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D01797

United Nations Industrial Development Organization

Distr.
GENERAL

ID/CONF.1/B.22
21 June 1967

ENGLISH ONLY

INTERNATIONAL SYMPOSIUM ON INDUSTRIAL DEVELOPMENT
Athens, 29 November-20 December 1967
Provisional agenda, Item 2

Background paper

TRENDS AND PROSPECTS OF WORLD FERTILIZER PRODUCTION CAPACITY AS RELATED TO FUTURE NEEDS[1/]

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1/ The views and opinions expressed in this paper are those of the consultants and do not necessarily reflect the views of the secretariat of UNIDO.

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19. There also have been substantial changes in types of fertilizer produced. Prior to 1960 most fertilizers were solid materials of relatively low analysis, and much of the production was a by-product of other industries. Ammonium sulfate until the late 1950's was the major nitrogen fertilizer and normal superphosphate the major phosphate material. These materials generally contained 20 per cent or less plant food. Most products, with the exception of some of the nitric phosphates produced in Western Europe, were pulverized and of low-analysis. Very little of this material entered into overseas shipments.

20. The world picture has changed rapidly in the past five years, and even more rapid changes are expected in the next five years. Low-analysis materials are being replaced by higher analysis materials. Ammonium sulfate and sodium nitrate are losing out to ammonium nitrate and urea, and to anhydrous ammonia and nitrogen solutions in some areas. Normal superphosphate is being replaced by concentrated superphosphate and to a greater extent by high-analysis complex fertilizers of either the nitric phosphate or ammonium phosphate types. Anhydrous ammonia has become the basic building block for nitrogen fertilizers while wet-process phosphoric acid is becoming the major source of phosphate fertilizers. Little change has taken place in potash, with potassium chloride remaining the major potassic material.

21. The following sections on nitrogen, phosphate, and potash fertilizers discuss the development from a production standpoint of these segments of the industry, the types of product being produced, and the changes expected in the next five years.

World nitrogen fertilizer industry

22. This section discusses the growth and outlook for nitrogen fertilizers, including the location of production facilities and prospective changes in types of products.

23. Prior to 1957 nitrogen was last in terms of level of plant nutrient consumption, but since that time it has become the fastest growing and most rapidly changing segment of the industry. Ammonia, the basic building block for

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all nitrogen fertilizers, was produced in small plants and converted to nitric acid for the production of complex fertilizers or ammonium nitrate, or used to produce ammonium sulfate. In contrast, many of today's ammonia plants have capacities exceeding 350,000 tons of product per year. Since 1960 urea has become an important nitrogen fertilizer and the use of ammonia and nitrogen solutions for direct application to the soil has increased in importance.

24. As shown in figure 6 (Annex III) and table 5 (Annex II) the production of nitrogen totaled 6.37 million metric tons in 1955. By 1965 this has almost tripled to 16.63 million metric tons--a compound growth rate of over 10 per cent per year.

25. If growth continues at the 10 per cent-per-year rate, nitrogen production would be 30 million metric tons in 1971 and 44 million by 1975. Capacity in 1966 has been estimated at 20.7 million metric tons of N, and is expected to reach 49.28 million by 1971. Thus, capacity is being scheduled to at least maintain the recent growth rate.

26. In 1955 Western Europe and North America were the only major producing areas of nitrogen fertilizers. Since that time Eastern Europe has increased production until it now accounts for 20 per cent of total production. These three developed areas accounted for 84 per cent of the total world production of nitrogen in 1965.

27. Capacity estimates for 1971 indicate that these three regions will continue to produce the greatest share of the world's nitrogen—accounting for 75 per cent of the world's total. Western Europe and North America are planning to double capacity in the next five years while Eastern Europe will almost triple its capacity. In the same period, capacity will be more than doubled in Asia and tripled in Latin America, while Africa is expected to record a five-fold increase.

28. There is a world-wide emphasis now on the use of ammonia for fertilizer production; however, ammonia is also used for industrial purposes. For this study it has been assumed that 20 per cent of all ammonia produced both in the developed and the developing countries is used for industrial purposes. Many of the developing nations will use their ammonia production entirely for

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fertilizer; however, this will be offset to some extent by the higher percentage of use for industry by the developed areas.

Nitrogen fertilizer products

29. Unlike the phosphate and potash fertilizer industries, where relatively few products are produced, the nitrogen industry is characterized by a wide assortment of materials. They range from 16 per cent to 82 per cent in nitrogen content. For purposes of discussion, these products are divided into five groups: (a) ammonium sulfate (21 per cent N) and ammonium sulfate nitrate (26 per cent N); (b) ammonium nitrate (33 per cent N) and ammonium nitrate limestone (20-26 per cent N); (c) other solids including sodium nitrate, calcium nitrate, and calcium cyanamide (all 16 per cent N); (d) urea (45 per cent N); and (e) other nitrogen. The last group includes ammonium chloride (16-18 per cent N), organic nitrogen, nitrogen solutions (20-45 per cent N), anhydrous ammonia (82 per cent N) for direct application to the soil, and nitrogen in complex fertilizers made either with nitric acid or by ammoniation. Also in group (e) is ammonia not accounted for by the production of the various products.

30. Figure 7, (Annex III), and table 6, (Annex II) show the production of nitrogen contributed by each of the groups. Figure 8, (Annex III) shows the share of the market now held by each group. Capacity data and the projected market composition for 1971 also are shown in the charts and tables.

31. The multiple uses of urea and ammonium nitrate either as a solid or as a nitrogen solution make the analysis of production and capacity data for these products uncertain. Production data for 1955-1965 are for the solid materials. Capacity information contain both solid and liquid materials.

32. Ammonium sulfate: Ammonium sulfate is the most widely used nitrogen product in the world and is produced in more countries than any other product. In recent years, however, the trend towards higher analysis materials, such as the ammonium nitrates and urea, has reduced ammonium sulfate's share of the world nitrogen market.

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33. Ammonium sulfate and ammonium sulfate nitrate production in 1955 totaled 1.83 million metric tons of nitrogen--over 31 per cent of all nitrogen produced. Production increased by more than 1.0 million metric tons during the next ten years; however, its share of the market had decreased to 20 per cent by 1965. Capacity is estimated to increase by another 800,000 metric tons of nitrogen by 1971; however, total ammonium sulfate and ammonium sulfate nitrate capacity will account for only 10 per cent of all nitrogen capacity. Still, the popularity of ammonium sulfate in many countries and the fact that it can be produced as a by-product of steel and caprolactum production suggest that ammonium sulfate will remain an important nitrogen fertiliser for some time.

34. Ammonium nitrate: The combined production of ammonium nitrate and ammonium nitrate limestone has replaced ammonium sulfate as the leading nitrogen fertiliser group. These products now account for over 33 per cent of all nitrogen produced. Capacity is divided equally between the two products; however, future capacity estimates show a more rapid increase in ammonium nitrate than in ammonium nitrate limestone.

35. Present capacity for ammonium nitrate is 3.59 million metric tons of nitrogen. This should increase to 5.63 million by 1971. Corresponding capacity levels for ammonium nitrate limestone are 3.29 and 4.62 million tons. Despite recent and anticipated growth, however, the share of world nitrogen capacity represented by this group will drop to 24 per cent by 1971.

36. Most ammonium nitrate capacity is in North America and Western Europe. Ammonium nitrate limestone capacity increases are scheduled mainly in Eastern Europe.

37. Other solid nitrogen: The major product in this group is calcium nitrate, followed by calcium cyanamid and sodium nitrate. Very little capacity increase is expected for any of these products, and calcium cyanamid and sodium nitrate capacity may actually decrease.

38. This group accounts for 6 per cent of the nitrogen market; its share will decrease to 2 per cent by 1971, with combined production no more than 1.0 million

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metric tons of nitrogen.

39. Urea: The most rapidly growing nitrogen material in the world today is urea. Its share of the world nitrogen market has increased from 2 per cent in 1955 to 12 per cent in 1965, and should increase to 22 per cent by 1971. Capacity is expected to more than double in the next five years. Many of the developing nations have announced ammonia and urea fertilizer complexes and do not plan to produce any other nitrogen products.

40. Urea is the highest analysis solid nitrogen material now produced, which allows more plant food to be transported per ton of fertilizer. Thus, developing nations with relatively poor transportation systems can distribute greater amounts of plant food. Also, they can ship the concentrated material for less cost per unit of nitrogen, and thus achieve large freight savings.

41. Urea solution production should increase more rapidly in the developed nations of the world indicating a shift to use of intermediate products for application to the soil. It is also expected that some of the ammonia capacity unaccounted for by present estimates of product capacity will be used for urea production and not for the production of some of the other lower analysis nitrogen materials.

42. Other nitrogen: Production trends for this group of products are difficult to define. Complex fertilizers account for 9 per cent of today's market, ammonium chloride less than 1 per cent, and organics 0.3 per cent, while nitrogen solutions and ammonia account for 17.5 per cent. Production of nitrogen in this group of products should account for over 40 per cent of all nitrogen produced by 1971.

43. With the large increase in production of complex fertilisers, especially ammonium phosphates, these types of materials should continue to capture a large share of the nitrogen market. These gains likely will be at the expense of solid nitrogen materials since there is a definite trend in developed regions towards greater use of nitrogen solutions and anhydrous ammonia for direct application to soils. So far, lack of handling equipment largely precludes the use of these intermediates in developing nations; thus, in the near future at least, they will

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rely on solid nitrogen materials and/or complex fertilizers.

World phosphate fertilizer industry

44. This section describes the recent growth and production outlook for phosphates through 1971. Regional production patterns are shown along with expected changes in types of products. The growing importance of phosphoric acid as the basis of the phosphate fertilizer industry also is documented.

45. Based on the oxide method of reporting, phosphorus was until 1961 the most important of the three primary plant nutrients. It now is second to nitrogen.

46. World production of phosphatic fertilizers in terms of P_2O_5 totaled 7.82 million metric tons in 1955. In 1965 it was 13.75 million—an increase of 76 per cent. This gain amounted to a compound growth rate of 5.8 per cent per year for the decade. The rate actually was higher in the last five years—6.8 per cent per year. Although short of gains recorded by nitrogen, phosphate fertilizers have shown a good growth pattern.

47. If production during the next five years climbs at the annual rate of the past five years (6.8 per cent), 1971 output would be 20.4 million metric tons of P_2O_5. At this same rate, 1975 production would be 26.5 million metric tons of P_2O_5.

48. Estimated capacity in 1966 was 20.34 million metric tons. By 1971 this is expected to increase to 33.33 million tons, as indicated in figure 9, (Annex III), and table 7, (Annex II). Phosphates are also used for industrial purposes. Production data in this report applies only to fertilizer P_2O_5. In developing the capacity estimates, an attempt was made to separate fertilizer and industrial phosphates. For example, furnace phosphoric acid capacity has been estimated using only the amounts reported as scheduled to be used in fertilizer. It is difficult to determine the extent that wet-process phosphoric acid is used for industrial purposes, or what percentage of the future capacity is scheduled for industrial uses. In the United States, 8 per cent of all wet-process phosphoric acid is used for industrial purposes. The level appears to be about the same in other developed countries. Data indicate that little if any of the wet-process

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phosphoric acid capacity scheduled in the developing countries will be used for industrial purposes.

49. Western Europe is the major producing region. However, its share of the world market declined from 40 per cent in 1955 to 32 per cent in 1965. North America held its share at 30 per cent during the same period, with the United States producing more phosphatic fertilisers than any other nation. Eastern Europe was the only region to show a gain, increasing its share of the total market from 14 to 21 per cent since 1955.

50. Scheduled capacities for 1971 indicate, however, that the share of the market held by the leading phosphate producers--the developed regions--will decrease. Western Europe will have 23 per cent of total P_2O_5 capacity, Eastern Europe 22 per cent, and North America 27 per cent. On the other hand, Asia should increase its proportion of world capacity from 6 per cent in 1965 to 10 per cent in 1971. Africa will increase its share from 2 to 5 per cent, and Latin America from 2 to 7 per cent.

Phosphate fertiliser products

51. Major phosphatic fertilizers include normal superphosphate (16-20 per cent P_2O_5), basic slag (16 per cent P_2O_5), and concentrated superphosphate (32-46 per cent P_2O_5). The other major sources of P_2O_5 are complex fertilisers which contain various amounts of nitrogen and phosphate, and, in many cases, potash. These products include the ammonium phosphates and other materials made by ammoniating phosphoric acid, and nitric phosphates, produced by acidulating phosphate rock with nitric acid.

52. Production of the major phosphate products is shown in figure 10, (Annex III), along with anticipated capacity for 1971. Table 8 (Annex II) lists production statistics for the individual products. Figure 11 (Annex III) shows the share of the market for each of the products.

53. Normal superphosphate Normal superphosphate remains the leading phosphate fertiliser. From 1955 to 1965, production climbed 28 per cent--from 4.18 to 5.33

million metric tons of P_2O_5. However, its share fell from 63 to 45 per cent of all P_2O_5 during this period. Higher analysis products are replacing normal superphosphate, which is expected to have only 27 per cent of the market by 1971.

54. In Western Europe and in North America the production of normal superphosphate has not increased since 1960. In 1965 world production of normal superphosphate actually decreased. Western Europe and North America have excess capacity to produce this material. However, many of the plants are over ten years old, and some have been converted to produce complex fertilizers. The excess capacity was not included in the 1971 capacity estimates. As the trend towards higher analysis materials continues, normal superphosphate will continue to lose ground, perhaps even faster than indicated by the 1971 capacity data.

55. Basic slag: Basic slag is a by-product of steel production, and thus its production growth rate is determined by the growth of the parent industry. It is a major phosphate fertilizer in Europe, but little is produced in other regions. World-wide, basic slag was second only to normal superphosphate as a phosphate fertilizer as recent as 1955. Its production has increased very slowly, however, and its share of the market decreases each year. By 1971 basic slag should account for only 5 per cent of all phosphates.

56. Concentrated superphosphate: North America is the major world producer of concentrated superphosphate, accounting for 1.30 out of the 1.81 million metric tons (P_2O_5) produced throughout the world in 1965. Western Europe, Africa, and Latin America also produce concentrated superphosphate. World production of concentrated superphosphate has increased 50 per cent in the last five years, with its share of the total phosphate market holding at about 14 per cent.

57. The future growth pattern for concentrated superphosphate is uncertain. Although it is the most concentrated straight phosphate produced commercially, it is equaled in phosphate content by some of the ammonium phosphates. This tends to put concentrated superphosphate at some disadvantage in transportation and handling costs since the ammonium phosphates also carry nitrogen.

58. Small expansions in concentrated superphosphate capacity are expected in

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Western Europe and North America. Eastern Europe, Africa, Asia, and Latin America are scheduling relatively large increases in capacity. Since both concentrated superphosphate and the ammonium phosphates are based on phosphoric acid and conversion from concentrated superphosphate to diammonium phosphate is technically and economically feasible it is expected that some concentrated superphosphate capacity will be converted to complex fertilizers of the ammonium phosphate type.

59. Complex fertilizers: Complex fertilizers (including other materials) in 1955 accounted for only 10 per cent of the total world production of P_2O_5. In the last ten years, however, production has increased over 400 per cent and they now account for 28 per cent of all phosphate fertilizers--second only to normal superphosphate. The growth is expected to continue--perhaps at a faster pace than shown over the past ten years. By 1971 complex fertilizer could account for 50 per cent of all phosphate fertilizers.

60. Production statistics do not indicate the individual products that are classified as complex fertilizers. Capacity data for 1966 and 1971 as shown in the following tabulation indicate the materials that are found under this classification.

61. Ammonium phosphates account for the largest share of all complex fertilizers. Present capacity is located primarily in North America, and most of the scheduled increase is in this region. Nitric phosphates are produced in Western Europe and form the basis of the complex fertilizer portion of the phosphate industry in this area.

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World capacity for complex fertilisers

Product	Capacity 1966	Capacity 1971
	. Million Metric Tons P_2O_5 .	
Complex fertilisers	5.29	7.66
Nitric phosphates 1/	(1.23)	(1.57)
Ammonium phosphates	(3.48)	(5.13)
Other complex	(.58)	(.96)
Organics	.08	.08
Other Phosphates	.23	.25
Phosphoric Acid 2/	2.36	6.38
TOTAL	7.96	14.37

1/ Products not based on acidulation of phosphate rock with phosphoric acid.

2/ Phosphoric acid capacity not accounted for by the production of ammonium phosphates and concentrated superphosphate. May include some phosphoric acid for industrial purposes.

62. The scheduled expansion will also be in this same area. Organics produced mainly in Chile and Peru make up a very small portion of all complex fertilisers.

63. Phosphoric acid: As shown in the above tabulation the largest increase in complex fertiliser capacity during the next five years will be contributed by phosphoric acid. This figure represents the remaining acid available for fertiliser production after the P_2O_5 requirements for ammonium phosphates, other complex, and concentrated superphosphate have been subtracted from the total phosphoric acid capacity. Any industrial phosphoric acid capacity which could

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not be separated from fertiliser capacity would be included in this category.

64. The major change in the phosphate industry in the last ten years has been the shift from acidulation of phosphate rock with sulfuric acid to produce solid fertilisers to the production of phosphoric acid from sulfuric acid and phosphate rock and the use of this product as the major building block for concentrated phosphate fertilisers. As the demand for higher analysis materials increases, the use of phosphoric acid and the finished fertiliser materials that can be produced from it will increase in importance.

65. Capacity data for years previous to 1966 are not available. Future capacity data indicate the important role that wet-process phosphoric acid will play in the future phosphate industry. Estimated capacity of wet-process phosphoric acid in 1966 is 7.61 million metric tons of P_2O_5. Capacity is expected to double by 1971 reaching 14.76 million metric tons. Furnace phosphoric acid used for fertiliser and superphosphoric acid capacities could raise this total to 15.86 million metric tons of P_2O_5.

66. The phosphate fertiliser industry will change rapidly in the next ten years. More substitution of phosphoric acid-based complex fertilisers for the lower analysis materials can be expected, perhaps at a more rapid rate than indicated by the estimated future capacity data.

<u>World potash fertiliser industry</u>

67. The growth in the production of potash fertilisers has been slower than nitrogen and at about the same rate as phosphates. Potash now ranks third of the three primary plant nutrients contained in fertilisers. This is due in part to the fact that many of the soils of the world contain relatively high amounts of K_2O and crop production has not depleted these soil reserves. As crop production levels increase, however, it is expected that greater amounts of potash will be used, thus bringing potash consumption to the level of phosphates. This section deals with the historical and future production trends in potash, by region and by product.

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68. Since 1955 potash production has increased at a compound growth rate of 6.2 per cent per year. World production has nearly doubled in the past ten years– from 6.68 million metric tons of K_2O in 1955 to 12.22 million in 1965. The increase in 1965 alone exceeded 1.0 million metric tons as several large mines came on stream in Canada and European producers expanded their production levels. Assuming potash production continues to increase at a growth rate of 6.2 per cent per year, production will reach 16.5 million metric tons of K_2O in 1970 and 22.3 million metric tons by 1975.

69. Capacity data indicate, however, that potash production may increase at a faster rate. World potash capacity in 1966 is estimated at 14.0 million metric tons of K_2O. By 1971 production capacity could reach 26.8 million metric tons. Figure 12 (Annex III) shows the relationship of potash production and capacity. Production data is shown in table 1, (Annex II).

70. In estimating future supplies of potash for fertilizer, five per cent of total capacity has been subtracted for industrial use in Western Europe, Eastern Europe, and North America.

71. While potash reserves have been found in all areas of the world, with the exception of Oceania, production has been confined to a relatively few countries in Western and Eastern Europe, and North America. Israel recently began production of potash and Chile and Peru are producing potash from their guano deposits.

72. Production is divided fairly equally among the Western European, Eastern European, and North American regions, with Western Europe leading by a small margin. Capacity data indicate, however, that by 1971 North America will be the major producer with 40 per cent of the total. Eastern Europe will then have over 30 per cent of world production and Western Europe 22 per cent.

73. Several new production units are being planned in Africa and Latin America, while Israel is planning to double its output in the next few years. Their share of the total market will remain small, however.

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74. Over 94 per cent of all potash produced is in the form of potassium chloride, with potassium sulfate and potassium nitrate accounting for the remainder. Most potash is incorporated into mixed or complex fertilizers before application to the soil.

75. Potassium sulfate is used mainly on crops that do not tolerate the chloride ion or where there is danger of chloride accumulation in the soil. Its share of the market will continue to decrease. Also, little growth is expected in the production of potassium nitrate and other potassium fertilizer materials, until the economics of production become competitive with potassium chloride.

The supply-demand balance

76. A look at the capacity data for nitrogen, phosphate, and potash indicates future rates of increase far greater than those experienced during the past ten years. From a practical standpoint, however, the extent of an apparent over-capacity can yet be affected by several factors.

77. In the first place, every attempt was made during compilation of capacity data to determine the net increase when a new plant was to replace smaller units. However, since this was not always possible the indicated capacity figures may be on the high side. Unless the closing of a plant has been announced, it was assumed that this plant will be operating in 1971.

78. In addition, decisions to retire some older, less efficient units may be made after the production economies associated with planned large plants are demonstrated. In some cases, depletion of raw materials reserves may dictate a closing or a reduction in capacity for some mining operations.

79. Furthermore, the capacity data includes many plants now in advanced planning stages but for which no construction contracts have been let. Obviously, any of these can be delayed or cancelled in response to evolving market patterns.

80. Even at face value, the compound annual growth rates indicated by the planned additions to capacity from 1966 to 1971--15 per cent for nitrogen, 11 per cent for phosphate, and 13.9 per cent for potash--are not greatly higher than

previous maximum rates for any one year.

81. In summary, over-capacity may be a short-term problem in some areas. However, it seems reasonable to assume that long-term supply and demand will be balanced, especially as keener competition leads to more astute planning.

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II. PRODUCTION TRENDS IN THE DEVELOPING COUNTRIES

82. This section deals with the relative position of the developing countries in producing fertilizers. It includes a discussion of present and future trends, plus information on the types of products being emphasized in the developing regions as compared to the developed areas.

83. Fertilizer production historically has been heavily concentrated in the developed nations, not in the developing regions that now face critical food shortages. The trend has been for the developing countries to produce from 8 to 10 per cent of the world's fertilizer output.

84. Their position would seem to be improving, however. Although their share of the world market did not change substantially, the developing regions in the past five years increased production 150 per cent--from 1.72 to 4.32 million metric tons (figure 13, Annex III). The capacity data indicate a greater change during the next five years. By 1971 developing regions plan to increase plant nutrient production to more than 20 million tons. This would give them 18 per cent of the world total.

85. Figure 14, (Annex III), shows the share of world production of the three primary plant nutrients held by the developing nations.

86. The developing nations are in a relatively better position with nitrogen than with either of the two other major nutrients, accounting for about 15 per cent of the world output during the past decade. Capacity is expected to be increased by more than 7.0 million metric tons during the next five years. This would give the developing regions 23 per cent of the world capacity by 1971.

87. About 10 per cent of the world's phosphate fertilizers is produced in the developing nations. This represents a substantial under-utilization of facilities, however, since these nations have 15 per cent of the world capacity. The developing nations are adding phosphate facilities at a faster rate than the developed nations, and will have 22 per cent of the world's capacity by 1971.

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88. Developing nations account for only 2 per cent of world potash production. Unless large, new deposits of potash having economic feasibility for development are found in the developing nations they will not greatly increase their share. It does not appear that potash production in the developing nations will go beyond 5 per cent of the world's capacity in the immediate future.

89. The largest expansion in nitrogen product capacity will be in urea. At present 42 per cent of all urea is produced in the developing nations; however, by 1971 well over half--56 per cent--of all urea capacity is scheduled for the developing regions. In 1971 about 14 per cent of all ammonium nitrates, 40 per cent of all ammonium sulfates, and 10 per cent of the capacity for all other nitrogen products will be produced in these regions. Thus, while the developed nations are moving towards the use of more and more other nitrogen materials, such as ammonia and nitrogen solutions for direct application, the developing nations are producing a larger share of the solid nitrogen materials, especially urea.

90. In phosphates, the developing nations now produce 15 per cent of the world's normal superphosphate. However, the developed nations are shifting away from this low-analysis product fairly rapidly, with the result that, without adding much capacity, developing areas will account for 27 per cent of production by 1971. The developing nations will increase their share of concentrated superphosphate from the current level of 11 per cent to 32 per cent during the next five years. Their share of complex fertilizers will move from 5 per cent to 17 per cent by 1971.

91. All regions are moving towards the use of higher analysis phosphate materials. However, the greatest tonnage gains in developed nations will be in complex fertilizers, while the greatest expansion by developing nations will be in concentrated superphosphate.

92. Potash production throughout the world will be mainly in the form of potassium chloride; possible exceptions in the developing regions are potassium nitrate or sulfate where the raw material balance may favour their production in some situations.

III. FUTURE CAPACITY IN RELATION TO NEEDS

93. Interpolated needs for 1971 based on the estimated world fertiliser requirements reported by the TVA for 1970 (Annex I, ref. 16) show that by 1971 a minimum of 71.0 million metric tons of plant nutrients will be needed and that by 1980 this will increase to 111.7 million metric tons of total plant food. Of the total, developed countries would require 49.0 million metric tons by 1971 and 73.2 million metric tons by 1980. Minimum requirements for the developing regions are 22.0 and 38.5 million metric tons for the same years. This section attempts to equate future needs with future capacity for each region of the world. A discussion of individual plant nutrient needs and anticipated capacity is also included.

94. Table 10, (Annex II) shows anticipated production capacity and the estimated minimum requirements of total plant nutrients by regions. Overall, the developed regions now have an installed capacity capable of meeting their 1971 requirements. By 1971 their announced capacity will exceed their needs by 40.0 million metric tons of plant nutrients. In the developing regions, however, present capacity lags far behind 1971 minimum needs. By 1971 only Latin America is expected to have capacity to meet its 1971 needs. Asian plans fall 3.6 million metric tons below their minimum requirements, and Africa will be 0.2 million metric tons below their estimated needs in 1971.

95. In total, the planned capacity for 1971 will be almost 38.4 million metric tons over 1971 requirements.

96. Comparing estimated needs for 1980 with capacity data for 1971 shows that the developed regions will have installed by 1971 the capacity to meet their 1980 needs. The developing regions, while approaching their 1971 needs, have not announced plans that would meet their 1980 needs. With the large expansion in the developed nations, however, the world totals indicate that capacity in 1971 approaches the 1980 overall needs. The point of production will not be at the point of greatest need, however.

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97. Table 11, (Annex II) defines needs in terms of the individual plant nutrients and relates these estimates to future capacity by regions. These estimates are based on a ratio of two units of nitrogen for each unit of P_2O_5 and K_2O. Developing regions currently use nitrogen far in excess of this 2-1-1 ratio. However, as their fertilizer markets develop it appears that relatively larger amounts of P_2O_5 and K_2O will be required, thus bringing the ratio close to that in the developed regions.

98. Among the developed regions, only Oceania will not have by 1971 the capacity to produce its 1980 needs for primary plant nutrients.

99. Indications are that capacity levels will continue to lag behind needs in developing regions, although there are exceptions. Potash capacity will be less than 1971 needs in all developing regions. On the other hand, by 1971 Africa will have phosphate capacity to meet its 1980 needs, and Latin America will have capacity equal to 1980 needs in both phosphate and nitrogen. Comparisons of 1971 capacity to 1980 needs show large deficiencies of nitrogen in Africa and Asia and phosphate in Asia.

100. Figure 15 (Annex III) shows the relationship between capacity and requirements in the developing regions. This approach, however, obscures some large imbalances within regions. For example, Asia is projected as being nearly self sufficient in nitrogen and phosphate, with capacities at 96 and 92 per cent, respectively, of 1971 needs. But the detailed data show that the largest share of this capacity will be located in one country--Japan. India, although making great strides in expanding capacity, will be able to produce only a small percentage of its total fertiliser needs. A similar situation exists with nitrogen in Africa, where the Republic of South Africa and the United Arab Republic will possess the greater share of the region's capacity. To a lesser extent Latin America faces the same problem, with Mexico being the leading potential producer, especially of phosphates.

101. A word of caution is in order at this point. From a practical standpoint, the direct comparisons made between anticipated capacity and estimated needs very

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likely overstate final capabilities to produce fertilisers. Experience suggests it is unrealistic to expect all announced facilities to go on stream as presently scheduled. Slight to lengthy delays, and maybe even some cancellations, are to be expected. Thus, the capacity level achieved in 1971 will probably be less than the data indicate.

102. Also, it should not be assumed that capacity and production will be of the same magnitude. Production cannot reasonably be expected to equal 100 per cent of rated capacity, especially in developing countries where problems of establishing efficient marketing systems and of procuring repairs, raw materials, and trained operators are critical.

103. These two factors can alter the outlook considerably. For example, if all anticipated capacity becomes actual capacity, operation at 65 per cent of capacity would meet stated nutrient needs. However, if only 80 per cent of anticipated 1971 capacity is built, facilities would have to be operated world-wide at 81 per cent of capacity to meet needs.

104. The effect of this achievement and this more realistic level of operation would be quite pronounced in the developing regions. The deficit of 1.6 million metric tons of plant food--indicated with achievement of all anticipated capacity and production at 100 per cent of capacity--would burgeon into a deficit of nearly six million metric tons.

105. Still another factor to be kept in mind is that the estimated needs are based on straight-line projections of present dietary levels for a growing population. As indicated earlier, per capita demand for food in developing areas can be expected to increase as incomes and educational levels go up. This will tend to widen further the gap between food supplies and demand.

106. All of the factors highlight the need for critical assessments of long-range needs. Immediate problems of increasing fertiliser use and crop production in the next five years to reduce the food crises now faced by developing nations may seem of paramount importance. But with the lead time necessary for industrial

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planning and the ever increasing demands that will occur by 1980, it is not too early to start long-range planning of future programmes. If delayed too long, the problems of the next five years will seem minor compared to the problems to be faced in the next fifteen years.

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IV. FERTILIZER RAW MATERIAL SUPPLIES

107. The present and future supply situation for the basic fertiliser materials and the products made from these materials were discussed earlier in this paper. The availability of raw materials to produce fertilizers will be examined in this section. Although there are only three primary plant nutrients, a critical review must consider four major raw materials: feedstocks for ammonia production; phosphate rock; potash; and sulfur, used primarily in the production of phosphate fertilizers.

Feedstocks for nitrogen fertilisers

108. Capacity data indicate that nitrogen fertilisers using ammonia as the basic building-block will be produced throughout the world. Since nitrogen for ammonia production is supplied from the air, feedstocks of hydrogen become the governing factor. Early technology of ammonia production limited the supply of hydrogen to refinery or coke oven gas. With present-day technology, however, almost any economical supply of hydrogen can be used for ammonia production.

109. Natural gas has become the leading source of hydrogen for ammonia production, and most anticipated plants will use natural gas. Many areas, both developed and developing, have large supplies of this feedstock. In some cases this gas is associated with petroleum production but goes unused. Coal once was an important source of hydrogen in developed areas, but has been largely superseded by natural gas where adequate supplies are available. Replacement of older, less efficient plants with larger, more efficient units, has been one of the reasons for the rapid increase in nitrogen capacity in the developed regions.

110. Countries with oil refineries can use by-product tail-gas for ammonia production. Nations with no suitable local feedstock can import naphtha or liquefied natural gas. Thus, in the foreseeable future, raw materials for nitrogen fertiliser production should not limit location of plants or anticipated production levels.

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Phosphate rock

111. Phosphate rock is the basis of the entire phosphate industry. It is found in many areas of the world, although quantity and quality vary widely. Three areas--North America (United States), Africa, and Eastern Europe (Russia)--produce almost 90 per cent of the world supply. Table 12 (Annex II) shows phosphate rock production by areas and estimated capacities for 1971.

112. World production of phosphate rock totaled 58 million metric tons in 1964. The United States accounted for 40 per cent of the total, Africa 25 per cent, and Russia 22 per cent. Remaining production was centered in Asia and Oceania. The same three regions will continue to supply 90 per cent of all rock produced.

113. World production of phosphate rock could reach almost 110 million metric tons of material by 1971. Supplies are more than adequate for the foreseeable future. In fact, indicated reserves exceed 46,000 million metric tons--enough to last over 400 years at the 1971 rate of use.

Potash

114. Potash production will reach almost 27 million metric tons of K_2O by 1971, with production centered in North America and Western and Eastern Europe. Known reserves, indicated in table 13 (Annex II) total more than 82,000 million metric tons of K_2O.

Sulphur

115. Sulphur, while not considered a primary plant nutrient, is closely associated with fertiliser production in that sulphuric acid acidulation of phosphate rock forms the basis of today's phosphate industry. The recent rapid expansion in the phosphate industry has caused an equally rapid rise in the demand for sulphur. As a result sulphur prices have risen and supplies are short in many areas of the world. This has touched off a world-wide expansion of sulphur production and large-scale exploration for new supplies, including some sources which were not feasible to develop at the lower price levels. Table 14 (Annex II) shows the supply-demand situation for sulphur, excluding Eastern Europe and

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China (Mainland), and estimated requirements based on the types of phosphate products expected in 1971. The capacity data do not include several projects now under study. If built, they could add substantially to the indicated capacity.

116. Figure 16 (Annex III) depicts the present sulphur situation. Since 1963 consumption of sulphur in all forms has exceeded production. In 1966 consumption exceeded production (24,125,000 metric tons) by 775,000 metric tons. The difference has been made up through draw-down of stocks, which were at high levels prior to the rapid increase in demand which began in 1963. Capacity data indicate that steps are being taken to meet the increased sulphur demands. Estimated capacity scheduled through 1969 shows a more rapid increase than the projected growth in demand. Capacity should reach 32.3 million metric tons by 1969—the latest year for which data are now available. It is anticipated that supply and demand should be in balance sometime in 1968. Indications are that sulphur supplies should be adequate but will not be much in excess of demand for sulphur in 1969. This situation could change rapidly, however, as the results of present exploration are evaluated.

117. Elemental sulphur production is located primarily in North America and the major expansion of sulphur capacity will occur in this region. Substantial increases in recovered sulphur are expected in Asia as the countries of the Near East develop their sour gas fields. Little expansion in the production of other forms of sulphur appear likely except in North America.

118. The above discussion of raw material supplies and reserves shows that the world should have adequate capacity to meet the requirements for the production of fertilisers that are scheduled by 1971.

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V. WORLD TRADE IN FERTILIZER MATERIALS

119. With the deficit in estimated fertilizer production capacity in relation to needs in the developing regions, it is apparent that world trade will be an important segment of the world fertilizer industry. The following section reviews past world trade patterns and the changes that can be expected.

120. Over the past five years approximately 24 per cent of all plant nutrients produced have entered into world trade. Twenty per cent of all nitrogen, 13 per cent of all phosphates, and over 42 per cent of all potash is moved through world trade channels before reaching the point of use. The amount of nitrogen entering trade has increased from 2.2 million metric tons in 1960 to 3.2 million metric tons in 1965. This was a slight decrease, however, as a percentage of total production. Phosphate and potash trade has increased as a percentage of total production.

121. Developing regions received 3.4 million metric tons, or 33 per cent, of the 10.21 million metric tons of plant nutrients traded. Over the last five years trade with the developing regions has increased 1.17 million metric tons with the percentage of material moving into these regions remaining constant.

122. Almost half of all nitrogen traded goes to the developing regions, while 40 per cent of the phosphates and less than 25 per cent of the potash is imported by the developing regions. Table 15 (Annex II) shows the extent of world trade in the primary fertilizer nutrients.

123. If the developing countries are going to meet their present fertiliser requirements and develop domestic fertiliser markets, world trade with these regions must increase substantially, at least until the time when planned local production units are brought into operation. With the exception of potash, trade among developed nations should decrease as more of these countries add production facilities. World trade in the form of overseas shipments to the developing regions should increase. With the development of fertiliser markets in the developing regions, world trade can be expected to increase in terms of local tonnage of plant nutrients, however, there may be a decrease in trade relative to world production.

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124. Shifts can be expected in types of products entering world trade, partly in response to efforts to reduce transportation costs per unit of plant nutrient through use of more concentrated materials. This trend already is apparent in nitrogen. In 1960, ammonium sulfate accounted for 37 per cent of all nitrogen traded, followed by ammonium nitrates with 24 per cent and urea 12 per cent. By 1965 urea had increased its share to 23 per cent, while ammonium sulfate accounted for only 31 per cent and ammonium nitrates 18 per cent.

125. The trend towards higher analysis is also apparent in phosphates. Concentrated superphosphate now contributes 29 per cent and complex fertilisers 31 per cent of all P_2O_5 exported. In 1960 these materials accounted for 22 per cent and 21 per cent, respectively. During the same period, normal superphosphate's share of world trade decreased from 20 to 14 per cent. Basic slag declined from 37 to 26 per cent.

126. These export data are world totals, and thus include trade within continents. High-analysis products constitute an even higher percentage of overseas shipments.

127. There are sound reasons for the entrance of high hypothetical analysis products into world trade, as indicated by the following tabulation:

Effect of analysis on costs of imported fertiliser materials [1/]

		Ammonium Sulfate (21% N)	Urea (45% N)
Nitrogen requirements (tons)		100,000	100,000
Material to be shipped (tons)		476,190	222,222
Cost of material	($/ton)	40.00	85.00
Transportation cost	($/ton)	10.00	10.00
Other charges	($/ton)	4.00	4.00
Total cost	($/ton)	54.00	99.00
Total cost of material	($)	25,714,260.00	21,999,978.00
Cost of plant nutrient	($/ton)	257.14	220.00
Net savings	($)	3,714,282	
Percent savings	(%)	14.4	

1/ A hypothetical situation for illustration purposes based on assumed prices and charges.

128. Substitution of urea for ammonium sulfate results in a net savings of 14.4 per cent. The assumed prices and charges represent 1966 market conditions. The advantage will change depending on point of origin and destination of the material, and the types of material under consideration. Further savings may be realised during distribution in the receiving country.

129. A look at the product capacity estimates for 1971 points to another important reason for the expected increase in the trading of high-analysis materials. Fertilisers imported by the developing countries will be used for market development and education purposes, eventually leading to the use of domestically produced materials. Planned production facilities in the developing nations are centered around the higher analysis nitrogen materials such as urea, and high-analysis phosphate materials, such as concentrated superphosphate and complex fertilisers. If markets are going to be developed for these materials the development programme should be based on the types of materials that will

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eventually be produced. A rapid transfer from one type of product cannot be expected as supplies become available. Programmes based on low analysis materials will delay the acceptance of the higher analysis products.

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VI. INVESTMENT OPPORTUNITIES

130. Various levels of development exist in the developing countries. However, almost all of these nations have the problem of limited foreign exchange. Thus, sound economic planning for a fertilizer supply is necessary to ensure the most productive use of the funds that are available. The developed nations have the capital and the know-how to help the developing nations establish a fertilizer industry. This section looks at the role the developed countries can play in this development and the conditions under which investment in the developing countries can be expected.

131. Four stages of development have been suggested by Douglas (Annex I, ref. 7). Although much overlapping is normal, they can be viewed as distinct and progressive steps in the development of a nation's agriculture and fertilizer industry. Douglas' suggested stages are:

1. Importation of food to stave off famine while fertilizers are being introduced and demonstrated to create a market;
2. Importation of finished fertilizers to meet growing demand until a domestic industry is justified;
3. Building of local production facilities with aid of imported technical construction and operation know-how;
4. Self sufficiency of production and operation, with imports limited to raw materials not available locally.

Figure 17 (Annex III) illustrates the overlapping of these development stages.

132. The first stage at best is a short-run solution to supplying food needs. Developed regions cannot be expected to produce and furnish in excess of their own needs the quantities needed to meet imminent huge demands in developing areas. In fact, continuation of such a practice can lead to even greater food problems.

133. Secondly, the developed nations should not continue to supply all of the finished fertilizer products needed by the developing countries. This type of programme would require the outlay of large amounts of foreign exchange which is now inadequate in the developing countries. These countries should encourage the use of their own resources, both human and material whenever it can be economically justified.

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Preface

The National Fertilizer Development Center located at Muscle Shoals, Alabama, a part of the Tennessee Valley Authority (TVA), is called on by the United States Government, especially the Agency for International Development, to furnish information on various problems relating to fertilizers. As a part of this responsibility TVA has been requested to maintain a current tabulation known as the "World Fertilizer Production Capacity as Related to Future Needs"; first report on this subject was published in February 1966. Information presented in this paper is taken largely from this study. Included is survey information of industries and organizations in Western Europe, Japan, and North America. The activities of these organizations include furnishing fertilizers, construction of fertilizer production facilities, and financing of various programmes in the developing countries. This report is the result of TVA's attempt to keep up-to-date with the world fertilizer situation through frequent contacts with representatives of the fertilizer industries throughout the world.

134. Savings in foreign exchange can be realized through careful investigation of all of the possible alternatives. For example, a recent study by Achorn and Walkup (Annex I, ref. 1) indicates the potential for reducing foreign exchange requirements by processing intermediate products into the finished fertilizer product in the developing countries. They found that the developing countries could import urea-ammonia solution and process it into complex fertilizer at a savings of from $U.S. .92 to $U.S.5.31 per ton of product as opposed to making the same grades of complex fertilizer using imported anhydrous ammonia and solid urea.

135. The importation of intermediate fertilizer materials by the developing nations may prove to be a major step towards the establishment of a domestic fertilizer industry. Plants for the processing of intermediate materials into finished fertilizer products do not require as large an investment as plants to produce the basic raw materials. Savings may be realized through purchasing the intermediates from points with lower production costs than would be possible from smaller production plants located in each country. Transportation savings are possible with the importation of high-analysis intermediate products rather than the relatively lower plant nutrient content of the finished materials. Flexibility and the ability to meet changing demand patterns are maintained, however.

136. The step-by-step development of the fertilizer industries in the developing regions will vary from country to country. Each country must attempt, however, to achieve the most efficient use of all available resources. This can only be accomplished by exploring all other possible alternatives.

137. It becomes apparent that the role of the developed nations ideally should be that of helping the developing nations through investment of capital and furnishing technical know-how. Experience abounds in the developed countries in construction, operation, management and maintenance of fertilizer plants. The development of efficient distribution and marketing systems can also be aided with the help of the developed countries.

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138. A favourable investment climate must exist in the developing regions before developed nations can be expected to put their resources into such programmes. Returns on investment must at least be equal to that available in the developed regions. This involves easily transferable profits and liberal write-off terms. It is of primary importance that the system permits the producer to exercise a high degree of control over the marketing of the products. While the risk factor is present in any investment, every attempt should be made to keep it to a minimum.

139. The developed nations have demonstrated that they have the resources available and are willing to undertake programmes of assistance to the developing nations. The developing nations should do everything possible to encourage their participation.

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VII. FACTORS THAT INHIBIT FERTILIZER INDUSTRY EXPANSION IN DEVELOPING COUNTRIES

140. The fact that a country needs to increase its use of fertilizers does not assure that a fertilizer industry will develop or that adequate quantities of fertilizers will be used. Need does not automatically create a demand. Unless sufficient demand exists or can be created rapidly, development of a fertilizer industry should not be encouraged.

141. On the other hand, farmer demand for fertilizer is insufficient to guarantee development or expansion of a fertilizer industry in developing countries. Other factors also play an important role, especially when the industry is dependent on making a profit. Although a complete discussion is not attempted here, the factors discussed in this section are those most often mentioned by those interested in fertilizer investments in the developing countries.

Governmental attitude

142. Although investors in fertilizer facilities in developing countries expect to assume major responsibility for establishing the industry, they are well aware that governmental contributions can and must smooth the way. This is referred to as "favourable investment climate".

143. For investments to be encouraged, investors not only look for stability of the Government, but they also need assurance that all major factions vying for control are in general accord with progressive policies towards investments and are cognizant of the value and need for expanding the use of fertilizer use.

144. Indicators of governmental attitude include policy towards:

(a) Tariffs: Imports of raw materials, equipment and replacement parts should not be discouraged by excessive tariffs;

(b) Domestic raw materials: Raw materials that may be of inferior quality or excessively high priced should not be unrealistically promoted;

(c) Taxes: Whether internal or external, taxes that raise the cost of fertilizers in relation to farm products sold should be eliminated;

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(d) Credit: Industry is willing to co-operate in the mechanics of extending credit but looks to the Government to establish and execute realistic credit policies; credit should be available at a reasonable rate and be tailored to fit the agricultural cycle;

(e) Port, transportation and distribution systems: Investors can, under certain conditions, help in the development of these essential facilities; it is felt, however, that public development may be in the best interest of the country as a whole;

(f) Repatriation of a realistic part of the profit: Where foreign investors are involved a realistic attitude must be taken towards repatriation of profits to amortise the investment; with a good investment climate, however, outside investors are willing to use much of this money in further expansion of industry;

(g) Management of production facilities: Until such time that trained and experienced personnel are available, investors should be assured that they will have some control of the staffing of these facilities to assure successful operation.

(h) Sale of fertiliser materials: Experiences in the heavy fertiliser using countries has indicated that services offered by the seller of fertilisers are often as important in increasing fertiliser sales as price; investors are generally convinced that sales personnel with an incentive to sell will give better service and thus increase sales better than governmental sales organisations;

(i) Insurance against losses due to unnatural causes: Although there are available various forms of insurance that will somewhat alleviate this fear, the preferred assurance is a governmental policy that inspires confidence through its attitude towards private enterprise.

Financing

145. Capital requirements for the total world increase in fertiliser production capacity between 1965 and 1970 has been estimated to be in excess of $U.S.9 billion (Annex I, fig. 16). The expenditure for hard currency in the developing countries averages about 60 per cent of the total cost (Annex I, fig. 5).

146. Local sources, either governmental or private, usually can be found to invest the needed local currency. Hard currency is often quite limited and much of it must be obtained from external sources. Sources of hard currency for fertiliser plant construction are numerous and are increasing. A recent paper presented at the Fertiliser Association of India by Dr. C. Coleman Fisher

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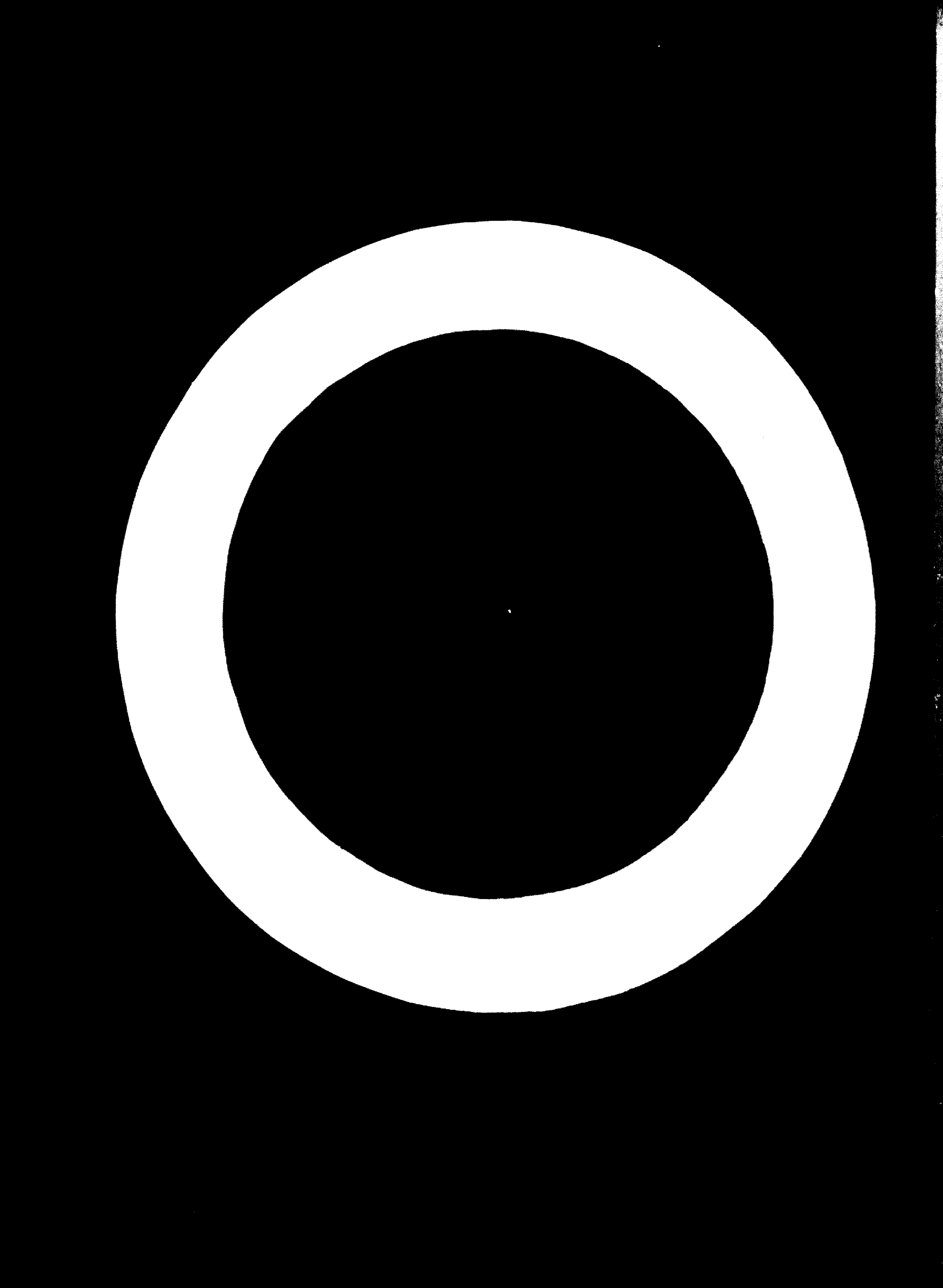
(Annex I, fig. 12) gives a good summary of the types of financing that are available and the terms under which they can be obtained. Dr. Fisher noted that contribution of foreign private enterprises are not only money and managerial skills but their presence in a project assures other financing sources of the viability of the project. This is so because private enterprise has the basic goal of making a profit. Host Governments which create an environment that attracts private enterprise usually find fertiliser plant financing easier than those Governments which fail to do so.

Personnel

147. Lack of personnel with adequate training and experience is a major deterrent to the establishment of fertiliser industries in the developing countries. This is true not only for the fertiliser industry itself, but also for related industries on which fertiliser industries depend. To overcome this deficiency many developing countries are finding that the contribution of management and operating personnel by private investors is as important as their contributions in money. To make this mutually beneficial, a spirit of co-operation must prevail which insures that local personnel will be trained and, with sufficient experience, be given management and operating responsibilities.



References

1. Achorn, F. W. and H. G. Walkup. "Cost Comparison of Ocean Shipment of Anhydrous Ammonia and Solid Urea vs Shipment of Urea-Ammonia Solution", Tennessee Valley Authority, Muscle Shoals, Alabama, December 1966.

2. Brown, L. R. "Man, Land, and Food: Looking Ahead at World Food Needs". Foreign Agricultural Economic Report No. 11, U. S. Department of Agriculture, Washington, D. C. 1963.

3. Carpentier, J. I. "Fertilizer Production in the Developing Countries", presented at Journées Techniques of Paris, International Conference of Chemical Arts, April 21-May 2, 1965; Phosphate Notes, The International Superphosphate Manufacturers' Association, Paris, France, May 1965.

4. "Changes in Agriculture in 26 Developing Nations--1948 to 1963", Foreign Agricultural Economics Report No. 27, Economic Research Service, U. S. Department of Agriculture, November 1965.

5. Cilingiroglu, Ayhan (World Bank). Personal communication, 1965.

6. Coleman, Russell. Fertiliser News (India), 9, No. 4, 1964.

7. Douglas, J. R., Jr. "U. S. Fertiliser Industries Opportunity in Fulfilling World Fertilizer Needs", presented at the National Fertiliser Solutions Association, annual meeting, Miami Beach, Florida, December 5-9, 1966.

8. Engineering and Mining Journal, "Sulphur-Annual Survey of Outlook", 1960-1965.

9. Ewell, Raymond. Insert for "Famine and Fertiliser", presented to the American Chemical Society, Chicago, Illinois, January 1965.

10. Ewell, Raymond. Chemical and Engineering News, No. 50, 108-17, 1964.

11. Fertiliser Use in U.S.A. Agricultural Economic Report No. 92, Economic Research Service--U. S. Department of Agriculture, Washington, D. C. p. 3, May 1966.

12. Fisher, C. Coleman. "Capital Sources for Fertiliser Plant Construction", presented to the Fertiliser Association of India, annual seminar, December 1966.

13. Food and Agriculture Organization. "Third World Food Survey", FFHC Basic Study No. 11, United Nations, Rome, Italy, 1963.

/...

14. Food and Agriculture Organization. "Fertilisers--An Annual Review of World Production, Consumption, and Trade", United Nations, Rome, Italy, annual reports 1946-1965.

15. International Superphosphate Manufacturers' Association, "Phosphate Rock Statistics", London, 1960 and 1964.

16. McCune, D. L., T. P. Hignett, and J. R. Douglas, Jr., "Estimated World Fertiliser Production Capacity as Related to Future Needs", Tennessee Valley Authority, Muscle Shoals, Alabama, February 1966.

17. Oil and Gas Journal, January 9, 1967, p. 52.

18. Parker, F. W., D. D. Steward, and Paul Pepersak. Fertiliser News, (India), 9, No. 3, 1964.

19. Parker, F. W. "Priorities in Agriculture Development and Investment", presented at Conference on Economic Development of Agriculture, Iowa State University, Ames, Iowa, November 10-12, 1964.

20. Richardson, H. L. "The Freedom-From-Hunger-Campaign--Five Years of the FAO Fertiliser Programme (FAO)", United Nations, Rome, Italy, 1966.

TABLE 1

ANNUAL POPULATION GROWTH RATES (9)

	Rate of Population Growth Percent/Year
Developing Regions	
Africa	2.3
Asia	2.3
Latin America	2.8
Developed Regions	
North America	1.7
Europe	0.9
Soviet Union	1.7
Oceania	2.1

TABLE 2

COMPARISON OF FOOD DEMAND AND POPULATION GROWTH IN SELECTED COUNTRIES (4)

Country	Annual Population Growth Rate, Percent	Total Annual Food Demand Increase, Percent
Venezuela	4.0	6.2
Chile	2.5	3.0
Nigeria	3.7	4.9
Tunisia	1.8	2.9
Greece	1.0	3.3
Poland	1.8	5.1
India	2.0	3.4
Pakistan	2.2	2.4
Japan	1.2	5.6
Thailand	3.2	4.9

TABLE 3

ESTIMATED WORLD FERTILIZER REQUIREMENTS (16)

Region	Consumption 1964	Requirements 1970	Requirements 1980	Compound Annual Increase 1964-70	Compound Annual Increase 1970-80
	.... Millions of Metric Tons				
Western Europe	12.3	16.2	22.7	4.7	3.4
Eastern Europe 1/	7.4	13.2	22.9	10.2	5.7
North America	9.8	15.5	25.0	7.9	4.9
Oceania	1.2	1.9	2.6	8.7	3.2
Asia 2/	4.7	13.4	25.5	19.0	6.7
Africa	0.9	3.8	6.8	27.4	6.0
Latin America	1.4	3.5	6.2	16.4	5.9
World	37.7	67.5 3/	111.7 3/	10.2	5.1

1/ Including U.S.S.R.

2/ Including Mainland China

3/ Does not take into account transfers of food from developed to developing regions

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Introduction

1. Many nations--even regions of the world--are losing their ability to feed themselves. The reason is simple: population is growing faster than food production. The problem is compounded by the fact that food-short areas also are the areas with the highest population growth rates. Thus, the share of the world's population facing food shortages is increasing, as illustrated in Annex III, figures 1, 2, 3, and 4, and table 1 (Annex II).

2. Actually, the food problem is greater than indicated by the rate of population growth. Diet improvement is high on the list of human wants, table 2 (Annex II). Thus, as incomes climb in developing nations the per capita demand for food also climbs. If supplies are not commensurate with the higher demand, the diets of groups whose purchasing power has shown least improvement will deteriorate seriously because of their relatively weaker position in the market place.

3. Many countries with a deficit food production have little additional potentially productive agricultural lands which can be used to meet present and future needs. Developing nations which do have additional productive land often do not have the resources to bring it into production fast enough to keep up with the surging demand.

4. Thus, food needs over the next decade will have to be met largely through increased production from land presently under cultivation. This means that world-wide agricultural production levels must be advanced more rapidly than at any time in history. If world population is to double between now and the end of the century, food production must be doubled in a considerably shorter period to meet demand and avert famine.

5. The imminent need for a great increase in food production to meet the demands of an increased population and an expanding economy has been widely recognized (Annex I, refs. 2, 3, 6, 10, 18). The magnitude of the need is indicated in the FAO Third World Food Survey (Annex I, ref. 13) which notes that the developing regions, particularly the Far East, must increase their food supply at a much

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TABLE 4

WORLD PLANT NUTRIENT CONSUMPTION (14)

Year	N	P_2O_5	K_2O	Total
1946	2,025	3,375	2,100	7,500
1950	3,639	5,864	3,994	13,497
1955	6,230	7,580	6,450	20,260
1956	6,630	7,840	6,830	21,300
1957	7,310	8,250	7,190	22,750
1958	7,860	8,530	7,410	23,800
1959	8,780	9,140	7,940	25,860
1960	9,220	9,530	8,380	27,130
1961	10,210	9,950	8,470	28,630
1962	11,030	10,420	8,610	30,060
1963	12,350	11,010	9,130	32,490
1964	13,970	12,200	10,170	36,340
1965	15,480	13,310	11,140	39,930

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Table 5

World Production of Nitrogen Fertilizers (14)

Year	Western Europe	Eastern Europe (includes USSR)	Asia (excludes M. China)	Africa	Oceania	North America	Latin America	Total
	Region							
	Million Metric Tons of N							
1955	2.68	.62	.74	.02	.02	2.00	.29	6.37
1960	3.96	1.69	1.08	.06	.03	2.77	.31	9.90
1961	4.37	1.89	1.25	.08	.03	3.03	.28	10.93
1962	4.53	2.09	1.41	.14	.03	3.35	.40	11.95
1963	4.75	2.40	1.59	.18	.03	3.79	.42	13.17
1964	5.21	2.85	1.81	.17	.02	4.25	.48	14.77
1965	5.76	3.44	1.99	.17	.03	4.75	.49	16.63
	Estimated Capacity							
1966	7.53	4.22	3.03	.27	.05	7.95	1.14	24.19
1971	13.72	11.44	5.89	1.43	.36	12.14	3.28	49.28

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TABLE 6

PRODUCTION OF NITROGEN FERTILIZER PRODUCTS (N) 1/

Year	Ammonium Sulfate 2/	Ammonium Nitrate 3/	Other Solids 4/	Urea	Other	Total
	Product					
	.... Million Metric Tons of N					
1955	1.83	1.58	.84	.12	1.39	5.76
1960	2.47	2.74	.88	.69	2.22	9.00
1961	2.60	3.04	.85	.91	2.52	9.92
1962	2.69	3.28	.87	1.07	2.87	10.78
1963	2.72	3.78	.88	1.31	3.06	11.75
1964	2.75	4.28	.92	1.61	3.46	13.02
1965	2.93	4.83	.92	1.85	4.01	14.54
	Estimated Capacity					
1966	3.84	6.87	1.04	4.02	6.32	22.09
1971	4.63	10.25	1.08	9.44	17.70	43.10

1/ Excluding Russia and Mainland China

2/ Includes ammonium sulfate nitrate

3/ Includes ammonium nitrate and ammonium nitrate limestone

4/ Sodium nitrate, calcium nitrate, calcium cyanamide

/...

TABLE 7

WORLD PRODUCTION OF PHOSPHATE FERTILIZERS (14)

Year	Western Europe	Eastern Europe	Asia	Africa	Oceania	North America	Latin America	Total
	Region							
	.... Million Metric Tons of P_2O_5							
1955	3.09	1.07	.37	.19	.63	2.38	.09	7.82
1960	3.93	1.44	.60	.25	.70	2.78	.17	9.87
1961	3.84	1.56	.59	.26	.77	2.92	.20	10.14
1962	3.94	1.67	.63	.29	.80	2.88	.17	10.38
1963	4.11	1.88	.64	.32	.92	3.37	.21	11.45
1964	4.32	2.28	.74	.37	1.03	3.94	.24	12.97
1965	4.38	2.82	.81	.31	1.13	4.02	.28	13.75
			Estimated Capacity					
1966	5.93	2.88	1.92	.84	1.48	6.82	.47	20.34
1971	7.73	7.35 1/	3.31 2/	1.71	1.91	9.00 3/	2.31	33.33 4/

1/ Includes scheduled Russian capacity for all forms of P_2O_5 of 5.0 million tons. Estimated that 1.41 million metric tons will be phosphate rock for direct application

2/ Excluding Mainland China

3/ Does not include 1.29 million metric tons of P_2O_5 as furnace phosphoric acid for industrial purposes.

4/ Total world capacity of P_2O_5 excluding phosphate rock used in Russia and with the addition of Mainland China and furnace phosphoric acid in North America is estimated to be 33.49 million metric tons.

TABLE 8

PRODUCTION OF PHOSPHATIC FERTILIZER PRODUCTS (14) 1/

Year	Normal Superphosphate	Concentrated Superphosphate	Basic Slag	Complex Fertiliser and Other	Total
	Product				
	....	Million Metric Tons of P_2O_5		....	
1955	4.18	.78	1.00	.67	6.63 2/
1960	4.58	1.20	1.40	1.78	8.96
1961	4.60	1.26	1.34	1.99	9.19
1962	4.71	1.21	1.33	2.16	9.41
1963	5.06	1.45	1.34	2.50	10.35
1964	5.44	1.75	1.39	2.98	11.56
1965	5.33	1.81	1.42	3.37	11.93
		Estimated Capacity			
1966	6.80	2.73	1.44	7.96	18.93
1971	7.68	4.83	1.45	14.37	28.33

1/ Excluding Russia and Mainland China

2/ Excluding Poland, Russia and Mainland China

/...

TABLE 9

WORLD PRODUCTION OF POTASH FERTILIZERS (14)

Year	Western Europe	Eastern Europe	Asia	Africa	North America	Latin America	Total
	Region						
	....	Million Metric Tons of K_2O			....		
1955	3.01	2.00	-	-	1.65	.02	6.68
1960	3.63	2.68	.08	-	2.30	.02	8.70
1961	3.87	2.75	.09	-	2.05	.01	8.77
1962	4.08	2.84	.09	-	2.33	.02	9.36
1963	3.93	3.08	.11	-	2.59	.02	9.82
1964	4.21	3.25	.12	-	3.48	.03	11.10
1965	4.53	3.75	.24	-	3.67	.03	12.22
			Estimated Capacity				
1966	4.66	3.75	.24	-	5.31	.03	13.99
1971	5.98	8.41	.48	.68	10.93	.27	26.75

TABLE 10

WORLD FERTILIZER REQUIREMENTS AND ESTIMATED PRODUCTION CAPACITY (16)

Region	Estimated Requirements 1971	Estimated Requirements 1980	Estimated Capacity 1966	Estimated Capacity 1971	Balance of Requirements and Estimated Capacity 1971
	....	Million Metric Tons of Plant Nutrient			....
Developed					
Western Europe	16.8	22.7	18.1	27.4	10.6
Eastern Europe	13.9	22.9	10.9	27.2	13.3
Oceania	2.0	2.6	1.5	2.3	0.3
North America	16.3	25.0	20.1	32.1	15.8
Total	49.0	73.2	50.6	89.0	40.0
Developing					
Asia	14.3	25.5	5.2	10.7	-3.6
Africa	4.0	6.8	1.1	3.8	-0.2
Latin America	3.7	6.2	1.6	5.9	2.2
Total	22.0	38.5	7.9	20.4	-1.6
WORLD TOTAL	71.0	111.7	58.5	109.4	38.4

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TABLE 11

WORLD REQUIREMENTS AND PRODUCTION CAPACITY FOR NITROGEN, P_2O_5, AND K_2O, BY REGIONS (16)

Regions	Plant Nutrient Requirements 1/ 1971 N	1971 P_2O_5	1971 K_2O	1980 N	1980 P_2O_5	1980 K_2O	Capacity 1971 N	Capacity 1971 P_2O_5	Capacity 1971 K_2O
	.... Million Metric Tons								
Developed									
Western Europe	8.400	4.200	4.200	11.350	5.675	5.675	13.72	7.73	5.98
Eastern Europe	6.950	3.475	3.475	11.450	5.725	5.725	11.44	7.35	8.41
Oceania	1.000	.500	.500	1.300	.650	.650	.38	1.91	-
North America	8.150	4.075	4.075	12.500	6.250	6.250	12.14	9.00	10.93
Total	24.500	12.250	12.250	36.600	18.300	18.300	37.68	25.99	25.32
Developing									
Asia	7.150	3.575	3.575	12.750	6.375	6.375	6.89	3.31	.48
Africa	2.000	1.000	1.000	3.400	1.700	1.700	1.43	1.71	.68
Latin America	1.850	.925	.925	3.100	1.550	1.550	3.28	2.31	.27
Total	11.000	5.500	5.500	19.250	9.625	9.625	11.60	7.33	1.43
WORLD TOTAL	35.500	17.750	17.750	55.850	27.925	27.925	49.28	33.33	26.75

1/ Based on an N-P_2O_5-K_2O ratio of 2-1-1.

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faster rate than the world as a whole.

6. Several individuals and organizations have emphasized the role that fertilizers can and must play in expanding food production, and estimate the amounts of fertilizers that will be needed (Annex I, refs. 6, 10, 16, 19). The estimate made by the Tennessee Valley Authority is one of the most recent. This estimate, shown in table 3 (Annex II) indicates that world plant nutrient requirements will be 67.5 million metric tons by 1970 and will approach 112 million metric tons by 1980. To reach these levels will require an annual growth rate of 10 per cent in the 1965-1970 period and a 5 per cent annual growth rate from 1970 to 1980. The required growth rates in the developing regions range from 17 to 27 per cent per year in the 1965-1970 period and 6 to 7 per cent per year from 1970 to 1980.

7. Throughout this report comparisons are made between estimated capacity levels and estimated needs. The estimates of needs are based on maintaining present dietary levels in the developing countries. It is assumed that additional food demand due to an increasing standard of living can be met by reducing distribution and storage losses and by bringing additional land into production. The needs for 1970, 1971, and 1980 are offered as a minimum guideline. For the reasons discussed above, these estimates may well prove too conservative.

Fertilizers in relation to other inputs

8. In the early stages of agricultural development, movement from traditional methods towards new technology is frequently slow and difficult to achieve. Farmers with limited resources, education, and vision are understandably hesitant to change from their traditional ways. They cannot be expected to readily adopt a group of unfamiliar practices. A key in overcoming this inertia is to gain farmer acceptance of one or more practices which can be carried out easily and which quickly produce visible results.

9. Fertilizer is generally accepted as such a "lead" practice. Its effects show up early as differences in growth and color of well fertilized plants and in a few weeks or months as increased crop yields or profits. Other practices may

/...

achieve the same results, but often require larger cash outlays and have less effect on income and profit.

10. As farmers become aware of the gains that can accrue from the use of fertilizers, they are more willing to try other improved methods that move them towards a more modern and productive agriculture. Thus, while fertilizer use is desirable in itself, its role as a "lead" practice to initiate change may be of equal or greater importance. Without the use of improved crop varieties, insect and plant disease control and other improved cultural practices, fertilizers can have only a limited effect on agricultural production. All inputs must be in proper balance to approach an optimum level of production.

Fertilizers as a short-run answer

11. The Freedom-From-Hunger-Campaign fertilizer programme--administered by the FAO and supported by contributions of money, men and fertilizer materials from the world fertilizer industry and by contributions from various Governments--has provided valuable information on the potentials for using fertilizers as a "lead" practice with small peasant farmers. In reporting results of the first five years of the programme, Dr. H. L. Richardson, manager of the fertilizer programme states (Annex I, ref. 20):

> ".....fertilizers can be used effectively in developing countries to increase production of crops, including food crops to feed their growing populations. Small peasant farmers can increase their crop yield by an average of over 50 per cent by using fertilizers alone, and it is difficult to set a limit to the possibilities when fertilizers are combined with other improved methods of farming."

12. In this same paper, Dr. Richardson reports on the results of over 11,500 demonstrations. Of these, 88 per cent had at least one profitable fertiliser treatment. On small farms and using local prices the average value-cost ratio of the best treatment was 3.4. This implies an average profit of 240 per cent. Small plot fertilizer trials using more treatments had even better results.

13. The results have been duplicated in many different countries with different levels of development. The United States Department of Agriculture estimates,

/...

for example, that 35 to 40 per cent of the increased agricultural production in the United States during recent years is due to increased fertilizer use (Annex I, ref. 11). In developing countries where soils are less fertile, the use of fertilisers is even more important since very little increase in food production will result unless fertilisers are applied.

I. WORLD FERTILIZER CONSUMPTION AND PRODUCTION TRENDS

Consumption patterns

14. Prior to 1963 the world fertilizer industry was characterized by a steady growth averaging 5.8 per cent per year.

15. During 1963-1965 world fertilizer consumption increased at an average rate of 10 per cent per year. Although figures for the 1965/1966 fertilizer year are not yet available, indications are that fertilizer consumption exceeded the previous year by more than 10 per cent. It is apparent that the world fertilizer industry is expanding at a rate which will meet the 1970 requirements indicated by TVA (Annex I, ref. 16).

16. Although world fertilizer use has been increasing at a rate adequate to meet indicated needs, the developing regions--South America, Asia, and Africa--have not been increasing fertilizer use at a rate sufficient to meet their 1970 needs. These three regions, according to FAO data (Annex I, ref. 14), consumed about 13.5 per cent of the total fertilizer used during 1959/1960 and only about 14 per cent in 1964/1965. Compared to needed compound annual increases of from 11 to 27 per cent for the period 1965-1970, these regions have increased use at an average rate of less than 10 per cent per year.

17. On the other hand, the developed nations are expanding use much in excess of the rate necessary to meet their needs. This indicates that adequate food could be produced in these regions, at least in the short run, to meet world food needs if transportation, distribution, and financing problems can be overcome. With the scope of these problems, however, this approach to solving the world food problem for other than the short run appears dubious.

18. The relative importance of the primary nutrients has changed in recent years. Prior to 1961 consumption of phosphates exceeded that of nitrogen or potash, as shown in figure 5 (Annex III) and table 4 (Annex II). Since that time nitrogen has become the leading plant nutrient.

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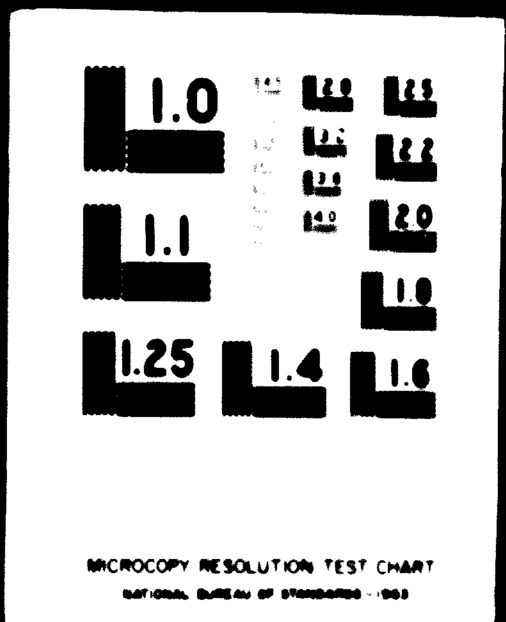

1.0
1.1
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963

Figure 5

WORLD PLANT NUTRIENT CONSUMPTION

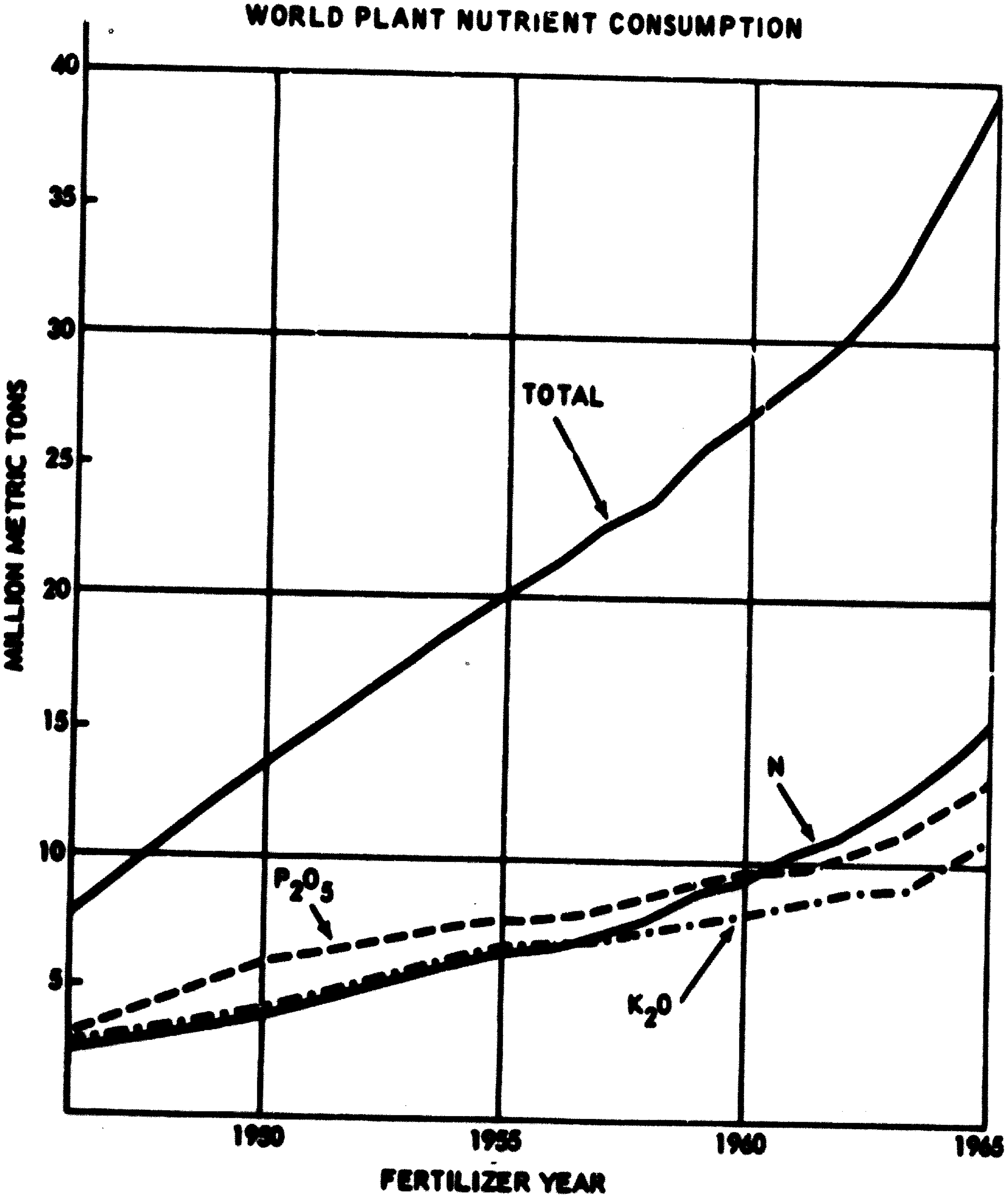


Figure 6

WORLD NITROGEN PRODUCTION

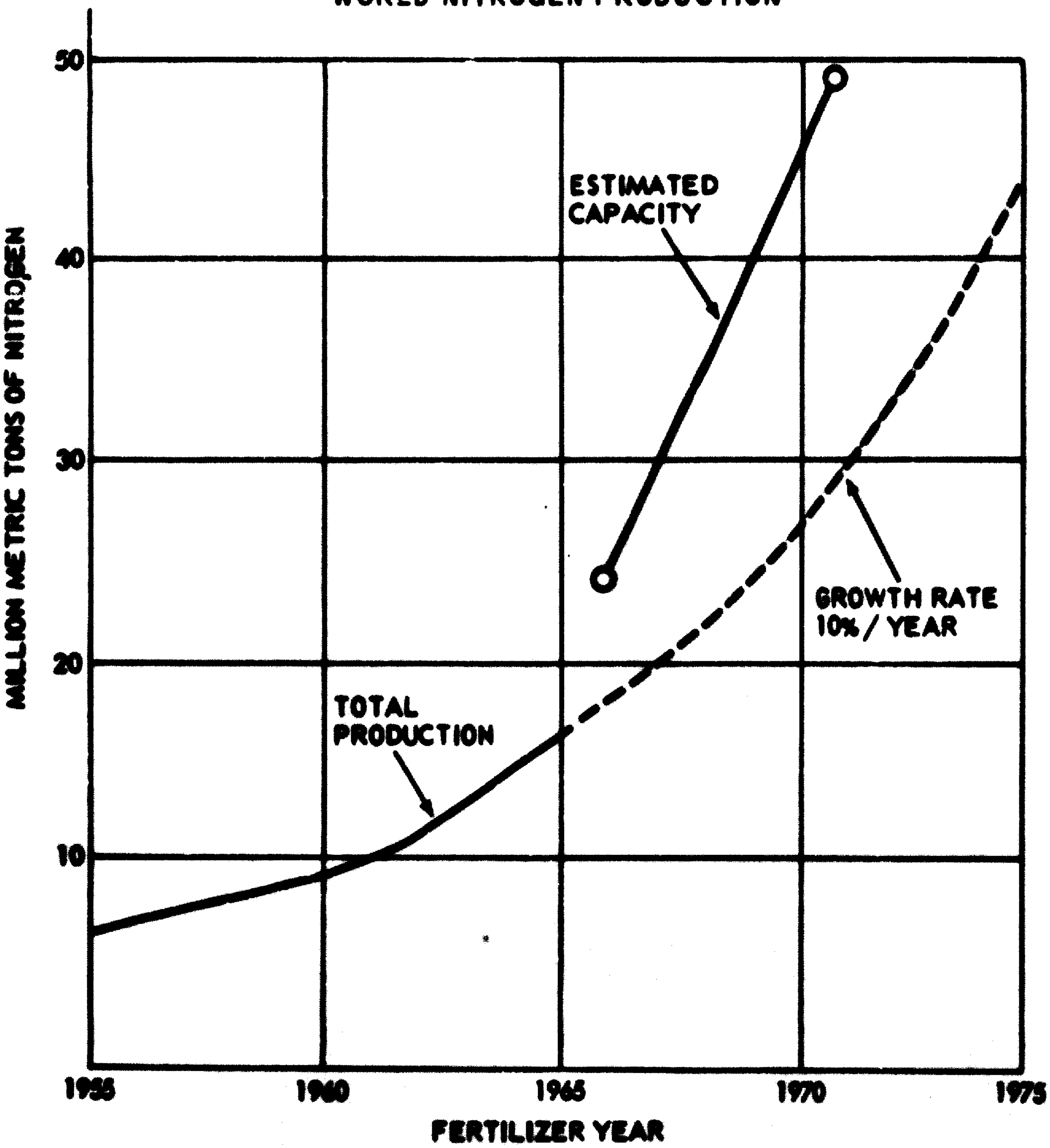


Figure 7

WORLD PRODUCTION
OF NITROGEN FERTILIZER PRODUCTS
(Excluding U.S.S.R. and China)

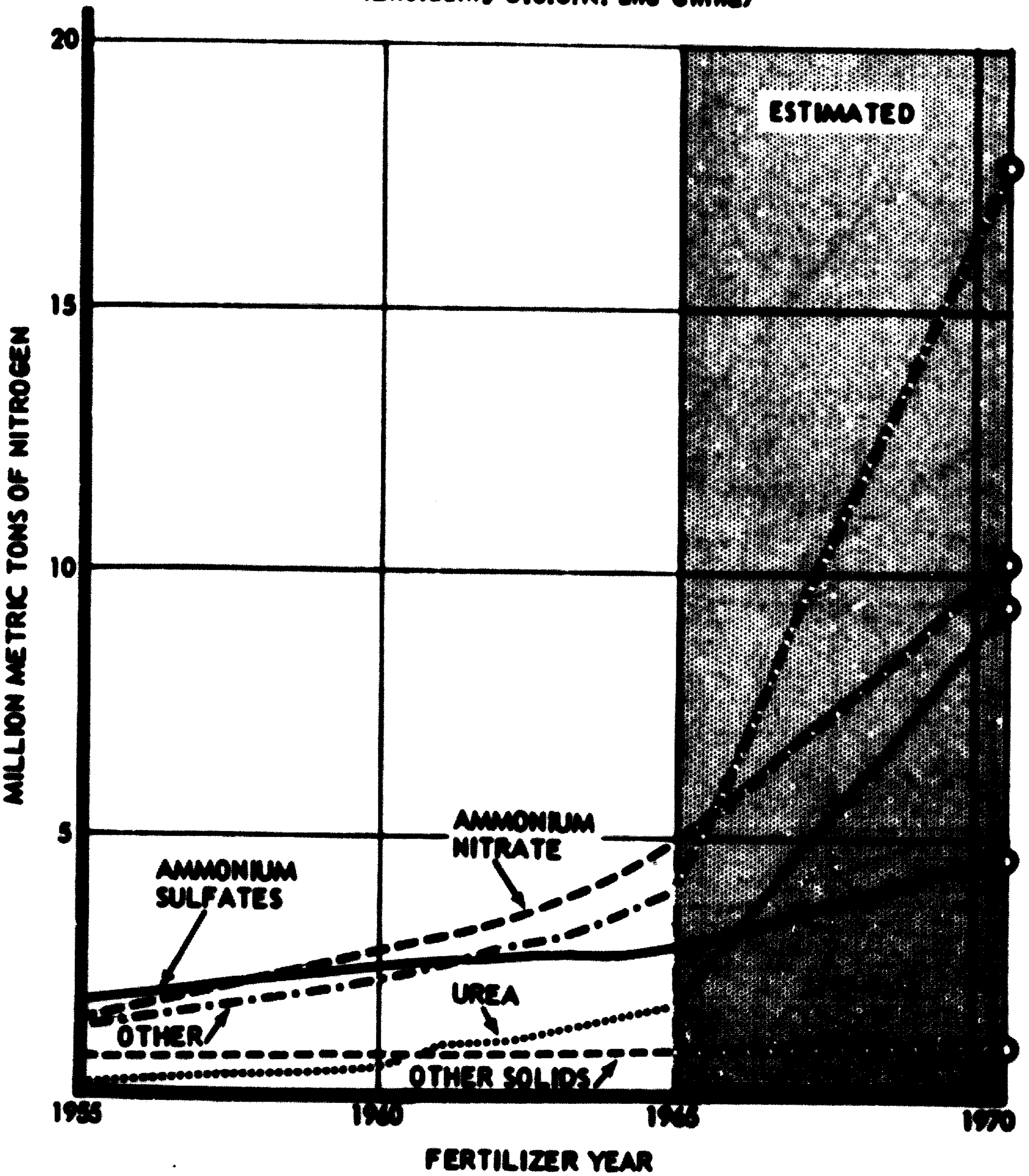


Figure 8

RELATIVE CONTRIBUTION OF NITROGEN FERTILIZER PRODUCTS TO WORLD NITROGEN PRODUCTION (Excluding U.S.S.R. and China)

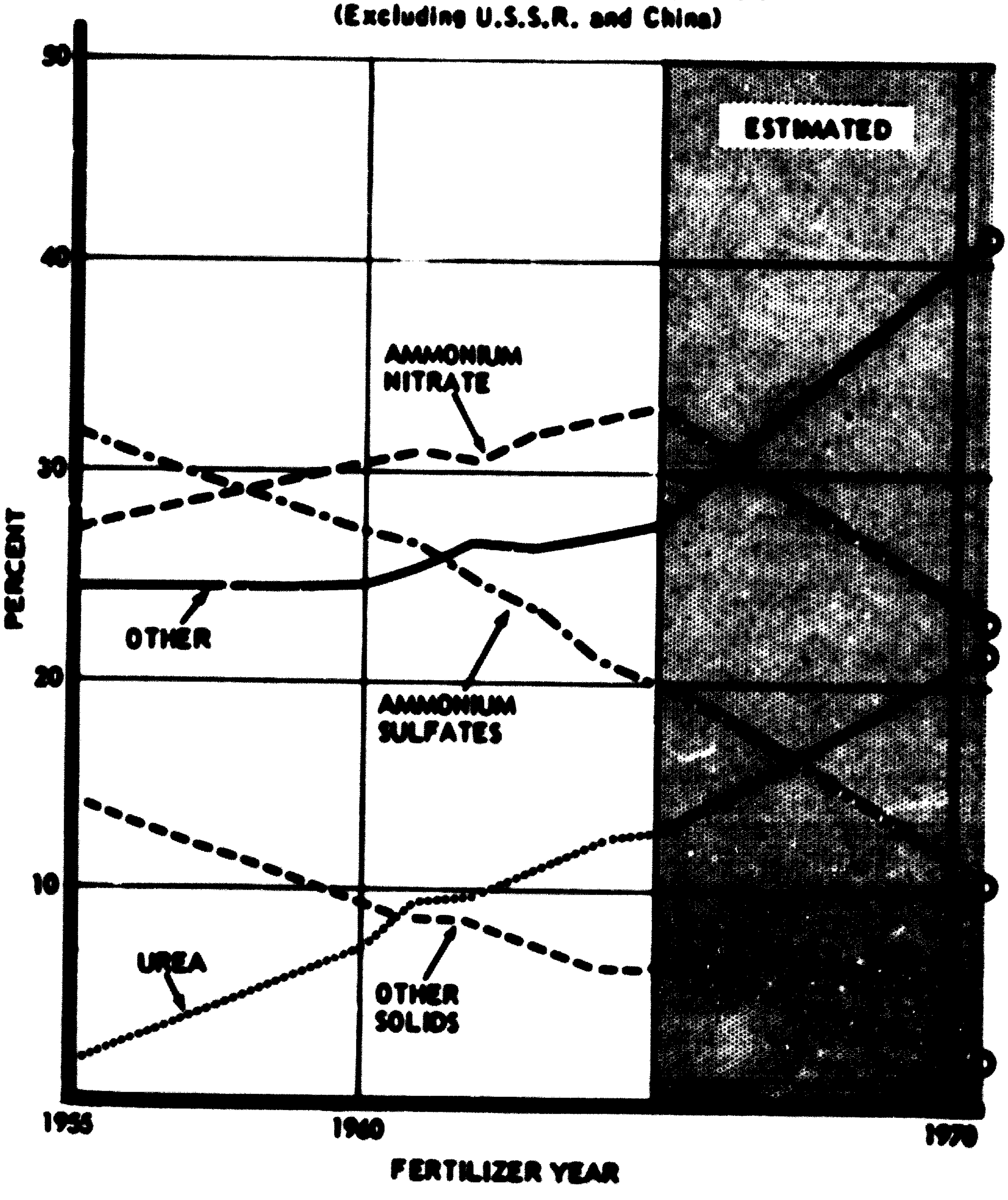


Figure 9

WORLD PHOSPHATE PRODUCTION

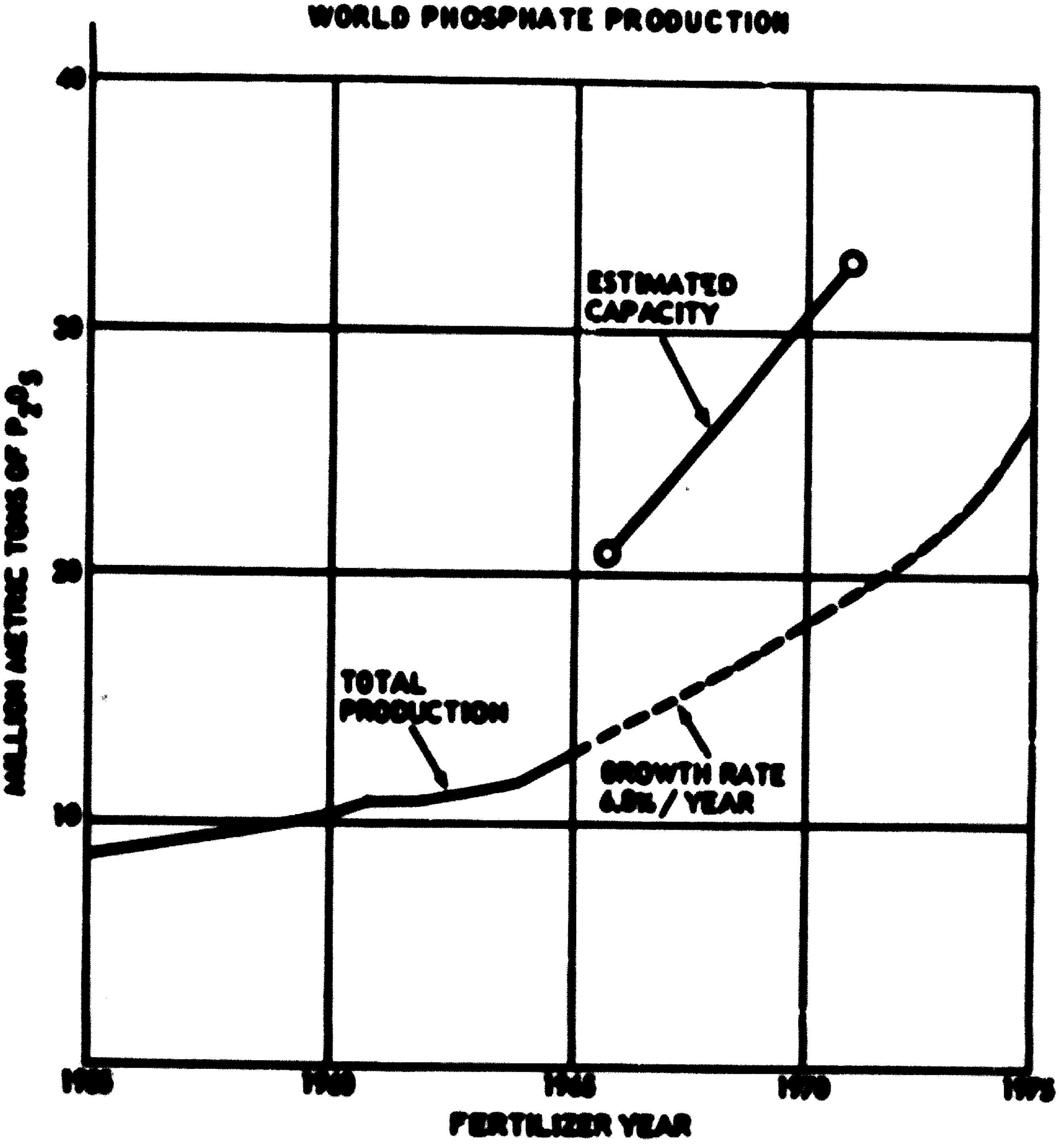


Figure 10

WORLD PRODUCTION
OF PHOSPHATE FERTILIZER PRODUCTS
(Excluding U.S.S.R. and China)

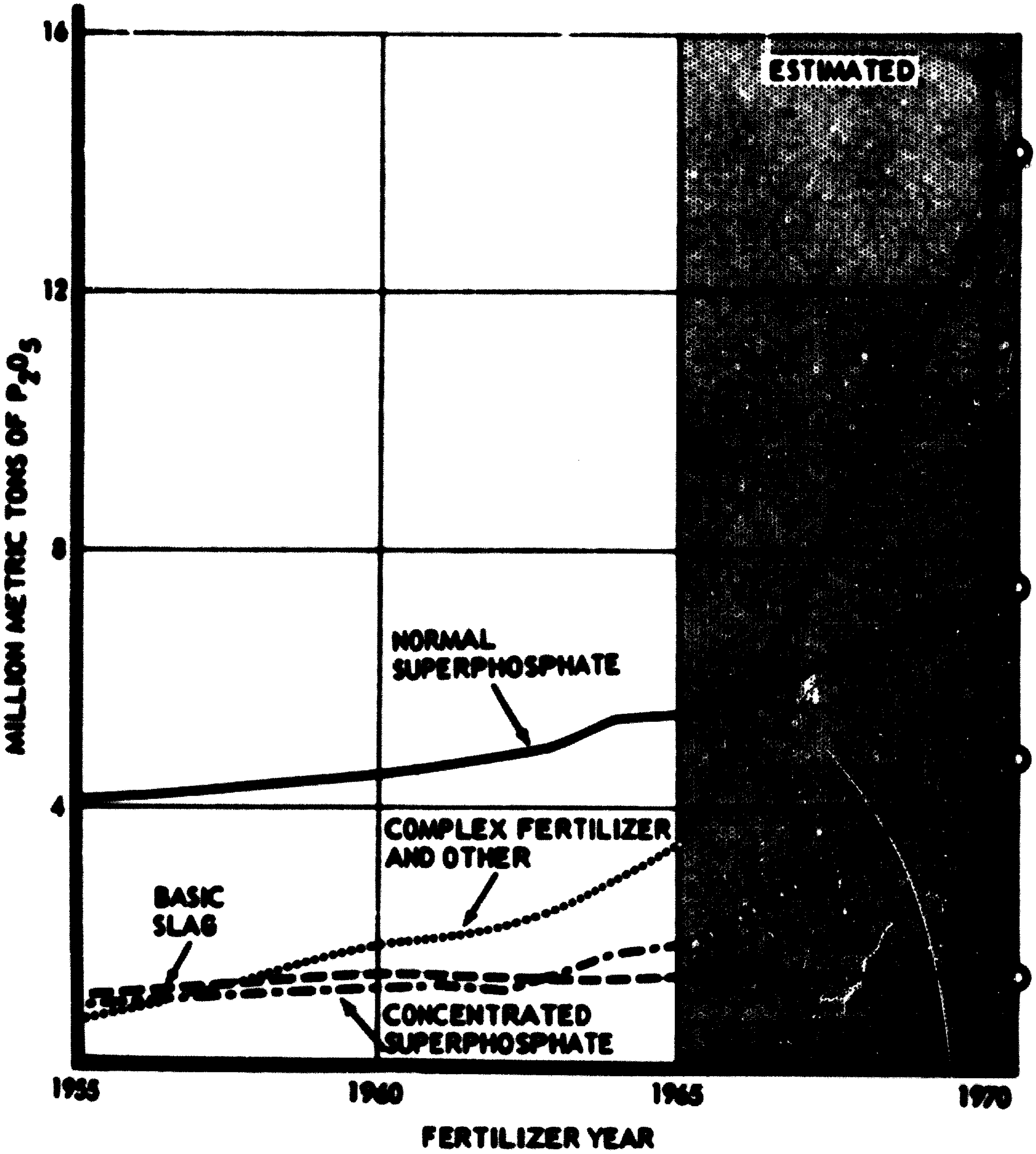


Figure 11

RELATIVE CONTRIBUTION OF PHOSPHATE FERTILIZER PRODUCTS TO WORLD PHOSPHATE PRODUCTION (Excluding U.S.S.R. and China)

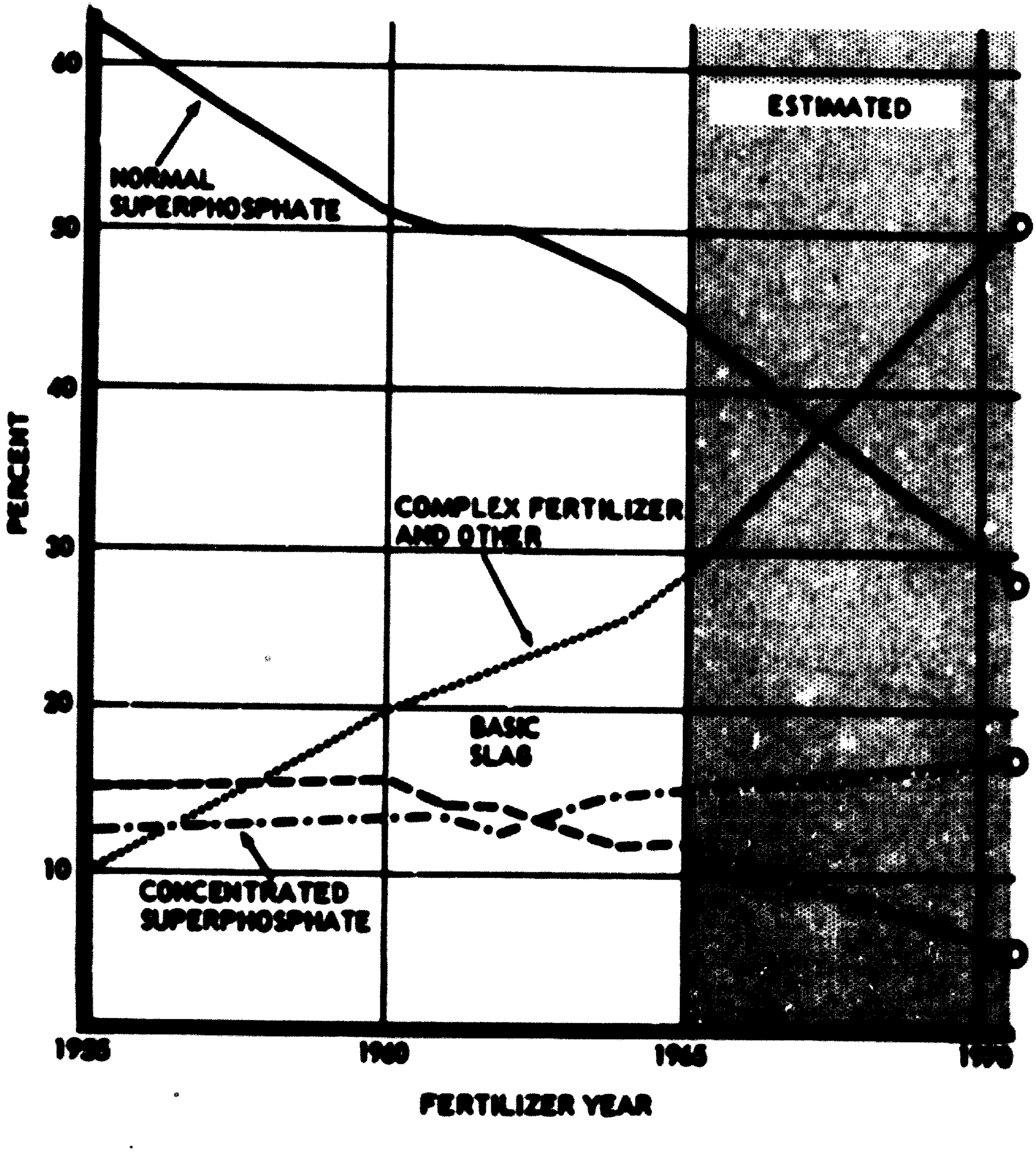


Figure 12

WORLD POTASH PRODUCTION

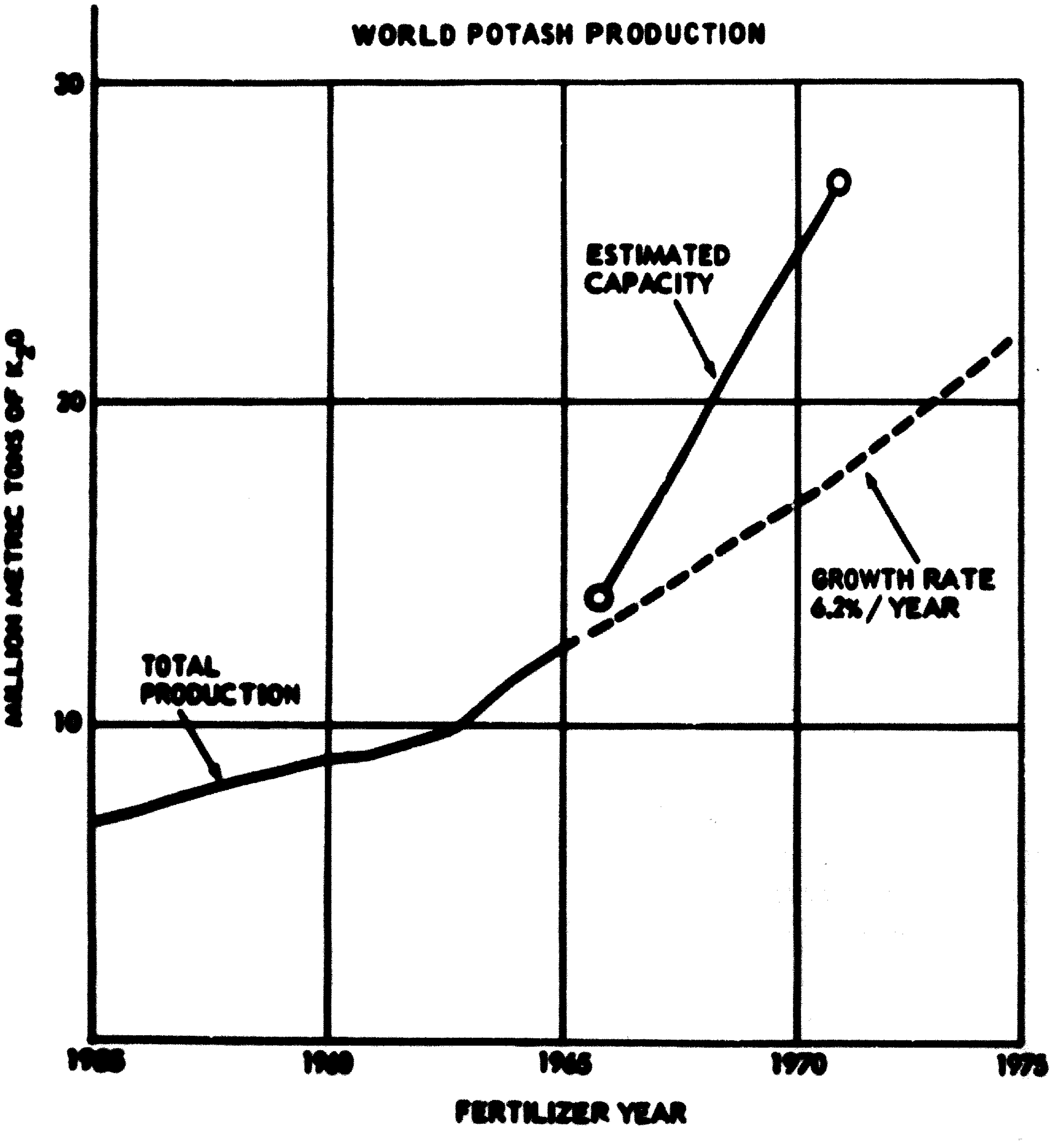


Figure 13

WORLD PRODUCTION IN THE DEVELOPED AND DEVELOPING REGIONS

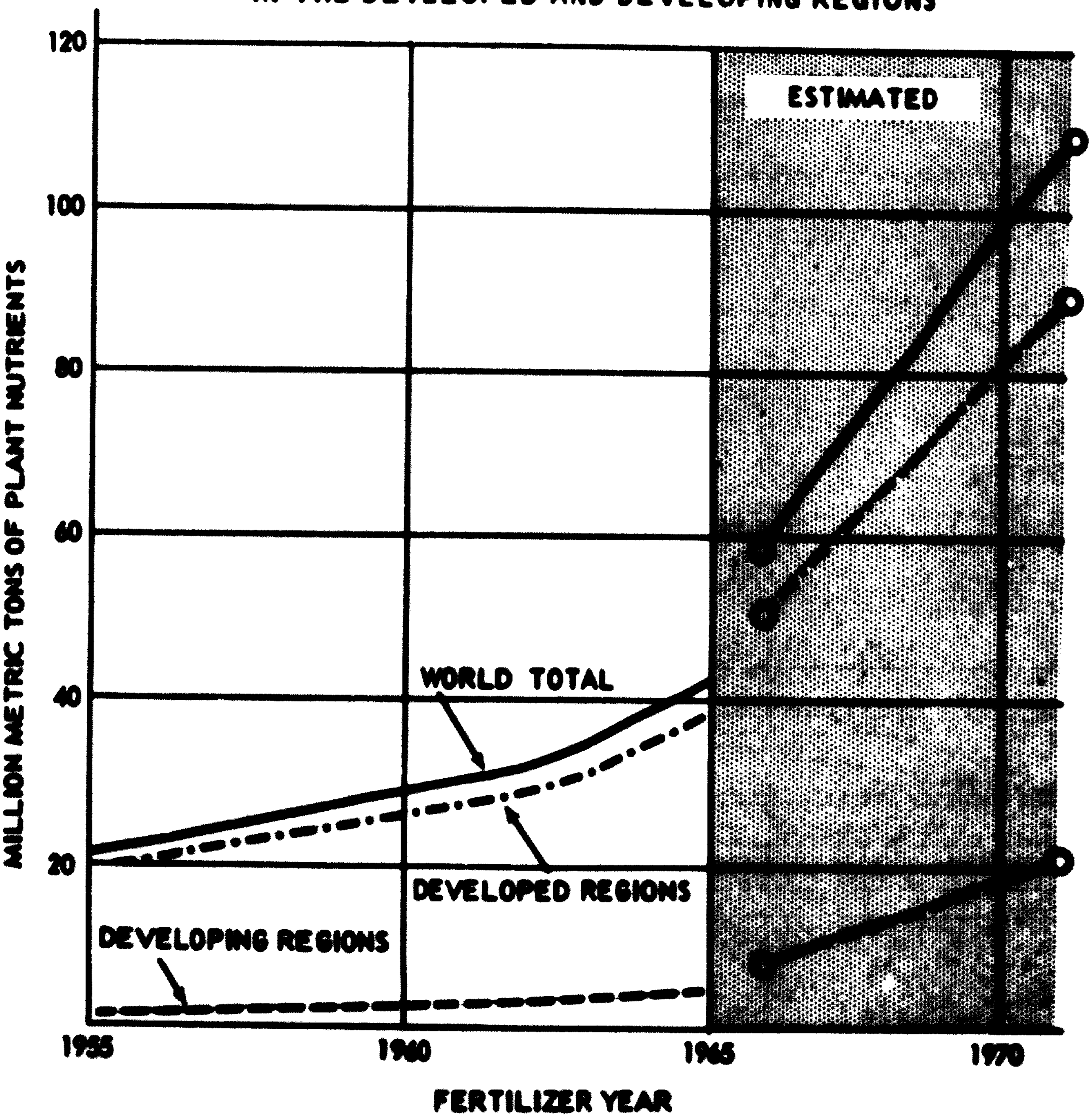


Figure 14

SHARE OF WORLD PRODUCTION
IN THE DEVELOPING REGIONS

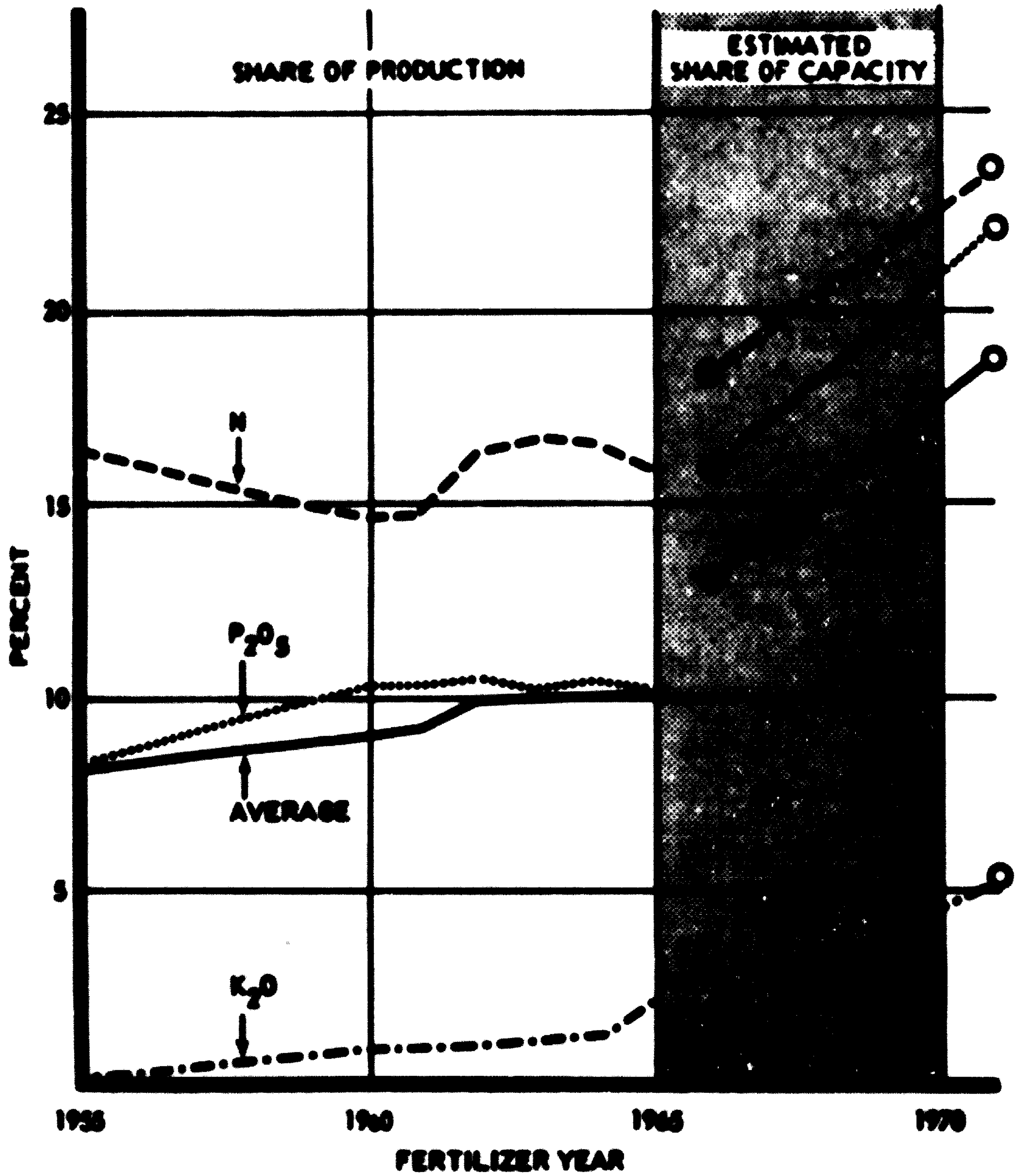


TABLE 12

WORLD SUPPLIES OF PHOSPHATE ROCK (14, 15)

Region	Production 1960	Production 1964	Capacity 1971	Reserves
	... (Million Metric Tons of Material) ...			
Western Europe	.04	.02	.02	...
Eastern Europe	8.06	13.06	25.06	7,568.00
Asia	2.52	3.58	7.03	...
Africa	10.83	15.27	37.10	24,179.00
Oceania	2.06	2.57	2.35	182.00
North America	17.80	23.33	37.57	13,526.00
Latin America	.44	.28	.65	572.00
Total	41.75	58.11	109.78	46,697.00 1/

... Data unavailable

1/ Includes 670.00 million metric tons in 23 countries not included in the data for the above regions.

/...

Figure 15

ESTIMATED NEEDS AND CAPACITY IN THE DEVELOPING REGIONS

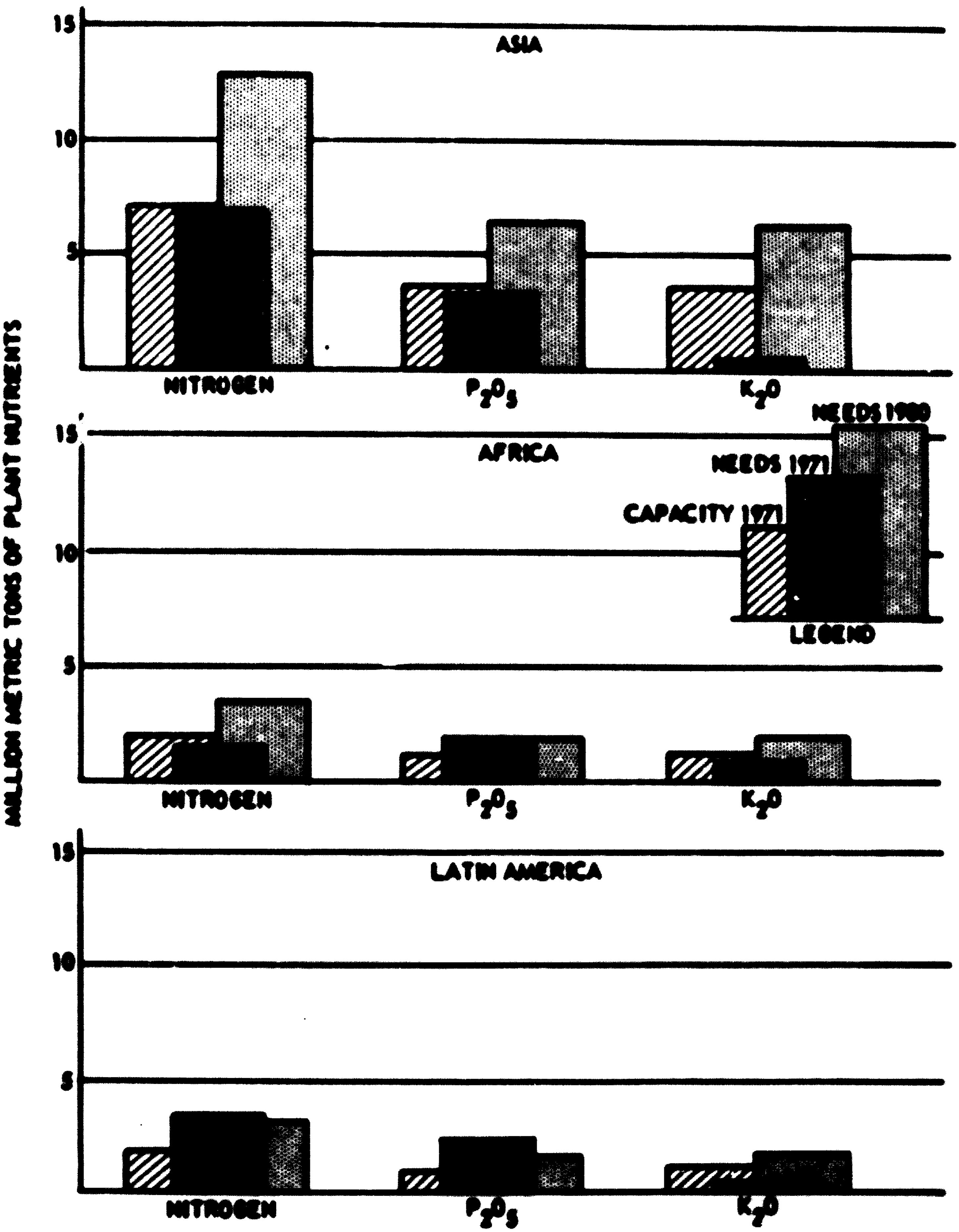
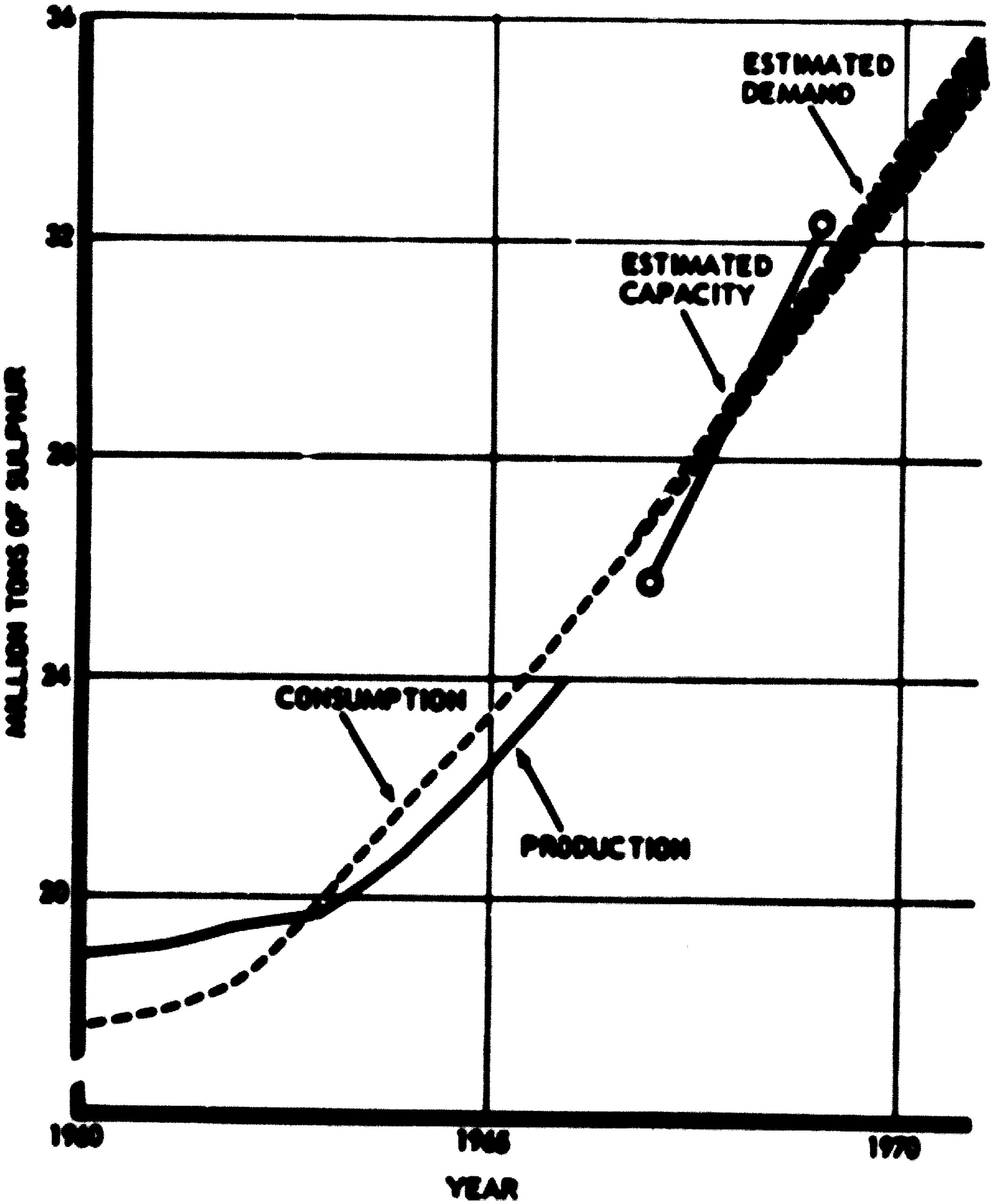


Figure 16

WORLD SULPHUR SUPPLY AND DEMAND[1/]



1/ Excludes eastern Europe, U.S.S.R., and China.

Figure 17

PHASES OF DEVELOPMENT OF THE FERTILIZER INDUSTRY IN A DEVELOPING COUNTRY

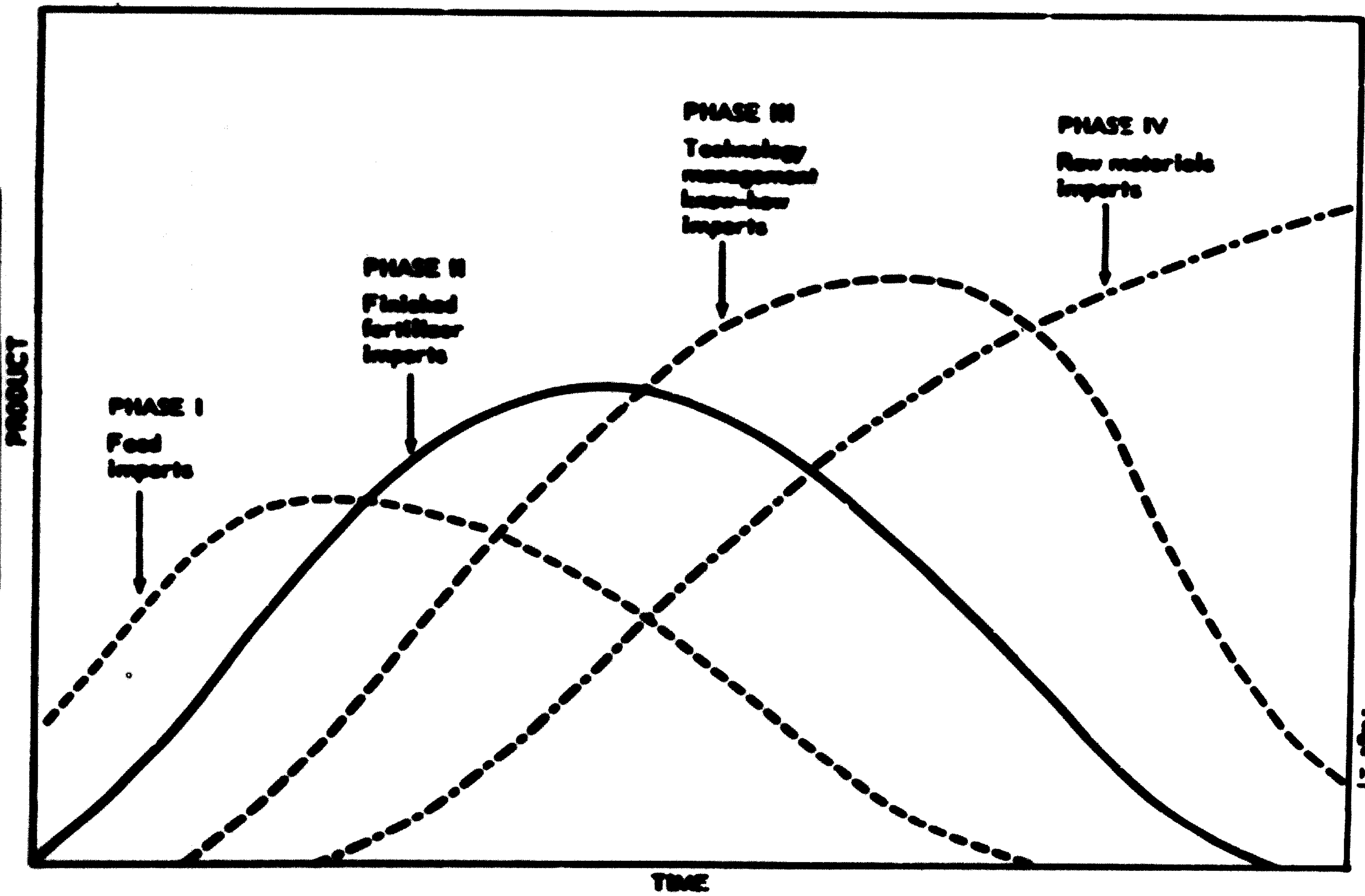


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TABLE 13

WORLD POTASH RESERVES (14)

Region	Reserves (Million Metric Tons of K_2O)
Western Europe	23,192.00
Eastern Europe	37,809.00
Asia	2,205.00
Africa	...
Oceania	-
North America	19,731.00
Latin America	...
Total	82,937.00

... Data unavailable

/...

TABLE 14

WORLD PRODUCTION AND CONSUMPTION OF SULFUR (8,17) 1/

Year	Production	Consumption	Estimated Capacity
	..... Million Metric Tons of Sulphur		
1960	18,891	17,600	-
1961	19,100	17,900	-
1962	19,500	18,450	-
1963	19,725	19,900	-
1964	20,850	21,775	-
1965	22,500	23,275	-
1966	24,125	24,900	-
1967	-	-	25,830
1969	-	-	32,330
1971	-	35.0-35.9 2/	-

1/ Sulfur in all forms. Data excludes eastern Europe, U.S.S.R., and China

2/ TVA demand estimate based on estimated capacity of phosphate products requiring sulfur and an assumed industrial use growth rate of 4 to 5 percent per Year.

/...

TABLE 15

WORLD TRADE IN PLANT NUTRIENTS (14)1/

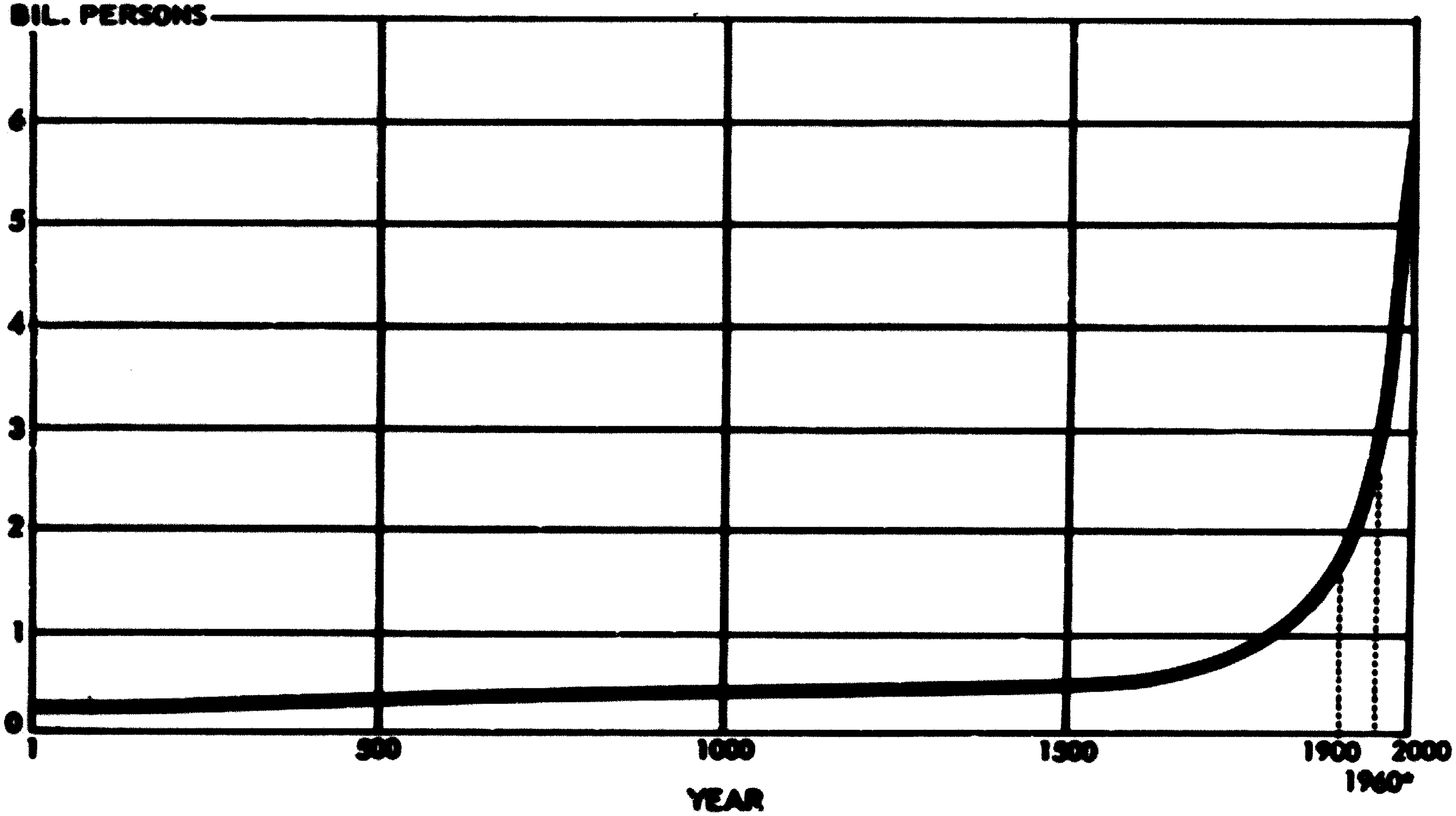
Million Metric Tons

Year	Nitrogen			Phosphate			Potash			Total		
	Developed	Developing	Total	Developed	Developing	Total	Developed	Developing	Total	Developed	Developing	Total
1960	1.18	1.04	2.22	.84	.31	1.15	2.57	.90	3.47	4.59	2.25	6.84
1961	1.11	1.30	2.41	.78	.36	1.14	2.77	1.09	3.86	4.66	2.75	7.41
1962	1.24	1.26	2.50	.84	.48	1.32	2.77	.96	3.73	4.85	2.70	7.55
1963	1.36	1.24	2.60	.94	.53	1.47	3.01	.99	4.00	5.31	2.76	8.07
1964	1.62	1.41	3.03	1.07	.63	1.70	3.49	1.21	4.70	6.18	3.25	9.43
1965	1.63	1.55	3.18	1.12	.71	1.83	4.04	1.16	5.20	6.79	3.42	10.21

1/ Based on imports of fertilizer materials.

Figure 1

TWENTY CENTURIES OF WORLD POPULATION GROWTH



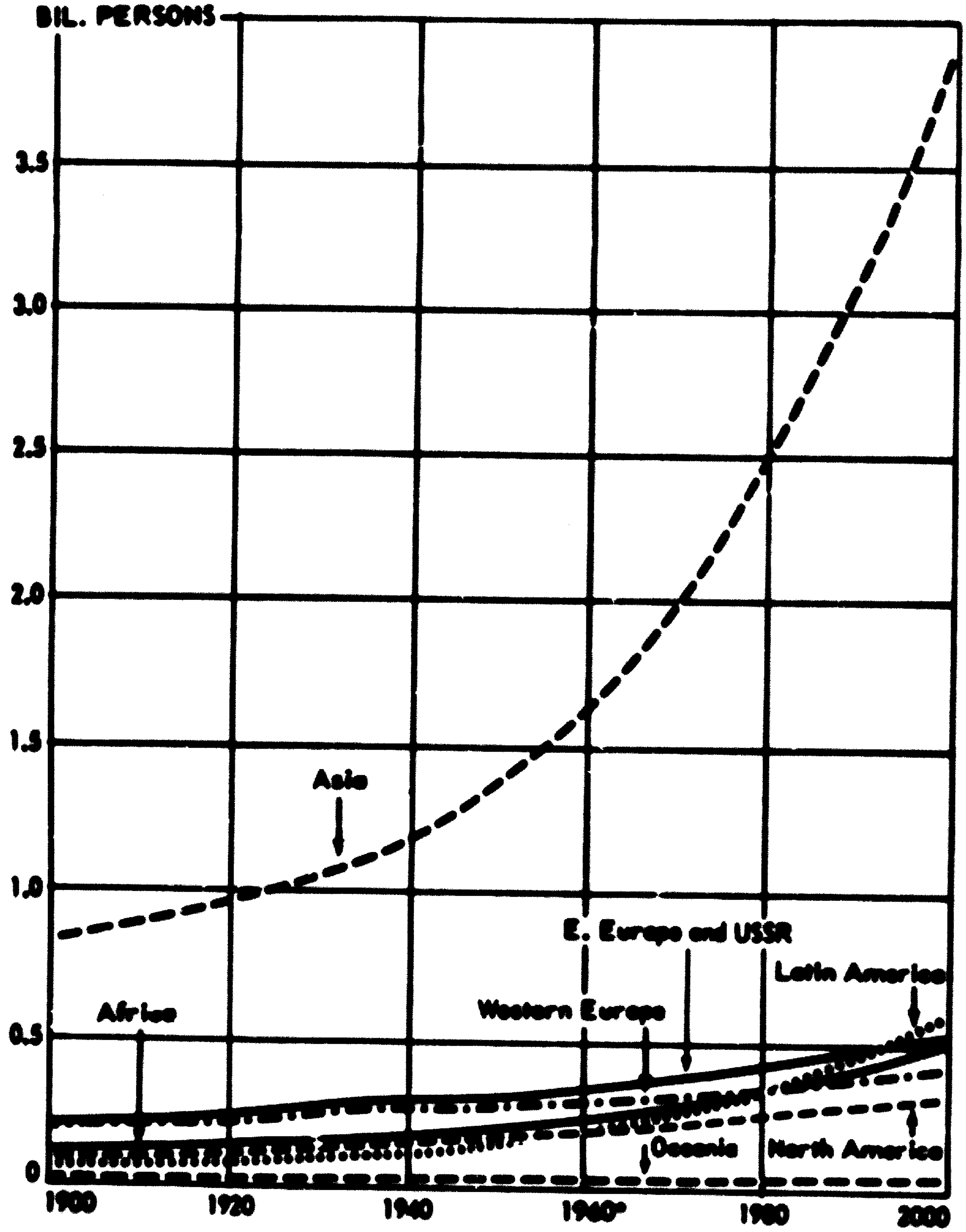
U.S. Department of Agriculture

Economic Research Service

*Projected from 1960.

Figure 2

WORLD POPULATION BY GEOGRAPHIC REGIONS, WITH PROJECTIONS



U.S. Department of Agriculture Neg. [illegible] (8) Economic Research Service *Projected from 1960

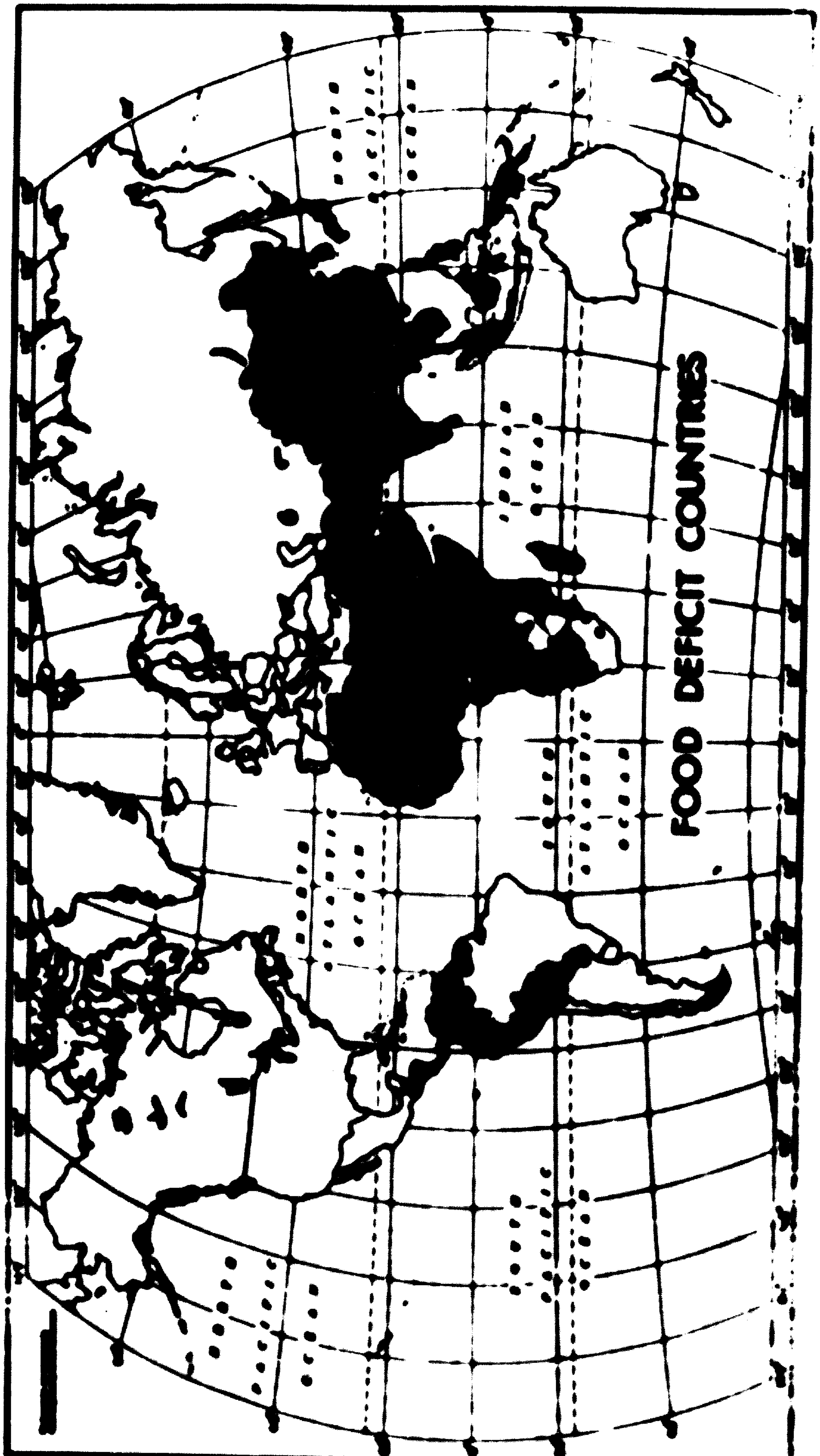
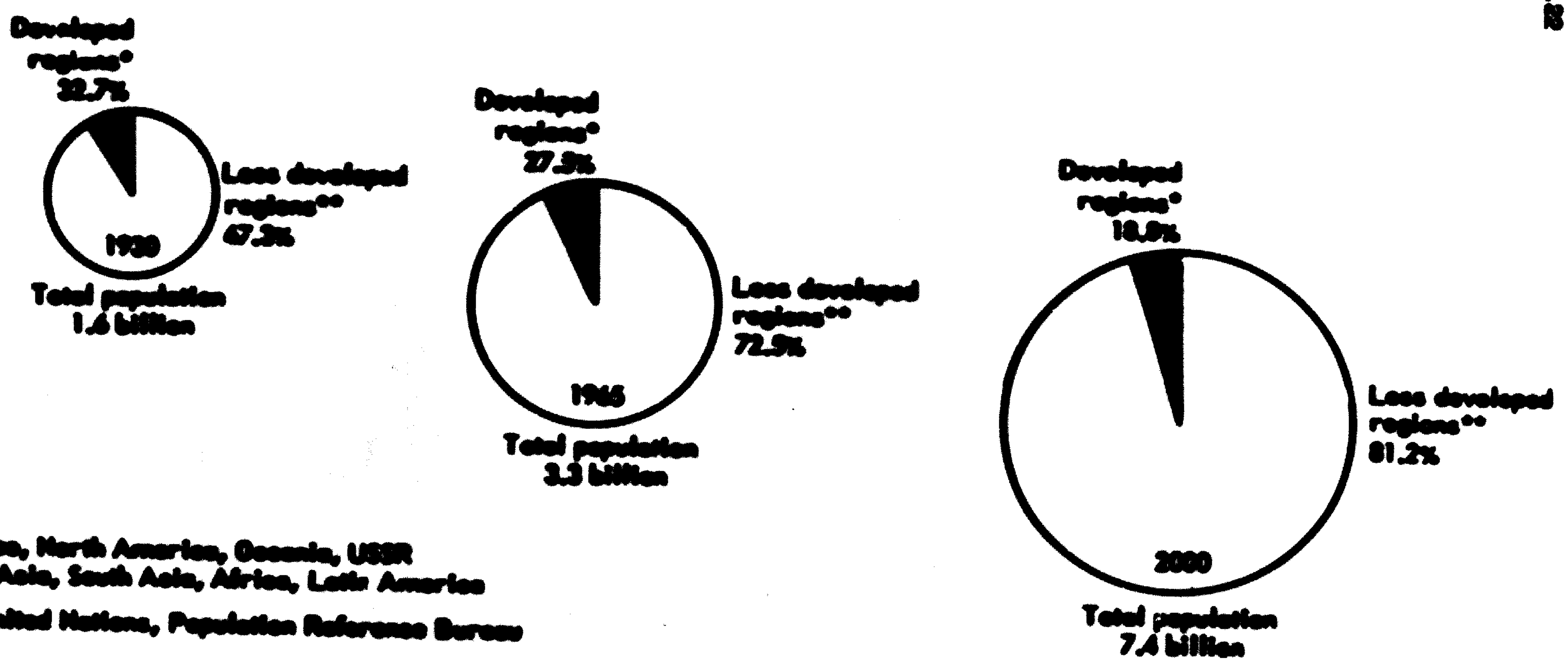

FOOD DEFICIT COUNTRIES

Figure 4

ALL OF WHICH WILL LEAD TO A LARGER PERCENTAGE OF THE WORLD'S POPULATION LIVING IN LESS DEVELOPED REGIONS



*Europe, North America, Oceania, USSR
**East Asia, South Asia, Africa, Latin America

Data: United Nations, Population Reference Bureau