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PN-AAZ-118

ISN 54099

A FERTILIZER GUIDEBOOK

Framework and Guide to Assessment and Development of the Fertilizer Sector in Asia and the Near East

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September 1987

AID/ANE-0249-C-00-6074

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PREFACE

Background to the Guidebook

Agriculture is the most important sector in developing countries in terms of employment and ranks very near the top in terms of contribution to gross domestic product, export earnings, and raw material used by industry. It currently is accorded the highest priority by the U.S. and most other important bilateral and multilateral development assistance donors. Fertilizer use has been the major factor in the accelerated agricultural growth rates that have occurred in many developing countries, particularly in Asia and the Near East Region, in the last 10 to 20 years. Improved seed and expanded irrigation also have contributed directly to increased production and indirectly by increasing crop response to increased fertilizer use. Most of the countries in the Region now have developed virtually all their irrigation potential and improved seed of major food crops is commonly in use. There still is considerable opportunity for improvement in irrigation efficiency and in seed quality, but the gains from the water and seed seen earlier are unlikely to be repeated. Thus, fertilizer is widely looked to as necessarily the major contributor to agricultural growth for the remainder of this century and well into the next.

The major objective of AID's Bureau for Asia and the Near East (ANE) in commissioning the present effort was to help identify and define fertilizer related constraints and issues and provide guidance to Bureau field personnel in design of effective fertilizer sector development strategies and techniques. This required the assembly and presentation of information on the major functions and activities of the fertilizer sector, ranging from fertilizer production and marketing through the technology of fertilizer use on the farm.

In the past AID has been substantially involved in fertilizer production as well as marketing and on-farm use; however, current and anticipated U.S. future development assistance priorities have shifted away from development of large fertilizer producing industrial complexes to emphasize management of procurement, distribution, pricing, on-farm use, and the planning and policy issues involved in decisions at these functional levels.

Outputs

The main output of the study is a guidebook (manual) which will:

A. Present a low-cost and time-saving analytic methodology based upon a "checklist" of important questions or issues which AID missions may use to determine whether AID should invest in a full-scale fertilizer sector analysis;

B. Present a concise generalized methodology for analyzing a country's fertilizer sector when judged necessary, including its structure, performance, and interactions with other agriculture subsectors; and

C. Provide generalized guidance and supporting information on design of fertilizer programs/projects, including policy and institutional reforms associated with donor assistance.

This guidebook examines important fertilizer sector issues such as:

A. Public vs. private sector roles in fertilizer distribution, marketing, and diffusion of technology;

B. Fertilizer subsidies/taxes and their impact on fertilizer distribution, marketing, and use;

C. Fertilizer use under dryland and low-input production systems; and

D. Policy, institutional, physical, agroclimatic, and other conditions which must exist for investments in fertilizer to be economically sound and financially viable.

The second output is a bibliography of studies, reports, project documents, and other materials which study indicates will be of particular value to AID officials dealing with fertilizer related activities and issues.

Organization of the Guidebook

Chapter I reviews agricultural growth rates in developed and developing countries, cites the contributions of fertilizer to agricultural growth, and provides background information on fertilizer production, consumption, and trade. It includes a checklist of major constraints and issues in fertilizer sector analysis and design for use of programmers in deciding whether the fertilizer sector in a given country requires attention and in identifying areas of emphasis. These constraints and issues constitute the principal substance of the remainder of the report. Chapter II reviews AID requirements and experience in fertilizer sector planning and analysis and suggests methodology for fertilizer sector analysis and project design. Chapters III, IV, and V provide background information on the fertilizer sector with emphasis on ANE countries: Chapter III focuses on government and private enterprise roles in the fertilizer sector; Chapter IV addresses issues of supply planning, marketing, pricing; and Chapter V discusses technical aspects of fertilizer production and use.

The annexes provide additional fertilizer sector data and supplemental information on a number of issues discussed in the main body of the report. They include a set of dummy tables for use of analysts in assembly of data for cross-country or regional comparisons of sectoral progress, problems, and needs.

Responsibility for Content

While AID has provided financial support for the preparation of the Guidebook and Bibliography, responsibility for conclusions and recommendations rests solely with the authors and RONCO Consulting Corporation. Opinions stated should not be construed to represent official AID policy.

The authors are indebted to David Alverson ASIA/TR for many constructive suggestions on this report and for the careful reading of the several drafts.

I. INTRODUCTION

The objective of this chapter is threefold: a) to briefly examine rates of agricultural growth in developed and developing countries, and to appraise the role of fertilizers as a major contributing factor in the agricultural growth rates among countries; b) to provide an historical overview of fertilizer consumption, production, and trade with a focus on ANE countries; and c) to introduce a checklist of issues and constraints relevant to fertilizer sector development which may be used by USAID in sector assessment and subsequent program and project design.

This chapter presents data which makes a compelling argument that fertilizer has been by far the most important causal factor in the greatly accelerated rates of agricultural growth which have occurred in most of the Asia and the Near East countries beginning in the 1950s and 1960s. Four of the developing countries in Asia, most notably Taiwan and both Koreas appear to have reached levels of maturity in fertilizer use, where fertilizer is unlikely to contribute greatly to future increases in yields unless major technological breakthroughs are achieved. However, the other developing agricultural countries with the exception of China and Egypt consume fertilizer at levels that range from 1 to 20% of the levels in the mature fertilizer using countries. Figure 1 shows consumption per hectare for 17 Asian countries for the period 1970-83, with a theoretical curve indicating average consumption at different stages from general initiation of fertilizer development. The placement of countries on the time dimension is somewhat judgemental. However, the data clearly indicate a pattern of slow growth in use per hectare in the first 20-25 years after general introduction of fertilizer, followed by a period of rapid growth of 20-25 years leading to maturity in use about 50 years after general introduction. The process can be accelerated by major efforts such as took place in China and led to an unusually high growth rate from 1975-1980. Several other countries also have increased normal growth rates by major efforts, especially in the areas of fertilizer supply, price incentives, and development and dissemination of improved technology. Some of the highest fertilizer using countries have resorted to levels of subsidy and other incentives that can not be supported, justified or sustained in many countries. Fertilizer development efforts, rainfall and other physical and economic factors will influence levels at which maturity in use can economically be reached and sustained. The data are indicative of general growth patterns that can be expected in developing countries. For most of the countries in the ANE region, fertilizer can be the major contributor to agricultural growth over at least the next couple of decades if adequate resources are available and policies and programs provide essential incentives and support.

The development programmer interested in examining the potential of the fertilizer sector in particular countries may find the data and analysis in this chapter interesting and helpful in examining the particular country and in making a presentation for fertilizer sector support. Where this is not the case, the reader may want to skip to the section D Summary Checklist of Potential Constraints and Issues in Fertilizer Sector Development (p. 28) or Chapter II, Fertilizer Sector Design.

A. Agricultural Growth Rates and the Role of Fertilizer

The period from 1950 to 1985 will undoubtedly go down in history as a period of unprecedented growth in agricultural production. During this period, total world-wide agricultural production increased by approximately 150% for an annual growth rate of about 2.43%/year.

In recent years, average agricultural growth rates in the developing countries have been well above rates in developed countries. However, due to high rates of growth in population, developing countries generally have sustained lower growth rates per capita than developed countries. China, since 1976, has been a major exception; it has achieved very high agricultural growth rates while keeping population growth rates down to about 1%. Overall, Asian countries have sustained higher production growth patterns than any of the other major regions. Growth rates for countries in Asia and other regions are shown in the following tables and figures.[1]

World-wide growth in agricultural production in absolute terms, in the 35 years from 1950 to 1985 was about 1.5 times greater than the total increase in the five thousand years or more since agriculture was first undertaken. Some of the highest growth rates in developing countries were in countries with the highest population densities relative to land resources. For example, 1985 production levels in Southeast Asia were about three times the 1950 level; in China the 1985 level was almost

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1. The rate of growth in total output and in output per capita are used as the principal measures of progress in agricultural development. Other important measures of development including total and per capita income, average caloric intake, infant and child mortality, life expectancy, access to potable water supplies, and literacy rates must also be taken into consideration. However, most of these must be dealt with outside the agricultural sector. A high agricultural growth rate usually contributes directly to more adequate levels of food intake and also indirectly to improvements in other quality of life measures.

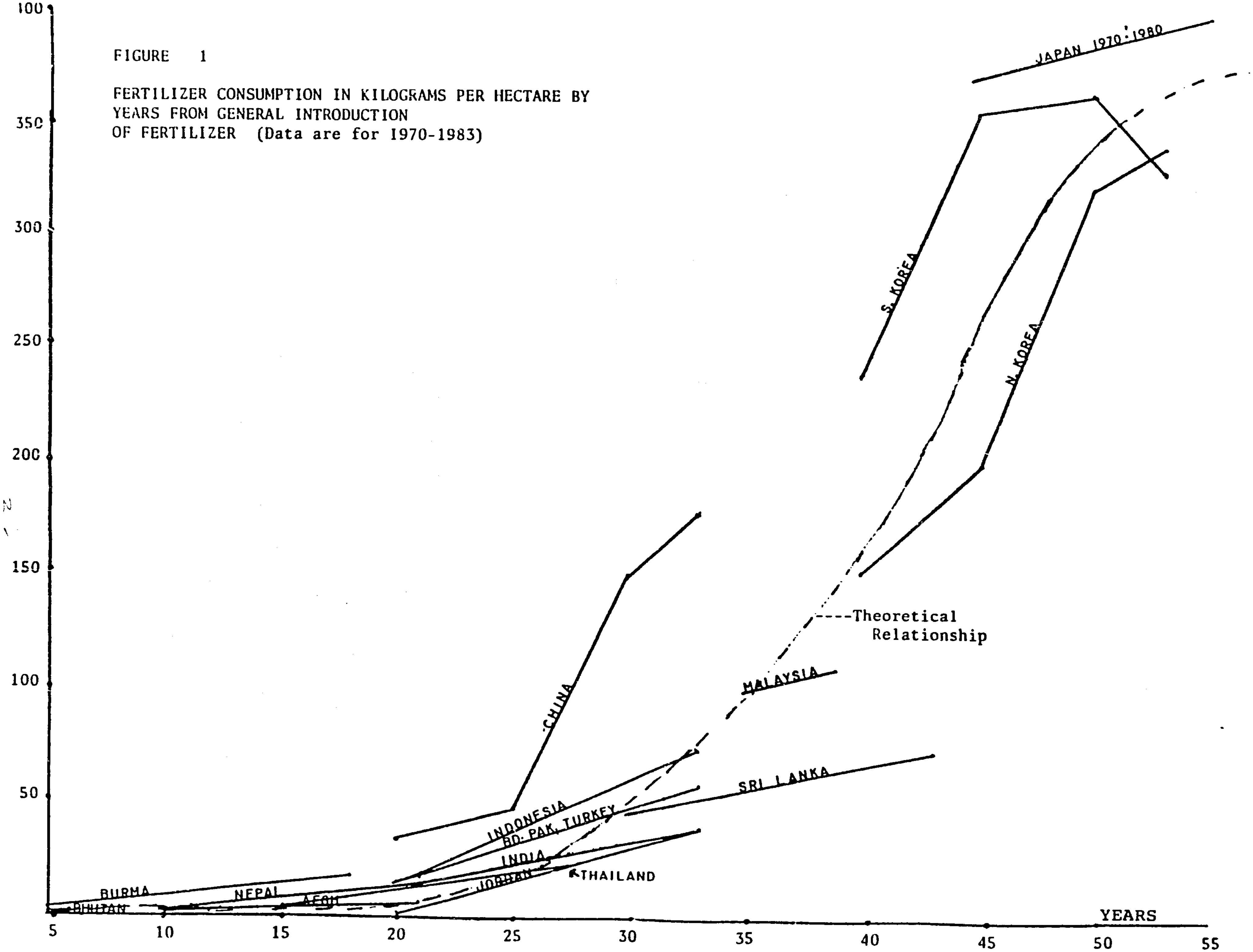


FIGURE 1
FERTILIZER CONSUMPTION IN KILOGRAMS PER HECTARE BY YEARS FROM GENERAL INTRODUCTION OF FERTILIZER (Data are for 1970-1983)
100
350
300
250
200
150
100
50
5
10
15
20
25
30
35
40
45
50
55
YEARS
JAPAN 1970-1980
S. KOREA
N. KOREA
CHINA
----Theoretical Relationship
MALAYSIA
SRI LANKA
INDONESIA
BD. PAK. TURKEY
INDIA
JORDAN
THAILAND
BURMA
NEPAL
AFGH
BHUTAN

TABLE 1

Annual Growth Rate in Agricultural Production
By regions, 1950-1985

Region	Total 1950-1985	Per Capita	Total 1976-1985	Per Capita
Latin America	3.11 %	0.49 %	2.71 %	0.40 %
South Asia	2.55	0.39	3.03	0.74
South East Asia	3.46	1.10	4.52	2.25
West Asia	3.25	0.45	2.06	-0.72
Africa	2.20	-0.31	1.72	-1.04
Western Europe	1.93	1.28	1.98	1.74
Eastern Europe	2.24	1.53	1.14	0.57
World	2.43	0.55	2.25	0.60

SOURCE: USDA Periodic Reports; Indices of Agricultural Production.

TABLE 2

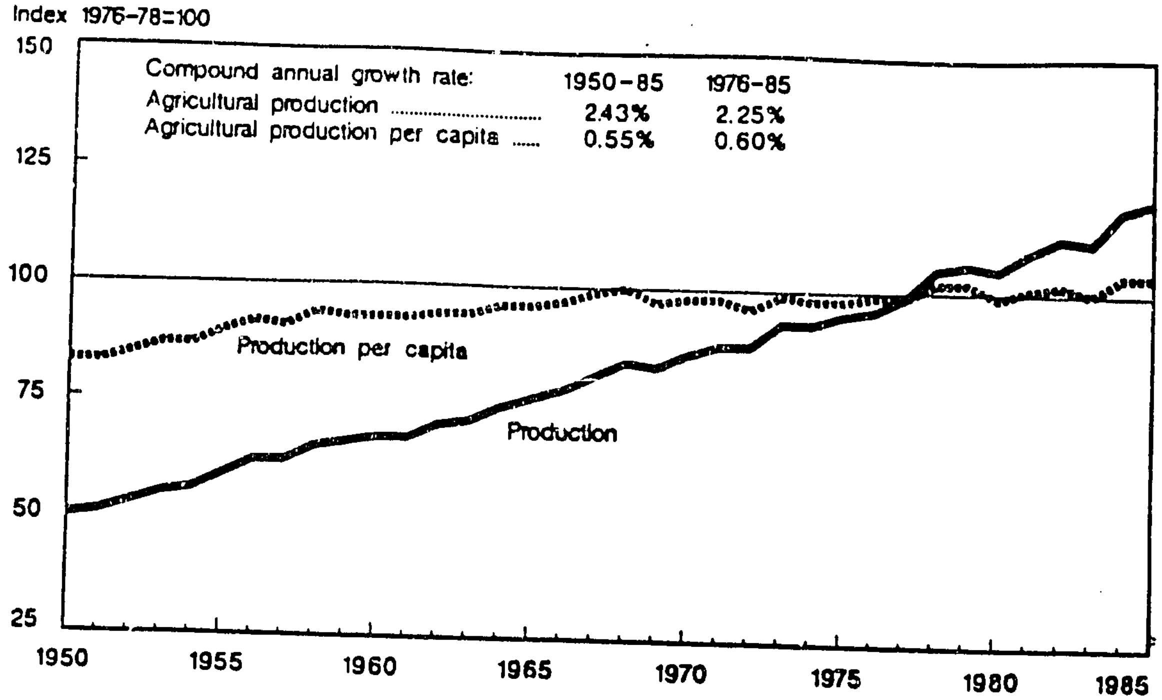
Indexes of Agricultural Production in Major Regions (1950-1985)
(index 1976-78 = 100)

	1950	1960	1965	1970	1975	1980	1985
US	59	73	78	82	95	102	115
Japan	72	99	101	99	101	90	101
Western Europe	59	77	84	92	99	112	115
Developed market Economies	60	78	83	89	97	105	113
So. and Central America	42	58	72	80	94	112	125
East Asia (except Japan, China)	39	55	64	76	90	109	133
South Asia	48	66	69	87	85	103	125
West Asia (ME)	35	54	64	75	91	103	119
Africa (except RSA)	54	72	80	89	97	108	121
USSR	42	63	71	88	89	95	102
Eastern Europe	51	69	75	82	96	97	108
China	43	46	68	81	98	119	162
World	50	67	76	86	95	104	119

Source: USDA Periodic Reports; Indices of Agricultural Production

FIGURE 2

World: Index of Production



Southeast Asia: Index of Production

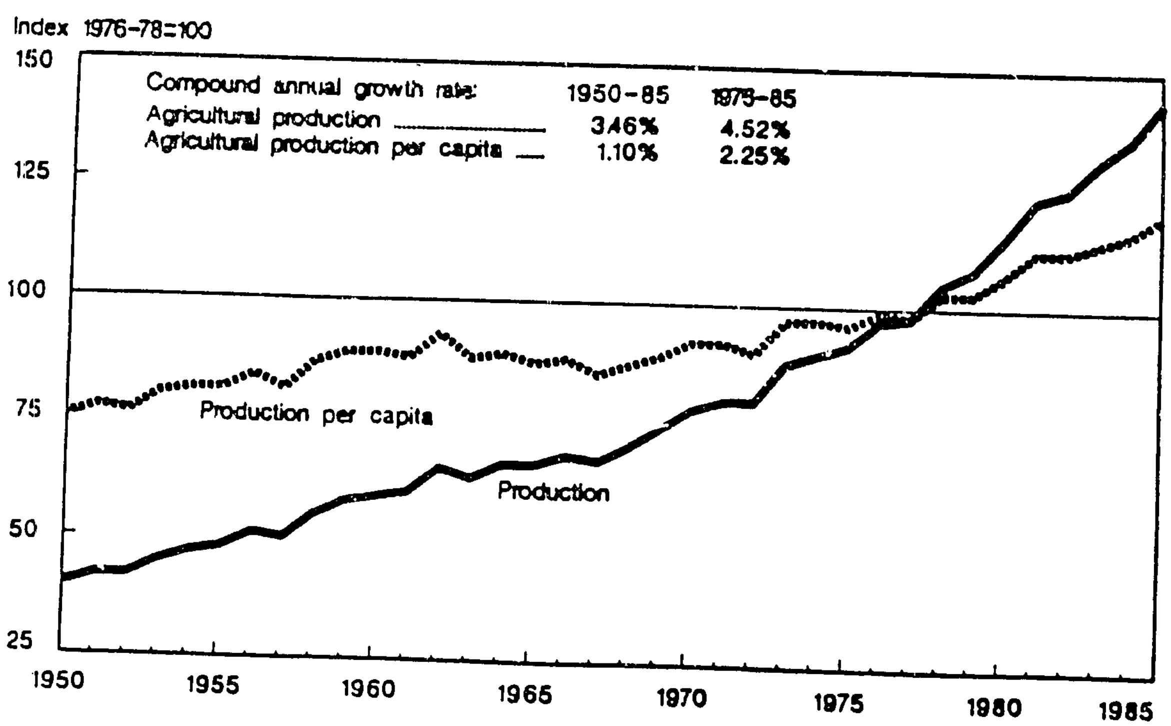
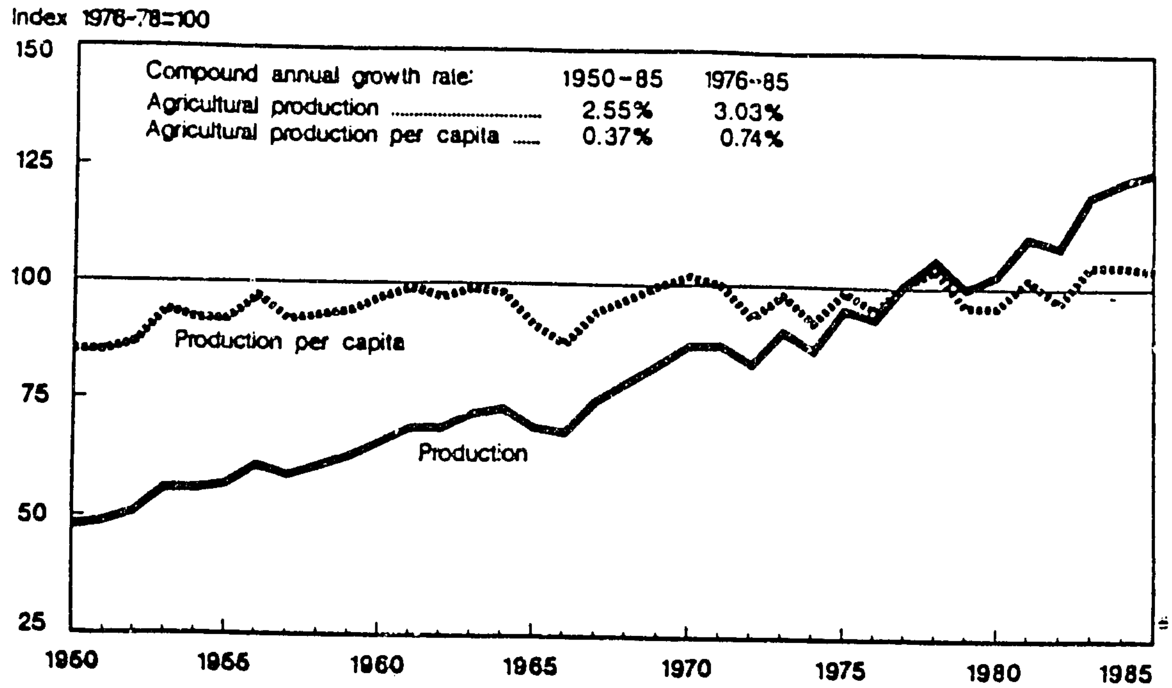
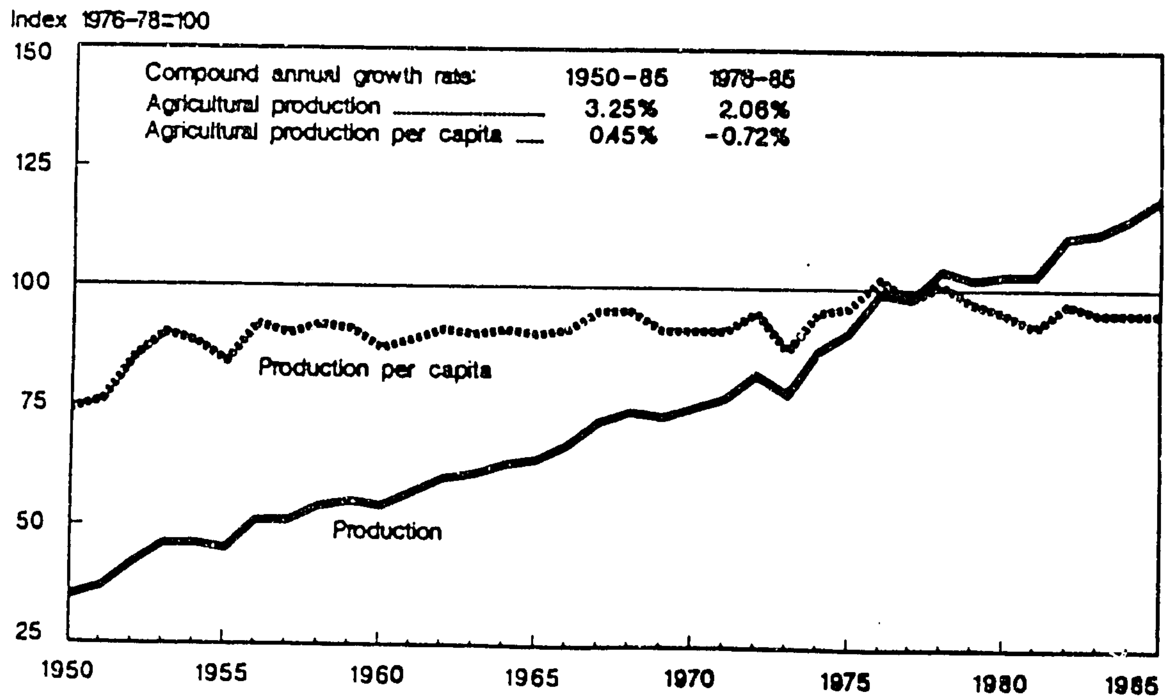


FIGURE 2 (cont'd)

South Asia: Index of Production



West Asia: Index of Production



four times the 1950 level.

The principal factor responsible for increasing agricultural output over the centuries has been increasing the area used for farming -- bringing new land under cultivation within older, established agricultural societies and/or by settlement/colonization of new areas. Major changes in agricultural technology took place only at rare intervals and adoption was usually drawn out over long periods. In contrast, during this century, particularly over the last 30 years, there have been unprecedented increases in agricultural production at a time when little additional land could be brought into farm use. Most of the increases in agricultural production have resulted from increased yields on land already under cultivation. FAO world-wide data suggest that land used for agriculture was only 5% greater in 1981 than the average used from 1961-65. In the socialist countries of Asia (mainly China) the area in agriculture production was estimated to have declined by about 10%, while production increased by 83% (yield more than doubled).2

Most of the recent increase in yield is physically attributable to the availability and increased application of plant nutrients and measures to increase crop responses to higher fertilizer application rates.3 Increased fertilizer use is estimated to have been responsible for at least 50% of the recent increase in crop yields in developing countries. Rapid farmer adoption of yield increasing technology, where it has occurred, has largely been the result of measures designed to provide information and economic incentives and to ensure the availability of needed inputs.

B. Consumption, Production, and Trade in Fertilizer

The availability of plant nutrients in sufficient quantity is as important to plants as food is to animals and people. Sustained, high and gradually increasing agricultural yields which are a common objective, generally require much higher levels of nutrients than typically are naturally available. Even if high levels of crop yields were possible initially, without supplying nutrients the crops would remove nutrients in larger amounts than are made available by natural soil decomposition and

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1. UNCTAD/TT/451 Re V, 1, p.5. These data suggest that the fertilizer consumption increase of about 10 fold in the socialist countries was largely responsible for the large increase in production.

3. One study estimates that 60% of the yield increases world wide over the last 120 years have come from fertilizer application.

natural nitrogen fixation, and thus gradually reduce soil fertility. The need for increased plant nutrients may be addressed by heavy application of inorganic commercial fertilizers in natural and processed forms; however, this requirement is most efficiently addressed by the combination of inorganic fertilizers with:

- Improved management of available or potentially available organic materials;
- Improvement in soil conditions to increase the natural availability of chemicals in the soil from whatever source;
- The application of commercial fertilizer in a manner which will minimize losses: i.e., in adherence to practices which encourage maximum efficiency of utilization.

Consumption

Statistics on consumption, production and trade are normally expressed in terms of nitrogen (N), phosphate (P_2O_5), and potash (K_2O). Nitrogen is the principal nutrient applied in the ANE region. Nitrogen consumption in Asia (excluding Japan and Russia), increased from a level of 0.2 million MT in 1951 to 8.5 million MT in 1974 and a total of about 27 million MT in 1984. Most of this increase was accounted for by China and India, the two countries which dominate overall fertilizer consumption in the region. It is estimated that about 42% of the nitrogen is used for rice, 24% for wheat and barley, 15% for maize, sorghum and other grains, 8% for cotton and jute, 10% for fruits and vegetables, and 3% for sugar, oil palm, rubber, tea and forage. Urea is the principal nitrogen fertilizer applied in Asia, accounting for 75% of total nitrogen.

Phosphate consumption (as P_2O_5) in Asia (excluding Japan and Russia) was about 3.3 million tons in 1974, and 8.5 million tons in 1984. Phosphate use was only about 300,000 MT in Asia in 1951, with only a very small part of that consumed in developing countries. The bulk of the current 8.5 million MT is consumed by China (approximately 50% of regional share) and India (about 24%). It is estimated that about 46% of phosphate goes to rice, 27% to wheat and barley, 7% to maize, sorghum and grains, 7% to cotton, rubber and oil palm, 10% to fruits and vegetables and 3% to sugarcane. Most of the increase in consumption over the last decade has gone towards cereal production.

ANE regional consumption of potassium (K_2O) is low: it accounted for only 4% of the world total in 1971, and 9% in 1984. There was no increase in the world K consumption from 1977 to 1984, but consumption in Asia (excluding Japan and Russia) increased from 0.6 million MT of K_2O in 1974 to 2.6 million MT in 1984. Again, China and India account for the major shares of regional consumption, at 34 and 33 percent, respectively; Korea and Malaysia each account for about 8%, and Indonesia 6%. The bulk of potassium has been applied on fruits and vegetables, groundnuts, soybeans, sugarcane and plantation and estate crops such as palm oil, rubber, tea and coconuts. Sri Lanka was the major developing country consumer of potassium in 1950-51.

Rates and ratios of amounts of fertilizer applied per hectare give an indication of the intensity of fertilizer use by country. Per hectare use has doubled, tripled, and in some instances expanded even more rapidly in the past decade. Among the Asian countries, the highest use rate in 1983 was 783 Kg/ha in Singapore. The next highest rates among developing countries were in North and South Korea (345 and 331 respectively), and in China (181 kg/ha). At the low end were Laos (0.5), Socialist Yemen (0.3), Yemen (5.7), Afghanistan (6.3), Bhutan (1.0), Cambodia (1.6), Mongolia (11.6), Nepal (13.7), and Burma (15.8). With the exception of China and Malaysia, in 1983 the developing countries of Asia used less than 20% of the Korean levels per hectare and most were below 10% of levels per hectare in Korea. Thus, they have far to go in fully exploiting the potential of fertilizer to contribute to agricultural growth. (See Figure 1)

Based on Kg/ha, some countries made significant progress while others made little progress in the 1970-83 period. In the Philippines, use increased very little while Jordan, Indonesia, Pakistan and Turkey showed some of the best performances. China had the largest growth, from 33 to 181 kg/ha. South Korea has experienced a decline in use and use in North Korea and Taiwan has stagnated in recent years. Consumption in Vietnam in 1983 was about 25% below 1970 and 1971 levels.

Fertilizer consumption per capita provides a good measure of the stage of agricultural development and intensification. Of course, in countries with a higher land to population ratio, fertilizer use per hectare may be much lower than in less well endowed countries where intensified fertilizer use is substituted for land. For example, Argentina uses very low levels of fertilizer per hectare while Korea uses very high rates. Egypt has long been among the heaviest users of fertilizer per capita but recently has been surpassed by several other countries in the region. World-wide per capita consumption averages about 30 kg. Most developed countries exceed 50 kg/capita and many have much higher rates. In 1983, among 17 developing countries of Asia and the Near East (on which data were obtained), consumption was highest in Malaysia and Korea at about 40 kg/capita and lowest in Nepal.

Significant gains in plant nutrient application per capita were made between 1970 and 1985 in almost all of the ANE countries. The notable exception was the Philippines, where consumption declined from 5.9 to 4.9 Kg/capita. Bangladesh, Burma, and Nepal still had very low rates of use (6.1, 5.2, and

TABLE 3

Fertilizer Consumption by Regions in 1950-51
(1,000 MT)

Region	N	P_2O_5	K_2O
Europe	1,858	2,657	2,587
North & Central America	1,233	2,015	1,365
South America	71	63	29
Asia	631	313	141
Africa	129	129	37
Oceania	20	466	13
Total	3,942	5,643	4,172

Some Major Consumers

Country	N	P_2O_5	K_2O
Ceylon	12	*	101
Israel	*	282	*
Korea	40	13	2
Japan	397	9	122
India	65	*	*
Pakistan	5	*	*
Philippines	16	*	*
Taiwan	64	*	7
Sub total	599	303	134
All Asia	631	313	141
Brazil	12	13	12
Peru	38	*	6
Sub total	50	13	18
All South America	71	63	29

* Use not available for this individual country.

Source: FAO, 1951-52 World Report.

TABLE 4

Fertilizer Consumption by Region and Annual Growth Rate
1974/75 and 1984/85[a]

Area	1974/75 Million mt Nutrients	1974/75 World, %	1984/85 Million mt Nutrients	1984/85 World, %	Annual Compound Growth Rate, %
North America	17.2	21	22.0	17	2.5
Latin America	4.2	5	7.3	6	5.6
Western Europe	16.9	21	20.4	16	1.9
Eastern Europe	10.4	13	11.8	9	1.3
U.S.S.R.	13.9	17	22.3	17	4.9
Asia	14.9	18	40.6	31	10.5
Africa	2.2	3	3.4	3	4.7
Oceania	1.4	2	1.8	1	2.6
TOTAL WORLD	81.0	100	129.6	100	4.8
Developed Countries	62.5	77	81.4	63	2.7
Developing Countries	18.5	23	48.2	37	10.1
TOTAL WORLD	81.0	100	129.6	100	4.8

a. Does not include ground phosphate rock. Calendar year data for 1984 would be included with 1984/85. Totals may not add due to rounding. It should be noted that the 1974/75 consumption declined from the 1973/74 level because of high prices.

Source: FAO.

IFDC Asia Fertilizer Situation, 1986, p.4.

TABLE 5

Asia: Total Fertilizer Use Per Hectare of Arable Land and Land in Permanent Crops, 1970-83

Country	1970	1975	1979	1980	1981	1982	1983
				(kg/ha)			
Afghanistan	2.4	4.3	6.2	6.4	5.7	5.6	6.3
Bahrain	NA	NA	13.0	NA	150.0	57.0	213.5
Bangladesh	15.7	22.6	44.6	45.6	43.8	51.2	59.6
Bhutan	NA	NA	1.1	1.1	1.1	1.0	1.0
Burma	2.1	4.1	9.3	10.0	12.5	16.7	15.8
China	33.5	48.1	130.3	152.7	150.2	157.5	180.6
Cyprus	63.5	66.7	39.6	34.4	36.7	44.7	46.3
India	13.2	16.5	29.6	30.9	34.0	34.6	39.4
Indonesia	13.1	26.0	44.1	60.2	74.4	75.0	74.5
Iran	5.9	20.7	27.5	41.7	49.5	65.6	75.8
Iraq	3.4	6.3	18.7	16.9	14.1	14.5	16.5
Israel	140.1	170.7	188.5	191.9	180.4	178.3	183.1
Japan	372.6	319.3	477.7	372.1	387.2	412.1	437.0
Jordan	2.1	4.3	10.6	36.2	17.8	34.6	39.4
Kampuchea DM	1.1	0.6	NA	2.7	6.2	3.6	1.6
Korea N.	154.7	201.8	336.0	325.5	348.6	338.3	345.2
Korea S.	241.6	357.9	385.7	365.7	351.3	281.7	331.1
Kuwait	-	-	660.0	440.0	250.0	732.0	420.0
Lao	0.2	0.4	0.1	4.5	4.5	.5	.6
Lebanon	135.4	37.4	129.3	76.4	118.1	148.7	119.1
Malaysia	NA	NA	101.1	105.1	92.3	102.1	111.5
Mongolia	2.6	5.3	7.2	6.9	10.8	10.9	11.6
Nepal	2.7	6.1	9.0	9.3	9.4	13.8	13.7
Oman	NA	11.8	30.6	25.9	39.5	27.2	88.4
Pakistan	14.6	28.0	48.6	53.3	53.1	61.6	58.6
Philippines	28.0	28.1	34.6	28.6	28.8	28.8	32.0
Qatar	NA	NA	200.0	400.0	280.0	273.0	246.7
Saudi Arabia	7.3	11.6	19.5	36.8	60.0	83.2	177.7
Singapore	250.0	375.0	537.5	550.0	671.4	783.3	783.3
Sri Lanka	47.3	32.5	68.2	77.0	68.4	71.3	74.0
Syria	6.7	11.9	22.0	22.2	23.4	27.0	32.0
Thailand	5.9	10.9	18.0	16.2	17.3	18.3	24.0
Turkey	15.7	29.8	51.0	51.0	45.5	53.5	58.1
UA Emirates	NA	69.2	218.8	234.9	281.2	332.4	299.1
Vietnam	61.7	61.0	31.1	36.8	34.0	50.6	47.1
Yemen Arab	0.1	3.8	4.8	3.5	4.3	5.1	5.7
Yemen Dem	NA	6.6	6.5	9.8	8.8	10.9	0.3
Asia	25.1	33.0	61.9	67.4	68.7	72.5	81.2

Source: Latest FAO yearbooks.

TABLE 6

Fertilizer Consumption and Growth Rates and Cereal Yields by Regions

Region	Growth rate 1951-70/71	Growth rate 1970/71-1981/82	Consumption 1982 Kg/Ha	Cereal yield MT/Ha
Developed regions	6.9	3.2	114.8	2.8
Market economies	5.9	1.9	118.2	3.6
USSR & E. Europe	10.0	5.6	109.8	1.8
Developing regions	15.7	9.9	47.9	2.0
Market economies	14.1	8.9	32.1	1.6
Africa	10.2	5.6	9.7	0.8
Latin America	12.5	7.3	36.7	2.0
Asia	16.4	9.7	39.7	1.6
Other	-	13.9	28.7	2.1
Socialist countries of Asia	20.4	11.6	142.8	3.3
World	7.8	4.9	78.5	2.3

Source: UNCTAD, Fertilizer Supplies for Developing Countries: Issues in the transfer and Development of Technology, UNCTAD/TT/45/rev., 1986, p. 7.

TABLE 7

Population, Fertilizer Use and Fertilizer Use per Capita

Country	Pop (mil) (mid 1984)	MT of N,P,K used	Kg of N,P,K/person 1985	Kg of N,P,K/person 1970
Afghanistan		49,700		0.9
Bangladesh	98.1	602,214	6.1	3.3[2]
Burma	36.1	188,200	5.2	0.9
India	749.2	7,974,700	10.6	4.0
Indonesia	158.9	1,874,300	11.8	2.1
Iran	43.8	933,500	21.3	3.4
Iraq	15.1	117,320	7.8	2.4
Lebanon		50,800		15.5
Malaysia[1]	15.3	609,000	39.8	15.5[1]
Nepal	16.1	43,400	2.7	0.5
Pakistan	92.4	1,253,134	13.6	3.31[2]
Philippines	53.4	261,838	4.9	5.9
Thailand	50.0	498,700	10.0	2.6
Korea	19.9	778,100	39.1	17.4
China	1029.2	14,800,000	14.4	
Egypt	45.9	851,190	18.5	10.4
Tunisia	7.0	86,800	12.4	9.2
Morocco	21.4	248,840	11.6	6.3
Turkey	48.4			12.3
Jordan	3.4			1.2

1/ 15.5 was for West Malaysia, while Sabah (Eastern) Malaysia was 3.5.
2/ Includes both Pakistan and Bangladesh as undivided Pakistan.

2.7 Kg/capita respectively) in 1985, while most of the other countries were in the 10 to 15 Kg/capita range. If one assumes a response rate of only 10 Kg of grain equivalent per Kg of N applied, these typical application rates would translate into at least 100 Kg of additional grain per capita as a result of fertilizer application. Put the other way, in the absence of fertilizer they would have produced 100 Kg less grain equivalent per capita.

Production

Total production of fertilizer in developing countries increased by 200% in the decade from 1974/75 to 1984/85 (12.1 to 36.1 MMT). The major part of the increase was nitrogen fertilizer, with most of that coming in Asian countries. During the decade total production of fertilizer in Asia increased from 12.8 to 32.5 MMT and nitrogen production from 8.7 to 24.1 MMT. Since nitrogen production in Japan (included in the above data) declined by about a million MT during the decade, the growth in production of nitrogen in the developing countries, including the Gulf countries, was even more significant.[4]

Continued rapid expansion in nitrogen production in Asia is planned for the next several years. Ammonia production, which was 9.5 MMT in 1970, and 29.6 MMT in 1980, was estimated at 36 MMT in 1986 and is expected to reach 42 MMT in 1990. Production of phosphate in Asia increased only from 3.4 MMT to 6.9 MMT and potassium from 0.7 MMT to 1.5 MMT during the decade. Wet process phosphoric acid capacity increased from 1.2 MMT to an estimated 4.5 MMT between 1970 and 1986 and is expected to reach 4.8 MMT by 1990. Phosphate production has expanded rapidly in the Near East, especially in Morocco and Tunisia, both of which have large deposits of phosphate rock. In contrast, much of the South and East Asia phosphate production was based on imported rock. Raw materials mining and production of potassium fertilizer has been very low. (The Annex to this chapter contains a table which summarizes the numbers and types of fertilizer plants and total fertilizer production capacity in 14 developing countries in South and East Asia in 1985.)

Fertilizer Production-Consumption Balance

Consumption of fertilizer was concentrated in the developed countries in 1951-52 except for small amounts used to produce cash, mainly export, crops (e.g., coffee, tea, cotton, tobacco). Korea, Taiwan, and Egypt were somewhat exceptional in having achieved fairly high rates of fertilizer consumption earlier than other developing countries, with food crops important recipients

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4. IFDC, Asian Fertilizer Situation, 1986, Tables 1,2, 12, 16, 20.

of fertilizer. Fertilizer consumption grew rapidly in many developing countries from the mid-1960s onward and by 1974-75, consumption in developing countries had reached 18.5 MMT, of which 11 MMT was nitrogen and 5.2 MMT P_2O_5. The rate of growth in consumption (in absolute terms) accelerated and the gap between production and consumption made up by imports grew from 6 MMT in 1974-75 to 12 MMT in 1984-85. The largest increase in the deficit was in potash (from 2.2 MMT to 4.4 MMT), with production unchanged at 0.3 MMT. The 1984-85 deficit of 12 MMT of total fertilizer translated into an annual FX cost of about $5 billion a year at typical CIF prices. Dependence on imports for some raw materials further increases these annual FX costs.

Total fertilizer production has lagged two to three years behind total consumption in Asia (excluding Japan and Russia), leaving a gap of about 20% in a typical year. Production of phosphate and potassium, particularly the latter, has lagged far behind consumption in the region. This gap is becoming increasingly serious. Local production of phosphate products is growing but in most of the regions it is heavily dependent on imported phosphate rock. In the Far East there is virtually no production of potash, while consumption is growing rapidly and is expected to grow even more rapidly in the future. Asia (excluding Russia) has only three significant potash producers: Israel, Jordan, and China. Their estimated total production in 1984 was 1.5 million MT. Israel accounted for 78% of the total, Jordan 20%, and China only 2%. Exports from Israel and Jordan totalled 1.2 million MT, while the total imports by importing nations of Asia were 2.8 million MT (excluding Japan). India and China together imported 1.6 million MT (India imported almost 900,000 MT). The North African countries included in ANE also are dependent on imports for potassium fertilizers.

The large dependence on imports for potassium fertilizer of all but two of the nations in the ANE region, the dependence of most on imports for phosphate, and the inevitable need to increase consumption of P and K relative to nitrogen poses a serious FX and development problem for the region. Rapid rises in prices of these fertilizers relative to nitrogen in recent years accentuates the problem. Exploration for phosphate and potash generally has been given much lower priority than exploration for petroleum and many other high value minerals. However, the growing dependence on imports suggests a need for much more effort in the future on exploration for phosphate and potassium and development of local potential where it may exist.

Trade

The developing countries of Asia and the Near East, with a few exceptions, have been heavily dependent on fertilizer imports, especially for P and K. Figure 3 shows the regional gap made up by imports. Annex 1 contains tables which display

TABLE 8

Fertilizer import dependency of selected developing countries in the Asia-Pacific region[a]
(in percentage; 1980/81, 1981/82 and 1982/83)

	1980/81	*1981/82*	*1982/83*
Afghanistan	37.6	39.4	20.2
Bangladesh	34.3	62.2	38.2
Burma	76.1	85.5	76.2
China	18.2	16.4	17.6
Democratic Kampuchea	100.0	100.0	100.0
Fiji	100.0	100.0	100.0
India	52.3	35.7	19.0
Indonesia	25.0	27.5	50.8
Iran	86.5	100.0	95.0
Malaysia	86.3	89.3	85.0[b]
Mongolia	100.0	100.0	100.0
Nepal	100.0	100.0	100.0
Pakistan	70.6	13.4	32.7
Papua New Guinea	100.0	100.0	100.0
Philippines	82.2	77.2	90.4
Republic of Korea	20.6	26.0	32.2
Samoa	100.0	100.0	100.0
Sri Lanka	100.0	81.1	53.3
Thailand	100.0	100.0	100.0
Viet Nam	67.5	72.7	80.0[c]

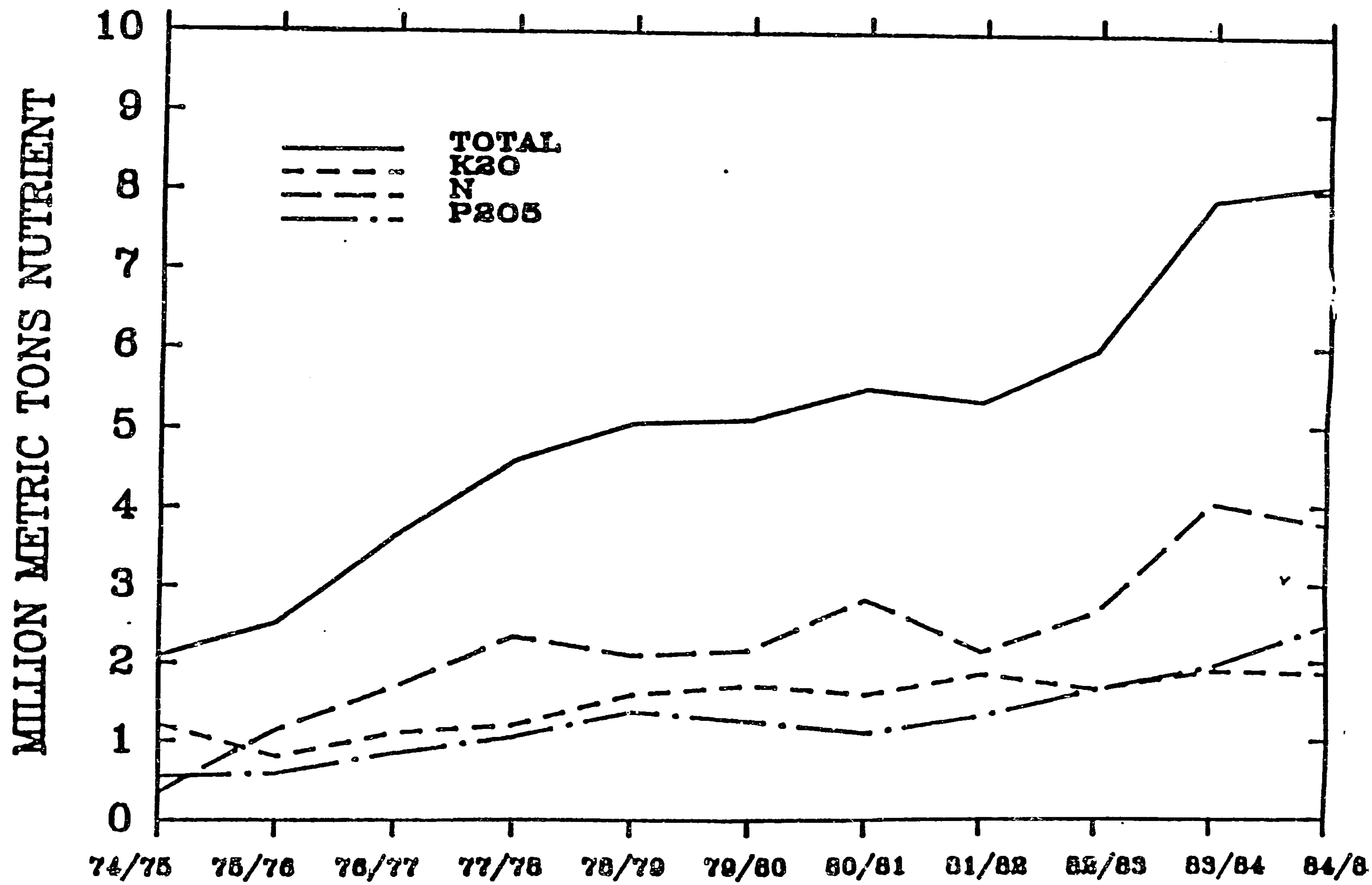
[a] 1980/81 and 1981/82: *FAO Monthly Bulletin of Statistics*, Vol. 5, Vol. 6, FAO, Rome, March 1983. 1982/83: as reported by the countries and FAO preliminary data.

[b] Net import as percentage of total supply.

[c] Estimated.

FIGURE 3

ASIA: GAP BETWEEN NUTRIENT PRODUCTION AND CONSUMPTION
1974/75 – 1984/85



country by country consumption and trade figures for 1974-1984. Recently some ANE countries have become net fertilizer exporters. In North Africa, Tunisia and Morocco have become major exporters of phosphate. Since 1981, Jordan and Iraq also have exported phosphate while exports of phosphate from Lebanon have ceased. Jordan and Israel export potash. Korea, as a result of stagnation in fertilizer use and a decline in consumption, has become a substantial exporter of both nitrogen and phosphate fertilizers in recent years (250 - 300,000 MT/year of phosphate and about 200,000 MT/year of nitrogen). With the rapid construction of ammonia/urea plants based on indigenous natural gas, Indonesia's nitrogen production has exceeded its rapid growth in consumption, and it began exporting nitrogen in 1977. Exports averaged about 100,000 MT/year from 1977 through 1984. Pakistan also was a net exporter of small amounts of nitrogen in 1983 and 1984. The Gulf oil producing nations (Kuwait, Saudi Arabia, UAE, and Quatar) are major net exporters of nitrogen fertilizer, with over one million MT of exports in 1986. These exports are expected to continue to grow.

C. Major Goals and Constraints in Fertilizer Sector Development

Past development assistance provided by AID to the fertilizer sectors in ANE countries has been designed to support a variety of goals including:

a) Increased agricultural production, agricultural income and growth in agricultural GDP.

b) Increased food supplies, food stability, food self-reliance.

c) Improvement in balance of payments and economic growth and stability by increased agricultural production.

d) Benefits for particular groups.

Quantitatively measured values of contribution to these first three goals can be fairly accurately predicted in advance of the project implementation. Fertilizer projects designed to benefit particular groups, e.g. small farmers, may require special measures to assure target groups have equal or greater access than previously. However, simple saturation of the market often is sufficient to greatly increase equity (overcome previous inequities in access). While not goals in the usual sense, fertilizer projects and programs can and should be designed to draw upon and powerfully reinforce the contribution of the four development vehicles singled out by AID for emphasis, namely:

1. Private sector development (as a substitute for the current widespread public sector activities in production and distribution of fertilizer).

2. Institutional development (research, extension, fertilizer trade monitoring, etc.).

3. Transfer of technology (in fertilizer production, distribution and on-farm use).

4. Conduct of a productive policy dialogue (on a wide variety of fertilizer and agricultural issues).

D. Checklist of Constraints and Issues in Fertilizer Sector Development

Successful utilization of fertilizer as a means of increasing levels of agricultural productivity involves dealing with a large and complex range of issues. Many questions and issues must be carefully considered in deciding whether to undertake a new program or to support an existing program in agriculture. A checklist of issues and questions has been prepared to assist in a) identifying problems and opportunities in the fertilizer sector; b) deciding whether to support a fertilizer program or specific activities and; c) selecting specific activities and designing a project or plan. The checklist should be used as a reminder and format for noting and classifying possible constraints as to their potential seriousness. For example, does the price at the factory level act as a constraint on fertilizer production? Do prices at intermediate levels constrain distributors? Do high prices constrain use? Do policies on establishment of margin levels adversely affect supply, the distribution system and availability of fertilizer when and as needed? The analyst should consider whether high subsidy costs may lead governments deliberately to restrict supplies or indirectly restrict supplies by delaying key actions such as authorization of imports, release of FX, payment of subsidies, and provision of credit to finance stocks.

The checklist which follows is intended to facilitate the identification of potential constraints and of opportunities to be addressed in program/project design. Utilization of the checklist should suggest key indicators of problems within the fertilizer sector, and help pre-select specific activities to be supported, and/or essential components to be incorporated into program/project design. Effective use of the checklist in most instances will require consultation with knowledgeable people in countries who are able to make assessments and provide qualitative judgements on the seriousness of the various possible constraints listed in the following checklist. It may be desirable to reproduce copies of the checklist and ask a few selected government officials, economic researchers and people in the fertilizer trade to indicate how they characterize the seriousness of various constraints in relation to specific development or project goals and objectives. Results of such a simple survey might also be used along with results of efforts to complete the Chapter I Annex in development of a scope of work for appropriate study of the fertilizer sector or selected components of the sector. Successful utilization of the checklist, guided by the supporting materials including data obtained in the field, should enable the staff of ANE missions to determine in a relatively short period of time (i.e., 2-3 weeks) whether or not it might be feasible and advisable for AID to invest in the sector and whether additional fertilizer sector analysis is needed.

Other sections of this paper provide additional information on major issues. The Annex to Chapter I provides tabular formats for assembly of relevant data for analysis. Selected data on countries in Asia are provided for comparison in reviewing the existing situation in a particular country. Sources are indicated in the bibliography for updating these data and obtaining additional information.

Constraints and Issues in Fertilizer Sector Development

	Constraint Assessment*			
	Nil or Minor	Moderate	Serious	Critical
Fertilizer Pricing				
Factory level				
Wholesale level				
Farm level				
Margin Adequacy				
Wholesale				
Retail				
Other				
Transport allowances/costs				
Storage allowance				
Subsidies				
Levels				
Costs				
Impacts				
Fertilizer Supply and Distribution				
Importation arrangements				
FX for import				
local financing				
licensing of importers				
controls on imports				
facilitation of imports				
import scheduling				
port handling				
amounts imported				
Production				
incentives to invest				
no. of plants				
size of plants				
total capacity				
production obtained				

* Insert a check in the appropriate place. Insert a ? or NK (not known) if sufficient information is not available to make a judgement.

Check List of Potential Constraints (cont.)

	Constraint Assessment			
	Nil or Minor	Moderate	Serious	Critical
Plant operations				
use of high technology				
use of small-scale technology				
overall efficiency				
% of capacity operation				
down time				
cost/ton				
use of local raw material				
dependence on imports				
Local raw material development				
exploration for ore				
exploitation of ore				
pricing of ore				
fuel supply and pricing				
Wholesaling				
no. of wholesalers				
total capacity				
efficiency of operation				
storage facilities				
stocking levels				
services provided				
Retailing				
no. of outlets				
farmers/outlet				
efficiency of retailing				
services provided by retailers				
delivery				
application				
information				
soil testing				
bulk sales				
less than bag sales				
weighing of bags				
other ____________				
Transport				
availability of equipment				
charges				
scheduling of transport				

Check List of Potential Constraints (cont.)

	Constraint Assessment			
	Nil or Minor	Moderate	Serious	Critical
back hauls used				
services provided				
Supply management				
level of responsibility				
speed of response				
demand estimating				
growth planning				
stock reporting				
problem identification				
staffing				
Crop Pricing/Marketing				
Farmer price levels				
Price controls				
method of setting				
level of prices				
Price supports				
methods of setting				
levels				
Effectiveness of supports				
Consumer subsidies				
levels				
costs				
impacts				
Assembly from farms				
public sector				
private sector				
transport from farms				
Local wholesaling				
public sector				
private sector				
Local retailing				
Storage/processing				
public facilities				

Check List of Potential Constraints (cont.)

	Constraint Assessment			
	Nil or Minor	Moderate	Serious	Critical
private facilities				
efficiency of operation				
public				
private				
other				
Summary of Adequacy of Private Sector Participation in				
Fertilizer manufacturing				
Fertilizer distribution				
Fertilizer importing				
Fertilizer retailing				
Farm credit				
Assembly of farm produce				
Processing				
Wholesale/retail				
Export/import of crops				
Other				
Financing of Trade				
Levels				
Sources				
Efficiency				
Availability				
Institutional Services				
Research				
varietal improvement				
crop production technology				
fertilizer response norms for soil test interpretation				
Extension services				
public agencies				
no. of agents				
training				

Check List of Potential Constraints (cont.)

	Constraint Assessment			
	Nil or Minor	Moderate	Serious	Critical
financing				
support services				
other assignments				
private sector participation				
effectiveness				
Soil testing services				
no. of labs				
quality of analysis				
availability				
effectiveness				
Inspection services				
fertilizer analysis				
weights of bags				
other				
Market Information				
on supplies				
on prices				
Other Factors Affecting Fertilizer Use				
HYV of grain available				
Supply of Seed				
Pesticide Supply				
Water supplies (adequacy)				
rain				
irrigation				
water management				
Machinery				
tillage				
sowing				
fertilizer application				
pesticides application				
harvesting				

Check List of Potential Constraints (cont.)

	Constraint Assessment			
	Nil or Minor	Moderate	Serious	Critical
Farm credit for:				
input supplies				
equipment				
other ___________				
Tenure				
share cropping terms				
other rental terms				
input cost sharing				
Resource Management				
Use of organic fertilizer				
farm yard manure				
nitrogen fixing legumes				
human wastes				
other				
Use of factory wastes				
Soil conservation				
Water management				
Energy resource conservation				

In using this check list project designers may find it useful to prepare a simple summary table such as the following.

Issue/Constraint	Description	Seriousness	Goal Affected

II. FERTILIZER SECTOR DESIGN

The primary objective of this chapter is to provide USAID project officers with guidance for fertilizer sector assessment and subsequent program and/or project design. The chapter first reviews major factors to consider in fertilizer sector development, some of which are discussed in other chapters, and work required for a fertilizer sector assessment. It addresses some of the principal issues and requirements in AID program/project design and implementation.

A. Principal Fertilizer Sector Activities

The fertilizer sector properly may include all the activities from the search for and mining of fertilizer raw materials through production, distribution and final on-farm use, with individual activities/elements included as part of the industrial sector, of trade and commerce, agriculture, or of two or more sectors as summarized below.

Activity/Element	Usual Sectoral Association
1. Raw material exploration and development[5]	Mining and Energy or Industry
2. Processing and transformation (final stages of blending and formulation of liquid products may be in Agr. or Commerce)	Industry
3. International trade in raw materials, intermediate and finished products	Trade or Commerce
4. Receipt, storage, distribution	Trade, Commerce or Agriculture
5. Fertilizer related research, soil testing and extension	Agriculture
6. On-farm application and use	Agriculture
7. Development of specialized fertilizers	Agriculture or Industry

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5. Usually restricted to phosphate, potassium and perhaps limestone. Energy (e.g. gas), sulphur (for acidulation of phosphate rock) and minor elements (Ca, Mg, Fe, Zn, Cu, B, Mn and Mo) for fertilizer are usually but a minor part of broader applications. The principal input for nitrogen, the major fertilizer product, is fossil fuel, usually natural gas.

8. Monitoring and management of the sector	Agriculture/Commerce[6]
9. Complementary activities (improved seed, tillage, pest management, etc.)	Agriculture
10. Legislation, inspection, information services	Public sector agencies with private sector inputs

B. Fertilizer Sector Assessment

A thorough fertilizer sector assessment should review and appraise all aspects from fertilizer production or import through distribution, on-farm use and regulatory and other services. It should begin with a careful review of the agricultural sector: the past, present and prospective future growth rates; adequacy of agricultural growth rates to achieve various agriculture related goals; the natural resource base including the characteristics of the major soils and other resources available to achieve alternative agricultural growth rates; and national economic goals. Soil nutrient levels as a potential constraint on development should be carefully examined. Alternative sources of nutrients (commercial fertilizer, better management of organic sources, etc.) should be appraised. Specific targets on fertilizer consumption should be identified in relation to agricultural targets and various aspects evaluated for technical, economic and other feasibility. The resource base and advantage and disadvantage of domestic production versus import should be carefully analyzed for each nutrient. Major constraints to achievement of otherwise technically and economically feasible alternatives should be identified. The particular goals, purposes and/or objectives accorded high priority by the host government and/or by the donor agency should be identified; the extent to which fertilizer sector constraints act as major obstacles to their achievement should then receive major attention in the analysis.

One approach to analyzing how particular goals/objectives may be achieved is to pose an ideal or near ideal structure for agriculture and rural development and within that structure establish ideal requirements for the essential productive inputs which historical data have shown to have been effective in increasing productivity. Having set down the country specific characteristics of an ideal system, the next steps are: a) to

6. Usually most successful as a high level inter-ministerial group with staff provided by the principally interested ministry.

identify and appraise deviation from these ideals and b) to evaluate the extent to which these constraints or deviations from the ideal detract from the potential for achievement of different goals/objectives. Alternatives for overcoming these constraints should then be identified and appraised as to feasibility (technical, financial, economic, etc.).

Characteristics of an ideal system for the fertilizer (and agricultural limestone) sector include:

Needs identification

Nutrient and soil amendment needs have been identified for major soil types and ecosystems and important crops. These have been translated into recommended levels of use of specific types of fertilizer and other soil additives (N,P,K, minor nutrients, limestone used to correct acidity, gypsum) for each major set of conditions.

Variety in supply of fertilizer and limestone and other soil additives

Types of fertilizer products, limestone, and gypsum identified as needed are produced locally and/or imported. The numbers and types of products are adequate but kept to a minimum consistent with essential soil/plant needs.

Level and continuity of supply

Liberal estimates are made of total needs to cover past use and rapid expansion in use. The supply system is managed to insure that supplies of all products identified are available in adequate quantities to satisfy all demands at all times of the year. Breaks in supply never occur prior to or during application seasons. (In most of the warmer regions of the world, that means never, since at all times one crop or another is growing.) The supply is sufficient to encourage active promotion of increased use by distribution agents at all levels.

The distribution system provides ready access

The distribution system is sufficiently large, widely dispersed, and well stocked at all times so that farmers using available transport are readily able to obtain supplies as needed. Evidence suggests that where the transport facilities of small farmers are limited to pack animals and an occasional animal drawn cart, distance to sales points should not exceed 5-6 km.

Information dissemination

Farmers, large and small, have adequate access to sound, research-based technical information on needs and proper uses of different plant nutrients and soil amendments. A well managed program of fertilizer research and trials on farms is underway in each ecological region. Farmers have ready access to extension workers trained in fertilizer and other crop practices and are easily able to visit fertilizer demonstrations. Soil test and interpretive services based on good research are available from extension services and other sources. Fertilizer salesmen have some training in fertilizer use technology.

Produce markets

Farmers have reasonably stable and profitable markets for their principal products, particularly those using or likely to use commercial fertilizer.

Price relationships

Fertilizer/crop price relationships are such as to offer returns of about 2.5 or better in value of marginal product for each monetary unit spent for fertilizer.

Other inputs

Simple and effective tools and implements (for seed bed preparation, seeding and fertilizer placement) and power sources (animal or small tractors) are widely owned or available for hire. Quality seeds of suitable varieties are widely available. Available water is well managed and efficiently utilized. Pests (weeds, insects, disease) are managed to a sufficient degree so as not to be a major obstacle.

Deviations from the ideal (such as those posed in general terms above) should be identified and appraised. The ultimate constraints should be identified. For example, one or more basic causes may be responsible for chronic scarcity in fertilizer supplies. Chronic scarcity may be a symptom resulting from:

- inadequate collection, analysis,and dissemination of information on supply, consumption, import, production, etc.;
- lack of clearly defined responsibility or lack of management capability;
- government policies which restrict fertilizer imports, e.g., import licensing, foreign exchange controls;
- an inadequate system for fertilizer production/import and distribution;
- lack of funds for plants, import financing, stocking, distribution operations; and
- poor transportation facilities.

Some groups may face chronic scarcity because of inadequate numbers/distribution of outlets, or of inadequate supplies in some outlets. This may be due to lack of transport or of incentives to sell in remote areas. Uniform prices without adequate transport allowances commonly discourage selling in more remote areas.

After identification of the major and minor constraints (basic causes), a specific plan or set of alternative plans should be developed, tested for feasibility (technical, economic, administrative, social, etc.) and a set of recommendations prepared. These recommendations should include the detailed cost and benefit estimates, feasibility analyses, implementation details, and, in general, the type of data, information and analyses required by AID or other donors for preparation of a program, project, or series of projects. The prototype scope of work for a recent Bangladesh fertilizer sector assessment presented below illustrates the content of sector assessments (the bibliography identifies many other such studies).

<u>Prototype Scope of Work from Bangladesh Fertilizer Sector Assessment</u>

A team consisting of four TVA and an equal number of Bangladesh technicians will:

1. Review available agronomic data to determine the adequacy of present fertilizer recommendations by crops and regions.

2. Make fertilizer use estimates by crop, region and by season of demand (irrigated and non-irrigated) for five and ten year periods and provide a methodology for updating annually.

3. Recommend kinds and quantities of fertilizer (urea, straight phosphates, N-P, N-P-K, and possible micro-nutrients) best suited to Bangladesh agriculture.

4. Evaluate the possible use of rock phosphate in Bangladesh agriculture and crops in which it could be used and the price at which it could replace TSP or other manufactured phosphates.

5. Recommend possible needs for liming materials or other amendments and how needs can be satisfied.

6. Estimate regional fertilizer needs (total and by kind) and recommend date of arrival at regional godowns, so that fertilizers will be available for moving through the system on a timely basis. In order to assess future transportation requirements, the study will make recommendations concerning not only the areas of fertilizer usage but also the points within the country from where the fertilizer will be supplied whether locally manufactured or imported. Provide a methodology for updating this annually.

7. Review and estimate local fertilizer production capability. Recommend kinds and amounts of fertilizer that should be produced in Bangladesh over the years ahead.

8. Recommend import needs (amounts and kinds) to supplement total production and better serve agricultural needs. Suggest tendering procedures and import schedules.

9. Evaluate the potential for bulk handling for imported and locally produced fertilizers and provide guidance on types of equipment and handling facilities needed. Advise on most suitable size and type bags for transport and delivery of fertilizer (especially urea) under the conditions prevailing in Bangladesh.

10. Study present storage facilities and plans for expansion as to adequacy and in light of good inventory management.

11. Provide guidance on how present production can be utilized to provide fertilizer needs and suggest alterations of existing facilities to contribute to meeting this need.

12. Determine probable value/cost ratios and utilize these to derive priorities for fertilizer use in a sellers market situation and as a guide for the reduction or elimination of subsidies.

13. Study the present pricing and subsidy policies and suggest future policies.

14. Study the present credit system to ascertain its effect on fertilizer sale and suggest improvements based on estimated future requirements.

15. Utilize data generated by transport survey and build on this, provide a transport strategy and system for fertilizer, identify where possible, specific projects required to meet transport system objectives.

16. Describe, evaluate and recommend improvement in the overall distribution and marketing system for fertilizers in Bangladesh.

17. Study the method of appointment and regulation of fertilizer distributors, wholesalers and retailers. Comment on past effectiveness, adequacy and suitability of marketing structure at Thana level and below, along with its commercial effectiveness. Identify weaknesses and propose options to the government.

18. Observe workings of fertilizer retailing system at farm level and the extent of farmer education, demonstration or other training program. Identify weaknesses and propose options to the

government.

19. Evaluate present research, extension and training efforts and suggest further training in the U.S., other countries and Bangladesh that will be beneficial.

20. Work with the Fertilizer Corporation to:

a) Identify spare parts inventory needs for operating fertilizer plants; suggest how these needs can be satisfied (what can be locally produced and what should be imported); work out a system for continuous inventory control.

b) Provide assistance in the establishment of preventive maintenance programs to assure a minimum of down time and methods for predicting probable trouble areas so corrective measures can be taken rapidly during planned periodic down time.

c) Work out a plan for training of key personnel in various aspects of operation, maintenance, instrumentation, water treatment, corrosion control, safety, etc.

d) Plan and program a strategy for the utilization of existing facilities and supplementing them with new facilities to provide the full range of fertilizers needed by Bangladesh agriculture with special attention being given to N-P and N-P-K fertilizers at minimum cost and at minimum foreign exchange expenditure.

21. Examine the organization, responsibilities and authority of the different agencies involved in production, procurement marketing and distribution of fertilizer and comment on their past and present effectiveness particularly with respect to importing and supply of adequate quantities of fertilizer when and where they are needed. Make suggestions and recommendations on the future function and operations of the agencies in the fertilizer field and on any improved practices and procedures they may usefully adopt in forward planning, day to day operation, and on collecting and analyzing market information. Suggest the needs of any training program for the agencies' staff which should be instituted.

22. Prepare a draft report and feasibility study for principal investment.

There are several areas which might be given additional emphasis in a fertilizer sector assessment:

1. Estimation of cost of operation of intermediaries in the distribution system and adequacy of margins allowed where prices and/or margins are controlled.

2. Appraisal of the costs and benefits from use of fertilizer under different price assumptions.

3. Design of procedures for continuous monitoring of prospective supplies (import and production), stocks at all levels, current and projected off-take, and a system for high level review which will ensure timely response where supply problems appear likely.

4. Preparation of a clear set of recommendations on public and private roles in fertilizer supply, distribution, and management based on economic factors.

5. Recommendations on methodology for projecting demand.

6. Review of the adequacy of exploration for and development of raw materials and, as appropriate, recommendations. (This might be covered under item 7 of the above scope of work.)

C. Planning the Fertilizer Sector

Planning the fertilizer sector involves difficult data collection, analysis, and decisions at each stage from appraisal of potential raw material sources through mineral extraction, product choices, manufacturing processes and locations, fertilizer packaging, transport, distribution systems, pricing, and on-farm use. Choksi, et. al. propose classifying the broad planning problems into two major categories. The first category includes decisions involved in specifying the planning problems. Illustratively: What feed stocks and end products should be included in the investigation? How many and what potential production sites should be specified? How many and what marketing centers adequately represent the dispersion of demand? What transport forms should be considered?7 The second set of problems relates to formulation of an efficient investment program once the scope of the planning problem is specified. This (Choksi) approach to planning is particularly designed to utilize mathematical models for final decisions on plant locations, scale timing, and transport. The questions on sites, marketing centers and transport, etc. help define parameters of the model and the information needed.

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7. Choksi, Armeane M. et al, The Planning of Investment Programs in the Fertilizer Industry, IBRD, Washington, D.C., 1980.

Models can be very helpful but should not be depended upon as the sole criterion in the decision making process. Many of the most important decisions are based largely on judgments by knowledgeable persons. Models commonly require similar judgments on technical or economic relationships for their complete specification. A serious risk exists that once judgments for the model have been made, the model may then preclude or at least no longer be as sensitive to other options as the expert participating on a continuing basis would be.

1. Fertilizer Sector Design Considerations

AID has established a standardized outline and set of components which are normally included in project papers, as follows:

(1) Project Data Sheet

(2) Draft Project Authorization

(3) Project Rationale and Description

(4) Cost Estimate and Financial Plan

(5) Implementation Plan

(6) Monitoring Plan

(7) Summaries of Analysis

(8) Conditions and Covenants

(9) Evaluation Arrangements

(10) Annexes, as follows:

(a) PID Approval message

(b) Log Frame Matrix

(c) Statutory Checklist

(d) B/G request for assistance

(e) FAA, Section 611 (e) certifications, if applicable (See Appendix 3L or Appendix 4B, G.I.)

(f) Project Analyses, as follows:

(i) Technical

(ii) Financial

(iii) Economic

(iv) Social Soundness

(v) Administrative

(vi) Environmental (if appropriate)

(vii) Energy (if appropriate)

Many parts of the above listed requirements are fairly standardized for all types of projects and hence need not be discussed further in detail in this chapter. Some are mere summaries which obviously grow out of other parts of the project documentation. These latter include: 1. Project Data Sheet, 2. Draft Project Authorization, 10 (a) PID Approval message, 10 (c) Statutory Checklist, and 10 (d) B/G request for assistance. Major project and program design requirements are discussed in the following sections with, where appropriate, specific fertilizer-related experience from ANE countries.

Three principal types of fertilizer projects are considered:

a) Major capital development projects involving large facility investments: fertilizer plants, storage, port handling, transportation;

b) Smaller, largely institutional development projects such as research, extension, soil testing, training, management assistance; and

c) Programmatic assistance primarily to finance the import or other procurement and distribution of fertilizer.

Any of these, but particularly types (a) and (c) often involve appraisal, discussions and commitments on major policy and development issues affecting the fertilizer sector or the agriculture sector more broadly. Analysis and planning in the fertilizer sector has been made more complex in recent years by large and difficult-to-predict changes in the prices of fertilizer raw material such as energy (the demand for which is affected very little by fertilizer demand) and changes in the demand for fertilizer, which is largely determined by agricultural prices and agricultural policies. Both energy and agricultural prices have fluctuated greatly in short periods. This complicates fertilizer planning, which requires medium to long term commitments -- especially where new plants may be included in plans.

2. Goal Formulation

In fertilizer sector planning and activity design, goal formulation is usually the first step, followed by constraint analysis and then development and examination of alternative proposed courses of action for constraint alleviation. Identification and analysis of constraints is the most important step in the diagnostic process. Program analysts must be certain that constraints are real, not merely symptoms of other more basic problems in the fertilizer sector and that the various constraints are properly weighted.

Program analysts should be sensitive to the compatibility of the timeframe of the problem and possible solutions and usual donor action schedules. It often requires 1-2 years to mobilize resouces in donor funded projects and requires 2 - 3 years for most donors to show any impact even on a short-term problem. More time is required to deal with long-term and basic problems such as the development of fertilizer distribution infrastructure, new plants, and fertility research. Plans should reflect realistic analysis of the time required by donors to mobilize and deploy resources.

Criteria to be applied in selection among alternative activities and alternative approaches to alleviation of particular constraints should be clearly understood and, where feasible, clearly stated. Criteria should indicate comparative costs of alternatives and costs relative to benefits: that is, rate of return. Another consideration should be the distribution of benefits among different groups. Timing also should be adequately considered. Other things being equal, an approach expected to yield measurable impact in 24 months should be accorded priority over one which only begins to have an impact after four or five years. Probability of success also may be weighed where it can be reasonably estimated. Probability is more likely to be meaningful in evaluating a discrete event such as, for example, a host country decision to change a particular fertilizer related policy.[8]

Fertilizer activities frequently are criticized as lacking goals or a focus or of being only a temporary expedient since supplies must be replenished annually. The rationale for undertaking a fertilizer project or program should be carefully thought through and appraised in relation to the AID CDSS and the country development plan, strategy, or other statement of development goals and/or objectives. Well designed fertilizer activities or programs may have major social, economic, and/or political goals and a wide variety of objectives such as

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8. See Handbook 3, Appendix 1A.

advancement of particular groups (e.g., women, small farmers), and improvement of the balance of payments (import substitution, increased exports), domestic budget, food security, and employment. Even projects that merely finance fertilizer imports may have important long-term social impacts by setting in motion a continuing process or by the negotiation of an enduring policy change. Fertilizer import financing usually has very high rates of return to society and to farmers. Import financing, along with an application of resources by use of the imported product can provide the means of financing future supply replacement and thus permanently eliminate need for this aid.

Where a major and quick disbursing resource transfer is planned for political or economic reasons, fertilizer import financing may be identified as a desirable means of quick disbursement of resources and at the same time advance other ends or goals. The fertilizer project thus would be formulated after the decision to undertake resource transfer for political or macroeconomic reasons. A commitment to achievement of fertilizer related secondary goals might help mobilize support from officials otherwise opposed to simple resource transfers. Development programmers should seek such means to utilize fertilizer import financing to address economic and/or social goals in addition to the primary political or economic goal being addressed by the rapid resource transfer.

Fertilizer projects have the advantage of considerable design flexibility in responding to more than one goal. They may involve any one or a combination of activities such as: a) capital development projects, usually for plants or other major fixed facilities; b) institutional development projects (research, extension, management, etc.); c) program type financing of imports or fertilizer operations.

Impacts may be obtained by a variety of mechanisms, including:

- direct application of the resources supplied to produce particular outputs to achieve the desired purposes; that is, use of imported fertilizer, the product of a new plant, the increased productivity of new or improved distribution facilities or specific institutional outputs.
- application of local currency generated by sale of goods and services, directly financed.[9]
- use of the opportunity presented by the project/program to discuss and/or negotiate changes in approaches within the

9. The reader may want to refer to the latest AID Policy Paper of Local Currency Financing and to the 1986 review of PL 480 programs by Morton and Newberg.

fertilizer sector, agricultural sector or other sectors--e.g., price or subsidy or other policy changes, increased investment or other host country financial commitments to desired activities, changes in regulations or procedures affecting the fertilizer sector, promotion of a greater role for private enterprise and greater market competition.

Success in largely policy oriented areas requires:

- correct identification and definition of the constraints;
- definition of needed action and action agent(s) and of the action-constraint relationships;
- effectiveness in establishing and justifying or negotiating the needed action; and
- an adequate monitoring and evaluation system to determine whether planned actions are taken and whether the expected results occur.

In justification of financial support of fertilizer activities, it should be noted that evidence clearly shows that increased fertilizer use is currently the major factor in increasing agricultural production in developing countries. Given the low levels of use that still prevail in most developing countries, fertilizer is the most certain possibility for major production increases in the next couple of decades. Unless prices are very badly distorted, fertilizer use results in an increase in value of agricultural production that exceeds incremental costs (of fertilizer, other complementary inputs, services, etc.). Farmers usually require a return of at least two and often 2.5 (dollar equivalent) for each one (dollar equivalent) spent for fertilizer before they will expand use. (The difference covers additional costs associated with the increased fertilizer use and increased yield and risk and profit sufficient to induce adoption.) This sets lower limits on financial rates of return and insures a net gain to society in income unless price policies badly distort relationships.

An increase in the volume of exports and/or reduced imports result from increased agricultural production. FX savings/earnings normally exceed by a substantial amount all incremental FX costs (for fertilizer, other goods, and services). Fertilizer projects may be designed to insure that recurrent budgetary costs will be reduced as a result of the project (e.g., reduced subsidies). They may result in the collection of additional duties and other taxes.

Increased production attributable to increased supplies of fertilizer or better use of fertilizer in a properly designed program will result in increased rural income. It will also result in a measurable net increase in employment at farm, agribusiness, and other levels. It has been shown that small farmers, when given access, use productivity-increasing resources as intensively and frequently more intensively than large farmers. Several studies have demonstrated that lack of access to productivity-increasing inputs, particularly fertilizer, is one of the most serious constraints to increase in yields and incomes of small and remotely located farmers.

Local currency, generated by imports or other fertilizer-related activities, may be used directly for economic, social, or equity purposes. It may be used to finance improved distribution facilities and operations or improved on-farm use of inputs, which result in greater or more widely distributed fertilizer supplies, greater efficiency of use, lower costs, reduced product losses, or some combination of these. Local currency may also be used to finance farm credit, research, extension, soil testing, training, institutional development, or other uses which benefit particular groups or society as a whole. Designers should seek such opportunities for productive use of local currency generated under fertilizer activities.

3. Purposes, Outputs, Inputs

The purpose of fertilizer projects usually includes one or more of the following, designed to overcome constraints to increased overall fertilizer use:

- Increase total fertilizer supply to overcome national or local shortage;
- Expand or improve operation of the distribution system to reduce costs, improve timeliness of supply, and make fertilizer accessible to more farmers;
- Improve the efficiency of use, thereby making fertilizer more profitable and/or reducing need for subsidies;
- Improve overall management and monitoring of the system, and protection of consumers; and/or
- Provide improved services such as research, extension, information and soil testing.

Major outputs are likely to include some of the following:

- New or expanded fertilizer plants, and/or increased imports;
- New or expanded distribution facilities; improved operations; and
- Improvements in performance of institutions (research, extension, information services) or possibly availability of equipment to increase fertilizer use efficiency.

Inputs, of course, usually are funds and the goods and services they finance which are needed to provide the outputs listed above.

In the case of a large fertilizer plant, the log frame might be simply stated as follows:

Inputs: Dollar loan to provide funds which

Output: Finance a new or remodelled plant which

Purpose: Expands supplies of fertilizer and improves equity in access to fertilizer; increased fertilizer applied to fields which results in

Goal: Increased food output, improvements in farmer income, GDP, BOP and likely contributes to food security and, to the extent past scarcity resulted in inequitable access, it improves equality in income distribution.

Financing of fertilizer projects may lead to a policy dialogue leading to a variety of policy changes resulting in desired changes in, for example, fertilizer subsidies, prices and margins, crop prices and/or improved government services.

Some examples of fertilizer sector log frames are contained in the Annex to Chapter II.

4. Cost Estimates and Financial Plan

The project proposal should present a financial plan which shows total costs of all inputs required (facilities, materials, management and others), the sources of financing for each element, and the time phasing for inputs and financial contributions. This should include cash inflow required both for investment and for working capital (raw materials, labor, etc.). In the case of a business or similar investment which will produce a saleable product, the plan should indicate sales and cash flow from sales. It should show as outflow expenditures for repayment of capital costs as well as costs of goods and services required for operations.

The cost should be estimated for individual elements, as well as the total. The financial plan should show plans for mobilizing and deploying the needed resources over the life of the project. It should also address the issue of continuity of financing after the completion of the U.S. or other donor contribution to the project where need for public support will continue.10 This section should also describe the supply arrangements. From a presentational viewpoint, most fertilizer projects will be similar to other AID projects with respect to cost estimates and the financial plan. The large and rapidly escalating cost of large fertilizer plants in recent years, and often increased cost due to delays of months or even years in

10. See AID Policy Paper on Recurrent Costs, AID May 1982.

completion of facilities in developing countries, have made cost estimating very difficult and risky. Cost overruns are the rule rather than the exception. While host country participants (public or private) may be required to accept the cost overrun risks, this often proves inadequate since their financial resources usually are sharply limited. Developing country plant operating levels (as a percentage of capacity) also have usually been well below levels achieved in developed countries.

Where a single discrete unit is to be financed, such as a large nitrogen plant, full financing to completion, including overruns, must be assured or the investment is worthless. Where major facilities are to be constructed -- plants, storage, handling, bagging, etc. -- the project designers should obtain the necessary technical assistance from firms or agencies that specialize in such matters. There are several large U.S. firms with access to the latest fertilizer production and handling technology. Feasibility studies, if undertaken, should provide needed information on costs. The scope of work may be designed to require a detailed financial plan as well.[11] Fortunately, most of the AID's recent fertilizer project financing has been made up of many small units (e.g., fertilizer storage units or quantities of fertilizer) which can be reduced without jeopardizing work completed if costs escalate.[12] In the case of fertilizer importation, the total volume may decline if prices escalate, but this clearly does not diminish the value of the quantities financed, though it does increase total and per unit costs of inputs and outputs. Rates of return will be adversely affected by cost overruns or price increases. Even in the case of fertilizer import financing, AID may want a specific commitment of resources from the host country (and other donors, if any) to insure that its financing does not simply displace funds otherwise provided by the host country or other donors.

5. Implementation Plan

The implementation plan should describe in detail precisely

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11. AID has funded a large number of fertilizer assessment studies, many of which were carried out by IFDC (see bibliography).

12. It is doubtful that AID will finance large new fertilizer plants in the near future. The major opportunities appear to be in improving efficiency of present plants, marketing systems and on-farm use of fertilizer. Recent projects involving financing of fertilizer storage and distribution facilities in Nepal and Bangladesh were made up of many discrete and separately functioning units. The number could be reduced, if costs proved higher than estimated, without damage to the functioning of units completed.

what actions are required, and when and by whom they will be performed. It also should describe interrelationships of one action to another. Consequences for subsequent actions or outputs of delay or failure of a particular action or activity should be clearly understood.

Fertilizer projects should include very specific quantities, schedules, review points and action plans even if the project only involves imports. Since fertilizer must be on the farmer's field by certain deadlines, planning should start with field application deadlines and work backwards to regional arrival dates, stock build-up in factories or port warehouses, production, and/or import scheduling, import purchase agreements, financial deadlines, etc. Field application deadlines should be available from research and extension services for different crops. Data on seasonal farm sales should be available from sales agencies. Once schedules have been established, a responsible agency should be identified and it should establish and maintain an adequate system for assembly of data on offtake (or sales) at each level and also on actual arrivals, scheduled arrivals, firm import commitments, actual factory production, stocks and future schedules, etc. This should include planning and monitoring import schedules for raw materials. Ideally, the host government already has an adequate system of data collection and monitoring in operation or such an indigenous system can be developed with minimal AID input. Thus, AID would not need to be directly involved in data collection and monitoring. Frequently, where AID has provided major financing of fertilizer imports and factories, it has obtained monthly, updated reports from the host government detailing past operations, the current situation and plans and commitments for the next 12 months.

6. Monitoring Plan

During the course of project design, needs for technical, economic, financial, and social feasibility data will evolve. Plans should include appropriate assembly of such data. The detailed implementation plan should provide the principal basis for project monitoring, including the assembly of detailed monthly or more frequent data. Insofar as possible, requirements for the collection of data, analysis, periodic review of progress and decisions on in-process redesign, if appropriate, should be built into the project and established as a requirement of the principal implementing agencies. This relieves the donor of an otherwise onerous (and expensive) job. Further, it puts the monitoring responsibility with the implementing entity, where it belongs. The donor will still want to obtain and review copies of the data and analyze and periodically discuss the data and progress with the implementing entities. Such reviews should be formally scheduled on at least a monthly basis. As a minimum, they should precede major project financing decisions such as release of a tranche of funds.

7. Technical Analysis

The technical analysis examines all aspects of technical feasibility of implementation of the fertilizer project. The most important issue is whether the technology exists for achievement of the goals from the purpose, the purpose from the outputs and the outputs from the inputs. In some cases the technical analysis may include the feasibility of mobilization and deployment of the specified inputs. Beyond this there is the question of whether the proposed methods or approaches for achievement of the various project elements are technically most suitable (and, ultimately, most efficient) under the circumstances that are expected to prevail at least at the initiation of the project. The analyst must consider the suitability and compatibility of the various elements of the proposed technology as well as the suitability of the technology in relation to the market to be served; the resources available; the management, financial and technical capability existing in the particular country or to be provided; and the compatibility with the infrastructure separately available or to be put in place.

Fertilizer plants frequently involve particularly critical, technical issues. Developing countries commonly have encountered serious conflicts between the perceived need to achieve the highest levels of efficiency, particularly in energy cost, and the local capability for operation of technologically highly advanced plants. Plants where the latest technology is attempted frequently encounter long delays (of two years or more), large cost overruns (50-100% or more) and operate much below design capacity (65-70% of capacity).[13]

Since the first energy crisis of 1973, major developments have taken place in fertilizer plant technology permitting substantially reduced energy input per MT of fertilizer produced (especially for nitrogen, the highest energy user). With fertilizer accounting for 60% or more of the total energy used in agriculture in developing countries, efficiency in fertilizer production and fertilizer use is critically important for energy deficient countries.

The technical analysis is important not only for large fertilizer plants, but also in procurement and handling of fertilizer to ensure that suitable products are procured and efficiently used, to maintain product quality, to reduce health hazards and protect the environment, and in on-farm use to

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13. See Sustainability of Projects; Review of Experience in the Fertilizer Subsector, Report #6073, IBRD, February 1986.

increase returns to fertilizer use and minimize environmental pollution from field surface run-off and leaching into ground water. The fertilizer products and technology chosen for farm level use also may have significant effects on the distribution of benefits and other social impacts.

Given a) the rapid rates of development of new technology in fertilizer production and handling, b) rapid changes in world prices and other economic relationships which impinge on viable technical solutions, and c) changes in knowledge and practices in fertilizer utilization both in experimental stations and on farms, it is important that agencies contemplating major initiatives in the fertilizer sector arrange for expert advice at the earliest stages of technical analysis and activity design.

8. Economic and Financial Analysis

a) Economic Analysis

Economic analysis should provide the project designer and project reviewing and approval officials with data on combined costs of all inputs to a particular proposed activity and total value of the contributions and benefits at the primary and subsequent levels (secondary, tertiary, etc.). This may be referred to in its simplest form as the ratio of benefits to costs or benefits/costs ratio. The usual practice in preparing an economic analysis is to apply international values (prices) and thereby to approximate the total costs and benefits of a given allocation of resources to society.[14] A common measure of economic viability used in the economic analysis is the IRR (internal rate of return). IRR is a measure of the total costs and returns of a given project to the country, appropriately considering deferred flows of benefits and cost outlays.

While improvement in the balance of payments normally is not the major objective of agriculture or fertilizer projects, the impact on balance of payments (BOP) and domestic budgets commonly is a matter of great concern to host government officials who must deal with finance and planning. The rapid growth of international debts and debt servicing burdens make BOP considerations particularly important to host governments and donors. In major projects, at least, analysts should attempt to estimate direct short- and long-term impacts of the project on imports and exports over a reasonable period of time (10-15 years is suggested). If donor grants or highly concessional financing

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14. In financial analysis local market values and prices, which often are controlled or subsidized, are applied. The local price of fertilizer would be used in financial analysis while total cost, including any subsidy, would be used in economic analysis.

are provided, cost estimates should be based on real or "world" costs of imports and the opportunity cost of money.

In calculating the benefit/cost ratio, both input costs and value of direct outputs and other results should be appropriately adjusted for time by some factor such as the going commercial rate of interest. A "discounted cash flow" or "present value" equivalent may be used as a measure of benefits relative to costs over time. In the simplest case, the elapsed time from fertilizer purchase through sale of the resulting increased crop may be only six months. The current value of the deferred income (the crop) then would be adjusted by a factor of 1/1+r (where r is the interest rate). This would be 0.95 based on a 10% interest for six months. Thus, $100 spent for fertilizer which gives a return of $200 in increased value of crops would give a discounted cash flow of approximately $190 for a discounted rate of return of 1.9 on an investment of 1.0 at r = 10%. Of course, there are other costs incurred, such as acquisition and application of the fertilizer, harvesting, and marketing of the incremental volume of produce. Most of these additional costs which the farmer incurs would go to others in the economy as increased income (mostly labor). Thus, the total discounted return to society may be close to the 1.9 value.[15] Methods such as these are usually used for arriving at a "discounted cash flow" for financial analysis, where all prices and costs are in country values in contrast with world values for economic analysis.

Discount tables can by used to calculate the current value of a deferred income flow at a given discount rate. The internal rate of return (IRR) is the discount rate at which the discounted value of expenditures and discounted value of income flow are equal. The IRR (either financial or economic) is compared with some exogenously determined minimum to make decisions. If the IRR exceeds the critical level, the project is presumed to be economically or financially viable or both, as the case may be.[16] The internal rate of return, when used in financial analysis (applying local prices for inputs and outputs), is referred to as

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15. If some of the additional costs are for imported goods, such as fuel and equipment for fertilizer application, harvesting, and marketing, the 1.9 figure would be adjusted downward somewhat to arrive at a value that reflects total benefits to the economy.

16. Estimates of the IRR may be obtained by a series of iterations using different assumed discount rates for expenditure and income. For more detail on methods of calculation of the IRR see Gittenger; op. cit; pp. 333-343. Computer programs, such as Lotus 1-2-3, also can be used to calculate IRRs.

the financial rate of return.

In benefit/cost analysis, the internal rate of return, when used in economic analysis (using world prices), is referred to as the economic rate of return. The net present worth of a given investment at a given discount rate is obtained by adjusting the net annual income (annual net sales - annual costs other than interest on investment) by an assumed adjustment factor for deferred income and summing over the total life of the investment. Immediate investment and returns are valued at their monetary value, while delayed costs and returns are adjusted by the factor, r; "r" is usually the commercial interest rate expressed as a decimal. Costs and returns to a project of a year after start-up are adjusted by multiplying by 1/1+r; two years later by (1/1+r)2 etc.[17] The total outlay and returns, monetized and adjusted, then add up to total net returns adjusted to the moment of initiation of the project, which usually would be taken as the point in time at which the first funds must be advanced.

This time adjustment factor has only a minor impact on a project which involves purchase and sale of fertilizer where the time from fertilizer purchase through sale of the resulting increased crop yield may be only six months. However, effects of deferral of income are very important where a large fixed investment is planned in a major facility, such as a fertilizer plant, which is expected to produce an income flow over many years. In modern large-scale nitrogen plants (including facilities for production of ammonia and finished products such as urea, AN, etc.), the total time from initiation to production of the first saleable product may be 4 -5 years or longer. Typically, projects in developing countries have taken much longer than similar projects in developed countries. Further, plants commonly do not produce at capacity for several years.[18] At a 10% discount rate, discounted cash value of the first sales, beginning five years after the initiation of the project, would be only 59% of the monetary face value. A $2 return on $1 invested, coming at the end of the sixth year, would have a discounted, initiation time value of only $1.13 for a rate of return of only 1.5% above the 10% adjustment factor. This would be a compounded rate of return (IRR) of about 11.5% on the original investment through the sixth year when the return is obtained. Where investment in a large plant takes place over the entire construction period and there is a return flow over 15 or 20 years of expected life of the plant, each of the annual outlays and returns must be appropriately adjusted. At an

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17. If the interest rate used is 10%, the adjustment factor for the end of year one would be (1/1 + .10) = 0.91, for year 2, (1/1 + .10)2 = 0.826 etc.

18. See IBRD Report #6073.

adjustment factor of 10% or more, the discounted value of returns deferred beyond 20-25 years does not greatly affect the total returns. For example, at a 10% factor, a dollar of return expected at year 20 is worth only about 15 cents at year zero and less if inherent risks are considered.

Fertilizer projects which involve fertilizer imports or local purchase and distribution typically involve a year or less total delay between the commitment and harvest of the first crop fertilized. However, for some uses the flow of return may be spread over several years. Most of the return to nitrogen applications comes in the first crop season and hence can be treated accordingly, with adjustment for lead time for imports and delays for post harvest marketing etc. In contrast, returns to investments in P and K may come over 2 to 3 years with the largest part in the first year. Outlays for liming of fields to reduce acidity typically come over a period of about three years.

The fertilizer sector may include a variety of activities which affect fertilizer use but do not involve fertilizer production, supply or distribution directly. These may include: measures to increase effectiveness of fertilizer use by development and supply of better fertilizer application techniques and equipment; supply of more fertilizer responsive seed and better seed placement; better tillage and pest management, better water management; liming to reduce acidity; research and soil testing to determine optimal nutrient application rates and combinations; and informing and training farmers about fertilizer use.

Institutional development is an appropriate fertilizer sector activity. This may include improvements in the distribution system, development of fertilizer quality control monitoring systems, research, extension, soil testing capability, etc. Some of these activities may involve major delays before a flow of benefits begins. They also may involve considerable uncertainty about levels of benefits. The benefits from such activities as fertilizer response research, soil testing, and improved placement of fertilizer and seed are generally quicker and more predictable than returns from plant breeding. A number of analysts have developed estimates of annual rates of return on plant breeding and other research of 30% or more. Benefit-cost analysis for major multi-faceted institutional development projects is difficult and conclusions usually are tentative. To the extent feasible, the analysts should attempt to reduce the project to major elements such as investment in soil testing, plant breeding, tillage, pest management, etc., which permits clearer identification of results and estimation of benefits.

Adequate rates of return to application of fertilizer on farmers' fields are virtually guaranteed by avoiding artificial pricing and leaving decisions on amounts to be used to farmers.

Farmers usually require a value of marginal product of between 2 and 2.5 times the incremental expenditure for fertilizer to begin using fertilizer or to increase application rates. This provides a reasonable approximation of likely benefits before allowance for other costs of using increased amounts of fertilizer (cost of interest, application, complementary technical improvement such as fertilizer responsive seed, better tillage practices, harvesting and marketing the increased product, risk, etc.).

Another way to approach estimating returns to increased on-farm use of fertilizer is to obtain estimates of marginal physical product resulting from an increment of 1 Kg of N, P, or K.[19] This is marginal return multiplied by the ratio of farm price/Kg of the product divided by the price per Kg of the nutrient to obtain the gross benefits to cost ratio. E.g., if:

- marginal product is 10 Kg of paddy/Kg of N; and

- price of paddy is 11/Kg and nitrogen 40/Kg,

then the gross financial benefits/cost ratio is $\frac{10 \times 11}{40} = 2.75$.

Results from many experiments and farm trials suggest grain returns in a range of about 5 to 20 Kg per Kg of N. Extension and research services should be able to provide the project designer with some estimates of physical input/output relationships. Commissioning of special studies to refine estimates may be desirable if a large or long-term fertilizer activity is planned. The economic rates of return would be obtained by applying economic prices and costs instead of

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19. An average return of 10 kg of grain for 1 kg of nutrients commonly is used. However, in Asia in the past, physical returns usually have been higher for N and lower for P and K as results below for India and Thailand illustrate (kg. of grain per kg. of nutrient).

	India		Thailand	
	Paddy	Wheat	Paddy	
			HYV	traditional
N	10	10	15.2	10.5
P	9	7	5.6	5.6
K	4	4	3.1	3.1

Source: APO; op. cit.; 1985; p. 73, 170.

Results of 24 years of research in Sri Lanka provided an average of 8 kg. of paddy/ 1 kg. of nutrients. ibid. p. 190.

financial prices and costs. If there are no significant price controls, subsidies, or other price interventions, etc., the financial and economic values would be approximately the same.

Another useful calculation is the ratio of FX benefits to costs. To obtain such a figure, the total FX cost equivalent of fertilizer and the FX equivalent value of the crop produced would be calculated. For example, the FX cost of the fertilizer may be made up of the actual cost CIF which might be 60% of the retail price plus 30% of the marketing and distribution margins which are FX costs. Thus, the farm FX cost would be .72 times the farm price of fertilizer.[20] The FX value of the crop would be roughly the same as the CIF price, which may be, say, 10% above the farm price (a factor of 1.10 would be applied to the farm price). Thus the FX benefit/cost ratio would be

$$\frac{10 \times (1.10 \times 11)}{40 \times .72} = \frac{121}{28.8} = 4.2.$$

In other words, there would be a FX savings or return of $4.20 for each $1.00 spent to import fertilizer and use it on this particular crop (a net gain of $3.20).

The recent Burma Maize and Oilseed Project Paper provides an example of estimating costs and benefits using a combination of direct application of fertilizer and directly affected farmers, indirectly affected farmers (spread effect) and effects of application of inoculant to increase biological nitrogen fixation by legumes. Costs of both fertilizer and of inoculant used on legumes are estimated. Both direct and indirect (spread) effects on yield and area are estimated in order to obtain the total estimated costs and benefits expected; FX impacts also are estimated.[21]

Typically, a domestic limestone industry might have a total FX cost of $5/MT of limestone (plus $20 of local costs by the time it is applied to the field). Limestone application might result in a 50-100% gain in yield with the same fertilizer applied (e.g., 1 MT/ha of grain valued at $150 CIF). If 2 MT of limestone were needed, the ratio of FX cost to FX savings would thus be 1:15 ($10 to $150). Alternatively, the farmer might need to apply only half as much fertilizer to obtain an equal yield, thereby saving $30 out of a normal $60/ha spent per crop for

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20. 60%, which is the CIF cost, + .3 x 40%, which is margin, = 72%.

21. The Maize and Oilseed Production Project Paper is available in the AID, Rosslyn library. See bibliography. Chapter II Annex includes a copy of the log frame for this project.

fertilizer by liming acid soils. The FX part of the fertilizer might be 60-70% of the total farm costs ($20). This would give a FX benefit/cost ratio for one crop of 20/10 = 2. Since lime has an effect over about three years, the total benefits would be substantially higher. This delay in production of benefits is one of the reasons liming is often subsidized by governments.

Full-scale economic analysis usually requires consideration of secondary and subsequent effects on the economy. It also should consider the incidence of benefits among different groups or segments in society. In most development situations, the principal issue for project design or resource allocation is not whether or not to provide a particular level of resources to a country, but rather selection from among a variety of alternatives. A decision to proceed with a particular resource commitment (e.g., fertilizer) may hinge almost as much on demonstrable incidence of benefits (who benefits) as on the differences in the levels of total returns. Incidence of benefits is discussed in the social soundness analysis (section 9 of this chapter).

b) Financial Analysis

Financial analysis has two major objectives: a) to determine whether, in terms of the local financial or monetary units and local prices, the activity will have a stream of benefits that exceeds the costs; and b) to determine whether the beneficiaries will have a sufficient flow of returns to finance the costs. Financial analysis differs from economic analysis in that it uses prevailing or projected local prices of all inputs (including labor) and local prices of outputs, while economic analysis uses world prices or "shadow prices". Thus, economic analysis attempts to estimate the returns to the society which operates in the world market place at world market prices, while financial analysis examines the costs and returns in local monetary units at local prices of goods and services. The distinction is particularly important where controls are placed on markets and prices, import/export taxes are assessed, subsidies paid, and exchange rates are managed at artificial levels. Financial analysis usually takes both time and money into account. For example, if a discounted cash flow present value approach is used, the analysis leads to the financial rate of return (FRR) on the investment, with the period considered usually covering the expected life of the investment. That may be 20 years or more for a major fertilizer plant or marketing facility (e.g., storage); one to three years for limestone, P and K applied to the land; and 4 to 12 months for N applied to crops.

For projects which do not lend themselves to estimates of returns in monetary terms, a "least cost" analysis may be carried out for otherwise feasible alternatives to determine which alternative will achieve the desired objective at the lowest total cost. In most cases, analysts should attempt to make some estimates of the value of benefits even where a "least cost" approach is being employed because accurate estimation of benefits in monetary terms is difficult.22

9. Social Soundness Analysis

The principal objective of the social soundness analysis is to identify and estimate the types, amounts, and distribution of potential benefits among different groups in society.

The social soundness analysis usually involves examination of the project in several contexts.

i. Social-cultural context: An examination of the specific social objectives and expected positive and negative impacts in relation to the broader social-cultural structure.

ii. Beneficiaries: Identification of expected direct and indirect beneficiaries and/or beneficiary groups as a result of project activities (e.g., women, low income farmers, remotely located farmers who will now have access to fertilizer). The analysis should also identify groups likely to be adversely affected by the project, and it should identify, appraise, and discuss the processes and channels through which benefits will flow to different groups. Indirect beneficiaries may include landless laborers who experience increased demand for their services, agribusiness firms and consumers.

iii. Participation: The analysis should review the extent of participation by potential beneficiaries in the process of project identification and design and, where appropriate, the manner in which participation has been built into project implementation.

iv. Social-cultural feasibility: The analysis should review the manner in which planned benefits will be generated and planned distribution achieved. It should identify and appraise potential obstacles to achievement of these objectives.

v. Impact: The analysis should indentify and appraise both direct and indirect impacts. It should also identify the potential for replication or extension of benefits beyond the project (and assumptions, if any, behind this). It should identify significant risks and untested assumptions.

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22. Economic Analysis of Agricultural Projects by J. Price Gittenger, John Hopkins University Press, 1982, is a good reference source on methods for economic and financial analysis.

vi. Issues: The analysis should identify and address social issues which have particular bearing on the success of the project. These may include areas of special concern to economic development (e.g., energy use, employment, population growth rates, small or disadvantaged farmers). The analysis should help to identify specific data needs for project monitoring, evaluation, and redesign.

vii. Tenure: Designers should be particularly sensitive to tenure issues in the social analysis for fertilizer projects. This can be a particularly serious problem in crop share rental arrangements where, traditionally, the renter supplies all the inputs. Studies made of fertilizer use under crop share rental arrangements indicate that where the renter must pay all input costs and pay a share of the crop, use of fertilizer usually is substantially below use on owner operated farms or where costs are shared in proportion to the crop share. Share crop renters who must pay all input costs require a substantially more favorable fertilizer/crop price ratio in order to be able to afford otherwise economic levels of fertilizer applications (that is, levels that would be optimal for society as a whole). In some cases, with the early use of HYV, fertilizer proved so profitable that landlords received a large windfall gain. In other cases, land owners evicted tenants and took over farm operations. The inequitable sharing of costs continues to be a widespread problem.

General Comments on Social Analysis

While the above analyses are important to developing a sound project design, social analysis should not be designed to demonstrate equity or group impacts that clearly are not a part of the project objectives. Illustratively, a large fertilizer plant cannot be expected in its operations to adopt special measures to ensure access by particular groups to the products it will produce. However, availability of greatly increased supplies may incidentally provide virtually unlimited access to all, particularly in instances where certain groups were previously denied access because other groups monopolized available supplies. Additions to the network of distributors and dealers may also greatly increase access by reducing the average distance to outlets (if the new outlets are not located in the same towns or market places). Expanded imports and provision of incentives for small private dealers in villages may have similar desirable impacts in terms of increasing access by small farmers in remote locations. Measures that encourage merchants of consumer goods to sell fertilizer where its sales were previously monopolized by large farm supply dealers may greatly increase exposure to and purchase of fertilizer, especially by female heads of farm households.

The most important function of social analysis is probably the identification and careful analysis of constraints to greater participation by particular groups and the definition of measures required to bring about increased participation. Evidence suggests that where major constraints do not interfere, small farmers use more fertilizer per hectare than large farmers (though less per farm). The following questions are important to address in the analysis: To what extent do certain groups use more fertilizer in the given situation? To what extent do particular groups use less fertilizer? What are the constraints where less is used (supply, information, markets, application equipment)? What is needed to overcome the constraints? How efficiently do small farmers or women use fertilizer compared with others (returns per Kg of nutrients)? If a problem exists, what is needed to overcome the problem?

10. Women in Development

When one thinks about the design of fertilizer projects analysis of impacts on women does not ordinarily come to mind. However, fertilizer has a direct impact on agricultural production, which in turn affects women's roles in the production process and their well-being. Therefore, it is also important to assess impacts on women and to take them into consideration in the project design. The following suggestions, largely derived from the AID paper Gender Issues in Latin America and the Caribbean, should assist.[23]

a) Project Design Considerations

1) Base project design upon sex-disaggregated secondary data. Incorporate questions into surveys or questionnaires to be implemented by the project which will allow for the data to be disaggregated on a gender basis. This may simply require the addition of one or two questions to a questionnaire, to classify data such as the following, by sex.

- head of household;
- division of labor;
- daily and seasonal time use;
- income sources and expenditures; and
- access to fertilizer credit, land, etc.

2) Evaluate possible constraints to women's purchase and use of fertilizer. Do location of fertilizer sales, activities

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23. Gender Issues in Latin America and the Caribbean; Integrating Women into Development Programs: A Guide for Implementation for Latin America and the Caribbean.

and educational services and the timing and duration of such activities permit equal access by women?

3) Where opportunities exist, select implementing institutions committed to incorporating relevant women's issues into project implementation.

4) Identify support activities which will increase and improve use of fertilizer by women.

5) Review constraints on access of women to fertilizer supplies such as availability of transport.

6) Determine advantages/disadvantages to targeting women as recipients if increased supplies and numbers of sales points does not provide equal access.

7) Determine how cultural mores may affect women's participation and/or ability to participate fully; and address these issues in the project design.

b) Guidelines for Project Implementation

1) Observe whether project implementation is meeting goals set out in project design as they relate to women and revise project design if necessary.

2) Consider the degree to which women retain project benefits.

c) Guidelines for Evaluation

Indicators of progress obtained from sex-disaggregated data on the nature of women's participation in programs and projects should be used to evaluate participation by female heads of households in fertilizer sales and benef'ts from increased use.

11. Administrative Analysis

The principal purposes of the administrative analysis are: a) to determine whether adequate administrative and managerial capacity exists and can be employed to implement the activity successfully, and b) to appraise alternatives and identify and define the most feasible arrangements for administering and managing the activity.

The most critical aspects of administrative analysis are: a) early development of a clear and general understanding of the nature of all the implementation tasks; and b) clear and specific assignment of direct and supporting responsibility for implementation of each task both within the host country and the donor agency. Administrative analysis should emphasize these aspects along with review of the organizational capability. Because of the magnitude, or potential magnitude of the fertilizer sector compared, for example, with activities involving seed and pesticides, fertilizer activities require particular care in analysis of administrative and management capability. Design, construction, and operation of a large scale modern ammonia plant, with downstream final product units, involves one of the most technologically and managerially complex and dynamic, modern industrial systems found in developing or developed countries. The volume of raw material and product output may easily exceed one million tons per year for a large plant, and the value of inputs and outputs is likely to dwarf previously existing industrial units in most developing countries.

An efficient fertilizer distribution system also imposes requirements that are likely to exceed anything previously experienced in developing countries. Currently, developing countries move about 125 million MT of fertilizer each year to well over 100 million individual farm buyers. The time period of movement is short and, in many cases, volume and timing are heavily dependent on climatic factors (such as seasonal rainfall). Total volume and timing of offtake have proven very difficult to estimate accurately in advance. In Pakistan about five million MT of fertilizer moves in major commercial channels, probably about the same volume as wheat, the major food staple. However, wheat moves in fairly equal and predictable amounts each week over the year, while the fertilizer moves in short periods. Fertilizer demand is dependent on many factors, and fertilizer as a product has many special handling requirements. Further, in many developing regions of the world, including parts of ANE, fertilizer is a new and unfamiliar item which requires special education and training programs.

The fertilizer sector involves many other problems and issues beyond production and physical handling such as financing the large investment and annual operating costs, providing competition under conditions of large economies of scale relative to most domestic markets, price determination, subsidy decisions and financing, quality control, measures needed to achieve reasonable levels of use efficiency, pollution control, etc. In most countries it involves a combination of public and private roles with governments struggling to find the most politically and economically acceptable division of responsibility and roles between public and private sectors. Some of these requirements relative to fertilizer activities are discussed in Chapters III, IV, and V.[24] The detailed requirements for major fertilizer

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24. Chapter 8 of Handbook 3 provides additional guidance on general AID requirements and methods for administration and management analysis.

industrial plants are too extensive and complex to be covered in this report. Specialized expertise should be obtained in dealing with the technology and management of such activities.

12. Energy Use

While fertilizer projects do not transform energy in quite the way thermoelectric power projects do, they are extremely heavy users of energy, especially those projects which produce ammonia or other nitrogen forms. Current fertilizer production technology depends heavily on gas for production of ammonia (about 95% of the ammonia production is based on gas as a fuel). A few plants use electricity rather than gas to obtain nitrogen where hydropower projects provide cheap and abundant electricity, but the energy required (in BTUs per ton) is many times higher than production of nitrogen using gas. Other fossil fuels such as coal and fuel oil use processes similar to gas, but the BTUs required per ton from these fuels are considerably greater than from use of natural gas (typically about 15-20% higher). Under current economics, gas, where it is available, is the preferred fuel for ammonia production. Even with gas, fuel costs may make up over 50% of total costs. Major efforts are underway by the industry to develop processes which are more energy efficient, particularly since the oil crisis of 1973. Considerable progress already has been made in development and adoption of energy saving technology in large-scale plants (See V.C.).25

However, there is a continuing need to balance the desire for the ultimate energy-efficient technology with the realities of developing country limitations on material, financial, and human resources (particularly the limitations on capability of local technical and management personnel and the logistical problems of maintaining highly sophisticated technology under conditions that prevail in many developing countries).

13. Environmental Assessment

An **Environmental Assessment** is defined by AID as "a detailed study of the reasonably foreseeable significant effects, both beneficial and adverse, of a proposed activity on the environment of a foreign country or countries".26 It should examine in considerable detail the impacts of the proposed activity on the environment to the extent they are known, identify alternatives and compare impacts of alternative approaches. It should examine means for mitigating adverse impacts: better application of

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25. By 1980, energy conservation efforts had reduced energy inputs per ton in the U.S. by 16% relative to pre-1973 levels. (Information from the Fertilizer Institute.)

26. See CFR-2, Part 216, Section 216.6 for guidance.

fertilizer; more efficient and hence lower use of fertilizer to achieve the same results; better handling to reduce pollution from, for example, dust or spillage; better means of controlling and disposing of plant wastes; etc.

Pesticides are subject to a whole host of special requirements. Thus, in projects dealing with pesticides, the environmental officer and other experts should be involved at the earliest possible stages of conceptualization and planning. Most fertilizer does not involve the level of concern and risk involved with pesticides. However, some forms of fertilizer are associated with special problems and hence involve special concerns because of their potentially explosive nature (ammonium nitrate), or corrosiveness alone or in combination with other products.

In general, all fertilizer activities involve concerns over adverse environmental impacts. There are particular concerns with fertilizer production, including basic fertilizer materials (extraction of phosphate rock and potassic ore, ammonia, phosphoric acid, etc.) and primary fertilizers (AN, AS, urea, CAN, nitrophos, super phosphate, MOP, SOP), production of granulated NP and NPK and blending of NPK from primary fertilizers. The only possible exception is very small, widely replicated, local units. Environmental concerns include major bulk port handling and bagging facilities where dust and spillage offer substantial potential for water, ground and air pollution. Large storage facilities also are likely to fall into this category, especially where they involve materials that may be dangerous (e.g., ammonium nitrate) or corrosive (e.g., urea and certain fertilizer combinations). Concerns over use of non-renewable resources, especially energy, and their environmental impacts have recently led to greater concern with measures to increase the efficiency in manufacture and use of fertilizer materials and reduction in wastage. In some areas, pollution of streams and lakes due to run-off of applied fertilizer also is a problem.

Activities or actions considered to have a significant effect on the environment normally require an Assessment or Statement as appropriate. Where the project or activity is of this type (and hence clearly requires an Assessment or Statement), the design need not go through the formal process of preparation of an <u>Initial Environmental Examination</u>. This applies to industrial plants including all types of manufacturing of basic fertilizer ingredients, primary and final products, granulation, blending, and even port handling of bulk materials and bagging, large scale storage and handling even in bagged form.

III. GOVERNMENT ROLES IN THE FERTILIZER SECTOR

A. Background

The appropriate roles for the public and private sectors is one of the major issues to be addressed in the planning for and design of the fertilizer sector in developing countries. That is, which functions is it essential for the public sector to perform and which might better be left to private sector, individually owned businesses, cooperatives, and corporations? The basis for the decisions on the appropriate roles for the public as opposed to the private sectors usually is not clearly articulated. The objective of this chapter is to explore traditional functions of both the public and private sectors in fertilizer sector development, and to identify the primary criteria for decision-making.

In the free enterprise, market oriented, developed countries, the inclination reflected in policy is to leave investments and management of economic activities to the private sector to the maximum extent feasible. The principal criterion for decisions of governments to undertake particular economic functions is that they cannot or would not be carried out effectively by private sector firms acting alone or in consort because it would not be possible for them to cover costs and make a profit. Controls are imposed in situations where the nature of the service provided by the private sector inevitably involves a substantial opportunity for monopolistic exploitation--e.g., utilities. In the U.S., at least, economy of scale alone is rarely used as a justification for close government controls or for substitution of the public sector for private sector operations. Protection of the public welfare is a major justification for regulation and control of the private sector. Even in the most private enterprise oriented societies, increased controls are now being imposed to reduce environmental degradation and to protect the public from health hazards and economic exploitation.

The rationale used by developing countries for varying degrees of public intervention is similar to that used by the developed market economies. There are major differences in degree of government control and operation among countries in both groups. However, there clearly is a much higher level of public intervention in the fertilizer sector in developing than in developed countries. Further, in developing countries the nature of the intervention more frequently involves direct investment and assumption of operational control rather than legislation, regulation, and monitoring. In many developing countries critically important traditional government services, such as research and extension and minimal regulation and monitoring are neglected, while financial and human resources of the public sector are engaged in direct operation and in competition with or in substitution for the private sector. This is the case even in areas where the private sector has demonstrated notable capability and efficiency in other countries. With only minor exceptions, the public sector in ANE countries is engaged in direct fertilizer production and marketing activities as well as direct control of private sector firms. In some countries/ activities public sector operations exclude, or virtually exclude, private sector participation.

Major factors in decisions to pursue public investment and operation rather than to permit and promote private investment have included: the small size of fertilizer markets in developing countries, especially in early years; the large economies of scale in fertilizer plants; the high level of investment required for economic size; and the extreme shortages of investment funds, especially foreign exchange. By the early 1960s, the time most of the developing countries of ANE were seized with the importance of fertilizer in achievement of production and food security goals, the scale of economic plants was already such that 1,000 MT/day nitrogen plants commonly were being built (about 300,000 MT/year of nitrogen). This level of production far exceeded consumption in all but very large developing countries such as India and China. It was widely believed that the lack of farmer knowledge of fertilizer and the importance of fertilizer in achievement of growth and income targets, would leave farmers, especially smaller farmers, and societies as a whole highly vulnerable to exploitation by large private sector fertilizer companies if they were given a free hand. Government assumption of control was viewed as a more effective means of protecting society than were efforts at regulation and control of the private sector. The urgency to increase agricultural production added pressure on many governments to undertake direct control of fertilizer importation and distribution. As a result, government operations often were accompanied by subsidies and rationing of what was a scarce commodity purchased with scarce foreign exchange.

This logic cannot be easily faulted; most donors have given tacit, if not explicit, approval and financial support to government operations in the fertilizer sector. The problem has been that the efficiency of public sector planning, investment, and operations generally has been notably lower than similar activities operated by the private sector. Furthermore, government preoccupation with the direct public operation of plants, marketing, and related economic activities normally undertaken by the private sector commonly has been accompanied by a serious neglect of supporting services traditionally provided by the public sector. In many countries what started out as a small-scale public sector intervention to develop the market subsequently become a massive government investment which it could neither afford nor manage.

The solution at this point is not an easy one. It will require an overt decision to shift as much responsibility as possible from the public to the private sector and, where necessary, to substitute legislation, regulation, and monitoring for direct operation. A number of factors including political philosophy, stage of economic development, and sophistication of the private sector are likely to color judgements in this matter. Reduction of government involvement necessarily requires a continuing examination of the nature of the public sector role to identify those activities and services that can either be spun off to the private sector or be sharply curtailed. Remaining public sector corporations or agencies must be forced to operate on a cost-efficient basis by the imposition of self-financing and profit requirements similar to those used by the private sector. Unfortunately, the wide variations in market size and structure preclude the development and general application of specific private-public sector formulas to different countries. Each country, supported and encouraged by donors, must find and implement its own formula. As a guiding principle, governments should act as the court of last resort, assuming responsibility only for those functions which evidence clearly indicates cannot and will not be performed by any feasible private sector arrangement.

B. Traditional Public Sector Roles

The traditional public sector roles related to the fertilizer sector include: research, extension, soil testing; legislation, regulation, and monitoring; and the provision of market information on fertilizer sector operations.

Research, extension, and soil testing should include: a) well designed research to develop fertilizer-responsive crop varieties and identify optimal fertilizer use rates and methods of application; b) provision of soil analysis and diagnostic services for farmers based on sound soil analysis--fertilizer response correlation research; c) development of techniques for increasing fertilizer use efficiency; and d) widespread demonstration and dissemination of information on fertilizer use.

Legislation, regulation, and monitoring activities should be designed so as to encourage and stimulate efficient private sector operation and should serve to protect farmers, the general public and the environment from improper fertilizer sector operations ranging from fertilizer production through on-farm use. Legislation, regulation and monitoring should provide at least minimal protection from economic exploitation by unscrupulous operators through implementation of specific measures such as: inspection for quality; widespread consumer education on product characteristics and use; collection and dissemination of accurate and up-to-date information on prices, supplies, demand, and related information.

Existing information services (public or private) should be called upon to provide both the trade and the general public with up-to-date technical and economic information--on old or new fertilizer products, their characteristics and uses, supply and demand, price situations, etc. Legislation and regulations should establish quality and bag weight standards. A government agency, preferably one with a similar responsibility for other products, should be assigned enforcement responsibility. This agency should periodically weigh, sample, and chemically analyze all products marketed to ensure adherence to weight and quality standards. However, it is important that the enforcement agency not have a vested interest in protecting organizations operating in the fertilizer sector, whether public or private.

C. Fertilizer Planning

In developed, market oriented countries, fertilizer supply planning is largely left in the hands of the private sector and, given substantial competition, this is a fairly adequate mechanism. Individual companies make estimates of demand for their own products based on assessment of past experience and information available on market supply, demand, prices, and other factors. They pay a penalty in business lost for errors. A large international trade and fairly stable rates of growth in world supply have served world needs of both producers and consumers. The major exception came in 1973-74 (following the 1973 energy crisis), and to a lesser extent following the 1979 increase in energy prices. In both cases, the increase in energy prices brought major increases in fertilizer prices. In the first instance, panic buying and hoarding caused temporary shortages and drove prices higher than otherwise would have been the case. It is quite well accepted now that fertilizer prices are very sensitive to energy prices both on the up and down sides. Fertilizer prices recently declined sharply with the approximately 50% decline in fuel oil prices.

The supply-demand situation in individual developing countries has generally proven more difficult to predict than the world supply-demand situation. Quantity demanded is greatly affected by market prices of fertilizer, especially in the short run, but many other factors, including political decisions, may greatly influence quantities taken from the market by consumers. Retail prices and supplies of both fertilizer and fertilizer production inputs may be drastically and suddenly changed by price setting authorities, by import and export restrictions, and by changes in taxes and subsidies. The relaxation or increase of constraints on supplies may therefore be a more important determinant of quantity sold than are changes in demand in many developing countries. Political decisions also may greatly influence the size and dispersion of sales points, thereby greatly modifying access of farmers to supplies.

Since the early 1960s, the demand functions for fertilizer have been greatly altered by specific priorities attached to increased agricultural production which have influenced policy decisions on price and other incentives. High priorities on production increase have also led to the acceleration of the introduction and dissemination of fertilizer use technology, improved seeds and other agronomic practices which increase returns to fertilizer. The increase in farmers' knowledge of fertilizer and new perceptions of physical and financial returns to fertilizer use in turn have resulted in an upward shift in the demand function for fertilizer. In a few developing countries a level of maturity in fertilizer use has been reached where all farmers are accustomed to using fertilizer and demand is fairly stable at high rates of use per hectare. However, in most developing countries, demand is still growing rapidly with large year to year changes in consumption resulting from changes in policies and/or government actions affecting fertilizer or crop prices, fertilizer supplies, the distribution system, or other factors.27

Government policies usually have included major interventions in fertilizer and crop prices, price relationships and control of supplies. Where favorable price and other conditions have been established, rates of growth of 15-20% per year have been common and a rate of growth of nearly 10% per year has been experienced by most Asian countries from the mid-1960s to the early 1980s. Where appropriate price conditions were not established or where either supplies or the distribution system were constrained, growth commonly has been very low -- and in some years has even been negative. This commonly was the case for long periods in countries on the low end of the growth curve shown in Figure 1, (e.g., Burma, Nepal).

With very rare exceptions, governments in developing countries play major roles in fertilizer supply planning; this holds true for both local plants and imports even when governments do not invest directly in local production. At a minimum, they usually control allocation of foreign exchange needed to finance important plant components and also to finance imported products which compete with local production. Once decisions have been made to invest in local plants, whether

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27. Examination of the literature provides very little in the way of helpful examples of successful application of quantitative economic forecasting methods for fertilizer demand in developing countries. Econometric estimating has been greatly complicated by erratic government policies with respect to fertilizer supplies, fertilizer and crop pricing, fertilizer subsidies, and other interventions in the fertilizer sector.

public or private, there is a reluctance to allocate foreign exchange for imports. Managers of plants, whether public or private sector, naturally encourage limitations on competing imports. Thus, the existence of local production provides no assurance that supplies will be more adequate.

Planning should be based on the most accurate estimates possible for probable demand, suitably adjusted for consumption targets required to achieve agricultural output objectives. These in turn should be reflected in policies and specific actions taken to provide economically justifiable price incentives (e.g., ratios of crop to fertilizer prices), and measures to improve research, extension, fertilizer promotion, in order to influence demand positively. Subsidies may be economically justified as a temporary expedient in early promotion of fertilizer consumption, but they should not become a general pratice. Adequacy of supply planning, forward buying, shipment and distribution systems should be objectively assessed. Planning should define specific measures and action agents where needs for action are identified and justified. E.g., if supplies are deficient, the action needed to increase supply should be defined and responsibility assigned.

Fertilizer planning thus starts with the best estimates that can be made of demand and supply. It should be responsive to national policies and targets on agricultural growth. Planning should begin with an assessment of the adequacy of the fertilizer sector to perform its required role in achievement of agricultural growth targets and should proceed to the design of policies, programs, and activities to achieve growth targets where needs are identified.

D. Public vs. Private Sector Roles in Fertilizer Sector Development

In the free market developed countries, the role of the government has largely been limited to enactment and enforcement of legislation and inspection of fertilizer production and trade, as means of consumer protection, and research and extension functions. In contrast, in developing countries including those of the ANE region, the fertilizer sector is characterized by a substantial degree of pricing and supply control and management by the government. For example, the importation of fertilizer is exclusively government-controlled and operated in 11 out of 17 countries in the region on which data were available (Table 9).

The public sector either has a total monopoly or accounts for a major part of fertilizer production in most of the ANE countries: 100% or near 100% in Afghanistan, Bangladesh, Burma, Egypt, Morocco, Tunisia and China; the largest part in India, Pakistan and the Philippines; with only a small part (or none) in Korea, Malaysia, and Thailand.

In addition to being highly involved in the production and import process, government frequently is very active in the domestic marketing and distribution of fertilizers, although the percentage of control does not approach that of procurement (Table 9). Serious questions are being raised whether the benefits justify the costs of such extensive government involvement.

E. Essential Government Service

The experience during the period of rapid development of the fertilizer sector in the last two decades suggests that government should concentrate on the following:

1. Creation of economic, political and financial conditions which stimulate private initiative and competition in fertilizer production, import, and wholesale and retail distribution. If prices are controlled, adequate studies should be conducted and action taken to ensure that control prices do not introduce serious price distortions in the economy and that the prices encourage levels of use of fertilizer that are as near economic as feasible for both the farmer and the economy. Levels and margins should be reviewed to insure that incentives to the private trade are not stifled.28 In general, subsidies should be avoided, as should rationing.

2. Establishment and enforcement of appropriate regulations with respect to the composition of fertilizer products, labeling, size and type of containers and protection of the environment. At a minimum, provision should be made for periodic field inspection, sampling and analysis of products to protect consumers and for project analysis to avoid serious environmental degradation.

3. Planning and execution of adequate research on soil fertility and fertilizer response in different ecological zones and crops and the provision of economically and environmentally sound recommendations on fertilizer use for different crops and conditions. The private sector fertilizer distributors should be encouraged to provide soil analysis and fertilizer recommendation services. Government should provide a supplementary soil analysis with fertilizer recommendations based on scientific research, current prices and other economic conditions.

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28. Currently FAO and other organizations are encouraging annual collection of data on marketing margins and other measures of fertilizer marketing efficiency. (See Bibliography.)

TABLE 9
Share of Public Sector Involvement in the Import of Chemical Fertilizers (1982/83)a

Country	Percentage
Afghanistan	100
Bangladesh	100
Burma	100
China	100
Democratic Kampuchea	100
Fiji	2
Indonesia	100
Islamic Republic of Iran	100
Malaysia	35
Mongolia	100
Nepal	100
Pakistan	100
Papua New Guinea	--
Republic of Korea	10
Sri Lanka	75
Thailand	15b
Viet Nam	100

a Agro-chemicals News in Brief, Special Issue, FADINAP, September 1984; and Agro-Chemicals News in Brief, Vol. VIII, No. 4, October 1985, p. 11.

b Thailand's share of fertilizer imports has increased recently because of the government-to-government barter deals during 1984 and 1985. Also, the procurement of fertilizers under ADB loans and EEC grants are noteworthy.

* Imports into the Philippines not shown on the table were essentially all private sector operations, but with considerable government control.

4. Continued monitoring and analysis of current and prospective stocks, imports, production, and consumption. Data and analysis should be kept current on no less than a monthly, and if possible, on a fortnightly basis.

An inter-ministerial or other high level organizational entity should review the current and prospective supply and demand situation on a regular basis and, on an emergency basis when problems are anticipated (such as FX shortages, delays in imports, production, or new plant start-up). This entity should have the authority to act to alleviate problems; e.g., arrange for FX, accelerate procurement, provide preferential access to intra-country transport, port handling, etc. Funds should be available to the entity to finance a modest amount of data collection and analysis concerning the fertilizer sector. The nature and latitude for action would depend upon the organization of fertilizer production, imports, stocking and distribution. Authority might include action to: increase FX available for imports; authorize increased imports; provide internal financing of stocks; assign transport on a priority basis; and limit exports to increase domestic supply. Where the production, import and distribution are largely in the public sector, appropriate changes in operations may be recommended or directed. Where these activities are largely in the private sector, needed information would, of course, be supplied to the private sector, and recommendations and financial or other actions would be taken to facilitate appropriate private sector action.[29]

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29. Provision should be made for representation from the private sector where the private private sector plays a role.

IV. FERTILIZER MARKETING IN ANE COUNTRIES

Marketing of fertilizer is complex; it involves procurement and movement of over 100 million MT of product in ANE per year from a large number of foreign and domestic factories to over 100 million buyers for use in short periods of the year. It involves many complex problems and issues in organization, physical operations, pricing, education, and promotion. Governments commonly play a major role directly in marketing and also less directly by regulation of practices, allocation of resources, fixation of prices, and payment of subsidies. The outcomes of marketing, pricing, promotion and related activities are recognized as critically important in achievement of economic growth and equity objectives.

The objective of this chapter is to review and appraise fertilizer marketing in ANE countries, particularly with respect to demand estimating, supply planning, promotion, methods and costs of physical distribution, and prices and subsidies.

A. Fertilizer Demand

Growth rates in fertilizer consumption in developing countries have been high, on average, since 1954. For developing countries in Asia, growth averaged about 16% per year from 1951 to 1971 and almost 10% over the next decade. Consumption rates have varied widely from year to year in individual countries and demand forecasting which is critical for sound fertilizer sector planning has proven difficult and subject to large errors. Demand forecasting must consider actual prices and projected price changes and/or changes planned in price policies affecting fertilizer and major fertilizer utilizing crops; but other non-price factors are likely to greatly affect amount consumed in a given year. These other factors include: adequacy of water from rainfall; present and planned irrigation and water management practices; fertilizer promotion programs (underway or planned); changes in the distribution system which may provide increased access by small farmers and farmers in remote areas; changes in supplies and supply arrangements which may alleviate supply constraints; changes in formal or informal rationing; increased availability of credit or simplification in credit procedures; increased availability of fertilizer-responsive crop varieties; and improvements in fertilizer use and other cultural practices. Of course, policy changes and other actions also may lead to increased constraints.

The existing level of fertilizer use is also an important consideration. A large percentage increase (e.g. 25-50%) is possible in fertilizer consumption when prior levels are only a few kilograms per hectare (e.g. 5 kgs. of nutrients). However, even a 10% increase may be difficult to achieve where consumption already is at high levels, e.g. 300 kg/hectare, such as in Korea.

In absolute terms, a much larger increase is usually possible in areas already using fairly heavy amounts of fertilizer (e.g. 10-20 kg increase per hectare). (Table 6 shows growth rates for 1951-71 and 1971-81/2 and consumption levels for 1982.)

No easy economic forecasting formulas are available for estimating growth in demand under the dynamic conditions likely to prevail in early stages of market development. Experience in the ANE region suggests that 10-15% growth rates should be feasible in early stages of market growth -- up to about 50 kg/hectare. Beyond this, growth is likely to begin to taper off. Some efforts have been made to classify countries into three major categories of fertilizer use and growth, i.e., early stage, take-off stage and mature market stage. Korea and Taiwan fall in the "mature market" category along with most (not all) of the developed countries. Many of the Asian countries would fall into the "take-off" category e.g., Pakistan, India, Indonesia. Some would fall into the first ("early stage") category e.g., Nepal, Burma, and Thailand (see Figure I-1). As other countries approach the levels of current use in the mature category of over 300 Kg/hectare, they should anticipate a leveling off of growth in consumption per hectare unless major technological breakthroughs occur. For most of ANE, that is quite a while in the future. Some of the "mature" countries have reached high consumption levels as the result in part of fertilizer subsidies. From a societal welfare perspective, somewhat lower use rates may be economically optimal.

Political or physical subdivisions of individual countries may be used as a basis for estimations, with district estimates combined into regions and regions combined to obtain national estimates. This should have the advantage of reducing sampling and estimating errors. Separate regions of a country may be used also to develop and test estimation methodologies and to test alternative methods of promotion and development of markets. (See discussion of promotion in India later in this section.)

With fertilizer now widely recognized as the major propellant of agriculture growth, fertilizer off-take targets may be and often are established based on agricultural growth targets. Both India and Pakistan have used agricultural production targets as a basis for establishment of fertilizer supply, distribution and sales targets. In the simplest form, a target on cereal crop production may be translated into a fertilizer use target by applying the estimated average marginal returns to increased fertilizer use. If the estimated marginal return of increased nitrogen application is 12 kg of grain to 1 kg of nitrogen, a grain increase target (attributable to fertilizer) of 1.2 million MT would require an increase of 100,000 MT in nitrogen use on grain. Improvements in seed and other practices might contribute 50% more for a total of 1.8 MMT of grain. Contribution by fertilizer of 2/3 of the increase in yield is not uncommon.

Alternatively, past relationships between fertilizer consumption and crop production may be used as a basis for estimating growth in fertilizer consumption to achieve specific production targets or to estimate changes in crop production using fertilizer off-take data. However, errors in a given year can be large where crops are heavily dependent on highly variable rainfall.

Given the wide variations in fertilizer sales from year to year among and within countries as well as among regions in a given country, it is recommended that estimation and projection of fertilizer demand be approached with caution. It should be undertaken as a joint effort involving personnel trained and experienced in fertilizer marketing, economic forecasting, policy analysis, development planning and agronomy. Particular attention should be paid to non-price factors, including the adequacy of supply and distribution and government policies.

B. Promotion

Fertilizer is a product which requires extensive user information and advice in order both to encourage initial use and to increase consumption thereafter. The principal objective of fertilizer promotion programs usually is either to increase national consumption of fertilizer, or consumption by a particular target area, group or crop. Farmers are more likely to adopt new ideas if they are exposed to them through demonstrations near home and under conditions with which they can empathize, and if explanations are keyed to local growing conditions. Clearly, education and special promotion techniques are most important in countries where farmers are just beginning to use fertilizer, but they are also very important in countries where use is expanding but where many farmers remain unconvinced, and where technical knowledge is very limited. Development of detailed plans for implementation of promotion programs should involve the following steps:

a) Select the constraints that will receive primary attention under the promotion program. Appraise these for compatibility with available resources;

b) Identify and define total available resources, both within the project and those that can be called upon from other public agencies and the private sector;

c) Identify and design specific actions needed to overcome the selected constraints relative to the target;

d) Assess action requirements [from (c)], estimate inputs required, and recommend action plans and inputs within total potentially available resources from (b);

e) Define specific tasks and alternative assignments of roles among agencies; and

f) Reach agreement with public and private sector agencies on the specific tasks each entity will carry out, resources to be provided, schedules, and coordinating relationships among entities. The private enterprise sector which has a vested interest in market growth should be encouraged to play a major role in fertilizer promotion and education in fertilizer use.

At a minimum, the promotion program should ensure that:

a) Appropriate recommendations are available on fertilizer use;

b) Adequate supplies will be available as needed in the area;

c) Farmers are appropriately informed about the program, the advantages of using fertilizer and are shown methods of use consistent with their resources, technical capability and realistic assessment of their economic means; and

d) Costs and prices in the area offer prospects for reasonable returns without leading to unrealistic expectations on long-term returns (i.e., if subsidies are provided, it should be clearly understood that such subsidies will be limited in time and level of benefits per farmer).

The promotion program should define plans and schedules for regular evaluation of impacts and, as appropriate, in-process redesign. This should include specifications on data to be assembled and analysis to measure impacts of the promotion effort. Responsibility for data collection should be clearly assigned and necessary provisions should be made for its support.

FAO Fertilizer Promotion

As part of FAO's action program to increase fertilizer use in developing countries, it has developed and supported:

1) Trials on farmers' fields where fertilizer recommendations are non-existent or where existing ones need to be refined.

2) Demonstrations on fertilizer application, related inputs and other improved cultural practices. These are combined with field days and relevant extension methods.

3) Training of extension personnel.

4) Training of fertilizer dealers and the staff of cooperatives

in distribution, promotion.

5) Support of local extension field staff and others with manuals, flip-charts, slides, and films.

6) Pilot schemes for distribution of fertilizer and related inputs for cash or credit to assure their availability if this has been identified as a potential problem.

Price incentives and the promotion of fertilizer are important components in building markets. Measures to improve efficiency of use and increase returns also are very important in stimulating consumption as well as increasing rates of return.

Case Studies of Successful Promotion

INDIA: Fertilizer Development Institute

Fertilizer promotion in India has, over the last decade, moved away from sales promotion and publicity towards farmer service oriented programs and promotion of fertilizer in areas as yet unexploited. A number of innovative methods have been utilized to promote fertilizer in India.

a) The issue of what organization and/or agency might best handle the promotion of fertilizer was resolved in India by establishing a new organization, the Fertilizer Development Institute in New Delhi. This organization was developed with the purpose of bringing together people from different agencies and the private sector to develop a common fertilizer use promotion strategy. To achieve this goal, the Fertilizer Development Institute set up a training program for cooperative personnel and fertilizer dealers from the private sector.

b) Farmers' service centers have been established in India by a number of fertilizer companies, with the goal of supplying all farm inputs under one roof in previously untapped fertilizer market areas.

c) In conjunction with the promotion of fertilizer, seed multiplication programs and fertilizer demonstrations have been implemented in rainfed areas.

d) A number of fertilizer organizations have taken up the village adoption program, which includes:

1) the posting of promotional staff in the villages;

2) preparation of crop plans for the farmers as an inducement for them to adopt modern agricultural practices and use high yielding varieties;

3) assistance to the farmers in the procurement and use of inputs such as improved seeds, fertilizers, pesticides, farm machinery, and other industry supplied inputs and irrigation;

4) additional social services such as visits from veterinary specialists, medical check-ups.

e) An intensive fertilizer promotion campaign has been undertaken in 104 districts throughout the country. These districts are considered to have the best potential for higher fertilizer consumption. The campaign's goals include:

1) preparation of benchmark survey reports;

2) assessment of inter-district variation in fertilizer consumption;

3) study of the existing network of sales points and their geographical distribution in relation to their effectiveness;

4) arrangements for inputs supply (including seeds, fertilizer, and pesticides) to ensure that adequate stocks exist;

5) assistance to farmers in the preparation of crop plans and advice on crop systems;

6) soil tests and fertilizer advice;

7) improved agricultural implements;

8) farmer education; and

9) the distribution (in some areas) of mini-kits containing all needed inputs (including improved seed varieties).

PAKISTAN: Private Company Promotion

The approach taken by Fauji Fertilizer Corporation (FFC) of Pakistan illustrates a promotional campaign undertaken by a distributor. In Pakistan, several private and public companies distribute and promote fertilizer and their brand names. In June 1982, FFC launched a campaign to sell its urea product, SONA, using posters, newspapers, radio, dealer signs, and for the first time, the extensive use of TV. The promotion program of FFC included:

- Soil and water testing facilities at no cost to farmers and provision of fertilizer recommendations for optimum returns based on the soil/water test results;
- Fertilizer trials to establish thresholds for various soil test results, particularly of phosphorus and potash;
- Soil reclamation recommendations based on test results of problem soils;
- Farmer meetings using audio-visual equipment such as 16-mm slide projectors to educate farmers on production technology of various crops, general plant nutrition, soils, organic matter, fertilizer use, economics and suitability of different fertilizers for various crops and under different soil conditions;
- Field demonstrations and field days to demonstrate to the farmers the economics of balanced and proper use of fertilizer;
- Personalized services to a large number of progressive farmers by visiting farms and discussing specific problems;
- Crop production literature in local languages for all major crops distributed widely throughout the country;
- Intensive advisory services to sugarcane growers at the request of various sugar mills; and
- Advice from sugarcane development staff of various sugar mills on the most effective sugarcane production technology.

Promotion of fertilizer use via targeted information dissemination campaigns is one of the initial, and most fundamental steps towards increasing consumer demand for fertilizer. Complementary means of stimulating consumption include the implementation of economic incentives to assure farmers that expenditure of scarce resources on the purchase of fertilizer constitutes a sound investment. In the past, incentives have included fertilizer price controls, subsidies and crop price supports which provide a favorable ratio of fertilizer/crop prices compared with input-output relationships. Such price intervention policies may be helpful in stimulating demand and consumption but they also can be costly and once started, difficult to discontinue. Thus need for, value and cost of such interventions should be carefully evaluated before they are undertaken. A principal argument for input subsidies is that they are less costly than output subsidies to achieve a given input/output price ratio.

C. Fertilizer Supply Planning

The principal problem in fertilizer supply planning is estimating demand, or more precisely, the supply required to service the distribution system (discussed in section A). A large potential demand commonly goes unsatisfied, unresolved, and often unidentified due to deficiencies in the supply and distribution system. These deficiencies commonly include: too few outlets; concentration of outlets in a few major market centers or at transport terminals; delays in product ordering, shipment and arrival; incorrect quantities and/or types; formal or informal rationing to ensure that fertilizer is available to everyone or to particular individuals, groups, or areas; limitations on funds to pay required subsidies; and restrictions on private dealer operations.

Markets may never really be tested because of constraints such as these. Delays and conservatism in ordering are particularly common weaknesses in publicly operated supply and distribution systems as well as in private systems where government control sets low prices and/or margin levels which effectively discourage investment in early procurement, adequate stocking and expansion of distribution systems into new and as yet undeveloped market areas. Much of this is due to poor planning but risk aversion is a factor. Bureaucrats who manage public systems usually are very sensitive to financial costs and possible losses due to over-ordering and deterioration of stocks carried over from one season to the next. The tendency is to attempt to procure only amounts sufficient to insure that stocks are essentially all cleared at the end of each sales season. This usually results in localized and national shortages and limitations on growth in consumption. Thus, a basis for real demand estimating and reliable planning does not exist.

A number of different formulas have been utilized to insure adequate supplies at all times. In Pakistan, a planning and procurement formula used successfully in the 1970s to avoid supply gaps involved counting only commitments for arrival of imported fertilizer six months or longer in advance of expected application and counting of local production three months or longer in advance of application. Thus, stocks on hand plus firm import orders to arrive at least six months in advance, plus firmly scheduled local production three months or more in advance of the application period must equal or exceed the estimated requirements for a particular period. Orders scheduled to arrive less than six months in advance of the application period and local production scheduled less than three months in advance would not be counted toward requirements for the particular period. Such lead time, though it may seem long, is particularly important in early stages of market development when many uncertainties exist in production, procurement, scheduling of imports, unloading and shipment up country. Recently, with a much larger market and more sophisticated planning, efforts have been made in Pakistan to reduce the stocking levels somewhat and cut carrying costs while still providing protection against supply gaps.

Data on fertilizer plant operations in developing countries show typical levels of output of only 60-65% of capacity and frequent stoppages of 1-3 months due to lack of parts or raw materials or other problems. Planners cannot afford to base supply planning on assumptions of 100% operation and 2 weeks delivery as has been attempted in some countries. Often, imports are found to take 3 to 6 months more than planned, particularly when concessional financing or barter deals are involved.[30]

A clear understanding that such a formula is to be applied removes some of the reluctance of officials to place orders sufficiently in advance to insure supply requirements are fully met. The tendency otherwise is to wait to see how supplies are moving or to restrict procurement to "last year's offtake". With assurance of abundant stocks, promotion and aggressive selling usually become more commonplace. After substantial experience is gained, the length of lead-time may be reduced, but care should be taken that this is not done prematurely.

Appropriate planning and ordering will be neither feasible nor effective unless accompanied by reliable and up-to-date reporting of fertilizer operations at all levels -- actual and planned local factory production; import commitments and actions consummated at each stage from arrangement of financing through purchase, loading, transit, and unloading; stocks at each point from factory and ports through major wholesale depots, minor distributors and final retailers; and offtake by farmers and minor retailers. As a minimum, such data should be assembled monthly, summarized and made available to interested parties within a week of the end of the month. In some countries, such information is assembled on a weekly basis with summarization and release of data to monitoring and management entities within a day or so of receipt of the information. Rapid access to reliable data permits some reduction in stocking, which may in turn provide major savings on interest and storage costs as well as reductions in product deterioration.

Data collection should be designed using very simple formats keyed to rapid data transmission, e.g., telephone or telex and rapid computer processing. Exchange of experience among countries should be helpful in design and improvement in national systems.

D. Distribution of Fertilizer

This section focuses on major problems and issues in design and operation of an efficient distribution system which makes adequate amounts of fertilizer widely accessible to farmers when

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30. For safety in dealing with uncertainties of barter and concessional financing, developing countries should be prepared at all times for expeditious release of their own foreign exchange to finance imports in substitution for expected imports under concessional financing or barter agreements.

needed.

In addition to the sheer volume needed, a number of other factors characterize fertilizer marketing and distribution. These factors effectively increase the magnitude and difficulty of the task when compared, for example, with the marketing of food grains. Among these factors are:

- Seasonality. Fertilizer is produced at a steady rate over the year but in many areas is applied during a fairly short season. Virtually all of the P and K and much of the N is applied at planting time; the balance of the N is applied in a short period during the crop growing season. In countries with a single short growing season this means fertilizer must be accumulated, stored and then sold in a very short period, often a few days or weeks.

- Lack of Training and Experience. At the outset few, if any, farmers and individuals involved in marketing, storage and transport have had experience with fertilizer handling. In addition to problems resulting from improper handling, buyers frequently are suspicious of the product offered.

- Special Characteristics. Unlike grain, fertilizer does not suffer from insect infestation, but some types can be seriously damaged by exposure to moisture or direct sunlight. Some types are not compatible with other products including other types of fertilizer. Some of the special characteristics necessitate care in handling to reduce risks and require special storage facilities.

- High Product Cost. High cost per ton discourages early farmer purchases and carrying of stocks by dealers. This accentuates other logistical problems.

In developing countries commercial fertilizers constitute by far the largest percentage of the total volume of required production inputs and present the largest logistical, marketing and distribution problems. Typically, fertilizer necessitates the timely movement of huge volumes of bulky and weather sensitive products from one or a few factories or ports to millions of farmers scattered throughout the country.31 Failure

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31. Illustratively, China currently has a fertilizer product volume of about 50 million MT/year compared with about 15 million in the early 1970s. Pakistan now handles about 4 million MT compared with about a million MT in the early 1970s and about 1,000 MT in 1947. India handles about 20 million MT. Indian experts estimate that it will be necessary to increase the fertilizer product volume by about 2 million MT/year to achieve its agricultural targets.

to deal with the transport and distribution requirements commonly has been the principal factor in static or grossly inadequate growth in agricultural production.

In many developing countries fertilizer use typically began on a few high value cash crops frequently destined for export, e.g., tea, coffee, sugar, cotton, tobacco. Supply and distribution of inputs often was handled by the organization which handled the crop. When handled in this way, input supply operations were closely coordinated with crop marketing and were restricted in supply to a relatively small part of the total agricultural sector. The recent large expansion in fertilizer volume and crops fertilized has overwhelmed such initially adequate systems.

Public Vs. Private Sector Roles in Distribution

In most of the Asian countries, governments exercise control over FX and directly manage imports. The public sector also has a monopoly or plays a major role in fertilizer production in most countries. Public sector domination decreases as fertilizer moves to lower levels in the distribution system. At lower levels (wholesaling and retailing), private entrepreneurs, along with cooperatives, tend to dominate distribution operations though governments exercise control over prices (see Table 10 for data on Asia). Evidence suggests that private entrepreneurs and cooperatives are able to operate small and low per-transaction volume businesses at lower costs and are more sensitive to farmer needs. Commonly, they operate stores much longer hours, handle other goods, break bags to sell in small lots, provide some informal credit and other services and have better knowledge of and rapport with their customers. This personalized attention is especially important to small farmers first using fertilizer.

The available information on public and private retailing may understate the role of the private sector since frequently unlicensed village merchants buy from other dealers or public agencies and unofficially sell in small lots as a service to their customers. The most important factor in private dealer services is the willingness and ability of the small private merchant to sell at very low margins and accept a return to his time and investment far below larger firms or government agencies.

Countries in the Near East exhibit patterns of public-cooperative-private participation similar to those in Asia which were shown in Table 10. In Egypt, the production is entirely under the control of the public sector (imports are very small). The wholesale and retail functions are dominated by the Principal Bank (PBDAC), which combines input distribution and agricultural credit operations. Cooperatives performed these functions until about 10 years ago, when the inadequacy of their performance led

TABLE 1Ø

Channels of Import, Wholesale and Retail Distribution of Fertilizers in Selected Countries, 198Ø/81

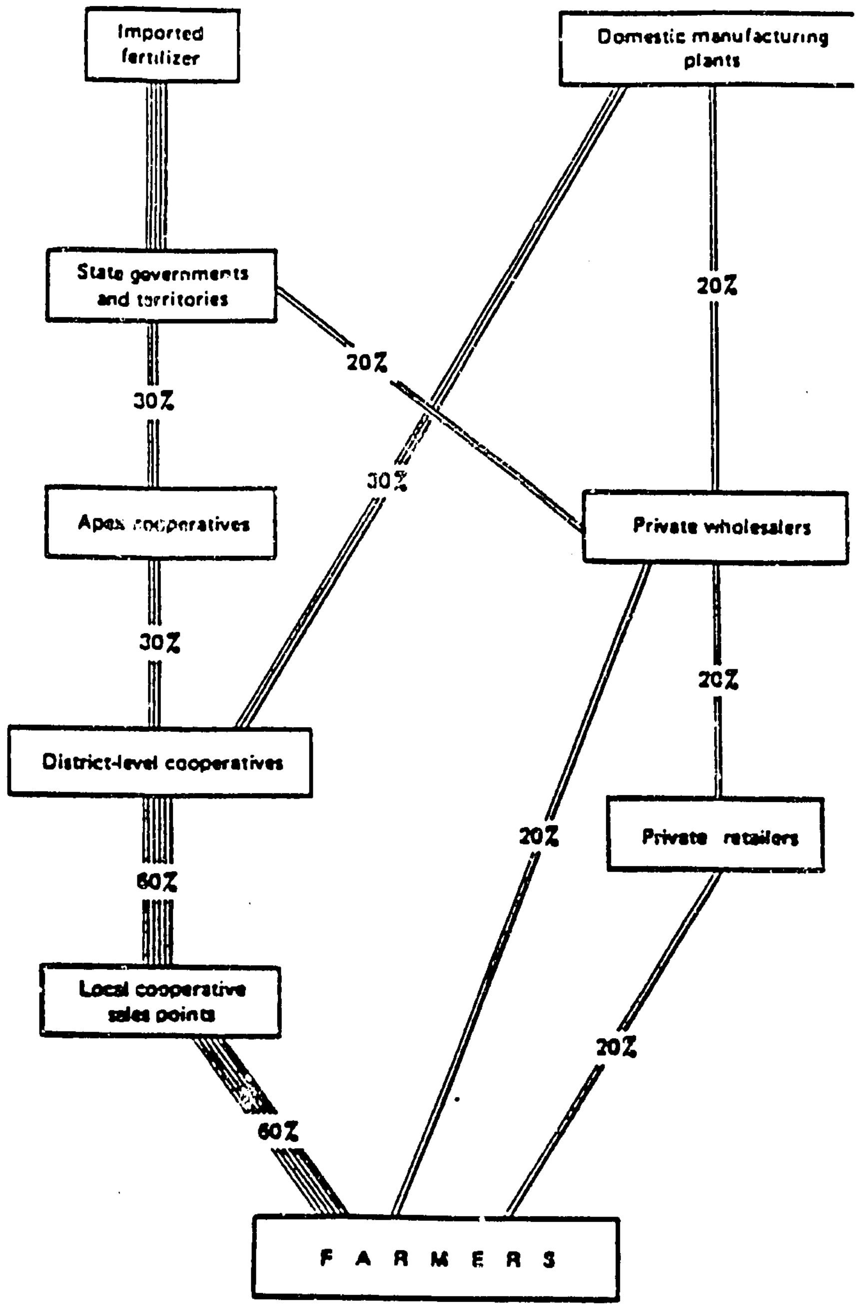
(Percentage)

	Import		Distribution					
			Wholesale			Retail		
	Govt	Private	Govt	Coop	Private	Govt	Coop	Private
Bangladesh	1ØØ	-	1ØØ	-	-	-	1Ø	9Ø
Burma	1ØØ	-	1ØØ	-	-	7Ø	3Ø	-
India	1ØØ	-	-	55	45	-	55	45
Indonesia	1ØØ	-	28	32	4Ø	-	46	54
Malaysia	35	62	5Ø	16	35	5Ø	15	35
Nepal	1ØØ	-	1ØØ	-	-	3	95	2
Pakistan	1ØØ	-	6Ø	1Ø	3Ø	6Ø	2Ø	2Ø
Philippines	-	-	-	1Ø	9Ø	-	1Ø	9Ø
Republic of Korea	1Ø	9Ø	-	1ØØ	-	-	1ØØ	-
Sri Lanka	75	25	75	-	25	49	44	7
Thailand	6	94	7	13	8Ø	7	13	8Ø

Source: Agro-Chemicals News in Brief, Vol. VII, No. 3, July 1984, p. 11.

FIGURE 4

Fertilizer Marketing Channels in India



to the transfer of responsibility to the PBDAC. The private sector's role is insignificant. In Tunisia, production and wholesaling are dominated by the public sector; there are several separate public companies and parastatals. Until recently, private retailers had been gradually squeezed out through control of their margins, but since the government substantially increased margins in 1982/83, they have expanded their volume greatly; their volume accounts for almost half the total. The current policy is to further increase the private sector role in distribution. Consumption has expanded rapidly with the growth of the distribution system through increased private retailing. In Morocco, production, import and wholesaling are public sector operations. In both Tunisia and Morocco public sector companies provide large amounts of phosphates for export.

In both The Peoples Republic of China and Burma, production, import and distribution are essentially a public monopoly. In Burma, distribution to farmer groups and individual farmers is rationed under the intensive village production program. Distribution is managed effectively and at low cost with a very disciplined system under which farmer groups jointly pick up fertilizer at the closest government godown. Most farmers have access to ox carts and thus transport from godowns to the village appears not to present a serious problem. The very rapid growth in consumption of fertilizer in China and Burma in recent years suggests that these systems perform the distribution functions effectively.

Politicians and planners may take strong positions in favor of the public sector, the private sector, or within the private sector, cooperative operation of the distribution system. However, the organizational form in and of itself does not appear to provide any guarantee of efficiency or effectiveness. Individual systems, regardless of market structure, must be examined from the perspectives of costs and services provided. Distribution costs in some areas have been kept low by the restriction of outlets to a few points in major trade centers, conservatively estimating demand, and arranging supplies as late as possible to reduce risks and storage costs. Such a system, though low in cost, scarcely meets the needs of farmers and may hinder achievement of growth objectives for agriculture or society in general.

Government competition (not monopolization) at higher wholesale levels with liberal licensing or uncontrolled entry of small, private distributors, retailers, and small traders has proven a workable approach in several countries. In such a system, prices are likely to be fixed, but fixed retail prices may apply only to larger licensed dealers and not to small village traders who buy from licensed dealers to serve remote areas and small farmers. The Indian system illustrated in Figure 1 involves a mixture of private, cooperative, and public operations which has functioned fairly well. Cooperatives play a major role in India as they do in many parts of the world. The Government of India has experimented with various means of reaching small farmers and remote areas including allowances for higher transport cost.

Bulk vs. Bagged Fertilizer

Bulk fertilizer has proven to be a much more cost effective way to handle fertilizer when conditions are appropriate. In the United States most of the total dry fertilizer is handled in bulk and much of the total is handled and applied in ammonia (gas) form or as solutions or suspensions of N, NP, or NPK. Much of the fertilizer is applied on a custom service basis. Most developing countries are far from this stage, but bulk ocean shipment now is the predominant method of shipment. Some countries are beginning to experiment with bulk inland transport of dry fertilizer, and also are considering direct application of ammonia (gas) and solutions and suspensions of N, NP, or NPK. Some countries, particularly those buying in small quantities, or lacking in seaports (e.g., Nepal) still buy in bags and pay the higher cost of loading and ocean shipping of bagged fertilizer because of uncertainties or problems in port bagging and handling. India probably has the greatest experience with bulk shipments and port bagging. A variety of methods may be used in moving from bulk in ships to bags at the port at nominal costs per ton and major total cost and FX savings. A recent study done in Bangladesh estimated total cost savings of $30 per MT and FX savings of nearly $50 per MT by shipping in bulk vs. bags.[32] The basis of these estimates is shown in Table IV-1. These cost differentials may be somewhat less in 1986/87, with the depressed and highly competitive international fertilizer market. Still, the FX savings are large. Further, port bagging creates additional income and employment in the importing country.

One of the major complaints with port bagging has been varying weights and hand stitching which lead to physical losses and concerns of farmers over light weight and adulteration. Mechanical weighing and sewing systems should be applied in the hold or on the dock to avoid the problem. One alternative is to rough fill and hand stitch in the hold and then move bags to an out-of-port site to standardize weights and mechanically close the bags.[33]

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32. Review of the Fertilizer Distribution and Handling System in Bangladesh by W.E. Claxton, transportation and distribution specialist, IFDC under USAID contract.

33. For those interested in pursuing the issue of bulk shipment and bagging, it is suggested that a copy of the Bangladesh report be obtained. Requests for copies

Improving Efficiency

Measures that might be incorporated into fertilizer sector design as a means of reducing distribution costs and improving efficiency include:

- Shift to high analysis (more concentrated) products;
- Improve transport facilities and operation;
- Increase use of bulk shipment especially on ocean transport; (This implies improved facilities for bulk unloading and port bagging);
- Improve handling facilities at ports and in the distribution system;
- Increase multiple use of facilities and services where feasible (e.g., combined fertilizer and grain storage and joint use of office space and personnel) to lower per unit costs of operation;
- Improve scheduling of shipment to utilize transport efficiently, particularly to take advantage of back hauls to reduce costs;
- Improve scheduling to reduce storage costs and reduce product losses;
- Provide incentives to dealers and farmers to take early delivery, thereby reducing transport and storage congestion; and
- Provide better training of personnel in all operations.

E. Pricing

1. World Fertilizer Prices

The international supply and pricing of intermediate fertilizer production goods, final products, and most raw materials are fundamentally determined by the free play of market forces. The principal exception to this is fossil fuel, particularly oil, which since 1973 has been subject to manipulation by the OPEC oil cartel. In contrast, within developing countries, government intervention in pricing and in the marketplace is commonplace. Governments in all developing

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of this report (currently not yet published) should be addressed to the IFDC library.

countries in Asia and the Near East manage input prices in one way or another.

Despite the large world volume of production, sales, and intermediate trade, the world market in fertilizer is less developed than for most major commodities such as grains and metals. Illustratively, there is no futures market for fertilizer products as there is for most major agricultural commodities, industrial raw materials, and many final products, e.g., petroleum products. Price information is restricted largely to reporting of some major international sales in shipload or larger lots.[34] The major determinants of international prices of fertilizer are the development costs of plants and principal raw materials (particularly natural gas, sulfur, phosphate rock, and potassium raw materials).

Prices of major raw materials/feed stock and finished products from IBRD price series are shown in Table 12. Due to technological progress, prices of principal fertilizer products were lower in constant dollar terms in 1984 than in the 1950s and 1960s. Prices declined substantially from 1984 to 1986; the price of urea in 1986 was about half the 1984 price.

Nitrogen accounts for about 65% of the total nutrients (N, P_2O_5, K_2O) used in developing countries, and about 70% of the total for Asia.[35] Energy is by far the most important cost in the production of nitrogen. The cost of natural gas increased by about nine fold between 1973 and 1985. Despite technical improvement, energy as a percentage of total cost of ammonia increased from 41% in 1970 and 46% in 1973 to 76% in 1985. Fertilizer must compete with other uses of gas such as household use which often is accorded a higher priority for political reasons. Energy also is an important input in P and K fertilizers but phosphate ore, sulfur, and potassium ore make up a major part of total raw material costs.

International trade is subject to controls by governments and some large trade organizations representing major national or international fertilizer producing and exporting groups. Despite these barriers to free fertilizer pricing, substantial competition exists in international fertilizer trade and prices

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34. A number of sources provide such information. The monthly FAO <u>Food Outlook</u> report provides information on at least a scattering of sales of major products, some in bulk, some in bags. Trade reports provide more timely and complete information, but subscriptions are quite expensive.

35. In more precise nutrient terms (N, P, and K), N accounts for about 80% of the total nutrients used in Asia.

TABLE 11

Indicative Import Cost Comparisons, Bags Versus Bulk (U.S. $/ton) (Shipment of urea, TSP, and DAP from U.S. Gulf to Chittagong and Chalna)

Currency	Imported in Bags Foreign Exchange	Imported in Bags Local	Imported in Bulk Foreign Exchange	Imported in Bulk Local
Bagging and handling, U.S.	16	-		
Cost of bags	13	-	-	13[a]
Transport to dockside and stevedoring/ shiploading	15	-	1	-
Freight	65	-	60	-[b]
Discharge	-	5[c]		
Bagging and handling, Bangladesh				10[d]
Handling losses		[e]		[e]
TOTAL	109	5	61	23
GRAND TOTAL	$114/ton		$84/ton	

a. Assuming woven polypropylene/polyethylene liner, U.S., and jute/polyethylene liner, Bangladesh (Bangladesh Government-controlled price is artifically high; Indian price is used).
b. Assuming load/offload bags 2,000/1,000, bulk 8,000/1,000. Loss of cube for bags 2½% costing $1.50, saving of ship's time, $3.50.
c. Including lighterage from anchorage. Ship's hold to loaded transport on wharf.
d. Assuming manual bagging methods, including lightering.
e. Assumed same level, current overall losses on bagged cargo already higher than should be accepted for bulk handling.

Agro Chemicals News in Brief, 1985.

have proven volatile, influenced in the upward as well as the downward direction by international energy prices.

Investment costs are a major fixed expenditure in fertilizer production. A typical modern 300-400,000 MT/year ammonia plant with down-stream finished products may require an investment of as much as $500 million in developing countries, perhaps more, and have an effective capital servicing cost of $75 - $100 million/year. Energy and capital servicing thus become the major factor in final fertilizer cost and determination of the break-even price.

Requirements for fixed capital in the form of warehouses, machinery, transport, and operating capital (the latter mainly to carry inventory) are major items in fertilizer distribution. Table 14 shows capital costs for illustrative enterprises in four countries in 1972-73. A firm just starting up in the mid-1980s probably would incur costs of four to five times the levels shown in this Table 12.

Given the high capital cost requirement, particularly working capital requirement, short term financing is critically important to the effective and efficient functioning of the fertilizer industry and trade. Most private enterprises make use of lines of credit from commercial banks to finance most of the working capital needs, including that required for accumulation of fertilizer stocks in advance of the sales season.

In some countries, public or quasi-public financing of the fertilizer trade is provided with the understanding that dealers in turn will provide credit to farmers.[36] Where production and large wholesale operations are dominated by public institutions or cooperatives, these entities frequently enjoy special access to financing of fixed and working capital needs. However, many such publicly owned organizations still depend heavily on banks to finance stocks and other working needs.

2. Domestic Fertilizer Prices in ANE Countries

The principal objective of governmental management and control of input prices is to offer incentives to farmers to expand their use of yield-increasing inputs and technology. Managed prices commonly are based on estimates of prices of outputs relative to input prices that are required to achieve the desired level of input use (and thereby, the agricultural production target). Inconsistencies among different pricing objectives usually are resolved by an array of subsidies, taxes, trade constraints, rationing, and other measures.

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36. e.g., Mexico and Brazil. In Brazil, this was initiated in 1965 under an early AID loan to finance fertilizer imports.

Prices of Major Fertilizers and Fertilizer Feed Stocks for Selected Years, 1950-1985 (U.S.$/MT)

	Coal1	Crude Oil2	Phosphate Rock3	DAP4	Potassium Chloride6	TSP7	Urea8
1950	8.94	1.70					
1955	9.38	1.90	14.50		32.50		
1960	10.00	1.50	13.00		28.50		72.309
1965	10.22	1.30	14.00	68.505	29.50	47.005	95.80
1970	14.77	1.30	11.00	54.00	31.50	43.00	48.30
1973	20.90	2.70	13.80	91.00	42.50	100.00	94.80
1975	54.27	10.90	67.00	243.00	81.30	202.00	198.00
1980	55.70	30.50	46.70	222.20	115.70	180.00	221.00
1983	61.51	29.10	36.90	183.50	75.30	135.00	135.40
1984	N.A.	28.50	38.30	189.19	83.70	131.00	171.30
1985*	55.82	27.80	34.00	168.50	85.20	119.00	142.10

*/January-October 1985
1/ FOB U.S. Ports
2/ FOB Weighted Average OPEC Oil (per barrel)
3/ FOB Moroccan Rock
4/ FOB U.S. Gulf
5/ 1967
6/ FOB Vancouver
7/ FOB U.S. Gulf
8/ FOB Europe Bagged
9/ 1963

Source: IBRD Commodity Trade and Price Trends, 1985 Edition, pp. 101, 103, 126, 128, 130, 132, 134.

Table 13

U.S. Prices of Selected Fertilizer Products Selected Years 1947 - 1982 and International Prices 1985, 1986 (U.S.$/Ton)

Year	Ammonia	Sulfuric Acid	Ammonium Nitrate	Ammonium Sulfate	Urea	Phos. Acid[1]
1947	63	13		48		162
1953	91	19	69 [2]	47	101	165
1960	69	19	62	32	89	144
1965	67	17	59	28	70	111
1970	34	17	44	18	60	99
1975	152	23	117	71	152	183
1977	102	32	111	54	125	193
1980	136	45	123	70	184	303
1982	151	53	144	76	160	338
1985				67 [4]	125 [3,5]	
1986				33 [4]	80 [5]	

[1] 100% P_2O_5
[2] 1954
[3] August 1985
[4] Western Europe
[5] Near East

Sources: 1947-1982 Inorganic Chemicals; U.S. Department of Commerce, Bureau of Census. 1985,1986 FAO Food Outlook; Sept. 1986.

TABLE 14

Capital Allocations Reported by Illustrative Fertilizer Marketing Enterprises in Selected Countries, 1972-73

	Brazil	Mexico	Pakistan	United Kingdom
FACILITIES ($)				
Administrative	900,000	20,585	1,700	6,700[1]
Warehouses		165,570	1,700	
EQUIPMENT ($)				
Transport		30,115	1,700	
Handling	1,400,000	19,010	1,700	6,700
Other		43,190	1,700	220
OPERATING CAPITAL ($)	3,000,000	210,920	1,600	42,500
TOTAL ($)	5,300,000	489,390	3,300	56,120
Annual fertilizer sales (tons)	170,000	26,249	300	3,700
Capital allocation ($) (per ton of annual sales)	31	19	11	15

1/ Warehouses are rented.

Source: Werner and Abbott, op.cit., p. 110.

In the period beginning in 1973 of rapid price increases and shortages of food and fertilizer, subsidization of fertilizer to offset high world prices probably reached its peak. Most developing countries offered some level of subsidy with the most common level at about 50% of the total costs of the product plus its distribution. Though many fertilizer prices have declined in real terms to levels below those of 1973-74, subsidies continue. Most developing countries now have some local fertilizer industry, often with high costs, requiring subsidies to be able to compete. Each situation requires careful analysis of the underlying conditions which gave rise to the special sets of prices, taxes, subsidies, duties, and other price management approaches. Imported fertilizers usually are purchased through competitive bids in world markets, but sometimes purchases are made at non-competitive prices, especially under barter or concessional aid terms which tie procurement to a particular source. Where these non-competitive prices are paid for imports, internal compensations often must be made, e.g., a subsidy to offset a higher price. Taxes sometimes are assessed to offset lower prices, special licenses, or favorable access to foreign exchange.

In the developing countries in Asia and the Near East, locally produced raw materials (gas, other energy, phosphate rock and potash) commonly have been made available to local plants at prices which are much below world prices. This is to be expected for plants in the public sector. However, even privately owned plants commonly have long term agreements that involve concessionality on raw materials. Plants with low costs, by virtue of low raw material prices and low investment costs (hence low total costs), commonly receive a lower ex-plant price. This may be accomplished by a special charge (in effect an equalization tax) or by lower subsidies compared with other plants. In some cases efficient private sector plants are penalized for their efficiency, e.g., they are taxed more heavily than inefficient (public sector) plants.

Subsidies and degree of price control may differ from product to product. In some countries, prices and subsidies for the same product differ depending on the crop to be fertilized and farmer classification. Table 15 shows subsidy levels for several products in 1981/82 and 1982/83 for 12 Asian countries. Small farmers may receive preferential treatment or all farmers may enjoy the same subsidies. Often, large farmers are the primary beneficiaries where credit is subsidized; this subsidy frequently benefits mainly those already enjoying economic, political or locational advantages. Differential pricing of fertilizer for different crops or purposes where tried has proven difficult to administer and easily abused. For example, fertilizer intended for production of basic staples went onto plantation and export crops because returns were greater to those crops (Philippines, mid-1970's).

The effect of high subsidies in some countries and virtually none in others has been to produce a great variation in retail prices. In 1982, reported prices of urea ranged from a low of US $45/MT in Burma to a high of $325/MT in Korea. The Philippines and Thailand, which had little or no subsidy, had the next highest prices ($295 and $296 respectively) for urea.[37]

The least favorable crop/fertilizer price relationships were obtained where fertilizers were not subsidized (The Philippines and Thailand) and most favorable where fertilizer was produced locally from local gas and also subsidized (Indonesia). In fact, farmers were taxed implicitly in the Philippines during much of the 1970's and early 1980's.

Fertilizer-Crop Price Relationship

The major objective of fertilizer price management in developing countries has been to keep fertilizer prices low and thereby provide incentives to greater fertilizer use and/or compensate for farm prices which are either depressed by general economic conditions or are artificially depressed by government policies seeking to keep food prices down.

Fertilizer project designers need to review the fertilizer and crop price structure as a part of the economic analysis to insure that prices are not likely to be a serious constraint in achievement of fertilizer consumption targets. Two methods may be used to appraise the adequacy of fertilizer and crop prices to encourage fertilizer use: a) comprehensive analysis of total cost functions for a sample of farmers. (If the project is directed at a particular target group, the sample should be selected from that population); and b) collection and analysis of data on crop response to fertilizer and the crop-fertilizer price relationship.

The latter method is much less time consuming and is usually a more reliable measure of adequacy of the price relationship than collection and analysis of detailed farm cost data. Experience indicates that, when other conditions are satisfactory, farmers will increase fertilizer consumption when the ratio of value of incremental crop production to cost of fertilizer is 2.5 or more. If the desired ratio to achieve a high rate of acceptance is 3.0, and the average response rate is 12/1 for wheat, then a Kg of nitrogen should sell for 4 times the cost of a Kg of wheat. With wheat at $125 per MT (near the 1986

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37. In 1983, subsidies on urea were reported to be: India US $75-115/MT, Indonesia $44, Iran $168, Nepal $34, and Sri Lanka $141 (Agro Chemical NIB, Vol. VIII, 2 April 1985, p. 6.)

TABLE 15

SUBSIDIES FOR SELECTED FERTILIZER PRODUCTS 1981/82
(US$/metric ton) 1/

Country	Urea	AS	TSP	DAP	MOP	NPK	Percentage of Subsidy of real cost 2/	Government Budget (US$ million)
Afghanistan (1980/81)	-	-	42	52	-	-	TSP 23; DAP 19	1.37[a]
Bangladesh (1981/82)	21[b]	-	185	131[b]	120	-	Urea 10.5; TSP 58; DAP 42.5; MOP 52	63.0
Burma (1981/82)	270 (64)[c]	-	193	-	165	-	Urea 85 (57); TSP 54; MOP 67	32.0[d]
India (1980/81)	44[e]		n.a.	-	-	-	Urea 15.5	634.0[f]
Indonesia (1981)	61	151	232	-	-	-	Urea 35.5; AS 58; TSP 68	n.a.
Iran (1981)	229	174	187	237	-	-	Urea 67; AS 73; TSP 60; DAP 61	299.0
Malaysia (1983)	g	-	-	-	-	-	Urea 100	296.5
Nepal (1981)	226	132	-	-	-	225 (20-20-0)	Urea 47; AS 40; 20-20-0 49	4.2
Pakistan (1980/81)	67.9	45	-	77.2	-	-	Urea 26.5; AS 35; DAP 28	245.0[h]
Philippines (1981)	31.7	-	-	-	-	-	Urea 9; 14-14-14 27	69.3[i]
Rep. of Korea (1981)	75.8	34.4	-	-	78.6	144	Urea 17; AS 17; MOP 39; NPK 33	237.0
Sri Lanka (1981)	145[j]	-	185[j]	-	49.50[j]	139	Urea 65; TSP 65 MOP 40; NPK 52	53.3
Thailand (1981)	-	-	-	-	-	15.2	16-20-0 6	2.7

1/ IMF exchange rates of June 1981. If December 1981 rates are used, subsidy will, in most cases, show a smaller dollar amount, owing to the stronger dollar vis-à-vis local currencies.

2/ Real cost is procurement/domestic purchase price plus marketing costs and margins, including retail-level margins.

Footnotes:

a. Estimate based on consumption times subsidy per product.
b. Projected; exchange rates of December 1981 are used.
c. Local production.
d. Provisional consumption figures used to arrive at government budget.
e. Price increased by Rs. 350 on 7.6.81 thus lowering the subsidy by some US$ 40/metric ton.
f. Net subsidy paid to manufacturers.
g. Actual price is subsidized for 100 percent.
h. Amount actually spent in 1980/81.
i. Amount claimed by importers/manufacturers.
j. Subsidy based on average c.i.f. value/metric ton of product.
\- Figures not available.

Sources : FADINAP Technical Liaison Offices
FADINAP documentation.

world price), nitrogen should not exceed $500/MT of N, which would be about $225/MT of urea. Experienced and sophisticated farmers may increase fertilizer use even at levels somewhat below 2.0. The major data need is estimates of average crop responses to fertilizer. These will vary, of course, among crops and with all the factors that influence yield (moisture, seed variety, plant density, soil type, initial fertilizer, tillage method, etc.). However, researchers and extension workers should be able to provide some data on typical response rates under typical conditions. If not, then field trials on farms should be given high priority in extension and research field work.

As the rate of fertilizer application per hectare increases, the crop response (marginal rate of return) tends to decline somewhat, other things being equal. However, farmers generally use better seed and improve other practices as they become more experienced and apply more fertilizer. As a result, the marginal product may change little over a long period of increasing fertilizer use.

Fairly high rates of fertilizer use on cereal crops should be feasible in most countries if farmers are able to obtain near the world price for cereals and pay near the world price plus reasonable transport and distribution costs for fertilizer. Unless crop prices are well below world levels there is little reason at current world fertilizer prices to pay subsidies. Of course, countries which produce a major part of their own fertilizer may find it necessary to compensate fertilizer producers for fertilizer production costs that substantially exceed current world prices if fertilizer is to be sold at world market prices.

The current low world prices for fertilizer offer a unique opportunity for countries to sharply reduce any existing subsidies on fertilizer designed to benefit farmers. Subsidies designed to benefit the industry should be carefully appraised in light of the current price structure. Taxes on fertilizer, including duties on fertilizer imports should be eliminated where farmers are expected to compete with world prices for their produce.

F. Distribution Costs and Margins

With total volume of fertilizer products consumed in developing countries at about 125 million MT per year, small differences in procurement and distribution costs can amount to large differences in total cost.[38] The importance of fertilizer

38. Nutrients consumption is near 40 million MT. At 33% average analysis, this would be over 120 million MT of product.

is now widely recognized and countries and donors are concerned about distribution efficiency. However, the efficiency of different distribution systems is difficult to appraise because of the great variations in conditions and the difference in direct and indirect government subsidies. In some countries transport costs from the source (e.g., ports in India for Nepal and in Pakistan for Afghanistan) are very high; 60% of the marketing margin was transport cost in Afghanistan.39 In contrast, in Malaysia transport was reported to account for only 8-9% of the total marketing costs.40 Efficient distribution of fertilizer supplies requires the successful coordination and implementation of a number of different functions including: loading and unloading, bagging and handling, storage, transportation and sales operations. The items of cost involved in distribution include not only the direct payment for these operations but also interest on stocks, risks, losses and a reasonable rate of return or profit. Total cost of distribution in absolute terms and as a percentage of the retail cost of fertilizer fluctuates greatly from country to country, and is dependent upon a wide range of variables including method(s) of procurement, storage and transportation requirements, as well as government policies on provision of credit, subsidization, and private sector involvement in marketing.

Total costs per metric ton for distribution have escalated substantially in recent years, while world prices of fertilizer are near the levels observed in 1973 and 1975. In 1978, one study showed Hong Kong retail distribution costs in a range of $6 to $10/MT excluding delivery to the farm and $3 - $5/MT for delivery, which together was only 5 to 7.5% of the total cost of fertilizer.41 Recently in Bangladesh, distribution costs were reported to be about 15% of total costs and in India, minor wholesale and retail operations averaged about 10% of total costs, with cooperatives receiving about 1 percentage point higher margins than other private businesses. Cooperatives were reported to receive 60 days of free credit. In Indonesia, total margins were reported to be about 7% of costs. In Pakistan, urea marketing allowances were reported to be about $10/MT, (less than 5% of total costs). In Thailand total costs from port to farm were reported to be about 50% of the CIF cost. Wholesale handling, storage and in-country transport were about 20 - 25% of

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39. APO, 1978, op. cit., pp. 187-220.

40. Ibid, pp. 187-199.

41. Costs as used here include the factory or import cost for the product plus all distribution costs. Where subsidies are paid, the true cost may be much higher than the price paid by the farmer.

the CIF cost and local transport and retailing about 20%.[42] Figure 5, although out of date, illustrates the variations that may occur in different cost components among countries.

Storage and Transport

Wholesalers normally play a substantially larger role than dealers in storage and transport. Where prices determining margins are set by governments or margins are set directly, an allowance usually is made for cost of transport. The actual cost incurred for each shipment or at an average cost for the particular distributor or for distributors in general is allowed. Storage costs also are allowed based on estimated actual cost or average for the industry. The margins for receipt, handling, short term storage, and sales allowed wholesalers commonly are near levels allowed retailers (5-10% of the final price).

Typically storage costs run about 2% of the value of fertilizer in storage per month, with about one half of this needed to cover costs of facilities and operations and half for interest costs. The cost of facilities may be considerably higher per month where facilities are used only a small part of the year. Distributing agencies often are reluctant to store fertilizer because of high interest costs and low fixed margins.

Transport costs may account for the largest part of the total distribution costs for fertilizer. Fertilizers have a low value relative to weight and volume. This is especially true for low analysis fertilizers. An increase in the nutrient content of fertilizer, typically from about 20% in 1950 to 45-65% in 1985 has helped hold transport costs down. With large increases in total volume, there has been a substantial increase in shipment in bulk (relative to bags), both on water and land. Some products such as ammonium sulfate (20-21% N) and simple super phosphate (16-20% P_2O_5) have fallen into disfavor because of high shipping and handling costs. In some countries (such as Nepal and Afghanistan) which are dependent on imports and far from ports, transport including payment of forwarding agencies may constitute the largest part of the total differential between the FOB cost of imports and the cost at the farm level. In China, early development of the fertilizer production emphasized widely dispersed small scale plants and usually low analysis fertilizer. Thus, distances fertilizer had to be moved were minimized. In fertilizer production and distribution planning, distances and transport should be major considerations. Models have been developed for optimizing location and minimizing transport

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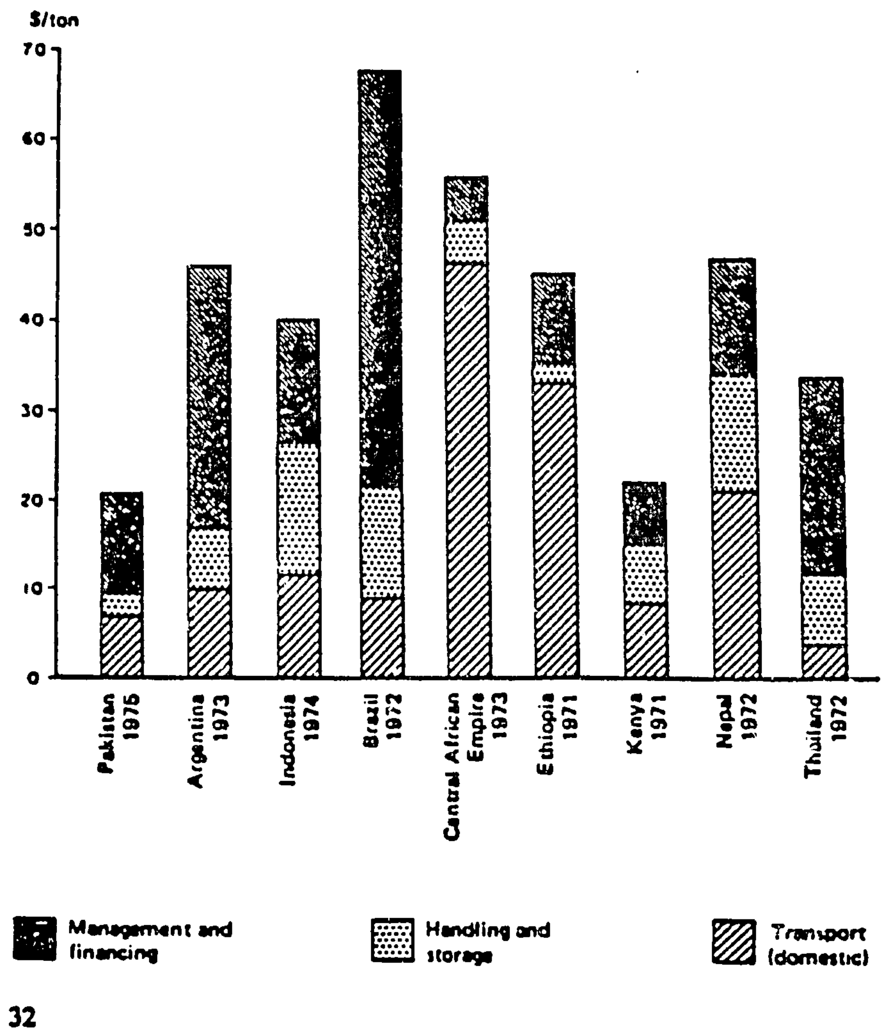
42. Of the total allowances, about 40% was a commission, 20% transport, 13% interest, and 7% promotion.

FIGURE 5

Breakdown of marketing costs for bagged fertilizer in some developing countries early in the 1970s



Werrier and Abbot, op. cit., p. 32.

costs.[43]

The methods employed by governments in establishing allowances for transport and storage, which are designed to reflect the average situation, often fail to provide incentives for somewhat unusual situations. As a result, remote areas and small volume areas are often not well served and there is little incentive for penetrating into new areas. Adequate incentives to distributors for sufficiently advanced procurement and ample stocking often are lacking. Ordering and shipping then become concentrated at peak demand periods and available transport and higher level storage facilities are unnecessarily overloaded.

Tables 16 and 17 present recently available data on fertilizer prices, marketing costs and rates of subsidy in Asia/Near East region countries. A careful examination of these data, which provide breakdowns of overall marketing costs into definable categories such as transport, storage, baggage and handling, taxes, losses, etc., indicates that the expenses involved in the marketing and distribution of fertilizer can account for upwards of <u>50%</u> of the total cost of fertilizers. Study of the breakdown of these costs by function may serve to alert ANE staff both to potential constraints and opportunities for design of programs/projects which will increase fertilizer marketing efficiency and reduce real costs of fertilizer and thus of agricultural production.

Transportation and storage of fertilizer, while presenting substantial logistical difficulties, may be two areas where considerable savings can be realized as the result of careful planning. Transportation costs per MT/Km vary widely from country to country, among different transport modes in a given country and within modes among countries.

Seasonality of Fertilizer Use and Costs of Marketing

Seasonality of fertilizer sales depends on a number of factors. The most important of these is the cropping pattern and use of fertilizer on the range of different crops grown. In the cooler temperate zones, the growing season is restricted by cold temperatures to a few months. Some fertilizers may be applied in the fall, especially for fall planted crops such as winter wheat, but most is applied in a period of a couple of months during spring planting and the early growing season. Most of the P and K goes on at planting time. In contrast, in tropical areas the growing season continues throughout the year (if not limited by water), but there still are notable peaks even when major amounts

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43. See Choksi, A. Et. al., <u>The Planning of Investment Programs in the Fertilizer Industry</u>, which reports methodology and results in Egypt.

TABLE 16

Fertilizer Pricesand Marketing Costs in Asian Countries

(US$/mt – August 1981)

Country	Afghanistan	Bangladesh	India	Indonesia	Iran	Korea	Malaysia	Nepal	Pakistan	Philippines	Sri Lanka	
Product	Urea	Urea	Urea	Urea	Urea	Urea	Urea	Urea	Urea	Urea	Urea	1
Source	Local	Local	Local	Local[g]	Import	Local	Import	Import	Import	Import	Import	1
1. Import or ex-factory price	113.00	136.00	227.78[d]	128.13	275.00	297.76	212.17	303.00[j]	240.00[m]	275.00	276.13	2
2. Retail price	160.00	166.30	266.11[e]	112.00	109.30	319.28	–	250.00	187.07	322.76	115.62	2
3. Govt. subsidy	–	12.03	12.44	49.58	231.10	0.00	323.40	190.00	52.12	67.14	207.11	
4. "Real" costs to farmer	160.00	178.33	273.56	161.58	340.90	319.28	323.40	440.00	255.64	309.90	322.73	2
5. Marketing costs	42.00	42.33	45.78	33.45	65.90	27.53	112.23	145.00	15.03	114.90	46.60	
Breakdown of Marketing Costs (Item 5)												
6. Transport	26.00	14.33[a]	12.89	10.20		13.07	17.39	75.00[k]	2.52	16.06[o]	11.34[q]	1
7. Storage	0.70	1.67[b]	1.44	1.10		5.55	5.22	4.00	2.32	3.07	0.41	
8. Bagging	–	0.28	13.33	–		–	15.65	1.00	2.52	–	7.81	1
9. Handling	0.40	1.11	0.67	0.67		0.76	12.61	14.00[l]		–	4.96	
10. Losses	1.90	3.39	0.89	2.28[h]		0.12	3.04	5.00	–[n]	2.70[p]	0.35[r]	
11. Tax/levy etc.	–	–	–	0.07		1.38	10.61	–	–	6.06	1.88	
12. Interest	–	2.94	7.22	5.44		–	8.70	25.00	1.26	44.07	4.11[s]	
13. Others	7.00	0.78	6.56	1.12[i]		–	4.44	3.00	1.96	10.02	10.32	
14. Dealer margin	11.00	17.03	2.78[f]	12.57		5.05	33.67	10.00	5.05	22.44	5.41	[illegible]
Importer				(2.24)			(19.19)			(7.44)		(
Wholesaler	(5.00)	(6.39)[c]		(4.53)			(14.50)	(3.00)		(7.50)	(4.12)	(
Retailer	(6.00)	(11.44)		(5.80)			(9.73)	(15.00)		(7.50)	(1.29)	(
Total Marketing Costs	42.00	42.33	45.78	33.45	65.90	27.53	112.23	145.00	15.65	114.90	46.60	4

Fertilizer Marketing Costs in Developing Countries, Developing Countries Trading Group, PALMA, May 1982, IFA.

TABLE 17

Major marketing cost items per metric ton of urea (1982/83 and 1983/84)

Country	1983/84			1982/83		
	Cost item	USD	Percentage share	Cost item	USD	Percentage share
India (public channel)	Transport	15.12	53.5	Transport	17.40	37.3
	Others[1]	5.82	20.6	Bagging	9.40	20.2
	Mktg margins	2.25	8.0	Others	7.20	15.5
(private channel)	Transport	17.09	60.3	Mktg margins	15.[illegible]0	39.2
	Others[1]	3.94	13.9			
	Mktg margins	2.25	8.0			
Indonesia	Transport	10.20	39.2	Mktg margins	15.10	39.2
	Mktg margins	8.30	31.9	Transport	14.70	38.2
	Interest	4.21	16.2	Interest	6.10	15.8
Iran, (Islamic Republic of)	Transport	56.47	68.3			
	Handling	7.35	8.9			
	Taxes, etc.	5.94	7.2			
Nepal	Transport	44.50	49.0	Transport	39.30	41.6
	Interest	16.65	18.3	Mktg margins	26.60	28.1
	Mktg margins	11.80	13.0	Interest	19.50	20.6
Republic of Korea	Interest	16.30	35.0	Interest	62.20	65.30
	Transport	12.23	26.3	Transport	10.90	11.40
	Mktg margins	8.96	19.2	Mktg margins	10.20	10.70
Sri Lanka	Mktg margins	6.07	29.8	Mktg margins	7.70	23.4
	Storage	3.67	18.0	Storage	7.00	21.3
	Taxes, etc.	2.82	13.8	Bagging	5.10	15.5
Thailand (16-20-0)	Transport	7.81	24.0	Transport	10.70	31.6
	Others	6.25	19.2	Mktg margins	8.50	25.1
	Storage	6.03	18.5	Handling	4.20	12.4
Philippines (private channel I)	Interest	65.98	52.0			
	Mktg margins (and profit)	43.51	34.3			
	Others[2]	9.60	7.6			
(private channel II)	Transport	16.00	27.6			
	Interest	14.40	24.8			
	Others[3]	9.60	16.6			

Sources: Agro-chemicals News in Brief, Bangkok, Special Issue, September 1984.
FADINAP. *Survey on Fertilizer Marketing Costs and Margins in Asia and the Pacific Region*, Bangkok, March 1985.

[1] Including inventory costs, establishment costs and letter of credit charges.

[2] Salaries and wages; travel, meetings; contractual services; materials and supplies; and other administrative expenses.

[3] Operational expenses.

Agro Chemicals News in Brief, Special Issue, September 1985.

of land are irrigated. Illustratively, in Egypt and Pakistan where most of the cropped area is irrigated, there are two major crop seasons. Winter crops are planted in October-December and summer crops (e.g., cotton and rice) planted in Aprill-June. Cropping in some areas may be dictated mainly by rainfall, resulting, for example, in the largely monomodal pattern in Ethiopia or bimodal pattern in South Asia (the Kharif and Rabi seasons). In Bangladesh, with the introduction of irrigated wheat, the Boro season has become increasingly important though it is still minor relative to the two main seasons (Aman and Aus).

The major cost implication for the fertilizer industry of these different seasonal cropping patterns is stocking requirements. Fertilizer producers usually attempt to operate plants at capacity for 11 months, with a 30 day shutdown for maintenance and repair. Figure 6 illustrates the stocking implications for the industry of different seasonal use patterns. "a)" is a single growing period; "b)" a bimodal system such as exists in South Asia; and "c)" a cropping pattern involving four or more growing periods with approximately equal application periods. The peak inventory for the former is almost four times the peak for the latter situation. This means four times as much storage facilities are required, which may cost $100 per MT or more; interest and other variable storage costs also are four times as great.44 At $200 per MT for fertilizer, the working capital alone would peak at nearly a $200 average per MT handled during the year in the monomodal situation. Unless the storage is near the farm, it also implies a much greater short-season burden on the transport system to move the required fertilizer during the short sales season. Opportunities for direct factory to farm movement, which minimizes handling, are less in a monomodal situation. Risks are also increased by virtue of having to make stocking commitments 8-10 months in advance of sales.

When excessive amounts are stocked, the residual must be carried for almost a year. On the other hand, underestimates result in deficiencies which may seriously affect the entire year's agricultural output. Costs of estimation errors in terms of storage of excesses or lost production due to shortages are much less serious in the multiple application situations. In some countries, efforts have been made to alleviate the problems for the industry by offering incentives for early purchase by farmers and/or dealers. Farmers have been encouraged by

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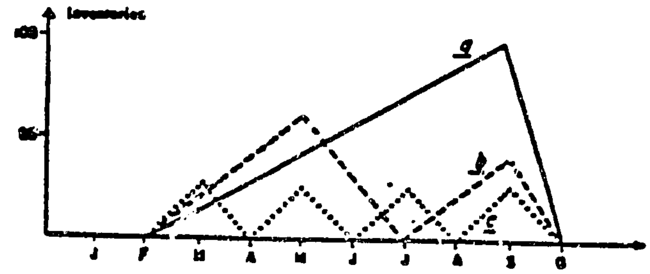
44. If storage facilities cost $100/MT and interest 12%/year, these two items may add $15/MT or more to costs of storage and marketing fertilizer in a single crop season situation compared with a situation of a multiple crop application.

incentives to make fall applications in monomodal cropping situations when cold temperatures minimize nutrient loss between fall application and the spring planting season. Availability of credit may be a crucial factor in farmer acceptance of incentives for early procurement.

FIGURE 6



The impact of seasonal concentration of fertilizer sales on capital requirements and interest costs.

Source: Wierer and Abbott, Fertilizer Marketing. FAO, 1978.

G. Credit

Credit for farmers is provided by some fertilizer distribution organizations, both public and private, as a part of their service package. However, reliance on other agencies or farmers to arrange credit is by far the more common practice. "Official" (government supported) credit institutions commonly provide an interest subsidy and thereby an indirect subsidy for use of the input. More serious in many countries, the rate of repayment to public entities is very low; a 50% or greater default rate is not uncommon. Under such circumstances, many farmers (often the better-off farmers) are effectively obtaining fertilizer supplies free of charge. Such poor credit repayment performance cannot continue indefinitely without leading to serious repercussions such as the insolvency of the lending institutions and an unbearable continuing drain on the treasury.

Egypt is one country which has demonstrated a successful public farm credit system operated in conjunction with public distribution of subsidized inputs, mainly fertilizer. Since fertilizer supplies are restricted, fertilizer is in short supply and rationed at prescribed amounts for each feddan of individual crops. Credit repayment is close to 100% due largely to the threat of being denied access to subsidized inputs in the event of default. Costs of operation of input distribution and credit operations appear to be reasonable compared with costs in other developing countries.

V. TECHNICAL CONSIDERATIONS

The formulation and recommendation of appropriate fertilizer sector strategies necessarily requires a basic knowledge of some of the more important technical considerations involved in fertilizer use, in addition to a familiarity with economic incentive measures. The objective of this chapter is to present an overview of principal technical considerations with which program/project designers should be familiar. The chapter reviews measures to increase fertilizer effectiveness and efficiency, and energy and environmentally related aspects of fertilizer production and use.

A. Types of Fertilizer

Fertilizers may be divided into two principal types: straight, or simple fertilizers, which contain only one of the three primary nutrients, (N, P, K); and compound fertilizers, which contain more than one of the three primary nutrients. Compound fertilizers may be further divided into: complex fertilizer, in which all nutrients are present in each granule, and mixed fertilizer, in which different products are physically mixed together. These solid fertilizers are the simplest forms of fertilizer to handle and are almost the only forms used in developing countries at the present time. They particularly lend themselves to small-scale retailing and small farm use. Solid fertilizer may be available either in bulk or bagged form.

Fertilizers are also available in liquid form, but successful utilization requires a sophisticated infrastructure, as well as specialized storage, transport and application equipment, making them impractical for use in most developing countries at this time.

B. Technical Aspects of Fertilizer Use

Fertilizer Use Efficiency

Most developing country governments have employed a wide variety of measures to increase fertilizer consumption and thence agricultural production. The importance of economic incentives is widely recognized and implemented via various price management mechanisms, including fertilizer subsidies, price and margin controls and crop price supports, to provide a favorable ratio of fertilizer/crop prices compared with physical input-output relationships. Evidence indicates much also can be done at minimal cost to increase overall fertilizer use efficiency, (improve input/output relationships) and thereby increase the incentive to use fertilizer. This section reviews some of the basic principles underlying fertilizer use and discusses basic methods for increasing physical returns to fertilizer use.

Improving fertilizer use efficiency is very important to developing countries but receives inadequate attention. Fertilizer involves by far the largest recurrent cash outlay by farmers, and the largest FX outlay for crop production in developing countries (about $10-20 billion per year depending on current prices). It also is by far the largest agricultural user of fossil fuels in developing counties -- in some cases virtually the only farm use of fossil fuels. Increase in efficiency of fertilizer use that would mean savings of 10-20% of total fertilizer used translates into savings of several billion dollars per year to developing countries. In some instances fertilizer use efficiency is currently less than 50% of levels possible with good fertilizer management practices. Further, some of the fertilizer losses due to mismanagement result in additional, although less obvious, costs through pollution of the environment when fertilizers are washed off fields into lakes and streams and soluble nutrients, particularly nitrates, and leach into ground water.

Total nutrient losses can be estimated by comparing results in terms of nutrient uptake in the form of crops removed under typical farm conditions and those under conditions where the best feasible fertilizer and cropping practices are followed. Overall nitrogen fertilizer uptake by plants in Egypt, for example, was recently estimated to be only about 30% of the amount applied -- about half of levels of uptake that should be obtained under good management.

Recent research on constraints to high rice yields in farmers' fields in the Philippines shows that improper fertilizer management accounts for 1/2 to 2/3 of the gap between actual yields in farmers' fields and potential rice yields in the same field (IRRI, 1977). Two-thirds of the nitrogen is lost with broadcasting of nitrogen on top of the paddy water. Research has indicated that losses can be cut in half by proper incorporation into the soil using simple application equipment.

Factors Affecting Fertilizer Use Efficiency

The objective in efficient fertilizer management is to provide nutrients to the crop (not to the soil as common practice seems to suggest). Nutrients should be supplied to plants in the amounts and forms that can be readily used, and at the times needed. The timing of application, amounts, and placement are particularly critical for those types of fertilizer which are more subject to heavy loss by volatilization or leaching.

Nutrient needs vary with the type of plant, stage of development and other conditions such as soil characteristics. Different nutrients are important at different stages of crop growth. Nitrogen is essential at the beginning of a plant's establishment to stimulate maximum elongation of plant cells and plant growth. Later in the life cycle it becomes less important and may even have a negative impact on yields at some stages by diverting energy away from seed formation. Needs for phosphorus, potassium, and other essential nutrients are most critical at later stages. They can be applied at planting because they continue to be available over the season. In contrast, much of the nitrogen may not be available at the time of peak needs if all is applied at planting. While the farmer cannot afford to apply each nutrient to the field at the stage where it is most needed, major increases in returns can be achieved by overall optimization of the placement and timing of nutrient application to coincide with the most critical needs. Thus, efficient use of fertilizers requires an integrated knowledge of specific needs of crops as well as an intimate understanding of the local ecology and translation of that knowledge into specific nutrient application practices. Since fertilizer is used to supply nutrients that do not exist in sufficient quantities in the soil for the particular crop, it is necessary to start with information on the crop needs and levels of nutrients available. Nutrient deficiencies then should be supplied in a manner that maximizes availability to the plant at critical growth stages. Implicitly, nutrient management involves knowing and managing nutrients available in both organic and inorganic forms as well as nutrients to be physically applied. The usual objective is to obtain maximum net returns to a given level of inputs.

Knowledge of local crop and soil characteristics is necessary to design an efficient fertilizer program. Soil characteristics determine the potential fertilizer storage capability. Sandy soils have little nutrient holding capacity while clay absorbs and holds nutrients quite readily. Some soils also bind nutrients so as to prevent their absorption by the plant.

Fertilizer losses occur in various amounts at different stages of the cropping cycle, between crops and during fallow periods. Each nutrient experiences loss through a different mechanism. Good fertilizer management requires a knowledge of the specific chemical characteristics of different fertilizers and an understanding of their reactions under different environmental conditions. Some nutrients are more "volatile" (e.g., ammonia) while other forms are more water soluble (nitrate) and thus affected more by water movement. The stability of fertilizer depends upon its chemical characteristics.

Controlling losses is as important to the farmer as the nutrient is to the crop. Nitrogen is the nutrient that most frequently limits yields in both temperate and tropical regions of the world and accounts for the largest part of the fertilizer applied in developing countries. Nitrogen deficiency tends to be more common in the tropics than in temperate areas; it is more easily lost in warm, wet climates. Volatilization, denitrification, leaching and erosion all contribute to nitrogen losses. Leaching and erosion, which physically transport nutrients away from the plant, affect all nutrients, but in varying degrees.

Increasing Fertilizer Use Efficiency

1. Control of Leaching and Erosion

A number of soil conservation measures can be implemented to reduce the amount of nutrients displaced through leaching and erosion. The extent of leaching loss is related to the structure of the soil itself, and can be minimized through the incorporation of organic matter which, because of its highly charged particles, tends to hold the nutrients and prevent movement into the sub-soil beyond the reach of plant roots. Erosion losses can be curbed by soil conservation farming practices such as contour farming, strip cropping, drainage, and planting cover crops, all of which help to prevent soil displacement. Erosion may extract more than the total nutrients applied, and without adequate control, erosion may greatly reduce the productive capability of soils despite annual additions of otherwise ample amounts of balanced nutrients.[45]

2. Timing of Fertilizer Application

The optimum time of fertilizer application depends upon the nutrient, climate, soil, and crop. Temperature and the amount of water received on the field between the time of application and utilization by plants particularly affect fertilizer loss. Heavy rains immediately after application carry away nutrients by soil erosion and leaching. Temperature affects the breakdown and subsequent loss of N, P and sulfur from the soil.

The objective of fertilizer application timing is to optimize provision of the amounts and balance of nutrients required by plants at different stages to achieve maximum productivity while minimizing nutrient losses and application costs. Plants initially rely heavily on nutrients stored in the

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45. Total annual losses due to erosion in the U.S. have been estimated at 45 MMT of K_2O, 4.5 MMT of P_2O_5, and 3 MMT of N. Losses of K are estimated to be 10 times the amount of potassium applied. The difference comes from potassium stored in the soil, mostly not currently available to plants. Erosion loss of phosphate exceeded total phosphate applied. Erosion per hectare is notably higher in many developing countries than on average in the U.S. Total K_2O applied in developing countries was only 4.7 MMT in 1984/5 and phosphate 11.7 MMT. It is likely erosion losses exceeded application by many times for both P and K.

seed. Additional nutrient requirements are minimal from the time of germination through the period of early plant growth. Thereafter, adequate nutrients are critical to rapid plant growth and maturation. Table 18 shows estimated nutrient uptake at different stages for three crops.

Since other nutrients tend to be less mobile than nitrogen, timing of their application is not as critical. Phosphorus remains relatively immobile and has a high residual effect, allowing one years' application to be utilized in later years. Phosphorus and other nutrients with similar behavior patterns can be considered for pre-season application unless the chemical form and soil characteristics result in tying up of the nutrient. Potassium is usually best applied before or at planting. It is a relatively immobile nutrient and, like phosphorus, a high residual effect can be expected.

Research in India showed gains of 1.4 MT of paddy per hectare by three split nitrogen applications versus a single application. Split applications on maize, sorghum, and millet added 10 to 50% to yields.[46] Research on corn in Nebraska showed almost double the effect of 40 lb./acre of N when it was applied at the critical time versus fall or spring application. Yields obtained from 40 lbs. of N side dressed at the key time were equal to those with 80 lbs. all applied in the fall or spring.[47]

3. Placement of Fertilizer

Precise placement of fertilizers has a substantial effect on efficiency. Fertilizer should be placed so that it can be intercepted by roots of the young plant and also is available in deeper root zones of more mature plants. Since each chemical reacts differently at the interface between root and soil, choice of the fertilizer influences fertilizer management practices for a particular crop. As a general rule, placement in the soil in bands below and to the side of the seed row is the best practice. Development and use of simple equipment for precise placement of seed and fertilizer will usually produce very high rates of return compared with typical practices of broadcasting seed and fertilizer on top of the soil and then incorporating it by tillage. Direct incorporation of nitrogen fertilizer into the soil rather than surface placement is particularly beneficial under flood paddy conditions; nitrogen efficiency can be doubled by use of suitable equipment and methods for placement of nitrogen directly into the soil.

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46. Spratt and Chowdhury, 1978.

47. Olson et al., University of Neb. Bul. S479 (1964).

TABLE 18
ESTIMATED PERCENTAGE OF THE TOTAL NUTRIENT REQUIREMENT TAKEN UP AT DIFFERENT GROWTH STAGES

Corn Growth Periods (days)

	0-25	26-50	51-75	76-100	101-115
N	8	35	31	20	6
P	4	27	36	25	8
K	9	44	31	14	2

Soybean Growth Periods (days)

	0-40	41-80	81-100	101-120	121-140
N	3	46	3	24	24
P	2	41	7	25	24
K	3	53	3	21	20

Sorghum Growth Periods (days)

	0-20	21-40	41-60	61-85	86-95
N	5	33	32	15	15
P	3	23	34	26	14
K	7	40	33	15	5

Source: Basic data on soybeans and sorghum from North Carolina and Kansas, respectively. Corn, soybean, and sorghum data appeared in Better Crops Plant Food, 56(2)(1971), and 57(4)(1973).

4. <u>Soil and Foliar Testing to Help Determine Nutrient Needs</u>

Soil testing is done both as a basis for designing and interpreting research results and as a basis for making decisions on fertilizer application rates on crops and fields. Interpretation and recommendation of fertilizer rates requires research to combine soil test results with fertilizer response. Foliar testing involves collection of samples of the crop tissue at critical growth stages and chemical analysis to identify existing levels of different nutrients. These results are compared with chemical composition of well nourished plants to determine requirements for fertilization.

Costs of soil and foliar analysis typically are several dollars per sample. In many places, services such as analysis and even collection and forwarding of the sample, if available at all, are conducted for the farmer at no charge. In other places, he or she must pay the full cost. The returns to soil testing vary widely depending on the management levels, the reliability of tests, and the quality of norms used for the interpretation and recommendations. Returns accrue in two forms -- savings on fertilizer not required, which otherwise would be applied, and increases in crop yields by optimizing application rates and nutrient combinations. Before the large increase in fertilizer prices, farmers in developing countries frequently were advised to apply phosphate and possibly potassium for insurance even though the needs for these nutrients were not determined. Given the subsequent large price increases, it is clear that farmers and developing countries cannot afford such luxury. Savings realized by not applying P and K not needed may run $25/hectare. With a soil sample covering several hectares, returns are many times costs. Returns in terms of increased yields where certain deficiencies which previously limited production are now supplied can be much higher. An increase in yield of grains of 1-1.5 MT/hectare is not uncommon. Costs of the added nutrients may be a small fraction of the value of increased yield. Returns to micro-nutrient applications (per dollar spent), where deficiencies exist, may be much higher than returns to N, P, and K. The returns to soil testing are evidenced by the high rate of use of this technique in developed countries where farmers already are well informed, experienced and sophisticated in fertilizer use. Over 3 million samples are analyzed each year in the U.S.

5. Use of Improved Crop Varieties

Crop varieties in use before the introduction of fertilizer generally had been developed and adapted over long periods to produce under existing conditions of low nutrient availability, and to yield a crop even under adverse conditions, e.g., drought. Responses to increased nutrients supplied by fertilizer were small and high nutrient application frequently resulted in rapidly diminishing and even negative marginal rates of return to nitrogen. Major efforts have gone into the development of plants more responsive to high nutrient application rates. Several studies on returns to research and development of improved varieties (e.g., hybrid corn) have arrived at estimates of internal (annual) rates of return to total expenditure of 50% and above.

6. Soil Acidity and Liming

Conditioning of soils to reduce acidity can be critically important in obtaining high returns to fertilizer and in achieving increased yields for some crops.[48] Under the highly acid conditions found in some areas, nutrients in the soil are available in much reduced amounts and yield responses to fertilizer are extremely low. Many crops do not tolerate high levels of acidity. Under such circumstances, application of limestone to reduce acidity provides high returns. A 1984 demonstration in Nepal on soil with a pH of 5.05 showed an increase of 3.2 MT/ha. of maize in the first year to application of 4 MT of limestone/ha. Fertilizer was applied at the rate of 100-60-60 (in Kg/ha). Results were:

No fertilizer, no limestone	1.7 MT/ha
Fertilizer, no limestone	4.5 MT/ha
Fertilizer and limestone	7.7 MT/ha

Since liming effects may be expected to last about 3 years, the returns would be over 2 MT of maize per MT of limestone applied. Limestone should cost much less per MT than corn. Given the very high costs of transporting fertilizer to Nepal, this would seem to be a highly desirable component of a fertilizer program where limestone is available.

Acidity is not the only problem. Many parts of Asia, in particular the Indo-Gangetic plains, tend to have soil alkalinity problems. High soil pH reduces the availability of some nutrients and some crops do not tolerate high pH levels.

7. Water Management

Experience has shown that water management is extremely important in obtaining high yields and high rates of return to nutrients applied. Where ample irrigation water is available, farmers frequently apply far more than that which is economically desirable. Studies in Pakistan found that water often was applied to wheat well beyond the point at which marginal returns became negative. Excessive application of water leaches away nutrients, especially nitrogen, in addition to adversely affecting some crops and creating waterlogging and salinity problems. Returns to use of fertilizer may in fact be lower on irrigated fields than on nearby unirrigated fields. Precise application of water in relation to consumptive plant needs will reduce loss of fertilizer into the ground water, increase yields and increase returns to fertilizer application. Improved management of available water, particularly conservation, under rainfed conditions also may increase yields and increase returns to fertilizer. This is particularly important in low rainfall areas and erosion susceptible areas.

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48. (From Agro-Chemical News in Brief, Vol. VIII, January 1985, P. 39.)

8. Machinery and Equipment

As noted earlier, timing of application and physical placement of fertilizer substantially affect losses, crop uptake and overall fertilizer use efficiency. It may be possible in some situations to achieve fairy precise placement by hand or with available hand tools. However, usually it can be done economically only with specialized equipment even in areas with very low wage rates. Returns to use of specialized equipment for this purpose can be very high. Research on nitrogen fertilizer application on flooded paddy indicated that a 100% increase in nitrogen fertilizer uptake could be achieved by the use of simple hand drawn equipment designed by IRRI to open the soil, place fertilizer, and close the soil over the fertilizer. Small, low cost equipment for more optimal placement of dry fertilizer in flooded paddy and dry fields has been developed suited to small fields and other conditions typically encountered in developing countries. The reasons for failure to adopt such technology deserves careful study in each country.

Small-scale equipment also has been developed and is available for precision placement of seeds to achieve more uniform and optimal plant density which will increase returns to investment in fertilizer. Precision placement of seed using specialized mechanical equipment can be particularly important when very small and expensive seed is involved. Recent experience in Egypt showed a 100% increase in yield by use of mechanical seeders. The amount of seed was actually reduced, providing further returns; other practices were held constant.

9. Research and Extension

The primary areas of research and extension of relevance to the fertilizer sector in ANE are fertilizer use research and development of new, improved, more effective fertilizer materials. Fertilizer treatments have been developed which delay the release of nutrients, especially nitrogen, and hence provide sustained availability over longer periods. The shift from low analysis to high analysis fertilizer and, most recently, the reduced costs and large increase in use of solutions, suspensions, etc. in developed countries are the result of research on fertilizer technology. Research on soil test-fertilizer response correlation is almost non-existent in many developing countries and soil test interpretation norms and soil test services are either not available and/or are seriously inadequate. Fertility research that provides the basis for generalized recommendations on fertilizer use rates commonly is neither site- nor crop-specific. Major improvements in fertilizer use efficiency are possible with more adequate research, more situation specific recommendations, and more widespread use of soil and foliar analysis.

Research that attempts to optimally combine and adapt fertilizer and other complementary yield increasing practices is generally under-funded and weak despite potentially high returns. In most developing countries, much higher returns to society could be realized by diversion of some of the large amounts spent for fertilizer and crop subsidies to research on and extension of methods which improve fertilizer use efficiency. Research alone, however, is not sufficient: programs must include specific measures to link the information to inprovements in farmer practices by widespread dissemination of research results.

10. Improving Organic Fertilizer Management

Recently, there has been a resurgence of interest in organic methods of sustaining or improving soil nutrient levels and conditioning the soil. These include:

Green manure crops, particularly nitrogen fixing leguminous plants grown primarily for their soil conditioning and nutrient supplementing capability. Azolla and blue-green algae are a subset of green manure crops. Green manure crops may add well over 100 Kg of nitrogen per hectare. However, these specialized crops may divert land from crop production for a season. Hence, the economics of planting green manure crops should be carefully studied before recommendations are made for a specific area.

Composting, which involves systematic assembly of organic material (e.g., crop residue such as straw, animal manure, factory and human waste) and subjecting it to bacterial processes which preserve and concentrate the nutrients and in the process destroy most of the weed seed and potentially harmful micro-organisms. Typically, compost contains 1-2% N, 0.4-0.5% P and 1-1.2% K plus some micronutrients. Earthworms may be raised in the composting process and improve the value of the final product. In some areas, earthworms are valued for animal and fish feed and even for food use.

Biogas slurry, which involves production of biogas using agricultural and other wastes to produce methane gas as a principal product, while leaving most plant nutrients from the original organic biomass in the slurry for application as fertilizer.

C. Fertilizer Production Processes

1. Phosphates

Phosphate fertilizers initially were produced by simply grinding phosphate rock (usually 15 - 33% P_2O_5) and applying it to the soil. The most common modern phosphate products now are produced by reducing rock phosphate with sulfuric acid. Most high analysis products involve production of phosphoric acid as a first step. The principal feed stocks for phosphoric acid are rock phosphate and some form of sulfur used to produce sulfuric acid. Nitro phosphate may be produced by use of nitric acid to process the rock phosphate, thus avoiding the need for sulfur. Use of nitro phosphate products has grown particularly rapidly in the U.S. and Asia. Diamnonium phosphate (18-46-0) is the most popular form of phosphate in the ANE countries, especially South and East Asia.

FINAL PRODUCTS

Simple super phosphate (16 to 21 % P_2O_5); produced through one of the simplest processes. It involves mixing of sulfuric acid and ground rock phosphate which hardens when the action is completed. The product is broken up and packaged for use. Demand for SSP which once was very popular, has declined with increased demand for more highly concentrated, lower cost (per unit of nutrient) products such as TSP, DAP and MAP.

INTERMEDIATE PRODUCTS

Phosphoric acid (52-54% P_2O_5); production requires a higher ratio of sulfuric acid to phosphate rock; calcium sulfate is removed by filtration. Phosphoric acid is used in making TSP, ammonium phosphate and liquid mixed fertilizers.

Super phosphoric acid (68-72% P_2O_5); made by further concentration of phosphoric acid. It is the principal ingredient of current high analysis liquid fertilizers.

Triple super phosphate (44-46% P_2O_5); Phosphate rock is treated with phosphoric acid to produce this fertilizer.

Ammonium phosphate products (DAP 18-46-0, MAP 11-48-0, and others); Phosphoric acid is treated with ammonia.

Nitro phosphate (e.g., 23-23-0); rock phosphate is treated with nitric acid rather than sulfuric acid.

2. Nitrogen Products

Ammonia (82% N)

The atmosphere, which is 80% nitrogen provides an inexhaustible supply of nitrogen. The problem is that plants cannot avail themselves of the nitrogen except in small quantities. A small amount (5 to 15 kg/ha per year) is made available by atmospheric precipitation but this meets only a fraction of plant needs for high yields. The problem, then, is to take the nitrogen from the air and make it available to plants in forms they can use. The first step usually is the production of ammonia (NH_3) using atmospheric nitrogen. Ammonia is usually manufactured from natural gas, but also from naphtha, coal and fuel oil. The four major steps in ammonia manufacture are synthesis gas preparation, carbon monoxide conversion, gas purification and ammonia synthesis.

First, natural gas is treated with steam at high temperatures with a nickel catalyst to produce hydrogen and carbon monoxide. The processed gas is then passed through two stages of catalytic shift conversion at medium high temperatures (400-800 degrees F). The carbon monoxide reacts with steam to produce more hydrogen and carbon dioxide. The carbon dioxide is removed and the residual purified as CO and CO_2. Air is added to the hydrogen passed over a catalyst at high temperature and pressure. This produces NH_3 ($N_2 + 3H_2$ yields $2NH_3$).

The type of feed stock is most critical for the first (or synthetic gas preparation stage). The two principal synthetic gas preparatory processes are steam reforming and partial oxidation. The principal feed stock for steam reforming is natural gas which must first be desulfurized. Naphtha, which is an alternative feed stock, is higher in sulfur and first requires preliminary acid treatment to reduce high sulfur levels.

The production of ammonia using the electrolytic process differs from the above by producing hydrogen by electrolysis of water. It requires abundant supplies of electricity. It has been most widely used in Norway.[49] One plant in Egypt initially was based on surplus power from the Aswan High Dam. However, with other claimants for that power, the plant recently was considered to be not economically viable.

<u>Urea (46% N)</u>

Carbon dioxide, a by-product of ammonium production, is reacted with ammonia to produce urea.

$$2NH_3 + CO_2 \text{ yields } CO(NH_2)_2 + H_2O.$$

<u>Ammonium nitrate (33% N)</u>

NH_3 is oxidized at high temperatures while passing over a catalyst and absorbed in water to produce nitric acid which is reacted with ammonia to produce an ammonium nitrate solution which is evaporated and granulated.

$$NH_3 + HNO_3 \text{ yields } NH_4NO_3.$$

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49. Norway also has used the nitric acid process for production of nitro phosphates, thus precluding need for sulfuric acid to process the rock phosphate.

Ammonium sulfate (20-21% N)

In the early coke oven process, sulfuric acid was used to remove nitrogen evolved from coal to produce ammonium sulfate, i.e., $2NH_3 + H_2SO_4$ yields $(NH_4)_2SO_4$.[50] Some AS also is obtained as a by-product of the caprolactam industry and some is made directly from ammonia and sulfuric acid. At one time AS was the most important source of solid nitrogen, but recently it has become less popular because of its low nutrient content (21-0-0).

Nutrient content of principal primary fertilizer products is shown in Table 19 (from the Fertilizer Handbook 1982 of TFI).

3. Potassium

The two major sources of potassium are: a) potassium sulfate, which contains about 50% K_2O_2 (potassium oxide) plus about 17 % sulfur; and b) potassium chloride, which contains about 60% K_2O. (The latter is not suitable for some chloride sensitive plants.) Potassium nitrate and potassium magnesium sulfate also are produced (the former has some N and the latter has Mg and S). The principal feed stocks for potassium fertilizer manufacture are soluble salts such as potassium chloride and insoluble minerals containing potassium. Extraction of potassium bearing materials from the ground is accomplished by mining, especially for the less deeply deposited materials such as syvinate and carnalite (the former is a mixture of potassium chloride and sodium chloride and the latter is a mixture of potassium chloride and magnesium chloride). Solution mining is employed for extraction of potash from deep mines. Water is pumped into the mine and dissolved minerals are pumped out. The main processing required is reduction or elimination of impurities such as sodium chloride, which is accomplished by solution, crystallization or flotation processes to produce near pure potassium chloride.

Potassium sulfate is preferred for some crops such as tobacco (which are sensitive to chloride) and in some soils for potatoes and citrus. Production of potassium sulfate involves processing of potassium chloride with a form of sulfur (e.g. sulfuric acid, sulfur dioxide or langbinite which is a double salt of potassium magnesium sulfate) and separation.

4. Recent Developments in Energy Use in Fertilizer Production

Fertilizer production is energy intensive, with essentially all of the energy obtained from fossil fuel sources. Fertilizer

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50. TFI Fertilizer Handbook, 1982, pp.45-68 and 159-176.

accounts for about 50% of the energy used in agriculture world wide and about 68% in developing countries. It accounts for almost 100% of the fossil fuel use in agriculture in many societies. The heaviest fertilizer-related use of energy is the production of nitrogen based on anhydrous ammonia.

Substantial progress has been made over the years in improving the efficiency of ammonia plants. Around 1960, centrifugal compressors were introduced in larger plants, replacing the less efficient reciprocating compressors. The scale at which this shift was feasible, about 550 MT/day, brought a significant drop in costs per MT. However, the energy price shocks of 1973 and 1979 greatly increased the energy cost of fertilizer plants, especially nitrogen plants. Responses of the fertilizer industry included:

1. Major efforts to reduce the amount of energy used to produce ammonia.

2. Increased interest in use of coal as feed stock. Supplies are large, especially in the U.S. and India, and prices per BTU are lower.

3. Construction of plants in petroleum producing areas such as the Gulf, Indonesia, Nigeria and Mexico to utilize gas otherwise flared off from oil wells.

4. Special efforts to improve technology and operating efficiency and lower capital costs in developing countries.

5. Increased emphasis on higher analysis fertilizers (e.g. NH_3 used directly, urea, DAP and MAP), which reduce transport and handling costs.

6. Increased emphasis on production of high analysis intermediate products transported to final product factories (e.g. super phosphoric acids and NH_3).

7. Efforts to improve efficiency of fertilizer use.

In general, ammonia plants developed before 1973 used an average of nearly 40 million BTUs per MT of ammonia produced, using natural gas. Those built between 1973 and 1980 averaged about 12 to 15% less energy per MT. The latest technology will produce ammonia with energy requirements of near 30 million BTUs/MT (35% above the theoretical minimum).

Developing countries generally suffer several competitive disadvantages in energy use. Most fertilizer plants are operated at a much lower level of efficiency than in developed countries. Operation of plants at 60% of capacity can increase energy costs

TABLE 19

Composition of principal fertilizer materials [1]

Material	Nitrogen %	Available Phosphate % P_2O_5	Potash % K_2O	Calcium %	Magnesium %	Sulfur %	Chlorine %	Copper %	Manganese %	Zinc %	Boron %	Approximate Calcium Carbonate equiv.,[2] Lbs. per ton
NITROGEN												
Ammonia, Anhydrous	82	—	—	—	—	—	—	—	—	—	—	—2,960
Ammonia, Aqua	16-25	—	—	—	—	—	—	—	—	—	—	—720 to —1,080
Ammonium nitrate	33.5	—	—	—	—	—	—	—	—	.01	—	—1,180
Ammonium nit.-lime-stone mixtures	20.5	—	—	7.3	4.4	.4	.4	—	—	—	—	0
Ammonium sulfate	21	—	—	.3	—	23.7	.5	.3	—	.1	—	—2,200
Ammonium sulfate-nitrate	26	—	—	—	—	15.1	—	—	—	—	—	—1,700
Calcium cyanamide	21	—	—	38.5	.06	.3	.2	.02	.04	—	—	+1,260
Calcium nitrate	15	—	—	19.4	1.5	.02	.2	—	—	—	—	+ 400
Nitrogen solutions	21-49	—	—	—	—	—	—	—	—	—	—	—750 to —1,760
Sodium nitrate	16	—	.2	.1	.05	.07	.4	.07	—	—	.01	+ 580
Urea	46	—	—	—	—	—	—	—	—	—	—	—1,680
Urea-form	38	—	—	—	—	—	—	—	—	—	—	—1,360
PHOSPHATE												
Basic slag, Open hearth	—	8-12[3]	—	29.0	3.4	.3	—	—	2.2	—	—	+1,000
Bone meal	2-4.5	22-28[4]	.2	20-25	.4	.1	.2	—	—	.02	—	+400 to 500
Phosphoric acid	—	52-60	—	—	—	—	—	—	—	—	—	—1000 to —1400
Rock phosphate	—	[5]	—	33.2	.2	.3	.1	—	.03	—	—	+ 200
Superphosphate, Normal	—	18-20	.2	20.4	.2	11.9	.3	—	—	.01	—	0
Superphosphate, Concentrated	—	42-50	.4	13.6	.3	1.4	—	.01	.01	—	01	0
Superphosphoric acid	—	69-76	—	—	—	—	—	—	—	—	—	—
POTASH												
Potassium chloride (muriate)	—	—	60-62	.1	.1	—	47.0	—	—	—	.03	0
Potassium magnesium sulfate	—	—	22	—	11.2	22.7	1.5	—	—	—	—	0
Potassium sulfate	—	—	50	.7	1.2	17.6	2.1	.001	—	—	.002	0
MULTIPLE NUTRIENT												
Ammoniated super-phosphate	3-6	18-20	—	17.2	—	12	—	—	—	—	—	— 140
Ammonium phosphate-nitrate	27	15	—	—	—	—	—	—	—	—	—	—1240
Ammonium phosphate-sulfate	13-16	20-39	.2	.3	.1	15.4	.1	.02	.2	.02	.03	—1520 to —2260
Diammonium phosphate	16-21	48-53	—	—	—	—	—	—	—	—	—	—1250 to —1,550
Monoammonium phosphate	11	48	.2	1.1	.3	2.2	.1	.02	.03	.03	.02	—1,300
Nitric phosphates	14-22	10-22	—	8-10	.1	.2-3.6	1.-12.0	.02	.2	.02	.03	—300 to —500
Nitrate of soda-potash	15	—	14	—	—	—	.5	—	—	—	.13	+ 550
Potassium nitrate	13	—	44	.6	.4	.2	1.1	—	—	—	.10	+ 520
Wood ashes	—	1.8	5.5	23.3	2.2	.4	.2	.12	.76	.20	.16	+
Blast furnace slag	—	1.7	.6	29.3	3.8	1.4	—	—	1.02	.001	.01	+
Dolomite	—	—	—	21.5	11.4	.3	—	.001	.11	—	.01	+1,960
Gypsum	—	—	.5	22.5	.4	16.8	.3	—	—	—	—	0
Kieserite (emjeo)	—	—	—	1.6	18.2	—	—	—	—	—	—	0
Limestone	—	—	.3	31.7	3.4	.1	—	.004	.48	.05	.003	+1,800
Lime-sulfur solution	—	—	—	6.7	—	23.8	—	—	—	—	—	—
Magnesium sulfate (Epsom salt)	—	—	—	2.2	10.5	14.0	.4	—	—	—	—	0
Sulfur	—	—	—	—	—	30-39.6	—	—	—	—	—	—1900 to —6,320

[1] Most of the percentages larger than one of N, P_2O_5 and K_2O are the usual guarantees. Where more than one grade is sold, the range is indicated by two members separated by a dash. The rest of the percentages are averages compiled by A. L. Mehring from many published analyses. [2] Ind. Eng. Chem. Anal. Ed. 5, 229-34 and other sources. A minus sign indicates the number of pounds of calcium carbonate needed to neutralize acid formed when 1 ton of the material is added to the soil. A plus sign indicates basic materials, and a zero physiologically neutral materials. [3] By the 2% citric acid method. [4] Total P_2O_5. All of the P_2O_5 in natural organics is considered available. [5] 30-36% total P_2O_5, which is relatively unavoidable in some soils.

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per ton by 25%.[51] Further, many developing countries use fuel sources that are inherently less efficient in terms of BTUs per ton of ammonia, e.g., naphtha, coal, oil, or electricity (the arc process uses about 60,000 KWH/ton of nitrogen which is almost 10 times the energy used by efficient gas-fueled plants).

The inefficiencies do not stop there. Field application and plant uptake of fertilizer generally are much less efficient than in developed countries. Efficiency of nitrogen use in several developing country situations has been estimated to be 30% or less compared with an average of over 50% in the U.S. and 70% or more on some crops such as maize grown under good U.S. cropping systems. This is not to suggest that use of fertilizer in developing countries is inherently undesirable. One MT of NH_3, even if it requires 40 million BTUs to produce and is used at low levels of efficiency in developing countries, still can be expected to increase paddy or wheat grain plus straw output by at least 15 MT, which would have an energy value of about 5 times the energy used in fertilizer production. Of course, if that grain is fed to beef cattle or sheep, much of the energy is lost before it is used by humans.

In developed countries, major efforts were made by farmers and government agencies to increase fertilizer use efficiency when price increased greatly in the 1970s. In developing countries, less effort was made to improve fertilizer efficiency in part because farmers were insulated from large price increases by government and in part because service agencies failed to provide needed technical know-how and services such as soil testing. Most fertilizer prices have declined by 50% or more since 1984 and some countries have reduced subsidies. There is a concern that the decline in world fertilizer prices will be used (perhaps unconsciously) in developing countries as a justification for a reduction in (or continued failure to undertake) the efforts needed to increase efficiency of fertilizer use.

With the large increase in energy costs, major attention of international donors naturally was directed to ensuring that new fertilizer plants were efficiently designed, that all plants were operated efficiently and that fertilizer was moved to farmers with minimal waste. Mission officials, in complying with AID guidance in energy use, should be particularly careful to appraise efficiency of on-farm use and, where needed, include measures to increase the efficiency of on-farm use. This offers one of the major opportunities for improvement of energy use efficiency in agriculture.

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51. Hignett, T.P. and D.H. Parish, Appropriate Fertilizer Technology for Developing Countries, IFDC, 1983.

5. Appropriate Fertilizer Technology

a. Manufacturing Technology

Practically from the outset, fertilizer manufacturing has demonstrated major economies of scale. While the largest scale economies came with development of centrifugal processes for ammonia production, plants continued to grow in size, as large units require less total fuel and substitute capital for labor. However, in recent years the increase in energy costs for transport has offset some of these gains. For some countries, transport costs are a very major element, and smaller capacity, local plants might prove more economic. This might particularly be the case for countries with small local fertilizer markets which are a considerable distance from ocean transport (e.g., Afghanistan, Nepal, and several countries in mid Africa-- Zambia, Zimbabwe, Malawi, Uganda -- and Paraguay and Bolivia in South America).

Up to the 1970s, China pursued a course of developing many small scale, widely distributed plants, in part to overcome transport limitations and costs. However, in recent years, partly in response to increased energy prices, new plants being constructed are much larger. Part of this shift in strategy reflects the rapid growth and current large size of the market (equivalent in 1986 to about 50 large scale ammonia plants).

Many considerations may enter into plant scale decisions. Where small amounts of fuel and raw materials are available from other manufacturing processes, a small scale plant may prove economic. Some countries have attempted to utilize the most modern energy efficient process even though local capability for management of the plant may be quite limited. The level of operation of plants in most developing countries has typically been far below capacity and start-up greatly delayed in part due to attempts to apply very high technology. Frequently, simpler, less energy efficient technology, operated near capacity would yield lower cost per unit of output. It was noted earlier that reduction in level of operation from near 100% to 60% will increase energy costs per MT by 25%. In such cases a smaller and simpler plant likely would be more economic. It is not only the fertilizer processes but also the instrumentation which may prove unrealistically complex.52 Size usually must be decided and defined carefully at the time requests for bids are being issued. Alternatives should be examined before this stage.

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52. See Hignett, T.P. and D.H. Porich, "Appropriate Fertilizer Technology for Developing Countries", IFDC.

Pollution is another area where plant scale must be considered. A smaller plant in a developing country may have a higher acceptable tolerance for emissions per unit than a large plant, especially where the latter would be located in an already heavily industrialized area. Small amounts of N,P,K emissions in rural areas may actually be beneficial to land and water life or have little effect, whereas a large plant could have serious consequences. A common sense approach to the local situation should be adopted, rather than dogmatic adherence to high technology standards of the U.S. or other developed countries.

Where a small supply of low cost fuel is available and transport costs are otherwise high, small ammonia plants (100-300 MT/day) may be justified. Where electricity is abundant and cheap, the electrolytic or arc process may be used to produce nitrate types of fertilizer. In China large numbers of small plants (5-20,000 MT/annum of ammonia) were constructed, many using coal as a feed stock.53

Phosphates offer the potential for direct application of finely ground rock where deposits are available; plant scale can be very small. Very small batch type plants for production of simple super phosphate also may prove economic. Such simple processes for phosphate, used along with nitrogen fixing legumes, offer promise in remote areas where low phosphate content ore may be available. Sulfuric acid, a major input for SSP, may be available as a local industrial by-product. The sulfur may be important as a nutrient for many soils. Ground rock phosphate has many advantages in terms of cost, simplicity, low investment, and it may add essential calcium and other nutrients along with the P. Other possibilities are fused magnesium phosphate and partially acidulated rock phosphates.

The possibilities for simple potash technology may be particularly important for the Asia/Near East region, which is seriously deficient in this element. Potassium may be found in small amounts in many locations; e.g., brine deposits or salt lakes, and the brine remaining after salt (NaCl) recovery from sea water. Potassium also may be recovered as a by-product in extraction of other minerals. It is found in large quantities in most crop residues and in wood ashes.

Possibilities for small scale plants should be examined for

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53. In 1983, China had 2,200 fertilizer plants; 1,300 nitrogen plants were in the 5,000 to 20,000 MT/year mainly using coal as a fuel. There were 1,400 nitrogen plants and 700 phosphate plants. Ninety percent of the phosphate was produced in small plants.NFC/FADINAP, February 1984, Fertilizer Marketing Meeting in Asia. (Material prepared by FADINAP Fertilizer Advisor).

other fertilizer operations such as mixing and blending. Another form of appropriate technology is to leave such mixing to final users by selling primary materials only. This should be coupled with sound education programs.

b. Distribution

Appropriate technology also should be reviewed in conjunction with imports and distribution arrangements. Imports in bulk may be more economic than bags for large scale imports, but have not proven economic where small shipments are involved. In large shipments from the U.S. to South Asia, it is estimated that shipping cost savings of $30 or more per ton may be achieved by shipping in bulk rather than in bags.

Storage facilities may be designed to incorporate low cost locally available materials rather than more expensive purchased materials such as sheet metal or concrete, thereby saving cash outlays and increasing employment. The principal requirement for fertilizer storage is protection from moisture and direct sunlight. This is especially important for hygroscopic fertilizers, stored in bulk. Packaging in moisture proof plastic bags eliminates much of the problem with moisture in the air.

c. On-Farm Technology

Biological processes may be a viable alternative for landlocked countries -- nitrogen fixing forage and cereal legumes, azolla in rice fields and leguminous trees have been widely researched and are commonly used in most developed countries and many developing countries. The international centers in the region have been particularly active in research and development of biological methods of fertility enhancement (e.g., IRRI, ICRISAT). Economic analysis of the size specific potential of these approaches is generally needed. To the maximum extent feasible, nutrients in crop and factory residue also should be utilized. This may require data collection and analysis of the availability and economics of such residue use.

Probably the most economic and appropriate technology is that which incorporates the following: emphasis on economic efficiency in fertilizer use; the right nutrient combinations, including minor nutrients; the best timing and placement; liming where needed; optimizing other crop practices (seed bed preparation, plant population, good water management, pest control) and biological fertility enhancement.[54]

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54. In some areas large expenditures (including subsidies) are mostly wasted because of poor fertilizer application, poor water management, failure to correct excessive soil acidity, poor crop stand, and failure to

CHAPTER I ANNEX

follow simple pest management practices.

TABLE 20

Approximate pounds per acre of nutrients contained in portion of crop of the size shown

These figures may vary with soil type, season, and fertility of soil

Crop	Acre yield	Nitrogen	Phosphorus as P_2O_5	Potassium as K_2O	Calcium	Magnesium	Sulfur	Copper	Manganese	Zinc
GRAINS										
Barley (Grain)	40 bu.	35	15	10	1	2	3	0.03	0.03	0.06
Barley (Straw)	1 ton	15	5	30	8	2	4	0.01	0.32	0.05
Corn (Grain)	150 bu.	135	53	40	2	8	10	0.06	0.09	0.15
Corn (Stover)	4.5 tons	100	37	145	26	20	14	0.05	1.50	0.30
Oats (Grain)	80 bu.	50	20	15	2	3	5	0.03	0.12	0.05
Oats (Straw)	2 tons	25	15	80	8	8	9	0.03	....	0.29
Rice (Rough)	80 bu.	50	20	10	3	4	3	0.01	0.08	0.07
Rice (Straw)	2.5 tons	30	10	70	9	5	....	....	1.58	....
Rye (Grain)	30 bu.	35	10	10	2	3	7	0.02	0.22	0.03
Rye (Straw)	1.5 tons	15	8	25	8	2	3	0.01	0.14	0.07
Sorghum (Grain)	60 bu.	50	25	15	4	5	5	0.01	0.04	0.04
Sorghum (Stover)	3 tons	65	20	95	29	18	....	....	....	....
Wheat (Grain)	40 bu.	50	25	15	1	6	3	0.03	0.09	0.14
Wheat (Straw)	1.5 tons	20	5	35	6	3	5	0.01	0.16	0.05
HAY										
Alfalfa*	4 tons	180	40	180	112	21	19	0.06	0.44	0.42
Bluegrass	2 tons	60	20	60	16	7	5	0.02	0.30	0.08
Coastal Bermuda	8 tons	300	70	270	59	24	35	0.21	....	....
Cowpea*	2 tons	120	25	80	55	15	13	....	0.65	....
Peanut*	2.25 tons	105	25	95	45	17	16	....	0.23	....
Red Clover*	2.5 tons	100	25	100	69	17	7	0.04	0.54	0.36
Soybean*	2 tons	90	20	50	40	18	10	0.04	0.46	0.15
Timothy	2.5 tons	60	25	95	18	6	5	0.03	0.31	0.20
FRUITS AND VEGETABLES										
Apples	500 bu.	30	10	45	8	5	10	0.03	0.03	0.03
Bean, Dry	30 bu.	75	25	25	2	2	5	0.02	0.03	0.06
Cabbage	20 tons	130	35	130	20	8	44	0.04	0.10	0.08
Onions	7.5 tons	45	20	40	11	2	18	0.03	0.08	0.31
Oranges (70 Pound Boxes)	800 boxes	85	30	140	33	12	9	0.20	0.06	0.24
Peaches	600 bu.	35	20	65	4	8	2	....	....	0.01
Potatoes (Tubers)	400 bu.	80	30	150	3	6	6	0.04	0.09	0.05
Spinach	5 tons	50	15	30	12	5	4	0.02	0.10	0.10
Sweet Potatoes (Roots)	300 bu.	45	15	75	4	9	6	0.03	0.06	0.03
Tomatoes (Fruit)	20 tons	120	40	160	7	11	14	0.07	0.13	0.16
Turnips (Roots)	10 tons	45	20	90	12	6	....	....	....	....
OTHER CROPS										
Cotton (Seed and Lint)	1500 lbs.	40	20	15	2	4	3	0.06	0.11	0.32
Cotton (Stalks, Leaves & Burs)	2000 lbs.	35	10	35	28	8	15	....	....	....
Peanuts (Nuts)*	1.25 tons	90	10	15	1	3	6	0.02	0.01	....
Soybeans (Grain)*	40 bu.	150	35	55	7	7	4	0.04	0.05	0.04
Sugar Beets (Roots)	15 tons	60	20	50	33	24	10	0.03	0.75	....
Sugarcane	30 tons	96	54	270	28	24	24	....	....	....
Tobacco (Leaves)	2000 lbs.	75	15	120	75	18	14	0.03	0.55	0.07
Tobacco (Stalks)	—	35	15	50	....	....	....	....	....	....

* Legumes normally get the greater part of their nitrogen from air.

Calculated from plant composition data of Beeson in USDA Misc. Pub. 369, Morrison in the 21st ed. of "Feeds and Feedings," Lowe in a Special USDA report and the American Potash Institute. The data on micronutrients in tobacco are USDA Tech. Bul. 1009. Data for Boron are: alfalfa hay, 0.06; cowpea hay, 0.21; red clover hay, 0.05; soybean hay, 0.01; apples, 0.01; cabbage, 0.09; oranges, 0.14; peaches, 0.05; potatoes, 0.05; tomatoes, 0.14; and tobacco, 0.05 lbs. per acre. 1000 lbs. each of milk and beef (live weight) contain N, 6 and 27; P_2O_5, 2 and 17; K_2O, 2 and 2; and Ca, 1 and 13 lbs., respectively.

From: Our Land and Its Care, The Fertilizer Institute.

TFI Handbook, p. 18-19

TABLE 21

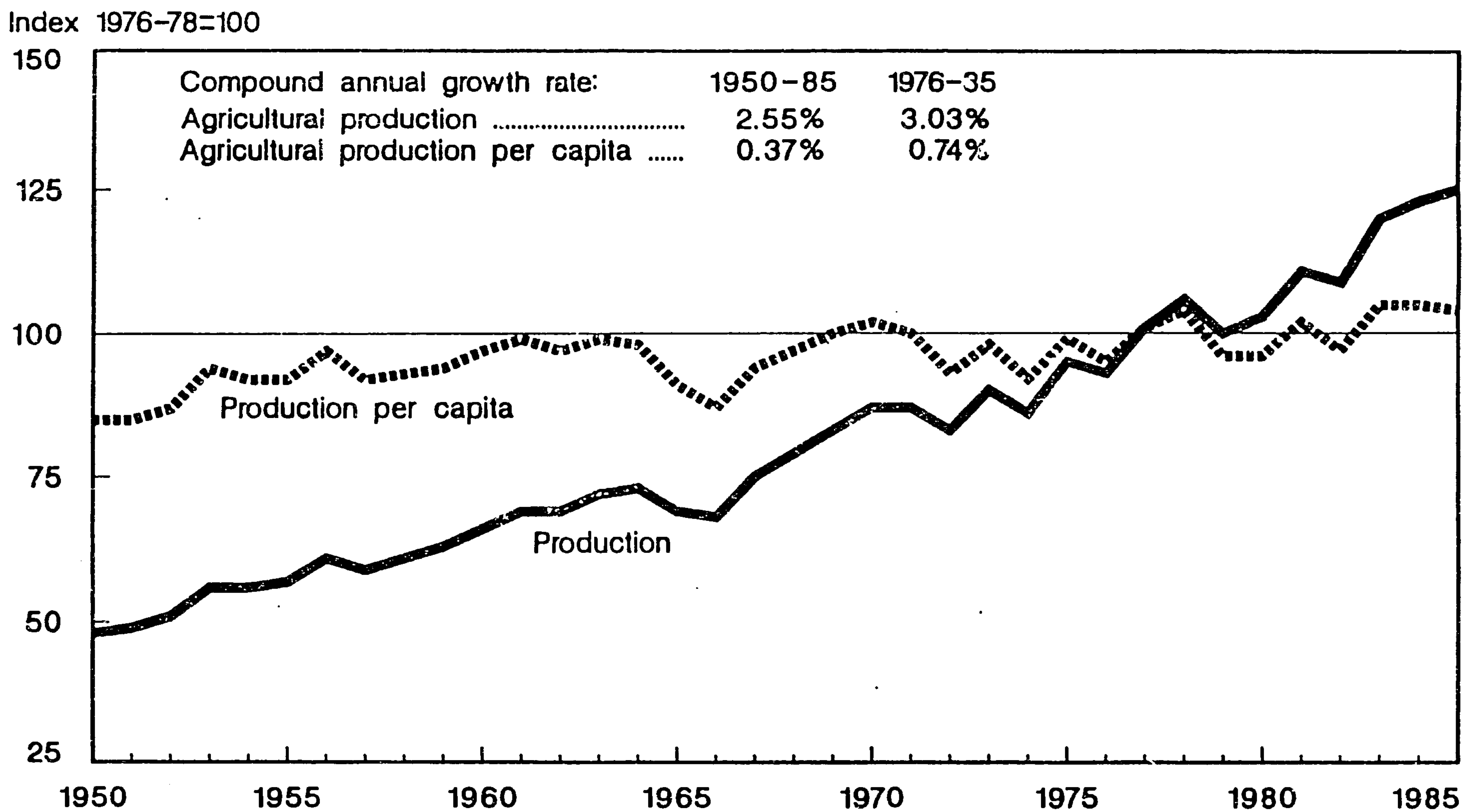
Asia: Total Fertilizer Use Per Hectare of Arable Land and Land in Permanent Crops, 1970-83

Country	1970	1975	1979	1980	1981	1982	1983
				(kg/ha)			
Afghanistan	2.4	4.3	6.2	6.4	5.7	5.6	6.3
Bahrain	NA	NA	13.0	NA	150.0	57.0	213.5
Bangladesh	15.7	22.6	44.6	45.6	43.8	51.2	59.6
Bhutan	NA	NA	1.1	1.1	1.1	1.0	1.0
Burma	2.1	4.1	9.3	10.0	12.5	16.7	15.8
China	33.5	48.1	130.3	152.7	150.2	157.5	180.6
Cyprus	63.5	66.7	39.6	34.4	36.7	44.7	46.3
India	13.2	16.5	29.6	30.9	34.0	34.6	39.4
Indonesia	13.1	26.0	44.1	60.2	74.4	75.0	74.5
Iran	5.9	20.7	27.5	41.7	49.5	65.6	75.8
Iraq	3.4	6.3	18.7	16.9	14.1	14.5	16.5
Israel	140.1	170.7	188.5	191.9	180.4	178.3	183.1
Japan	372.6	319.3	477.7	372.1	387.2	412.1	437.0
Jordan	2.1	4.3	10.6	36.2	17.8	34.6	39.4
Kampuchea DM	1.1	0.6	NA	2.7	6.2	3.6	1.6
Korea N.	154.7	201.8	336.0	325.5	348.6	338.3	345.2
Korea S.	241.6	357.9	385.7	365.7	351.3	281.7	331.1
Kuwait	-	-	660.0	440.0	250.0	732.0	420.0
Lao	0.2	0.4	0.1	4.5	4.5	.6	.6
Lebanon	135.4	37.4	129.3	76.4	118.1	148.7	119.1
Malaysia	NA	NA	101.1	105.1	92.3	102.1	111.5
Mongolia	2.6	5.3	7.2	6.9	10.8	10.9	11.6
Nepal	2.7	6.1	9.0	9.3	9.4	13.8	13.7
Oman	NA	11.8	30.6	25.9	39.5	27.2	88.4
Pakistan	14.6	28.0	46.6	53.3	53.1	61.6	58.6
Philippines	28.8	28.1	34.6	28.6	28.8	28.8	32.0
Qatar	NA	NA	200.0	400.0	280.0	273.0	246.7
Saudi Arabia	7.3	11.6	19.5	36.8	60.0	83.2	177.7
Singapore	250.0	375.0	537.5	550.0	671.4	783.3	783.3
Sri Lanka	47.3	32.5	68.2	77.0	68.4	71.3	74.0
Syria	6.7	11.9	22.0	22.2	23.4	27.0	32.0
Thailand	5.9	10.9	18.0	16.2	17.3	18.3	24.0
Turkey	15.7	29.8	51.0	51.0	45.5	53.5	58.1
UA Emirates	NA	69.2	218.8	234.9	281.2	332.4	299.1
Vietnam	61.7	61.0	31.1	36.8	34.0	50.6	47.1
Yemen Arab	0.1	3.8	4.8	3.5	4.3	5.1	5.7
Yemen Dem	NA	6.6	6.5	9.8	8.8	10.9	0.3
Asia	25.1	33.0	61.9	67.4	68.7	72.5	81.2

Source: Latest FAO yearbooks.

FIGURE 7

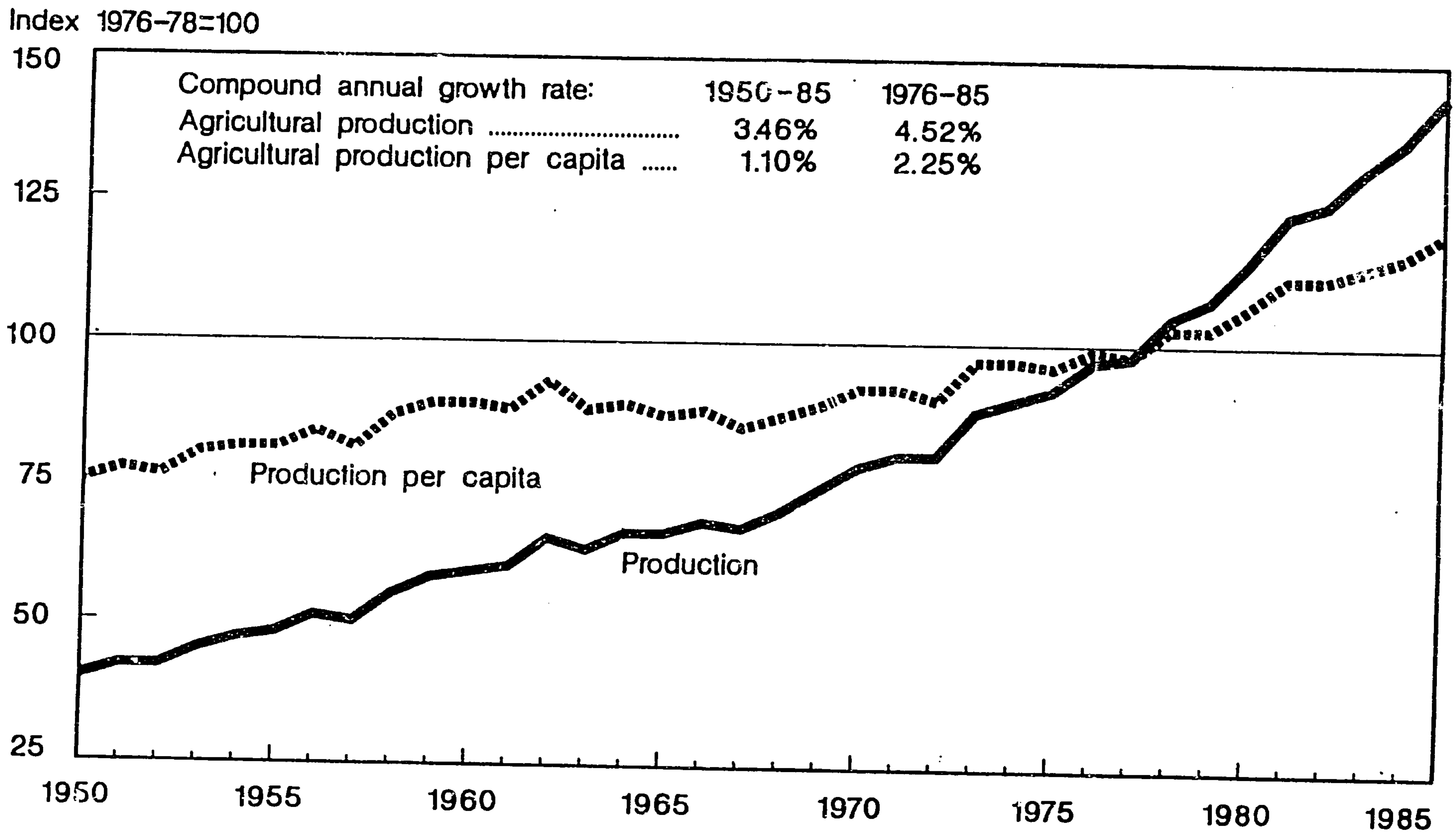
South Asia: Index of Production



USDA

FIGURE 8

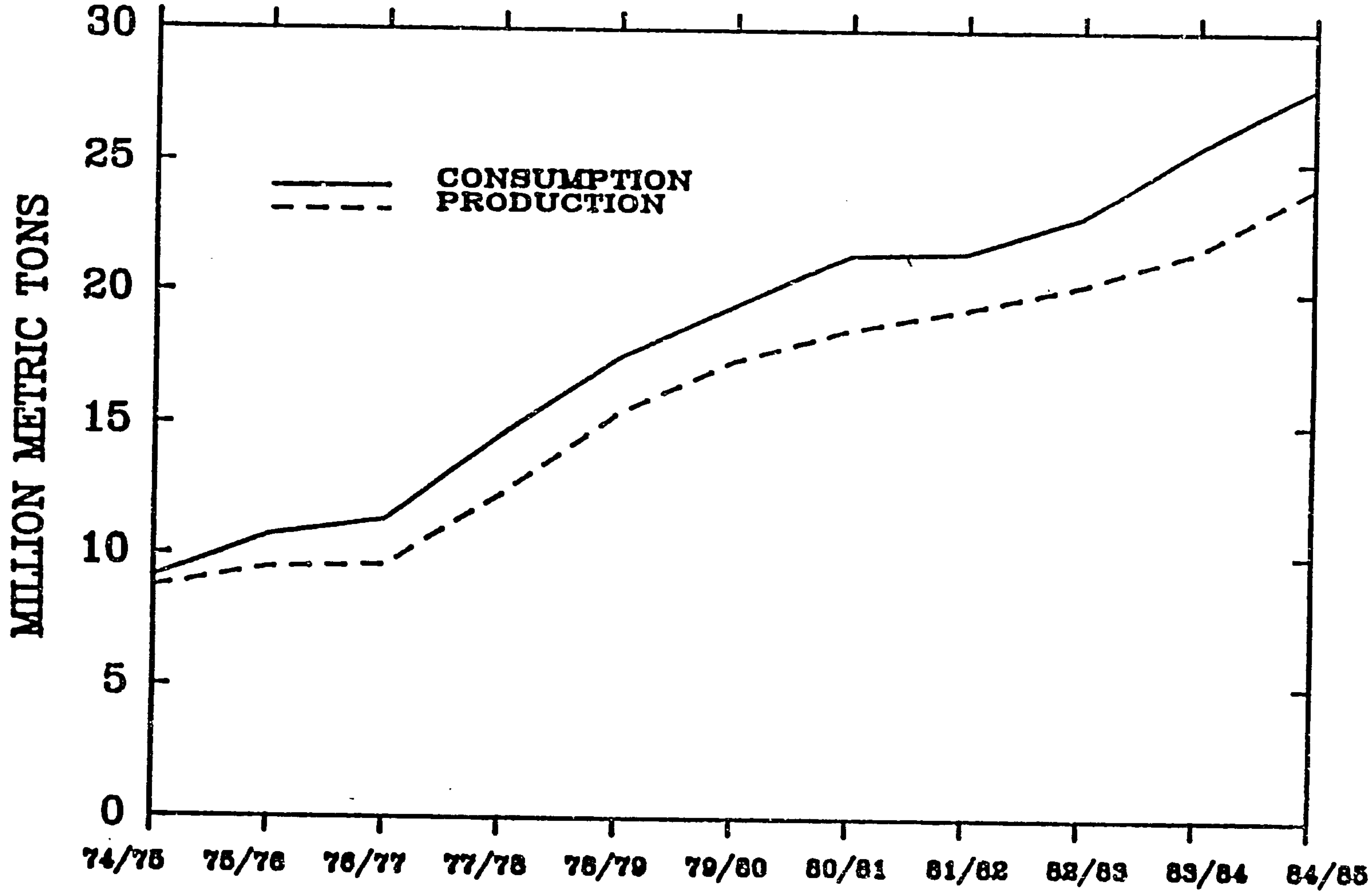
Southeast Asia: Index of Production



USDA

FIGURE 9

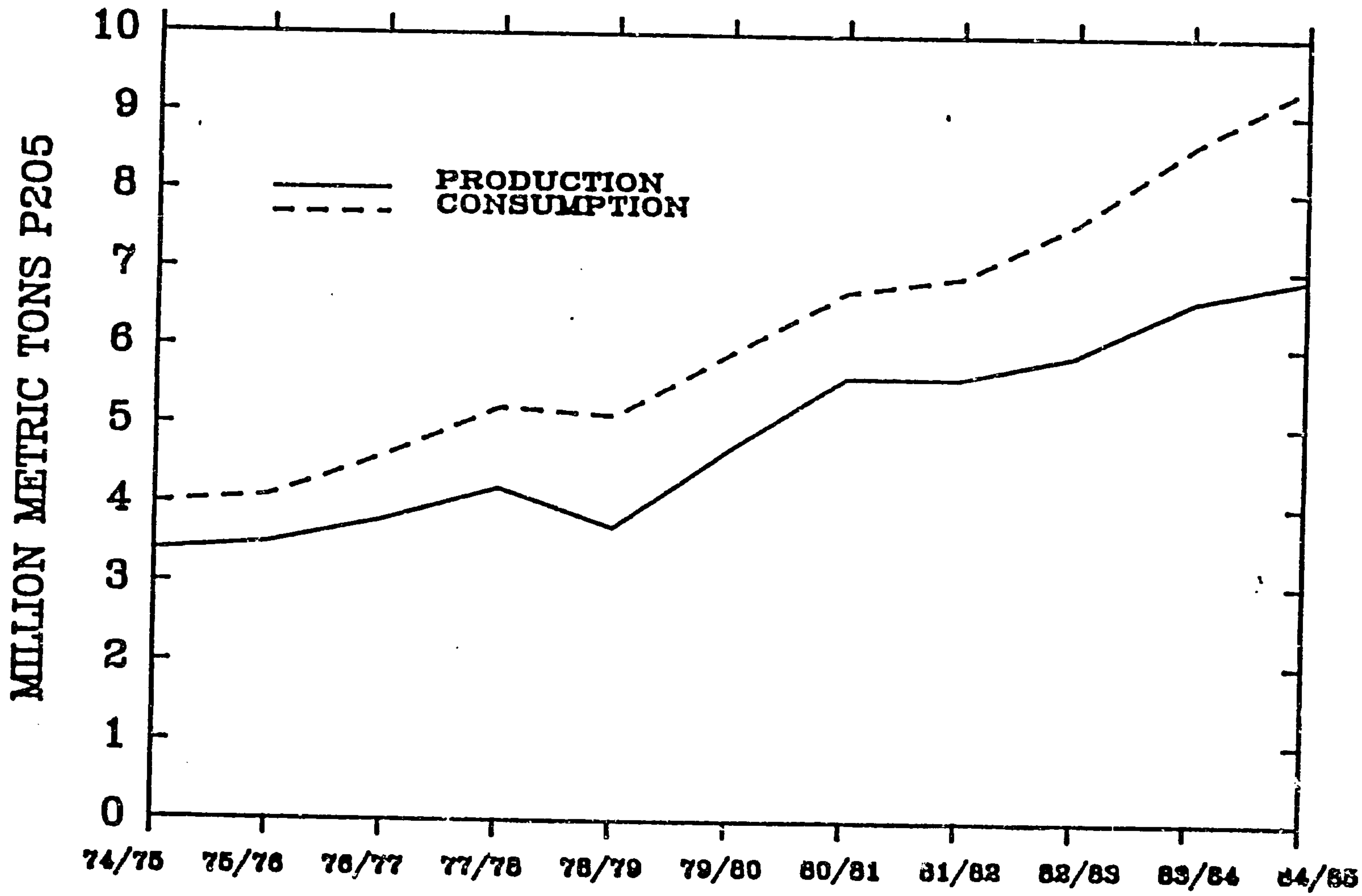
ASIA: NITROGEN PRODUCTION AND CONSUMPTION 1974/75 – 1984/85



SOURCE: FAO

FIGURE 10

ASIA: PHOSPHATE PRODUCTION AND CONSUMPTION 1974/75 – 1984/85

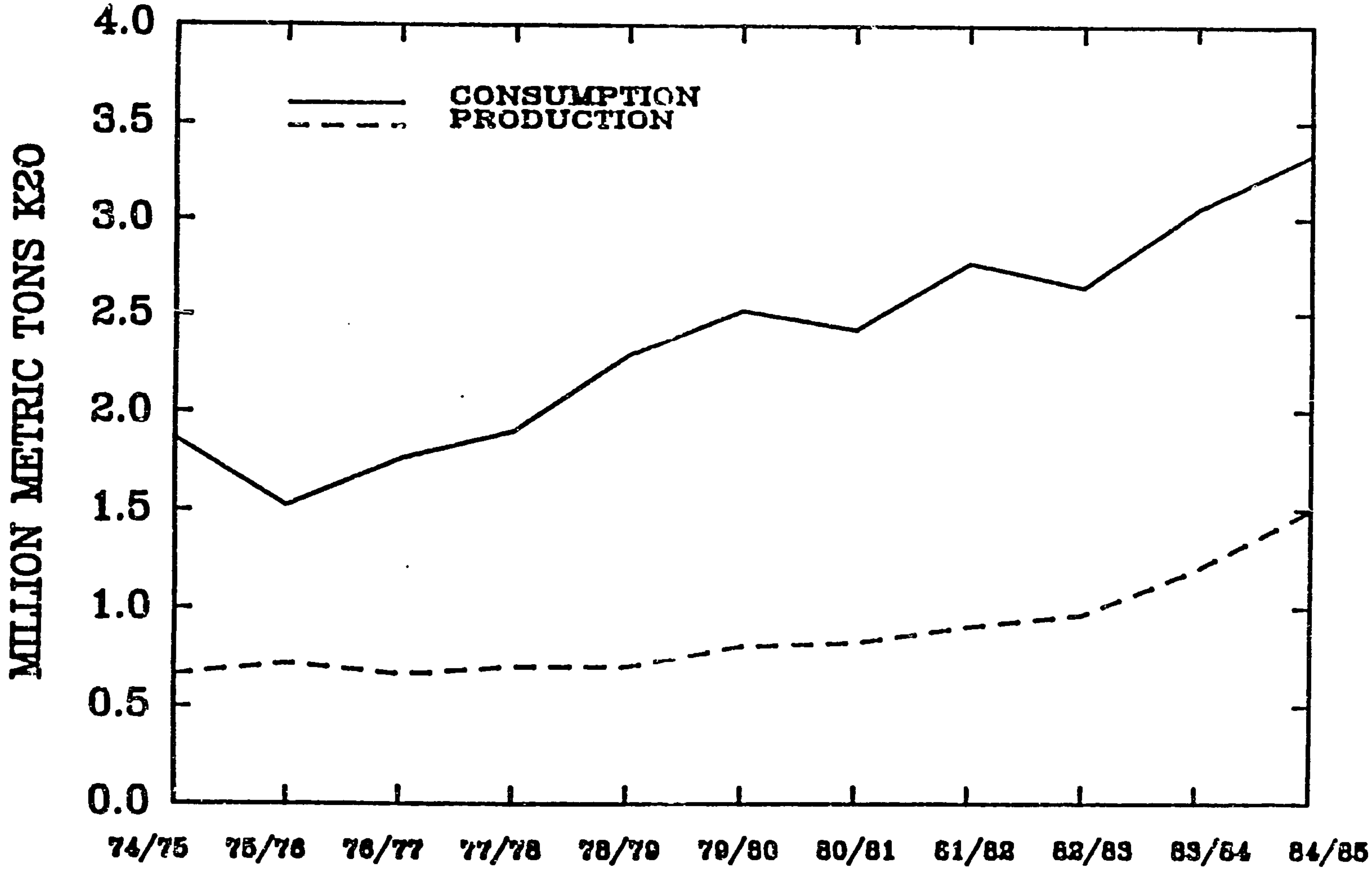


SOURCE: FAO

NOTE: DOES NOT INCLUDE GROUND PHOSPHATE ROCK FOR DIRECT APPLICATION

FIGURE 11

ASIA: POTASH PRODUCTION AND CONSUMPTION 1974/75 - 1984/85



SOURCE: FAO

TABLE 22

Trade in Fertilizers, 1981/1982

	Fertilizer imports								Fertilizer exports							
	Nitrogenous		Phosphate		Potash		Total		Nitrogenous		Phosphate		Potash		Total	
	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%	Q	%
World	12.5	100	5.6	100	15.5	100	33.6	100	11.6	100	6.3	100	14.9	100	32.8	100
Developed regions	5.9	47	2.8	50	11.6	75	20.4	61	10.4	90	5.5	86	14.9	100	30.8	94
Developed market-economy countries	5.5	44	2.2	39	8.5	55	16.3	48	7.3	63	5.0	79	9.0	60	21.3	65
Socialist countries of Eastern Europe	0.4	3	0.6	11	3.1	20	4.1	12	3.1	27	0.4	6	5.9	40	9.4	29
Developing regions	6.5	52	2.8	50	3.9	25	13.2	39	1.1	9	0.9	14	-	-	2.0	6
Developing market-economy countries	4.9	39	2.4	43	3.1	20	10.4	31	1.1	9	0.9	14	-	-	2.0	6
Socialist countries of Asia	1.6	13	0.4	7	0.8	5	2.8	8	-	-	-	-	-	-	-	-

Source: UNCTAD secretariat, based on data from FAO, Fertilizer Yearbook, vol. 32, 1982.

Notes: The symbol "Q" indicates quantity in millions of tons.
The symbol "%" indicates percentage share.
The symbol "-" indicates nil or negligible.

The differences between import and export figures are due to (a) the time-lag between reporting of exports and imports; (b) different reference periods used by different countries; and (c) different systems of treating traded ammonia. For a more detailed explanation, see the notes to the tables in the source document.

Components and percentages may not add to totals owing to rounding.

Table 23

MAY 19, 1986

IFDC

ASIA
NITROGEN
CONSUMPTION
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	24230.	27658.	30646.	37014.	35437.	33227.	37846.	28740.	38843.	36900.	40000.
BAHRAIN	20.	23.	0.	0.	23.	13.	0.	300.	8.	200.	300.
BANGLADESH	82511.	140723.	155835.	225191.	227755.	250215.	267908.	251628.	305779.	356400.	377000.
BHUTAN	74.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.
BURMA	38142.	42470.	42931.	49301.	57942.	69700.	66300.	92900.	114700.	115000.	127400.
CHINA	3621000.	4807000.	4515000.	6824000.	9060000.	10363000.	11844400.	11272000.	11969000.	13421000.	14811000.
TAIWAN	225000.	230000.	240000.	243000.	220000.	253000.	267700.	256300.	241700.	257700.	255000.
CYPRUS	7441.	15000.	15000.	3200.	7490.	9136.	6197.	9036.	11638.	10600.	10400.
INDIA	1345200.	1302700.	2351700.	2313400.	[illegible]	3444200.	3522000.	3881700.	4043000.	4627300.	5333300.
INDONESIA	345000.	341500.	351200.	465200.	546938.	620419.	850931.	997054.	1082450.	1049100.	1285400.
IRAN	135525.	135980.	220460.	221655.	167237.	237000.	274800.	336500.	492735.	595500.	435500.
IRAQ	27317.	23000.	35000.	45000.	43338.	74200.	54500.	53600.	62138.	61300.	73000.
ISRAEL	32504.	37375.	35495.	32195.	37620.	35717.	39506.	35830.	43195.	47100.	51500.
JAPAN	630500.	653000.	702000.	716000.	723000.	777000.	614000.	643000.	683000.	701000.	577000.
JORDAN	1970.	1300.	3577.	1400.	3173.	6200.	6000.	2918.	7080.	3500.	7000.
KAMPUCHEA DM	900.	100.	100.	0.	0.	0.	7200.	10500.	7300.	1600.	500.
KOREA N.	251900.	264000.	335200.	442800.	535000.	540000.	550000.	564100.	564100.	582300.	597000.
KOREA REP	447377.	467678.	361239.	327890.	461610.	443900.	447224.	431638.	303600.	357300.	401300.
KUWAIT	0.	0.	0.	100.	100.	250.	140.	300.	572.	300.	500.
LAOS	100.	100.	100.	100.	52.	87.	4000.	4000.	150.	500.	0.
LEBANON	19120.	7000.	17700.	13700.	14400.	15000.	14000.	16700.	24600.	15000.	17400.
MALAYSIA	66876.	77573.	90000.	102000.	109500.	137700.	139300.	127300.	138000.	235000.	249000.
MONGOLIA	1500.	1500.	4400.	3700.	6300.	4600.	3700.	9500.	9700.	11700.	11500.
NEPAL	3951.	6421.	10637.	13012.	13746.	15479.	16434.	17351.	23000.	33000.	31500.
OMAN	177.	254.	130.	200.	132.	308.	667.	1020.	705.	800.	400.
PAKISTAN	362900.	443451.	511000.	554100.	684300.	775804.	843574.	832572.	952647.	914300.	934800.
PHILIPPINES	177361.	144100.	177200.	174257.	205400.	226790.	224100.	210713.	231622.	240200.	177900.
QATAR	0.	200.	300.	300.	414.	500.	800.	840.	659.	500.	600.
SAUDI ARABIA	5000.	5700.	6415.	4705.	7020.	15971.	25168.	41535.	59025.	113300.	130000.
SINGAPORE	1000.	1000.	1000.	1000.	1000.	1800.	1800.	2000.	2000.	2000.	2000.
SRI LANKA	74430.	37300.	52400.	65300.	80700.	77200.	91500.	73500.	79400.	83000.	96100.
SYRIA	35624.	35214.	43099.	55242.	55000.	79940.	79731.	83102.	95915.	109500.	126700.
THAILAND	75345.	78852.	135300.	150100.	153500.	160000.	159000.	162000.	199100.	235200.	243000.
TURKEY	282335.	432204.	590700.	665700.	773900.	695537.	807490.	798852.	863402.	1021400.	954300.
U A EMIRATES	536.	300.	1000.	500.	730.	2100.	2261.	2356.	2900.	2500.	3000.
VIETNAM	121200.	194000.	241500.	288000.	207000.	121000.	129000.	174700.	235000.	351000.	310000.
YEMEN AR	600.	3372.	2043.	1894.	9000.	11700.	9400.	10600.	10100.	14100.	14500.
YEMEN DEM	460.	920.	811.	100.	1000.	1100.	1840.	1748.	1600.	2000.	2000.
ASIA	9075084.	10583078.	11349339.	14529981.	17458703.	19523418.	21425870.	21504636.	22905720.	25630600.	27892500.

SOURCE: FAO DATA COMPILED BY TVA

NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 24

ASIA
NITROGEN
PRODUCTION
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	13117.	14774.	26203.	37689.	43300.	48300.	48900.	48300.	48300.	48300.	48300.
BAHRAIN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BANGLADESH	32680.	131068.	126144.	107574.	134351.	169125.	160508.	193428.	236579.	337100.	343100.
BHUTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	43328.	47354.	55490.	53003.	57524.	61600.	59000.	50000.	51200.	60000.	86500.
CHINA	2327000.	3709000.	3615000.	5509000.	7633000.	8821000.	10042400.	9905600.	10219000.	11094000.	12211000.
TAIWAN	190000.	255000.	227000.	242000.	254100.	274900.	244000.	249000.	237000.	195000.	208000.
CYPRUS	0.	0.	0.	0.	0.	0.	0.	0.	2584.	3900.	0.
INDIA	1135600.	1503033.	1552400.	1993300.	2173000.	2224300.	2163700.	3143300.	3429700.	3471500.	3717300.
INDONESIA	165900.	207500.	134200.	336100.	594044.	874926.	958426.	970566.	940294.	1077200.	1402400.
IRAN	131025.	125700.	136214.	124025.	72344.	93200.	71000.	21400.	22256.	23500.	13300.
IRAQ	33600.	24300.	25332.	125460.	165300.	337000.	355000.	0.	0.	14000.	11000.
ISRAEL	33135.	59570.	55435.	63095.	79500.	76070.	62236.	62430.	74138.	81700.	71900.
JAPAN	2340900.	1557000.	1171000.	1445000.	1457000.	1458000.	1202000.	1253000.	1125000.	1077000.	1211000.
JORDAN	0.	0.	0.	0.	0.	0.	0.	0.	21240.	60700.	102400.
KAMPUCHEA DM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KOREA N.	250000.	250000.	370000.	450000.	540000.	550000.	553000.	600000.	588000.	603000.	620000.
KOREA REP	513773.	579203.	535300.	635900.	751900.	785400.	638400.	656000.	615500.	550300.	559700.
KUWAIT	275500.	253700.	223000.	270313.	310030.	397100.	217600.	183000.	234119.	223500.	230800.
LAOS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LEBANON	0.	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	0.	0.	0.
MALAYSIA	37000.	34000.	42000.	43000.	37400.	37200.	35200.	20000.	13600.	44000.	47000.
MONGOLIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NEPAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OMAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PAKISTAN	236326.	316456.	312129.	310983.	335675.	398700.	579954.	715040.	979436.	1014600.	1027900.
PHILIPPINES	53419.	62100.	43400.	37503.	45705.	35500.	34000.	41051.	18133.	23400.	15400.
QATAR	55453.	67000.	95200.	75900.	104000.	225500.	236100.	264500.	304700.	319000.	341000.
SAUDI ARABIA	40600.	93820.	84134.	92300.	120900.	137500.	152000.	158700.	159400.	266300.	397000.
SINGAPORE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SRI LANKA	0.	0.	0.	0.	0.	0.	0.	38400.	90734.	57500.	64300.
SYRIA	12500.	26000.	22046.	24130.	24950.	20800.	12524.	36356.	80016.	74900.	117000.
THAILAND	5722.	4238.	6852.	2700.	2500.	0.	0.	0.	0.	0.	0.
TURKEY	146211.	170547.	189000.	197300.	253700.	340242.	571745.	717728.	723024.	783100.	759500.
U A EMIRATES	0.	0.	0.	0.	0.	0.	0.	0.	0.	7000.	157700.
VIETNAM	0.	0.	25000.	34000.	40000.	40000.	15000.	15000.	15000.	15000.	15000.
YEMEN AR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN DEM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ASIA	8736739.	9336107.	9644701.	12291734.	15369563.	17369254.	19513944.	19363350.	20256226.	21586700.	24123500.

SOURCE: FAO DATA COMPILED BY IVA
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 25

MAY 19, 1986
IFDC

ASIA
NITROGEN
EXPORTS
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	0.	0.	9200.	6300.	15400.	27600.	18400.	11620.	11628.	13100.	4600.
BAHRAIN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BANGLADESH	0.	0.	0.	0.	0.	0.	19090.	4000.	33000.	25300.	12000.
BHUTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	6000.	3000.	2700.	0.	0.	0.	0.	0.	0.	0.	0.
CHINA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TAIWAN	2700.	0.	2200.	12300.	9637.	11129.	0.	0.	0.	0.	0.
CYPRUS	0.	0.	0.	0.	0.	0.	0.	0.	2500.	0.	6400.
INDIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	1600.	0.
INDONESIA	0.	0.	0.	194090.	106013.	137678.	82516.	17695.	43838.	143500.	104000.
IRAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IRAQ	7750.	0.	100.	43700.	107500.	244100.	306400.	0.	0.	5000.	8000.
ISRAEL	7535.	16680.	15725.	20105.	23575.	25230.	21920.	21010.	22631.	25400.	27000.
JAPAN	1410430.	851300.	742000.	322000.	506000.	701000.	590000.	470000.	333000.	194000.	310000.
JORDAN	0.	0.	0.	0.	0.	0.	0.	0.	12591.	65000.	95300.
KAMPUCHEA DM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KOREA N.	22300.	4500.	0.	6400.	14500.	13300.	11700.	45100.	29000.	39000.	32300.
KOREA REP	0.	6000.	44989.	215700.	304564.	279153.	362000.	195300.	193500.	210000.	234100.
KUWAIT	273900.	233630.	245900.	271441.	326200.	290500.	225700.	175900.	195715.	241000.	270700.
LAOS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LEBANON	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MALAYSIA	5514.	5538.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MONGOLIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NEPAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OMAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PAKISTAN	0.	0.	0.	0.	0.	0.	0.	0.	45494.	153500.	210100.
PHILIPPINES	0.	0.	0.	4500.	1200.	0.	0.	0.	0.	0.	0.
QATAR	40000.	68125.	107649.	52600.	135900.	181600.	320900.	253780.	283059.	333000.	332000.
SAUDI ARABIA	80000.	35335.	62967.	96351.	118095.	133900.	131300.	132610.	137654.	135700.	325300.
SINGAPORE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SRI LANKA	0.	0.	0.	0.	0.	0.	0.	0.	22700.	0.	0.
SYRIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	5400.	11700.
THAILAND	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURKEY	0.	0.	0.	0.	0.	0.	0.	0.	2000.	13500.	0.
U A EMIRATES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	155000.
VIETNAM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN AR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN DEM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ASIA	1356399.	1228829.	1234452.	1739087.	1976583.	2045290.	2079926.	1317223.	1370371.	1645700.	2129100.

SOURCE: FAO DATA COMPILED BY TVA

NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 26

MAY 19, 1986
IFDC

ASIA
NITROGEN
IMPORTS
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	12800.	3173.	5586.	5624.	5660.	7920.	5400.	700.	1700.	7700.	0.
BAHRAIN	20.	23.	0.	0.	23.	13.	0.	300.	62.	200.	300.
BANGLADESH	65447.	33263.	5069.	119751.	176021.	140560.	38800.	124000.	34500.	65500.	81000.
BHUTAN	74.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.
BURMA	0.	0.	0.	3347.	9488.	4100.	24800.	46500.	67400.	55000.	57100.
CHINA	794000.	1100000.	700000.	1315000.	1421000.	1562000.	1851000.	1414400.	1750000.	2327000.	2600000.
TAIWAN	125000.	63500.	55500.	44200.	3132.	522.	2129.	16200.	17200.	66500.	72200.
CYPRUS	7441.	17500.	12000.	3200.	7570.	12016.	8095.	6420.	6957.	5900.	13100.
INDIA	264731.	990000.	750100.	795100.	1233100.	1295300.	1510400.	1055100.	424600.	656100.	200500.
INDONESIA	311000.	153000.	10300.	3877.	17926.	14356.	134905.	183620.	235153.	72000.	123000.
IRAN	117699.	77650.	96850.	53223.	41110.	157500.	212000.	393400.	472345.	572000.	471500.
IRAQ	4550.	900.	9200.	0.	900.	4000.	7300.	55200.	87735.	64400.	58000.
ISRAEL	2645.	4710.	0.	1570.	0.	3100.	6300.	6300.	6600.	10500.	10000.
JAPAN	22500.	15000.	44000.	25000.	34000.	35000.	42000.	48000.	73000.	75000.	72000.
JORDAN	1596.	1500.	3997.	1400.	3173.	6200.	6000.	2318.	7643.	9700.	2730.
KAMPUCHEA DM	900.	100.	100.	0.	0.	0.	7200.	10500.	7300.	1600.	500.
KOREA N.	24900.	7300.	13800.	9200.	9100.	4600.	9200.	9200.	5100.	13600.	10000.
KOREA REP	0.	9548.	4006.	4941.	1100.	0.	0.	2500.	1300.	1500.	3700.
KUWAIT	0.	0.	0.	0.	0.	200.	0.	200.	20.	100.	100.
LAOS	100.	100.	100.	100.	52.	37.	6900.	1200.	150.	500.	0.
LEBANON	13120.	5400.	15500.	12500.	13200.	19000.	10800.	16700.	24600.	15000.	17400.
MALAYSIA	75274.	44911.	53000.	66000.	103000.	140000.	110000.	105000.	142500.	190000.	194000.
MONGOLIA	1500.	1500.	4400.	3700.	4300.	4500.	5700.	9500.	9700.	11700.	11900.
NEPAL	14463.	1760.	12173.	13012.	13746.	17500.	14792.	22827.	20900.	33000.	31200.
OMAN	177.	254.	130.	200.	132.	308.	567.	1020.	705.	600.	400.
PAKISTAN	105437.	73496.	139561.	341823.	480249.	440976.	336554.	94958.	130804.	75400.	86900.
PHILIPPINES	239440.	44100.	63200.	141597.	177493.	217100.	224433.	112679.	221935.	129700.	173100.
QATAR	0.	0.	0.	0.	0.	0.	0.	80.	45.	100.	0.
SAUDI ARABIA	1995.	2300.	759.	3300.	3037.	4188.	9595.	17205.	15550.	44200.	47000.
SINGAPORE	1000.	1000.	1000.	1000.	1000.	1300.	1800.	2000.	2000.	2000.	2000.
SRI LANKA	50604.	34200.	45700.	75600.	78703.	39312.	73443.	46500.	11520.	13100.	53500.
SYRIA	39091.	15500.	16500.	37700.	35000.	72350.	67157.	45543.	27058.	0.	20700.
THAILAND	75123.	74534.	129700.	151200.	178900.	197000.	155400.	158300.	179100.	235200.	242000.
TURKEY	195743.	320657.	534200.	407400.	469700.	449576.	331127.	127821.	117553.	257000.	294000.
U A EMIRATES	532.	200.	1000.	500.	730.	2100.	2261.	2356.	3300.	2500.	1100.
VIETNAM	121200.	204000.	203000.	254000.	169000.	79100.	114000.	159700.	220000.	339000.	255000.
YEMEN AR	600.	3572.	2043.	1954.	9000.	11700.	9400.	10600.	10100.	14100.	14500.
YEMEN DEM	460.	920.	811.	100.	1000.	1100.	1840.	1749.	1800.	2000.	2000.
ASIA	3556996.	3345321.	2347505.	3973265.	4700914.	4956234.	5389703.	4311595.	4365305.	5437400.	7094300.

SOURCE: FAO DATA COMPILED BY TVA
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 27

MAY 19, 1986
IFDC

ASIA
PHOSPHATE
CONSUMPTION
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	9500.	6716.	13590.	17212.	18122.	15430.	12980.	16871.	14100.	19800.	9700.
BAHRAIN	10.	0.	0.	0.	10.	13.	0.	0.	53.	100.	100.
BANGLADESH	35555.	54263.	51123.	90533.	99357.	110340.	119300.	120200.	130400.	163000.	150550.
BHUTAN	9.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	4135.	10779.	5744.	10147.	14400.	21230.	30300.	29900.	43100.	32700.	46700.
CHINA	1412000.	1546000.	1587000.	1762000.	1232500.	1989000.	2673900.	2864100.	3154300.	3670900.	3507000.
TAIWAN	52000.	53030.	63050.	70700.	64730.	60000.	71400.	67200.	54500.	53100.	60900.
CYPRUS	3567.	6500.	10030.	6000.	7300.	5451.	5701.	5460.	6520.	7500.	7700.
INDIA	437400.	373600.	643500.	773100.	730600.	977900.	1075100.	1155700.	1102500.	1351300.	1775500.
INDONESIA	114100.	116500.	105600.	104900.	126951.	131929.	209731.	303317.	352052.	345500.	432700.
IRAN	141435.	142300.	151460.	153055.	119433.	197600.	297200.	289400.	374185.	427300.	456900.
IRAQ	6052.	7000.	5000.	8300.	13000.	25800.	23300.	13100.	12133.	26200.	40300.
ISRAEL	15255.	19240.	13709.	19400.	15340.	20805.	16996.	16610.	14755.	13100.	20900.
JAPAN	692400.	623300.	727000.	747000.	775000.	831000.	690000.	701000.	721000.	765000.	777000.
JORDAN	2200.	3100.	3156.	3500.	3500.	6200.	7000.	3357.	6300.	6500.	6500.
KAMPUCHEA DM	503.	0.	0.	0.	0.	0.	700.	7500.	5400.	3200.	500.
KOREA N.	124000.	124600.	127000.	127003.	127000.	127000.	127003.	130000.	127400.	130000.	132000.
KOREA REP	245554.	236422.	142145.	210253.	235617.	215724.	172500.	137767.	149000.	171100.	151200.
KUWAIT	0.	0.	0.	0.	0.	200.	200.	100.	30.	0.	0.
LAOS	100.	0.	0.	0.	15.	37.	0.	0.	77.	0.	0.
LEBANON	12400.	5000.	12000.	5000.	13000.	23030.	6000.	8000.	6300.	5200.	22700.
MALAYSIA	31051.	28255.	35442.	38700.	52400.	52800.	51200.	36000.	44800.	55000.	70000.
MONGOLIA	1730.	700.	1400.	2800.	2700.	3700.	2300.	3600.	3900.	3500.	3300.
NEPAL	2349.	2439.	2766.	3383.	3341.	4234.	4742.	3978.	8200.	9900.	10500.
OMAN	0.	86.	100.	100.	52.	151.	197.	300.	235.	400.	300.
PAKISTAN	60580.	108500.	117900.	157330.	187900.	201036.	226487.	225502.	265235.	261400.	293700.
PHILIPPINES	47774.	34000.	49000.	40414.	49753.	51900.	53400.	47753.	51016.	54600.	45400.
QATAR	0.	0.	0.	0.	0.	0.	0.	0.	60.	100.	0.
SAUDI ARABIA	1690.	2300.	533.	3000.	4573.	5559.	14356.	23615.	33105.	87700.	109500.
SINGAPORE	1000.	1000.	1000.	1000.	1000.	500.	500.	500.	500.	500.	500.
SRI LANKA	19430.	10570.	4460.	13400.	11252.	12974.	14051.	16139.	21016.	24900.	37500.
SYRIA	13456.	15568.	23515.	29867.	33000.	43340.	44089.	46401.	53500.	53700.	86500.
THAILAND	70437.	52223.	50330.	99000.	104400.	171355.	101600.	125200.	130000.	152003.	167200.
TURKEY	227003.	363577.	521530.	613560.	554100.	539075.	619000.	439335.	565433.	617600.	554300.
U A EMIRATES	63.	103.	170.	400.	455.	600.	635.	970.	970.	200.	300.
VIETNAM	123500.	100200.	95000.	126000.	130000.	30000.	27575.	28152.	38400.	41600.	65000.
YEMEN AR	150.	1300.	80.	445.	500.	800.	500.	900.	852.	900.	1400.
YEMEN DEM	0.	60.	73.	100.	150.	140.	184.	80.	300.	200.	500.
ASIA	3975679.	4095753.	4625805.	5241664.	5104499.	5905963.	6698535.	6918002.	7591722.	8600300.	9597200.

SOURCE: FAO DATA COMPILED BY TVA
DOES NOT INCLUDE GROUND PHOSPHATE ROCK FOR DIRECT APPLICATION
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 28

MAY 19, 1986
IFDC

ASIA
PHOSPHATE
PRODUCTION
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BAHRAIN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BANGLADESH	13312.	22453.	20132.	17646.	23552.	32710.	32900.	27000.	32000.	37400.	26500.
BHUTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CHINA	1379000.	1531000.	1579000.	1650000.	1033000.	1817000.	2292200.	2508300.	2537000.	2656000.	2359000.
TAIWAN	51000.	65000.	57000.	73000.	73400.	52700.	75800.	85600.	52100.	57200.	61700.
CYPRUS	0.	0.	0.	0.	0.	0.	0.	0.	3230.	11400.	0.
INDIA	331200.	319700.	479300.	659500.	775000.	751100.	841500.	949700.	935300.	1064100.	1317400.
INDONESIA	0.	0.	0.	0.	0.	55206.	213908.	257209.	265598.	365700.	460000.
IRAN	82800.	53250.	108991.	31430.	57875.	46000.	30400.	2600.	6969.	3930.	0.
IRAQ	0.	0.	0.	0.	0.	0.	0.	0.	5500.	85000.	195700.
ISRAEL	19015.	26170.	23370.	25735.	17250.	33935.	41356.	33405.	50000.	97000.	120000.
JAPAN	769400.	595300.	625000.	636000.	707000.	744000.	648000.	580000.	625000.	647000.	541000.
JORDAN	1403.	1500.	1594.	0.	0.	0.	0.	0.	47230.	140900.	243700.
KAMPUCHEA DM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KOREA N.	113000.	115000.	127000.	127000.	127000.	127000.	127000.	130000.	130000.	130000.	132000.
KOREA REP	155194.	191300.	214800.	281200.	389100.	498614.	494000.	323700.	447100.	457500.	487500.
KUWAIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LAOS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LEBANON	127600.	67500.	50000.	55000.	62000.	53000.	103000.	51000.	9400.	4700.	13900.
MALAYSIA	0.	20900.	22000.	25300.	25300.	32500.	25900.	20000.	26000.	48000.	70000.
MONGOLIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NEPAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OMAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PAKISTAN	10620.	10624.	11893.	13519.	27227.	49779.	57596.	66903.	73535.	91900.	90000.
PHILIPPINES	42145.	31200.	31000.	25254.	35143.	33300.	37000.	36154.	16870.	23300.	14200.
QATAR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SAUDI ARABIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SINGAPORE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SRI LANKA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SYRIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	4900.	4200.
THAILAND	0.	0.	0.	0.	0.	0.	0.	26316.	53620.	57500.	97900.
TURKEY	225145.	340632.	344200.	275900.	220500.	254737.	563987.	468981.	513029.	621500.	580100.
U A EMIRATES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VIETNAM	95000.	100000.	95000.	126000.	130000.	30000.	23000.	26152.	30000.	35000.	33000.
YEMEN AR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN DEM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ASIA	3437336.	3512059.	3779300.	4147543.	3723975.	4666331.	5608547.	5601920.	5927332.	6652300.	6933000.

SOURCE: FAO DATA COMPILED BY TVA
DOES NOT INCLUDE GROUND PHOSPHATE ROCK FOR DIRECT APPLICATION
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 29

MAY 19, 1985
IFDC

ASIA
PHOSPHATE
EXPORTS
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BAHRAIN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BANGLADESH	0.	0.	0.	0.	0.	0.	0.	0.	0.	2000.	2300.
BHUTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CHINA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TAIWAN	700.	0.	0.	2900.	537.	1707.	0.	0.	0.	0.	6600.
CYPRUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	4100.	0.
INDIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
INDONESIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	13900.	10000.
IRAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IRAQ	0.	0.	0.	0.	0.	0.	0.	0.	0.	59700.	122200.
ISRAEL	2075.	2335.	3890.	1035.	1030.	3300.	25400.	22300.	45000.	60400.	100000.
JAPAN	24500.	16200.	12000.	12000.	35000.	30000.	35000.	42000.	71000.	31000.	36000.
JORDAN	0.	0.	0.	0.	0.	0.	0.	0.	27200.	153200.	225300.
KAMPUCHEA DM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KOREA N.	0.	0.	0.	0.	0.	0.	0.	0.	600.	0.	0.
KOREA REP	0.	0.	3657.	93132.	196277.	283307.	344000.	142000.	261900.	265900.	236300.
KUWAIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LAOS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LEBANON	110200.	61800.	20000.	53000.	57400.	72000.	75000.	47000.	18300.	0.	0.
MALAYSIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MONGOLIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NEPAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OMAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PAKISTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PHILIPPINES	0.	0.	0.	5600.	2500.	0.	0.	0.	0.	0.	0.
QATAR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SAUDI ARABIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SINGAPORE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SRI LANKA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SYRIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	7100.	100.
THAILAND	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURKEY	0.	0.	0.	0.	0.	0.	0.	15160.	116000.	85200.	45200.
U A EMIRATES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VIETNAM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN AR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN DEM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ASIA	137475.	80335.	39547.	167567.	292394.	390314.	479400.	268460.	540000.	702100.	336300.

SOURCE: FAO DATA COMPILED BY TVA
DOES NOT INCLUDE GROUND PHOSPHATE ROCK FOR DIRECT APPLICATION
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 30

MAY 19, 1986
IFDC

ASIA
PHOSPHATE
IMPORTS
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	5200.	8108.	15190.	16541.	22140.	20240.	13800.	6900.	13940.	19300.	9700.
BAHRAIN	10.	0.	0.	0.	10.	13.	0.	0.	53.	100.	100.
BANGLADESH	21600.	102453.	3559.	52712.	37375.	100550.	108500.	85000.	96500.	92000.	170000.
BHUTAN	9.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	0.	6750.	13500.	9765.	25336.	24800.	24900.	37400.	39400.	32700.	39330.
CHINA	33000.	15000.	3000.	34000.	247100.	171900.	365000.	355800.	616900.	1094800.	1450000.
TAIWAN	0.	0.	0.	0.	2433.	138.	1767.	3700.	500.	5100.	6500.
CYPRUS	3567.	1520.	19500.	6000.	7300.	11321.	4315.	2277.	5571.	800.	7400.
INDIA	233530.	361600.	[illegible]	153400.	243500.	237100.	452100.	343200.	53600.	142500.	745230.
INDONESIA	34500.	21000.	5000.	29100.	129837.	77000.	75899.	61415.	207635.	4900.	0.
IRAN	32160.	23530.	55530.	23780.	37720.	167400.	282900.	303600.	394015.	422600.	444400.
IRAQ	15553.	6400.	9380.	6900.	13000.	25530.	23300.	15100.	12138.	0.	0.
ISRAEL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
JAPAN	45900.	40700.	103000.	67000.	100030.	97000.	109000.	117000.	150000.	153000.	170000.
JORDAN	500.	1300.	1564.	1500.	3120.	7100.	5300.	3347.	6300.	3000.	1700.
KAMPUCHEA DM	500.	0.	0.	0.	0.	0.	900.	7500.	3400.	3200.	600.
KOREA N.	10500.	9200.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KOREA REP	91922.	85175.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KUWAIT	0.	0.	0.	0.	0.	200.	200.	100.	60.	0.	0.
LAOS	100.	0.	0.	0.	15.	37.	0.	0.	77.	0.	0.
LEBANON	0.	0.	2400.	5300.	5500.	9700.	3300.	10300.	8600.	5700.	6300.
MALAYSIA	13301.	12653.	13324.	24700.	31900.	20200.	24300.	16200.	13800.	6000.	0.
MONGOLIA	1700.	700.	1400.	2800.	2760.	3700.	5300.	4900.	4200.	2500.	3400.
NEPAL	3695.	400.	2491.	3393.	3241.	5500.	3597.	5629.	8200.	9700.	10500.
OMAN	0.	86.	100.	100.	31.	131.	197.	300.	235.	400.	300.
PAKISTAN	26059.	109175.	140071.	204770.	202313.	162439.	302343.	34429.	247073.	179500.	212000.
PHILIPPINES	47723.	600.	0.	0.	8200.	13230.	13519.	10944.	25024.	25503.	33400.
QATAR	0.	0.	0.	0.	0.	0.	0.	0.	60.	100.	0.
SAUDI ARABIA	1550.	2300.	533.	3000.	4513.	5559.	14355.	23615.	33105.	37700.	109500.
SINGAPORE	1000.	1000.	1000.	1000.	1000.	500.	500.	500.	500.	500.	500.
SRI LANKA	19400.	19330.	4190.	4700.	2050.	7290.	20247.	18868.	19622.	25500.	25500.
SYRIA	23230.	23000.	23000.	34400.	23000.	43320.	44089.	29500.	2530.	300.	0.
THAILAND	70407.	62223.	30300.	132600.	125000.	132550.	126500.	123900.	130000.	163000.	167300.
TURKEY	39244.	0.	34200.	215100.	405400.	325114.	406129.	0.	0.	35600.	69000.
U A EMIRATES	53.	100.	100.	400.	459.	800.	535.	970.	970.	800.	800.
VIETNAM	33500.	200.	0.	0.	0.	0.	4500.	0.	9400.	5500.	28000.
YEMEN AR	190.	1300.	60.	445.	500.	600.	500.	900.	852.	900.	1400.
YEMEN DEM	0.	60.	73.	100.	150.	140.	184.	60.	300.	200.	500.
ASIA	1239466.	936479.	577239.	1112495.	1747416.	1677752.	2446076.	1624774.	2129731.	2455000.	3750200.

SOURCE: FAO DATA COMPILED BY TVA
DOES NOT INCLUDE GROUND PHOSPHATE ROCK FOR DIRECT APPLICATION
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 31

MAY 19, 1986
IFDC

ASIA
POTASH
CONSUMPTION
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	100.	0.	0.	0.	50.	82.	300.	100.	0.	0.	0.
BAHRAIN	10.	0.	0.	0.	10.	0.	0.	0.	53.	100.	100.
BANGLADESH	10745.	14523.	14475.	25100.	27443.	29340.	23700.	29200.	31400.	33500.	42500.
BHUTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	2345.	1475.	1470.	1916.	2152.	2200.	3100.	2900.	10800.	12000.	13900.
CHINA	153000.	105000.	75000.	35000.	143700.	251000.	332600.	581100.	518900.	715000.	731000.
TAIWAN	101000.	105000.	53000.	96500.	90100.	103900.	95500.	111650.	97100.	91200.	100300.
CYPRUS	2500.	2500.	3100.	3300.	2030.	1496.	971.	1378.	1139.	2100.	1300.
INDIA	317530.	227000.	377330.	432700.	550100.	545500.	617500.	670400.	621700.	626500.	345400.
INDONESIA	33000.	25000.	30000.	38400.	76437.	84200.	91100.	136235.	80453.	107000.	151200.
IRAN	2564.	3500.	2570.	3553.	1013.	3059.	0.	2300.	3920.	14100.	0.
IRAQ	1073.	700.	0.	900.	2248.	2000.	4500.	100.	500.	2400.	4000.
ISRAEL	15050.	17775.	16410.	21700.	21600.	21320.	22750.	22950.	18585.	16500.	17000.
JAPAN	721000.	525000.	647000.	651000.	723000.	736000.	512000.	535000.	581000.	632000.	631000.
JORDAN	450.	600.	312.	500.	1300.	2100.	1400.	1000.	929.	1100.	1500.
KAMPUCHEA DM	0.	0.	0.	0.	0.	0.	0.	1000.	200.	0.	26000.
KOREA N.	40500.	45000.	37700.	40600.	104700.	82200.	52200.	92000.	45400.	77800.	45000.
KOREA REP	155452.	161353.	139929.	137967.	173674.	151514	183326.	199146.	156500.	175100.	195100.
KUWAIT	0.	0.	0.	0.	0.	200.	100.	100.	80.	0.	0.
LAOS	0.	0.	0.	0.	0.	0.	0.	0.	32.	0.	0.
LEBANON	10500.	1200.	2400.	3200.	7100.	6000.	6600.	10300.	13600.	11000.	10700.
MALAYSIA	102637.	113692.	141104.	147100.	166600.	195800.	194900.	173600.	153900.	205000.	225000.
MONGOLIA	200.	500.	0.	100.	0.	0.	0.	0.	0.	300.	1300.
NEPAL	635.	1350.	1410.	1072.	1456.	1131.	392.	590.	1000.	2900.	1200.
OMAN	0.	60.	200.	200.	15.	257.	197.	300.	175.	400.	300.
PAKISTAN	2100.	1500.	2400.	5800.	7400.	3618.	9543.	21772.	25652.	28500.	24700.
PHILIPPINES	60035.	43200.	51500.	45333.	55534.	53700.	35300.	61135.	57575.	29300.	35500.
QATAR	0.	0.	0.	0.	0.	0.	0.	0.	100.	100.	0.
SAUDI ARABIA	1115.	1300.	153.	300.	2836.	379.	1940.	2269.	2175.	14200.	13200.
SINGAPORE	1000.	1000.	1000.	1000.	1000.	2000.	2100.	2200.	2200.	2200.	2500.
SRI LANKA	35500.	15500.	27700.	25400.	30224.	34300.	46000.	41300.	45000.	47300.	53100.
SYRIA	1577.	1139.	964.	1540.	1793.	2700.	2500.	5149.	5765.	5300.	5600.
THAILAND	33927.	33076.	23500.	22000.	30000.	44132.	35400.	35500.	63500.	55500.	57700.
TURKEY	12851.	23339.	25707.	19500.	25000.	24433.	29508.	8733.	30926.	24900.	31400.
U A EMIRATES	13.	0.	0.	0.	315.	600.	158.	323.	400.	1200.	1100.
VIETNAM	34100.	35800.	34200.	24600.	27300.	37200.	39300.	22100.	22000.	20600.	30600.
YEMEN AR	190.	400.	0.	400.	400.	800.	0.	500.	2800.	900.	1000.
YEMEN DEM	0.	10.	45.	0.	50.	100.	0.	0.	150.	0.	0.
ASIA	1371326.	1515111.	1761279.	1904011.	2230995.	2516261.	2420135.	2771589.	2633920.	3052000.	3338903.

SOURCE: FAO DATA COMPILED BY TVA
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 32

MAY 19, 1986
IFDC

ASIA
POTASH
PRODUCTION
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BAHRAIN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BANGLADESH	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BHUTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CHINA	7000.	8000.	11000.	16000.	21000.	13700.	19900.	24400.	25000.	29000.	31000.
TAIWAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CYPRUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
INDIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
INDONESIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IRAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IRAQ	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ISRAEL	653920.	712480.	644770.	685200.	573758.	791900.	811800.	884900.	939960.	955300.	1166000.
JAPAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
JORDAN	0.	0.	0.	0.	0.	0.	0.	0.	9000.	173000.	258000.
KAMPUCHEA DM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KOREA N.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KOREA REP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KUWAIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LAOS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LEBANON	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MALAYSIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MONGOLIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NEPAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OMAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PAKISTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PHILIPPINES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
QATAR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SAUDI ARABIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SINGAPORE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SRI LANKA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SYRIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
THAILAND	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURKEY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
U A EMIRATES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VIETNAM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN AR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN DEM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ASIA	660920.	720480.	655770.	701200.	595758.	807500.	831600.	909300.	973960.	1157300.	1455000.

SOURCE: FAO DATA COMPILED BY TVA
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 33

MAY 19, 1986
IFDC

ASIA
POTASH
EXPORTS
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BAHRAIN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BANGLADESH	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BHUTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CHINA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TAIWAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CYPRUS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
INDIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
INDONESIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IRAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IRAQ	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ISRAEL	592035.	393995.	535240.	609950.	684501.	773900.	762300.	806900.	863330.	962600.	955100.
JAPAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
JORDAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KAMPUCHEA DM	0.	0.	0.	0.	0.	0.	0.	0.	3200.	126700.	274900.
KOREA N.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KOREA REP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KUWAIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LAOS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LEBANON	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MALAYSIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MONGOLIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NEPAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OMAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PAKISTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PHILIPPINES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
QATAR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SAUDI ARABIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SINGAPORE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SRI LANKA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SYRIA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
THAILAND	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURKEY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
U A EMIRATES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
VIETNAM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN AR	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
YEMEN DEM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ASIA	592035.	393995.	535240.	609950.	684501.	773900.	762300.	806900.	866530.	1089300.	1230000.

SOURCE: FAO DATA COMPILED BY TVA
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

Table 34

MAY 19, 1986
IFDC

ASIA
POTASH
IMPORTS
(METRIC TONS)

AREA	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AFGHANISTAN	100.	0.	0.	0.	1000.	0.	0.	0.	0.	0.	0.
BAHRAIN	10.	0.	0.	0.	10.	0.	0.	0.	53.	100.	100.
BANGLADESH	4200.	22423.	6000.	22500.	45675.	37300.	28300.	16000.	27500.	36500.	47000.
BHUTAN	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
BURMA	0.	0.	2700.	2700.	1200.	2400.	5400.	14900.	14100.	12500.	15200.
CHINA	145000.	100000.	65000.	70000.	122700.	275000.	352800.	556700.	493900.	690000.	700000.
TAIWAN	112500.	52500.	40000.	79000.	64299.	97026.	136599.	141900.	82097.	73500.	122500.
CYPRUS	2600.	2500.	3100.	3200.	2000.	2927.	827.	965.	2161.	2100.	1500.
INDIA	443044.	275000.	277300.	595500.	517400.	473200.	776500.	543800.	643700.	555400.	871000.
INDONESIA	33200.	13400.	30000.	40000.	77375.	84201.	91100.	136235.	121651.	151100.	132600.
IRAN	2554.	3500.	2670.	3250.	0.	0.	0.	0.	5110.	14100.	0.
IRAQ	1250.	700.	0.	300.	2243.	2000.	4500.	100.	3500.	9000.	4800.
ISRAEL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
JAPAN	810500.	546000.	656000.	655000.	667000.	767000.	602400.	459000.	610600.	637000.	536000.
JORDAN	439.	800.	312.	600.	1000.	2100.	1400.	1000.	979.	600.	700.
KAMPUCHEA DM	0.	0.	0.	0.	0.	0.	0.	1000.	200.	0.	26000.
KOREA DPR	40300.	45020.	37700.	40300.	104700.	52200.	52200.	72000.	46400.	77800.	45000.
KOREA REP	167500.	164352.	134282.	217517.	196927.	210946.	170000.	197500.	235600.	224500.	259500.
KUWAIT	0.	0.	0.	0.	0.	200.	100.	100.	80.	0.	0.
LAOS	0.	0.	0.	0.	0.	0.	0.	0.	32.	0.	0.
LEBANON	10400.	1000.	1400.	5200.	7100.	6000.	6500.	10300.	13500.	11000.	10700.
MALAYSIA	132397.	113747.	143353.	143000.	168600.	195800.	218000.	206000.	186900.	245500.	300000.
MONGOLIA	200.	500.	0.	100.	0.	0.	0.	0.	0.	900.	1900.
NEPAL	2375.	0.	297.	1072.	1455.	1131.	1440.	0.	1000.	2900.	1200.
OMAN	0.	25.	200.	200.	15.	257.	197.	300.	175.	400.	300.
PAKISTAN	745.	0.	0.	2091.	9591.	13559.	22064.	15603.	21451.	27200.	21300.
PHILIPPINES	85319.	44000.	48000.	42777.	53542.	70900.	75626.	72984.	73304.	45100.	43700.
QATAR	0.	0.	0.	0.	0.	0.	0.	0.	100.	100.	0.
SAUDI ARABIA	1115.	1300.	133.	300.	2339.	379.	1440.	2269.	2175.	14205.	13200.
SINGAPORE	1000.	1000.	1000.	1000.	1000.	2000.	2100.	2200.	2200.	2200.	2500.
SRI LANKA	31370.	17180.	19400.	32500.	39900.	39720.	48436.	49300.	36341.	49300.	53100.
SYRIA	2195.	2000.	2000.	2250.	2300.	2500.	2500.	6000.	5843.	5600.	5600.
THAILAND	59925.	39074.	20500.	23200.	34000.	32000.	32800.	36600.	60500.	25403.	87700.
TURKEY	26944.	2537.	33663.	24400.	20600.	22264.	33235.	10000.	33613.	25500.	35200.
U A EMIRATES	18.	0.	0.	0.	315.	600.	158.	327.	700.	1100.	1100.
VIETNAM	35300.	35200.	34200.	24600.	27200.	37200.	39300.	22100.	22000.	26800.	30600.
YEMEN AR	100.	400.	0.	430.	430.	300.	0.	600.	2800.	900.	1000.
YEMEN DEM	0.	10.	45.	0.	50.	100.	0.	0.	150.	0.	0.
ASIA	2133176.	1494835.	1566300.	2065557.	2175961.	2460769.	2737042.	2695785.	2751115.	3032000.	3461300.

SOURCE: FAO DATA COMPILED BY TVA
NOTE: 1984/85 FISCAL YEAR DATA INCLUDED WITH 1984

SUMMARY TABLES AND SUGGESTIONS FOR ASSEMBLY OF INFORMATION ON THE FERTILIZER SECTOR

Use of these tables

The following tables are suggested for use of analysts in collection and summarization of information on the fertilizer sector and assessment of problems. In some cases completion of tables may be largely a matter of filling in available data from memory or secondary sources. In others, a considerable amount of primary as well as secondary data collection and careful analysis may be required. These tables are intended primarily as illustrative of useful information, not a comprehensive statement of requirements for sector analysis. However, they should be useful in identifying major information gaps and in identifying some of the major sectoral problems. In some of those tables as in the final section of Chapter I, it is suggested that the adequacy of particular policies, conditions or institutions be assessed. Adequacy as used here is intended to reflect the existence of conditions conducive to achievement of a specific development goal, objective or set of objectives. An assessment of "adequate" with respect to a particular factor should be taken to mean that under present conditions the factor does not act as a significant constraint to achievement of the defined goal or objectives. Assessment of adequacy thus requires that the relevant goal and objectives be clearly understood. Additional space may be required for some data and responses to questions.

Prices - Fertilizer/MT

Government Managed Prices

Prices Controlled to: (check)	Amount/MT	Assessment of Adequacy
Farmers		
Retailers		
Wholesalers		
Manufacturers		
Other		

Margins Established to: (check)	Amount/MT	Assessment of Adequacy
Importers		
Wholesalers		
Retailers		
Transporters		
Other		

Subsidies Paid to: (check) Amount/MT Percentage of Cost*

Manufacturers
Importers
Wholesalers
Retailers
Total Subsidy as % of Total Cost of all Fertilizer __________
Average Subsidy as % of Average Farm Price __________

---

* Since farmers may also be subsidized through price controls, this possibility should be examined and considered in fertilizer sector assessment.

No. of Market Entities and Product Volume in MT/Year

Market Structure	Public No.	Public Volume	Cooperative No.	Cooperative Volume	Private No.	Private Volume	Total No.	Total Volume
Factories								
Importers								
Wholesalers								
Retailers								

(If appropriate, prepare separate tables for different products)

Retail Market Structure	1970	1980	1985	Current
No. of Units				
No. of Farms				
Farms per Outlet				
Hectares of Crop Land				
Hectares per Outlet				

Distribution of Sales Outlets

Uniformly distributed for rural areas

Concentrated in major centers

Typical Transport of Small Farmers (% with each form of transport)

Backpack ___ Animal pack ___ Animal cart ___ Tractor ___ Truck ___

Distance Farmers Must Travel for Fertilizer (% in each category)

0-2 Km ____ 2-5 Km ____ 5-10 Km ____ 10-25 Km ____ 25+ Km _____

Capacity/ Storage	No.	Volume (MT)	% of Total Annual Sales	Private (MT)
Manufacturers				
Importers				
Total at ports				
Wholesalers				
Retailers				
Total				

(Avoid double counting of importers and wholesalers, some of which may perform both functions.)

Distance From Retailers to Wholesale Stock Points

Distance (maximum)	% of Retailers
0-5 Km	
5-10 Km	
10-25 Km	
25-50 Km	
over 50 Km	

Full Range of Fertilizers at Wholesale Storage Centers

100% of time

95 % of time

90 % of time

80 % of time

70 % of time

National Stocking Plan (related to Annual Volume)

Minimum stocks on hand are never less than sales volume for:

0-2 weeks__ 2-4 weeks__ 1-2 mo__ 2-3 mo__ 3-6 mo__ 6 mo or more__

Fertilizer Promotion Program

Describe and assess existing and planned Government sponsored program and assess likelihood of success.

Describe and assess existing and planned private trade and cooperative promotional efforts.

Financing

Describe and assess adequacy of public and private credit available or to be made available to farmers to buy fertilizer and other inputs.

Describe and assess financial facilities for fertilizer distribution.

Describe and assess adequacy of import financing, including FX allocations.

Assess adequacy of the investment climate for new fertilizer plants and development of fertilizer resources.

Crop Marketing

Describe and assess adequacy of existing crop marketing structure.

Describe and assess marketing constraints for major crops.

Is there a government-sponsored system of crop price supports? (If so describe it.)

Is it effective? Are price levels adequate to stimulate production and is the system for implementation effective in supporting the price to farmers in general? To small farmers?

Stock Monitoring/Action Responsibility

Agency/Officials involved	Effectiveness
Council of Ministers ______	
Min. of Agriculture	
Min. of Commerce	
Other Ministers	
Deputy Min. Level Council	
Deputy Min. of __________	
Other Level	
Private Sector Representation	
Frequency of Meetings	
Effectiveness of Action	

Describe stock management reporting system employed by public agencies to monitor public and private sector operations.

Reports on Operations and Stocks

Report Schedules	Weekly	Monthly	Quarterly	Other (state)	Accuracy of Report
On:					
Scheduled imports					
Actual Imports					
Operation and Stocks of:					
Importers					
Manufacturers					
Wholesalers					
Retailers					

Farmer Level

purchases
stocks
use

Administrative level to which reports are directed

National fertilizer committee ______
Ministerial level ______
Deputy Minister ______
Department ______
Other ______

Is sufficient authority vested in those receiving the reports to take direct action on supply problems?

Is action taken in a timely fashion?

Are incentives provided for early purchase?

By farmers
% discount per month _____

By retailers
% discount per month _____

Are incentives provided for volume purchases?

By farmers
% discount _____

By retailers
% discount _____

Port and Transport

Port receipts	% in Bags	% in Bulk	Adequacy of Unloading	Adequacy of Bagging

Transport facilities	% by Form	Costs per MT/Km
Port to first point of stocking		
Rail		
Water		
coastal		
inland		
Truck		
Other (specify)		
First point of stocking to wholesale		
Rail		
Water		
coastal		
inland		
Truck		
Other (specify)		
Wholesale to Retail		
Rail		
Water		
coastal		
inland		
Truck		
Other (specify)		

Soil Acidity

Cropped or potentially cropped areas with acidity problems.

Area with PH of 5.0-6.0 ________ ha.

Area with PH below 5.0 ________ ha.

Total area cropped or potentially cropped ________ ha.

Are there deposits of limestone potentially usable for agriculture? ________

If yes, how many sites? ________

Quality of limestone? ________

Potential tonnage? ________

Average distance to acid areas? ________

Is agricultural limestone presently applied? ________

If so, what volume/year? ________

Cost/MT at farm level? ________

Is lime spreading equipment commonly available? ________

Is high alkalinity (PH of 8 or above) a common problem? ________

How many hectares are affected? ________

Is high salinity or sodium in soils a common problem? ________

How many hectares are affected? ________

Is gypsum available? ________

Used for agriculture? ________

If so, how many MT/year? ________

Cost/MT? ________

Do private firms market lime and/or gypsum to farmers? ________

How many? ________

Volume? ________

Gross Benefits Relative to Costs at Current Input/Output Prices and Physical Relationships

a. Assemble prices per Kg for a few major crops for the last 20 years and prices per Kg of N, P_2O_5 and K_2O.

b. Calculate number of Kg of farm products (e.g. wheat, rice, maize, sugar cane, seed cotton) required by year, 1965 - 1986 to buy a Kg of N, P_2O_5 and K_2O (on following tables).

c. Calculate gross return per unit of local currency spent on fertilizer using following tables.

Calculate Benefit/Cost Ratios

A. Estimated Cost of Fertilizer

1 Product	2 Plant Cost	3 CIF Cost	4 Distribution Cost	5 Subsidy	6 Farm Price/Kg	Cost/Kg of Nutrients[1]
TSP						
DAP						
MAP						
UREA						
AN						
MOP						
Other ___						

1/ Divide column 6 by nutrient content; e.g., TSP is 0.46

B. Price for Principal Crops

Crop	Crops Imported in Part		Exported Crops		Farm Price
	CIF/MT	/Kg	FOB/MT	/Kg	/Kg
Rice					
Wheat					
Maize					
Other grains (list)					
______					
______					
______					
Sugar cane					
Seed cotton					
Other crops (list)					
______					
______					
______					
______					

C. Gross Benefit/Cost Ratio

1 Crop	2 Fertilizer	3 Yield Increment per Kg of Nutrient	4 Kg of Crop to Buy a Kg of Fert	5 Gross Benefits/Cost Ratio

Note: The gross benefits/costs ratio (column 5) is obtained by dividing column 3 by column 4.

D. For financial costs/benefit calculations use local prices. Economic benefit/cost ratios can be obtained by substituting economic prices for in-country prices (e.g., world prices for crops and inputs); e.g., include subsidy and taxes in fertilizer price and use world prices for crops.

Total Cropped Area (hectares) and Nutrients Used per Hectare (N, P_2O_5, K_2O)

Estimated Use on Major Crops

Crop	Crop Area	Total Fertilizer Used in MT N	P_2O_5	K_2O

Kg used per Hectare

Crop	N	P_2O_5	K_2O

Current Consumption of Fertilizer

Principal Types Consumed and Volume

Type	Analysis	Volume (MT)	Nutrient (MT)			
			N	P_2O_5	K_2O	Total
N						
Ammonium sulphate	(21-0-0)					
Ammonium nitrate	(e.g. 33.5-0-0)					
CAN	(e.g. 26-0-0)					
Urea	(46-0-0)					
Ammonia (NH_3)	(e.g. 82.5-0-0)					
Aqueous ammonia	____________					
Other	____________					
N/P						
Nitro Phos	(e.g. 23-23-0)					
DAP	(e.g. 11-46-0)					
MAP	(e.g. 11-52-0)					
Other	____________					
Phosphate						
SSP	(e.g. 0-20-0)					
TSP	(e.g. 0-46-0)					
Other	____________					
Potassium						
Chlor[illegible]te of Potash	potassium sulfate (0-0-50)					
Muriate of Potash	(0-0-60)					
Other	____________					
N/P/K						
__________	____________					

Current Consumption of Fertilizer (cont.)

Principal Types Consumed and Volume

Type	Analysis	Volume (MT)	Nutrient (MT) N	P_2O_5	K_2O	Total
Compounds						
________						
________						
________						
________						
________						
________						
Totals						

Physical Input/Output Relationship

Assemble available farm and experiment station data; estimate increase in Kg of products per Kg of N and of P_2O_5 applied.

	Kg of Product/Kg of N	Kg of Product/Kg of P_2O_5
Wheat		
Paddy rice		
Maize		
Cotton		
Sugar cane		
Other ____		
____		
____		
____		

Growth in Fertilizer Consumption, MT of Nutrients Used

	N	P_2O_5	K_2O	Total	Crop Area	Kg/ha of Crop
1950						
1960						
1965						
1970						
1975						
1980						
1981						
1982						
1983						
1984						
1985						
1986						
1987						
1988						
1989						
1990						

Fertilizer Imports and Production (000 MT of Product)

Year	Production	Imports	Total	Import Cost ($million)
1950				
1955				
1960				
1965				
1970				
1975				
1980				
1985				
1986				
____				
____				
____				
Projections				
5 Years				
10 Years				
15 Years				

(Prepare separate tables for major products and do N, P, K separately.)

COMPARISON OF LOCAL PRODUCTION COSTS AND WORLD PRICES

Product	Cost of Local Production/MT	CIF Cost of Imports/MT	Gain (Loss) from Production

Raw Materials Available for Use for Fertilizer Production

Product	Amount	Cost/MT	Cost/Million BTUs
Nitrogen Feed Stock			
Natural gas			
Naphtha			
Crude Oil			
Coal			
Other (list)			
________			
________			
________			

Phosphate Raw Materials	Amount	Cost/MT
Rock Phosphate		
Sulfur		
Sulfuric acid		
Pyrite		
Other (list)		
________		
________		
________		

Potassium Raw Materials	Amount	Cost/MT
________		
________		
________		

Availability of Farm Technology Complementary to Increased Fertilizer Use

Item	% of Farmers Using	Area	
		Hectares	% of Total Area
HYV availability			
Rice			
Wheat			
Maize			
Soybeans			
Other			
Herbicide use			
Insecticide use crop _______			
_______			
_______			
_______			
Tillage methods used			
Hand tillage			
Animal tillage			
Tractor tillage			
Seeding method used			
Hand			
Hand-powered spreader			
Animal powered drill			
Tractor powered drill			

Availability of Farm Technology (cont.)

Item	% of Farmers Using	Area	
		Hectares	% of Total Area
Fertilizer Application			
Hand			
Mechanical			
Spreaders on top of soil			
Injection with seed			
Injection side dress			
Flooded paddy injection in soil			
Mechanical Harvesters			
Grain cutter			
Mechanical thresher			
Grain combine			
Cotton picker			
Other ________			
________			
________			
________			

Availability (arm Technology (cont.)

Item	% of Farmers Using	Area: Hectares	Area: % of Cropped Area
IRRIGATION			
Total			
Public Irrigation Systems			
Large scale gravity			
Medium scale			
Other			
Total			
Private Irrigation Systems			
Tube wells			
Open wells			
Other			
Total			

RESEARCH

	Total budget	% of Agricultural GDP	Adequacy
Cereals			
Fruits and Vegetables			
Other			
Soil Fertility			
Water Management			
Other			
Total			

Extension budget ________ Budget as % of ag. GDP ________

Adequacy of budget ________

Extension Field Worker

total numbers ______

No. of farmers assisted/year _____

Farmer/Worker

farmers per ext. worker ______

% of farmers assisted/year ____

Soil Testing Service

No. of labs ____, tests/year ____, total farmers ____,

% of farmers served/year ____

Is the basic soil test-fertilizer response correlation research adequate to

provide reliable recommendations? _______

Are research, extension, soil testing services adequate to provide farmers

reliable advice? ________

Major constraints to greater service

Per cent of farmers that could be reliably served if constraints were overcome: ________

CHAPTER II ANNEX

LOG FRAME EXAMPLES

MAIZE AND OILSEED PROJECT - BURMA

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	AREAS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Growth: the objective to which the project contributes: (A-1)	Examples of Goal Achievement (A-2)	(A-3)	Assumptions for utilizing (A-4)
1. To increase agricultural production, rural incomes and rural employment and begin to improve nutrition. 2. To improve Burma's balance of trade through an increase in export of oil cake, and a reduction in imports of edible oil.	By year 5 the following increases will have been achieved: 1. Groundnut production up: 375,000 MT (Direct-125,000 MT) (Spread-250,000 MT) 2. Sesamum production up: 49,100 MT 3. Sunflower production up: 65,500 MT 4. Soybean production up: 12,000 MT 5. Gross farm income up: K1,160 million ($161.1 million equivalent). 6. Exports of oil cake, soybean and maize up: 100.9 million 7. Foreign exchange value of increased vegetable oil availability of $94.5 million. 8. Per capita intake of vegetable oil up by 30% from approximately 2.8 Kgs. to 3.8 Kgs. 9. Maize production up: 375,000 MT	Items 1-4 a) Crop reporting statistics of SRUB. b) Project reports of Agriculture Corporation. c) Routine reports Township and Village Tract Councils and Agriculture Corporation Managers. Item 5-a) Reports of prices, home consumption and mktg. of project commodities of farmer participants at the township and village tract levels. b) Annual SRUB statistics on GDP contribution by state/ division. Items 6-8 a) Bimonthly economic reports of the GSRUB on exports. b)Bimonthly SRUB reports on imports. c) Estimated domestic production of edible oils by the Ministry of Planning & Finance.	1. That weather will be normal on average throughout life of project. 2. That economic, political and social conditions will remain stable permitting the farmers to plant and harvest on schedule. 3. That no unexpected difficulties will be encountered in marketing of production. 4. That policies with respect to distribution of income remain essentially as at present. 5. That price relationships between vegetable oil and other food at retail are approximately as at present.

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	AREAS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Purpose (B-1)	Conditions that will indicate purpose has been endorsed. (B-2)	(B-3)	Assumptions for achieving purposes (B-4)
To bring about a rapid rate of adoption of high-yielding inputs and tillage practices for improved maize and oil-seeds by farmers in selected townships.	The following acreages (by crop) will be planted using recommended higher yielding technology and inputs: Direct Impact from Project Maize 383,000 acres Groundnuts 3 ,000 acres Sesamum 312,200 acres Sunflower 115,400 acres Total 1,188,800 acres Indirect-Spread Effect Groundnuts 1,500,000 acres Soybean 20,000 acres	Detailed township, village and farm records maintained at township and village tract levels on acres with improved tillage practices and inputs used by individual farmers.	1. That acceptable technology can be introduced. 2. That acceptable economic incentives for adoption are provided. 3. That inputs and technical information can be delivered as planned in acceptable form and in the townships selected. 4. That weather conditions are near normal.

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	AREAS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Outputs (C-1)	Designated Outputs (C-2)	(C-3)	Assumptions for achieving outputs (C-4)
1. Improved national research capability in maize and oil-seeds.	1. Research: On-going trials conducted at central research facilities in Yezin and at 40 field-level high technology sites within 8 intensive townships on seed varieties, soils, fertilizer application rates, water control and other production variables affecting yields of maize and oilseeds.	1. Regular records of Agriculture Research Institute at Yezin and other sites.	1. That necessary staff is assigned and facilities can be established for conduct of trials, development of seed farms, etc.
2. Introduction of improved maize and oilseed technology and production practices (seed, water, fertilizer, extension services).	2. Cultural Practices: Newly developed technology farm-tested at high technology sites resulting in township and/or village specific production packages for each crop per township.	2. Regular records of the Extension Division staff managing high technology sites in the intensive townships.	2. That suitable technology can be tested and proven on a timely basis for use at demonstration sites.
3. Fully equiped and staffed maize and oilseeds seed farms.	3. Seed Farms: 2 foundation seed farms of 70 acres for oilseeds and 110 acres for maize plus 2 certified seed farms of 800 acres for oil-seeds and approximately 3,000 acres for maize; all four operational and integrated with seed processing facilities for drying, bag-going and storing 3,550 MT's per year of maize, groundnuts, sesamum, flower and soybean seed.	3. Records of seed farm managers Agriculture Corporation project staff and U.S. seed technology advisors.	3. That needed equipment, funds and staff are provided on time.
4. an operational farm management information system for monitoring farm-level production practices and providing feedback on results to research and extension centers.		4. AC regular reports.	4. That U.S. and local procurement proceeds as scheduled. That ocean shipping, internal trans-port and storage can be arranged as needed.
5. Returned participant trainees in place within the research, extension, seed farm and fertilizer distribution elements of the project.		5. AC personnel records.	
6. Inputs supplied to farmer participants (fertilizer, seed, management, equipment-rhizobium inoculum).		6. AC Procurement Division receipt and distribution records for fertilizer and pesticides; and AC/ Extension Division records on production and distribution of improved seeds, equipment and inoculum.	
7. A functional rhizobium production facility (inoculum for groundnuts and soybeans).			

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	AREAS OF VERIFICATION	IMPORTANT ASSUMPTIONS
	4. A functional data collection and farm management information system in place and operated by trained staff in 6 in tensive townships.		
	5. 75–100% of returned Burmese participant trainees occupy positions directly or indirectly involved with maize and oilseed production.		
	6. Cumulative inputs supplies as follows to project townships: - Fertilizer - 70,000 MT's - Seed - about 9,000 MT's - Pest management inputs (exact mix to evolve from project) - Agriculture equipment Approx. $5 million - Inoculum - 8 million pound		
	7. Local inoculum production of 3 million pounds per year by fifth year of project.		

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	AREAS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Project Input: (D-1)	Implementation Target (Type and Quantity)(D-2)	(D-3)	Assumptions for providing inputs: (D-4)
AID Funding	AID – ($30.0 million)	AID	AID
1. Technical assistance $ 2.4 million 2. Participant training $ 3.0 million 3. Commodities $20.0 million 4. Contingency/inflation $ 3.5 million 5. Evaluation $ ______ million SUBTOTAL $30.0 million	1. Technical assistance a) 156 person months of long-term TA (13 PY's x 12 mos.) b) 70 person months of short-term technical assistance. 2. Participant Training a) 11 PhD degrees at 4 years each—(44 PY's or 528 PM's) b) 25 MS degrees at 2 yrs each—(50 PY's or 600 PM's) c) 70 short-term training programs at average of 4.5 months (315 PM's) 3. Commodity Procurement a) Fertilizer ($15.0 million) TSP-10,000 MT (Approx.) UREA-10,000 MT (Approx.) b) Machinery, equipment, parts and supplies ($5.00 million) (1) Seed farms with farm production, processing & storage facilities ($2.70 million) (2) 1 rhizobium production facility ($0.25 million) (3) Laboratory equipment publications and related research needs at AAI/Yezin ($0.10 million) (4) Equipment & materials for extension information demonstration on farm use	1. Contractor reports and quarterly reports; AID-financed documents (vouchers, etc.) 2. Contractor records & quarterly reports; GSRU project records; AID/Burma participant training records. 3. a. AID/W procurement & shipping records; AC procurement, shipping, unloading records and monthly inventory reports. b. Contractor procurement reports. AID/W financial records AC records and reports. 4. All of above depending on allocation and use of contingency reserve.	1. That the project is approved on schedule and that funds are provided as scheduled on an annual basis. 2. That contractor selection and procurement and staffing proceeds on schedule. 3. That participants are named, qualified and processed on schedule. 4. That commodity procurement proceeds as planned and commodities are shipped, cleared, and moved to project sites expeditiously. 5. That the contingency allowance for escalation in costs of TA, training and commodities proves adequate to meet needs.
SRUB Funding		SRUB	SRUB
1. Fertilizer $10.0 million 2. Fertilizer Distribution $ 4.0 million 3. Other local costs including personnel, facilities and supplies (K equivalent in US $) $ 4.0 million SUBTOTAL $18.0 million TOTAL $48.0 million		1 & 2. Agriculture Corp. Procurement Division records and monthly reports. 3. SRUB project records and quarterly reports.	1. That SRUB budget resources are released on schedule. 2. That unusual difficulties are not encountered by the GSRUB, AID or the contractor in making needed procurement and inports. 3. That SRUB staff personnel and AID contractors can be assigned and remain in the project as planned.

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	AREAS OF VERIFICATION	IMPORTANT ASSUMPTIONS
	(5) Spare parts plus procurement costs, shipping handling, etc. ($0.05 million) 4. <u>Contingency</u> ISI contingency to cover inflation in costs of training, commodities and technical assistance and to finance some import needs which may have been missed in preparing detailed listings of requirements. <u>SRUB</u> - ($10.0 million) 1. Fertilizer ($10.0 million) UREA 26,000 MT (Approx.) MOP 4,000 MT (Approx.) 2. Fertilizer handling, transport and distribution from Rangoon port to township level godowns ($20.0 million or 4.0 million) 3. Other costs including pesticide, management, staff logistical support, research and extension facilities, seed farm facilities and operation plus establishment and operation of high technology sites. Total: (Kyat $7.6 million or $ 8.0 million) (at K 7.2 = $1 U.S.)		4. That complementary facilities and equipment can be constructed, developed or purchased locally to meet project requirements.

FERTILIZER PROMOTION PROJECT - INDONESIA

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Sector Goals: Increase agricultural output over 1979-1983 period. Increase small farmer incomes.	Measures of goal achievements: Annual average growth rate of crop output of four percent continued participation of small farmers in adoption of HYV package.	Data: GOI statistics on agricultural production. Review and synthesize relevant evaluation reports of ARDC, SFDA/MFAL, Program Evaluation Organizations, REC, etc.	Assumptions: "Normal" weather over '79-'82 period. "Normal" plant disease and plant infestation. Implementation of projected levels of investment in irrigation and other complementary inputs.
Project Purposes: Maintain current momentum of fertilizer consumption on an equitable basis.	EOPS: Increase national fertilizer consumption at an average rate of 10%/annum. Increase growth rate of "lagging" areas relative to State averages. Continued participation of small farmers in increased fertilizer consumption.	Data prepared by Fertilizer Section, MOA. Using NCAER study as a benchmark may be necessary for example to land sample survey to evaluate progress.	Current crop/fertilizer price relationships will be maintained. Planned increase in rural credit will be attained. Investment plans for complementing inputs will be achieved. Planned extension activities is lagging areas will be implemented.
Outputs: Adequate supply of fertilizer at local level. Expanded base of consumption.	Magnitude of Outputs: Consumption of approximately 25 million M.T. of fertilizers. Additional supply points will be established in the "lagging" areas.	Data prepared by Fertilizer Section, MOA. Data prepared by Fertilizer Sections, State DOA. Jointly agreed upon GOI/AID evaluation studies of distribution and promotion activities.	Transportation and storage will not be a constraint. Current foreign exchange picture will not change dramatically. Production capacity will develop on schedule.
Inputs: GOI: Government budget to cover fertilizer imports, transportation costs, promotional activities, personnel salaries and general operating expenses. AID: $150 million for imports.	Implementation targets: GOI: Continuous import program sufficient to maintain necessary buffer stocks. AID: Fertilizer Imports according to following schedule: FY 1979 $22 mil* FY 1980 $49 mil* FY 1981 $79 mil* * landed cost	GOI Reports and instructions. AID Procurement and disbursement records.	

SMALL FARMER PRODUCTION PROJECT - EGYPT

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program Sector Goals: The broader objective to which the project maintains: Increase productivity of small farms leading to greater small farmer income and employment.	Indicators of Goal Achievement: Farmers in project area increase outputs by 1986 as: follows: 1. Cooperating farmers, initial 9 groups: 25% 2. Remaining cooperating farmers in 9 villages: 20% 3. Cooperating farmers in 10 villages: 15% 4. Other farmers in 27 villages: 10% 5. Farms in remaining villages of the 6 project districts: 5%	1. Project baseline and control group studies. 2. MOA data.	Assumptions for achieving goal targets: 1. Price policies remain as are or move closer to free market. 2. Demonstration effect and government/district level changes provide significant benefit to farmers in non-project villages.
Project Purpose: To develop and apply in 3 governorates on improved PPB&C credit and input system to provide small farmers with access to agricultural inputs, including seed, fertilizer, cash, technological in formation and capital equipment.	Conditions that will indicate purpose has been achieved. End of project status: By 1986: Effective system operational in 8 markets, ready to be applied on a larger basis. System enables farmers to increase yields and income by 10% by providing greater access to inputs, encouraging use of new technologies, and increasing farmer service by the Bank and Extension Service.	1. Project Baseline and control group studies. 2. Bank data. 3. Results of outside evaluations, 1 and 2.	Assumptions for achieving purpose: 1. Bank employees can be motivated to be responsive to small farmer needs. 2. Bank remains principal actor in input delivery system in long-term. 3. New technologies exist that can be applied by farmers.
Outputs: 1. Improved Bank Management and Administration System. 2. Improved Short-term and Medium-term Credit System. 3. Farm management system developed. 4. Improved input storage and handling system.	Magnitude of Outputs: 1. System implemented in 27 village banks. 2. System implemented in 27 village banks. 3. 162 cooperating farmer groups (4000 farmers) formed and assisted by 27 farm mgmt. teams.	1. Project records. 2. Bank records.	Assumptions for achieving outputs: 1. Supplies available to Bank at correct time in amounts needed. 2. Transport to governate facilities available. 3. Bank remains willing to experiment with new approaches and cooperate

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
5. Bank training system upgraded.	4. 150 storage facilities upgraded, 50,000 new facilities constructed, 54 transport units in use. 5. 1 trng. facility upgraded, 50 Village Bank officials trained. 300 village bank employees trained.		with Extension. 4. High level policies continue to favor more op distribution of inputs. 5. Farmers willing to partic pate.
Inputs:	Implementation Target (Type and Quantity):		Assumptions for providing inputs:
1. Technical Assistance 2. Loan Funds 3. Training 4. Storage Facilities and Equipment 5. Building Rennovation 6. GOE Staff	1. 460 work months 2. $12,375 million. 3. Construction, participant training, in-country training contract. 4. New construction, transport equipment, land, handling eqpt., repairs. 5. Furniture and equipment, repairs to 34 bank buildings. 6. 913 work years.	1. Project records. 2. Bank records.	1. Bank and Extension are willing to provide personnel. 2. MOA estimates to support growth of loanable funds.

FERTILIZER PROJECT - SRI LANKA

1. Goal: Agricultural Development that:

    1. Increases domestic food production
    2. Expands employment opportunities
    3. Improves small farmers' standard of living.

    A. Indicators:

    1. Paddy production
    2. ABsolute and relative numbers of productivity employed people in the agriculture sector.
    3. Small farmer incomes.

    B. Means of Verification:

    1. Bureau of Census and Statistics data
    2. Ministry of Agriculture and Lands data
    3. Central Bank data.

    C. Assumptions:

    1. Increased domestic rice production creates more jobs
    2. Small farmers who produce more paddy, have an increased marketable surplus of paddy and are able to capture enough of the additional returns from increased production to enable them to improve their standard of living.

2. Project Purpose: Increased use of fertilizer by small farmers

    A. End of Project Status:

    1. Fertilizer use rates by paddy farmers with 5 acres or less who use fertilizer will be: (nutrients)

        a. Wet Zone

A.	Rainfed	80 lbs/acre
B.	Irrigated	100 lbs/acre

        b. Dry Zone

A.	Major system	100 lbs/acre
B.	Minor system	70 lbs/acre

    2. Percent of paddy farmers with 5 acres or less who use fertilizer will be 90 or 85 for rainfed and irrigated areas.

B. Means of Verification:

GSL surveys

C. Assumptions for Achieving Project Purpose:

1. Institutional credit isn to a major constraint to fertilizer use
2. Farmers are aware of benefits of fertilizer use
3. Costs and prices continue to provide economic incentives for using fertilizer
4. Lack of timely availability of fertilizer is a major constraint to its use
5. Rainfall is normal.

3. Outputs: Adequate supply of fertilizer at local level during Maha 78/79, Yala 79, and Maha 79/80.

A. Magnitude of Outputs:

1. Approximately 264,000 tons of urea, 48,000 tons of TSP, 48,000 tons of NPK
2. GSL policy, procedural and institutional reforms.

B. Means of Vertification:

CPC records

C. Assumptions for Achieving Inputs:

1. Demand equals GSL projections
2. Sufficient system improvements now being considered will be implemented.

4. Inputs:

A. Target

Imported Fertilizer	AID	$26 million
	GSL	$10-20 million
	Other donors	$24 million
Operation of marketing systems		Approx. $14,400,000 local cost if distribution costs = Rs. 600/ton. System improvements should decrease this cost.

B. Means of Verification:

AID records
CPC records
External Resources Division records

C. Beginning of Project Status:

See Tables VII and IX

FERTILIZER STUDY SCOPE EXAMPLE
STUDY FOR THE ASHUGANJ FERTILIZER PROJECT
BANGLADESH

Terms of Reference

I. Objective

1. To develop phased proposal for improving the fertilizer marketing and distribution system (complete with all its personnel and material components) so that, taking into account costs and benefits, foreign exchange scarcity and administrative constraints, the resulting system should be the best achievable for the period 1976 through 1986. Investment proposals and, to the extent applicable, proposals for reorganization should be so phased as to be able to distribute and market the country's fertilizer requirements by the end of 1978, when the Ashuganj Fertilizer Plant is expected to commence commercial operations.[1]

2. The study must:

Phase I.

(a) Carry out economic and financial analysis of alternative distribution systems provide sufficient information on the optimal distribution system, including in particular transport modes, bulk vs. bag shipment, size the material of bags, etc. so as to enable the Ashuganj Fertilizer and Chemical Company to take decisions on the design of the storage, bagging and dispatch facilities of the Ashuganj Fertilizer Plant; and

(b) On the basis of projections of demand for fertilizer estimate the seasonal storage requirements for the major transshipping and trans wholesale locations up to 1985/86.

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1. USAID note: Plant commercial operation date now probably mid-1980. SOURCE: BADC, June 1976

Phase II.

(c) Complete the feasibility study of proposed investments to improve the fertilizer marketing and distribution system, including, where deemed more efficient, multipurpose facilities for storage or transport of grain, pesticides, seeds, etc. as well as for fertilizer. The feasibility study will include cost estimates and economic and financial analysis in sufficient detail to enable a proposed project to be appraised for financing by a bilateral or international agency.

3. The draft final report for PHase I is to be completed within four months of inception and the final report within one month of receipt of written comments from the Government. The draft final report for Phase II is to be completed within three months of inception and the final report within one month of receipt of comments from the Government.

II. Specific Tasks Under Phase I

1. Making use of existing fertilizer consumption projections updated to take account of more recent experience and specific development plans that are likely to have an impact on fertilizer use, such as irrigation projects and the rainfed rice improvement project, establish Thana-wise seasonal and annual consumption projections for 1976/77 to 1985/86 and an indicative forecast for a further approximately 10-year period.

2. Factors affecting procurement of all imported fertilizers and fertilizer raw materials (rock phosphate, sulphuric acid) must be assessed. THese include, but are not confined to, the likely world market situation of the materials concerned, Bangladesh's foreign exchange situation and priorities thereof, domestic production forecasts, and information, inter alia, from all branches of the Government of Bangladesh, the Bangladesh Aid Group, bilateral aid-giving agencies and the IBRD.

3. Based on the foregoing, a judgement must be made on the quantity of minimum pipeline storage requirements year by year, for the ten-year period under review.

4. Arising out of domestic production projections and the likely demand for the domestically procured fertilizer, exportable surpluses and import requirements must be determined year by year, and methods for their movement developed, in conjunction with other fertilizer transport and storage needs.

5. Assuming that farmers' points of purchase (the retailers' outlet) will be supplied from Thana stores and that these points will be required to carry adequate, pre-determined inventories, a model for developing seasonal and monthly fertilizer movements must be constructed. It is to commence at the point at which the fertilizers become the property of the marketing and distribution organization and end in the Thana stores.

6. Taking into account information to be provided under Paragraph 4.9 of this Agreement and listed in Appendix-D, the location, capacity...

9. Examine the present pricing structure and on-costs and recommend a fair and equitable price build-up based on costs and reasonable profit margins commensurate with services rendered.

10. Taking due notice of existing private and public transport organizations, make specific recommendations as to what part, if any, of the additional transport equipment should be owned by the fertilizer marketing and distribution organization.

11. Determine the most suitable package size, balancing end-user convenience against costs.

12. Arising out of 11, packaging methods and materials must be evaluated, approximate specifications as to dimensions and strengths given, bag testing methods established and stacking patterns developed to ensure proper inventory and movement control on a "first-in-first-out" basis. The costs and economic benefits of changing existing bagging materials must be analyzed and specific recommendations made to enable, inter alia, the drawing up of specification of the bagging lines of the Ashuganj plant and the desirability, under the conditions of Bangladesh, to have a completely weatherproof package.

13. Determine whether BADC will be capable of carrying the fertilizer marketing and distribution business along with its other growing activities and make specific recommendations as to whether, and when (in terms of time or volume of business) a separate fertilizer marketing and distribution corporation might have to be set up. Determine at what point along the distribution pipeline it should hand over to other organizations such as private, cooperative, or public sector wholesalers and/or retailers.

14. In view of the geographic spread of the fertilizer (and, possibly, pesticides, seeds, etc.) business, prepare an organization charge for the marketing and distribution organization. This should include, but not be confined to:

   a. the sales organization, comprising of personnel in contact with the dealers;
   b. the distribution organization, comprising movement, bagging, warehouse management, and contact with the railways, water transport, truckers, and local hauliers;
   c. product line personnel for times that may be distributed along with fertilizer (see Phase II);
   d. a market research and market intelligence organization that will develop annual and five-yearly consumption forecasts on a Thana, product, and seasonal basis every year. This forecast must be available to enable ordering the next year's import need in good time and to give a positive basis for longer-range supply contracts;
   e. as part of d. above, specify the time of the yar when such forecasts are to be submitted in a country-wide consolidated form;
   f. a market development organization which must include dealer training and may include market development, advertising and sales promotion activities directly operated by the fertilizer marketing and distribution organization;
   g. develop the necessary supervisory superstructure including the criteria and location of regional subdivisions and the headquarters organization. Establish a realistic salary formula for all cadres, with due regard to equivalent Government and private enterprise compensation structures that will enable the build-up of motivated, high quality staff.

15. Calculate the costs of such an organization under the overall management system that will evolve from 12 above and make specific recommendations as to the necessary dealer, wholesaler, distributor and importing organization's mark-ups. In this context, evaluate and make specific recommendations on whether any part of the distribution chain should work on a commission agency basis (pay after sale) or whether ownership of fertilizer and final responsibility of disposal should devolve on the extraneous wholesaler and/or retailer. Similar recommendations are required for other products marketed with fertilizers.

16. Estimate extent and duration of credit needs of the distribution chain, on the assumption that the end-user pays cash for this purchase (whether from his own resources or borrowed is not part of this study).

17. Determine whether there are any specific technical assistance and/or domestic and external training needs for developing the fertilizer marketing and distribution program; and quantify and cost them.

III. Specific Tasks Under Phase II

1. Examine whether and how the distribution of seeds, pesticides, sprayers and other purchased inputs should be integrated with that of fertilizer distribution and in what way such integration affects distribution management and the multiple use of storage and handling facilities. Also, examine, in coordination with consultants involved in the foodgrain storage study, any possible saving through joint use of storage, transportation or distribution facilities.

2. For all assets to be acquired or rehabilitated for the fertilizer marketing and distribution system, including to the extent found justified transportation investments and satellite bagging facilities, and to the extent found desirable facilities for the combined storage and/or distribution of grain, pesticides, seeds, etc. as well as fertilizer, determine:

   a. Capacity, location (including a map) and suggested five-year phased program for rehabilitation of existing storage facilities and/or construction and acquisition of new facilities;
   b. Investment cost, broken down into local and foreign exchange components;
   c. Proposed organizational arrangements for project implementation and for management of facilities once acquired;
   d. Estimated seasonal patterns of utilization of facilities;
   e. Estimated annual operating costs and recommended charges for the use of facilities and resulting projected cash flows;
   f. Benefit analysis, including both the financial and economic rates of return.

In examining possible multipurpose storage facilities for foodgrains and pesticides as well as fertilizer, use should be made of results of the foodgrain study[2] and pesticides study[3] to be undertaken by USAID-financed consultants. The feasibility study for the proposed investments should be in sufficient detail to enable a proposed project to be appraised for financing by a bilateral or multilateral aid agency.

Expected Report Outline

Summary and Conclusions - Phase I

A. Past Performance

1. fertilizer marketing and distribution since 1963/64; evaluation of achievements; shortcomings;
2. analyze and evaluate the present cost structure methods of payment and margins;
3. prepare fertilizer production and consumption projections for the next 10 years, by nutrients; review available data, evaluate and develop the product-wise figures on which the marketing and distribution plan is to be based (a desk study).

B. Project Planning Parameters

1. Review of fertilizer supply situation from:

   i. indigenous sources;
   ii. imports;
   iii. expected control over import phasing of raw materials and finished products.

2. Time perspective of proposed project, reasons.

C. The Project

1. Need for the project.

2. Project components.

   a. Sales to end-users

      i. location and numbers (within each Thana) of final sellers;

---

2. Apparently refers to Kansas State University team scheduled for July 1976.

3. Pesticides study completed March 1976.

ii. minimum deliveries to dealers, their method of payment, handling charges;
iii. permitted dealer margins; enforcement.

b. Supplying dealers

i. by wholesalers/distributors;
ii. by BADC direct;
iii. TCCA and/or other wholesaler involvement;
iv. proposed flow chart from factory/port to the sales point;
v. seasonal storage facilities required, their location and size;
vi. costs of operation.

c. Product preparation

i. bag sizes, bagging materials, reasons for recommendation (economic and operational);
ii. points of bagging, facilities required, cost (local & FX);
iii. costs of operation.

d. Market development and market intelligence

i. details of market intelligence required, methods of consumption forecasts for one year; and of or each of the following five years;
ii. marketing services, sales promotion, and market development required; identify socipe and extent devolving on the marketing organization, with special reference to dealer training.

e. Integrating other input services marketing with fertilizers

i. identify and discuss product lines;
ii. additional physical facility requirements in distribution chain;
iii. procurement, packaging;
vi. incremental costs to organization; total marketing costs.

f. Related services and facilities

i. indigenous production phasing (routine plant shutdown timings, new plant construction schedules);
ii. import phasing and management;
iii. transportation needs:

(a) rail
(b) road
(c) water
(d) local
(e) delivery methods of dealers
(f) terminal handling facilities

iv. satellite bagging facilities (if found justified).

g. <u>Organization and Management</u>

i. evaluate BADC's capability to carry fertilizers;
ii. BADC and/or alternative organizations, their formations, timing of change over, if any;
iii. staffing patterns, organization charts, locations, office and transport equipment needs, job descriptions at each stage;
iv. recommendation for technical assistance and training.

<u>Summary and Conclusions - Phase II</u>

A. <u>Past Performance and Current Situation</u>

1. marketing and distribution of other production inputs;

2. pesticides and seeds: review of available data, consumption forecasts (a desk study);

3. same for any other product arising out of a. above;

4. existing unitary and multipurpose storage facilities owned and rented by public agencies for fertilizer and for any other commodity for which multipurpose storage facilities are recommended;

5. performance of the system, its volume of commodities handled and stored, seasonal movement, location;

6. major problems experienced with the existing system.

B. <u>Project Planning Parameters</u>

1. projections on a seasonal and Thana basis of the volume of fertilizer to be handles and stored and the volume of any other commodity recommended to be stored in multipurpose facilities with fertilizers;

2. comparison of the above projections with the quantity and quality for existing facilities;

3. criteria for determining the location, capacity and design for transportation, storage or satellite bagging facilities or equipment proposed to be built, procured or rehabilitated;

4. justify the need for the project.

C. The Project

Describe the overall project and its major components, its total investment cost, and the criteria used in determining project design as against possible alternatives including:

1. capacity, location (including a map) and a suggested five-year phased program for construction or rehabilitation and/or acquiring of storage facilities;

2. investment cost, broken down into local and foreign exchange components;

3. proposed organizational arrangements for project implementation and for management of facilities once acquired;

4. estimated seasonal patterns of utilization of facilities;

5. estimated annual operating costs and recommended charges for the use of facilities and resulting projected each flows;

6. benefit analysis, including both the financial and economic rates of return.

Appendix

To contain all cost and facilities tables, in phasing-in table or diagram form and summary cost tables showing local and foreign exchange costs and phasing. Recurrent costs, year by year are to be shown.

PROJECT PAPER OUTLINE
ASHUGANJ FERTILIZER PROJECT - BANGLADESH
(December 1974)

19. Economic Analysis
20. Economic Cost and Benefit Streams
21. Economic Rate of Return and Sensitivity Analysis
22. Annual foreign Exchange SAvings
23. Interest During Construction
24. Draft Loan Agreement
25. FAA Section 611(e) Certification
26. Draft Loan Authorization
27. Draft Financing Agreement
28. Draft Project Agreement
29. Draft Memorandum of Agreement Regarding Project Execution, Procurement and the Use of Loan Funds
30. Checklist of Statutory Criteria
31. Environmental Impact

Much of the narrative and analysis in this paper was prepared by the International Development Association. The documents contained in Annexes 27, 28, and 19 resulted from the loan negotiations and were drafted by various parties thereto. The Summary and Recommendations, Sections IX through XII and Annexes 24, 25,26 and 30 were prepared by A.I.D.

ANE FERTILIZER STUDY

BIBLIOGRAPHY

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Nancy Voght

July 1987

TABLE OF CONTENTS

INTRODUCTION

The bibliography is selection from materials reviewed in the course of the study on the spectrum of issues expected to be useful to USAID Project Officers involved in fertilizer sector assessment or fetilizer sector activities. It is not intended to be a complete listing of materials reviewed in connection with the guidebook, which was the principal product of the study and represents but a small part of the voluminous literature on the subject.

The bibliography is divided into three parts: an annotated bibliography of materials deemed most useful, a listing of other literature of potential interest including recent AID reports (which are available in the AID Library in Rosslyn), and journals and other reports focusing on fertilizer or fertilizer related issues.

There are several reports which the authors recommend should be maintained, on a current basis, in every USAID Agriculture Office. They are as follows:

- **The Food Outlook**, produced monthly by FAO which provides up to date information on the food situation, commodity prices, current international fertilizer prices and recent sales.

- **The Indices of Agricultural Production** published by the USDA Economic Research Service which provides regional and individual country data on agricultural production, food production and per capita production.

- **The Fertilizer Situation** reports for each of the regions (Asia, Africa and Latin America) prepared by International Fertilizer Development Center (IFDC).

- **The Fertilizer Handbook** of the Fertilizer Institute (1015 M Street, NW, Washington, D.C. 20036)

- **International Market Information Sources,** International Fertilizer Development Center (IFDC), P.O. Box 2040, Muscle Shoals, Alabama, 35662, March 1984.

- **IBRD Commodity Trade and Price Trends** (published by Johns Hopkins University Press). Annual issues which provide price services monthly back to 1950 for major world commodities.

It would be desirable for USAID Missions' agriculture offices to establish and maintain contact with International Fertilizer Development Center (IFDC), Muscle Shoals, Alabama, in order to receive current listings of recent publications on fertilizer. AID has a contract with IFDC to provide technical assistance in the fertilizer sector.

India and Pakistan both have domestic fertilizer organizations, the Fertilizer Association of India and the National Fertilizer Development Centre of Pakistan, which provide various development services, including publication of many useful reports on fertilizer.

The Marketing and Credit Service, Agricultural Services Division, FAO, Rome, and the journal Agro-Chemical News in Brief issued by the Fertilizer Advisory Development and Information Network for Asia and the Pacific (FADINAP) of the United Nations are also valuable sources of information and reports on current fertilizer issues.

A. ANNOTATED BIBLIOGRAPHY

Agricultural Assessment, Tunisia, Newberg, Richard R., MASI Development Services, Washington, D.C., February 1981.

This sector assessment examines agricultural pricing, marketing, input supply and distribution, agricultural policy and other factors in Tunisian agricultural development; concludes that agricultural prices and slow growth in fertilizer consumption are major constraints to agricultural growth.

Agricultural and Economic Committee's Report on the Agricultural Situation and Fertilizer Consumption. International Fertilizer Industry Association Ltd. December 1982. 50 pages.

Synopsis divided into two sections. The first concerns the development of fertilizer consumption in the Western world in 1981/82, and the outlook for 1982/83. The information is derived from six reports from members of the IFA Agricultural and Economics committees.

The second section briefly describes developments in the international trade of processed phosphates and urea as of June 1982. The information in this section is derived from the Economic Committee's processed phosphate and urea trade statistics. Includes Tunisia, Philippines, India, Zimbabwe; provides consumption and price ratios for NPK per crop and gross financial returns for resources invested in fertilizer.

Agricultural Price Policies and the Developing Countries, Tolley, George S., Vinod Thomas, and Chung Ming Wong. IBRD, Washington, D.C., 1982.

Chapter 7, "Price Supports and Input Subsidies", provides an analysis of the relative costs and impacts of farm level price supports and input subsidies and circumstances under which one or the other may be preferable.

"Agronomic Techniques to Conserve Energy Inputs for Food Production", Oka, A. H.; Ida Nyoman; Partohardjano and Bahgiawati. In Alternative Sources of Energy for Agriculture, Proceedings of the International Symposium, September 4-7, 1984, Sugar Research Institute, Taiwan, pp. 416-431, 1985.

Discusses the potential for substituting organic fertilizers for chemical fertilizers to alleviate the input constraint to food production, and the importance of improved management of fertilizer and other chemical inputs in order to improve productive efficiency.

An Analysis of Fertilizer Policies in the Philippines, David, C.C., and A.M. Balisacan, Staff Paper Series No. 82-1, Philippine Institute for Development Studies, May 1982.

An analysis of the fertilizer subsector and price and other policies and their impact on the Philippines. Findings included the following: protection served largely to protect local firm; protection is highest for highest cost firms's; there is a tendancy to undervalue agricultural products; and farmers and general public bear burden of growing inefficiency in fertilizer industry.

Annual Report 1983, Planters Products, The Philippines, 1983.

A 1983 report of PPI discussing marketing and financial operations. In 1983 PPI was the largest distributor of fertilizer in the Philippines, but it encountered serious financial difficulties soon thereafter, which sharply reduced its role.

Appropriate Fertilizer Technology for Developing Countries, Fertilizer 1983, Volume 1 Hignett, T.P. and Parish, D.H. (A.I. More, Editor). International Fertilizer Development Center, Muscle Shoals, Alabama. pp. 349-359.

Reviews alternatives in adaptation of technologies for fertilizer processing and handling to small and low investment operations. Provides some significant examples from China's experience in small and decentralized plants.

Asia, Fertilizer Situation, 1986, International Fertilizer Development Center, Muscle Shoals, Alabama, January 1986, 84 pages.

Data presented on world production, consumption and trade by regions 1972/73 to 1982/83 in terms of N, P_2O_5, and N_2O and world prices of major products. Data are also presented on fertilizer consumption 1972/73 to 1982/83 in 38 Asian countries for major products and 1982/83 production, trade and consumption (all products) for 28 countries. (The report notes similar publications are available from IFDC on Africa, Latin America and the developed countries).

The Bangladesh Fertilizer Sector, 1978, Chuang, Yao H., John M. Hill, and Bill H. Barnett. International Fertilizer Development Center, Muscle Shoals, ALabama. October 1978, 57 pages.

Rapid expansion of the fertilizer industry is recommended to reduce food import dependence. Expansion and improved management of the distribution facilities are needed to meet needs. Major recommendations are for: improved information collection and flow, better supply managment and demand projection, better training, study of needed incentives for private fertilizer trade and for farmers, in-depth study and improved sector planning.

Bangladesh New Marketing System, Second Evaluation, Hill, John M. and Robert D. Benton. USAID/Dacca, International Fertilizer Development Center, Muscle Shoals Alabama. July 1980, 76 pages.

The report describes the marketing system in use prior to the new system and evaluated the new system as of May 1980. Findings reveal that the new marketing system has: increased farmers' access to fertilizer sources, comparatively lowered retail prices, consolidated government warehousing, and had minimal effect on the government costs of distribution. The new system has not worked well in underdeveloped areas where transportation and communications are inadequate and where fertilizer sales are low. The new marketing system is still in the early stages of transition and development; additional modifications are under consideration.

"Capital Costs of Fertilizer Plants", Nitrogen, No. 149, May-June 1984, pp. 30-34.

Provides recent data on ammonia plant costs (most plants with urea facilities). Major delays and cost overruns were experienced in developing country plants; as a result costs per unit are substantially increased.

Changes in the Form and Price of Fertilizer-A Global Perspective, Stangel, P.J., Extension Bulletin, Food and Fertilizer Technology Center, Taiwan, 1985, No. 217, 20 pages.

Bulletin discusses production and consumption of chemical fertilizer and indicates probable trends for the future.

The Changing Structure of the International Fertilizer Industry, Sheldrick, W.F., Vienna, 1983, 41 pages.

The paper forecasts the needs for each nutrient to meet increasing world demand and discusses some of the economic factors likely to influence the location of the plants. Discusses expectation for needed additional plant capacity after 1987.

Chemical Fertilizer Projects: Their Creation, Evaluation and Establishment. United Nations Industrial Development Organization, Monograph No. 1, 1968, 52 pages.

Discusses creation of sound projects, project planning in development, planning and project implementation, evaluation, setting up an industry.

"China: The Facts About Fertilizer", Richter, D. in Agro-Chemical News in Brief, Vol. 8, No. 3, (1985), Economic and Social Commission for Asia, Bangkok, Thailand, 1985, pp. 17-22.

Discusses the growth of fertilizer use in China, the distribution with cooperative retailing 87% (through stores). There are 55,000 input stores (which account for over 50%), 110,000 "retail" stores (30%) and temporary commercial agents (5%). Half of China's fertilizer comes from widely dispersed plants of 5,000 to 20,000 MT/year mainly producing ammonium bicarbonate. The rest of the N is produced by 13 large urea plants. Fertilizer sector constraints are discussed.

Commodity Trade and Price Trends, 1985 and 1986 editions, IBRD, The World Bank, and Johns Hopkins University Press, Baltimore, Maryland, 1985, 135 pages.

Provides data on all major commodity prices including various types of fertilizer, mostly going back to the 1950s.

Communications and Fertilizer Promotion, United Nations Economic and Social Commission for Asia and the Pacific, Agricultural Information Bulletin 1984, pp. 5-10.

Discusses the advantage of combining advertising and public relations with well tested methods such as demonstration plots. Recommends information elements essential to farmers such as safety, performance, appearance, convenience, reliability, economy and durability.

"The Compilation and Analysis of Statistical Data on Fertilizer Consumption: the Indian Experience", Parthasarathy, N.S., E.I.D. Party (India) Ltd., in Agro-Chemicals News in Brief, pp.38-42, Economic and Social Commission for Asia, Bangkok, Thailand, Special Issue, March 1983

This paper examines the need for and importance of a comprehensive data base, the present system of information flow, the possible role of the fertilizer industry in improving the present system, the importance of information on crop-wise usage, the role of the Fertilizer Association of India in statistical analysis and the present method of demand forecasting.

Current World Fertilizer Situation and Outlook, FAO, Rome, 1982, 39 pages.

Provides projection of 1986/87 fertilizer situation as of 1982. Includes price data for different products from 1965 to 1982. Tables show 1975-80/81 production and consumption by region and for the world, as well as 1982/83 situation.

"The Demand for Fertilizer in Developing Countries", Timmer, Peter. Stanford University Food Research Institute, Food Research Institute Studies, Agricultural Economics, Trade and Development, 13(3), pp. 197-224, 1974.

Reviews existing methodology for understanding and predicting farmers' demand for fertilizer. Micro-economic nature of all work on fertilizer demand is criticized and macro-model presented that alters expectations about the relationship between short-run and long-run responses to changes in fertilizer prices. List of important research topics closes the article.

Development and Spread of High-Yielding of Rice Varieties in Developing Countries, Dalrymple, Dana G., Agency for International Development, Washington, D.C., 1986, 113 pages.

Provides a detailed summary of the development and spread of high-yielding varieties (HYV) of rice, principally in developing countries. Includes data on genetic background of varieties and substantial information, country by country, on the introduction and spread of HYV and data on area and percentages of total rice area in HYV by country and region.

Development and Spread of High-Yielding of Wheat Varieties in Developing Countries, Dalrymple, Dana G., Agency for International Development, Washington, D.C., 1986, 99 pages.

Provides a detailed summary of the development and spread of high-yielding varieties (HYV) of wheat, principally in developing countries. Includes data on genetic background of varieties and substantial information, country by country, on the introduction and spread of HYV and data on area and percentages of total wheat area in HYV by country and region.

Dynamics of Price and Subsidies in Fertilizer Experience in Developing Countries, Couston, J.W., FAO, Regional Information Support Service, New Dehli, 1984, 10 pages.

This paper examines the dynamics of prices and subsidies for fertilizers with specific reference to the experience of developing countries, excluding India. Data on fertilizer consumption trends and crop prices of Latin American and African countries are included, together with a discussion of agricultural policies in various EC countries and the US.

Economic Analysis of Agricultural Projects, Gittinger, Price. Economic Development Institute, Johns Hopkins University Press, 1982, 504 pages.

Provides a comprehensive discussion of project analysis and design in agriculture from the definition of projects through identification of constraints and opportunities, project definition, and detailed economic and financial analysis under various conditions.

Economic, Financial and Budget Aspects of Fertilizer Use Development, FAO, Fertilizer Industry Advisory Committee ad hoc Working Party on the Economics of Fertilizer Use, Rome, 1983.

This paper concentrates on the economic factors and considerations involved in transforming the estimates of fertilizer required to achieve food production goals into effective demand by farmers.

"Economics of Fertilizer Manufacture", Hignett, T., Developments in Plant and Soil Sciences, Vol. 15 (1985),pp. 329-345.

Costs estimated for manufacture of different fertilizer products (NH_3, urea, nitric acid, AM, DAP, MAP, and TSP) based on different sizes of manufacturing plants and different costs of raw materials (based on 1976-78 experience).

"The Economics of Fertilizer Use—A Case Study in Production Economics", Hopper, W., in The Indian Journal of Agricultural Economics, The Indian Society of Agricultural Economics, Volume 17, No. 4, Bombay, India, pp. 12-22.

The paper presents a methodology for estimating return to fertilizer uses at 0, 30 and 60 lbs of N and P_2O_5 per acre. On average wheat yields increase by about 12 lbs per lb of N applied and per lb of P_2O_5 applied up to 100 lbs of N and 60 lbs of P_2O_5. Mathematical solution (by differentiation) indicates application rates about one-third as high if the farmer (tenant) must pay 50% as crop share rent.

Effect of Change in Fertilizer/Crop Price Relationship on Fertilizer Consumption and Crop Production in Brazil, Pakistan, Philippines, Sri Lanka, Togo and Upper Volta, FAO/FIAC Working Party on the Economics of Fertilizer Use, Rome, 1984.

The report consists of country case studies commissioned by the Working Party. The central issue discussed is the effect of changes in fertilizer crop prices on fertilizer use and crop production. Summarizes data for each country on crop response to fertilizer, fertilizer price, fertilizer/crop price ratio.

Energy and Fertilizer: Policy Implications and Options for Developing Countries, Mudahar, Mohinder S. and Travis P. Hignett. International Fertilizer Development Center, Muscle Shoals, Alabama, May 1982, 241 pages.

> Presents and economic and technical analysis of the linkages among energy, fertilizer and agricultural sectors. The report has three objectives: a) to estimate energy requirements for fertilizer manufacturing, packaging, transportation and application; b) to evaluate policy implications of energy supply and prices or fertilizer production, distribution and prices; and c) to evaluate policy options to reduce adverse impact of energy supply and prices on fertilizer and agricultural sectors.
>
> Conclusions: a) more efficient use of fertilizer at farm level is most promising means of saving fertilizer energy; b) in fertilizer manufacture, greatest energy savings are likely to come from more efficient plant operations; and c) potential for energy savings in fertilizer distribution is slight. Authors recommend that national governments take the lead in promotion of energy, efficient manufacture, distribution and use of fertilizer, and note that international organizations can be instrumental as facilitators in the design and implementation of such programs at the national level.

"Energy Efficiency in Nitrogen Fertilizer Production", Mudahar, Mohinder S. and Travis P. Hignett, in Energy in Agriculture, Elsevier Science Publisher B.V., Amsterdam, 4 (1985), pp. 159-177.

> Deals with estimating energy consumption and potential energy savings in nitrogen fertilizer manufacture. The report notes 45% of total energy used in agriculture worldwide is for fertilizer in developing countries 68% of energy is in fertilizer. It is noted that energy required to produce 1MT of NH_3 has declined from over 60 GJ in 1940 to 35 in 1980 and will likely be 31 only in 1990. The theoretical minimum is about 23 GJ/MT (about 23 million BTU). Possible savings of energy by more efficient plants and plant operation are discussed.

Environmental Impacts Report: Runciman Fertilizer Works, Harland, Charles William. (New Zealand, 1978).

> The publication provides a comprehensive review of pollution and other environmental issues related to construction and operation of a fertilizer plant. The discussion is of particular interest to those conducting environmental analyses.

Evaluation Report on the Small Farmer Production Project of the Principal Bank for Development and Agricultural Credit, Egypt, AID Grant No. 263-0079, Newberg, Richard R., Janna Laudato, and Glenn G. Browne. RONCO Consulting Corporation, Washington, D.C., June 1985.

> A review of U.S. assistance to the Principal Bank for Agricultural Credit. The PBAC has as one of its functions distribution and financing of fertilizer in Egypt. Fertilizer distribution costs are low; the large number of outlets provide easy access. Credit recovery is high in part because of possible loss of access to highly subsidized and rationed fertilizer in event of non-payment. High subsidies may contribute to uneconomic levels of use.

The FAO Fertilizer Programme, Fertilizer 1983, Volume 1 Braun, H., (A.I. More, editor). FAO, Rome, 1983, pp. 339-344.

Program is an extension oriented joint action program between FAO and collaborating governments of economically developing countries to increase farm income. Field projects of the FAO Fertilizer Program are composed of six phases: (i) project appraisal, (ii) applied research, if and where required, (iii) extension, (iv) distribution and credit, (v) training and (vi) fertilizer coordination and policy formulation. New approaches in agricultural extension are demonstration blocks and assistance in the establishment of national fertilizer institutions in the field of improved fertilizer coordination and policy formulation.

"Farm Level Fertilizer Demand". Sidhu, S. and Baanante, C. In American Journal of Agricultural Economics, Vol. 61, No. 3, August 1979, American Agricultural Economics Association, St. Paul, MN, pp. 455-462.

Attempts to estimate effects of prices on yields and inputs.

Fertilizer Application Equipment for Small Farmers, FAO, Regional Information Support Service, Rome, 1984, 107 pages.

Reviews various types of fertilizer applicators available for use by small farmers at reasonable cost. Describes animal drawn fertilizer applicators, the sebelle fertilizer applicator, fertilizer band applicator, seed/fertilizer applicators, deep placement fertilizer applicators and small fertilizer applicators. Describes principles of machinery and equipment used in fertilizer experiments.

Fertilizer and Related Input Marketing Policies in Zambia and Scope for Improvement, Mittendorf, H.J., FAO, Rome, September, 1985.

A detailed description of the Zambian fertilizer sector with data on production, distribution, consumption and factors affecting consumption. Provides recommendations on improvement of fertilizer supply and distribution in Zambia.

"Fertilizer Demand in Asia", Economic and Social Commission for Asia, Bangkok, Thailand, in Agro-Chemical News in Brief, Vol. 8, No. 4, 1985, 1985, pp. 3-9, 26.

Provides an update on fertilizer demand in Asia with estimates of consumption of N, P_2O_5, and N_2O per hectare in 1969/71, 1979/81, 1981/82 for 14 countries including mainland China which accounted for 55% of the fertilizer consumed in the region in 1982/83. Country by country situation reports are provided.

"Fertilizer Development in the Asian Pacific Basin", in Fertilizer International, 1985.

Presents information on recent developments in the fertilizer markets of Japan, South Korea, Thailand, Indonesia, the Philippines and China.

Fertilizer Distribution and Credit Schemes for Small-Scale Farmers, FAO Fertilizer Bulletin, 1979, 34 pages.

Describes: pilot fertilizer and related input and credit schemes for small-scale farmers; choices of fertilizer distribution channels for early and advanced stages of economic development; costs and benefits of FAO pilot distribution and credit schemes; and cases of the Philippines and Nigeria.

Explains effective distribution and prioritizing of fertilizer programs. Contains examples of loan agreements, credit agreements, balance sheets and promissory notes.

"Fertilizer Distribution and Pricing in Thailand", Rojvachiranonda, V., Thai Central Chemical Co. Ltd., Bangkok. In Agro-Chemical News in Brief, Economic and Social Commission for Asia, Bangkok, 1983.

The fertilizer marketing and pricing system and the reason for low fertilizer demand in Thailand are discussed.

Fertilizer Distribution in Selected Asian Countries, Report of the 1978 conference on the subject sponsored by Agricultural Production Organization, Tokyo, November 1978, 240 pages.

Provides a summary of the fertilizer distribution system in Japan and each of 10 developing countries in 1978 with some background on the agriculture, fertilizer production and consumption and historical information on fertilizer distribution and consumption in the countries reported upon. The report also provides detailed cost data on fertilizer marketing operations in some countries.

Fertilizer 83, Proceedings of the International Conference on Fertilizer, British Sulfur Corporation, Ltd., London, November 13-16, 1983, 400 pages.

The publication contains a large number of papers prepared by world fertilizer authorities primarily covering technical aspects of fertilizer manufacturing, handling, distribution and agricultural use of fertilizer. Papers also are included on micro-nutrients. Much of the conference was devoted to new, lower cost, cost energy efficient technology.

The Fertilizer Handbook, The Fertilizer Institute, Washington, D.C., 1982, 274 pages.

This publication contains a series of papers prepared by well known U.S. fertilizer authorities covering various aspects of the U.S. fertilizer industry, e.g., development of the fertilizer industry, characteristics of products, manufacturing processes, distribution of fertilizer, agricultural use, environmental aspects, energy use in fertilizer production, and economics of fertilizer use. Written in simple language for the lay person.

The Fertilizer Industry in the Philippines, Shields, John T. and Robert C. Gray. U.S. Agency for International Development, Washington D.C., 1971

> Publication provides (now somewhat dated) data and analyses of the fertilizer supply and demand, trade, distribution system, promotion and other aspects of the fertilizer industry in the Philippines and a brief summary of world and regional production and trade in fertilizer. Appendices of this publication provide fertilizer-crop response data.

"Fertilizer Industry: Processes, Pollution Control and Energy Conservation", Sittig, Marshal. NOYFES Data Corporation, 1979.

> Provides an up-to-date discussion of technology in fertilizer production with special emphasis on the important issue of pollution control and conservation of energy. Data on cost of production and on cost of pollution control are provided.

The Fertilizer Industry: The Key to World Food Supplies, International Fertilizer Industry Association (IFA), Paris, 1986.

> Discusses the sources of world fertilizer, producers and their products, the cost of fertilizers, the cost of investment in fertilizer production, the cost of fertilizer to the farmer, the role of technological progress, the future of fertilizer production, fertilizers and the environment, food supplies, financing fertilizers.

Fertilizer Manual, Hignett, T., International Fertilizer Development Center, Muscle Shoals, Alabama, 1979.

> Provides technical information on current manufacturing processes for principal types of fertilizer in a manner that would be useful to a person unfamiliar with the technology.

Fertilizer Marketing Abstract, Tennessee Valley Authority, 1977, 148 pages.

> Reference volume providing useful lists of publications on market analysis, market development, market organization, storage and transportation, pricing and cost, training and promotion, retail service, world trade, supply and demand.

Fertilizer Marketing Costs in Developing Countries, International Fertilizer Industry Association Developing Countries, Working Group of the Economics Committee, Palma, May 1982.

> Discussion of marketing systems/distribution systems costs as broken down by import/export factory prices, marketing costs, transport, storage, bagging, handling, losses, taxes and levies, interest and subsidies for Asia, Africa.

Fertilizer Marketing Guide No. 7, Wierer, K. and J.C. Abbott. Rome, Italy, 1983, 156 pages.

Topics discussed include: i) demand for fertilizers in developing countries; ii) fertilizer marketing organization and costs; iii) fertilizer marketing management; iv) logistics of fertilizer marketing; v) financing fertilizer distribution; and vi) government services and policies.

"Fertilizer Marketing in Developing Countries". Creupelandt, H. Soils Bulletin, FAO/SIDA, Volume 26, Rome 1975, pp. 62-74.

Focuses on fertilizer marketing to serve small farmers. Many demonstration schemes indicate small farmers require a large network of outlets to provide needed accessibility. Governments are faced with the need to provide for adequate accessibility and other fertilizer sector requirements. Discusses estimating demand, storage needs, transport, quality aspects, incentives, pricing, subsidies, farmer credit, and government policy.

"Fertilizer Marketing Policies in Asian Countries", Lee, C.Y., Marketing and Farm Supply Group, Agricultural Services Division, FAO, Rome. In Agro-Chemical News in Brief, Special Issue, March, 1983, pp. 49-59.

General tendancies and trends in government policies related to fertilizer use, marketing and promotion are analyzed and the basic direction for the improvement of future policies is indicated.

"Fertilizer Marketing, Distribution and Use in Thailand", in Agro-Chemical News in Brief, Volume 7, No. 3, 1984, pp. 18-23, Economic and Social Commission for Asia Bangkok, Thailand 1984.

Provides data and discriptions of the fertilizer sector in Thailand. Thailand is a relatively low user of fertilizer among Asian countries. Agricultural Exports have been maintained by transforming forest land into crop land. All of the fertilizer used is imported: 87% is imported and distributed by the private trade and 13% is publicly controlled. 85-90% of total transport is by truck. Retailer margins average about 5% of the sale price.

"Fertilizer Pricing in India", Narayan, P., Fertilizer Industry Coordination Committee, New Dehli, India. In Agro-Chemical News in Brief, Special Issue, March 1983, 77-81).

Fertilizer pricing in developing countries is discussed, with emphasis on India. Article deals with: the types of government price control, the determination of consumer prices, the scheme of price fixing in India, freight charges and the periodic review of prices.

"Fertilizer Pricing Policies", Maene, L.M., In Agro-Chemicals News in Brief, 1984, 7(2): pp. 13-20.

The article reviews fertilizer pricing policies in Asia. One key issue for improving crop productivity is the timely and adequate availability of fertilizers at prices farmers can afford. To promote the use of fertilizers, policy makers have to ensure a favorable input/output ratio for the farmer.

Fertilizer Pricing Policy and Food Grain Production in Bangladesh. IFPRI/BIDS. Volume II: Technical report. 1985. 370 pages text, 20 pages with charts.

Contents (Bangladesh-specific): Overview of consumption; structure, dynamics and related policy issues of fertilizer subsidies; fertilizer consumption, pricing and food grain production; agronomic and environmental constraints on fertilizer effectiveness; national fertilizer subsidy and supply adjustments; supply and distribution. Also, political economy of fertilizer pricing policy, distributional aspects of fertilizer pricing policy, and agricultural credit and fertilizer use.

Fertilizer Producer Pricing in Developing Countries, Segura, Edilberto L., Y.T. Shetty, and Mieko Nishamizu. IBRD, Washington, D.C., 1986, 251 pages.

The report of the "International Seminar on Fertilizer Pricing Policies" sponsored by the Industry Department of the World Bank in March 1984, contains three analytical papers on the economic issues raised by fertilizer pricing policies. Historical data are provided on consumption and prices. The study focuses on fertilizer prices in developing countries, both freely determined and administered. Desired objectives of pricing are to mobilize and utilize resources for manufacturing processes. Strengths and weaknesses of various national pricing approaches are examined. Basic conflicts of pricing for industrial and for agricultural growth objectives and use of subsidies are considered. Case studies are presented of actual pricing policies in 10 developing countries including Egypt, Nigeria, Portugal, India, Pakistan, Brazil, Colombia, Hungary, Yugoslavia, Turkey. Substantial reference material is provided.

"Fertilizer Prospects in Asia", In Agro-Chemicals News in Brief, 1985, 8(1), pp. 6-11.

Discusses fertilizer consumption in Asia and the estimates future demand.

Fertilizer Recommendations: Their Formulation and Dissemination, Saleem, M. Tahir, Nisar Ahmed, and D. Koole, Workshop Report 7, National Fertilizer Development Centre, Planning and Development Division, Government of Pakistan, Islamabad, November 1983.

Discusses fertilizer needs for producers and likely suppliers. The study notes that a 50 Kg. bag of urea requires as much energy as is contained in about 35 Kg. of gasoline; hence, efficienct use of nitrogen fertilizer is extremely important.

"Fertilizer Self-Sufficiency in ASEAN Region", in Agro-Chemicals News in Brief, 1985, 8(1), pp. 12-18.

Discusses shortfall of fertilizer in ASEAN regions.

Fertilizer Subsidies and Pricing Policy, (Pakistan), National Fertilizer Development Center, Planning and Development Division, Government of Pakistan, January 1984.

Reviews past efforts of the GOP to increase fertilizer consumption including, inter alia, operation of subsidies which grew in cost from Rs 200 million in the second 5 Year Plan (1960-63) to Rs 9,000 million in the 5th (1978-83), equal to 58% of the development expenditures for agriculture. In 1982-83, the decision was reached to cut subsidies by raising prices. The report reviews impacts of the new policy on consumption and costs and recommends the following: a switch from gross to net subsidy calculation, continuation of a more favorable price on P and K tha N to improve the N, P, K balance; and equal 20% return on plant equity; removal of the imprt surcharge (of 5%); measures to reduce distribution costs including reduced strategic reserves, and restriction of government agencies to necessary public roles (e.g., public fertilizer distribution in remote areas only), a special transport subsidy for remote areas.

"Fertilizer Subsidies in Asia", in Agro-Chemicals News in Brief, 1985, 8(3): pp. 8-10.

Provides a summary of prevailing systems of fertilizer subsidies in Asian countries, the expenditures incurred and the special ole of fertilizer subsidies in interplay with output price supports.

Fertilizer Subsidies in Developing Countries, Harris, G.T., International Fertilizer Development Center, Muscle Shoals, ALabama, 1984, 129 pages.

Composite of recent short papers. Describes the current status of subsidies as of mid-1984. Data are presented for 17 developing countries (Argentina, Burkina Faso, Chile, Colombia, Gambia, India, Indonesia, Ivory Coast, Nepal, Philippines, Saudi Arabia, Sierra Leone, Sri Lanka, Turkey, Venezuela, Zambia and Zimbabwe).

Fertilizer Subsidies in Developing Countries: In the Direct Application of Anhydrous Ammonia and Fertilizer Taxes and Subsidies, Wiersholm, L.A., IFA Bulletin 1983, pp. 22-33.

Direct and indirect subsidies are discussed. Author concludes that in general, indirect subsidy programs have proved not to be effective in improving the incomes of smaller farms.

Fertilizer, Sulfur and Food Production, Kanwar. J.S, and M.S. Mudahar, IFDC, Muscle Shoals, Alabama. Technical Bulletin , 1983, 19 pages.

This executive brief presents highlights of a study dealing with the economic importance of sulfur in the fertilizer industry, food production and the agricultural sector in the tropical countries of Asia, Africa and Latin America.

Fertilizer Supplies for Developing Countries: Issues in the Transfer and Development of Technology, Mukherjee, S.K., UNCTAD, New York, 95 pages.

Data on recent production, consumption and trade in fertilizer are presented and the market structure for fertilizer and fertilizer production technology are examined. It was found that a high rate of concentration exists both in production and international marketing and also in access to production technology. Multi-country cooperation and other means for developing countries to counter such concentration of market and process is a major recommendation of the report.

Fertilizer Use on Selected Crops in India, National Council of Applied Economic Research, (NCAER) September 1984, 50 pages text, 28 pages tables.

NCAER data from 4,118 rural households. Three-stage stratified sample design with districts/development blocks as the first stage, villages within those blocks as the second stage, and households within villages as third stage. Provides analysis of: 6 crops - rice, wheat, jawar, maize, cotton, and sugarcane; NPK use per hectare; proportion of fertilized area to gross area cultivated over a three year period, 1968/69-1970/71, on irrigated and unirrigated plots; and high-yielding versus traditional. Conclusions: a) gross cropped area of rice increased; b) small farmers applied fertilizer on smaller land area but more intensively than larger farmers.

Fertilizer Use Pattern in Pakistan, (Kharif Season, 1980) National Fertilizer Corporation of Pakistan.

Survey of: land use in the Punjab; fertilizer application rates and factors related to fertilizer use (credit, fertilizer price information, profitability and access to fertilizer); and policy implications of the survey. Includes discussion of research design/methodology.

Fertilizer Use Pattern in Pakistan, A Study on Differential Impact of Fertilizer Price Increase on its Use in Rabi, Pakistan, 1980-1981. National Fertilizer Corporation of Pakistan.

Presents results of a survey on the impact of the fertilizer price increase of February 1980 on farmers' fertilizer use. Survey included information on: 1) adoption of fertilizer; 2) discontinued use/non-use of fertilizer; 3) fertilizer use factors; 4) fertilizer application rates/factors; 5) sources of fertilizer credit; 6)fertilizer information sources; and 7) distribution channels and control prices.

Fertilizer Use Statistics in Crop Production, Martinez, A; Diamond, R. B., International Fertilizer Development Center, (IFDC) Muscle Shoal, Alabama, 1982.

This publication represents the International Fertilizer Development Center's first attempt to assemble statistics on fertilizer use for different crops on a country by country basis. Data as presented in this publication would provide a basis on which to develop and plan marketing development strategies. Data gathered from 78 countries showed that cereal crops, especially rice, maize and wheat, are the main users of N, P, and K. Total fertilizer use expressed in MT and KG/Ha. Regions which data are provided include: North Africa, Sahel/West Africa, West African coast, Eastern and Southern Africa, North America, Central America and Caribbean, Andean region, Central and South Asia, South-East Asia, Middle East, North East Asia, Europe and Oceania.

Fertilizers for Tropical and Subtropical Agriculture, McCune, Donald L., Twelfth Francis New Memorial Lecture, presented before The Fertiliser Society of London, March 12, 1981.

Study discusses measures to increase efficiency of fertilizer including use of soil testing. Reports experience with 1,200 barani (rainfed agriculture) trials in Pakistan in 1980. On average, fertilizer and improved seed increased wheat yield by 80% and maize by 62%. In 1977-78, the best investment (100-75-0) increased wheat yields by 120%; (75-50-0) by 104%. The smallest increase was with phosphate only.

Food, Fuel and Fertilizer from Organic Wastes, National Academy Press, Report from the Advisory Committee on Technology Innovation (1979), Washington D.C., 1981, 141 pages.

Examines some of the opportunities for the utilization of organic wastes and residues commonly found in poor rural areas of the world.

Guide to Information Sources on the Fertilizer Industry, UNIDO, #21, 1977.

The publication provides an extensive listing of UN, international and national (by country) trade organizations, sources of statistics, marketing, and e~oromic data, handbooks, manuals, proceedings, specialized dictionaries, source content listing and other information on world industry.

Guidelines on Planning, Organization and Execution of National Seminars and Workshops in Fertilizer Marketing, FAO, Marketing and Credit Service, Agricultural Services Division, Rome, 1982.

Designates 19 steps to be followed in planning for a marketing approach.

The Impact of Credit, Prices, Technology and Extension on Fertilizer Demand in Rainfed Areas in the Philippines, David, Christina. Ohio State University, September 1979, 20 pages.

Presents conceptual framework analyzing fertilizer demand in the Philippines. Demand funcuon derived from farm profit maximization depending fertilizer price, prices of other related inputs and price of output. Study examines the effects that prices, extension and credit have on raising fertilizer demand among rainfed farmers. Philippines survey illustrates that the demand of fertilizer is inelastic with respect to price of rice.

"The Importance of Fertilizer Marketing in Asia", in Agro-Chemical News in Brief, Vol. 7, No. 3, 1984, pp. 2-9, Economic and Social Commission for Asia, Bangkok, Thailand, 1984.

The paper discusses the market structure and public/private roles in major Asian developing country fertilizer sectors (Afghanistan, Bangladesh, China, Burma, India, Indonesia, Korea, Philippines, Pakistan, Sri Lanka, Iran, Thailand, Nepal); observes that there is little price competition; hence competition is mainly in non-price areas. Generally, margins and prices are government-managed and subsidies common. Provides a table comparing urea marketing margins and prices by function for 11 countries in 1981/82.

Input Marketing Study of the Mbeya Region, Weiler, E.; Merryman, J. and D. Eding. Tanzania Rural Development (TRDB) Bank, August, 1982. 108 pages.

Study of fertilizer marketing in Mbeya region of Tanzania based on field survey of a sample of villages. Major constraints identified as lack of supplies/inputs for sale (fertilizer, hand tools, ox plows) due to lack of FX. Authors concluded that TRDB input distribution inefficient due to low volume and should be turned over to identified alternatives (including private) distributors. Alternative distributors were suggested, (e.g., tea authority etc.).

Institutions, Infrastructure and Regional Variations in India's Input Delivery System, Subbarao, K., Institute of Economic Growth, New Delhi, October 1983, 20 pages.

Explains extent to which the delivery system restricts access to rural outlets. Outlines delivery systems, traces regional disparities, and the impact of infrastructure development on fertilizer distribution. Contains detailed discussion of India's fertilizer system.

International Fertilizer Market Information Sources, Chuang, Yao H., International Fertilizer Development Center, Muscle Shoals, Alabama. March 1984, 31 pages.

This special IFDC report lists a) major types of current information considered essential to the management of the modern day fertilizer industry, and b) sources, mostly commercial, from which such information may be obtained (generally purchased). Sources of information are listed for: raw material (e.g., phosphate rock, sulfur, gas, naphtha, fuel oil, ammonia, sulfuric acid, phosphoric acid), fertilizer products (N, P, K,), ocean freight.

International Trade in the Fertilizer Sector: Implications for Developing Countries, UNCTAD, 1984, 23 pages.

The analysis of current tariff protection in developed market economy countries on selected fertilizer products at different stages of processing revealed that overall, protection does not pose a serious obstacle to market access. Emphasizes need for constant vigilance and analysis of developments in the tariff and non-tariff areas.

"Introduction to Fertilizer Distribution in the Asia/Pacific Region", in Agro-Chemical News in Brief, Volume 7, No. 3, 1984, pp. 9-13.

The report briefly describes fertilizer distribution systems in 11 Asian countries. Degree of participation by public cooperative and private entities at wholesale and retail levels are presented. Data on principal transport systems used are shown (rail, truck, water) for 8 countries.

"Legacy of Change in the World Fertilizer Industry", Fertilizer International, 1985 (No. 202).

Discusses changes in the fertilizer industry due to shifts in economic conditions and developments which are likely to have the greatest impact on the fertilizer market today and in the future.

Marketing, Distribution and Use of Fertilizer in the Philippines, Fertilizer Advisory Development and Information Network (FADINAP), Bangkok, July 1985.

Profile of the fertilizer industry in the Philippines. Brief profile of the fertilizer companies operating in country. Government policies on fertilizer, including subsidy program. Detailed profile information in the annexes.

Marketing and Technology Transfer in Developing Countries, S. H. Ferguson Fertilizer Distribution, Ferguson Industries, Dallas, Texas, Fertilizer International, 1985 (No. 212).

Presents a typical distribution and marketing system for fertilizer, farm chemicals, seeds and technology. Also discusses methods for training and technology transfer.

Monitoring and Évaluation of Fertilizer Self-Sufficiency in the ASEAN Region, A Study Presented at the Workshop on the ASEAN ADPC Research Studies, Hat Yai, Thailand, 20-25 July, 1983, ASEAN Agricultural Development Planning Center, Bangkok.

The report provides a summary of the fertilizer situation and current fertilizer policies in ASEAN countries.

New Evidence on Yields, Fertilizer Application and Prices in Asian Rice Production, James, W.E., Ramirez, T.R., Report Series, Economics Office, Asian Development Bank, Philippines, 1983, 36 pages.

Report examines roles of fertilizer application and relative prices in explaining variations in levels of rice production and yields in 12 developing Asian countries. Concludes there is a positive and significant relationship between fertilizer use and the ratio of rice to fertilizer price at the farm gate.

"New Rice Technology and Fertilizer Demand", Te, A. and J. Flinn, in Agro-Chemical News in Brief, November 1984, pp. 17-23.

Estimates factors in increase in rice output in major world regions. Data on fertilizer use on rice 1965-1980 in Asian countries. Concludes 25% of 1965-1980 increase in rice output in Asia was due to fertilizer application. Suggests that the combination of more nitrogen responsive varieties with better nitrogen placement offers prospects for much greater effects with less fertilizer.

"The Outlook for Ammonia Production in the United States", Hay, Nelson E, Nitrogen, No. 157, September-October 1985, pp. 19-26.

Analysis (as of 1984) of competitive position of U.S. versus other world

plants for U.S. ammonia market. Concludes U.S. plants will be very competitive despite higher cost of gas. Includes IBRD nitrogen projections to 1992-93 which point to surplus N in the mid-1980s and a large shortage in 1992/93 unless more new plants are started. Estimates cost of NH_3 for new plants in 10 world regions. Estimates of fuel requirements are 40 million BTU/MT. An economic size plant costs $170 m and NH_3 non-fuel cost would be $160/MT. Reports 2 million MT of idle NH_3 capacity in the U.S.

Pakistan and the World Bank: Partners in Progress, The World Bank, Washington, D.C., Aptil 1986.

Discusses Pakistan's agenda for reform, the untapped potential for agriculture, and the quest for productivity and the search for new productive resources. Contains discussion on: regarding efforts to increase yields; effects of subsidies on agriculture, and industrial development and growth in Pakistan.

Pakistan Fertilizer Policy: Review and Analysis, Chemonics International Consulting Division, in collaboration with USAID/Pakistan, Janaury 1985, 257 pages.

Provides a detailed description and assessment of: fertilizer industry, trade, marketing system, pricing, fertilizer use efficiency and fertilizer policies in Pakistan. Finding includes the following: price elasticity of demand estimated at about -0.5; increased price was a major factor in 1983 decline in fertilizer consumption growth; and high fertilizer subsidy costs have resulted in decreases in resources available for other critical needs and have controbuted to inefficient fertilizer use. Recommendations include: reduction of prices and elimination of subsidies; denationalization of fertilizer production; continuation of existing trend to privatize fertilizer distribution, improve/increase fertilizer use efficiency, and consolidation and strengthening fertilizer policy processes in the Ministry of Agriculture.

Philippine Fertilizer Sector Study, UNICO International Corporation, Tokyo, Japan. Prepared for the Fertilizer and Pesticide Authority, Republic of the Philippines. Volume 1: Executive Summary, (94 pages); Volume 2: Main Report, (266 pages), March 1986,

This study analyzes the fertilizer subsector both from the industrial (production, import, distribution) and agricultural (needs, use, crop/fertilizer prices, access) perspectives. Levels and costs of production, import, distribution and factors constraining consumption are examined. Fertilizer decline in 1984 is related to high: interest rates; low margins; financial difficulties of the industry, banking system and farmers; inadequate distribution facilities which limited farmer access; plus low return to farmers. The study concludes that the Fertilizer and Pesticide Authority (FPA), which became involved in direct operation, needs to maintain more of a neutral position in operations. FPA should increase emphasis on planning, coordination, policy development, communications and monitoring.

"Planning for the Development of a Fertilizer Industry", Hignett, T.,. in Developments in Plant and Soil Sciences, Vol. 15, (1985), pp. 329-332.

Brief discussion of fertilizer planning including : choice of product; manufacturing function; marketing and distribution systems; plant location.

The Planning Of Investment Programs in the Fertilizer Industry, Choksi, Armane M.; Alexander Muraus; Ardy Stoutjeschijk, (Volume III), IBRD, September 1985, 240 pages.

Model used to find least cost investment, production and transportation pattern to meet a given set of demand projections. Report contains a) general methodology, and b) reports on an application. Specific chapters address the follwoing topics: introduction to terms in the fertilizer industry; production and processes of N, P, K manufacturing; planning models; data required and their sources

"Pneumatic Injector for Deep Placement of Urea in Wetland Rice Soils", Prins, W. H.; van Braakel, G. D. and van der Sar, T, in Development of the Agricultural Machinery Industry in Developing Countries, Proceedings of the 2nd International Conference, Amsterdam, January 1984, Pudoc Wageningen, The Netherlands, pp. 384-390.

Reports results of research to develop a pneumatic urea injector for wetland rice use. Reports 40-50 % savings in urea for same yield by injection of urea.

Policy Options for the Development of the Fertilizer Sector, International Fertilizer Development Center, Muscle Shoals, Alabama. September 1982.

Case-study of fertilizer marketing and distribution of Bangladesh Agricultural Development Corporation. Description of innovations for the market system, promotion of expansion and equity of fertilizer use by increasing the efficiency of the fertilizer delivery system. Recommendations are provided for improving the system.

The Possible Impact of a Reduction in Oil Prices on the Consumption and Production of Fertilizers in Developing Countries, Couston, J.W., Fertilizer Economics Group, FAO, IFA Bulletin 1983, pp. 16-30.

Concludes that, in view of the many factors involved in determining demand for fertilizer, oil prices are unlikely to have much of an impact on fertilizer production and consumption.

"Preliminary Estimates of the Contribution of Fertilizer to Cereal Production in Developing Market Economies", Pen Pinstrup-Andersen, International Fertilizer Development Center, The Missouri Valley Economics Association, Missouri, The Journal of Economics, Volume II, 1976.

The study appraises the effects on developing economics of different factors in food production, 1948/54 to 1971/73. In the early years 51 % of production increase comes from yield increases and in the later years, 63 %. The study concludes that fertilizer accounts for about 30 % of the increase in cereal production in Latin America, Asia and the developed market economics. Impacts of fertilizer in Africa have been much lower.

Prices, Trends, Terms of Trade, and Roles of Government in Pakistan's Agriculture, Kee-Cheok Cheong and Emmanuel H. D'Silva, World Bank Staff Working Paper #643. April 1984, 49 pages.

Examines terms of trade for agriculture and concludes there has been some, albeit small, improvement in the terms of trade of agriculture for 1960 to 1983. Until 1977, farmers paid more in direct and hidden taxes (surpressed farm prices) then they gained by subsides, etc. but since, this position has improved. Hence, farmers' ability to pay for inputs did not erode. Higher prices of fertilizer could be afforded by farmers'. Higher water charges also are feasible. The paper argues for more world prices.

"The Principles of Advertising Applied to Fertilizer Promotion", Loftus, J.P., in Agro-Chemicals News in Brief, Special Issue December, 1983 pp 14-16.

The paper highlights the importance of cost-effective mass-media approaches to fertilizer promotion and attempts to show that some of the techniques used in advertising can also be applied to development programs and need not be identified solely as the preserve of commercial marketers.

Proceedings of FAO/AIDO/ADAD Regional Consultation Meeting on the Development of Agricultural Credit Facilities and Fertilizer Pricing Policies, FAO, Rome, 1984, 339 pages.

Discussion of: role of fertilizers in agriculture; analysis of the factors affecting phosphate consumption in seven selected western countries; overview of fertilizer needs for the Food Security Program in the Arab Region; marketing of fertilizers and the role of agricultural credit in promoting and increasing utilization in the Near East and North Africa region; monitoring the economics of fertilizer use; and the effect of crop price supports and crop insurance on fertilizer usage.

Production Risk and Optimal Fertilizer Rates: An Application of the Rauden Coefficient Model, Smith, J; Umali, G., IRRI Publication, October 1985, 9 pages.

Investigates effects of risk aversion on fertilizer use. Model estimates probability distribution of yields at different nitrogen rates. Presents data from five years of N response trials by the Agronomy Department of IRRI. Results show slight risk aversion in use: this does not support the contention that risk is a major cause of low N fertilizer application rates.

Project Completion Report: Brazil - Araracaria Fertilizer Project, IBRD, August 15, 1986, 103 pages.

Provides a detailed report on development of a large plant to produce ammonia and urea using high sulfur, high residual fuel from a nearby refinery as feed stock. A cost overrun of 76% and delay in start-up of 45 months were experienced. The plant was originally expected to yield an ERR of about 23% but now may be near zero. Report documents some of the problems experienced in developing country plants including fertilizer pricing which is based on a favorable rate of return of an older "model" plant.

Projected Nitrogen Needs in the Year 2000 and Alternative Supply Sources, Ahmed, S, East-West Centre, Working Paper 15 pages text, 7 pages charts.

Projected of nitrogen demand based on figures for: global population, global food production. Methodology and prospect for growth in nitrogen fertilizer manufacturing are discussed.

"Promotion of Fertilizer Use by Small-Scale Farmers in Developing Countries". Zschernitz, K., Phosphorus in Agriculture, Vol. 33, No. 76, September 1979, pp. 157-168.

Reports on 18 years of FAO fertilizer promotion experience in over 40 countries. Notes that 50% of developing countries yield increases are attributable to increase use of fertilizer. Major constraints discussed vis-a-vis fertilizer development are: lack of information (research, extension); inadequate supplies and distribution; credit; and poor produce markets. Emphasizes importance of trials/demonstrations, improved distribution systems.

Public Enterprise Performance: A Methodology and an Application to Asian Fertilizer Plants, Jones, Leroy. Boston University, 1979.

Study of performance of public enterprises producing fertilizers in Bangladesh, India, Korea, and Pakistan. Presents economic principals which guide public industry. Study ovserves 13 nitrogeneous fertilizer units utilizing "verbal regression", an analysis of how performance is affected by independent variables. Social profit of these public enterprises is also derived from enterprise accounting at market prices, and a quantitative social efficiency audit is made of the enterprises. Study concludes that inefficiency exists in eight of the 13 plants and likely to exist in others.

Recommendation for Manufacture-Distribution of Agricultural Minerals in Brazil, Agri-Research, Inc., 1964 (for Ministry of Agriculture and USAID).

Provides estimates of demand and requirements for major fertilizer products (N, P, K) and for agricultural limestone and livestock mineral supplements. Estimates current and projected production. Reviews physical resources (e.g., mineral deposits). Recommends specific facilities and estimates cost of investment and development of fertilizer, agricultural limestone and mineral supplements in different locations. Recommendations are provided for different areas of Brazil through 1970; demand was projected to 1980. The first major attempt by AID in Brazil to assist in providing direction for the fertilizer sector. Fertilizer has since has become a major factor in Brazil's high rate of agricultural growth.

"Reducing Costs in Fertilizer Distribution in Malaysia", Koh P. B., et al. in Agro-Chemical News in Brief, Special Issue, March 1983, pp. 88-90.

The main imported fertilizers, main fertilizer users and the organization of fertilizer distribution in Malaysia are discussed. A breakdown of fertilizer distribution costs is given.

Regional Consultative Meeting on Fertilizer Use Promotion Methods in Asia and the Pacific, FADINAP/FAI, New Dehli, December 1983.

Discusses issues, strategy, innovations and the principle of advertising as applied to fertilizer promotion, as well as the function and role of the various fertilizer organizations. Presents case study of village promotion program utilized in India for fertilizer, and the sucessful Fauji promotion case in Pakistan.

Restrictions on Using More Fertilizer for Food Crops in Developing Countries, United States General Accounting Office, iii, 1977, 65 pages.

Study makes a case for more support for fertilizer in developing countries; and examines constraints to greater manufacture and use of fertilizer. Correlates early U.S. support of fertilizer subsector with high rate of fertilizer use, e.g., Brazil, Columbia, India, Pakistan. Examines use in different countries with the exception of Egypt, fertilizer use began late in Africa. Medium levels of use prevail in Algeria, Morocco, and Kenya.

A Review of Experience of Selected Countries on Four Agricultural Development Issues, Newberg, Richard, R. and Kim Ball. Draft for USAID/Dar es Salaam, September 1984.

Focusing on Tanzania, this study examines agricultural growth in developing countries worldwide in relation to policies on price management, operation of public marketing organizations, marketing systems and supply and distribution of inputs. Attempts to identify models for dealing with different issues such as: mixed public-private distribution (Pakistan and Indonesia); wholly public input distribution systems (Egypt and Burma); public grain market operation (Zimbabwe).

The Scope for Improving Fertilizer Marketing and Credit Systems in Developing Countries, Mittendorf, H. J, FAO, Rome. 1974, 32 pages of text, 24 pages of charts.

Describes credit systems for fertilizer. 34 case studies include: CAR, Mali, Ethiopia, Ghana, Kenya, Morocco, Nigeria, Senegal, Zambia, India, Pakistan, Iran, Jordan, Nepal, Thailand, Argentina, Brazil, Columbia, Mexico, Peru and Venezuela. Discusses factors affecting the efficiency of fertilizer marketing systems. Flow charts of types of marketing systems for above countries. Discusses state versus private enterprise. Good discussion of issues related to credit, marketing costs, forecasting and transportation.

"The Selection of Channels of Distribution for Fertilizers", Rajagopal, S.V., Southern Petrochemical Industries Corporation, Ltd., Madras, India, in Agro-Chemicals News in Brief, Special Issue, March 1983, pp. 59-65.

Article discusses the following: Fertilizer marketing and channels of distribution in India; factors affecting the selection of different channels of distribution; the multi-agency approach by the Indian government; and recent trends in fertilizer distribution in India.

Sri Lanka Agricultural Inputs, Project Paper, USAID, 1978.

Provides a description of the agricultural sector and assessment of the fertilizer subsector including marketing and distribution system as of 1978. At that time there were about 4,200 retail outlets. Discusses National Fertilizer Authority.

The State Owned Enterprise as an Entrepreneurial Substitution in Developing Countries: The Case of Nitrogen Fertilizer, Levy, B. Research Memorandum Series, Department of Economics, Center for Development Economics, Williams College. Williamstown, MA, 1985, No. 100, 32 pages.

Discusses the role of private vs. public firms in the nitrogen fertilizer industry. Explores how limited access to capital impacts on private sector initiatives in fertilizer producing enterprises. Describes evolution of the industry in India.

Suggested Fertilizer Related Policies for Governments and International Agencies, International Fertilizer Development Center, Muscle Shoals, Alabama. August 1977, 65 pages.

Provides a brief and simply stated set of recommendations principally for international development agencies and developing country governments dealing with common issues in development of the fertilizer industry. Policies are covered under six headings: raw materials; fertilizer production; fertilizer marketing and distribution; measures to increase fertilizer use; manpower utilization and training; investment and financing.

The report suggests that most developing countries should place a high priority on fertilizer subsector development as an essential part of a broader agricultural sector development strategy. The study suggests market volumes and conditions for development of alternative types of investment. It also suggests means to reduce costs and increase fertilizer use efficiency.

A Survey of the Fertilizer Sector in India, Bumb, Balu, IBRD, Staff Working Paper No. 331, IBRD, Washington, D.C., June 1979, 67 pages plus an annex with 131 pages of tables.

This fertilizer sector analysis covers production, import, costs of fertilizer operations, consumption and factors affecting consumption with data series from 1952/53 to 1977/78. Supply of raw materials, fertilizer pricing and price policies and evolution of the distribution system are discussed.

"1983/1984 Survey on Fertilizer Marketing Costs and Margins", in Agro-Chemicals News in Brief, Vol. 8, No. 2, April 1985, pp. 6-11.

The report provides data on fertilizer marketing costs and margins for developing countries in Asia. Urea marketing margins were less than U.S. $30/MT in Sri Lanka, Indonesia, and India but over $80/MT in Iran, Nepal and the Philippines. A breakdown of costs is provided.

Sustainability of Projects: Review of Experience in the Fertilizer Subsector, IBRD Report No. 6073, February 26, 1986, 55 pages.

This report evaluates experience with 14 large IBRD-assisted fertilizer production projects initiated in the 1970s, on which at least 4 years operating experience had accumulated prior to the evaluation. Major delays and cost overruns were encountered in all but 2 plants (Pusri III and IV in Indonesia). In most cases, technology was employed which inevitably contributed to delays and difficulty in achieving capacity operation. Government restrictions, management, weaknesses (13 of 14 facilities are in the public sector and the 14th, IFCO of India, mixed public and cooperative) and raw material problems (quality and continuity) were other frequent problems. IBRD has pursued an activist role in: technology choice; reduction in policy related constraints; and solution of problems including training and technology. Adequacy of market demand has been a relatively minor problem except for Brazil and more recently, Indonesia. Acceptable ERRs have been achieved in 7 of 14 projects. Technology transfer (via adequate use of qualified consulting firms) and management are identified as critical factors in success. Insufficient attention to maintenance and safety frequently were cited as serious weaknesses.

Sustaining Rapid Growth in India's Fertilizer Consumption: A Perspective Based on Compostion of Use, Desai, G.M.; Research Report 31, International Food Policy Research Institute, Washington, D.C., August 1982, 71 pages.

Reviews a major problem in sustaining growth in fertilizer consumption. Concludes physical productivity of fertilizer is more important than prices in expansion of consumption. Past growth could have been increased with a more complete diffusion of information on fertilizer use on crops other than wheat, rice, and groundnuts. Unirrigated areas have received too little attention. Achievement of future targets will require greater efforts.

Technology Transfer to Developing Countries: The Case of the Fertilizer Industry, Ghatak, S., JAI Press, Connecticut, 1981, 200 pages.

Chapters of particular interest includes:

Chapter 2. Data are presented by country on production, consumption import, and export of fertilizer, past, present and projected;
Chapter 3. Discusses fertilizer technology;
Chapter 5. Economic aspects of the fertilizer industry. Looks at case studies asking: why is the industry necessary, history of fertilizer in the Andes, India and West Africa. Discussion of distribution emphasizes dependence on foreign markets and thus susceptibility to monopolistic control by foreign industry. Argues for production rather than imports;
Chapter 6. Fertilizer in the environment: pollutants, cost of pollutants, policy.
Chapter 7. Alternatives: use of human and animal waste, municipal compost.

Thailand: Strategy for Fertilizer Development: A Prefeasibility Study, Technical Bulletin - T-17, International Fertilizer Development Center, Muscle Shoals, ALabama, May 1980, 32 pages.

> In 1978, about 80% of the total fertilizer was imported and distributed by the purely private sector with about half of this by the Metro Company Group and half by some 50 importer/traders of the Thai Fertilizer Importers and Traders Association. The public/quasi public sector involved the Marketing Organization of Farmers (MOF) and Agricultural Cooperative Federation of Thailand (ACFI), plus some public commodity agencies and the Ministry of Agriculture and Cooperatives. The public/quasi public sector both imported direcly and bought from importers. Fertilizer products were marketed under over 100 trade brand names and trademarks which were widely advertised. Over 80 grades were registered though 20 grades made up most of the volume (e.g., 16-20-0, 18-22-0, 18-24-0, 20-20-0, 13-13-21, and 15-15-15). Fertilizer was marketed in 50 Kg. bags. Competition was sharp and tended to keep prices low. Most of the storage facilities are located in or near the Bangkok port area. There is little promotion of fertilizer other than promotion of private brands.

Third Evaluation of the Bangladesh New Marketing System, International Fertilizer Development Center, Muscle Shoals, ALabama, April 1982, 68 pages plus appendices.

> Reviews fertilizer subsector, progress of new marketing system, and major constraints. There are 22,000 active dealers and 5,000-6,000 periodic dealers, but the number of dealers is declining because of capital requirements. New margins were expected to counter the downward trend. Lack of rapport between dealers and BADC is a problem. BADC still is unable to meet peak needs of dealers and farmers. Recommendations are made on improved BADC staffing.

Tools for Agriculture: A Buyer's Guide to Appropriate Equipment, Carruthers, et. al., I.T. Publications in association with GTZ/GATE, 3rd Edition, 1985.

> Provides a listing of types of small scale tools mostly hand and animal powered equipment for a wide variety of tillage, harvest, fertilizer application and other small farm production and marketing activities.

Trade and Development Realities for Fertilizer Security, Windridge, K. L. C., International Fertilizer Industry Association (IFA) Limited, Paris, 1984, 13 pages.

> World trade in fertilizer materials has grown large and complex: this paper disscusses means to secure a supply of fertilizer for developing countries. Also presents a scheme for allocating credit to developing countries for the purchase of fertilizers and other agricultural inputs. Scheme is advocated for times when the international price of commodities rises above a pre-defined average.

"Training Fertilizer Retailers in Bangladesh, Pakistan and Sri Lanka", in *Agro-Chemicals News in Brief*, 1983, 6(3), pp. 9-11.

> Reviews the FADINAP training program for the fertilizer retailer. The program is designed to improve fertilizer distribution from the retailer

to the farmer and make the retail outlet a channel of communication on the proper use of fertilizer.

Transnational Corporations in the Fertilizer Industry, United Nations Center on Transnational Corporations, United Nation, New York, 1982, 33 pages.

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Sri Lanka - Agricultural Inputs, Project Paper, Proposal and Recommendations for the Review of the Bilateral Assistance Committee, Agency for International Development, Washington, D.C.

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Statistics of Crop Responses to Fertilizers, WM/SAC/2/09, Rome, FAO.

Study on Differential Impact of Fertilizer Price on its Use in Pakistan, Fertilizer Use Pattern in Pakistan, Lahore, Padistan, National Fertilizer Corporation of Pakistan, Ltd.

Subsistence Agriculture and Economic Development, Wharton, Clifton R., ''dine Publishing Co., Chicago, IL, 1969, 481 pgs.

Survey of Fertilizer Marketing Costs in Asian Countries, Lee, Chong Yeong, (second survey), Bangkok, Thailand, FAO of the U.N., November 1981.

Survey on Fertilizer Marketing Costs in Selected Asian Countries, Bangkok, Thailand, FAO Regional Office for Asia and the Pacific, January 1982.

Systems to Support the Transfer of Fertilizer Technology, report prepared by the VLS Associates, Inc. for the International Fertilizer Section, NFDC, TVA, Muscle Shoals, 1980.

Thailand: Strategy for Fertilizer Development, Prefeasibility Study, Muscle Shoals, IFDC, 1980.

Thailand Strategy for Fertilizer Development, A Feasibility Study, International Fertilizer Development Center, P.O. Box 2040, Muscle Shoals, Alabama, May 1990.

Thailand Strategy for Fertilizer Development, A Feasibility Study, International Fertilizer Development Center, P.O. Box 2040, Muscle Shoals, May 1980.

Tunisia PL 480 Multiyear Program, 1985-1987, Newberg, Richard R. and A. Morton, USAID/Tunisia.

Two Analyses of Indian Foodgrain Production and Consumption Data, Sarma, J.S., Shyamal Roy and P.S. George, Research Report 12, International Food Policy Research Institute, 1979, 81 pages.

U.S. Bilateral Assistance to India - A Strategy for the Early 1960s, Lindblom, Charles E., Priscilla Boughton, Richard Newberg, Carl Gotsch, and Albert Hirshman, U.S. Agency for Internatioonal Development, Washington, D.C., June 1978.

"Use of Economic Indicators as a Guide in Maintaining Incentive Price Relationships", Coster, R. and L. Maene, Fertilizer Advisory Development and Information Network for Asia and the Pacific (FADINAP), Bangkok, Thailand, 4 pages.

Venezuela Fertilizer Supply Strategy, IFDC, 1981-90, Volumes I-IV, Muscle Shoals, AL, April 1981.

World Commodity Model for Fertilizer, The Alternative Long-term Prognosis of the World Fertilizer Production, Consumption and Trade on the Basis of an Econometric Model, Meszaros, S., International Institute for Applied Systems Analysis, Austria, January 1980, 46 pages of text, 36 pages of charts.

World Fertilizer Atlas, 7th Edition, British Sulphur Corporation, Ltd, London, 1983.

World Fertilizer Progress Into the 1980s, Lastigzon, Joseph, Muscle Shoals, IFDC, 1981.

Zimbabwe, Agricultural Sector Assistance (613-0203), PAAD, Agency for International Development, Washington, D.C., 1982.

C. AID PROJECT GUIDANCE

1. AID Handbook No. 3: Project Assistance, especially the following:

   a. Chapter I: Principles of Project Selection (7 pages) with Annex A: Criteria in Selecting Among Alternatives (6 pages) and Annex B: AID Policy on Length of Project Involvement.

   b. Chapter II: Project Identification (15 pages) - The project identification document and the following annexes:

      i. Information Retrieval Request (1 page).

      ii. Socio-Cultural Considerations at the PID stage (5 pages).

      iii. Environmental Procedures, Appendix 2D, (14 pages).

      iv. Recipient Country Contributions to the Activity (7 pages).

      v. Women in Development, Chapter 1, page 6. Also recently released Guidance on Women in Development in:

         Gender Issues in Latin America and the Caribbean; Integrating Women into Development Programs: A Guide for Implementation for Latin America and the Caribbean, prepared for the Bureau for Latin America and the Caribbean, USAID,May 1986.

   c. Chapter III: Project Development, Analysis and Presentation (36 pages).

2. Other AID Policy Papers

   The following are of particular relevance to fertilizer projects:

   Approaches to the Policy Dialogue, December 1982.

   Co-Financing, May 1983.

   Energy, July 1984.

   Environmental Procedure, 22 CRF Part 216, Oct. 1980.

   Food and Agriculture Development, May 1982.

   Institutional Development, March 1983.

   Local Organizations in Development, March 1984.

   Pricing, Subsidies, and Related Policies in Food and Agriculture, November 1982.

   Private Enterprise Development, May 1982.

Recurrent Costs, May 1982.

Programming Local Currency

D. RECENT AID FERTILIZER ACTIVITY REPORTS - THE FOLLOWING REPORTS OF RECENT AID FERTILIZER ACTIVITIES ARE ACCESSED BY THE AID LIBRARY, WASHINGTON

AFGHANISTAN

Afghanistan Fertilizer Company Management Support

AID Microfiche 3060143

Analysis of project for special assistance activity to AFC growing out of 11/75 evaluation report on 1972 and later inputs support. Emphasis on systems management.

Agricultural Inputs, 1975-77

AID Microfiche 3060151
PD-AAD-016-B1 Loan Paper, 6/75

Analysis for project for GOA and AFC to buy fertilizer and improve AFC's fertilizer management, increase storage facilities, adjust prices.

Fertilizer Distribution

AID Microfiche 3060129
PD-AAD-005-A1 Loan Paper, 10/72
PD-AAD-005-G1 Loan Paper, 6/72
PD-AAA-402-A1 Special Evaluation Report, 11/75

Analysis and evaluation of U.S. assistance to provide more adequate fertilizer supplies and transform distribution system from public to agriculture bank and private system. Dynamic growth model based on Pakistan, Indian experience to: reduce fertilizer subsidy; pass LC to AFC for financing of fertilizer; and improve monitoring of fertilizer. Evaluation shows considerable progress including monthly fertilizer monitoring ($19.4 million U.S. assistance).

National Agricultural Development Services, 1952-1971

AID Microfiche 3060002
PD-AAC-431-G1 Project Appraisal Report, 3/71

Appraisal of project to increase self sufficiency by privatization systems for distribution of inputs.

BANGLADESH

Fertilizer Distribution Improvement II

AID Microfiche 3880060
PD-AAP-884 Project Paper, 8/84

Analysis for $52 million grant and $13 million loan to encourage large scale private sector fertilizer wholesalers and increase marketing and distribution efficiency and support dealer sales promotions which are identified as major constraints.

Agricultural Inputs, 1977-81

AID Microfiche 3880035
PD-AAD-162-B1 Project Paper, 8/77
PD-AAD-163-A1 Project Evaluation Summary, 5/79

Analysis for $27.5 million U.S. grant for fertilizer imports and to assure supplies; project to increase small farmer access, will provide dealers with greater incentives and with increased supply thereby make fertilizer more accessible to small farmers.

Agricultural Assistance, 1974-77

AID Microfiche 3880014
PD-AAD-137-B1 Loan Paper, no date

Analysis for project to increase production. TVA team assists in analysis of fertilizer needs, storage/distribution, farmer education, other major aspects ($25 million provided).

PD-AAD-138-A1 Project Paper, 1975

(Adds $10 million and concludes that supply, not distribution, was the then major problem.)

Agricultural Inputs II

PD-AAD-140-B1 Loan Paper, 12/74

Analysis for $29.7 million loan for inputs. Report duplicates much of analysis contained in earlier paper (137-B1). ($29.7 million provided.)

Ashaganj Factory

AID Microfiche 3880016
PD-AAD-141 Project Paper ($30 million)
PD-AAF-723 Project Paper (added $23 million)
PD-AAD-143 Miscellaneous Document

Analysis for ($30 million) financing of plant; $23 million added later because of delays and increased costs.

See also interim progress reports for problems on construction PD-AAI-083-A1 (to 087-A1).

Fertilizer Distribution Improvement

AID Microfiche 3880024
PD-AAF-028-A1 Project Paper, 6/78
PD-AAG-314-C1 Special Evaluation Report, 2/79
PD-AAI-158 Project Paper, 8/81
PD-AAR-361 Special Evaluation Report, 4/82
(Report on distribution system)
PD-AAR-332 Progress and Interim Report, 6/85
Other interim and evaluation reports available from AID library.

Analysis and evaluation for $20.5 million grant and $3.2 million loan to improve fertilizer supplies and distribution system of Bangladesh Agricultural Development Corporation (facilities and management). Erratic supplies, shortages, lack of storage facilities and transport identified as major problems. Greater role for private sector needed but issue of how fast private sector can be induced to assume responsibilities. Margins for 32,000 dealers, about $7/MT under 6 miles and $10 over 6 miles. On national supply side problems include inefficiency of plants and inadequate import monitoring. (Need 5 months supply at all times). Farmer benefit/cost ratio 4.9 - 5.6 for owner operators and 2.2 - 2.7 for sharecroppers.

Fertilizer Storage

AID Microfiche 3880030
PD-AAD-156-B1 Project Paper, 6/76
PD-AAD-157-B1 Project Evaluation Summary, 8/78
PD-AAG-325-A1 Project Evaluation Summary, 1/81

Analysis and evaluation for project to finance fertilizer storage ($5.2 million). Identifies lack of facilities as major fertilizer problem. (In May 1976 IBD said it could not take proposed $30 million loan for fertilizer because of lack of facilities. See p. 54 of Inputs II.) Good analysis of distribution issues in PP. Project also addresses fertilizer ordering and transport problems and reduction in product loss. In January of 1981, 27,000 of planned 50,000 MT of storage was completed.

BURMA

Agricultural Production

AID Microfiche 4820007
PD-AAS-178 Project Paper of 26 November 1985

Describes $30 million follow on to Maize and Oilseed Production Project in 42 townships (but excludes maize). Major U.S. expenditure is for fertilizer but also includes better technology (e.g., farming systems, water, soil, pest management). Considerable discussion of Burmese society and social impacts.

Maize and Oilseed Production Paper of 1981 and Special Evaluation Report of 1985.

AID Microfiche 4820005
PD-AAI-284 Project Paper of 18 June 1981
PD-AAQ-789 Special Evaluation Report of 31 June 1985
PD-AAM-077 Annual Report of 14 January 1983
PD-AAP-467 Audit Report of 18 July 1984
PD-AAT-134 Progress Report/Interim Report of 31 December 1985

Project design for major project to increase maize and oilseed production in Burma includes increased inputs, especially fertilizer and seed, and research and extension. Output targets in terms of increased production over 5 years are quantified and benefits based on those planned increases in outputs of 50 to 100% are related to costs. Evaluation report shows after 3 years output targets were being achieved, e.g., maize and sunflower 50%, groundnuts 73%, sesame 83%, but as yet only 33% on edible oil. $30 million U.S. grant.

Oilseed Processing Project Paper

AID Microfiche 4820006
PD-AAQ-889 Project Paper

Follow on to Maize and Oilseed Production Project designed to improve processing of increased oilseed production ($9.5 million). Grows out of success of maize and oilseed production project with fertilizer element.

EGYPT

Agricultural Production Credit, pp. 86-90

AID Microfiche 2630202

Proposed follow-on to small farmer production project: would continue TA and funds for credit, expanded distribution of inputs.

Small Farmers Production

AID Microfiche 2630079
PD-AAD-979-B1 Project Paper, 7/78
XD-AAN-947-A Special Evaluation Report, 4/83
XD-AAS-315-A Special Evaluation Report, 6/85

Analysis and evaluation of a project to improve small farmer access to inputs and credit. Project with Principal Bank reduces control and rationing of inputs and subsidies and introduces greater privatization of input distribution. The Principal Bank supplies essentially 100% of farmers with fertilizer and other inputs, most with credit with almost 100% credit repayment, subsidized interest and inputs and rationing of credit and inputs. (U.S. assistance of $49 million)

Basic Input and Production Loan, 9/76

PAAD Document

PD-AAQ-616 PAAD, 9/76
PD-AAQ-865 PES, 2/75

Program loan assistance to finance agricultural and industrial machinery.

INDIA

Intensive Fertilizer Promotion

AID Microfiche 3860471
PD-AAF-855-A1 Project Paper, 8/80
PD-AAH-871 Project Evaluation Summary, 8/81
PD-AAM-613 Audit Report, 3/83

Analysis and evaluation for project of $101 million for fertilizer supplies to better serve small farmers and increase agricultural output; supply and distribution system includes 43,000 cooperative retailers and 59,000 private dealer outlets, breakdown of costs of marketing, fertilizer pricing. In 1983 it was reported that fertilizer growth targets were not achieved because of reforms and U.S. deobligation ($49 million of original $150 million).

Agricultural Inputs Development, 1966-76

AID Microfiche 3860367
PD-AAD-113-D1 1973
PD-AAD-113-E1 Final Report, 8/73

Project provides assistance for several subsectors: fertilizer, seeds, plant protection, farm machinery and oilseed processing. In 1966 with reorganization of Ministry of Agriculture an inputs wing was established. U.S. provided TA and resources to help develop Fertilizer Association of India, Pesticides Association of India and National Seed Corporation which played a major role in these 3 subsectors. Project was later divided into 5 parts. 1973 report discusses excellent results achieved by FAI in influencing marketing and other policies, including comprehensive fertilizer law, private dealer licensing vs. rationing and public monopoly. Provides history of fertilizer development and U.S. support from 1952-73.

Indian Farmer Fertilizer Cooperatives (IFFCO), 1971-75

PD-AAD-123-B1 Loan Paper, 6/69
PD-AAD-124-A1 Loan Paper, 5/71
PD-AAI-082-A1 Special Evaluation Report, 8/80

Analysis of project development of large IFFCO fertilizer manufacturing capacity. For a decade before this project IFFCO had been a major distributor but not producer of fertilizer. Paper discussed food targets (related fertilizer growth of 15-20%/year as a function of agricultural output - 4M MT fertilizer target needed by 1974), economic feasibility analysis, marketing study, market development plan of IFFCO which had approximately 50,000 farmer cooperatives as members.

JORDAN

Highlands Agricultural Development, 1985-92

AID Microfiche 2780264
PD-AAR-033 Project Paper, 5/85

Analysis of project for U.S. assistance ($17 million) for research, extension and institutional development to improve technology and inputs in highland area.

Potash Production

AID Microfiche 2780222
PD-AAR-844 Feasibility Study, 12/77
PD-AAF-435-B1 Project Paper, 7/78
PD-AAT-132 Project Evaluation Summary, 2/86

Project for fertilizer production, industrially oriented, some institution building (U.S. assistance $33 million).

Jordan Valley Farmer's Association

AID Microfiche 2780186
PD-AAS-566 Project Evaluation Summary, 10/85

Evaluation of a project to assist farmers associations to provide credit in kind for production inputs and services.

Wheat Research and Production, 1967-77

AID Microfiche 2780139
PD-AAP-582 Special Evaluation Report, 11/83

Analysis and evaluation of project to increase wheat production by use of improved technology including fertilizer. Results in terms of farmers adopting reported to be small.

NEPAL

Seed Production and Storage, 1978-85

AID Microfiche 3670118
PD-AAF-849-A1 Project Paper, 6/78
PD-AAN-975 Special Evaluation Report, 10/62
PD-AAT-894 Final Report, 8/85

Analysis and evaluation of project to produce and distribute seed and distribute other inputs. Aimed at increased private initiatives but major conceptual and implementation weaknesses were encountered.

PAKISTAN

Agricultural Commodities and Equipment

AID Microfiche 3910468
PD-AAL-862 Program Assistance Approval Document, 3/82
PD-AAP-011 Special Evaluation Report, 12/82
PD-AAN-237 Program Assistance Approval Document, 6/83
PD-AAP-630 Program Assistance Approval Document, 5/84
PD-AAS-004 Audit Paper, 10/85

Analysis for $35.3 million financing of imports of farmer production needs — imports mainly of seeds and tractors planned. LC to be programmed.

PORTUGAL

Agricultural Production 1980-85

AID Microfiche 1500023
PD-AAF-805-A1 Project Paper of August 1980
XD-AAR-0410A Special Evaluation Report of November 1984
PD-AAR-041 PES of February 1985

Analysis, design and evaluation report of AID assisted projects primarily for NE Portugal where 1979 sector assessment identified major opportunities for production increase and income improvement among small, low income farms with generally very low pH soils. Though assessment teams and GOP proposed emphasis on soil acidity and liming, U.S. project design team prepared a broader assistance plan (research, extension, livestock specialists, etc.). 1984 evaluation indicates major results coming from liming promotion and private sector limestone distribution.

SRI LANKA

Agricultural Inputs, 1978-81

AID Microfiche 3830051
PD-AAD-085-B1 Project Paper, 5/78

Analysis for $31 million loan to finance fertilizer imports. Deals with variety of issues: need to reduce number of mixes (102 to 21), reduce subsidy, import monitoring, better NPK balance, weakness in distribution system, distribution of benefits. Problem of attempting to segregate fertilizer distribution for different crops because of differential pricing policy. Observes that small farmers use more fertilizer than large.

Agricultural Inputs, 1975-76

AID Microfiche 3830039
PD-AAD-070-B1 Loan Paper, 12/74
PD-AAD-071-A1 Loan Paper, 9/76

Analysis of fertilizer sector for $72 million U.S. funding of imports and TA. Major issues, fertilizer sector discussed.