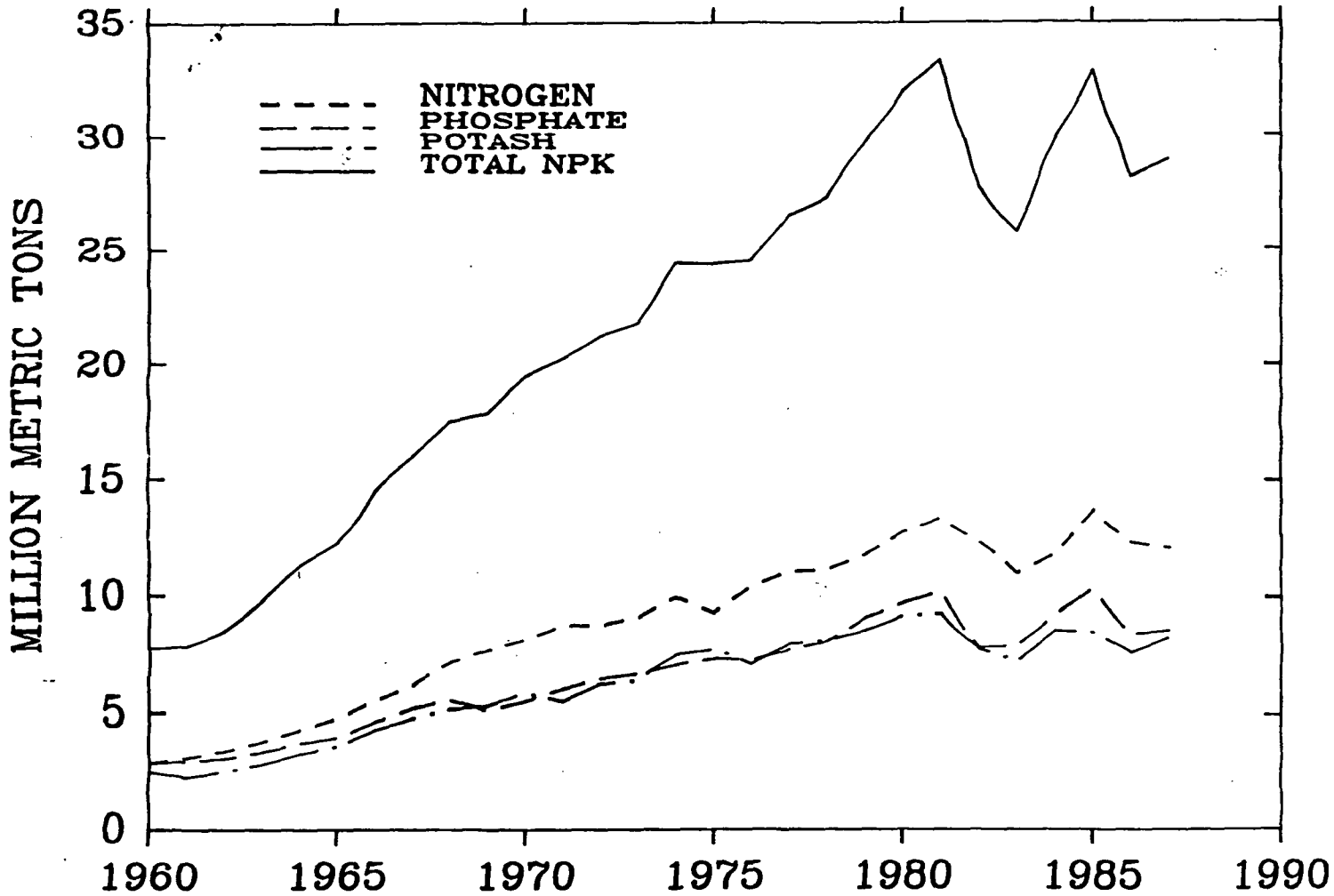
Table 3.18. Percent Changes in Regional Potash Production, 1960-87

Region	1960-65	1965-70	1970-75	1975-80	1980-85	1985-87
	(%)					
North America	55.6	61.1	33.4	20.9	-8.0	-3.6
Western Europe	25.9	4.5	10.9	7.3	-3.4	-11.4
Eastern Europe	13.0	26.3	22.1	18.5	2.1	0.6
U.S.S.R.	82.1	71.3	103.0	0.7	47.3	4.6
Africa	-	-	325.5	-100.0	-	-
Sub-Saharan Africa	-	-	325.5	-100.0	-	-
Latin America	225.1	-71.4	-10.0	-17.1	-100.0	-
South America	225.1	-71.4	-10.0	-17.1	-100.0	-
Asia	197.9	91.2	50.5	22.6	68.7	43.1
East Asia	-	200.0	66.7	214.0	103.8	-25.0
South Asia	-100.0	-	-	-	-	-
West Asia	200.3	90.8	50.4	21.1	68.1	44.8
WORLD	39.9	36.7	40.5	10.4	10.9	0.5

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Figure 3.3

NORTH AMERICA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK PRODUCTION, 1960–87



leading to a decrease in production. In 1985/86, about 2 million tons of capacity was estimated to be lying idle in the United States.

Nitrogen, phosphate, and potash production increased from 2.8, 2.7, and 2.5 million tons in 1960 to 8.2, 5.5, and 5.8 million tons in 1970, and 12.9, 9.8, and 9.3 million tons in 1980, respectively. In 1987, N, P_2O_5, and K_2O production levels were lower than those in 1980. In contrast to a steady increase in production during the 1960-80 period, fertilizer production fluctuated widely during the 1980-87 period (Figure 3.3). These fluctuations were caused by changes in both fertilizer prices and fertilizer use.

While the low prices of the mid-1980s induced decreases in production, the high prices of the mid-1960s and the mid-1970s promoted substantial investment in capacity buildups and production. Consequently, during the 1965-70 and the 1975-80 periods, total fertilizer production increased by about 7 million tons each. Against these substantial increases of the late 1960s and the late 1970s, early 1980s saw less than 1 million tons increase in production.

In terms of 5-year percentage changes, we find that the 1960s saw about 57%-58% increases in production in each subperiod. During the 1970-75 period, the percentage change was only one-half of the increase of the previous period. This may be due to the fact that low fertilizer prices and excess capacity of the late 1960s discouraged investment in capacity and production. However, during the 1975-80 period, the increase in fertilizer production accelerated to 32%. Higher prices of the mid-1970s seem to have induced this acceleration in production.

Like total production, nitrogen and phosphate production also accelerated during the 1975-80 period (Tables 3.16 and 3.17). Percentage increases in the production of these two nutrients during the 1975-80 period amounted to 38% and 35%. Potash production increased by about 20%. Accelerated percentage increases of 1975-80 were followed by very small percentage increases in total, N, and P_2O_5 production and a decrease in K_2O production during the 1980-85 period. Although increasing prices of 1988/89 will increase production, whether they will stimulate investment in capacity is not clear.

Western Europe

Like North America, Western Europe also experienced deceleration in its fertilizer production in the 1980s. However, unlike North America, which experienced accelerated growth in production of all three nutrients, especially in the late 1970s, Western Europe's total fertilizer production grew only at 1%/year during the 1970s and most of that increase came from a 3% growth in N production. K_2O production increased marginally and P_2O_5 production decreased at 1%/year during the 1970s. This contrast in the experiences of North America and Western Europe in the 1970s is a consequence of rich endowments of natural gas, phosphate rock, sulfur, and potash resources in North America which were converted into fertilizer production potential to reap the benefits of increased product prices. However, because Western Europe's fertilizer industry was based mostly on imported raw materials, and because Western Europe is not as richly endowed with feedstocks, it could not take advantage of higher product prices of the 1970s. In fact, increased prices of feedstocks made West European fertilizer products costly and uncompetitive. Consequently, Western Europe lost its export markets.

Total fertilizer production increased from 11.84 million tons in 1960 to 18.23 million tons in 1970 and 22.57 million tons in 1980. Thus, the slowdown in Western European fertilizer production started in the 1970s and intensified in the late 1970s because, compared with 6.4 million tons increase during the 1960-70 period, total fertilizer production increased by 4.3 million tons during the 1970s and only by 1.2 million tons during the 1975-80 period. This slowdown accelerated during the 1980s when total fertilizer production decreased by 1 million tons (in the 1980-85 period).

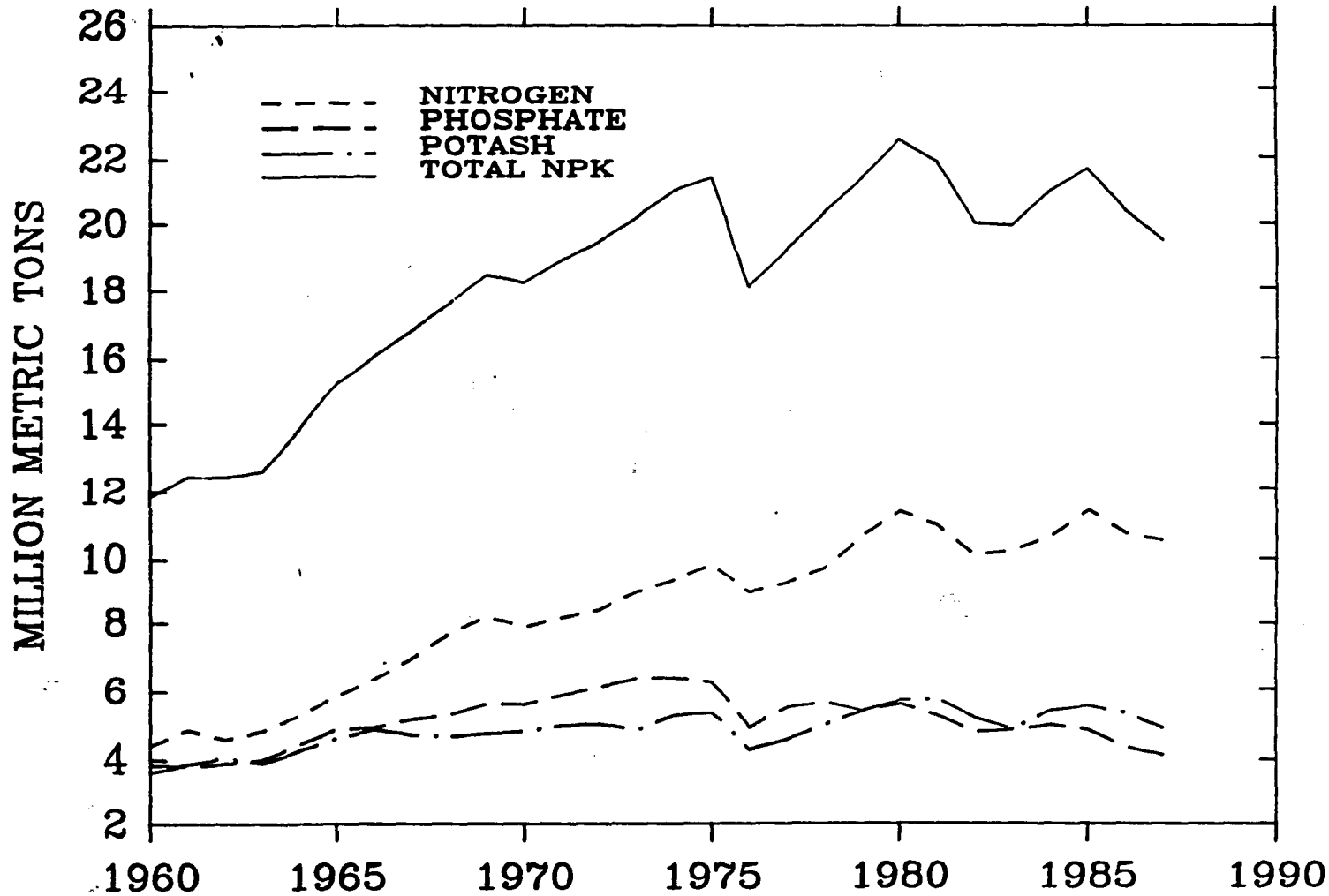
The production of all three nutrients increased steadily during the 1960-75 period and fluctuated considerably thereafter (Figure 3.4). N production increased from 4.4 million tons in 1960 to 7.9 million tons in 1970, and 11.3 million tons in 1980. After 1980, it decreased in 1982 but recovered to 11.3 million tons in 1985. After 1985 it decreased again.

P_2O_5 production increased from 3.84 million tons in 1960 to 6.3 million tons in 1975. Since 1975, it has been decreasing. In 1987, it was 4.1 million tons. High costs of imported rock and sulfur after 1975 seem to have caused this deceleration in P_2O_5 production in Western Europe.

Potash production increased from 3.6 million tons in 1960 to 5.7 million tons in 1980. After 1980, it started decreasing.

Figure 3.4

WESTERN EUROPE: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK PRODUCTION, 1960–87



Changes in fertilizer production during the 1960-85 period responded to both the changing price environment in the late 1970s and declining domestic fertilizer use in the 1980s. The West European experience also indicates the role the domestic availability of feedstock plays in sustaining growth in production in the face of increasing costs of imported raw materials. Because of its heavy dependence on imported feedstocks, Western Europe had very little comparative advantage in producing fertilizers and in expanding productive capacity during the late 1970s and the early 1980s.

Eastern Europe

Unlike Western Europe, which experienced a slowdown in its fertilizer production after the fertilizer crisis of 1975, Eastern Europe maintained growth in fertilizer production until 1985. Eastern Europe is better endowed with natural gas and other feedstocks and also because of its administered pricing system, its production system is less exposed to fluctuations in world fertilizer prices. However, growth in production slowed down during the 1980s compared with growth in the 1970s and the 1960s. This slowdown in production growth must be a result of slowdown in fertilizer use.

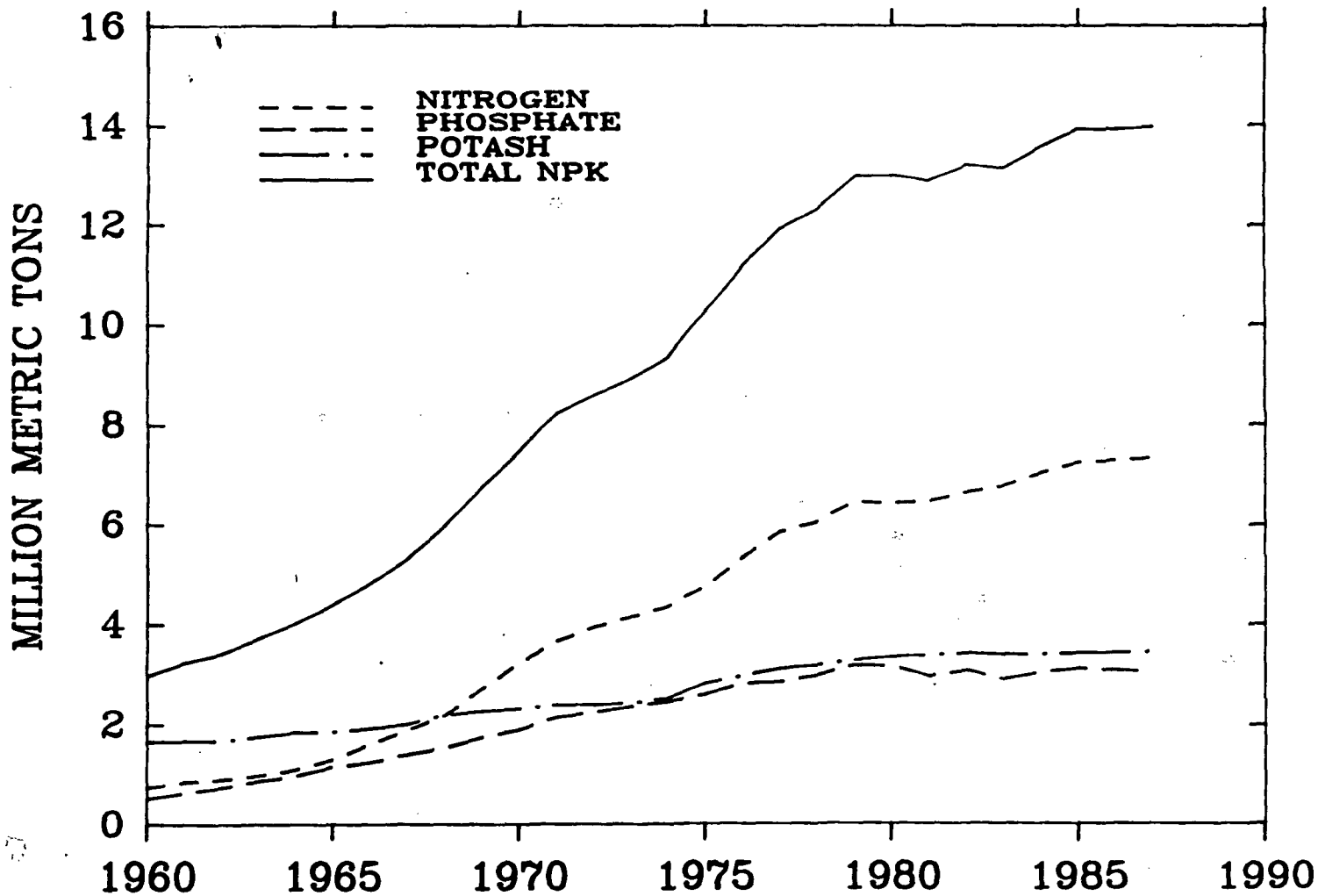
Total fertilizer production increased from about 3.0 million tons in 1960 to 7.5 million tons in 1970 and 13.0 million tons in 1980. Compared with increases of 4.5 and 4.4 million tons in the 1960s and the 1970s, respectively, fertilizer production increased only by about 1 million tons during the 1980s. In percentage terms, total fertilizer production increased by 150% during the 1960s, by 88% during the 1970s, and by 8% during the 1980s.

Nitrogen production increased from 0.8 million tons in 1960 to 3.25 million tons in 1970 and 6.4 million tons in 1980. Between 1980 and 1987, N production increased by another million tons. Thus, the observed increase of 1 million tons in total fertilizer production was mostly contributed by increase in N production. Having reached 3.2 and 3.4 million tons in 1980, P_2O_5 and K_2O production recorded little increase during the 1980s (Figure 3.5). However, during the 1970s, production levels of both nutrients increased by 1 million tons each. In the early 1960s, Eastern Europe produced less than half a million tons of these two nutrients.

In terms of 5-year percentage changes, the highest percentage increase was recorded in the 1965-70 period (Table 3.15). In absolute value also, the highest increase in total production was in that period.

Figure 3.5

EASTERN EUROPE: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK PRODUCTION, 1960–87



However, in spite of the decreased percentage changes in the 1970s, absolute increases in total production were relatively high--in the range of 2.8 million tons in each 5-year period. During the 1980-85 period, total fertilizer production increased by about 6%. This low percentage increase in total production was due to little increase in K_2O production and decrease in P_2O_5 production. Very little growth is expected in fertilizer production and capacity in Eastern Europe in the 1988-95 period.

The U.S.S.R.

Unlike North America and Western Europe whose total fertilizer production decreased during the 1980s, the U.S.S.R.'s total fertilizer production increased at 6.3%/year during the 1980s. Consequently, the U.S.S.R. accounted for about 25% of the total world fertilizer production and contributed more than 50% of the increase in global production during the 1980-87 period. The U.S.S.R. also became a leading exporter of nitrogen fertilizers.

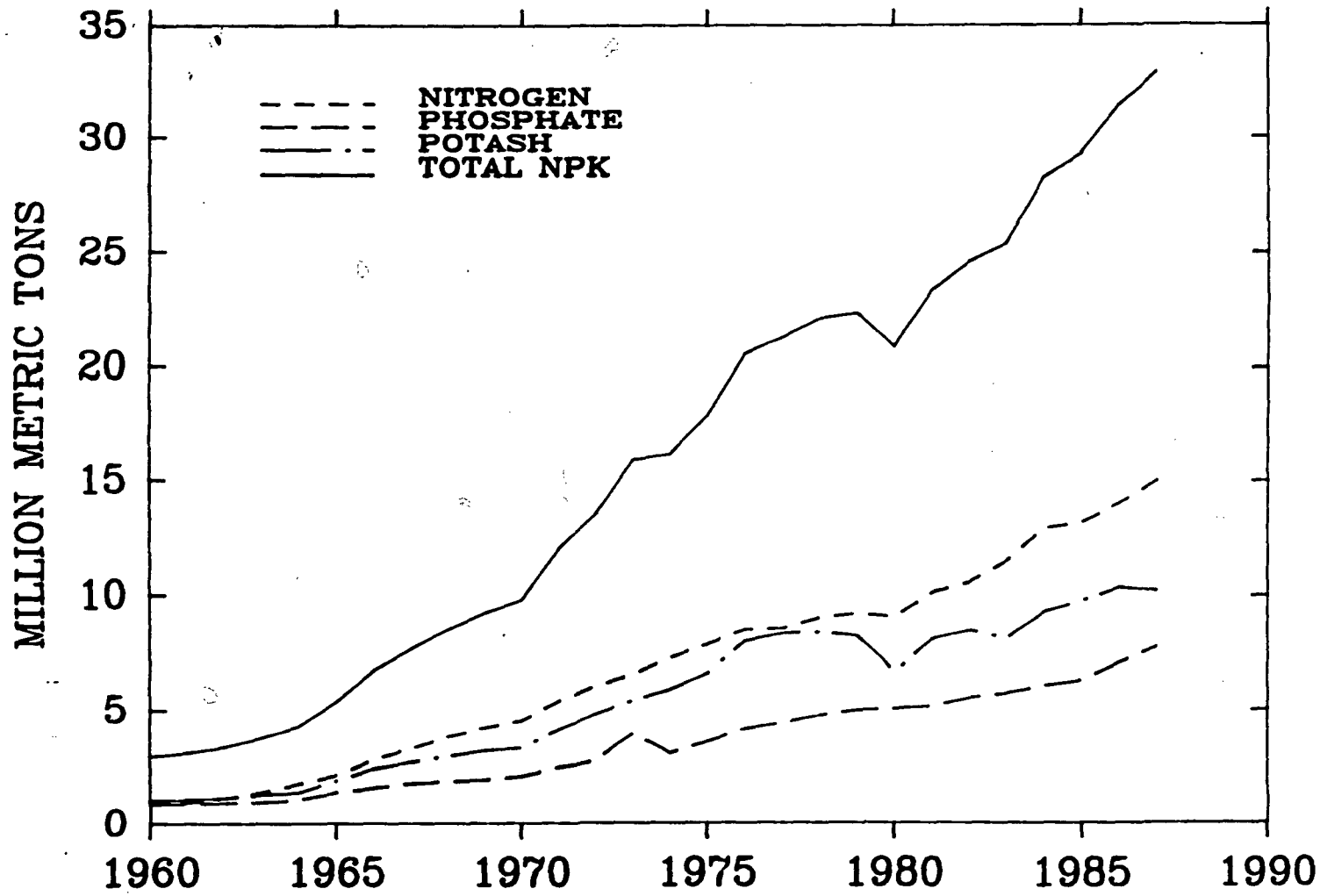
Total fertilizer production increased from less than 3 million tons in 1960 to 21 million tons in 1980--a sevenfold increase. Another 12 million tons was added during the 1980-87 period to this already high level of production (Figure 3.6). Its abundant natural gas and potash resources along with governmental commitment helped this rapid increase in production. Foreign exchange shortages of the 1970s and the early 1980s also appear to have contributed to this acceleration in production.

Nitrogen production increased from less than 1 million tons in 1960 to 9 million tons in 1980 and 15 million tons in 1987. Likewise, phosphate and potash levels increased from less than 1 million tons each in 1960 to 8 and 10 million tons, respectively, in 1987. Significantly higher absolute increases in N and K_2O production compared with P_2O_5 production are results of abundant natural gas and potash resources.

An analysis of 5-year percentage and absolute changes indicates that the U.S.S.R.'s fertilizer production increased rapidly during the 1970-75 and 1980-85 periods. In both periods, production increased by about 8 million tons each. During the 1975-80 period, when North America's production accelerated in response to high and remunerative prices of the mid-1970s, the U.S.S.R.'s production increased only by about 16% compared with 82% and 41% during the preceding and the following periods (Table 3.15). This delayed response to price changes of the mid-1970s indicates that fertilizer

Figure 3.6

U.S.S.R.: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK PRODUCTION, 1960–87



production in the U.S.S.R. responded less to price changes of the mid-1970s and more to other factors. Or, if it responded to price changes, then it responded slowly. This slowness may be due to delayed response by policymakers to changes in market conditions and delay in converting policy decision into implementation plans. Also, as the decisionmaking is more centralized, bureaucratic delays must have played an important role. Furthermore, fertilizer production in the U.S.S.R. seems to have responded to its food and foreign exchange shortages of the late 1970s.

Oceania

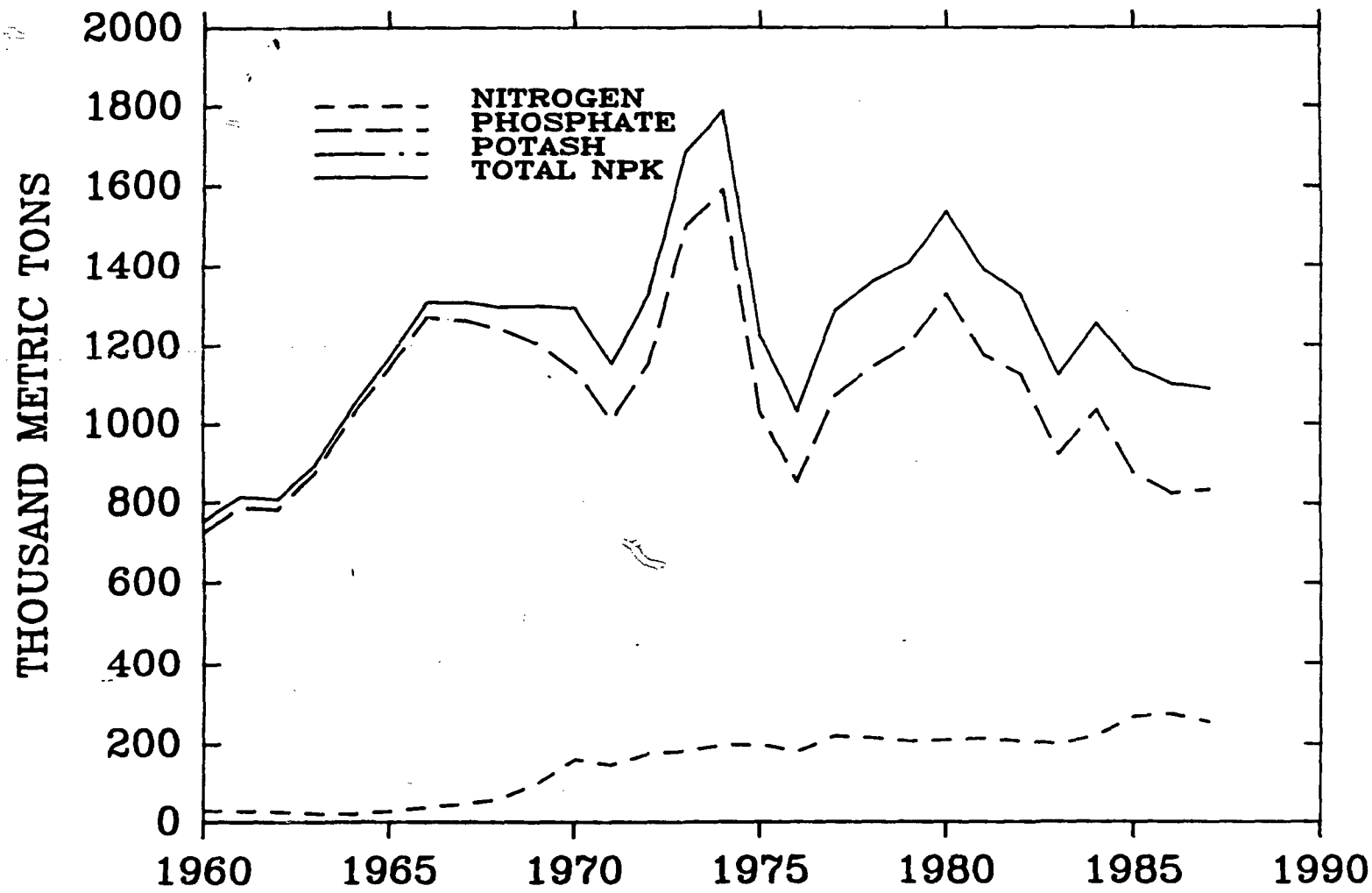
Oceania accounted for less than 1% of total world production. As fertilizer use decreased in Australia, fertilizer production also decreased significantly (at 5%/year) during the 1980s, just as in Western Europe and South Africa. However, during the late 1970s, fertilizer production increased by about 25%. Except for the 1975-80 period, Oceania experienced declines in fertilizer production in all other subperiods of the 1970s and the 1980s. A small production base dependent on fluctuating prices and world demand for grain imports made Oceania's fertilizer production fluctuate widely during the 1970s and the 1980s.

During the 1980s, total fertilizer production decreased from 1.54 million tons in 1980 to 1.09 million tons in 1987 (Figure 3.7). Most of this decrease was in P_2O_5 production, which decreased from 1.3 million tons in 1980 to 0.8 million tons in 1987. Nitrogen production increased between 1980 and 1985, but decreased during the 1985-87 period. Because fertilizer production responds to both fertilizer use and fertilizer prices, improved prospects in both areas may induce increases in fertilizer production in Oceania in the late 1980s and the early 1990s.

Oceania's fertilizer production, unlike that of many regions, is dominated by P_2O_5 production. For example, during the 1981-87 period, P_2O_5 production accounted for 75%-85% of total production. Excessive dominance of P_2O_5 in the total production also made Oceania's production fluctuate more in response to fluctuating demand. Between 1965 and 1985, P_2O_5 production decreased in three subperiods and increased in only one (1975-80). Against this, N production continued to increase until 1985. After 1985, it decreased by 5% (Tables 3.16 and 3.17).

Figure 3.7

OCEANIA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK PRODUCTION, 1960–87



Asia

Asia's total fertilizer production increased from a small base of 1.2 million tons in 1960 to 7.8 million tons in 1970 and 22.8 million tons in 1980. Another 12.4 million tons was added during the 1980s (Figure 3.8). With 35.2 million tons of total production, Asia accounted for about 25% of the total world production. Asia also contributed more than 50% of the increase in total global production and experienced a 6% annual increase in total production during the 1980s.

Nitrogen production increased from less than half a million tons in 1960 to about 17 million tons in 1980 and 26 million tons in 1987. This doubling of N production in the 1980s was achieved through several measures. Notable among them are a high degree of governmental commitment and involvement, incentive prices, conducive policy environment, availability of natural gas, and the desire to achieve food security through increased fertilizer use.

Phosphate production increased from less than 1 million tons in 1960 to 4.6 million tons in 1980 and 7.5 million tons in 1987. This relatively smaller absolute increase in P_2O_5 production compared with N production is mostly due to limited availability of feedstocks required for P_2O_5 production. Likewise, potash production also increased by a small quantity--from 0.44 million tons in 1970 to 1.95 million tons in 1987--because Asia's potash resources are not yet fully developed. Thus, most of the increase in total production was due to increased N production during the 1960-87 period.

Like North America and unlike the U.S.S.R., Asia experienced acceleration in its fertilizer production during the 1975-80 period. Total fertilizer production increased by 77% compared with 65% and 42% during the preceding and the succeeding periods (Table 3.15). In absolute amounts, total fertilizer production increased by a little less than 10 million tons. High costs of imported fertilizer during the late 1970s put pressure on the policymakers to create a suitable policy environment for increased fertilizer production. Further, through suitable pricing policy measures, many Asian countries protected their fertilizer industry during the declining and low fertilizer prices of the mid-1980s.[20]

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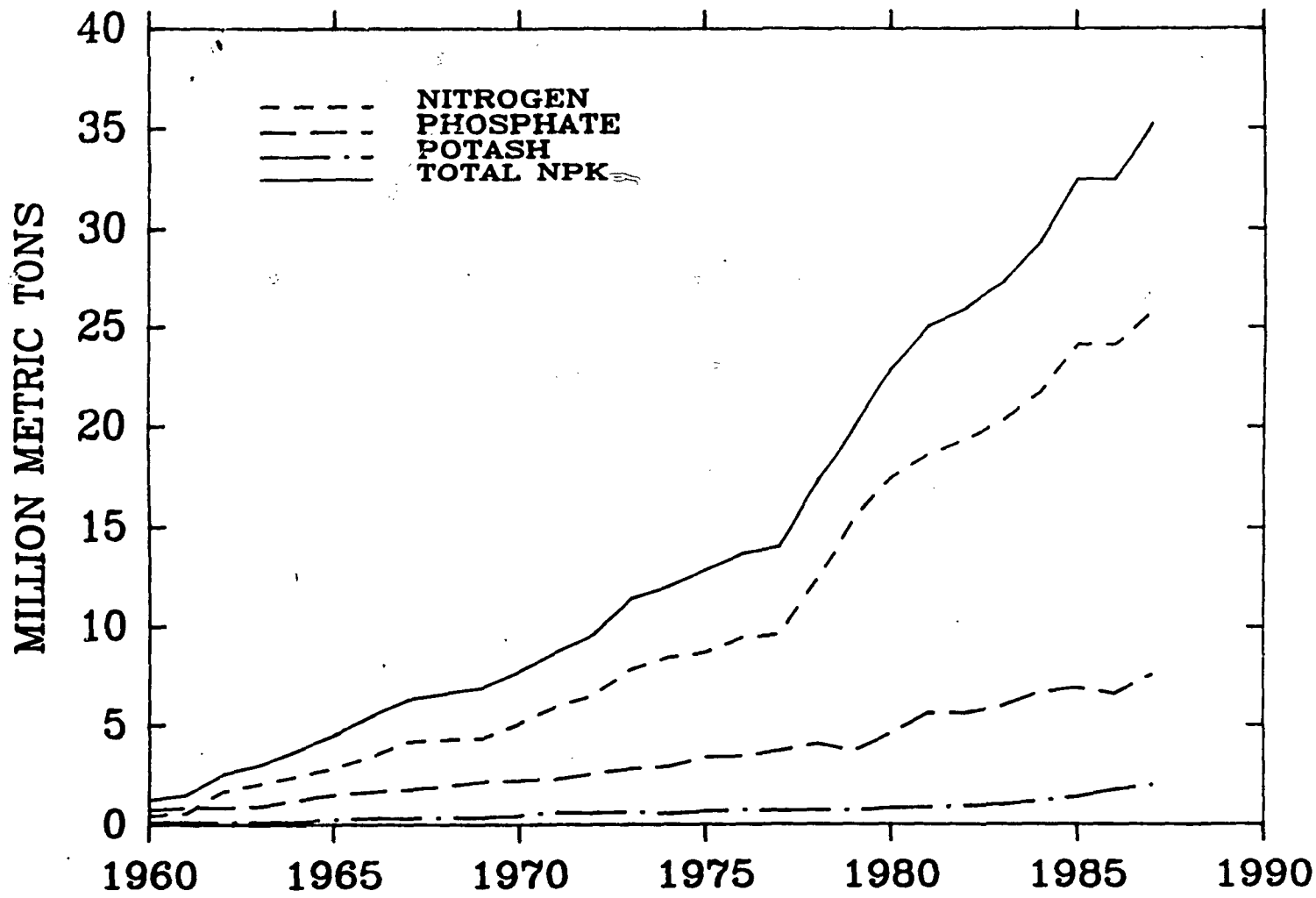
20. See Chapter 7 for trends in fertilizer prices.

Figure 3.8

ASIA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK PRODUCTION, 1960–87



Asia's three subregions have different growth experiences; hence each of them is analyzed separately below.

East Asia--In 1987, East Asia produced 21.6 million tons of total nutrients and accounted for about 60% of Asia's total fertilizer production.

Total fertilizer production increased from less than 1 million tons in 1960 to 16.2 million tons in 1980 and 20.6 million tons in 1987. Compared with 10% annual growth in the 1970s, fertilizer production grew only at 3%/year during the 1980s. This slowdown in total production was mostly because of closure of production capacity in Japan and slow growth in N capacity in China. Slow growth in demand also produced a slow increase in production.

Nitrogen production increased from 12.85 million tons in 1980 to 16.4 million tons in 1985 but dropped a little to 16.2 million tons in 1987. During the 1960s and the 1970s, East Asia experienced accelerated growth in N production. Between 1960 and 1980, N production increased several fold--from 0.32 million tons to 12.85 million tons. During the same period P_2O_5 production increased from 0.61 million tons to 3.35 million tons. In the 1980s, P_2O_5 production increased by about 1 million tons. Potash production in East Asia was insignificant (Table 3.14).

East Asia's total fertilizer production as well as production of all three nutrients accelerated in the 1975-80 period; it increased by 80%, compared with 52% and 27% during the preceding and the following periods. Several factors caused this acceleration. First, China commissioned 13 large-scale (1,000 tpd NH_3) ammonia-urea plants. Second, Indonesia also increased its capacity in 1978/79. Third, Japan increased its production in response to higher prices. This acceleration in total production was mostly due to acceleration in N production which increased by 102%. In absolute terms, N production increased by 6.5 million tons and total production by 7.2 million tons in the 1975-80 period. In the 1980-85 period, these increases were 3.5 and 4.4 million tons, respectively. Low fertilizer prices and high naphtha prices forced the closure of several Japanese plants. Hence, production increases slowed down.

South Asia--Although East Asia experienced a slowdown in its production growth, South Asia experienced 12%/year growth in its total fertilizer production during the 1980-87 period. With 9 million tons of production in 1987, South Asia accounted for about 25% of Asia's total

production. Because of its higher production growth, South Asia contributed more than 40% of the increase in total production in Asia during the 1980s.

Total fertilizer production increased from 3.74 million tons in 1980 to 9.00 million tons in 1987. Most of this increase was due to an increase in N production, which increased from 2.9 million tons to 7.1 million tons. P_2O_5 production increased from 0.8 million tons in 1980 to 1.8 million tons in 1987. South Asia does not produce K_2O.

During the 1960-80 period, total fertilizer production increased from 1.6 million tons in 1960 to 3.7 million tons in 1980, and N production from 1 million tons to 2.9 million tons. It is interesting to note that South Asia added two and one-half times (250%) more to its fertilizer production during the 1980s than it did in the 1960-80 period. This is partly due to the stable pricing environment the fertilizer industry has experienced in South Asia. Also, the governmental support in both capacity expansion and production played an important role. The retention price scheme in India (a dominant country in the region) assured 12% post-tax return on the invested capital even when world prices were going down. The need to achieve food security through increased fertilizer use also contributed towards this highly accelerated growth during the 1980s.

In both time periods, namely 1975-80 and 1980-85, South Asia's total production increased by high percentage points (92% and 85%). Percentage growth in the 1960s was also high although that was from a small base. South Asia's experience indicates the critical role played by price stability, policy stability, and governmental support in promoting production growth.

West Asia--With 5.6 million tons of total production in 1987, West Asia accounted for about 16% of total production in Asia. West Asia's higher share in production than in consumption (16% versus 8%) indicates that West Asia is a net exporter of fertilizer products. West Asia has feedstocks for N, P_2O_5, and K_2O production although the latter two are concentrated mostly in Jordan. A significant increase in production in this region during the 1980s was geared to exports. Abundant natural gas in the Middle East promoted N capacity and production in Saudi Arabia, Qatar, and Bahrain for exports.

Total fertilizer production increased from 0.7 million tons in 1970 to 2.8 million tons in 1980 and 5.6 million tons in 1987. Nitrogen production increased from 1.6 million tons in 1980 to 2.4 million tons in 1987. Likewise, P_2O_5 and K_2O production increased from 0.4 and 0.8 million tons in 1980 to 1.3 and 1.9 million tons, respectively, in 1987. West Asia is the

only region in Asia that has significant capacity to produce K_2O. Jordan and Israel are the main producing countries.

West Asia's total fertilizer production growth accelerated in the 1980-85 period as compared with the preceding period (Table 3.15). This acceleration was caused by acceleration in P_2O_5 and K_2O production, which increased by 180% and 70%, respectively. In absolute terms, the 1980s saw higher growth than the 1970s.

Thus, the production growth experiences of the three subregions of Asia are different. While East Asia's growth slowed down considerably, South and West Asia experienced high growth rates during the 1980s. Furthermore, South Asia's growth was geared toward import substitution and West Asia's toward export promotion.

Latin America

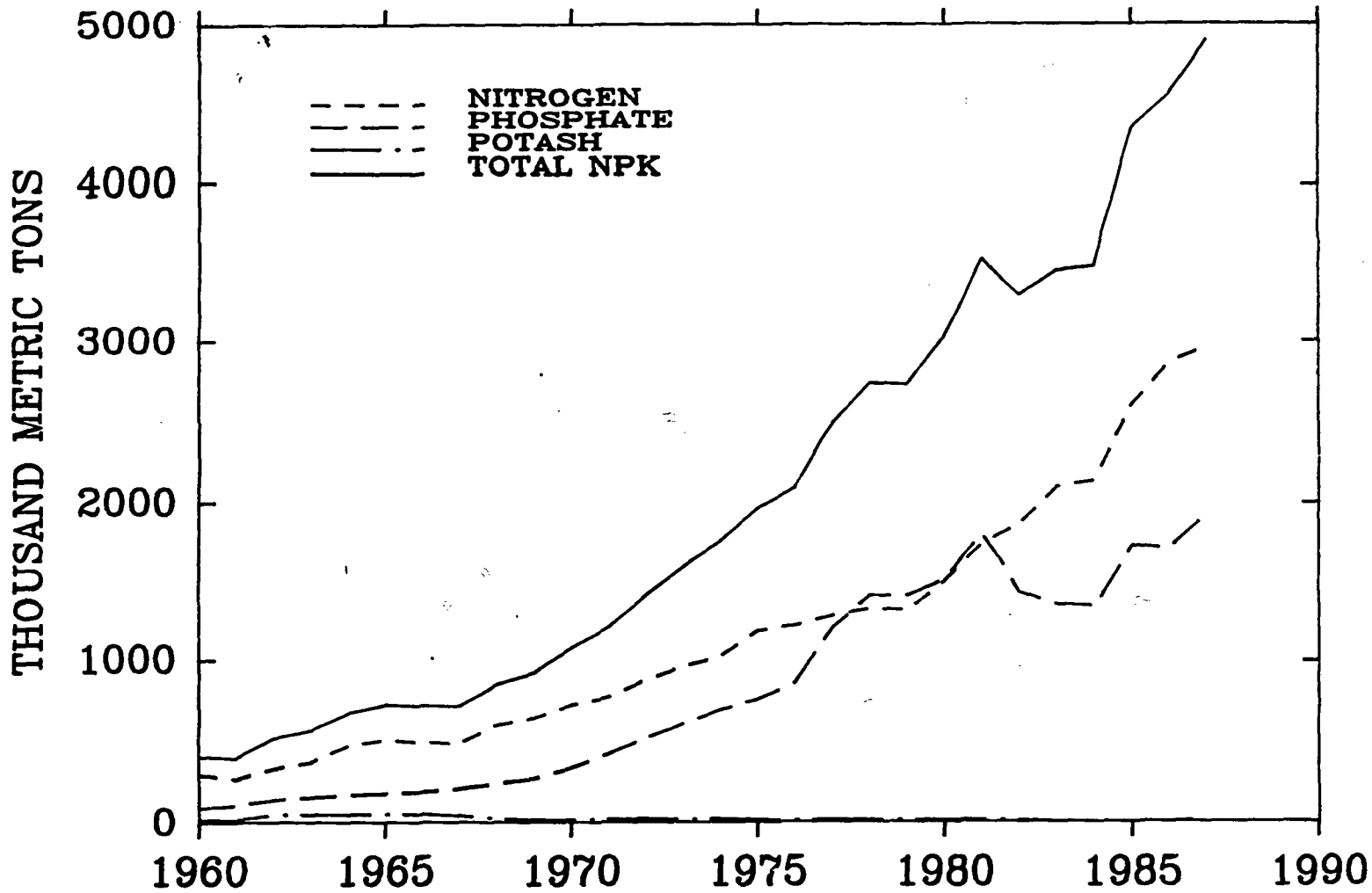
Compared with Asia, Latin America has a small share in world fertilizer production. In 1987, with 4.89 million tons of production, Latin America accounted for less than 4% of total world production. However, Latin America's share was higher than that of Africa and Oceania (Table 3.7).

Total fertilizer production increased from about 0.40 million tons in 1960 to 3 million tons in 1980 and 4.9 million tons in 1987 (Figure 3.9). Nitrogen production increased from 0.3 million tons in 1960 to 1.5 million tons in 1980 and 3 million tons in 1987, and P_2O_5 production increased from 0.10 million tons in 1960 to 1.5 million tons in 1980 and 1.9 million tons in 1987. K_2O production decreased from 1.5 million tons in 1970 to 1.0 million tons in 1987. Thus, in Latin America, as in Asia, increases in N production contributed the most towards total production increases. Overall, total production increased at 6.5%/year during the 1980-87 period.

In terms of 5-year percentage changes, Latin America's total fertilizer production accelerated during the 1970-75 period although N production accelerated during both 1970-75 and 1980-85 periods (Tables 3.15 and 3.16). Acceleration in the early 1980s in N production indicates that Latin American countries responded to the second energy crisis of 1978/79, which resulted in higher fertilizer prices. The absolute increases in total production were more or less equal during the 1970s and the 1980s.

Figure 3.9

LATIN AMERICA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK PRODUCTION, 1960–87



Central America--In 1987, Central America accounted for about 40% of total fertilizer production in Latin America. A relatively higher share in production than in consumption indicates that Central America is a net exporter of fertilizer products.

Total fertilizer production increased from 0.65 million tons in 1970 to 1.11 million tons in 1980 and 1.95 million tons in 1987. Nitrogen production increased from 0.88 million tons in 1980 to 1.68 million tons in 1987. This doubling of N production in the 1980s is a result of increased capacity in Mexico for export purposes. Availability of natural gas in Mexico induced a rapid increase in N production in the 1980s. Compared with N production, phosphate production changed marginally from 0.24 million tons in 1980 to 0.26 million tons in 1987. No potash is produced in this region.

As N production responded to increased fertilizer prices of the late 1970s and early 1980s, fertilizer production in Central America accelerated in the 1980-85 period rather than in 1975-80 as it did in North America (Table 3.16).

South America--With 2.94 million tons of total production, South America accounted for about 60% of total fertilizer production in Latin America. Total fertilizer production increased from 1.92 million tons in 1980 to 2.94 million tons in 1987. Although in percentage terms, South America's increase in production during the 1980-85 period was smaller than that of Central America (36% versus 56%), in absolute terms South America had slightly higher increase in total production than Central America had. During the 1970s, total fertilizer production increased from 0.4 million tons in 1970 to 2.0 million tons in 1980.

Nitrogen production increased from 0.25 million tons in 1970 to 0.63 million tons in 1980 and 1.3 million tons in 1987. Likewise phosphate production increased from 0.16 million tons in 1970 to 1.3 million tons in 1980 and 1.7 million tons in 1987. South America also produced a small quantity of potash in 1987 (Table 3.14).

South America's relatively higher levels of P_2O_5 production must have been induced by its cropping patterns and resource endowment. Compared with Central America, South America uses more P_2O_5 for its export crops--ccffee, sugarcane, soyabean, etc. Also, South America has more phosphate rock reserves than Central America.

Although South America's P_2O_5 production level is higher than that of Central America, South America's P_2O_5 production increased at a lower rate

than N production during the 1980s. During the 1970s, P_2O_5 production grew at a much higher rate than N production (Table 3.5 above). That may be due to a boom in commodity prices in the late 1970s.

Increased production in Venezuela and Brazil accelerated N production in South America during the 1980-85 period.

Africa

Like Latin America, Africa also accounts for a rather small proportion of total world fertilizer production. In 1987, with 3.5 million tons of total production, Africa accounted for less than 3% of total world production.

Total fertilizer production increased from 0.3 million tons in 1960 to 1.9 million tons in 1980 and 3.5 million tons in 1987 (Figure 3.10). Nitrogen production increased from less than 0.1 million tons in 1960 to 0.8 million tons in 1980 and 1.7 million tons in 1987, while P_2O_5 production increased from 0.2 million tons in 1960 to 1.1 and 1.7 million tons in 1980 and 1987, respectively. Africa does not produce K_2O; between 1970 and 1978, a potash mine in the Congo produced some potash, but due to flooding it was closed in 1978.

Not only does Africa contribute very little to world fertilizer production, but also most of its production is concentrated in North Africa. In 1987, North Africa accounted for 70% of total fertilizer production.[21] Another 20% of production came from South Africa and 10% from sub-Saharan Africa. Senegal, Zimbabwe, and Tanzania were important producers in sub-Saharan Africa until 1987. With the commissioning of an ammonia-urea plant in 1987, Nigeria will be a major producer in sub-Saharan Africa. Low fertilizer use and foreign exchange shortages have kept fertilizer production levels rather low in sub-Saharan Africa.

Africa's total fertilizer production increased 8.3%/year during the 1980-87 period, but all of this increase occurred in North Africa. Both sub-Saharan Africa and South Africa experienced declines in their production levels. In the 1970s, production of all three nutrients increased in all three subregions.

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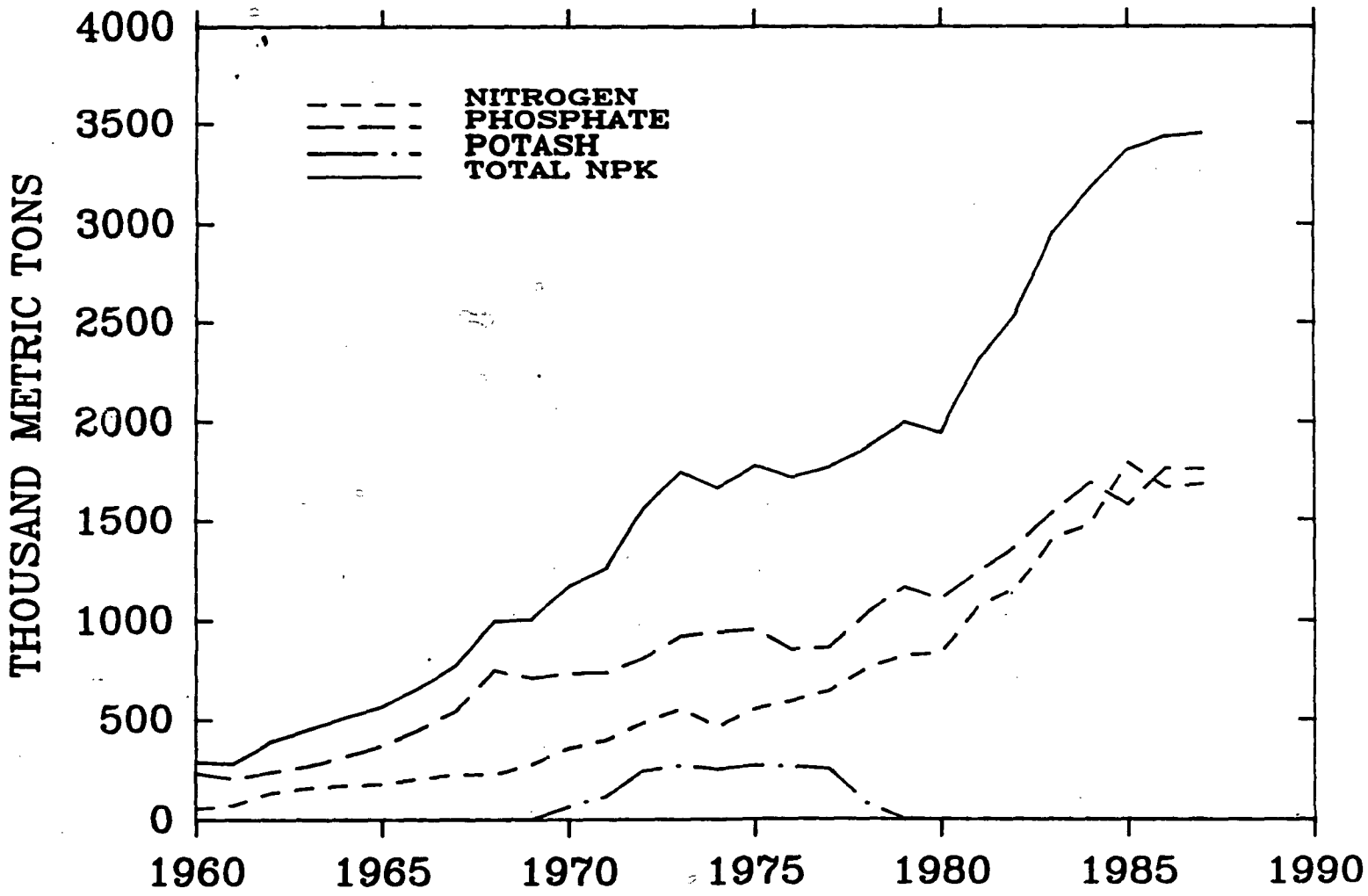
21. In North Africa, Morocco and Tunisia are important producers of P_2O_5 and Algeria and Egypt of N.

Figure 3.10

AFRICA: NITROGEN, PHOSPHATE, POTASH, AND TOTAL NPK PRODUCTION, 1960–87



Africa's fertilizer production, especially for North Africa, accelerated in the 1980-85 period. Percentage increases were 73% and 148%, respectively. Acceleration occurred for both N and P_2O_5. In response to high prices of the late 1970s, production capacity was built in Morocco and Algeria for export purposes.

South Africa's fertilizer production accelerated during the 1975-80 period. This was in response to high prices of the mid-1970s. However, as fertilizer prices decreased rapidly during the mid-1980s, South Africa experienced substantial declines in production. In 1985-87, production decreased by 22%. A small portion of its capacity was closed, and the remaining capacity was restructured.

PART II

FUTURE OUTLOOK

Chapter 4. Fertilizer Demand Projections, 1988-95.
Chapter 5. Fertilizer Supply Projections, 1988-95.
Chapter 6. Fertilizer Supply Demand Balances, 1988-95.
Chapter 7. Price Outlook: A Qualitative Assessment.

CHAPTER 4

FERTILIZER DEMAND PROJECTIONS, 1988-95

In this chapter, nutrientwise demand projections at the global as well as the regional levels are analyzed. Before we discuss these projections a few words about the methodology used and the assumptions made in deriving these demand projections are warranted here.

Methodology and Assumptions

Methodology

Fertilizer use (demand) is influenced by several economic, ecologic, agronomic, technological, and institutional factors which vary in relative importance from one region to the other (see Chapter 2 for details). To capture the influence of various factors on regional fertilizer use, a considerable effort is required. Hence, the following steps were used in deriving regional and global demand projections.

First, nutrientwise trend projections were made at the country level by using the historical consumption data for 1970-87. The dynamic trend equation[22] was used in making these projections. The dynamic trend equation, compared with the simple trend equation, better captures the influence of the short-run fluctuation on the long-run trend. More than 300 such equations in total were estimated. Second, countrywise projections were evaluated in the light of the country's recent performance and policy environment and were adjusted accordingly. Third, countrywise demand forecasts were grouped into regional forecasts. Again, the regional forecasts were compared with the historical trends and fluctuations, and were further adjusted in the light of the analysis of Chapter 2, where important causes and sources of change were identified. Possible changes in the macro and microeconomic situation and policies were used to modify these demand forecasts. Fourth, for North America, Western Europe, and Oceania, structural fertilizer demand equations[23]

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22. The dynamic trend equation uses lagged (previous year's) consumption and time as independent variables in estimating parameters and projecting consumption.

23. The structural demand equations used in deriving demand forecasts are described in Appendix B. IFDC is currently involved in estimating structural demand equations for major countries in the other regions as well.

were estimated by econometric methods and were used in making demand projections. This analysis identified the role of pricing policies in influencing demand projections. Fifth, after regional demand projections were obtained, global projections were derived by simply aggregating the regional projections for each nutrient.

Assumptions

As indicated earlier, crop and fertilizer prices play an important role in influencing fertilizer use in North America, Western Europe, and Oceania. Hence, projections of crop and fertilizer prices made by the World Bank and IFDC were used in deriving these projections. Nevertheless, like all other projections, these projections are also subject to the validity and the realization of the assumptions about macro and microeconomic variables and policies. Some of these assumptions need elaboration.

Because fertilizer use in North America and Western Europe is influenced by changes in crop and fertilizer prices, any drastic changes in these prices will affect fertilizer use. Special mention should be made of crop price support programs and farm subsidies in the United States, Western Europe, and Japan. If these subsidies are removed or cut drastically, fertilizer use may further slow down in these countries and the corresponding regions. The presentations by various participants from Japan and Western Europe at the 1988 World Food Conference indicated that farm subsidies will not be curtailed drastically for food security reasons. However, farm subsidies on export products could be reduced gradually in the early 1990s. That may reduce crop prices more than what was assumed here.

It was assumed that crop prices will increase in 1989 and 1990 and then decrease in the early 1990s. However, as crop prices decrease and crop output decreases, there will be upward pressure on crop prices because of higher demand for grain imports. The demand for grain imports is expected to be enhanced during the 1990s for several reasons. First, increased income at the global level will enhance demand for food and feed grains and will promote grain imports. The World Bank's economic forecast indicates better growth prospects in the early 1990s.[24] Second, as some of the densely populated countries hit the upper limit on crop production and fertilizer use while their populations continue to grow, these countries may come to the world food

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24. See World Bank, (1988a, Chapter 1).

markets for grain imports. In this context, China's food requirements deserve special mention. Currently, China is producing about 480 million tons of cereals and other food items. By the mid-1990s its food requirements would be about 540 million tons. Because of high intensification of cultivated land, China may not be able to increase its food production beyond 500 million tons. Furthermore, as the good quality land is diverted to other lucrative crops, China's capacity to produce all its food requirements may be constrained. However, because of a rapid increase in GDP, China may be able to import more food to meet its domestic requirements. Likewise, Japan may also depend increasingly on food imports. In other East Asian countries also, as fertilizer use is already high, further growth in rice production may be constrained. Thus, these countries' import demands will continue to keep food prices at a remunerative level. Third, because many Latin American and African countries are going through debt restructuring and structural adjustment programs, their capacity to import commodities, in general, and grains, in particular, may improve in the early 1990s. Furthermore, these countries may also benefit from improved crop prices for their export crops. These changes will also have a positive influence on crop prices. Thus, all these factors will indicate that although crop prices may decrease after 1990 because of increased food supplies, they will recover to reasonable levels in a short period. If these assumptions are not realized, then fertilizer use may grow at a lower rate in the 1990s than what is predicted below.

In addition to crop and fertilizer prices assumed here, a mention should also be made about policy changes in developing countries. If many countries in Asia reduce the governmental commitment and involvement, remove fertilizer subsidies, and expose their fertilizer sectors to the volatility of international prices, then growth may also slow down. However, the indications are that, because of food security concerns, these countries may not introduce drastic measures or "shock" treatments.

The assumption of the improved macroeconomic prospects of Latin American and African countries is equally important because of its positive influence on fertilizer imports in South America and sub-Saharan Africa. The continued donor support for the sub-Saharan African countries is also critical in realizing the projected demand.

Besides these economic and policy uncertainties, there is also uncertainty about the regulation of fertilizer use because of its supposedly adverse impact on the environment (ground water contamination and other

effects). Because there is no reliable and quantifiable information about the environmental consequences of fertilizer use, no adjustment has been made for this uncertainty in projecting demand. If laws are passed, especially in North America and Western Europe, to regulate fertilizer use below the optimum levels indicated by crop and fertilizer prices and sound agronomic practices, then the realized demand may be lower than what was projected here.

The last factor is weather, which is impossible to predict in the long run. It is assumed here that, on an average, weather will remain normal because weather's effect on fertilizer use is of a short-term duration. In a given year fertilizer use may decrease because of bad weather, but in the long run the effect will be recovered. However, the effect of weather on food production is still quite critical. A severe drought in the United States, India, or China can affect global crop production adversely and can cause instability in food supplies. This indicates that the war on the food front is still not over.[25]

With these qualifications, fertilizer demand projections are analyzed below.

Global Demand Projections

Global demand projections for total, N, P_2O_5, and K_2O are presented in Table 4.1. The table also indicates annual growth in total and nutrient use during 1980-87 and 1987-95.

Total fertilizer use at the global level is projected to increase at 2.6% per annum during the 1987-95 period. Nitrogen use will increase at 2.8% per annum, and P_2O_5 and K_2O use at 2.7% and 2.1%, respectively. For P_2O_5 and K_2O the projected growth rates are higher than those realized during the 1980-87 period. This is so because the projected improved micro and macroeconomic prospects and crop diversification, especially in East Asia, during the forecast period will exert relatively more positive influence on their use levels than on nitrogen use. However, the projected growth rates for P_2O_5 and K_2O are still lower than that for nitrogen, which itself is lower than what was realized during the 1980-87 period. A slightly lower growth

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25. See Brown (1988) and Chapter 8 below for details.

Table 4.1. Global Demand Projections

Nutrient	Actual 1987	1990	1993	1995	Annual Growth Rates 1980-87	1987-95
					- - - - (%)	- - - -
N	72.37	80.34	85.72	90.51	3.5	2.8
P_2O_5	33.84	37.66	40.25	42.16	1.9	2.7
K_2O	26.09	28.41	29.84	30.87	1.5	2.1
	132.30	146.41	155.81	163.54	2.6	2.6

Source: FAO (1988) for actual, and IFDC (1988a) for projections.

rate for N during the 1987-95 period (compared with the 1980-87 period) is a result of its lower sensitivity to economic changes and the already high levels (both total and per hectare) and rapid growth achieved in many regions.

In absolute amounts total fertilizer use is projected to increase from 132.30 million tons in 1987 to 163.54 million tons in 1995. Nitrogen use will increase from 72.37 million tons in 1987 to 90.51 million tons in 1995, while P_2O_5 and K_2O uses are expected to increase from 33.84 and 26.09 million tons in 1987 to 42.16 and 30.87 million tons, respectively, in 1995.

Of the 31 million tons projected increase in total fertilizer use, a little less than 60% (18 million tons) will be contributed by an increase in nitrogen use and a little more than 25% (8 million tons) by an increase in phosphate use. Increase in potash use will contribute only about 15%. The dominant contribution of N follows from the fact that a significant increase in N will take place in Asia where N use is less sensitive to both macro and microeconomic changes.

Regional Contributions

The regional contributions to the projected increase in global consumption are presented in Table 4.2.

Asia will be the leading contributor for the projected increases in nitrogen and phosphate demand and the U.S.S.R. for the projected increase in potash demand. Asia will contribute about 53% and 48% of the projected increases in N and P_2O_5 consumption at the global level and the U.S.S.R. about 30% of the projected increase in K_2O consumption. Asia will be a close second leading contributor in K_2O use increase (25%), while the U.S.S.R. will be a distant second in N (16%) and P_2O_5 (22%) use increases. North America will be the third leading contributor in all three nutrients. Its contribution will vary between 10% (P_2O_5) and 18% (K_2O). Both North America and Western Europe will contribute relatively more to a K_2O increase than to a N and P_2O_5 increase. Latin America's contribution will vary between 6% and 9%, while all other regions will contribute between 1% and 4%.

Table 4.2. Regional Contribution to the Projected Increase in Global Fertilizer Use[a]

Region	N	P_2O_5	K_2O
	(%)		
North America	12	10	18
Western Europe	5	3	10
Eastern Europe	2	3	3
U.S.S.R.	16	22	30
Oceania	1	2	2
Africa	3	4	3
Latin America	7	8	9
Asia	53	48	25
WORLD	100	100	100

a. The projected increase in global fertilizer use is treated as base for calculating these percentages.
Note: Totals may not add due to rounding.

Source: Derived from data in Tables 4.5, 4.6, and 4.7.

Regional Shares

Because fertilizer use in different regions is projected to grow at different rates during the 1987-95 period, the regional share in global fertilizer use in 1995 will be as indicated in Table 4.3.

In total fertilizer use, Asia will account for about 34% of global fertilizer use. The U.S.S.R. (19%) and North America (14%) will be the next two leading regions. Western Europe's share will be about 13%. The shares of other regions will vary between 1% (Oceania) and 8% (Eastern Europe).

Asia's share in N use will be higher than its share in total NPK use. Asia will account for about 42% of global N use (as against 34% of global total NPK use); the U.S.S.R. and North America will account for 16% and 14%, respectively. Thus, these three regions will account for about 71% of global nitrogen use in 1995. Western and Eastern Europe's shares will be 13% and 6%, respectively. Africa and Latin America will account for 3% and 6% of global N use in 1995.

As in N use, in P_2O_5 use also, Asia will be the leading region; its share will be 31% in global phosphate use (although significantly less than its share in N use). The U.S.S.R. will account for 22%. North America and Western Europe will have nearly identical shares (12% each). Likewise, Eastern Europe and Latin America will also have identical shares (8% each). Latin America's relatively higher annual growth will help it in catching up with Eastern Europe. The shares of Oceania and Africa will remain small and unchanged during the forecast period.

The leading regions in potash consumption are different from those in N and P_2O_5 use. The U.S.S.R., with 26% of global potash use, will be the leading region. North America and Western Europe will be the next two regions, each accounting for 18% of global potash consumption. Asia, the leading region in N and P_2O_5 global use, will account for about 15% of global potash use and, therefore, will rank fourth. Low levels of potash use in Asia make it the fourth region. Eastern Europe will account for 11%. Thus, a little less than three-fourths of global potash consumption will remain concentrated in these four regions--traditionally high potash using areas. For both macro and microeconomic regions, the total share of Asia, Africa, and Latin America will not exceed one-quarter of global potash use.

Table 4.3. Regional Shares in Global Fertilizer Use, 1995

Region	N	P_2O_5	K_2O	Total
North America	14	12	18	14
Western Europe	13	12	18	13
Eastern Europe	6	8	11	8
U.S.S.R.	16	22	26	19
Oceania	1	3	1	1
Africa	3	3	2	3
Latin America	5	8	8	7
Asia	42	31	15	34
World	100	100	100	100

Note: Totals may not add due to rounding.

Source: Derived from data in Tables 4.5, 4.6, and 4.7.

Regional Demand Projections

To facilitate the comparison between the projected demand and supply potential (in Chapter 5), the regional trends in the projected demand are analyzed separately for each nutrient. The projected nutrientwise growth rates at the regional level are projected in Table 4.4, and the regional demand forecasts for N, P_2O_5, and K_2O are presented in Tables 4.5, 4.6, and 4.7.

Nitrogen

In Asia, nitrogen demand is projected to grow at 4.2% per annum from 28.4 million tons in 1987 to about 38.2 million tons in 1995. Asia will remain the leading region--both in terms of its contribution to the growth in global N use and in terms of its own growth rate during the 1987-95 period.

All three subregions of Asia will experience more than 3% annual growth in nitrogen use. East Asia's N use will increase from 17.6 million tons in 1987 to 22.6 million tons in 1995, South Asia's from 8.6 million tons in 1980 to 12.4 million tons in 1995, and West Asia's from 2.1 million tons to 3.3 million tons. Relatively lower annual growth in N use in East Asia is a result of its already high N use levels (both total and per hectare) and a move towards upland crops.

The U.S.S.R.'s nitrogen use is expected to increase at an annual rate of 2.8%--from 11.5 million tons in 1987 to 14.4 million tons in 1995. A slowdown in the U.S.S.R.'s N use growth during this period, compared with the 1980-87 period, is the result of earlier rapid use growth and slowdown in capacity buildups. In contrast, North America's N use will grow at a faster rate during the forecast period compared with the 1980-87 period. This acceleration in N use in North America is a result of two factors. First, N use in North America is responsive to changes in crop prices and, as indicated above, crop prices will remain remunerative during the forecast period. Second, because of a decrease in grain output in 1988 due to drought, acreage planted will be increased. A growing world demand for grain imports will also enhance fertilizer use in North America. Consequently, N use will increase from 10.54 million tons in 1987 to 12.75 million tons in 1995 although a major portion of this increase will take place during the 1988-91 period. There is a possibility that because of low crop prices N use may decrease in 1992.

Table 4.4. Projected Nitrogen, Phosphate, Potash, and Total NPK Demand in Different Regions: Annual Growth Rates, 1987-95

Region	Nitrogen	Phosphate	Potash	Total NPK
	(%)			
North America	2.3	2.2	2.1	2.2
Western Europe	0.3	1.0	1.0	0.6
Eastern Europe	1.2	1.0	0.7	1.0
U.S.S.R.	2.8	2.8	2.4	2.7
Oceania	3.0	2.1	4.2	2.7
Africa	3.4	3.1	3.7	3.4
North Africa	3.4	4.0	4.5	3.7
Sub-Saharan Africa	4.6	3.7	4.0	4.2
South Africa	1.2	1.3	2.2	1.4
Latin America	3.5	2.9	2.5	3.1
Central America	3.1	3.2	3.4	3.2
South America	4.0	2.9	2.2	3.0
Asia	3.9	4.1	3.7	3.9
East Asia	3.3	3.3	3.4	3.3
South Asia	4.9	5.2	4.2	4.9
West Asia	5.5	4.5	3.4	5.0
WORLD	2.8	2.7	2.1	2.6

Source: Derived from data in Tables 4.5, 4.6, and 4.7.

Table 4.5. Projected Nitrogen Demand, 1988-95

Region	1987[a]	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons)								
North America	10,539	10,691	11,690	12,069	12,240	12,073	12,296	12,570	12,753
Western Europe	10,656	10,797	11,331	11,514	11,960	10,178	10,965	11,060	11,479
Eastern Europe	5,055	5,034	5,183	5,215	5,232	5,342	5,368	5,431	5,545
U.S.S.R.	11,475	11,749	12,070	12,421	12,790	13,171	13,559	13,951	14,346
Oceania	406	414	425	439	453	468	483	499	514
Africa	2,010	2,068	2,167	2,251	2,303	2,382	2,460	2,538	2,656
North Africa	993	1,014	1,056	1,076	1,136	1,174	1,212	1,248	1,286
Sub-Saharan Africa	655	684	707	759	780	817	853	891	950
South Africa	362	369	405	415	387	391	395	399	420
Latin America	3,831	3,915	4,054	4,209	4,366	4,530	4,701	4,871	5,043
Central America	1,995	2,041	2,112	2,187	2,261	2,327	2,404	2,482	2,545
South America	1,836	1,874	1,942	2,022	2,106	2,204	2,296	2,389	2,498
Asia	28,398	28,588	30,071	32,221	33,372	35,084	35,887	36,542	38,174
East Asia	17,624	18,107	18,731	20,228	20,723	21,484	21,843	22,115	22,550
South Asia	8,630	8,184	8,929	9,354	9,700	10,531	10,947	11,282	12,358
West Asia	2,144	2,296	2,411	2,638	2,948	3,069	3,097	3,145	3,266
WORLD	72,370	73,255	76,993	80,339	82,717	83,229	85,719	87,463	90,511

a. Actual.
Note: Totals may not add due to rounding.

Source: IFDC (1988a).

Table 4.6. Projected Phosphate Demand, 1988-95

Region	1987[a]	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons)								
North America	4,283	4,390	4,627	4,850	4,941	4,984	5,029	5,048	5,118
Western Europe	4,798	4,686	4,745	4,848	4,854	4,966	4,995	5,046	5,088
Eastern Europe	3,110	3,221	3,283	3,307	3,320	3,334	3,374	3,381	3,402
U.S.S.R.	7,567	7,701	7,956	8,219	8,490	8,769	9,057	9,206	9,350
Oceania	981	953	986	1,036	1,048	1,070	1,101	1,111	1,129
Africa	1,112	1,140	1,200	1,256	1,260	1,289	1,341	1,391	1,442
North Africa	418	443	459	480	500	516	535	563	582
Sub-Saharan Africa	357	360	375	391	408	424	440	456	472
South Africa	337	337	366	385	352	349	366	372	388
Latin America	2,796	2,778	2,870	2,959	3,058	3,167	3,253	3,363	3,467
Central America	599	626	652	674	697	719	742	752	775
South America	2,197	2,152	2,218	2,285	2,361	2,448	2,511	2,611	2,692
Asia	9,198	9,955	10,691	11,189	11,518	11,815	12,100	12,601	13,164
East Asia	5,032	5,512	5,840	6,107	6,258	6,390	6,445	6,568	6,775
South Asia	2,866	3,039	3,371	3,507	3,648	3,792	3,939	4,190	4,443
West Asia	1,300	1,404	1,480	1,575	1,612	1,633	1,715	1,843	1,907
WORLD	33,845	34,824	36,358	37,664	38,489	39,394	40,250	41,148	42,161

a. Actual.
Note: Totals may not add due to rounding.

Source: IFDC (1988a).

Table 4.7. Projected Potash Demand, 1988-95

Region	1987[a]	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons)								
North America	4,792	4,923	5,139	5,363	5,478	5,503	5,549	5,614	5,651
Western Europe	5,213	5,349	5,504	5,669	5,697	5,604	5,629	5,685	5,708
Eastern Europe	3,345	3,305	3,341	3,316	3,350	3,406	3,450	3,471	3,491
U.S.S.R.	6,677	6,906	7,133	7,360	7,587	7,613	7,840	7,966	8,092
Oceania	221	236	260	270	285	290	300	305	310
Africa	445	459	482	503	522	541	558	577	594
North Africa	136	132	138	145	153	161	170	178	187
Sub-Saharan Africa	189	201	213	223	231	240	247	256	263
South Africa	119	126	131	135	138	140	141	143	144
Latin America	2,007	2,035	2,097	2,151	2,200	2,249	2,314	2,364	2,437
Central America	434	443	457	474	491	507	525	549	566
South America	1,572	1,592	1,640	1,677	1,710	1,742	1,789	1,815	1,871
Asia	3,396	3,504	3,640	3,777	3,919	4,060	4,203	4,345	4,589
East Asia	2,232	2,313	2,390	2,470	2,552	2,634	2,717	2,802	2,987
South Asia	1,019	1,061	1,111	1,163	1,215	1,268	1,320	1,372	1,425
West Asia	145	130	139	144	153	159	166	171	177
WORLD	26,095	26,716	27,597	28,410	29,039	29,267	29,843	30,326	30,872

a. Actual.
Note: Totals may not add due to rounding.

Source: IFDC (1988a).

However, it will recover in 1993 and increase thereafter (Table 4.5). In spite of this rapid growth, North America will add only a million tons in 1995 to its N use in 1985.

These three regions, namely, Asia, the U.S.S.R., and North America, will account for a little less than three-fourths of global N use in 1995.

Both Western Europe and Eastern Europe will experience modest increases in their N use levels; they will add less than a million tons each to their existing use levels. A drastic reduction in farm subsidies may slow down even this modest growth.

Although Oceania's N use is projected to increase at 3% per annum, its N use will increase by about 0.1 million tons--from 0.4 million tons in 1987 to 0.5 million tons in 1995--and therefore will have insignificant impact on global N use.

Latin America's N use is projected to increase at 3.5% per annum, and both subregions, namely, Central America and South America, will increase their N use levels, although South America's N use is projected to increase at a higher rate. A higher growth rate for South America follows from better macroeconomic prospects and higher domestic production in the 1990s.

Latin America's total N use will increase from 3.8 million tons to a little over 5 million tons. South America's N use will increase from 1.8 million tons to 2.5 million tons, and Central America's from 2.0 million tons to 2.5 million tons during the 1987-95 period.

Africa currently accounts for about 3% of global N use and will continue to do so in the forecast period as well. Africa's total N use will increase from 2.0 million tons in 1987 to 2.7 million tons in 1995. Most of this increase will be shared by North Africa and Sub-Saharan Africa. South Africa's contribution to the projected increase in N use in Africa will be insignificant.

North Africa's N use will increase from about 1 million tons in 1987 to 1.3 million tons in 1995, and Sub-Saharan Africa's from 0.65 to 0.95 million tons during the same period.

Phosphate

Asia will remain the leading region for P_2O_5 demand growth also, both in terms of its contribution to global increase and in terms of its own growth rate.

North America, Western Europe, and Oceania are expected to see reversal in their growth trends (from declining to increasing trends), while Latin America's demand growth may accelerate a little. Asia and the U.S.S.R.'s growth rates will be lower during the forecast period compared with the 1980s, but that is because these regions grew at rapid rates during the 1980-87 period.

In Asia, P_2O_5 use will increase at 4.1% per annum--from 9.2 million tons in 1987 to 13.2 million tons in 1995. All three subregions will experience growth. South Asia's P_2O_5 use will increase at the maximum rate (5.2%), and East Asia's at the minimum (3.3%). East Asia's P_2O_5 use will increase from 5.00 million tons in 1987 to 6.8 million tons in 1995, South Asia's from 2.9 to 4.4 million tons, and West Asia's from 1.3 to 1.9 million tons during the 1987-95 period (Table 4.6).

The U.S.S.R. will add about 1.8 million tons to its 7.6 million tons P_2O_5 use in 1987.

In North America P_2O_5 use is projected to grow at 2.2% per annum--from 4.28 million tons in 1987 to 5.12 million tons in 1995. This reversal in trend for North America is mostly due to an improved microeconomic situation projected at the global level. Likewise, Oceania will also see reversal of its trend in P_2O_5 use during the 1980s. Its P_2O_5 use will increase at 2.1% per annum. Western Europe and Eastern Europe will experience marginal increases in their P_2O_5 use levels.

Improved macroeconomic prospects for Latin America will help it in increasing its P_2O_5 use at 2.9%. In absolute amount, Latin America's P_2O_5 use will increase from 2.8 million tons in 1987 to 3.5 million tons in 1995. More than 70% of the increase in P_2O_5 use will be contributed by South America.

Africa's P_2O_5 use will increase at 3.1% per annum; however, in absolute amount, it will be less than half a million tons--from 1.1 million tons in 1987 to 1.4 million tons in 1995. More than 65% of that increase will occur in North Africa.

Potash

The U.S.S.R. will continue to dominate the global potash use. The U.S.S.R.'s potash consumption will increase by about 1.4 million tons from 6.68 million tons in 1987 to 8.09 million tons in 1995. Although the U.S.S.R.'s growth rate will be lower during the 1987-95 period than in the 1980-87 period (2.4% versus 6.5%), the U.S.S.R. will still account for about a quarter of global potash use in 1995.

North America will add about 0.9 million tons to its 4.8 million tons K_2O use in 1987. This reversal in growth trend in North America is caused by microeconomic changes explained earlier.

Although Western Europe's potash use is projected to grow rather slowly, it will remain the third largest region (after the U.S.S.R. and North America) in global potash consumption in 1995. In absolute amount, its potash consumption will increase by about half a million tons--from 5.21 million tons in 1987 to 5.71 million tons in 1995.

Asia's potash consumption will increase at 3.7% per annum from 3.4 million tons in 1987 to 4.6 million tons in 1995. About 63% of the increase wil occur in East Asia, 34% in South Asia, and 3% in West Asia.

Latin America's potash consumption is projected to increase by a little less than half a million tons--from 2.01 million tons in 1987 to 2.44 million tons in 1995. About 70% of the projected increase will take place in South America.

In Oceania and Africa, K_2O use is forecast to increase at about 4% per annum but from a rather low base, and therefore will have a minor impact on global potash use. In Eastern Europe also, potash use will increase by a small amount (Table 4.7).

CHAPTER 5

FERTILIZER SUPPLY PROJECTIONS, 1988-95

The projections of production and supply potential at the global and regional levels for nitrogen, phosphate, and potash are discussed in this chapter. As these projections refer to potential of production and supply, they are different from demand projections. While the demand projections are behavioral, these projections are technical. The difference between behavioral and technical projections is that the behavioral projections are outcomes of the behavior of individuals and institutions involved in making a decision in response to changing environment (policy, institutional, and ecological), whereas the technical projections are outcome of a given technology and certain technical parameters relevant for that technology. Thus, in technical projections, it is assumed that a given fertilizer plant will operate at its maximum technical or engineering capacity; its technical performance will not be determined by day-to-day fluctuations in prices and other variables. However, in reality, actual production will depend on prevailing product and raw material prices. Very low and unremunerative prices will result in a reduction of actual production. The technical projections thus implicitly assume that economically it is always profitable to operate the plant at its maximum rated capacity. Hence, these projections provide maximum production likely to be available. Whether that maximum production is available in a given year depends on the prevailing pricing environment.

Furthermore, these projections indicate the maximum possible (not actual) production likely to be available from the installed capacity; hence they are not strictly comparable with the historical trends in production discussed in Chapter 3 because the historical production levels are the outcome of both technical and behavioral (response to changes in product and raw material prices) parameters.

Methodology for Projecting Production and Supply Potential

The assumptions used in deriving technical/engineering projections of production potential are discussed below.

Phasing-in Factors[26]

Because new plants require time to stabilize operations before they reach their full technical/engineering production potential, and because these factors vary from one nutrient to another, different phasing-in factors have been used for nitrogen, phosphate, and potash. Table 5.1 indicates these factors. A longer phasing-in period for P_2O_5 compared with that for nitrogen results from the fact that the downstream P_2O_5 plants (TSP, DAP, NPKs) take longer to stabilize operations than downstream N plants take. Hence, a 4-year phasing-in scheme is used. Likewise, potash mines take much longer to stabilize operations than both N and P_2O_5 plants. A rather low amount of available capacity in the first year results from the assumption that, on-average, the new plants come on stream in the mid-year. Nominal or nameplate capacity of a plant is multiplied by the phasing-in factors to arrive at stabilized capacity.

All closures and expansions in capacity are phased-in on a 2-year basis.

Capacity Utilization Factors[27]

Phased-in new capacity, closures, and expansions are added to the existing capacity, to arrive at effective capacity. The effective capacity is then multiplied by operating or capacity utilization (CU) rates. The capacity utilization rates vary from region to region and are derived from the region's historical performance. Regional variations in capacity utilization rates are mostly functions of efficiency of production management and availability of required raw materials. Table 5.2 indicates the assumed operating rates. North America, Western Europe, and Oceania have high capacity utilization rates, and Latin America, Asia, and Africa have relatively low capacity utilization rates. Eastern Europe and the U.S.S.R. have medium rates. Because production potential is sensitive to changes in these rates, we have developed different scenarios by changing these rates (Chapter 6).

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26. Phasing-in factors are applied to ammonia plants for N, phosphoric acid plants for P_2O_5, and potash mines for K_2O.

27. Capacity utilization factors are applied to effective capacity of ammonia for N, phosphoric acid for P_2O_5, and potash mines for K_2O.

Table 5.1. Phasing-in Factors: Percentage of Nominal Capacity Available in Years of Operations

Nutrient	First	Second	Third	Fourth	Fifth
N	40	85	100		
P_2O_5	35	75	85	100	
K_2O	30	65	75	85	100

Source: IFDC (1988a).

Table 5.2. Capacity Utilization Factors

Region	N	P_2O_5	K_2O
	(%)		
North America	95	95	90
Western Europe	95	95	90
Eastern Europe	85	85	95[a]
U.S.S.R.	85	85	90
Oceania	95	95	-
Africa			
North Africa	80	80	-
Sub-Saharan Africa	80	80	-
South Africa	95	95	-
Latin America			
Central America	80	80	-
South America	80	80	80
Asia			
East Asia	85	90	80
South Asia	80	80	-
West Asia	80	80	95[b]

a. As information about potash capacity in Eastern Europe is unavailable, this operating rate is applied to the average of potash production during the 1980-87 period.
b. In West Asia, potash is produced from sea brines. Hence, this rate is derived from the average of K_2O production during the 1980-87 period.

Source: IFDC (1988a). Estimated from historical data on production and capacity.

Industrial Uses

Production potential resulting from utilized capacity was adjusted for industrial and technical or non-fertilizer uses. Ideally, one should project industrial uses for all three nutrients, but because of lack of data on actual industrial uses in the past at the regional or country level, we have assumed that a certain percentage of utilized capacity will be used for non-fertilizer purposes. These percentages vary between 0% and 20% among different regions and nutrients (Table 5.3).

Conversion Losses

Because nitrogen and phosphate production potential is estimated from installed capacity of intermediate products, such as ammonia and phosphoric acid, an allowance is made for converting these intermediate products into final products that are used at the farm level. The assumed conversion losses for N and P_2O_5 are 8%, and 6%. These losses are due to volatilization (N), filtration and reversion (P_2O_5), and other conversion inefficiencies. For potash fertilizers, a 4% conversion loss was assumed because these are manufactured mostly from raw materials available from potash mines or sea brines.

Other Adjustments

The adjustments for industrial uses and conversion losses provide an estimate of production potential available from basic intermediate products like ammonia and phosphoric acid. However, both nitrogen and phosphate products are also available from non-ammonia and non-acid sources. Because more than 99% of N fertilizer products are produced from ammonia, no adjustment for non-ammonia N production has been made at the regional level; at the global level it is assumed that about 500,000 tons of N would be available from Chilean sodium nitrate, byproduct ammonium sulfate (from steel and caprolactam production) and others. In the case of phosphate, the P_2O_5 likely to be available from SSP, the phosphate rock content of TSP and NPKs, and basic slag was estimated from available data on production and capacity at the regional level. All K_2O production is assumed to come from potassium chloride.

Table 5.3. Industrial/Nonfertilizer Uses: Proportion of Utilized Capacity

Region	Ammonia (N)	Phosphoric Acid (P_2O_5)	Potash (K_2O)
	(%)		
North America	20	5	5
Western Europe	20	15	5
Eastern Europe	10	5	1
U.S.S.R.	10	5	1
Oceania	20	5	-
Africa			
North Africa	5	1	-
Sub-Saharan Africa	5	1	-
South Africa	20	5	-
Latin America			
Central America	5	10	-
South America	5	10	-
Asia			
East Asia	10	10	-
South Asia	1	2	-
West Asia	1	3	-

Source: Derived from actual use in North America and estimated use in other regions in 1986-87.

Distribution Losses

Distribution losses are the losses that occur between factory gate and farm gate; they result from bagging, transportation, and handling, from changes in inventories, and from in-transit shipment. In practice, such losses are reported to vary between 0.1% and 10%.[28] However, in most cases these losses are difficult to estimate because of reporting and measurement problems. Actual losses may be rather low in many cases.

Because there are no accurate data available on these losses at the regional level, no allowance has been made for these losses to derive supply potential at the regional level. Hence, the regional supply demand balances reflect a gap between production potential and forecast demand.

However, at the global level, the historical data indicate an average discrepancy between production and consumption of about 4.6% for N, 6.1% for P_2O_5, and 9.8% for K_2O (Table 5.4). The gap between production and consumption is relatively higher for K_2O than for N and P_2O_5 because potash production includes about 3% to 4% of K_2O production used for industrial and technical (non-fertilizer) purposes. Using these historical discrepancies as a guide, the global production potential has been adjusted by 4% for N and by 5% for P_2O_5 and K_2O to derive global supply potential. Because of these adjustments, the global supply-demand balances are slightly lower than the sums of regional supply-demand balances for all three nutrients.

Projected Fertilizer Production and Supply Potential

Projected fertilizer production potential is derived from nominal capacity, after making the above-mentioned adjustments for each nutrient; hence nominal capacity and production potential for each nutrient are analyzed separately.

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28. See Lewis and Isherwood (1982) for details.

Table 5.4 Gap Between Fertilizer Production and Consumption, 1970-87[a]

Year	N	P_2O_5	K_2O[b]
	(%)		
1969/70	7.3	3.5	10.0
1971	5.5	5.5	7.3
1972	5.7	6.0	10.9
1973	6.4	10.3	7.4
1974	5.4	3.0	7.5
1974/75	10.3	13.0	20.0
1976	2.5	2.7	8.8
1977	2.8	3.6	8.9
1978	3.0	7.0	11.3
1979	3.9	5.3	7.4
1979/80	4.3	7.8	7.7
1981	3.4	10.0	13.2
1982	3.3	3.3	7.9
1983	3.9	5.1	6.6
1984	1.0	7.5	9.7
1985	5.7	7.9	10.6
1986	4.7	4.2	10.6
1986/87	4.4	5.1	10.3
1970-87 Average	4.6	6.1	9.8

a. Excess of production over consumption.
b. Includes potash used for industrial and nonfertilizer purposes.

Source: Derived from FAO data. FAO (1988).

Nitrogen

Ammonia Nominal Capacity

Since ammonia provides more than 99% of N production at the global and regional levels, Table 5.5 indicates projected growth in N capacity through ammonia (NH_3). The N capacity projections, unlike demand projections which were derived from historical fertilizer use data, are estimated from announced plans about capacity buildups. As indicated above, June 30, 1988, has been used as a cutoff point for estimating these capacities. All known announcements about closures, expansions, and new capacity up to June 1988 are reflected in these projections.

At the global level, N capacity is projected to increase from 113.8 million tons in 1986/87 to 119.6 million tons in 1989/90 and 129.4 million tons in 1994-95. These estimates of capacity include about 1.5 million tons of capacity which was "not in active use" or idle during 1987/88 because of poor market conditions and unremunerative prices. It is assumed that most of this "idle" capacity will be able to produce fertilizer products when market conditions improve.

Of the total projected increase of 15.6 million tons during the 1987-95 period, about 40% increase is expected to come on stream by 1990, and the remaining 60% during 1991-95 period.

Table 5.6 indicates three components of the additional capacity likely to come on stream during the 1987-95 period. About one-fifth of this capacity came on stream in 1987-88, a little less than one-fourth of it is currently under construction (UCT), and more than half of it is still planned.

A regional breakdown of capacity under construction indicates that a little less than four-fifths of this capacity is under construction in Asia, Africa, and Latin America. Because of foreign exchange shortages and financial difficulties experienced by many countries in these regions, a delay in its completion may not be unrealistic. If its completion is delayed, then the realized production potential will be less than that projected here.

Although the planned capacity is believed to be firmly planned, its realization may be more uncertain than that of the completion of capacity under construction. Again, nearly two-thirds of the planned capacity is in Asia, Africa, and Latin America, and a little less than one-fourth of it is in the U.S.S.R. (Table 5.7). Delays in the execution of plans for fertilizer capacity buildups are not uncommon. All these regions (except West Asia in

Table 5.5. Ammonia Nominal Capacity, 1987-95

Region	1987	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons N)								
North America	16,951	16,770	16,652	16,444	16,444	16,444	16,444	16,810	16,810
Western Europe	14,126	13,438	13,532	13,532	12,997	13,272	13,272	13,272	13,272
Eastern Europe	11,238	11,608	11,478	11,626	11,646	11,704	11,704	11,704	11,704
U.S.S.R.	25,046	24,661	25,401	25,770	26,140	26,770	27,000	27,370	27,799
Oceania	581	606	606	565	524	524	931	931	931
Africa	2,984	3,512	3,512	3,540	3,540	4,084	4,356	4,356	4,356
North Africa	2,048	2,320	2,320	2,348	2,348	2,620	2,620	2,620	2,620
Sub-Saharan Africa	262	534	534	534	534	806	1,078	1,078	1,078
South Africa	674	658	658	658	658	658	658	658	658
Latin America	5,856	6,225	6,313	6,386	6,767	7,546	7,912	8,184	8,184
Central America	3,826	4,195	4,195	4,195	4,564	4,933	4,933	4,933	4,933
South America	2,030	2,030	2,118	2,191	2,203	2,613	2,979	3,251	3,251
Asia	37,369	39,033	40,858	41,705	42,536	44,251	45,083	45,956	46,328
East Asia	24,055	24,356	25,000	25,575	26,040	26,873	26,973	27,480	27,580
South Asia	9,522	10,160	11,069	11,069	11,435	12,317	13,049	13,415	13,687
West Asia	3,792	4,517	4,789	5,061	5,061	5,061	5,061	5,061	5,061
World	113,791	115,853	118,352	119,568	120,594	124,395	126,702	128,583	129,384

Source: TVA (1987), British Sulphur (1988), and IFDC (1988a).

Table 5.6. Projected Increase in N Capacity, 1987-95

Capacity	Million Tons	%
New	3.2	21
UCT[a]	3.6	23
Plan	8.8	56
	15.6	100

a. Under construction.

Source: British Sulphur (1988), TVA (1987), and IFDC (1988a).

Table 5.7. Regional Breakdown of Ammonia Capacity Under Construction and Planned, 1987-95

Region	Under Construction ('000 tons N)	Planned ('000 tons N)
North America	-	366
Western Europe	410	493
Eastern Europe	-	58
U.S.S.R.	369	2,029
Oceania	-	407
Africa	381	544
North Africa	381	-
Sub-Saharan Africa	-	544
Latin America	811	1,048
Central America	738	-
South America	73	1,048
Asia	1,617	3,815
East Asia	979	1,563
South Asia	366	2,252
West Asia	272	-
World	3,588	8,760

Source: British Sulphur (1988) and IFDC (1988a).

Asia) are known to suffer from foreign exchange shortages from time to time. Thus, the uncertainties attached to these two components of additional capacities may affect projected production and supply potential at the global and regional levels.

In addition to these two uncertainties, there is a third uncertainty associated with the closure of some of the existing capacity. As the existing capacity becomes old, it may require replacement. All announcements about closures until 1990-91 have been incorporated. Thereafter, no adjustments have been made because of lack of information.

Regional Distribution of Nominal Capacity

Asia and the U.S.S.R. are expected to contribute more than three-fourths of the additional capacity likely to come on stream during the 1987-95 period. Asia will add a little less than 9 million tons and the U.S.S.R. about 2.8 million tons of N. North America and Western Europe will experience declines in their N capacities. Likewise, South Africa will also experience a marginal decrease in its existing capacity. Although North America's capacity will decrease during the forecast period, it will expect some increase in its nominal capacity in 1993/94 because of a possibility of new plants to come on stream in Canada.

Latin America will experience about 2.3 million tons increase in its nominal capacity, and this increase will be shared more or less equally between Central America and South America, although the former's additional capacity is under construction while the latter's is mostly planned.

In Asia, South Asia will contribute about 46% of the projected increase, and East Asia about 39%. West Asia will contribute the remaining 15% of the projected increase.

In Africa, a little less than 60% of the projected increase in N capacity will be contributed by sub-Saharan Africa. In absolute amounts, SSA's nitrogen capacity will increase from 262,000 tons in 1986/87 to 1,078,000 tons in 1994/95--a more than 300% increase. This threefold increase in nitrogen capacity, if materialized, will help SSA in stimulating its nitrogen use rapidly, although it must be added that most of this expansion in capacity is geared to exports.

Probable Ammonia Capacity

In an earlier section, we have identified three uncertainties with the projected increase in nominal capacity. In this section, we analyze what we call as "probable" capacity.

Table 5.8 indicates data on probable capacity. This capacity is also planned capacity but its chance of coming on stream during the 1990-95 is only about 25%. Hence, we can call this "capacity on shelf." Because the feasibility studies are complete and the future locations are already identified, this capacity can come on stream only if market conditions are very good. Most of this capacity is geared to exports. A small part of this capacity is also aimed for import substitution, if N imports are no longer competitive with domestic production. This capacity includes plants in West Asia and other regions where natural gas is not a limiting factor.

This capacity is not yet firmly planned because in 1987/88, the planners of this capacity expected that low N prices would preclude adequate return from investing in this capacity. Thus, the probability that this capacity will come on stream is a function of market conditions. If N prices increase and make new investment profitable for export promotion, or import substitution, then some, or all, of this capacity may come on stream. Although in our forecasts of production and supply potential this capacity does not play any role, it may play a useful role in reducing the projected gap if such a gap really begins to develop. In that sense, it may also compensate for some of the uncertainties that may affect the projected production potential.

Production Potential[29]

Table 5.9 indicates data on the projected nitrogen production potential for 1987-95 period. Although actual production data are available for 1987, we have calculated production potential for 1987 in order to identify the influence of depressed market conditions on actual production. A comparison of actual production (75.5 million tons) with estimated production potential for 1987 indicates that, at the global level, actual N production was 6.0% below the technically possible maximum production because about 2 million tons capacity was lying idle and many plants operated much below the normal operating rates due to low and unremunerative prices.

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29. Refers to nitrogen fertilizer production potential.

Table 5.8. Ammonia Probable Capacity, 1992-95

Year	Additional	Cumulative Total
	('000 tons N)	
1992	814	814
1993	1,536	2,350
1994	816	3,160
1995	936	4,102

Source: Derived from data in British Sulphur (1988).

Table 5.9. Nitrogen Fertilizer Production Potential, 1987-95: Base Case

Region	1987	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons N)								
North America	11,767	11,801	11,685	11,850	11,498	11,498	11,498	11,600	11,715
Western Europe	9,843	9,260	9,210	9,411	9,088	9,073	9,228	9,280	9,280
Eastern Europe	7,796	7,991	8,085	8,182	8,196	8,213	8,231	8,237	8,237
U.S.S.R.	17,121	17,346	17,834	17,981	18,202	18,479	18,776	19,061	19,345
Oceania	406	424	424	410	386	366	480	608	651
Africa	2,164	2,213	2,399	2,459	2,464	2,627	2,875	3,017	3,046
North Africa	1,432	1,508	1,594	1,625	1,630	1,718	1,803	1,832	1,832
Sub-Saharan Africa	183	259	345	373	373	450	611	725	753
South Africa	549	445	460	460	460	460	460	460	460
Latin America	4,095	4,199	4,375	4,435	4,569	4,911	5,297	5,570	5,694
Central America	2,675	2,778	2,894	2,933	3,036	3,256	3,410	3,449	3,449
South America	1,419	1,421	1,481	1,501	1,533	1,655	1,886	2,121	2,245
Asia	26,584	27,171	28,308	29,283	29,957	30,798	31,679	32,391	32,869
East Asia	17,015	17,052	17,337	17,759	18,127	18,561	18,900	19,168	19,368
South Asia	6,836	7,124	7,678	7,985	8,172	8,549	9,092	9,535	9,814
West Asia	2,733	2,994	3,296	3,539	3,658	3,688	3,688	3,688	3,688
World (A)	80,277	80,905	82,820	84,511	84,854	86,465	88,563	90,265	91,337
(B)	77,066	77,668	79,507	81,131	81,460	83,006	85,021	86,654	87,683

A = Production potential (totals may not add due to non-NH_3 production added to global production potential).
B = Supply potential (derived from production potential after adjusting it for distribution losses).

Source: IFDC (1988a).

Global N production potential will increase from 80.3 million tons in 1986/87 to 91.3 million tons in 1994/95. Although nominal capacity will increase by 15.6 million tons, production potential will increase only by about 11.0 million tons or by about two-thirds of the increase in nominal capacity. This is so because of phasing-in of new capacity, regional variations in operating rates, industrial uses, and conversion losses.

Production potential will increase by 4.2 million tons between 1987 and 1990, and by 6.8 million tons between 1990 and 1995. Between 1990 and 1991, very little increase in production potential is expected because of little increase in nominal capacity in that year. However, between 1991 and 1994, production potential will increase by 5.4 million tons.

Among different regions, Asia will increase its production potential by about 6 million tons during the forecast period, and in Asia, South Asia will contribute nearly half of that increase and East Asia a little less than two-fifths.

North America's production potential will remain unchanged; although it will decrease during the early 1990s, it will recover to its 1987 level in the mid-1990s. Western Europe's production potential will decrease while Eastern Europe's will increase marginally.

After Asia, the U.S.S.R. will make the maximum contribution to the global increase in production potential; it will add about 2.2 million tons or about 20% of the expected increase in global production.

Latin America's production potential will increase by about 1.6 million tons and both Central and South America will contribute more or less equally.

With little growth in South Africa's production, North Africa and sub-Saharan Africa will contribute a little less than a million tons to the existing production potential. However, between the two, SSA will contribute more than 70% of the total increase in Africa's production potential.

Thus, Asia and the U.S.S.R. will contribute nearly 77% of the increase in N production and Latin America and Africa another 21%, leaving only 2% for North America, Western Europe, Eastern Europe, and Oceania--all the traditionally dominant producers and propellers of N production growth.

Regional Production Shares

By 1994/95, Asia's share in N production will be 37% and the U.S.S.R.'s 21%. Thus, more than half of the global N production will be

produced in Asia and the U.S.S.R. Although North America's share will have decreased from 25% in 1980 to 13% in 1995, it will be the third largest region in N production. Both Western and Eastern Europe will account for about one-tenth of total world production of nitrogen. Africa and Latin America will also experience some increase in their shares (Table 5.10).

Supply Potential

Global nitrogen supply potential during the forecast period is indicated in the last row of Table 5.9; it is derived from global production potential after adjusting the latter for distribution losses or statistical discrepancy, referred to above. The regional supply potential is not estimated for the reasons explained above.[30]

Nitrogen supply potential at the global level is projected to increase from 77.1 million tons in 1986/87 to 87.7 million tons in 1994/95--an annual growth of 1.6%. Of the projected 10.7 million tons increase during the forecast period, a little less than 40% will occur by 1989/90, and the remaining 60% during the 1991-95 period. Compared with 2.8% projected annual growth in nitrogen demand, a 1.6% annual growth in supply potential indicates that during the 1990s nitrogen supply will fall short of demand, if the current plans about capacity buildups are not modified in the next 2 or 3 years. The supply demand balances discussed in Chapter 6 indicate that the shortages will accentuate by the mid-1990s.

Phosphate

Phosphoric Acid Nominal Capacity

Although phosphoric acid does not account for as much production of phosphate fertilizers as ammonia does for production of nitrogen fertilizers, it accounts for more than half of total phosphate fertilizer production. Other important sources of P_2O_5 fertilizers are SSP, phosphate rock contents of TSP, NPs and NPKs, ground phosphate rock for direct application and basic slag. Partially acidulated phosphate rock (PAPR) may

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30. See p. 157 above.

Table 5.10. Regional Share in Global Nitrogen Production, 1995

Region	Share (%)
North America	13
Western Europe	10
Eastern Europe	9
U.S.S.R.	21
Oceania	1
Africa	3
Latin America	6
Asia	37
TOTAL	100

Source: Derived from data in Table 5.9.

become another important source in those areas where the quality of rock is poor and the availability of sulfur is constrained.

Because phosphoric acid forms the basis of more than half of all phosphate fertilizers produced and used, changes in its nominal capacity play an important role in determining phosphate supplies at both global and regional levels. Hence, the changes in phosphoric acid nominal capacity are analyzed below.

Table 5.11 indicates data on phosphoric acid nominal capacity at the global and regional levels. On the basis of the available information, phosphoric acid capacity is projected to increase from 37 million tons P_2O_5 in 1987 to 39.4 million tons P_2O_5 in 1995 at the global level. Of this 2.4 million tons increase during the forecast period, about 1.4 million tons increase is expected to occur by 1989/90 and another million tons increase by 1995. Thus, very little increase in nominal capacity is expected during the 1990s. This rather modest increase in the projected phosphoric acid capacity is a result mostly of existing excess capacity.

More than half of the projected increase in global phosphoric acid capacity will be contributed by Africa (North Africa) and another two-fifths by Asia. Thus, nearly 90% of the total increase in phosphoric acid capacity will come from these regions. The remaining 10% will be contributed by modest increases in capacity in Latin America, Oceania, Eastern Europe, and the U.S.S.R. Both North America and Western Europe will experience modest decreases in their acid capacities.

Phosphoric Acid Probable Capacity

Table 5.12 indicates data on probable phosphoric acid capacity having 25% chance of coming on stream during the 1990s. On the basis of the current information, about a million tons of P_2O_5 capacity can be classified as probable capacity. As is the case with ammonia capacity, some of this capacity may come on stream during the forecast period if market conditions improve and demand-supply balances become tight. It is shown below that, by the mid-1990s, there is a possibility of such shortages in P_2O_5 supplies.

Production Potential

P_2O_5 production potential is derived from both phosphoric acid capacity and non-acid sources. The methodology and assumptions used in estimating production potential are explained above.

Table 5.11. Phosphoric Acid, Nominal Capacity, 1987-95

Region	1987	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons P_2O_5)								
North America	12,022	11,855	11,771	11,771	11,771	11,771	11,771	11,771	11,771
Western Europe	4,316	4,209	4,049	3,983	3,960	3,960	3,960	3,960	3,960
Eastern Europe	2,477	2,477	2,477	2,620	2,620	2,620	2,620	2,620	2,620
U.S.S.R.	6,481	6,634	6,702	7,002	7,002	7,002	7,002	7,002	7,002
Oceania	363	363	363	363	363	487	487	487	487
Africa	4,868	5,471	5,492	5,492	5,492	5,822	6,152	6,152	6,152
North Africa	3,825	4,428	4,449	4,449	4,449	4,779	5,109	5,109	5,109
Sub-Saharan Africa	313	313	313	313	313	313	313	313	313
South Africa	730	730	730	730	730	730	730	730	730
Latin America	1,748	1,775	1,810	1,810	1,810	1,810	1,810	1,810	1,810
Central America	900	900	900	900	900	900	900	900	900
South America	848	875	910	910	910	910	910	910	910
Asia	4,717	4,731	5,314	5,346	5,511	5,511	5,511	5,601	5,601
East Asia	1,766	1,780	2,105	2,105	2,105	2,105	2,105	2,195	2,195
South Asia	956	956	1,204	1,204	1,204	1,204	1,204	1,204	1,204
West Asia	1,995	1,995	2,005	2,037	2,202	2,202	2,202	2,202	2,202
World	36,992	37,515	37,978	38,387	38,529	38,983	39,313	39,403	39,403

Source: TVA (1987), British Sulphur (1988), and IFDC (1988a).

Table 5.12. Phosphoric Acid Probable Capacity, 1990-95

Year	Additional	Cumulative Total
	- - - - - - - -('000 tons P_2O_5)- - - - - - - -	
1990	132	132
1991	124	256
1992	0	256
1993	250	506
1994	510	1,016
1995	0	1,016

Source: Derived from data in British Sulphur (1988).

Projected P_2O_5 production potential at the global and regional levels is indicated in Table 5.13. At the global level, production potential is projected to increase from 39.0 million tons in 1987 to 43.5 million tons in 1995. While the phosphoric acid capacity is projected to increase by 2.4 million tons, phosphate fertilizer production is projected to increase by 4.5 million tons, because of projected increase in production of non-acid sources like SSP, basic slag, nitrophosphates, and phosphate rock content of TSP. In spite of the projected increase in non-acid sources, the total increase in P_2O_5 fertilizer production is rather low in comparison with the projected increase in N production potential. The projected increase in P_2O_5 production potential is only about 41% of the projected increase in nitrogen production potential. The relatively small projected increase in P_2O_5 production potential is a result of slow growth expected in demand, excess (existing) capacity, and stocks. However, in percentage terms, the projected 11.5% increase in P_2O_5 production is not too low in comparison with the 13.5% projected increase in N production potential. This is so because the existing P_2O_5 potential is only one-half of N production potential.

A comparison of 1987 production potential with 1987 actual production of phosphate fertilizer reveals that actual production was about 9% below the potential production. This is so because a significant amount of capacity was lying idle, and many plants operated below their optimum rates due to low and unremunerative prices.

Nearly 60% of the projected increase in production potential is likely to occur by 1989/90 and the remaining 40% during the 1991-95 period. This is a result of slow increase in phosphoric acid capacity expected during the 1990s.

Among different regions, Asia and Africa will contribute nearly two-thirds of the projected increase in global phosphate production potential. In Africa, North Africa will contribute the most of the projected increase in production, while in Asia, East Asia will provide the lion's share. In addition to Asia and Africa, the U.S.S.R. will also contribute about one-fifth of the projected increase in production potential. Latin America's and Oceania's contributions will vary between 8% and 9%. North America's and Western Europe's production potential may decrease marginally.

Table 5.13. Phosphate Fertilizer Production Potential, 1987-95

Region	1987	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons P_2O_5)								
North America	10,656	10,782	10,483	10,500	10,502	10,502	10,502	10,502	10,502
Western Europe	4,869	5,036	4,863	4,780	4,763	4,763	4,763	4,763	4,763
Eastern Europe	3,640	3,670	3,680	3,723	3,766	3,783	3,799	3,799	3,799
U.S.S.R.	6,937	7,212	7,270	7,413	7,512	7,596	7,680	7,680	7,730
Oceania	1,114	1,221	1,332	1,333	1,344	1,386	1,430	1,455	1,481
Africa	3,777	4,194	4,509	4,675	4,755	4,840	5,019	5,171	5,236
North Africa	2,737	3,138	3,448	3,605	3,682	3,761	3,938	4,083	4,167
Sub-Saharan Africa	281	285	285	288	291	293	295	296	298
South Africa	759	771	776	781	781	786	786	791	791
Latin America	1,683	1,890	1,979	2,030	2,046	2,058	2,065	2,071	2,085
Central America	620	769	811	834	837	839	841	842	844
South America	1,063	1,121	1,168	1,196	1,209	1,219	1,224	1,229	1,241
Asia	6,347	6,576	7,022	7,294	7,464	7,610	7,695	7,764	7,860
East Asia	3,619	3,799	4,029	4,227	4,315	4,403	4,453	4,498	4,551
South Asia	1,169	1,193	1,386	1,447	1,467	1,476	1,492	1,495	1,538
West Asia	1,559	1,584	1,607	1,619	1,681	1,730	1,750	1,770	1,771
World (A)	39,024	40,581	41,137	41,747	42,151	42,537	42,952	43,204	43,476
(B)	37,073	38,552	39,081	39,660	40,043	40,410	40,805	41,044	41,302

A = Production potential (totals may not add due to rounding).
B = Supply potential (derived from production potential after adjusting it for distribution losses).

Source: IFDC (1988a).

Although North America's production potential may decrease marginally, North America will still account for about one-fourth of total P_2O_5 production in 1995. Asia and the U.S.S.R. will account for about 18% each of global production. The shares of other regions will vary between 3% and 12% (Table 5.14).

Supply Potential

Global phosphate supply potential (indicated in the last row of Table 5.13) is projected to increase from 37.1 million tons in 1986/87 to 41.3 million tons in 1994/95. More than 60% of the projected increase will occur by 1990 and the remaining 40% thereafter. Relatively lower growth in phosphate supply potential during the 1990s is a result of very little new capacity currently planned for the 1990s. Because of the excessive capacity in place and slower growth in phosphate use, supply potential will exceed the projected demand until 1994. In 1995, a deficit of about 1 million tons may emerge.[31]

Potash

Potash Nominal Capacity

Like the projected increase in phosphoric acid capacity, the projected increase in K_2O capacity is rather small. During 1987-95, potash capacity is projected to increase from 37.0 million tons K_2O to 39.0 million tons in 1995 (Table 5.15). About 75% of the projected increase is likely to occur by 1990 and about 25% during the 1991-95 period. Excess capacity, slow growth in demand, and low fertilizer prices are responsible for this rather modest increase expected in K_2O capacity. Not only in absolute amount, but in percentage terms also, the increase in capacity would be low. Only 5% increase in capacity is expected.

The U.S.S.R. and Asia will provide all the projected increase in global potash capacity. Also, the increase in capacity in these regions will compensate for the expected decreases in K_2O capacity in North America and Western Europe.

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31. See Chapter 6 for details.

Table 5.14. Regional Shares in Global Phosphate Production, 1995

Region	Shares (%)
North America	24
Western Europe	11
Eastern Europe	9
U.S.S.R.	18
Oceania	3
Africa	12
North Africa	10
Sub-Saharan Africa	-
South Africa	2
Latin America	5
Central America	2
South America	3
Asia	18
East Asia	10
South Asia	4
West Asia	4
World	100

Source: Derived from data in Table 5.13.

Table 5.15. Potash Capacity, 1987-95

Region	1987	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons K_2O)								
North America	13,458	13,644	13,241	13,340	12,985	12,985	12,985	12,985	12,985
Western Europe	6,480	6,180	6,280	6,280	6,280	6,280	6,280	6,280	6,280
Eastern Europe	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
U.S.S.R.	11,350	12,850	12,850	12,850	12,850	12,850	13,350	13,350	13,350
Oceania	0	0	0	0	0	0	0	0	0
Africa	0	0	0	0	0	0	0	0	0
North Africa	0	0	0	0	0	0	0	0	0
Sub-Saharan Africa	0	0	0	0	0	0	0	0	0
South Africa	0	0	0	0	0	0	0	0	0
Latin America	200	200	200	200	200	200	200	200	200
Central America	0	0	0	0	0	0	0	0	0
South America	200	200	200	200	200	200	200	200	200
Asia	2,080	2,080	2,200	2,340	2,340	2,700	2,700	2,700	2,700
East Asia	100	100	100	100	100	100	100	100	100
South Asia	0	0	0	0	0	0	0	0	0
West Asia	1,980	1,980	2,100	2,240	2,240	2,600	2,600	2,600	2,600
World	37,068	38,454	38,271	38,510	38,155	39,015	39,015	39,015	39,015

Source: TVA (1987) and British Sulphur (1988).

Unlike nitrogen capacity, which is dispersed in many regions, potash capacity is mostly concentrated in a few regions. For example, North America and the U.S.S.R. accounted for about two-thirds of the existing potash capacity in 1987. Western and Eastern Europe together accounted for another one-fourth. Thus, these four regions had more than 90% of potash capacity in 1987. Africa had none, Latin America a little, and Asia some. Most of Asia's 2 million tons capacity was in Western Asia (Israel and Jordan).

Because of such a heavy concentration of capacity in a few regions, potash use is highly sensitive to macroeconomic changes. Debt crises and foreign exchange shortages faced by many developing countries usually affect potash imports and use adversely. Since the potash resources are concentrated, potash capacity and production will remain concentrated in North America and the U.S.S.R.

Production Potential

Like the projected increase in potash capacity, the projected increase in potash production potential is rather modest. Global potash production potential is projected to increase by 1.7 million tons K_2O--from 31.2 million tons in 1987 to 32.9 million tons K_2O in 1995 (Table 5.16). This modest increase in production is a result of modest increase in projected capacity, which itself is a consequence of existing excess capacity and stocks.

Most of the increase in global potash production potential will be contributed by increases in production potential in Asia and the U.S.S.R. The U.S.S.R.'s production potential is expected to increase from 10.2 million tons K_2O in 1987 to 11.3 million tons in 1995 and Asia's production potential from 1.8 million tons in 1987 to 2.4 million tons in 1995. North America's and Eastern Europe's production potential is expected to remain unchanged, whereas Western Europe's production potential may decrease during the forecast period.

Although Asia will contribute about 35% of the projected increase in production potential, its share in global potash production will still remain small (7.5%) in 1995. North America (33%) and the U.S.S.R. (34%) will remain dominant producers and suppliers of potash fertilizers.

Supply Potential

Global potash supply potential (indicated in the last row of Table 5.16) is projected to increase from 29.7 million tons in 1987 to

Table 5.16. Potash Fertilizer Production Potential, 1987-95

Region	1987	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons K_2O)								
North America	10,526	10,705	10,708	10,835	10,751	10,636	10,652	10,658	10,658
Western Europe	5,483	5,196	5,114	5,155	5,155	5,155	5,155	5,155	5,155
Eastern Europe	3,160	3,160	3,160	3,160	3,160	3,160	3,160	3,160	3,160
U.S.S.R.	10,190	9,997	10,542	10,670	10,799	10,991	11,120	11,269	11,312
Oceania	0	0	0	0	0	0	0	0	0
Africa	0	0	0	0	0	0	0	0	0
North Africa	0	0	0	0	0	0	0	0	0
Sub-Saharan Africa	0	0	0	0	0	0	0	0	0
South Africa	0	0	0	0	0	0	0	0	0
Latin America	46	100	115	131	154	154	154	154	154
Central America	0	0	0	0	0	0	0	0	0
South America	46	100	115	131	154	154	154	154	154
Asia	1,844	1,856	1,918	2,044	2,120	2,284	2,448	2,448	2,448
East Asia	38	50	58	65	77	77	77	77	77
South Asia	0	0	0	0	0	0	0	0	0
West Asia	1,806	1,806	1,860	1,979	2,043	2,207	2,371	2,371	2,371
World (A)	31,249	31,014	31,557	31,995	32,138	32,379	32,668	32,844	32,887
(B)	29,687	29,463	29,980	30,395	30,531	30,760	31,054	31,202	31,242

A = Production potential (totals may not add due to rounding).
B = Supply potential (derived from production potential after adjusting it for distribution losses).

Source: IFDC (1988a).

31.2 million tons in 1995. A little less than half of the projected increase in supply potential will occur by 1990. Unlike growth in nitrogen supply potential, but like growth in phosphate supply potential, the relatively modest growth in potash supply potential (less than a million ton increase) during the 1991-95 period is a result of very little new capacity, or expansions in existing capacity, planned for the 1990s. Nevertheless, because of excess capacity currently in place, no shortages of potash fertilizers are expected by the mid-1990s.[32]

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32. See Chapter 6 for details.

CHAPTER 6

FERTILIZER SUPPLY-DEMAND BALANCES, 1988-95

Global and regional supply-demand balances for nitrogen, phosphate, and potash are discussed in this chapter. As demand and supply projections are discussed in earlier chapters, they are not repeated here. The focus here is only on the gap between supply/production potential and forecast demand. The supply-demand balance for each nutrient is defined as the difference between supply (global) or production (regional) potential and demand. In all tables and graphs, a positive balance indicates surplus or excess of supply/production potential over demand, and a negative (indicated by a minus [-] sign) balance indicates shortage (deficit) or supply/production potential less than demand.

The main findings of this chapter can be summarized as follows:

1. The projected supply-demand balances for nitrogen indicate that the nitrogen situation will remain in fragile balance. Under the base case scenario, nitrogen shortages will appear in 1991 and continue thereafter, although the magnitude of these shortages will decrease in 1992 and will magnify to about 2.8 million tons in 1995. However, if the capacity utilization rates were higher by one percentage point in all regions (High CU scenario), no nitrogen shortages would appear until 1995. On the other hand, if the capacity utilization rates were lower by one percentage point in all regions (Low CU scenario), marginal shortages might occur as early as 1990 and accentuate thereafter. Under this scenario, these shortages will vary between 2 million and 4 million tons during the 1991-95 period.
2. Unlike the nitrogen situation, the phosphate situation will remain stable and is less sensitive to changes in capacity utilization. No significant shortages are expected until 1995. During the late 1980s and the early 1990s, surpluses will dominate the phosphate scene.

3. The potash situation will be one of surplus. Even in the mid-1990s, available supplies will exceed the projected demand by a little less than half a million tons.

Nitrogen Supply-Demand Balances

Global Balances

The projected demand and supply potential at the global level are indicated in Figure 6.1. The global supply-demand balances are presented in Table 6.1 and Figure 6.2.

Three different scenarios are developed for estimating the supply potential. The base case scenario uses capacity utilization rates, or operating rates, indicated in Chapter 5. In the High CU scenario, the capacity utilization rates are increased by one percentage point, while in the Low CU scenario, the capacity utilization rates are decreased by one percentage point in all regions.

Under the base case scenario, the supply potential exceeds the projected demand until 1990 and falls short of demand thereafter. Although the projected demand exceeds the supply potential by about 1.3 million tons (shortage situation) in 1991, the deficit narrows to about 0.2 million tons in 1992 and then gradually increases to about 2.8 million tons in 1995 (Figure 6.2 and Table 6.1). The significantly higher deficits in 1991 are a result of rapidly growing demand and very little increase in capacity. As many new plants are commissioned in 1992, and as growth in demand slows down (compared with 1991), the gap between demand and supply narrows down. After 1992, as demand continues to grow, without matching increases in capacity, the deficits widen.

In the High CU scenario, the shortages of the 1991-94 period change into surpluses (except in 1991 when a deficit of 0.3 million tons still remains), and the deficits of 1995 are reduced by about a million tons--from 2.8 million tons to 1.8 million tons. In the Low CU scenario, marginal shortages develop even in 1990 and accentuate thereafter. By 1995 the shortages increase to 3.8 million tons--1 million tons higher than the shortage of the base case scenario and 2 million tons higher than that of the High CU scenario.

Figure 6.1

Nitrogen: Projected Global Demand and Supply Potential, 1987-95

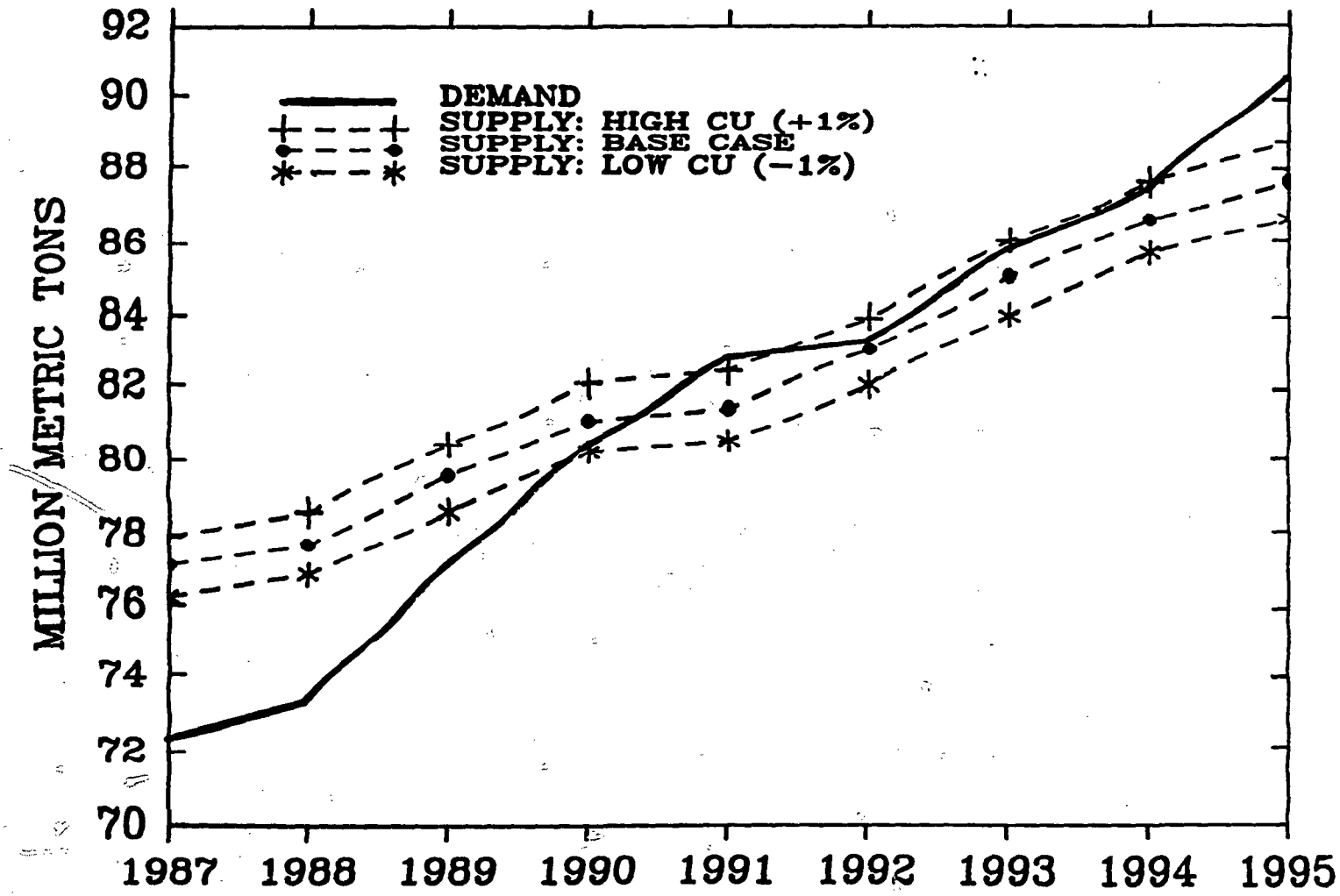


Table 6.1. Nitrogen: Global Supply-Demand Balances, 1987-95

Year	Low CU	Base Case	High CU
	- - - - - - -	('000 tons N)	- - - - - - -
1987	3,811	4,696	5,581
1988	3,520	4,413	5,306
1989	1,598	2,515	3,431
1990	-143	792	1,727
1991	-2,198	-1,258	-317
1992	-1,181	-222	737
1993	-1,682	-698	285
1994	-1,811	-809	194
1995	-3,822	-2,827	-1,812

Note: A negative (-) figure indicates deficit.

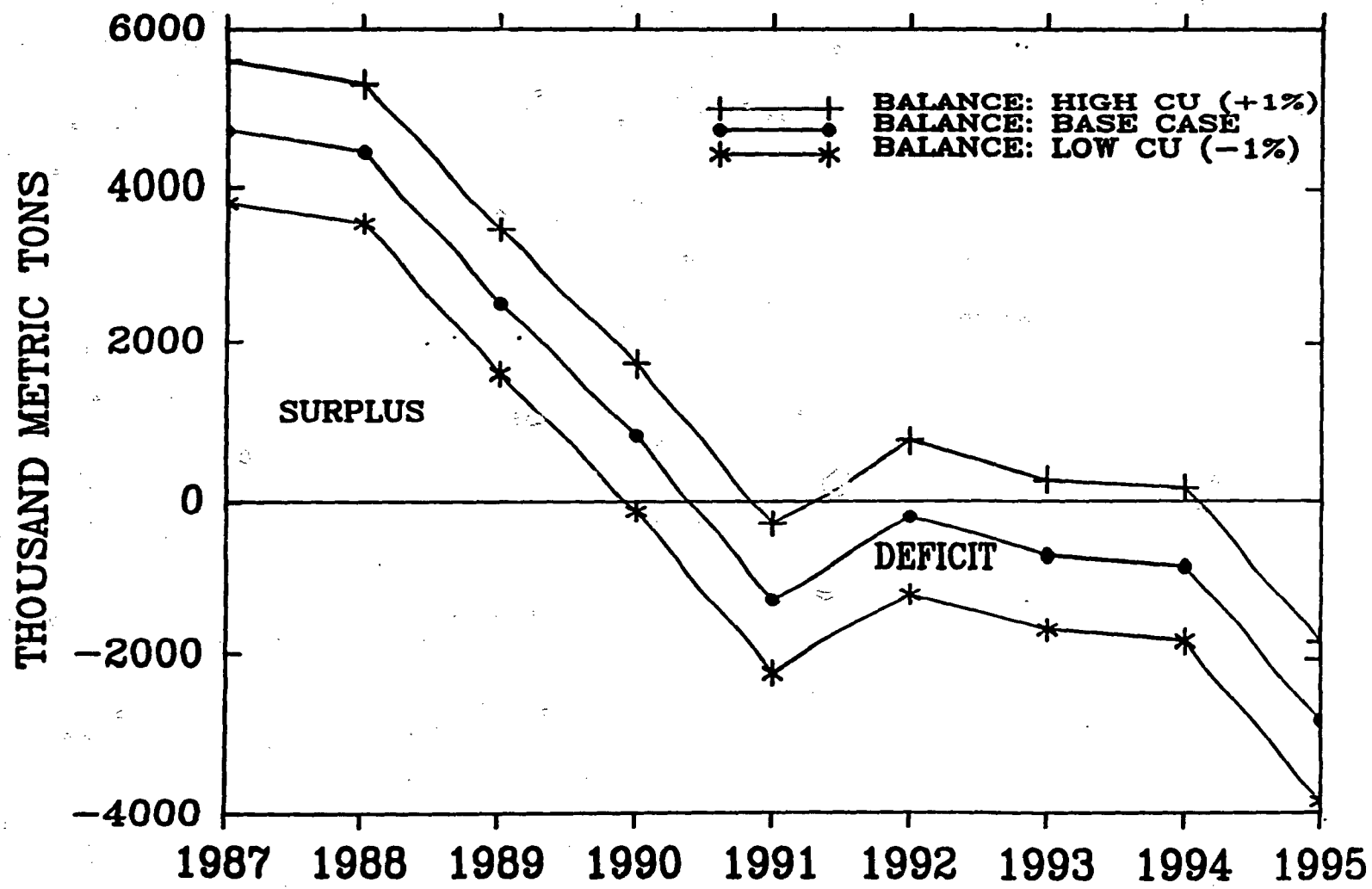
Low CU: Capacity utilization rates are 1 percentage point below the CU rates assumed in the base case.

High CU: Capacity utilization rates are 1 percentage point above the capacity utilization rates assumed in the base case.

Source: IFDC (1988a).

Figure 6.2

Nitrogen: Projected Global Supply-Demand Balances, 1987-95



This sensitivity analysis of changes in operating rates and their impact on supply-demand balances suggests that, although investment in capacity is required in the long run, the short-run shortages can be mitigated by improving capacity utilization or by improving what economists call the "ex-efficiency" of plant, that is, improving plant management by better planning, coordination, and waste reductions in the use of raw materials, machine time, labor services, and other operations.

Regional Balances

The supply-demand balances at the regional levels are presented in Table 6.2.

By the absolute size of their surpluses or shortages, two regions stand out distinctly in Table 6.2. These are the U.S.S.R. and Asia. During the forecast period, the U.S.S.R.'s surpluses will be more than 5 million tons in each year (except 1995), while Asia's deficits will gradually increase from 1.4 million tons in 1988 to about 5.3 million tons in 1995. It is rather interesting that although Asia will contribute more than a 55% increase in global production during the 1987-95 period, this region will not be able to become self-sufficient in nitrogen production even by the end of this century. Consequently, Asia will continue to depend on nitrogen imports, and due to the size of its imports, it will play a dominant role in setting world prices.[33]

In Asia, both East Asia and South Asia will remain deficit regions, and their deficits will increase from about a million tons in 1988 to 2.5-3.0 million tons in 1995. Against this, West Asia will continue to experience surpluses of the order of about half a million tons each year.

North America, Western Europe, and Oceania are the three other regions that will experience shortages of varying magnitudes during the late 1980s and the early and mid-1990s. North America's shortages will increase from a modest amount in 1990 to about a million tons in 1995, while Western Europe's deficits will fluctuate between 1.5 and 2.8 million tons. Because both regions have planned very little expansion in capacity, they will become dependent on imports if the projected demand materializes. As indicated above, if crop price support programs are changed and farm subsidies are drastically reduced, these regions may not experience as much shortage as is predicted here because demand will be reduced. Oceania's deficits are rather

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33. See Chapter 7 for details.

Table 6.2. Nitrogen: Regional Supply-Demand Balances, Base Case, 1987-95

Region	1987	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons N)								
North America	1,229	1,110	-5	-219	-742	-575	-798	-970	-1,038
Western Europe	-812	-1,538	-2,121	-2,103	-2,873	-1,105	-1,737	-1,780	-2,199
Eastern Europe	2,741	2,958	2,901	2,967	2,964	2,871	2,863	2,806	2,692
U.S.S.R.	5,646	5,597	5,763	5,560	5,412	5,308	5,217	5,110	4,998
Oceania	-	10	-2	-28	-73	-102	-3	109	137
Africa	154	145	231	208	161	246	414	479	390
North Africa	439	494	538	549	424	544	592	583	546
Sub-Saharan Africa	-472	-425	-362	-385	-407	-368	-242	-166	-197
South Africa	187	76	55	45	74	69	65	61	40
Latin America	264	285	321	225	203	380	596	699	651
Central America	680	737	782	746	776	929	1,006	967	904
South America	-416	-453	-461	-521	-573	-549	-410	-268	-253
Asia	-1,814	-1,417	-1,763	-2,938	-3,415	-4,286	-4,207	-4,151	-5,305
East Asia	-609	-1,055	-1,395	-2,470	-2,596	-2,923	-2,943	-2,946	-3,182
South Asia	-1,794	-1,060	-1,253	-1,368	-1,528	-1,982	-1,855	-1,747	-2,544
West Asia	589	698	885	901	710	619	591	543	421

Source: IFDC (1988a).

insignificant, but so is its N fertilizer use. Because of the planned capacity expansion in 1992/93, its marginal deficits will turn into small surpluses in the mid-1990s.

Unlike Western Europe, but like the U.S.S.R., Eastern Europe will have surpluses of the order of 2-3 million tons each during the 1988-95 period. Eastern Europe's surpluses are more a result of excess capacity already in existence and slow growth in demand. Increasing fertilizer prices of the late 1970s and the early 1980s, with abundant supply of cheap natural gas, resulted in excess capacity creation in these countries.

Latin America and Africa will also have nitrogen surpluses, although their surpluses are of smaller magnitude. In Africa, the surpluses will fluctuate between 0.15 and 0.48 million tons, and in Latin America between 0.30 and 0.70 million tons during the 1988-95 period. However, in both regions, the intraregional distribution of surpluses is quite different. In Latin America, all surpluses originate in Central America. Central America's abundant and cheap natural gas reserves provided it a comparative advantage in building nitrogen capacity for exports. Many producers in North America import cheap ammonia from Central America.

If Central America is an exporting region, South America is an importing region. South America's deficits will gradually decrease from about half a million tons in the late 1980s to about a quarter of a million tons in the mid-1990s.

As in Latin America, in Africa also, most of the projected surpluses are concentrated in one subregion, namely, North Africa. South Africa will also have some excess of production over demand during the 1988-95 period. Against this, sub-Saharan Africa is, and will remain, a deficit region, in spite of a significant increase planned in capacity during the forecast period. Because many countries in sub-Saharan Africa have both unsecure food supplies and foreign exchange shortages, the donor support in fulfilling this gap between demand and domestic production through imports will be critical. Even in the 1980s, many countries could sustain growth in fertilizer use simply because donor agencies provided funding (in cash as well as in kind) for fertilizer imports.[34]

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34. See Chapter 2, pp. 83-85 above.

Phosphate Supply-Demand Balances

Global Balances

Global phosphate supply potential (under three different scenarios) and projected demand are presented in Figure 6.3. Table 6.3 and Figure 6.4 indicate phosphate supply-demand balances at the global level.

It is clear from Figure 6.3 that, under all scenarios, supply potential will exceed the projected demand until 1993. In 1994, under the Low CU scenario, supply will fall short of demand by about 0.43 million tons. However, the projected demand will exceed the supply potential under all three scenarios in 1995. The deficits or shortages will vary between 0.53 million tons (High CU scenario) and 1.2 million tons (Low CU scenario). Under the base case scenario, the shortages will amount to about 0.86 million tons. Thus, compared with the nitrogen situation, the phosphate situation will be more stable.

Under the base case scenario, the surpluses will gradually decrease from 3.73 million tons in 1988 to about 0.56 million tons in 1993 (Table 6.3 and Figure 6.4). As the phosphate situation will remain that of surplus during the 1988-93 period, phosphate prices, compared with N prices, will increase slowly. The only upward pressure on phosphate prices will come from increasing demand and crop prices. Raw material prices may also put some upward pressure if phosphate rock has to be mined from difficult areas although in the short to medium run, that is less likely to happen.

Regional Balances

Regional phosphate supply-demand balances are presented in Table 6.4. The regions that stand out distinctly for their surpluses and deficits are North America and Africa (North Africa) for surpluses and Asia, Latin America, and the U.S.S.R. for shortages. Compared with these regions, Western Europe's shortages and Eastern Europe's surpluses are marginal. Oceania will also have some surpluses ranging between 0.27 and 0.35 million tons.

During the 1988-95 period, North America's surpluses will exceed 5 million tons per annum. In anticipation of rising prices of the late 1970s and the early 1980s, investments in capacity expanded rapidly. However, as

Figure 6.3

Phosphate: Projected Global Demand and Supply Potential, 1987-95

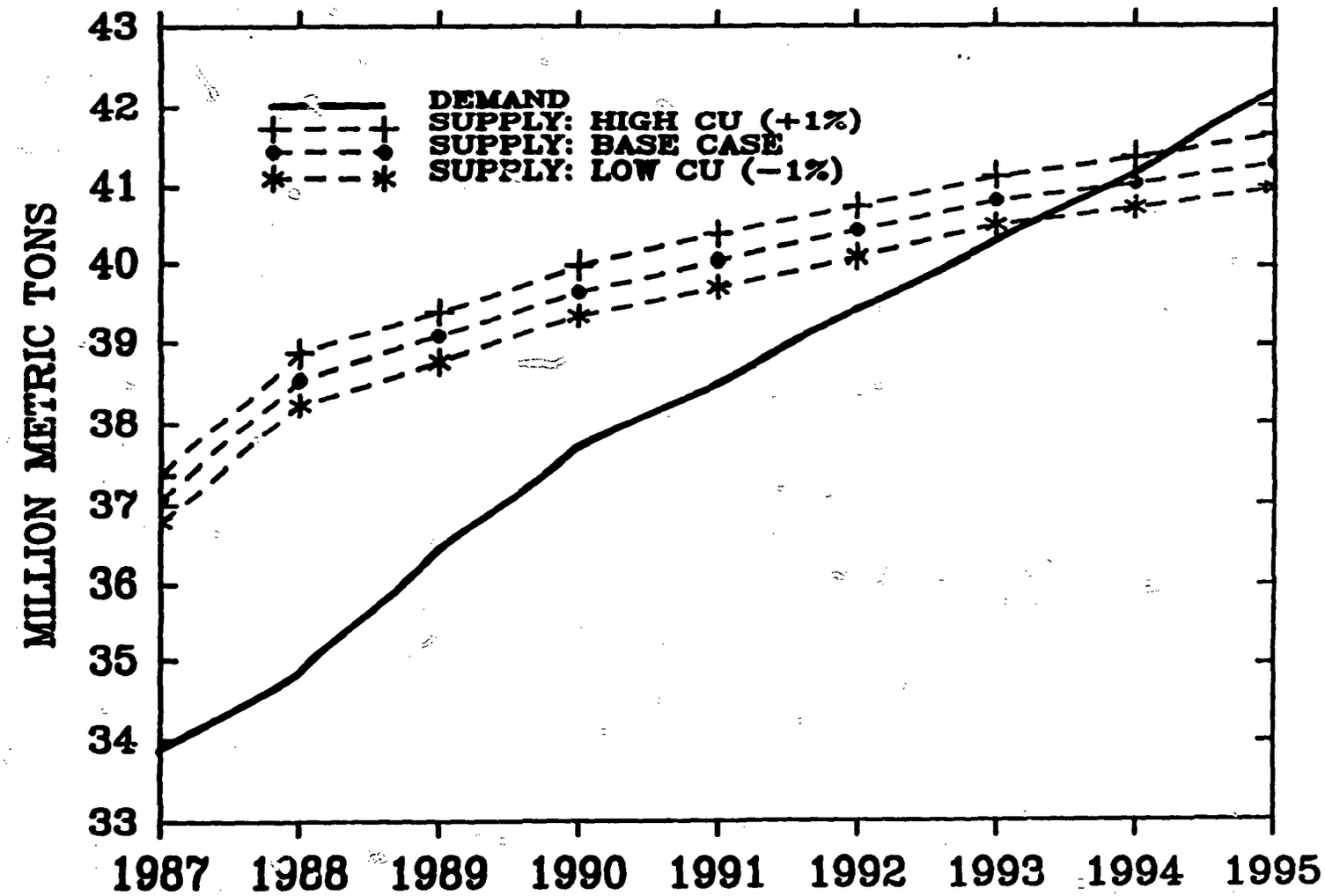

Table 6.3. Phosphate: Global Supply-Demand Balances, 1987-95

Year	Low CU	Base Case	High CU
	('000 tons P_2O_5)		
1987	2,926	3,228	3,530
1988	3,418	3,729	4,040
1989	2,409	2,723	3,037
1990	1,677	1,996	2,313
1991	1,232	1,554	1,875
1992	692	1,016	1,340
1993	228	555	883
1994	-433	-104	226
1995	-1,189	-859	-528

Note: A negative (-) figure indicates deficit.

Low CU: Capacity utilization rates are 1 percentage point below the CU rates assumed in the base case.

High CU: Capacity utilization rates are 1 percentage point above the capacity utilization rates assumed in the base case.

Source: IFDC (1988a).

Figure 6.4

PHOSPHATE: PROJECTED GLOBAL SUPPLY–DEMAND BALANCES, 1987–95

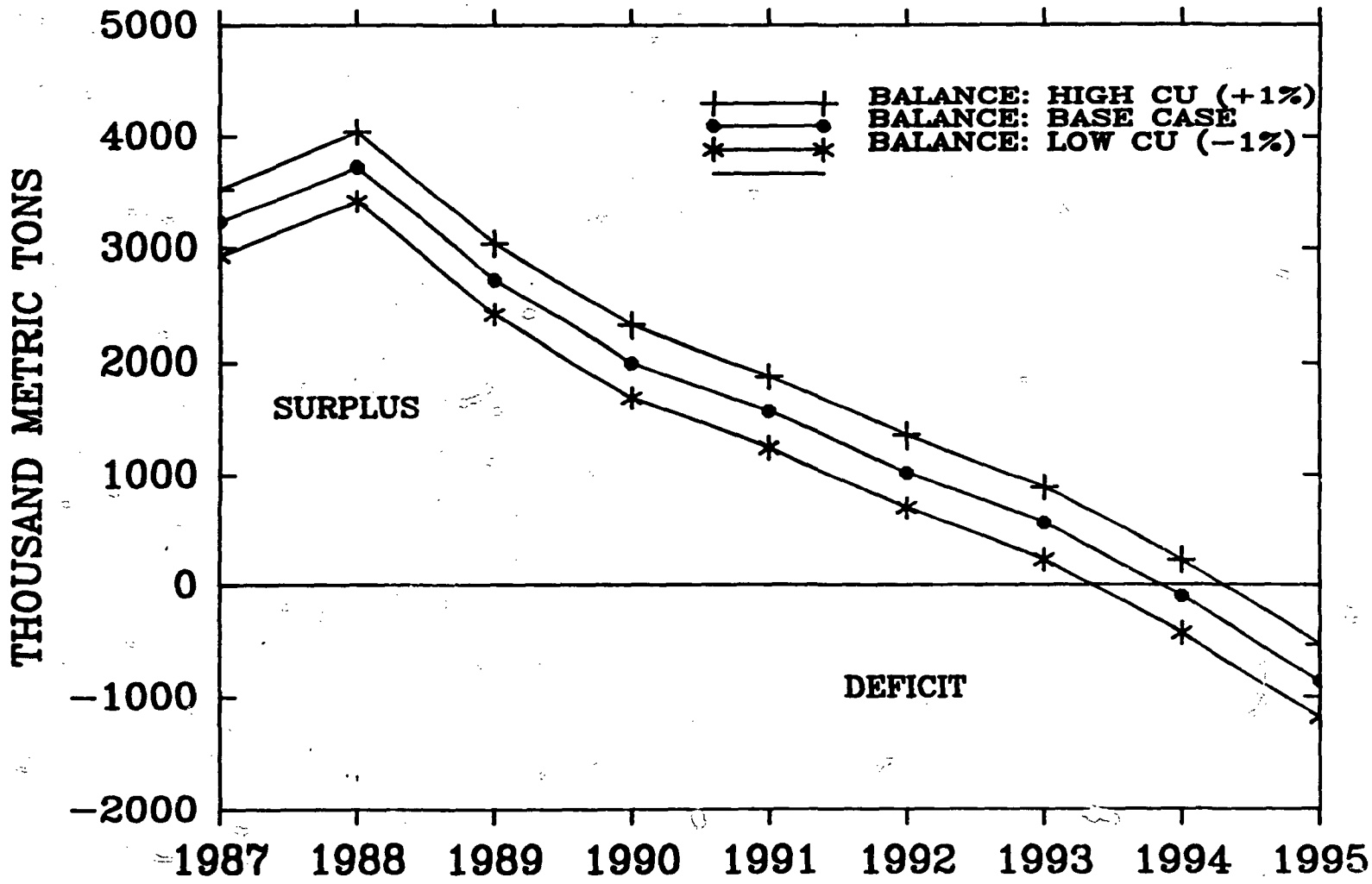

Table 6.4. Phosphate: Regional Supply-Demand Balances, Base Case, 1987-95

Region	1987	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons P_2O_5)								
North America	6,373	6,392	5,855	5,649	5,561	5,518	5,473	5,454	5,384
Western Europe	71	350	118	-70	-91	-203	-232	-283	-325
Eastern Europe	530	449	398	415	446	448	425	417	397
U.S.S.R.	-630	-489	-687	-805	-978	-1,173	-1,377	-1,526	-1,620
Oceania	133	268	346	297	296	317	329	343	352
Africa	2,666	3,055	3,309	3,419	3,494	3,551	3,679	3,780	3,815
North Africa	2,319	2,695	2,989	3,125	3,182	3,245	3,403	3,521	3,585
Sub-Saharan Africa	-76	-75	-90	-103	-117	-134	-145	-160	-174
South Africa	421	434	410	397	429	437	420	419	403
Latin America	-1,114	-887	-891	-929	-1,012	-1,109	-1,188	-1,292	-1,382
Central America	21	143	159	160	140	120	99	90	69
South America	-1,135	-1,031	-1,050	-1,089	-1,152	-1,229	-1,288	-1,382	-1,451
Asia	-2,851	-3,380	-3,669	-3,896	-4,054	-4,205	-4,405	-4,837	-5,304
East Asia	-1,412	-1,712	-1,811	-1,820	-1,943	-1,987	-1,993	-2,070	-2,224
South Asia	-1,698	-1,847	-1,985	-2,060	-2,180	-2,316	-2,447	-2,694	-2,905
West Asia	259	180	127	44	69	98	35	-72	-136

Source: IFDC (1988a).

the demand decreased significantly during the 1980s, North America was left with excess capacity. Hence, in spite of little increase in capacity planned during the forecast period, North America will continue to have surpluses and therefore will continue to export phosphate products.

Africa's surpluses mostly originate in North Africa. Morocco and Tunisia are important producers and exporters of processed phosphates. North Africa will continue to maintain a dominant position in the world phosphate industry during the forecast period. Sub-Saharan Africa is a deficit region and will continue to depend on imports in the future. Because the countries of sub-Saharan Africa are food-insecure and have foreign exchange shortages, finding viable means of meeting their phosphate demands should be a priority item for both donors and researchers. In this context, IFDC's research on PAPR should be strengthened, and efforts should be made to convert that research into viable production possibilities.[35]

Asia's deficits will continue to grow during the forecast period. In absolute amounts these deficits will increase from 3.4 million tons in 1988 to 5.3 million tons in 1995. Like nitrogen deficits, Asia's phosphate deficits are also concentrated in East and South Asia. West Asia will continue to have marginal surpluses until 1993. In 1994 and 1995 it may have marginal deficits.

South and East Asia's phosphate deficits are a consequence of both growing demand and limited availability of raw materials/feedstocks for manufacturing phosphate fertilizers. Although China in East Asia has phosphate rock reserves, their development on a large scale will need time and resources. The World Bank is looking into financing some projects in China.

Like Asia, Latin America will also continue to have deficits in its phosphate fertilizer supplies and therefore will continue to depend on imports. However, Latin America's deficits will originate in South America because Central America will remain self-sufficient in P_2O_5 production. During the 1980s many South American countries were heavily in debt and had difficulty in meeting their phosphate fertilizer requirements. Because imports are foreign-exchange intensive, and because many South American countries experience foreign-exchange shortages, finding ways to reduce import

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35. See IFDC (1986).

Figure 6.5

Potash: Projected Global Demand and Supply Potential, 1987-95

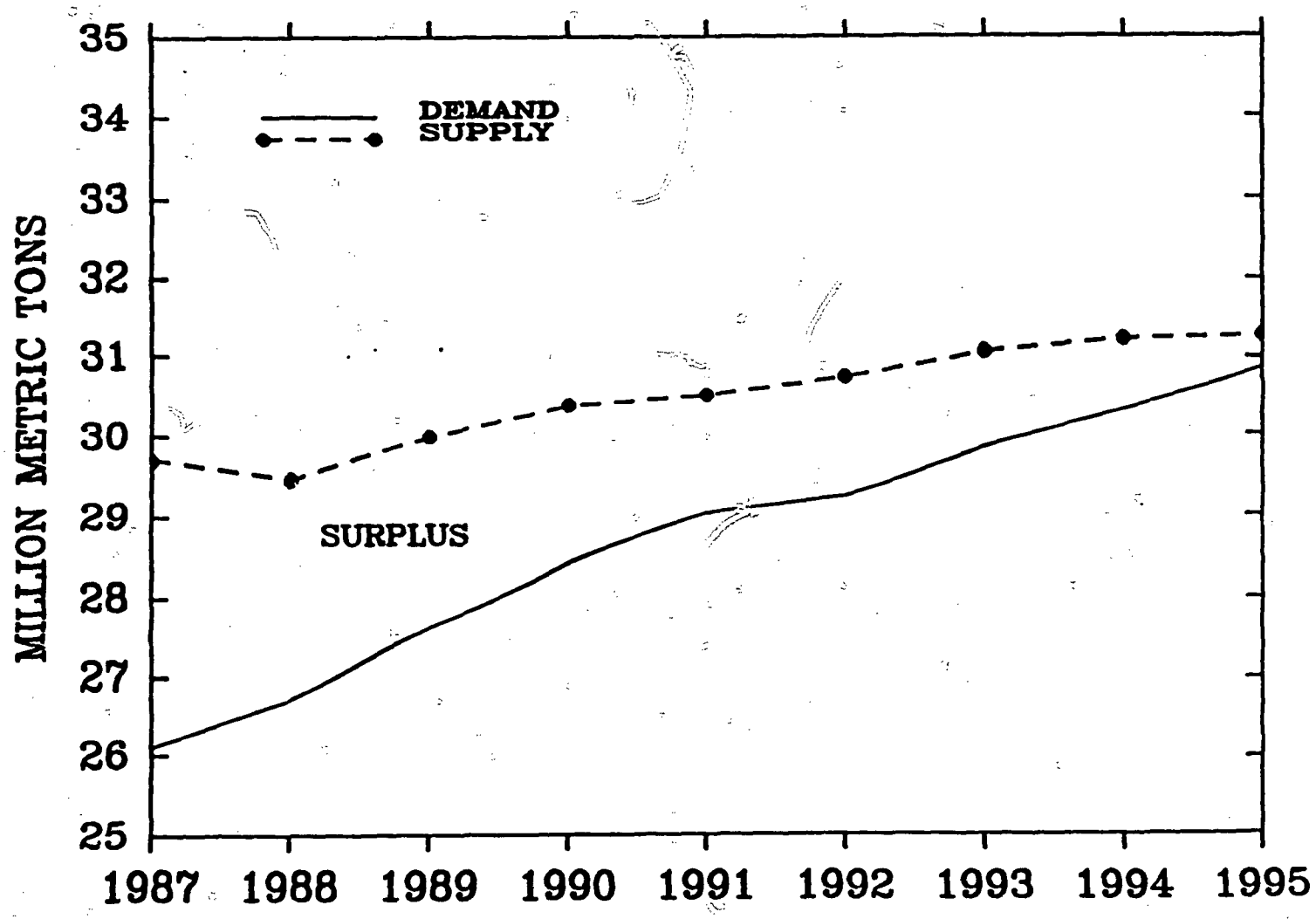


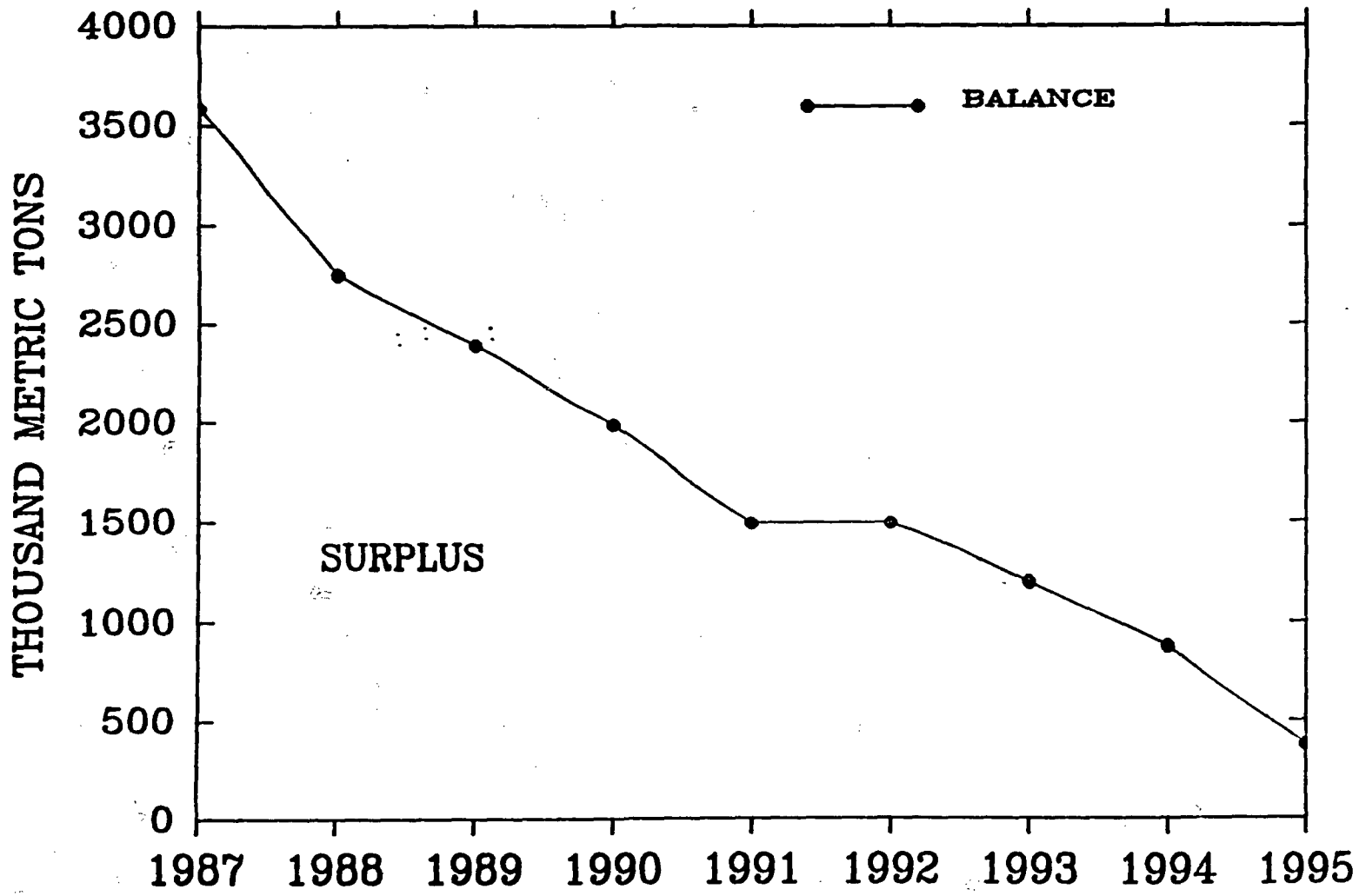
Table 6.5. Potash: Global Supply-Demand Balances, 1987-95

Year	Balance ('000 tons K_2O)
1987	3,592
1988	2,746
1989	2,383
1990	1,985
1991	1,491
1992	1,493
1993	1,211
1994	875
1995	370

Source: IFDC (1988a).

Figure 6.6

Potash: Projected Global Supply-Demand Balances, 1987-95



Excess capacity creation coupled with decreasing demand, mostly in North America and Western Europe during the early 1980s, left the industry with excess surpluses in the mid- and the late-1980s. Also, as demand is expected to grow slowly during the 1988-95 period, these excess production potentials will more than suffice to meet the growing demand. Relatively slow growth in potash demand is a consequence of both microeconomic (farm level) and macroeconomic (national level) factors (see Chapter 2 above for details).

Regional Balances

Potash resources are concentrated mostly in North America, the U.S.S.R., and West Asia; thus, many regions are currently deficit and will remain so during the forecast period. Table 6.6 indicates regional potash supply-demand balances.

North America and the U.S.S.R. are the only two regions that will have substantial potash surpluses during the forecast period. Their surpluses will vary between 3 and 6 million tons. All other regions will experience potash shortages and will be import dependent. Asia's shortages will increase from 1.6 million tons in 1988 to 2.1 million tons in 1995. In Asia both East and South Asia will have to depend on potash imports, whereas West Asia will have about 1.7-2.1 million tons of annual potash surpluses for exports.

Like Asia, Latin America will also depend on imports for almost all of its potash requirements. Both Central America and South America will experience shortages although the latter's shortages will amount to three times the shortages of the former. In an absolute amount, Central America's shortages will be about half a million tons per annum and South America's about 1.5 million tons per annum.

Because Africa currently produces no potash and nothing is planned for the 1990s, all three subregions in Africa will have to depend on potash imports to meet their potash requirements. However, because Africa's demand is low, its import requirements will vary around half a million tons during the forecast period.

Both Western Europe and Eastern Europe will meet most of their potash requirements through domestic production but will need some imports (300,000-500,000 tons K_2O per annum) to meet domestic requirements.

Oceania is no exception to most of the regions in the world and therefore will meet its potash requirements through imports.

Table 6.6. Potash: Regional Supply-Demand Balances, 1987-95

Region	1987	1988	1989	1990	1991	1992	1993	1994	1995
	('000 tons K_2O)								
North America	5,734	5,782	5,569	5,472	5,272	5,133	5,103	5,044	5,007
Western Europe	270	-153	-391	-515	-543	-450	-474	-531	-553
Eastern Europe	-185	-145	-181	-156	-190	-246	-290	-311	-331
U.S.S.R.	3,512	3,092	3,409	3,310	3,212	3,378	3,280	3,304	3,220
Oceania	-221	-236	-260	-270	-285	-290	-300	-305	-310
Africa	-445	-459	-482	-503	-522	-541	-558	-577	-594
North Africa	-136	-132	-138	-145	-152	-161	-170	-178	-187
Sub-Saharan Africa	-189	-201	-213	-221	-231	-240	-247	-256	-263
South Africa	-119	-126	-131	-135	-138	-140	-141	-143	-144
Latin America	-1,961	-1,935	-1,981	-2,021	-2,046	-2,096	-2,160	-2,210	-2,283
Central America	-434	-443	-457	-474	-491	-507	-525	-549	-566
South America	-1,526	-1,492	-1,525	-1,541	-1,556	-1,589	-1,635	-1,661	-1,717
Asia	-1,552	-1,649	-1,722	-1,733	-1,799	-1,777	-1,755	-1,897	-2,141
East Asia	-2,193	-2,263	-2,332	-2,405	-2,475	-2,577	-2,641	-2,725	-2,910
South Asia	-1,019	-1,061	-1,111	-1,163	-1,215	-1,268	-1,320	-1,372	-1,425
West Asia	1,660	1,675	1,721	1,835	1,890	2,048	2,205	2,200	2,194

Source: IFDC (1988a).

What is strikingly different about the potash situation is that, although most of the production is concentrated in only two regions (North America and the U.S.S.R.), these two regions have created so much excess capacity during the 1980s that their excess capacity will be more than sufficient to meet the growing demand in all regions during the 1990-95 period. This implies that earlier capacity expansions took place under highly optimistic expectations for growth in demand.

CHAPTER 7

PRICE OUTLOOK: A QUALITATIVE ASSESSMENT

The preceding three chapters focused on analyzing fertilizer demand projections, fertilizer supply projections, and the projected fertilizer supply-demand balances at the global level. This chapter analyzes trends in fertilizer prices as well as the future outlook for prices. No attempt is made to project the precise magnitude of prices for reasons explained below, but some qualitative conjectures are offered about the factors that may affect prices in the future.

Before analyzing trends in fertilizer prices and making qualitative conjectures about future fertilizer prices, the factors responsible for causing variations/fluctuations in prices are discussed.

Economics and Psychology of Price Variations

From the point of view of economic theory, prices in any market are determined by the forces of demand and supply. In a static world, an equilibrium price is a price at which quantity demanded equals quantity supplied. However, in a dynamic world, the price is determined not only by the quantity demanded and the quantity supplied, but also by the reaction of the buyers and the suppliers to a gap between quantity demanded and quantity supplied. If the buyers react in a panic manner to a perceived shortage in the market, price will increase much faster than what is justifiable by economic considerations. On the other hand, if the suppliers react in a hasty manner to a possible surplus, then prices will decrease much faster than what is justified by cost considerations. Thus, the realized price on a given day may be higher or lower than the equilibrium price depending on the strength of the buyers' or sellers' reactions.

The reaction of buyers and suppliers is a psychological factor and is hard to quantify. It was this psychological reaction to a perceived food and fertilizer shortage that made fertilizer prices increase by more than 200% in 1974. Because this reaction parameter (or coefficient) is hard to quantify, the short-run flunctuations in prices are hard to predict.

However, the trend in long-run prices is determined more by economic factors than by psychological factors, because any shortage in the long run will induce increase in production by increased capacity, whereas any long-run surpluses will lead to closures and idling of capacity. In the former case, the cost of supplying output from the new capacity will determine the long-run equilibrium price, and in the latter case the most efficient unit's cost of production will determine equilibrium price. (In the very short run, dumping is possible to drive marginal units out of production.) Thus, on the supply side, the principal factors that determine prices are capital charges, operating costs, and raw materials costs. Any change in these costs will be reflected in the supply price of the product. On the demand side, the factors that affect price are the uses to which a product is put. For example, the price of energy the buyers/users are willing to pay depends on its utility or productivity. Likewise, the price of fertilizers the farmers are willing to pay depends on what additional crop output they can gain by using fertilizers at the margin, and at what price that additional output can be sold in the market, i.e., what economists call, the "value of marginal product" of fertilizers. Thus, the factors that affect crop prices and marginal productivity of fertilizers (fertilizer response function) will also affect the price that the buyers will be willing to offer for fertilizers. As crop output and prices are influenced by weather fluctuations, fertilizer prices are also influenced by changes in weather and its impact on crop output. For example, a severe drought in the United States in 1988 reduced crop output significantly. Consequently, crop prices increased, and as increased crop prices enhanced the profitability of fertilizer use, fertilizer prices also increased in response to increased demand in the following season. This is another uncertainty that cannot be quantified to determine the precise magnitude of prices.

In addition to these ecological and microeconomic uncertainties (transmitted from the agricultural sector), fertilizer demand is also subject to macroeconomic uncertainty related to the allocation of foreign exchange resources required for fertilizer imports.

Thus, the uncertainties on the demand side and the unpredictability of the buyer/seller reaction to a perceived or likely shortage/surplus make it difficult to predict prices with great accuracy in the short and the long run. Although the uncertainties about raw material prices (e.g., energy prices) can also make the prediction of long-run

fertilizer prices difficult, the supplyside uncertainties are of smaller consequence than the uncertainties related to demandside and reaction parameters during the forecast period.

In addition to these three uncertainties, fertilizer prices in the short run are also affected by the purchases of particularly large buyers like China, India, and Brazil. Whenever these countries withdraw from the market fertilizer prices tend to decrease and vice versa.[37]

Price Expectations and Realizations

Table 7.1 provides data on expected and realized percentage changes in fertilizer prices. The expected percentage changes in fertilizer prices are derived from IFDC's price expectation survey. The survey was conducted twice in 1986 and once in 1988. More than 50 participants around the world were asked to indicate expectations about percentage changes in fertilizer prices during the next 6 months. For example, the January 1986 survey asked the participants about the expected percentage changes in July 1986 prices over January 1986 prices, and so on.[38]

In order to assess the accuracy of price expectations, the expected percentage changes in prices are compared with the realized (actual) percentage changes in prices of urea, TSP, DAP, and MOP in Table 7.1

A comparison of the July 1986 price expectations and price realizations indicates that, in direction as well as in magnitude, the price expectations were unrealized in July 1986. Although the participants expected urea, TSP, and DAP prices to increase by 3% to 5%, in reality the urea price changed a little, and the TSP and DAP prices decreased by 12% to 14%. For MOP, a marginal decrease (0.5%) in price was expected, but in reality, MOP price decreased by 8.5%. In January 1987 also, the actual price changes were significantly different from those expected by the survey participants.

However, in January 1989, the actual and the expected percentage changes were in the same direction, although of different magnitudes, for urea, TSP, and MOP and in the opposite direction for DAP.

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37. See Fertilizer Week, January 30, 1989 for details.

38. See IFDC (1988b).

Table 7.1. Global Fertilizer Prices: Expectations and Realizations
(Percentage Change)

	July 1986		January 1987		January 1989	
Product	Expected	Realized	Expected	Realized	Expected	Realized
Urea	4.7	0.1	0.4	-11.9	7.1	14.5
TSP	3.5	-14.4	2.3	-0.7	5.0	4.9
DAP	4.1	-12.4	2.6	-21.4	2.7	-1.6
MOP	-0.5	-8.5	-0.9	-13.6	3.8	1.2

Source: IFDC (1988b) for expected prices and Green Markets (various issues) for realized prices.

Although in the light of the uncertainties mentioned above, these discrepancies between price expectations and price realizations are not surprising, a few observations follow from these comparisons. First, the survey participants were guided by the current market conditions rather than by the structural and long-run changes taking place in the fertilizer sector. Second, the participants were biased towards rising prices rather than falling prices. Thus, when the actual prices were rising, the expected changes were in the same direction as the actual changes in prices. However, when the actual prices were falling, the expected changes were in the opposite direction. Furthermore, even when the prices were expected to decrease, the magnitude of the decrease was grossly underestimated.

Trends in Fertilizer Prices

The trends in fertilizer prices during the 1965-88 period for four fertilizer products, namely, urea, TSP, DAP, and MOP are analyzed below. A qualitative assessment of the outlook for these product prices is also made. Table 7.2 indicates current and constant (1985 US $) prices, and Table 7.3 provides data on annual percentage changes in current prices of these products.

Urea

From Figure 7.1 it is clear that urea prices peaked in 1974, 1980, and 1984 and troughed in 1971, 1976, 1983, and 1986.[39] Since 1986 urea prices have been rising slowly. These fluctuations in prices indicate that urea prices fluctuate widely both in the short run and in the long run. These fluctuations in prices were caused by all three factors we have mentioned earlier, namely, the demandside, the supplyside, and the psychological factors. A steep increase in urea price in 1974 was a result of all three factors mentioned above. On the supply side was the increase in energy prices (the energy crisis of 1973-74) and on the demand side was increase in crop prices. The prices of wheat, corn, and rice increased by 35% to 107% in 1974

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39. The reference here is to current prices. The fluctuations in constant (1985 US $) are similar to those in current prices (Figure 7.1).

Table 7.2. Global Fertilizer Prices, 1965-88

Year	Urea[a]		TSP[b]		DAP[c]		MOP[d]	
	A	B	A	B	A	B	A	B
	(US $/ton)							
1965	95.3	305.1	NA	NA	NA		29.5	93.9
1966	89.3	273.9	NA	NA	NA		27.5	84.4
1967	79.3	241.0	47.0	142.9	68.5	208.2	25.5	77.5
1968	65.6	200.3	38.0	116.2	65.5	200.3	24.0	73.4
1969	56.0	163.3	39.0	113.7	58.0	169.1	22.0	64.1
1970	48.3	132.3	42.5	116.4	54.0	147.9	31.5	86.3
1971	46.0	119.5	43.3	112.5	61.8	160.5	32.5	84.4
1972	59.3	141.5	67.5	161.1	91.0	217.2	33.5	80.0
1973	94.8	195.1	99.5	204.7	118.8	244.4	42.5	87.4
1974	315.8	533.4	303.6	512.8	332.6	561.8	60.5	102.2
1975	198.0	300.9	202.5	307.8	243.0	369.3	81.3	123.6
1976	112.0	167.9	90.9	136.3	120.0	179.9	55.0	82.5
1977	127.4	173.8	97.9	133.6	133.0	181.4	51.0	69.6
1978	144.8	171.8	98.0	116.3	139.8	165.8	56.4	66.9
1979	172.9	181.0	142.2	148.9	193.3	202.4	76.7	80.3
1980	222.1	212.1	180.3	172.2	222.2	212.2	115.7	110.5
1981	216.0	205.3	161.3	153.3	195.0	185.4	112.4	106.8
1982	158.8	153.0	138.4	133.3	182.8	176.1	81.6	78.6
1983	135.4	134.1	134.7	134.3	183.5	181.7	75.3	74.6
1984	171.3	172.5	131.3	132.2	189.1	190.4	83.7	84.3
1985	136.3	136.3	121.4	121.4	169.0	169.0	84.0	
1986	115.0	97.2	130.0	109.9	154.0	130.2	73.0	61.7
1987	135.0	103.8	130.0	100.0	174.0	133.8	74.0	56.9
1988	148.0	105.2	157.0	111.6	196.0	139.3	87.0	61.8

NA = Not available.
A = Current.
B = Constant 1985 US $ (deflated by Manufacturing Unit Value (MUV) Index.
a. Bagged, f.o.b. northwest Europe.
b. Bulk, f.o.b. Florida.
c. Bulk, f.o.b. Florida.
d. Bulk, f.o.b. Vancouver.

Source: World Bank (1986a) and the Green Markets (various issues).

Table 7.3. Global Fertilizer Prices: Annual Percentage Change, 1965-88[a]

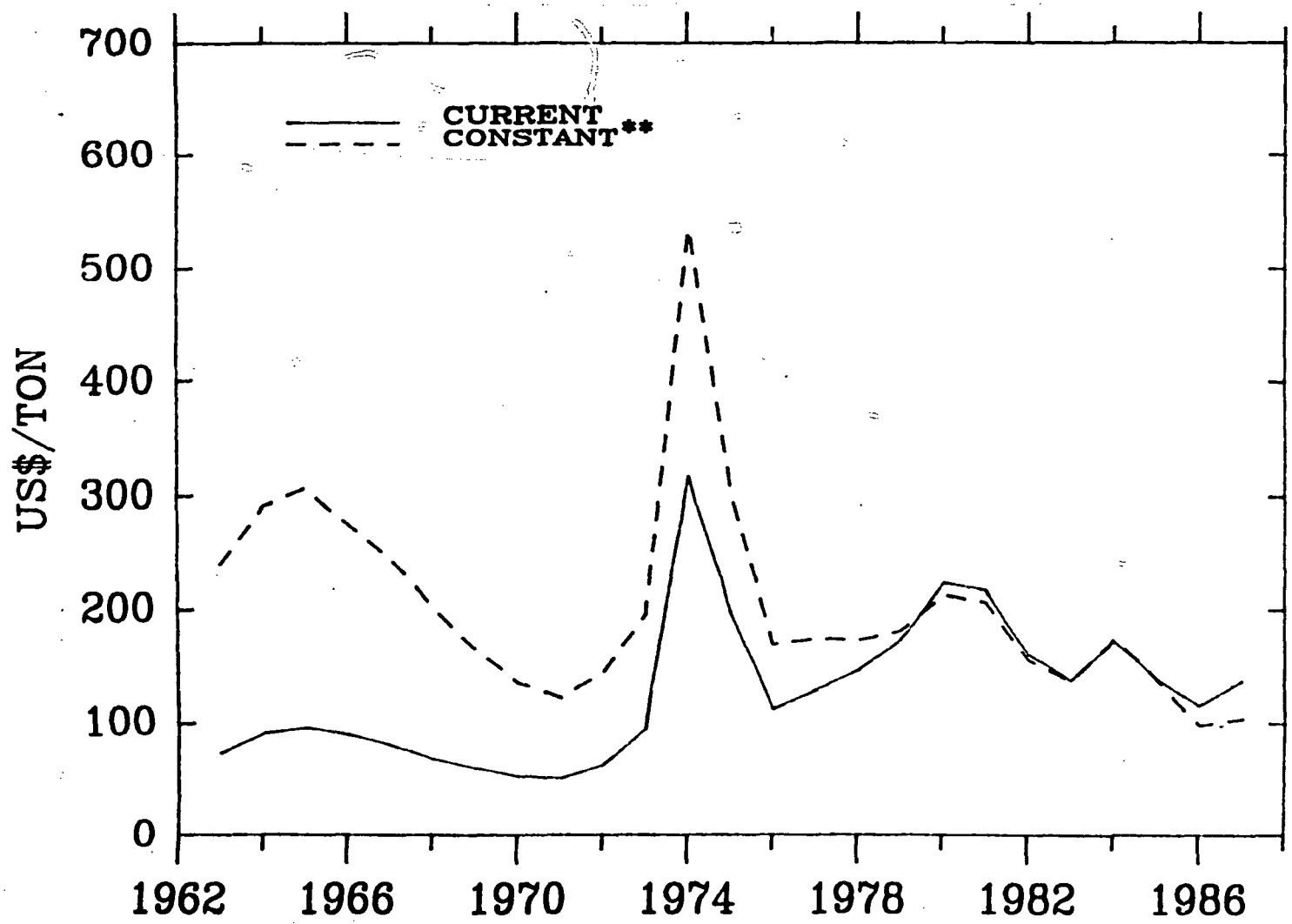
Year	Urea	TSP	DAP	MOP
	(%)			
1965	-	-	-	-
1966	-6.5	-	-	-6.8
1967	-11.2	-	-	-7.2
1968	-17.4	-19.1	-4.3	-5.9
1969	-14.5	2.6	-11.5	-8.3
1970	-13.8	9.0	-6.9	43.2
1971	-4.8	1.9	14.4	3.2
1972	28.9	55.9	47.2	3.0
1973	59.9	47.4	30.5	26.9
1974	233.1	205.1	180.0	42.4
1975	-37.3	-33.3	-89.6	34.3
1976	-43.4	-55.1	-50.6	-32.3
1977	13.8	7.7	10.8	-7.3
1978	13.7	0.1	5.1	10.6
1979	19.4	45.1	38.3	36.0
1980	28.5	26.8	15.3	50.8
1981	-2.7	-10.5	-12.2	-2.9
1982	-26.5	-14.2	-6.2	-27.4
1983	-14.7	-2.6	0.4	-7.7
1984	26.5	-2.5	3.1	11.1
1985	-20.4	-7.5	-10.6	0.4
1986	-15.6	7.1	-8.9	-13.1
1987	17.4	0.0	13.0	1.3
1988	9.6	20.7	12.6	17.6

a. Current prices.

Source: Derived from data in Table 7.2.

Figure 7.1

International Urea Prices, 1963-88*
(US $/Ton)



* Bagged N.W. Europe.
** 1985 US $.
Sources: World Bank/Green Markets

(Table 7.4). The increased crop prices enhanced fertilizer demand in both food-surplus and food-deficit countries. More important than these two factors was a psychological reaction to a perceived shortage of fertilizer. Consequently, some of the large importers increased their imports suddenly in a panic manner. The fact that urea prices dropped from $316/ton in 1974 to $112/ton in 1976 without any decrease in energy prices indicates that the psychological factor was more important than the supplyside or the demandside factors. Nevertheless, the increased energy costs left urea prices at a higher level than they were in the late 1960s. The second energy crisis and the commodity boom of the late 1970s put pressure on urea prices again. Consequently, urea prices increased from $112/ton in 1976 to $173/ton in 1979 and $222/ton in 1980. After 1980, urea prices decreased gradually to $135 in 1983. Both the increased supply and the decreased demand, especially in North America, seemed to have caused this decrease in prices. It is worth mentioning here that under the payment-in-kind (PIK) program, crop acreage was drastically reduced in the United States. This naturally reduced fertilizer demand. It should also be mentioned that the increased prices of the mid- and late 1970s induced increases in nitrogen capacity. Consequently, the increased supply was matched with decreased demand resulting from low crop prices and reduced acreage. As was indicated above, growth in fertilizer use was slowed down in North America, Western Europe, and Oceania. A sudden increase in price in 1984 was in response to increased demand in North America when cropped acreage increased under the removal of the PIK program. This was also the time when grain surpluses were mounting and crop prices started decreasing rapidly. Also, imports by Asia were reduced in response to stagnation in demand due to unfavorable weather. Thus, the low prices of the mid-1980s were a result of mostly demandside factors, although low energy prices and dumping (selling urea below operating costs) also induced these low prices. After 1986, prices started increasing again, more in response to increased demand both in North America and Asia.

The projected nitrogen supply-demand balances in Chapter 6 indicate that after 1990, the available supply will fall short of the projected demand. As fertilizer demand is projected to increase at a relatively higher rate (than that of the preceding few years) during the 1988-91 period, urea prices will continue to increase oward their economically viable levels. Because the 1990s will be a period of shortages, the long-run prices will be determined by the cost of supplying nitrogen from

Table 7.4. Global Crop Prices, 1965-88 (US $/ton)

Year	Rice[a]	% Change	Corn[b]	% Change	Wheat[c]	% Change
1965	136.3	-	55.0	-	65.9	-
1966	163.2	19.7	59.4	8.0	70.4	6.8
1967	205.8	26.1	49.9	-16.0	69.3	-1.6
1968	201.6	-2.0	49.1	-1.6	66.6	-3.9
1969	186.9	-7.3	53.9	9.8	64.2	-3.6
1970	144.0	-23.0	58.4	8.3	63.0	-1.9
1971	129.0	-10.4	58.4	-	63.9	1.4
1972	147.0	14.0	56.0	4.1	71.3	-11.6
1973	350.0	138.0	98.0	75.0	147.2	106.5
1974	542.0	55.9	132.0	34.7	208.7	41.8
1975	363.1	-33.0	119.6	-9.4	181.3	-13.1
1976	254.5	-30.0	112.4	-6.0	149.1	-17.8
1977	272.2	7.0	95.3	-15.2	115.8	-22.3
1978	365.5	34.3	100.7	5.7	134.8	16.4
1979	334.2	-8.6	115.5	14.7	172.4	-27.9
1980	433.9	29.8	125.3	8.5	191.8	11.3
1981	482.8	11.3	130.8	4.4	196.4	2.4
1982	292.9	-39.3	109.3	-16.4	166.5	-15.2
1983	276.9	-5.5	136.0	24.4	170.0	2.1
1984	252.1	-9.0	135.9	-	165.4	-2.7
1985	215.9	-14.4	112.2	-17.4	173.3	4.8
1986	211.0	-2.3	88.0	-21.6	161.0	-7.1
1987	230.1	9.1	76.0	-13.6	134.0	-16.8
1988	303.0	31.7	108.0	42.1	176.0	31.3

a. Thai 5% broken, f.o.b. Bangkok.
b. U.S. No. 2 Yellow, f.o.b. gulf.
c. Canadian No. 1 Western Red Spring in store, Thunder Bay.

Source: World Bank (1986) and personal communications with World Bank staff.

new plants. The buyer's reaction to these shortages will also play an important role in determining the actual prices in the markets. However, the buyer's reaction will not be as panicky as it was in the mid-1970s for several reasons. First, energy prices are not projected to increase as rapidly as they did in the 1970s. Second, the global food production base and the food production base of the developing countries will be much wider in the 1990s than it was in the mid-1970s.[40] Third, many fertilizer manufacturers have planned capacities on the shelf; as most of these plans (probable capacities) include addition of another large-scale ammonia-urea plant at the existing site, the gestation period (or time lag) involved in bringing another plant onstream will be shorter than it was in the 1970s. Fourth, many countries have possibilities of and are working on increasing capacity utilization of the existing plants. As we indicated earlier, the increased capacity utilization can eliminate some of the shortages of the early 1990s. Fifth, there is an uncertainty about the crop pricing policies of North America and Western Europe, as well as the fertilizer pricing policies of many developing countries, especially those who are heavily subsidizing their fertilizer use and crop production and exports. Sixth, the buyers and sellers are better informed now than they were in the mid-1970s. Hence, the psychological factor will play a smaller role in the 1990s than in the 1970s.

All these factors will work towards producing a stable pricing environment for nitrogen fertilizers, and therefore urea prices of the 1990s will be reflective of the long-run cost of production.

TSP

Figure 7.2 indicates trends in TSP prices during the 1967-87 period. Both current and constant prices are indicated, and changes in both are qualitatively in the same direction.

While urea prices show a cycle of 3 to 4 years, TSP prices show less cyclical fluctuations. For example, after decreasing by 19% in 1968, TSP prices continued to increase gradually during the 1968-73 period and jumped by more than 200% in 1974. This sudden jump was followed by quick decreases in 1975 and 1976. However, during the 1976-80 period, prices continued to increase. After 1980, TSP prices followed a downward path until 1986 when they increased by about 7%. Thus, while most of the 1970s (except 1975 and

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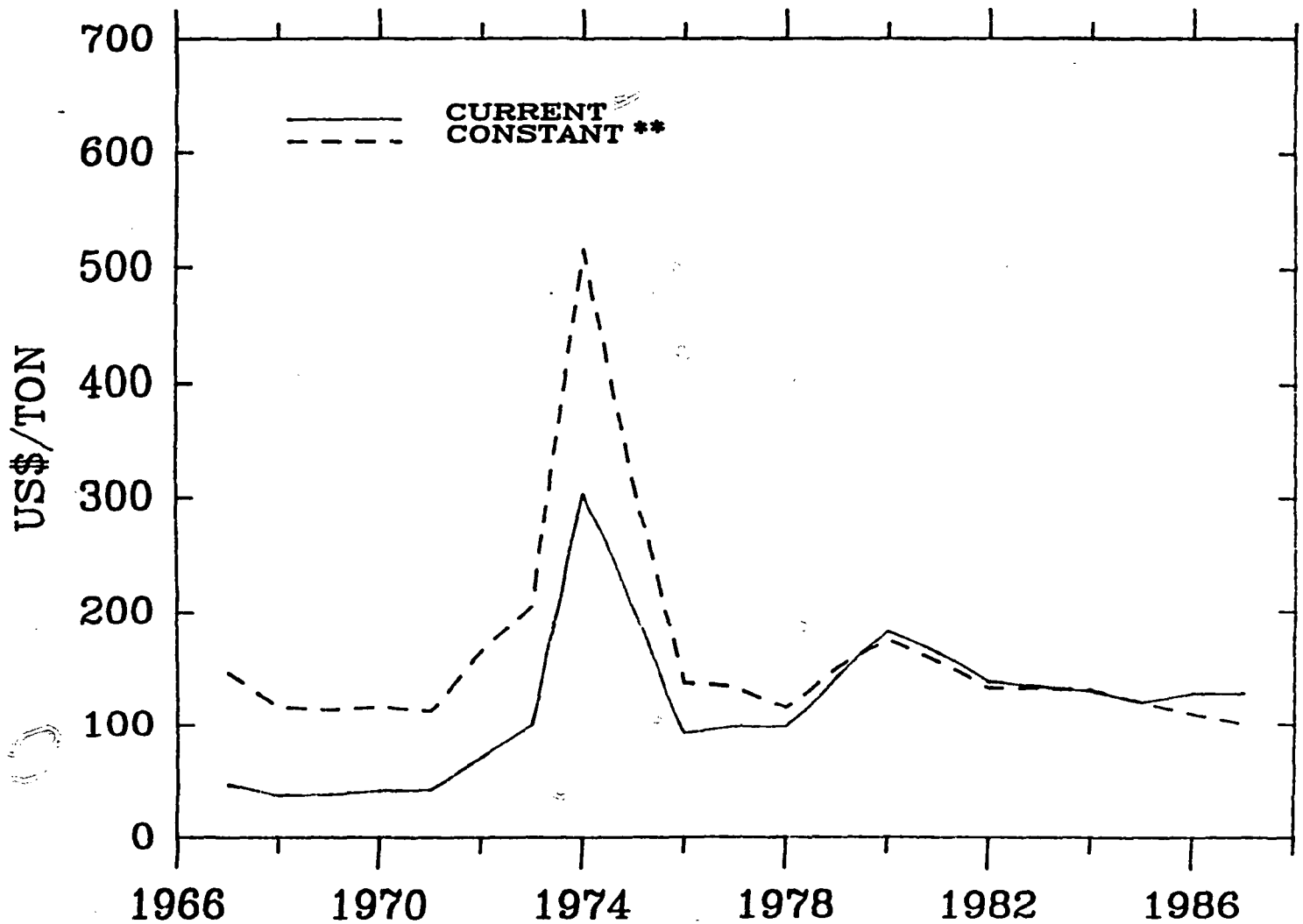
40. See FAO (1987) for details.

Figure 7.2

International TSP Prices, 1967-88
(US $/Ton)*



* Bulk f.o.b. Florida.
** 1985 US $.
Source: World Bank/Green Markets

1976) saw continuous increases in TSP prices, most of the 1980s saw continuous declines. These relatively long cycles of TSP price changes may be due to several factors. First, compared with nitrogen production, TSP production is less dependent on energy inputs. Hence, the flunctuations in energy cost are less reflected in TSP prices. Second, phosphate rock prices fluctuated less violently during this period than did energy prices. Phosphate rock price stability produces stability in TSP prices. Third, the demand for phosphate fertilizers has been growing slowly because of low crop prices and residual phosphorus in the soil. Hence, the demandside factors did not cause much fluctuation.

The growing demand of the late 1960s and 1970s kept TSP prices at the higher level. However, very slow growth at the global level and declines in phosphate use in North America, Western Europe, and Oceania in the 1980s created excess supplies in the world markets. Thus, the slow growth in demand and the surplus capacity and production are responsible for this downward trend in TSP prices in the 1980s.

As indicated above, during the 1988-93 period phosphate supply potential will exceed the projected demand, and TSP prices may not increase as rapidly as urea prices. However, relatively higher growth projected in phosphate demand during the forecast period will definitely pull TSP prices up from their depressed levels of the mid-1980s. By the mid-1990s the situation will be tight, and therefore the long-run price will be determined by the cost of TSP from a new plant, and by the reactions of buyers and sellers.

Again, a rapid increase in TSP prices is not expected for the same reasons that were mentioned for urea prices with one exception. It was indicated in Chapter 2 that phosphate demand is relatively more price elastic than nitrogen demand. Hence, if crop prices in North America and Western Europe decrease and fertilizer prices in developing countries increase because of removal of farm and fertilizer subsidies, then TSP prices may remain below their economically viable levels because of the continued existence of excess production over realizable demand.

DAP

Figure 7.3 indicates current and constant DAP prices. A comparison of changes in DAP prices with changes in urea and TSP prices indicates that changes in DAP prices are reflective of changes in both urea prices and TSP prices. This is so because DAP contains both N and P_2O_5. The relative stability of phosphate prices neutralizes the wide fluctuations in N prices. Nevertheless, DAP prices appear to have followed the cycle of urea prices although the N content of DAP is only about 40% of the P_2O_5 content of DAP.

Like urea prices, DAP prices also peaked in 1974, 1980, and 1984 and troughed in 1970, 1976, 1982, and 1986. The peak in 1974 was mostly due to the energy crisis and to panic buying. Likewise, an increase in prices in 1980 also occurred due to increased energy costs in 1978/79 as well as increased demand. However, after 1980 a slowdown in demand was responsible for a decrease in prices. If we exclude the 1984 increase in DAP price due to increased crop acreage in North America, DAP prices followed the same path as TSP prices because they both continued their downward slide in response to declining P_2O_5 demand in North America and Western Europe.

In absolute amounts, DAP prices increased from $54/ton in 1970 to $332/ton in 1974 but dropped to $120/ton in 1976. After 1976, DAP prices continued their upward trend until 1980 when they reached $222/ton. However, after 1980 they continuously declined during the 1980s (except 1984). In 1986 they averaged $154/ton. Increased demand in 1987 and 1988 is putting upward pressure on DAP prices.

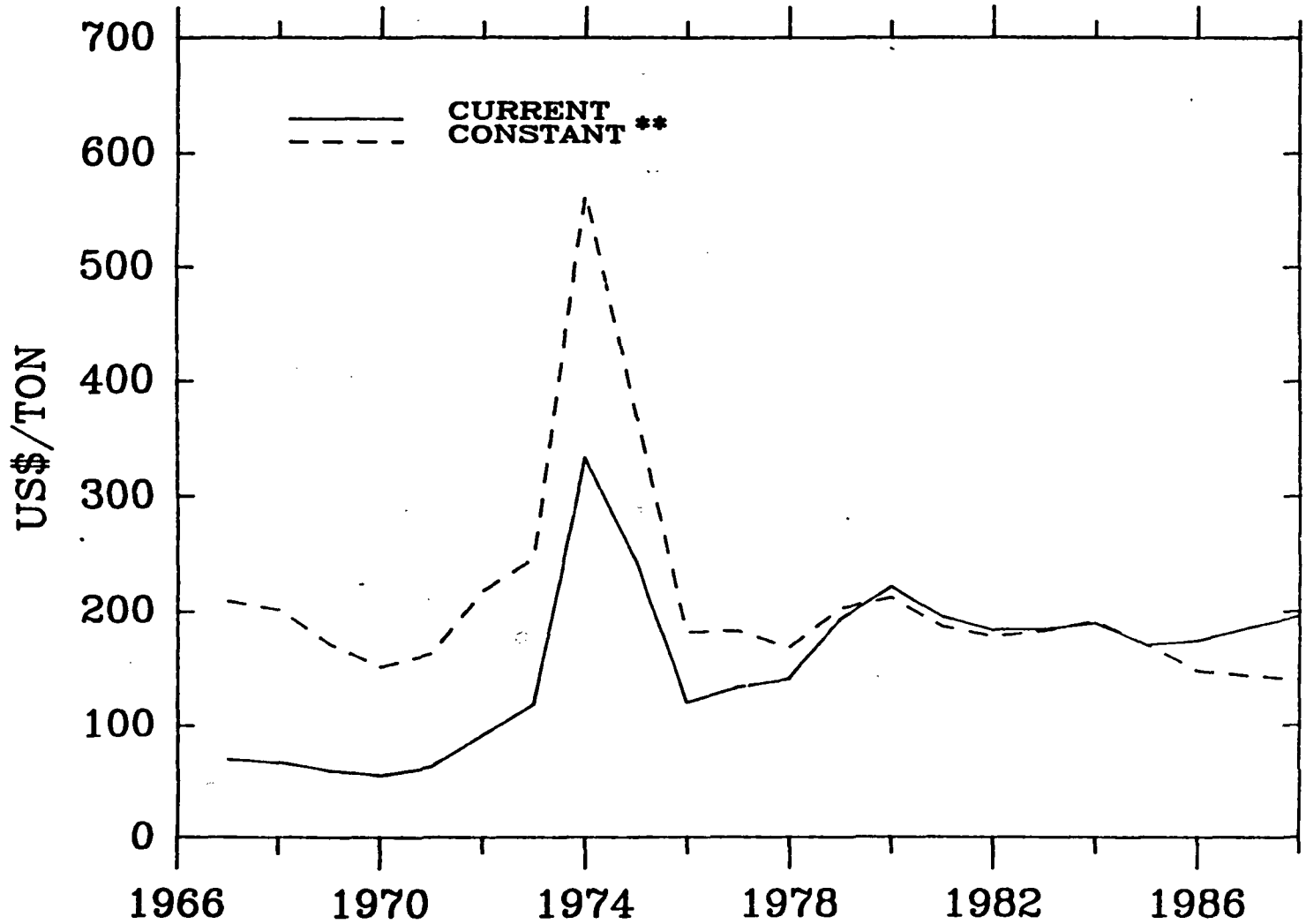
Because both urea and TSP prices are projected to grow in response to the supplyside and the demandside factors during the 1988-95 period, DAP price is also expected to move towards its economically viable level. However, the realized annual price will depend not only on the demandside and the supplyside factors, but also on the reactions of the buyers and suppliers to the perceived shortages and surpluses in N and P_2O_5 markets.

MOP

Figure 7.4 indicates current and constant potash (MOP) prices during the 1965-87 period. Like TSP prices, potash prices also seem to follow a long cycle of unidirectional change. Having decreased continuously during the 1965-69 period, MOP prices increased in 1970 by 43% and continued their upward trend until 1975, when they reached $81.3/ton from $22/ton in 1969.

Figure 7.3

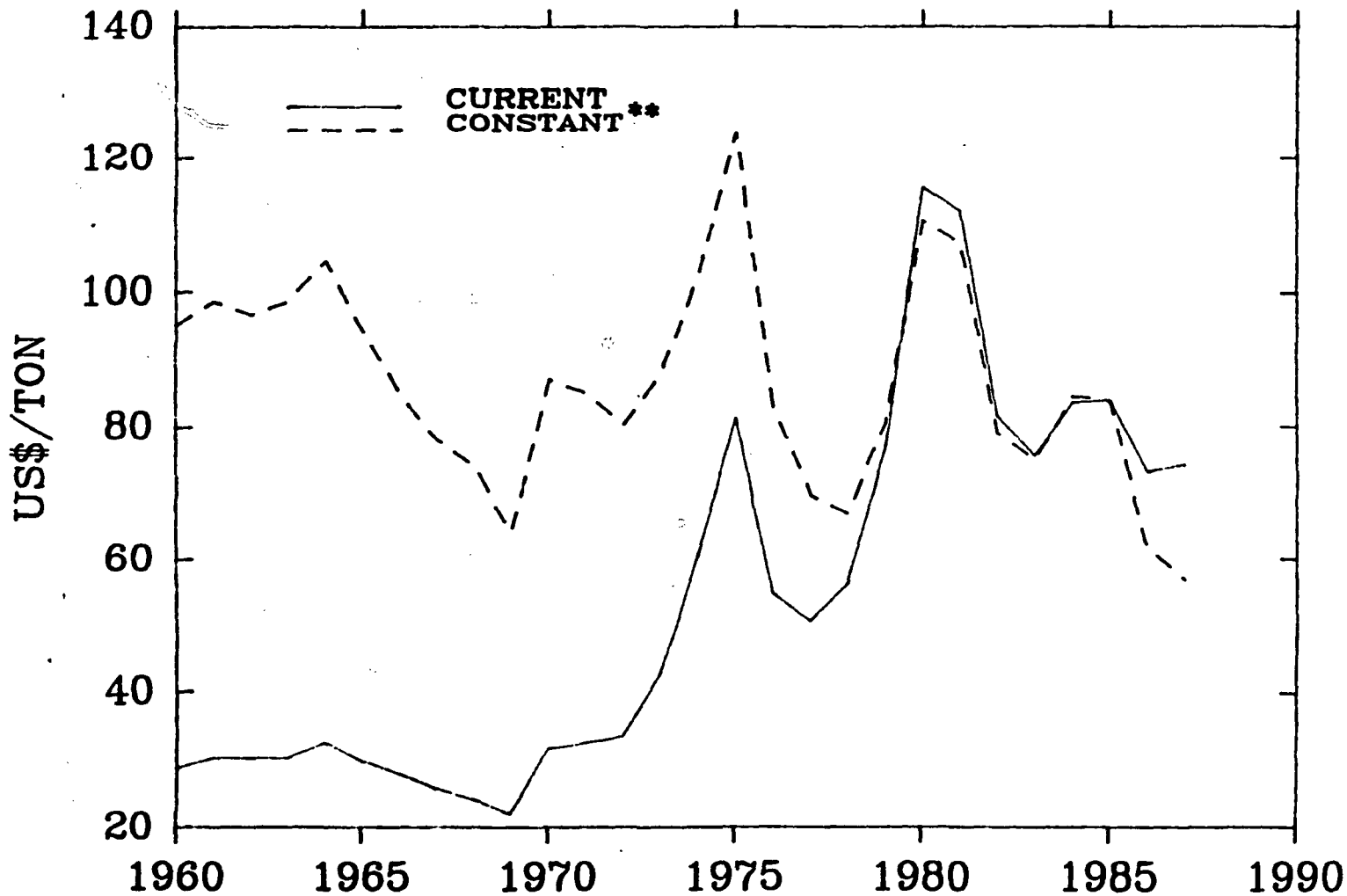
International DAP Prices, 1967-88
(US $/Ton)*



* Bulk f.o.b. Florida.
** 1985 US $.
Source: World Bank/Green Markets.

Figure 7.4

International MOP Prices, 1960-88
(US $/Ton)*



* Bulk f.o.b. Vancouver.
** 1985 US $.

After having decreased by 32% and 7% in 1976 and 1977, respectively, MOP prices increased by 11%, 36%, and 51% during the following 3 years. In 1980 they climaxed to their all time high of $115.7/ton. The increase in MOP prices in the late 1970s was mostly due to increased potash demand both globally and regionally. After 1980 MOP prices, like prices of urea, TSP, and DAP, also decreased until 1984. Slow growth in world demand and decrease in potash use in North America and Western Europe seemed to have produced these depressed prices. Excess supply in the wake of decreasing demand in North America also reduced MOP prices. Although potash production is heavily concentrated in North America and the U.S.S.R., the near monopoly of these regions had little influence on MOP prices in the face of declining potash demand in North America and slowly rising demand in Asia, Africa, and Latin America. Increased acreage and higher crop prices in North America in 1984 stimulated potash demand and therefore caused 11% increase in MOP prices. However, MOP prices dropped again in 1986 as global potash use dropped.[41]

The potash supply-demand balances described in Chapter 6 indicate that potash supplies will continue to dominate the projected demand during the 1988-95 period. Thus, the potash situation will be a situation of excess supply. However, because demand is projected to increase faster during the forecast period (compared with the 1980-87 period) and because the improved micro and macroeconomic situation is expected to exert upward pressure, potash prices will increase towards their economically viable level.

Although changes in fertilizer prices alone have less influence on fertilizer demand, high increases in MOP price can affect potash use in Asian, African, and Latin American countries because of foreign exchange required in importing potash fertilizers. In the late 1990s, potash demand may exceed the supply potential of the existing and the currently planned mining capacity. During that period, the increased costs of mining new ore bodies will play an important role in determining potash prices.

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41. See Chapter 2, pp. 23-24.

PART III

FOOD SECURITY AND FERTILIZER USE

Chapter 8. Food Security and Fertilizer Use

CHAPTER 8

FOOD SECURITY AND FERTILIZER USE

Because of droughts in India in 1987 and in the United States and China in 1988, world grain stocks are estimated to have decreased from 459 million tons in 1986 to about 250 million tons in 1988. This decrease in world grain stocks has caused some concern about global food security.[42] However, the availabilities of food grains at the regional level in the developing world will continue to mean food insecurity for many people in the 1990s and beyond. Hence, this chapter focuses on the key role that fertilizer use can play in enhancing food security at the regional level. Ideally, one should assess food security at the national and household levels, but because of paucity of data as well as the nature and scope of this study, only those issues related to regional food security are analyzed here.

Four broad issues discussed in this chapter are:

1. The paradox of hunger and malnutrition and excessive grain stocks.
2. Population growth, food production, and fertilizer use.
3. Fertilizer requirements and fertilizer demand.
4. Potential for fertilizer use.

The Paradox of Hunger and Malnutrition and Excessive Grain Stocks

During the mid-1980s, despite mounting food surpluses worldwide, hunger and malnutrition still persisted. An estimated 730 million people suffered from hunger and malnutrition in the developing countries, while the world stocks of cereals, mostly in North America and Western Europe, were excessive at 430 million tons.

The paradox of hunger and malnutrition and excessive grain stocks was caused by several factors. First, most of the food surpluses were in the developed countries while hunger and malnutrition plagued the developing countries in Africa, Asia, and Latin America. Thus, there was a geographical imbalance in supply of and demand for food grains. Second, the developing countries, where hunger and malnutrition prevail, had limited capacity to import food because of their debt crises and foreign exchange shortages.

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42. See Brown (1988).

Third, even in those countries that had the capacity to import food grains, poverty prevented many people from buying the necessary food to maintain healthy and productive lives.

One approach often used to alleviate the situation of food abundance on the one hand and hunger and malnutrition on the other is to provide emergency food aid. But emergency food aid is a precarious and ineffective way to provide enduring food security to the food-deficit countries because (a) it is induced by surplus and therefore is unstable and unpredictable, (b) it creates a burden on the taxpayers of the donor countries, and (c) particularly important, it discourages production and reduces income and employment opportunities in the recipient countries.

Another approach is to increase the import capacity of the food-deficit countries by developing their export potential. Although there is some scope for expanding the export potential of the developing countries, the foreign exchange needs of these countries outweigh their potential earnings. Moreover, even if these countries have sufficient foreign exchange to import food grains, the most needy, generally those in the rural areas, lack the financial means to purchase the imported food grains. When the countries with untapped agricultural potential import food grains, their agricultural and rural populations are deprived of opportunities for employment and income; it can then be said that those countries import unemployment.[43]

A third and a more effective approach in resolving the paradox of food surplus in some countries and hunger and malnutrition in others is to increase food production in food-deficit countries and decrease it in food-surplus countries. Compared with emergency food aid and food imports, this approach has at least three advantages. First, because food is produced where it is needed, time and resources are saved in transporting food from one country or region to another. Secondly, it provides greater social and political stability because of increased employment and adequate food supply. Finally, it can assist the developed countries in preserving their environments by reducing the amount of fertilizers and pesticides used in intensive cultivation of land for surplus food production. Because of low levels of fertilizer use in many developing countries, an increase in food

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43. See the World Commission on Environment and Development (1987).

production through the increased and prudent use of fertilizers is unlikely to pose any serious problem to the environment of such developing countries.

In order to shift the focus of food production from surplus to deficit countries, several integrated changes in policies and programs related to agriculture and rural development are required. For example, investment in rural infrastructure and manpower should be provided; irrigation development and the use of improved crop varieties should be promoted; fertilizer use should be increased; and incentive prices for farm products should be provided. Of all these factors, the one that can most significantly contribute to an increase in food production in the short run, as well as in the long run, is increased fertilizer use because a ton of fertilizer nutrients can add 5 to 10 tons of food grains depending on agroecological conditions.[44]

The contribution of fertilizers to food security is very well illustrated by the experience of India. In 1965/66, India produced about 72 million tons of food grains and imported about 10 million tons. In 1985/86, India produced about 150 million tons of food grains and had about 30 million tons of stocks. Food production was nearly doubled in 20 years through the widespread use of improved crop varieties, expanded irrigation, and accelerated fertilizer use. During the last 20 years (1966-86), fertilizer use in India increased from 785,000 tons in 1965/66 to 8,737,000 tons in 1985/86, an elevenfold increase.

Likewise, in Indonesia and the Philippines, the increased use of fertilizers has significantly contributed to increased food security by promoting domestic food production. Both countries were rice importers in the 1970s but are now nearly self-sufficient. Because of the lower cost of domestic food production (as compared to food imports), these countries have achieved national food security at less than half the cost of food imports.

While the accelerated growth in fertilizer use helped India, Indonesia, and the Philippines achieve food self-sufficiency and thereby food security, the slow growth in fertilizer use required for increasing food production to feed the growing population in sub-Saharan Africa is associated with the transformation of sub-Saharan Africa from a food-surplus region in the late 1960s to a food-deficit one in the mid-1980s.[45] Increased food

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44. See Baanante, Bumb, and Thompson (1989).

45. See FAO (1987, p. 77).

security for sub-Saharan Africa requires changes in policies and programs in the agricultural sector coupled with substantial increases in fertilizer use.

Population Growth, Food Production, and Fertilizer Use

Population Growth

The United Nations' population projections indicate that world population will increase from 4.8 billion in 1985 to 6.1 billion in 2000.[46] A little more than 90% of this increase is expected to occur in the developing countries. Thus, the population of the developing countries will increase from 3.6 billion in 1985 to 4.8 billion in 2000, an annual increase of 1.9%. This increase in population along with the expected increases in per capita income will make the demand for food and other agricultural products expand at an annual rate of 3.1%. The experience of the last 25 years (1961-85) indicates that agricultural production can be increased to meet this expansion in demand provided proper policies and programs are adopted by both the developed and the developing countries.[47]

Food Production

Worldwide production of cereals, the most important staple foods in developing countries, increased from 1,390 million tons in 1961-63 to 2,345 million tons in 1983-85, an annual increase of 2.4% (Table 8.1). Of the total increase of 955 million tons, about two-thirds was in the developing countries. As food production increased at a higher annual rate in the developing countries, the share of these countries in global food production increased from 46% in the early 1960s to 54% in the mid-1980s.

Among cereals and root crops, world production of cereals increased at a higher rate (2.9%) than that of root crops (1.0%). Likewise, production of cereals and root crops increased at a higher rate in the developing countries than in the developed countries. Consequently, the shares of the developing countries in both food groups increased from 46%-47% in 1961-63 to 52%-63% in 1983-85.

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46. See UNESCO (1987, pp. 1.12-13).

47. See FAO (1987) and World Commission on Environment and Development (1987).

Table 8.1. Global Food Production, 1961-63 and 1983-85[a]

Region	1961-63 Million Tons	1961-63 %	1983-85 Million Tons	1983-85 %	Annual Growth Rate (%)
A. Cereals					
Developed	505	54	851	48	2.4
Developing	422	46	914	52	3.5
World	927	100	1,765	100	2.9
B. Root Crops					
Developed	244	53	216	37	-0.6
Developing	219	47	364	63	2.3
World	463	100	580	100	1.0
C. Total (Cereals + Root Crops)					
Developed	749	54	1,067	46	1.6
Developing	641	46	1,278	54	3.1
World	1,390	100	2,345	100	2.4

Source: Derived from data in FAO Production Yearbooks. Various Issues.

Because of higher growth in food production in the developing countries and increased imports, especially by the oil-rich countries, per capita daily food availability increased from 1,960 calories in 1961-63 to 2,420 calories in 1983-85, an increase of about 23%. In the year 2000, food availabilities are estimated to reach 2,620 calories in the developing countries. The regional variations in the past, present, and future food availabilities are indicated in Table 8.2. These data clearly indicate that, except for sub-Saharan Africa, food availabilities for all regions increased by substantial amounts in the past and are projected to show significant increases in the future. Sub-Saharan Africa saw little growth in food availabilities in the past and is expected to experience only a modest increase (7%) in the year 2000.

These estimates of food availabilities in the year 2000 have been derived by FAO by estimating the agroecological and technical potential and input supply possibilities for crop production and the capacity to import food grains at the regional and country levels. Thus, a shortfall in crop production or grain imports or both may result in lower food availabilities for the populations of the developing countries in the year 2000.

Fertilizer Use and Food Production

The growth in food production was a result of increases in both harvested area and productivity (crop yields or crop output per hectare). FAO estimates indicate that about one-third of the increase in crop production was due to increases in harvested area and about two-thirds was due to increases in crop yields. Notable among the crops whose yields increased were rice and wheat. During the 1969-71 to 1983-85 period, wheat yield increased by 70% and rice by 41%. Yields of other cereals such as corn, barley, millet, and sorghum also increased appreciably (Table 8.3).

Several factors such as improved crop varieties, expanded irrigation, better farm practices, and increased use of fertilizers contributed to these historically "phenomenal" increases in crop yields. However, the increased use of fertilizers is credited with contributing the most to such increases. To quote FAO:

Table 8.2. Food Availabilities, 1961-63, 1983-85, and 2000

Region	1961-63	1983-85	2000
	(kcal/capita/day)		
Sub-Saharan Africa	2,050	2,050	2,190
Near East/North Africa[a]	2,220	2,980	3,100
Latin America	2,380	2,700	2,910
Southeast Asia[a]	1,860	2,380	2,610
Developing Countries	1,960	2,420	2,620

a. See Annex A, Part II for the countries included in these regions.

Source: FAO (1987, p. 7 & 27).

Table 8.3. Yields of Major Crops in Developing Countries, 1961-63 and 1982-84

Crop	1961-63	1982-84	Percent Change
	- - - - (tons/ha)	- - - -	
Wheat	1.0	1.7	70
Rice (Paddy)	1.7	2.4	41
Maize	1.1	1.6	45
Barley	1.0	1.2	20
Millet	0.5	0.6	20
Sorghum	0.7	0.9	29
Cassava	7.7	9.2	19
Sugarcane	45.7	57.4	26
Soybeans	0.7	1.6	128
Groundnuts	0.8	0.9	13
Coffee	0.4	0.5	25
Cotton (Seed)	0.7	0.8	14

Source: FAO (1987, page 120).

> A tremendous increase in fertilizer usage - a tenfold increase in developing countries and a doubling in developed market economies between 1961/63 and 1983/85 - was possibly the most potent single factor in raising productivity.[48]

Yield increases will continue to play an important role in meeting the growing demand for food production in the future because the arable land area available for the expansion of agriculture is severely limited. In Asia, about 80% of the arable land area is now under cultivation. Although there is potential for expanding the area of cultivated land in Africa and Latin America, the soils in these areas are often poor in quality, and expanded cultivation may endanger ecologically fragile areas, such as tropical forests. Hence, increasing food production through intensive agriculture will be essential in order to satisfy future food requirements of developing countries.

FAO estimates indicate that during the 1985-2000 period, yield increases will continue to be the source of two-thirds of the increase in crop output; the increases in crop area will provide the remaining one-third. Figure 8.1 indicates that at the regional level, the contribution of yield increases will vary between 49% in Latin America and 77% in Near East/North Africa.[49]

In order to achieve the projected increases in crop output through increases in both yield and harvested area, FAO estimated that fertilizer use in developing countries (excluding China) should double during the 1985-2000 period. That is, fertilizer use should increase at an annual rate of 4.7% from 25.8 million tons in 1984 to 56.0 million tons in 2000. Among different regions, fertilizer use should grow at 6.4% in sub-Saharan Africa, 4.3% in Southeast Asia, 4.6% in Latin America, and 5.4% in Near East/North Africa (Table 8.4). Any shortfall in achieving these increases in fertilizer use may result in slower growth in crop output and therefore less food for the rapidly increasing populations of the developing countries, unless the shortfalls in domestic crop output are compensated by an increase in imports from the developed regions.

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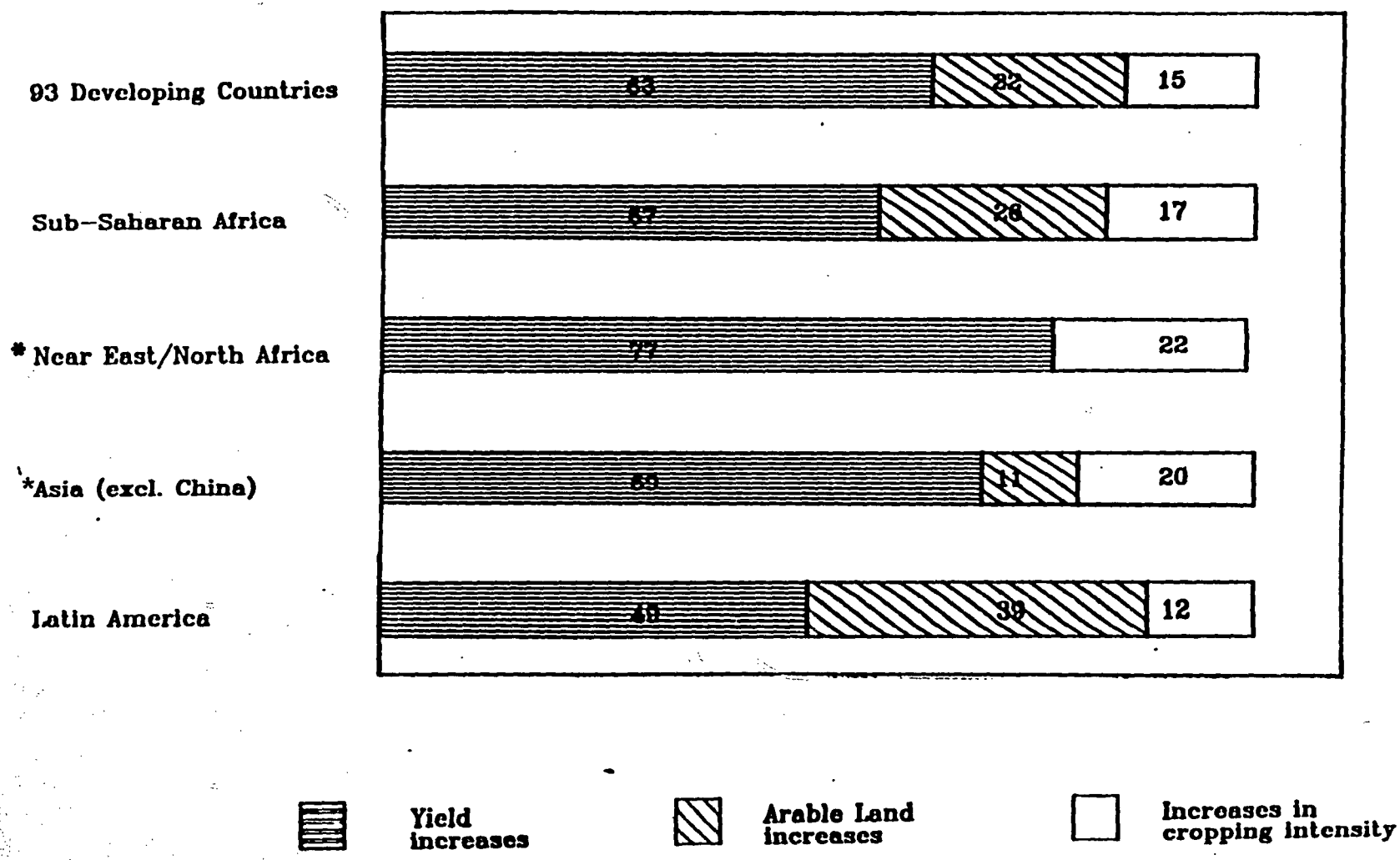
48. FAO (1987, p. 17).

49. See Appendix A, Part II for the countries included in Near East/North Africa and Southeast Asia.

Figure 8.1

EXPECTED PERCENT CONTRIBUTIONS OF YIELD, LAND AND CROP INTENSITY TO CROP PRODUCTION INCREASES

(1962–84 – 2000)



*See Appendix A, Part II for the regional classification used here.

Table 8.4. Fertilizer Requirements Versus Effective Demand: Projected Annual Growth Rates, 1985-2000

Region[a]	Required Growth[b] (%)	Projected Growth[c] (%)
Sub-Saharan Africa	6.4	4.2
Near East/North Africa	5.4	4.6
Latin America	4.6	3.1
Southeast Asia	4.3	4.8

a. As some of these regions are different from those used in the rest of this study, see Appendix A, Part II for details.
b. FAO (1987, p. 135).
c. This study. Chapter 4.

Fertilizer Requirements and Fertilizer Demand

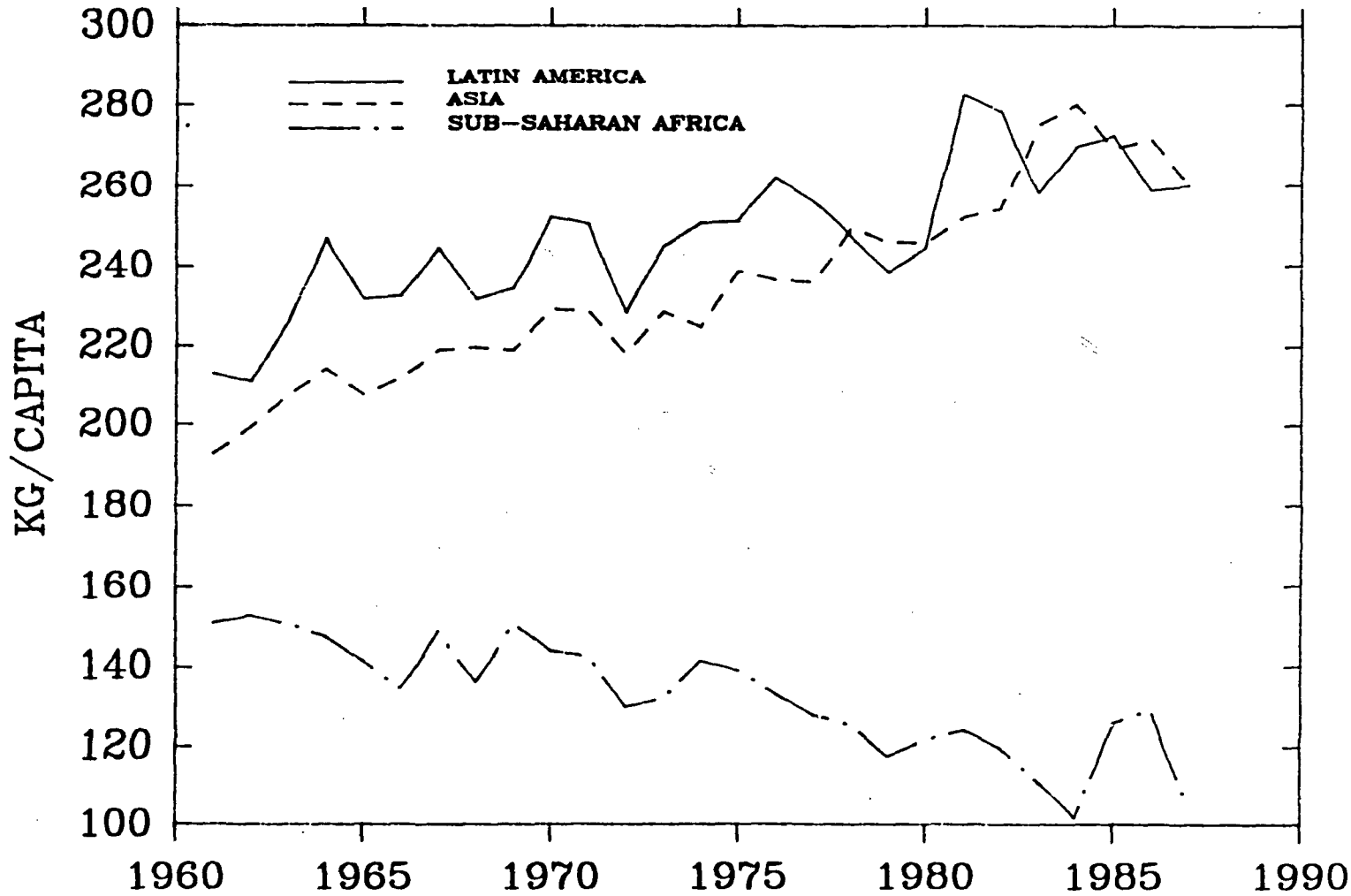
Table 8.4 presents data on the annual growth in fertilizer use required to meet FAO's estimates of crop output and food availability and the annual growth in fertilizer use projected in this study (Chapter 4). Two changes have been made in order to make the projections of this study comparable with FAO's estimates of fertilizer requirements. First, it is assumed that fertilizer use during the 1995-2000 period will grow at the same annual rate as that projected for the 1987-95 period. Second, as FAO's estimates for fertilizer requirements are not available at the country level, the demand projections developed in this study were regrouped to correspond to the countries in FAO regional classifications. FAO regional classification is given in Appendix A, Part II.

A comparison of the required and the projected annual growth in fertilizer use at the regional level indicates that only in Southeast Asia is the projected annual growth in fertilizer use higher than the required annual growth in fertilizer use for projected crop output. In the other three regions, namely, sub-Saharan Africa, Near East/North Africa, and Latin America, the projected annual growth is significantly lower than the required annual growth; the maximum shortfall is for sub-Saharan Africa and the minimum for Near East/North Africa.

In sub-Saharan Africa, the projected annual growth is 4.2%, as against the required annual growth of 6.4%, or 2.2 percentage points lower. This shortfall in the required growth in fertilizer use implies that sub-Saharan Africa may not experience the projected 7% increase in food availabilities--from 2,050 calories in 1983/85 to 2,190 calories in 2000. This is disturbing for three reasons. First, during the last quarter of a century (1961/63 to 1983-85), sub-Saharan Africa experienced little increase in food availabilities (Table 8.2). Second, per capita grain production in the region had been declining since the early 1970s (Figure 8.2). Third, the nutrition levels of sub-Saharan Africa (in 1983-85) were the lowest of all the three regions; the average calorie intake in sub-Saharan Africa was 2,050 as against 2,380 in Asia, 2,700 in Latin America, and 2,980 in Near East/North Africa.

Unless programs and policies are implemented to increase food production through increased fertilizer use and other previously noted measures, nutrition levels in sub-Saharan Africa in the year 2000 may not be

CEREAL PRODUCTION PER CAPITA
1961–1987



significantly different from those in the mid-1980s, or even from those in the early 1960s.

Although Near East/North Africa will also experience a shortfall in the growth of fertilizer use, the impact of this shortfall on food availabilities may not be as severe for this region as it may be for sub-Saharan Africa for several reasons. First, the existing nutritional intake is already high at 2,980 calories. Second, as many countries in this region have substantial potential for exports and foreign exchange earnings, this region's capacity to import food grains is higher than that of sub-Saharan Africa. Third, the shortfall in fertilizer use growth is of a small magnitude, less than 1 percentage point.

Like Near East/North Africa, Latin America will also experience a shortfall in required fertilizer use growth. Consequently, the food availabilities in Latin America could be less than the 2,910 calories (in the year 2000) estimated by FAO, unless these shortfalls are compensated by the increased food imports. The declining trend in grain production per capita (Figure 8.2) and the slow growth in fertilizer use in Latin America during the 1980s further indicate that serious efforts will be required to increase fertilizer use in order to reverse the declining trend in grain production and thereby increase food availabilities.

Unlike the other three regions, Southeast Asia will experience higher annual growth in fertilizer use than that estimated by FAO for food availability purposes (4.8% versus 4.3%). If the projected growth rates are realized, Asia may enjoy higher per capita availabilities of calories than those estimated by FAO for the year 2000. With the projected annual growth in fertilizer use falling short of the required annual growth in Latin America and Near East/North Africa, there is a possibility that Asia's nutritional levels (average calorie intakes) in the year 2000 may not be significantly different from those of Latin America and Near East/North Africa (Table 8.2). However, the realization of the projected annual growth for Asia will critically depend on price and policy stability as well as a continuation of the governmental commitment which facilitated high growth in fertilizer use in the 1980s.

Potential for Fertilizer Use

Data on fertilizer use per capita and per hectare at the regional level are shown in Table 8.5 and Figure 8.3. Figure 8.3 also contains three lines, namely, OA, OB, and OC indicating α (cultivated land per capita in hectares) and β (persons per hectare of cultivated land).[50] For example, line OB indicates that the regions that lie on or below this line have five or more persons per hectare of cultivated land. Likewise, the regions that lie on or above line OC have one or less than one person per hectare of cultivated land. The regions lying in between these two lines (OB and OC) have between one and five persons per hectare. Higher population pressure on land would indicate a higher need to use fertilizers to extract more crop output from a given amount of land.

Taking 100 kg/ha and 50 kg/capita as a reference point (Point D in Figure 8.3), the regions in Figure 8.3 can be divided into two broad groups, namely, high fertilizer-using regions (HFUR) and low fertilizer-using regions (LFUR). The high fertilizer-using regions lie above and to the right of point D, and the low fertilizer-using regions lie below and to the left of point D. The high fertilizer-using regions are Eastern Europe, Western Europe, North America, the U.S.S.R., and Oceania, while the low fertilizer-using regions are Asia, Africa, and Latin America. All subregions in these regions are also low fertilizer-using regions.

Before the variations in fertilizer use levels among regions and subregions in each group are analyzed, a few observations about fertilizer use levels in different regions are warranted.

First, although many subregions in the low fertilizer-using group have higher population pressures than regions in the high fertilizer-using group, per capita fertilizer use levels are rather low. For example, East Asia's population density was more than twice the population density of Eastern Europe, but its per capita fertilizer use was less than one-fourth of that in Eastern Europe. Likewise, sub-Saharan Africa's population density was as high as West Asia's but its per capita fertilizer use was only one-tenth of West Asia's. Thus, population pressure per se has little influence on

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50. $\beta = 1/\alpha$. α = slope of a line through origin = $\frac{\text{fert. use per capita}}{\text{fert. use per hectare}}$.

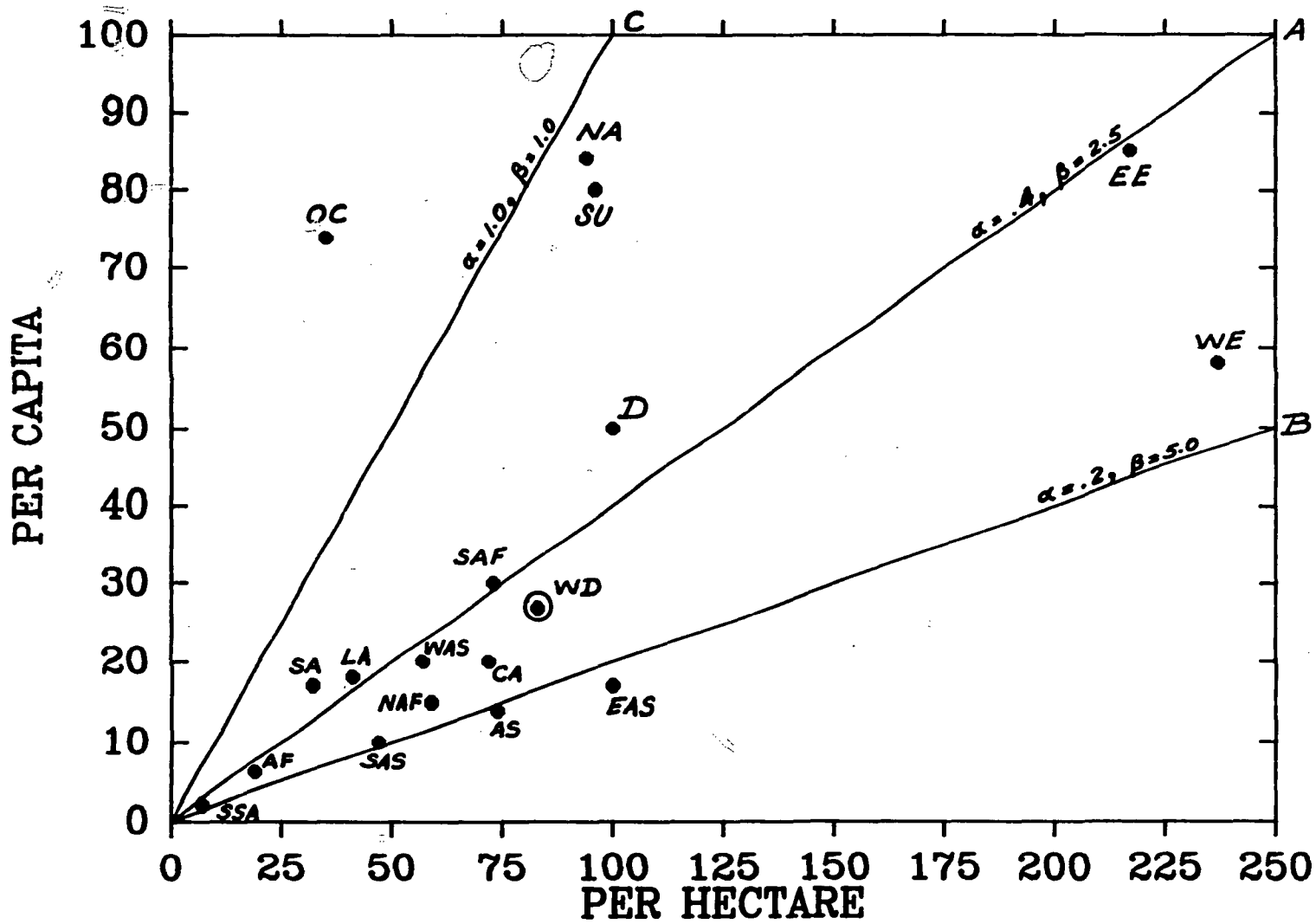
Table 8.5. Per Capita and Per Hectare Fertilizer Use, 1985

Region	Per Hectare (kg)	Per Capita (kg)
North America	94	84
Western Europe	237	58
Eastern Europe	217	85
U.S.S.R.	96	80
Oceania	35	74
Africa	19	6
North Africa	59	15
Sub-Saharan Africa	7	2
South Africa	73	30
Latin America	41	18
Central America	72	20
South America	32	17
Asia	74	14
East Asia	100	17
South Asia	47	10
West Asia	57	20
WORLD	83	27

Source: Derived from FAO data. Fertilizer Yearbook, 1986.

Figure 8.3

PER HECTARE AND PER CAPITA FERTILIZER USE: ALL REGIONS, 1985 (kg)



fertilizer use, unless it is accompanied by programs and policies to promote fertilizer use.

Second, although population pressures indicate the need to use fertilizers to produce food and fiber for a growing population, these needs may not be translated into actual fertilizer use because of agronomic and environmental constraints. For example, East Asia and North America had nearly identical levels of per hectare fertilizer use in the mid-1980s, yet the per capita fertilizer use in East Asia was less than one-fourth of that in North America (20 versus 84). Whether East Asia can achieve North America's per capita fertilizer use levels without endangering its ecological and environmental resource base needs further research, because 80 kg/capita fertilizer use in 1985 in East Asia would imply 400 kg/ha. This indicates that, as scope for further increase in per hectare fertilizer use becomes limited, East Asia may increasingly depend on food and fiber imports to meet its domestic requirements.

High Fertilizer-Using Regions

On the basis of per hectare fertilizer use, Eastern Europe and Western Europe dominate the other three regions. These two regions used more than 200 kg of fertilizer nutrients per hectare of cultivated land in 1985. Fertilizer use per hectare in North America and the U.S.S.R. was less than half of that in Europe (Western and Eastern), and Oceania's per hectare fertilizer use level was about one-third of North America's. In addition to the policies and programs pursued by these regions, the variations in population pressures and the desire to achieve food security, especially in Western Europe, seem to have generated these regional variations in per hectare fertilizer use levels; for example, the number of persons per hectare averaged 4 in Western Europe and less than 1 in Oceania.

On a per capita basis, North America and Eastern Europe had the highest fertilizer use levels (84-85 kg) and Western Europe the lowest (58 kg). Fertilizer use per capita in Oceania and the U.S.S.R. varied between 74 and 80 kg. Thus, although Oceania had the lowest per hectare fertilizer use (35 kg) among high fertilizer-using regions, it had relatively high per capita fertilizer use levels because of its low population density.

A comparison of per capita and per hectare fertilizer use levels in North America and the U.S.S.R. reveals that although North America and the U.S.S.R. had nearly identical fertilizer use levels, the U.S.S.R. was a

food-deficit country and North America a food-surplus region in the mid-1980s. Whether this difference between the two is due to relatively low fertilizer use efficiency in the U.S.S.R., or to other factors, needs further research.

Low Fertilizer-Using Regions

Figure 8.4 indicates fertilizer use levels in Asia, Africa, and Latin America and their corresponding subregions, as well as the global fertilizer use level.

Figure 8.4 clearly indicates that both per capita and per hectare fertilizer use levels were rather low in Africa and were more so in sub-Saharan Africa in the mid-1980s. In Africa, per capita and per hectare fertilizer use levels averaged 6 kg and 19 kg, respectively, and in sub-Saharan Africa 2 kg and 7 kg, respectively. While sub-Saharan Africa had the lowest fertilizer use levels, South Africa had the highest fertilizer use levels in Africa (73 kg/ha and 30 kg/capita). North Africa's fertilizer use levels averaged around 59 kg/ha and 15 kg/capita.

Compared with Africa's lowest per hectare and per capita fertilizer use levels, Asia had the highest per hectare fertilizer use and Latin America the highest per capita fertilizer use.

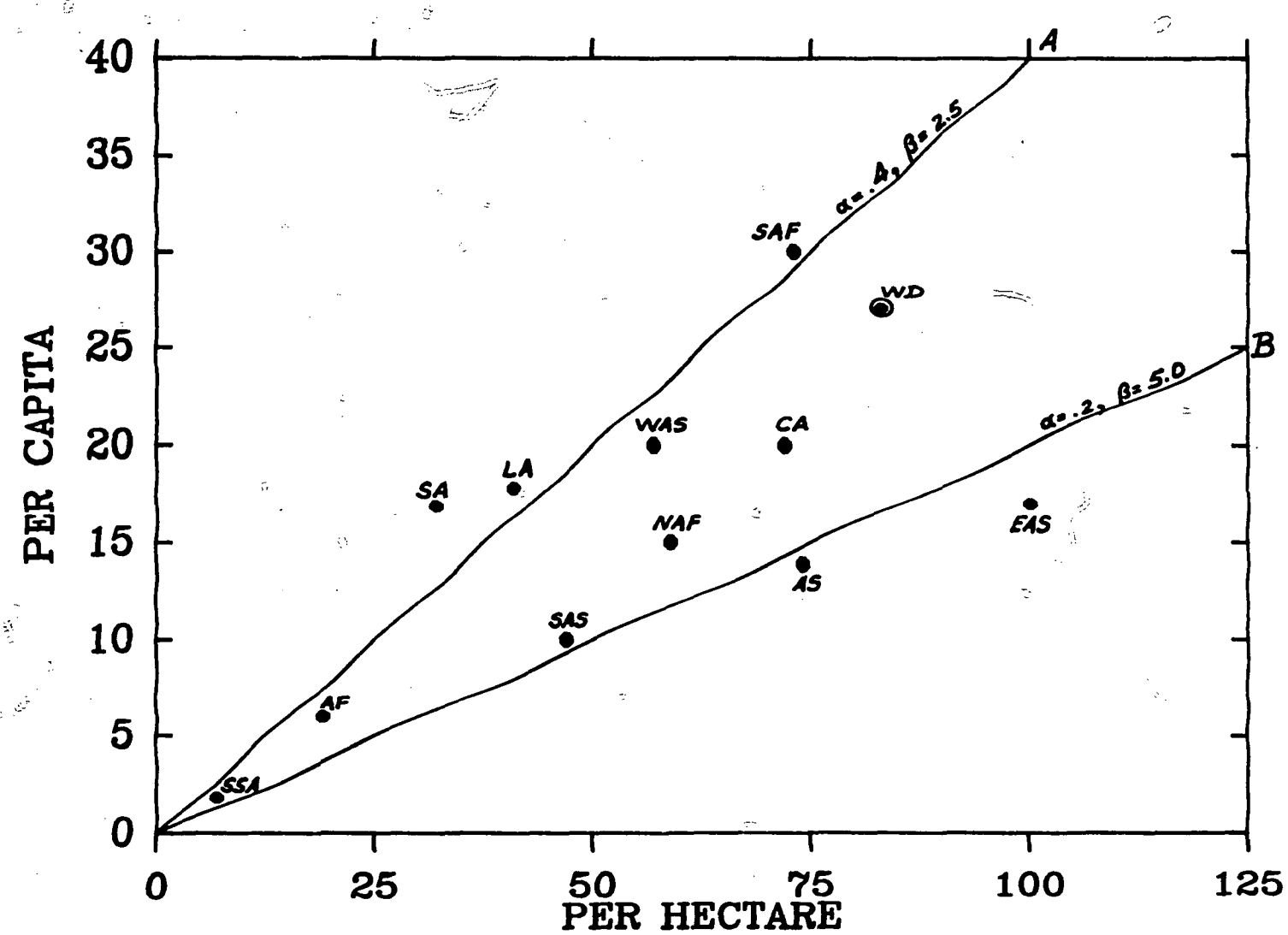
In Asia, East Asia dominated the other two subregions in per hectare fertilizer use and West Asia in per capita fertilizer use. East Asia used 100 kg of fertilizer nutrients per hectare, but because of high population density, its per capita fertilizer use was only 17 kg of fertilizer nutrients in 1985. Compared with East Asia, West Asia had slightly higher per capita fertilizer use levels and significantly lower per hectare fertilizer use levels. These were 20 kg and 57 kg, respectively. South Asia's fertilizer use levels were the lowest in Asia (47 kg/ha and 10 kg/capita).

In Latin America, although Central America had more than twice the per hectare fertilizer use levels of South America (72 kg versus 32 kg), its per capita fertilizer use level was only marginally higher than that of South America (20 kg versus 17 kg). This indicates that population pressures are higher in Central America than in South America (Figure 8.4).

This analysis of per hectare and per capita fertilizer use levels in various regions and subregions, along with the analysis of nutritional levels above, indicates that in many subregions of Asia, Africa, and Latin America, there is a strong need as well as a considerable potential for increasing fertilizer use to enhance food production and improve the nutritional levels

Figure 8.4

PER HECTARE AND PER CAPITA FERTILIZER USE: AFRICA, ASIA, AND LATIN AMERICA 1985 (kg)



of the growing population. However, the conversion of this agronomic potential into effective fertilizer use will require price and policy stability and governmental commitment as well as the development and improvement of physical and institutional infrastructure and fertilizer supply and distribution systems. It will also require investments in research and extension and in building human capital.

In addition to increasing fertilizer use to enhance food production, efforts should also be made to increase efficiency of fertilizer use. IFDC research indicates that by using better agronomic and management practices and improved fertilizer products, many farmers can achieve significantly higher crop output from the same level of nutrient use. In the light of the expected increases in fertilizer prices in the 1990s and the foreign exchange shortages experienced by many developing countries, especially in sub-Saharan Africa, improving fertilizer use efficiency warrants special efforts.

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APPENDIX A

Regional Classification

Part I. IFDC Regional Classification

North America	Western Europe	Eastern Europe	U.S.S.R.	Africa		Latin America	Asia	Oceania
Canada	Austria	Albania	U.S.S.R.	Sub-Saharan Africa	South Africa	Central America	West Asia	Australia
United States	Belgium-Lux	Bulgaria		Angola	Republic of	Bahamas	Bahrain	New Zealand
	Denmark	Czechoslovakia		Benin	South Africa	Barbados	Cyprus	Papua New Guinea
	Finland	Germany DR		Botswana		Belize	Iran	Samoa
	France	Hungary		Burkina Faso	North Africa	Bermuda	Iraq	Fiji
	Germany FR	Poland		Burundi	Algeria	Costa Rica	Israel	
	Greece	Romania		Cameroon	Egypt	Cuba	Jordan	
	Iceland	Yugoslavia		Central African	Libya	Dominica	Kuwait	
	Ireland			Republic	Morocco	Dominican	Lebanon	
	Italy			Chad	Tunisia	Republic	Oman	
	Malta			Congo		El Salvador	Qatar	
	Netherlands			Cote d'Ivoire		Guadeloupe	Saudi Arabia	
	Norway			Ethiopia		Guatemala	Syria	
	Portugal			Gabon		Haiti	Turkey	
	Spain			Gambia		Honduras	United Arab	
	Sweden			Ghana		Jamaica	Emirates	
	Switzerland			Guinea Bissau		Martinique	South Asia	
	United Kingdom			Guinea		Mexico	Afghanistan	
				Kenya		Nicaragua	Bangladesh	
				Lesotho		Panama	Bhutan	
				Liberia		St. Chris, etc.	Burma	
				Madagascar		Saint Lucia	India	
				Malawi		St. Vincent	Nepal	
				Mali		Trinidad, etc.	Pakistan	
				Mauritania		Virgin Islands	Sri Lanka	
				Mauritius		South America	East Asia	
				Mozambique		Argentina	China	
				Niger		Bolivia	Indonesia	
				Nigeria		Brazil	Japan	
				Rwanda		Chile	Kampuchea	
				Senegal		Colombia	Laos	
				Seychelles		Ecuador	Malaysia	
				Sierra Leone		French Guiana	Mongolia	
				Somalia		Guyana	Korea, DPR	
				Sudan		Paraguay	Korea, Republic	
				Swaziland		Peru	Philippines	
				Tanzania		Suriname	Singapore	
				Togo		Uruguay	Taiwan	
				Uganda		Venezuela	Thailand	
				Zaire			Viet Nam	
				Zambia				
				Zimbabwe				

Developed Countries--Includes North America, Western Europe, Eastern Europe, U.S.S.R., Japan, Israel, South Africa, Australia, and New Zealand.
Developing Countries--Includes Latin America, Asia (except Japan and Israel), Africa (except South Africa), and Oceania (except Australia and New Zealand).

APPENDIX A
Regional Classification

Part II. FAO Regional Classification of Developing Countries

Africa	Latin America	Near East/ North Africa	Asia
Sub-Saharan Africa	Central America	Afghanistan	Bangladesh
Angola	Bahamas	Algeria	Burma
Benin	Barbados	Cyprus	China
Botswana	Belize	Egypt	India
Burkina Faso	Bermuda	Iran	Indonesia
Burundi	Costa Rica	Iraq	Kampuchea DM
Cameroon	Cuba	Jordan	Korea DPR
Central African Republic	Dominica	Lebanon	Korea Rep.
Chad	Dominican Republic	Libya	Lao
Congo	El Salvador	Morocco	Malaysia
Cote d'Ivoire	Guadeloupe	Saudi Arabia	Nepal
Ethiopia	Guatemala	Syria	Pakistan
Gabon	Haiti	Tunisia	Sri Lanka
Gambia	Honduras	Turkey	Thailand
Ghana	Jamaica	Yemen AR	Vietnam
Guinea Bissau	Martinique	Yemen PDR	
Guinea	Mexico		
Kenya	Nicaragua		
Lesotho	Panama		
Liberia	St. Chris, etc.		
Madagascar	Saint Lucia		
Malawi	St. Vincent		
Mali	Trinidad, etc.		
Mauritania	Virgin Islands		
Mauritius	South America		
Mozambique	Argentina		
Niger	Bolivia		
Nigeria	Brazil		
Rwanda	Chile		
Senegal	Colombia		
Seychelles	Ecuador		
Sierra Leone	French Guiana		
Somalia	Guyana		
Sudan	Paraguay		
Swaziland	Peru		
Tanzania	Suriname		
Togo	Uruguay		
Uganda	Venezuela		
Zaire			
Zambia			
Zimbabwe			

Note: The FAO's Asia is referred to as Southeast Asia in this study, because Asia is used for a larger group of countries in Part I.

Appendix B

Structural Fertilizer Demand Equations

I. Variables

NCONS - Nitrogen use in the current year.
PCONS - Phosphate use in the current year.
KCONS - Potash use in the current year.
LAGN - Nitrogen use in the previous year.
LAGP - Phosphate use in the previous year.
LAGK - Potash use in the previous year.
PN - Nitrogen price (through urea).
PR - Phosphate price (through TSP).[a]
PK - Potash price (through MOP).
Area - Cropped area.[b]
T - Time trend.
PCORN - Corn price.
PWHT - Wheat price.
PRN - Nitrogen price divided by wheat price.
PRK - Potash price divided by wheat price.
DUMY - Qualitative variable having value of 0 for 1983-84 and 1's for all other years for the United States to quantify the impact the PIK program on fertilizer use.

II. Equations

A. North America (U.S.A.)

Nitrogen

$$NCONS = \underset{(0.21)}{325649.3} + \underset{(1.42)}{0.235}\ LAGN - \underset{(-0.87)}{195130}\ PRN + \underset{(3.82)}{0.074}\ AREA + \underset{(1.99)}{83785.7}\ T$$

$R^2 = .92$ $F(4,16) = 51.6$

Period: 1967-87

Phosphate

$$PCONS = \underset{(0.38)}{189991} + \underset{(4.44)}{0.553}\ LAGP - \underset{(-3.0)}{2892}\ PP + \underset{(1.39)}{4548.9}\ PCORN +$$

$$\underset{(3.34)}{0.040}\ AREA - \underset{(-2.30)}{39792}\ T$$

$R^2 = 0.86$ $F(5,19) = 22.9$

Period: 1963-87

Potash

KCONS = 1538741.3 + 0.721 LAGK - 254750 PRK + 16972.6 T - 700195 DUMY
(1.98) (4.15) (-0.84) (0.67) (-1.69)

R^2 = .82 F(4,16) = 18.7

Period: 1967-87

B. Western Europe

NCONS = 1622136.5 + 0.727 LAGN - 6957.3 PRN + 71335.4 T
(2.14) (3.69) (-1.46) (1.22)

R^2 = .99 F(3,16) = 553.8

Period: 1968-87

Phosphate

PCONS = 157096.3 + 0.979 LAGP - 1531 PP + 4096.9 PCORN - 6097.6 T
(0.23) (6.52) (-4.15) (1.83) (-0.50)

R^2 = .79 F(4,20) = 15.0

Period: 1968-87

Potash

KCONS = 1055886.1 + 0.877 LAGK - 85472 PRK + 15711.9 T
(1.28) (3.71) (-2.02) (1.0)

R^2 = .79 F(3,16) = 20.89

C. Oceania

Nitrogen

NCONS = 94716.8 + 0.135 LAGN - 255.22 PRN + 12440.5 T
(1.80) (0.42) (-0.03) (2.50)

R^2 = .91 F(3,11) = 42.0

Period: 1971-86

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Phosphate

$$PCONS = 1090731 + 0.015\ LAGP - 2427.9\ PP + 3297.3\ PWHT +$$
$$(3.74) \quad (0.11) \quad (-8.06) \quad (3.76)$$

$$0.027\ AREA + 21681.2\ T$$
$$(0.89) \quad (1.63)$$

$R^2 = .90$ $\qquad$ $F(5,9) = 17.1$

Period: 1971-86

Potash

No meaningful equations could be estimated.

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a. For Oceania, phosphate price is derived from SSP. For Western Europe, both corn and TSP prices used are world prices. All prices are deflated prices.
b. Sum of areas under wheat, corn, sorghum, and soybean. For the U.S.A. cotton is also included.

APPENDIX C

Data on Phosphate Consumption and Production Including Ground Phosphate Rock for Direct Application

- 28'

Table C-1. Regional Phosphate Consumption, 1960-87[a]

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	2,560	3,441	4,433	4,595	5,555	4,953	4,283
Western Europe	3,506	4,348	5,220	5,066	5,908	5,061	4,823
Eastern Europe	757	1,328	2,129	2,896	3,409	3,159	3,110
U.S.S.R.	838	1,849	2,766	4,160	5,480	6,625	8,354
Oceania	733	1,212	1,184	867	1,278	1,101	981
Africa	233	329	502	770	961	1,195	1,112
North Africa	78	97	131	231	323	471	418
Sub-Saharan Africa	21	52	102	180	200	308	357
South Africa	135	180	270	359	438	416	337
Latin America	299	466	845	1,655	2,464	2,417	2,799
Central America	45	157	309	414	403	562	599
South America	254	309	536	1,241	2,062	1,855	2,200
Asia	833	1,539	2,569	4,025	5,998	9,436	9,248
East Asia	718	1,269	1,958	2,975	3,682	5,765	5,035
South Asia	75	179	329	625	1,411	2,389	2,913
West Asia	41	91	282	425	905	1,282	1,300
WORLD	9,759	14,512	19,648	24,034	31,053	33,947	34,709

a. Includes ground phosphate rock for direct application.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table C-2. Regional Phosphate Production, 1960-87[a]

Region	1960	1965	1970	1975	1980	1985	1987
	('000 tons)						
North America	2,736	3,991	5,451	7,229	9,786	10,321	8,613
Western Europe	3,839	4,833	5,590	6,291	5,587	4,812	4,133
Eastern Europe	553	1,209	1,909	2,681	3,207	3,165	3,096
U.S.S.R.	879	2,006	3,036	4,538	5,930	7,096	8,477
Oceania	728	1,140	1,134	1,080	1,369	900	849
Africa	244	377	752	990	1,125	1,583	1,789
North Africa	118	182	386	509	602	1,001	1,350
Sub-Saharan Africa	1	19	45	95	79	82	69
South Africa	125	175	321	386	444	500	370
Latin America	91	213	380	932	1,595	1,787	1,921
Central America	-	67	169	260	238	258	264
South America	91	146	211	672	1,358	1,529	1,657
Asia	705	1,292	2,103	3,453	4,664	6,894	7,546
East Asia	612	1,108	1,784	2,645	3,354	4,196	4,418
South Asia	59	132	228	351	866	1,463	1,854
West Asia	34	52	91	457	445	1,236	1,275
WORLD	9,774	15,063	20,355	27,193	33,263	36,558	36,425

a. Includes ground phosphate rock for direct application.

Source: Derived from FAO data. FAO (1988) and FAO Fertilizer Yearbook (various issues).

Table C-3. Global Phosphate Consumption--Regional Shares, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	26.2	23.7	22.6	19.1	17.9	14.6	12.3
Western Europe	35.9	30.0	26.6	21.1	19.0	14.9	13.9
Eastern Europe	7.8	9.2	10.8	12.0	11.0	9.3	9.0
U.S.S.R.	8.6	12.7	14.1	17.3	17.6	19.5	24.1
Oceania	7.5	8.4	6.0	3.6	4.1	3.2	2.8
Africa	2.4	2.3	2.6	3.2	3.1	3.5	3.2
North Africa	0.8	0.7	0.7	1.0	1.0	1.4	1.2
Sub-Saharan Africa	0.2	0.4	0.5	0.7	0.6	0.9	1.0
South Africa	1.4	1.2	1.4	1.5	1.4	1.2	1.0
Latin America	3.1	3.2	4.3	6.9	8.0	7.1	8.1
Central America	0.5	1.1	1.6	1.7	1.3	1.7	1.7
South America	2.6	2.1	2.7	5.2	6.6	5.5	6.3
Asia	8.5	10.6	13.1	16.7	19.3	27.8	26.6
East Asia	7.4	8.7	10.0	12.4	11.9	17.0	14.5
South Asia	0.8	1.2	1.7	2.6	4.5	7.0	8.4
West Asia	0.4	0.6	1.4	1.8	2.9	3.8	3.7

Source: Derived from data in Table C-1.

Table C-4. Global Phosphate Production--Regional Shares, 1960-87

Region	1960	1965	1970	1975	1980	1985	1987
				(%)			
North America	28.0	26.5	26.8	26.6	29.4	28.2	23.6
Western Europe	39.3	32.1	27.5	23.1	16.8	13.2	11.3
Eastern Europe	5.7	8.0	9.4	9.9	9.6	8.7	8.5
U.S.S.R.	9.0	13.3	14.9	16.7	17.8	19.4	23.3
Oceania	7.5	7.6	5.6	4.0	4.1	2.5	2.3
Africa	2.5	2.5	3.7	3.6	3.4	4.3	4.9
North Africa	1.2	1.2	1.9	1.9	1.8	2.7	3.7
Sub-Saharan Africa	0	0.1	0.2	0.3	0.2	0.2	0.2
South Africa	1.3	1.2	1.6	1.4	1.3	1.4	1.0
Latin America	0.9	1.4	1.9	3.4	4.8	4.9	5.3
Central America	-	0.4	0.8	1.0	0.7	0.7	0.7
South America	0.9	1.0	1.0	2.5	4.1	4.2	4.5
Asia	7.2	8.6	10.3	12.7	14.0	18.9	20.7
East Asia	6.3	7.4	8.8	9.7	10.1	11.5	12.1
South Asia	0.6	0.9	1.1	1.3	2.6	4.0	5.1
West Asia	0.3	0.3	0.4	1.7	1.3	3.4	3.5

Source: Derived from data in Table C-2.

Appendix D

Fertilizer Consumption and Production, 1987/88

Consumption

Table D.1 indicates data on nitrogen, phosphate, and potash consumption in 1986/87 and 1987/88 at the global and regional levels. These data are based on preliminary estimates prepared by FAO in April 1989.

Global nitrogen consumption is estimated to have increased by 6%--from 71.7 million tons in 1986/87 to 76.0 million tons in 1987/88. More than 80% of the increase in global nitrogen use was contributed by an increase in apparent N consumption in East Asia, mainly in China. In China apparent nitrogen consumption increased by 26% (Table D.2). As the FAO does not receive data on fertilizer use in China from official sources, it uses the sum of production and imports as a proxy for actual consumption. Because of increase in production and imports, China's apparent nitrogen use shows a high increase, although most of this increase in supply must have gone to stocks, as is evident from data in Table D.2. The data from the China Fertilizer Development Center (CFDC) indicate that N use in China increased by only 2.3% in 1987/88.

North America, the U.S.S.R., and Latin America experienced about 2%-3% increase in nitrogen use; whereas, Western Europe, Eastern Europe, and Africa experienced a 1%-3% decline. In Africa nitrogen use decreased in both South Africa and sub-Saharan Africa (Table D.1).

Like global nitrogen use, global phosphate use also increased by 6%--from 34.7 million tons in 1986/87 to 36.9 million tons in 1987/88. Again, most of this increase in global phosphate use was contributed by an increase in apparent consumption in East Asia, mainly in China.

All regions and subregions, except Eastern Europe and Africa (South Africa), experienced increases in phosphate use. The percentage increases varied between 1.5% in South America and 9.0% in North Africa with the exception of East Asia, which experienced a 32.8% increase. Improvements in the microeconomic and macroeconomic situation seemed to have generated this appreciable growth in many regions.

Global potash consumption increased by 5%--from 26.2 million tons in 1987 to 27.5 million tons in 1988. An increase in apparent potash use in East Asia (China) is responsible for most of this increase in global potash use. Eastern and Western Europe, South and sub-Saharan Africa, and West Asia

experienced significant declines in their potash use; whereas, North America, the U.S.S.R., Latin America, and South Asia experienced significant increases in potash use. South America's 19% increase in K_2O use in 1988 indicates that the improved macroeconomic situation in South America is promoting growth in fertilizer use.

Production

Table D.3 indicates data on nitrogen, phosphate, and potash production at the global and regional levels.

Global nitrogen production increased by 6%--from 77.4 million tons in 1986/87 to 82.2 million tons in 1987/88. A little more than one-half of the increase in global nitrogen production was contributed by an increase in N production in Asia, and about 20% by an increase in N production in North America.

Asia's nitrogen production increased by about 10%, and both East and West Asia experienced more than 10% increases in their N production. Africa and Oceania also experienced more than 10% increases in their N production. Although sub-Saharan Africa's N production increased by 76%, it was from a low base of 108,000 tons. The newly commissioned ammonia-urea plant in Nigeria contributed most of this increase in N production in sub-Saharan Africa.

North America and Latin America experienced 6%-7% increase in nitrogen production. Western Europe is the only region that experienced a marginal decline in N production.

Like global N production, global P_2O_5 production also increased by 6%--from 37.3 million tons in 1986/87 to 39.6 million tons in 1987/88. Although Asia contributed the most to this increase in global phosphate production, North America and North Africa also contributed significantly.

The commissioning of new plants in Central America added 60% to its phosphate production. Unlike Central America, South America's phosphate production decreased. Eastern Europe, sub-Saharan Africa, and South Africa also experienced declines in their P_2O_5 production (Table D.3).

Global potash production increased by 6%--from 28.8 million tons to 30.5 million tons. Most of this increase in global potash production came from increases in potash production in North America, Western Europe, and the U.S.S.R. All three regions experienced 6%-7% increases in K_2O production. Eastern Europe witnessed a marginal increase. Although East Asia and South America experienced high percentage increases (66%-255%), these were on a very

small base. For example, East Asia's K_2O production increased from 24,000 tons in 1986/87 to 40,000 tons and South America's increased from 11,000 tons to 37,000 tons. Hence, these increases had little impact on global potash production.

Many regions experienced declines in P_2O_5 production; however, none experienced a decline in K_2O production. High concentrations of K_2O in a few regions and improved potash prices in 1987/88 might have caused this difference.

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Table D1. Fertilizer Use, 1986/87 and 1987/88[a]

Region	Nitrogen			Phosphate[b]			Potash		
	1986/87	1987/88	% Change	1986/87	1987/88	% Change	1986/87	1987/88	% Change
	('000 tons)								
North America	10,407	10,689	2.7	4,262	4,365	2.4	4,777	4,879	2.1
Western Europe	10,695	10,618	-0.7	4,818	4,905	1.8	5,303	5,197	-2.0
Eastern Europe	5,074	5,037	-0.7	3,151	2,894	-8.1	3,399	3,199	-5.9
U.S.S.R.	11,475	11,787	2.7	8,354	8,564	2.5	6,677	7,052	5.6
Oceania	406	428	5.4	1,014	1,100	8.6	222	229	3.2
Africa	1,944	1,884	-3.1	1,149	1,146	-0.3	445	446	0.3
North Africa	980	983	0.3	478	521	9.0	136	147	8.3
Sub-Saharan Africa	602	573	-4.8	335	362	7.9	189	183	-3.5
South Africa	362	328	-9.3	337	264	-21.6	119	116	-2.8
Latin America	3,897	3,997	2.6	2,809	2,867	2.1	2,039	2,378	16.6
Central America	1,998	2,023	1.2	608	632	4.0	438	471	7.6
South America	1,898	1,973	4.0	2,202	2,235	1.5	1,601	1,907	19.1
Asia	27,775	31,600	13.8	9,171	11,107	21.1	3,386	4,158	22.8
East Asia	17,804	21,500	20.8	5,051	6,706	32.8	2,211	2,924	32.3
South Asia	7,826	7,883	0.7	2,821	2,998	6.3	1,030	1,101	6.9
West Asia	2,145	2,217	3.4	1,300	1,402	7.9	145	133	-8.3
World	71,671	76,039	6.1	34,729	36,948	6.4	26,247	27,538	4.9

a. Data are revised estimates for 1986-87 and preliminary estimates for 1987-88.
b. Includes ground phosphate rock for direct application.

Note: Totals may not add due to rounding.

Source: FAO/FIAC Meeting, Rome, April 1989.

Table D2. Fertilizer Use in China, 1986 and 1987

Nutrient	CFDC[a] 1986	CFDC[a] 1987	CFDC[a] % Change	FAO 1986	FAO 1987	FAO % Change
	('000 tons)					
N	13,668	13,984	2.3	13,283	16,739	26.0
P_2O_5[b]	4,683	4,971	6.1	2,956	4,543	53.7
K_2O	955	1,128	18.1	624	1,240	98.7
Total	19,306	20,083	4.0	16,863	22,522	33.6

a. China Fertilizer Development Center.
b. P_2O_5 data from CFDC include ground phosphate rock for direct application. No separate information is available on it.

Source: CFDC (Personal communications) and FAO/FIAC Meeting, Rome, April 1989.

Table D3. Fertilizer Production, 1986/87 and 1987/88[a]

Region	Nitrogen 1986/87	Nitrogen 1987/88	Nitrogen % Change	Phosphate[b] 1986/87	Phosphate[b] 1987/88	Phosphate[b] % Change	Potash 1986/87	Potash 1987/88	Potash % Change
	('000 tons)								
North America	13,643	14,593	7.0	9,449	9,975	5.6	8,250	8,839	7.1
Western Europe	10,553	10,524	-0.3	4,111	4,143	0.8	4,860	5,236	7.7
Eastern Europe	7,385	7,643	3.5	3,120	2,994	-4.0	3,485	3,510	0.7
U.S.S.R.	14,996	15,538	3.6	8,477	8,840	4.3	10,228	10,888	6.5
Oceania	253	288	13.8	828	933	12.6	-	-	-
Africa	1,653	1,856	12.2	1,869	1,888	1.0	-	-	-
North Africa	1,177	1,285	9.1	1,410	1,503	6.6	-	-	-
Sub-Saharan Africa	108	191	76.4	90	85	-5.0	-	-	-
South Africa	368	380	3.3	370	300	-18.9	-	-	-
Latin America	3,046	3,231	6.1	1,920	2,030	5.7	11	37	255.2
Central America	1,684	1,795	6.6	264	427	61.6	-	-	-
South America	1,362	1,436	5.5	1,656	1,603	-3.2	11	37	255.2
Asia	25,903	28,570	10.3	7,544	8,806	16.7	1,926	2,014	4.5
East Asia	16,345	18,420	12.7	4,415	5,539	25.5	24	40	66.7
South Asia	7,118	7,362	3.4	1,854	1,861	0.4	-	-	-
West Asia	2,441	2,788	14.2	1,275	1,407	10.3	1,902	1,974	3.8
World	77,433	82,243	6.2	37,318	39,609	6.1	28,759	30,523	6.1

a. Data are revised estimates for 1986-87 and preliminary estimates for 1987-88.
b. Includes ground phosphate rock for direct application.

Note: Totals may not add due to rounding.

Source: FAO/FIAC Meeting, Rome, April 1989.