1. POLICY ISSUES FOR LONG-TERM GROWTH OF FERTILIZER USE IN BANGLADESH

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This paper discusses policy issues relevant to sustained rapid growth in Bangladesh's fertilizer consumption. The second section is an overview of fertilizer consumption as it has evolved over the years. It also provides a comparative perspective on the performance of Bangladesh among developing countries. The third section discusses policy requirements of long-term rapid growth in fertilizer use, keeping in mind various features of, and major forces behind, the past growth.

The paper concludes that, notwithstanding the policy of phasing out fertilizer subsidies adopted by the government, the potential for growth of fertilizer use is large. Realization of this potential, however, requires a new policy orientation. The emphasis on prices needs to be replaced by concentration on the productivity and efficiency of fertilizer use as key target variables.

Factors affecting growth in fertilizer use need to be viewed not in isolation from each other, but as a set of interacting variables that can be manipulated through policy. The dominant aim of these policies should be faster development and well-coordinated working of systems that influence the rate of growth of fertilizer use.

OVERVIEW OF FERTILIZER CONSUMPTION

Consumption in 1983/84

Fertilizer consumption in Bangladesh exceeded 500,000 metric tons of nutrients in 1983/84. In terms of materials, it was more than 1 million metric tons. Consumption reached 63 kilograms of net cultivated area and 41 kilograms per hectare of total cropped areas.

The view that Bangladesh's fertilizer consumption is among the world's lowest is somewhat misleading. While Bangladesh's fertilizer consumption per hectare is considerably lower than that in many developed countries, it is higher than average consumption in a large number of developing countries.

Comparison with Other Developing Countries

On the basis of 1981/82 fertilizer consumption per hectare of arable land and land under permanent crops, Bangladesh ranks 42nd among the 113 developing countries for which data are readily available.[1] Its consumption in that year was 9 percent lower than the average for all developing countries. However, if only developing market economies are considered (that is, if centrally planned economies are excluded from developing countries), then Bangladesh's consumption was 36 percent higher than the group's average.

Among the 34 developing countries of Asia, Bangladesh ranks 15th. But most of the developing countries with higher consumption than Bangladesh are either located in East Asia or in the Middle East. Among countries in South or Southeast Asia, Bangladesh's fertilizer consumption per hectare is lower than that of Singapore, Malaysia, Sri Lanka, Indonesia, and Pakistan. On the other hand, it is considerably higher than that of Nepal, Burma, Thailand, the Philippines, and a few others.

Bangladesh's fertilizer consumption per hectare of gross cultivated area in 1983/84 was about 8 percent lower than that of India. But it compares very favorably with states in East India (Table 1). Among these, only West Bengal's consumption was as high as that of Bangladesh, and consumption in Bihar, Orissa, Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, and Tripura was considerably lower than in Bangladesh.

That fertilizer consumption in Bangladesh was generally higher than in East India is also illustrated by Figures 1 and 2, which show levels of fertilizer consumption per hectare of gross cultivated area in the districts of East India and Bangladesh, respectively.

Not only is fertilizer consumption in Bangladesh higher than in a majority of the developing countries, but its growth has also been faster. In 1981/82 Bangladesh ranked third among the 40 developing countries that applied less than 5 kilograms of fertilizer per hectare in the early 1960s.

Trends of Growth in Consumption

Table 2 shows the growth of fertilizer consumption in Bangladesh from 1952/53 to 1983/84. The period can be broadly divided as: 1952/53 to 1959/60, 1959/60 to 1970/71, 1970/71 to 1974/75, 1974/75 to 1977/78, and 1977/78 to 1983/84.

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[1]Based on data from Food and Agriculture Organization of the United Nations, FAO Fertilizer Yearbook, various issues (Rome: FAO, various years).

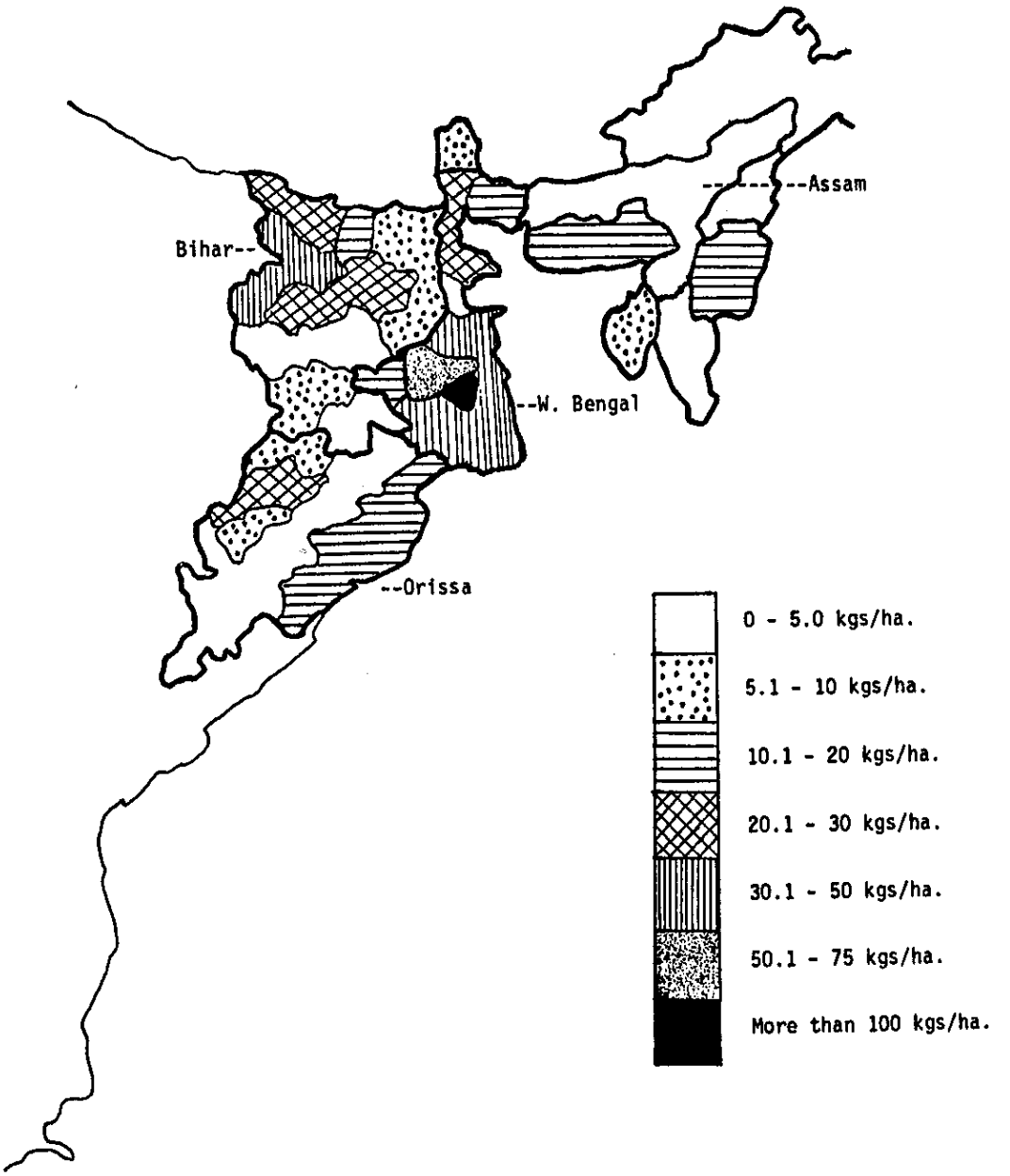
Table 1--Growth of fertilizer use in Bangladesh vis-à-vis India and major states of East India, 1961/62 to 1983/84

Year	Bangla-desh	Major States in East India				India
		West Bengal	Bihar	Orissa	Assam	
	(kilograms of nutrients per hectare of gross cropped area)					
1961/62	2.0	3.8	1.3	0.8	...	2.2
1962/63	2.2	3.3	1.8	0.9	0.1	2.9
1963/64	4.4	4.8	2.4	1.1	0.2	3.5
1964/65	4.1	6.5	3.1	1.3	1.0	4.9
1965/66	4.9	6.4	3.2	1.3	2.2	5.1
1966/67	6.1	5.1	3.6	2.5	1.9	7.0
1967/68	7.6	6.7	3.9	2.8	2.2	9.4
1968/69	8.2	8.0	6.1	2.9	3.3	11.1
1969/70	10.0	7.4	9.9	3.1	2.4	12.2
1970/71	11.4	11.0	9.0	3.3	3.1	13.6
1971/72	9.9	13.1	10.1	7.1	2.9	16.1
1972/73	15.1	13.0	11.5	8.1	3.3	17.1
1973/74	14.9	13.3	9.0	8.6	2.6	16.7
1974/75	10.8	16.2	10.8	6.9	1.9	15.7
1975/76	17.0	16.3	12.0	6.1	1.9	16.9
1976/77	19.6	20.0	15.2	8.6	1.3	20.4
1977/78	26.8	21.8	17.3	8.1	1.8	24.9
1978/79	27.6	30.9	17.1	8.7	2.4	29.2
1979/80	31.6	30.6	16.2	8.1	2.1	30.0
1980/81	32.3	35.9	18.0	9.2	2.8	31.5
1981/82	30.9	32.8	18.0	9.9	3.3	34.6
1982/83	34.6	33.1	18.5	10.8	4.1	36.6
1983/84	41.1	42.5	26.7	13.0	5.7	44.5

Sources: Bangladesh: Based on data from Bangladesh Ministry of Agriculture, Bangladesh Agriculture in Statistics (Dhaka, 1974); Bangladesh Bureau of Statistics, Ministry of Planning, Statistical Pocket Book of Bangladesh, 1980 (Dhaka: BBS, 1981); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1984.

India: Based on data from Fertilizer Association of India, Fertilizer Statistics (various issues); and India Ministry of Agriculture, Indian Agriculture in Brief (New Delhi).

Figure 1--Fertilizer nutrient consumption per hectare of total cropped area in various districts of Bihar, West Bengal, Orissa, Assam, and other Northeastern Indian states in the early 1980s



Note: No districts fall between 75.1 and 100 kilograms per hectare.

Figure 2--Fertilizer nutrient consumption per hectare of total cropped area in various districts of Bangladesh in the early 1980s

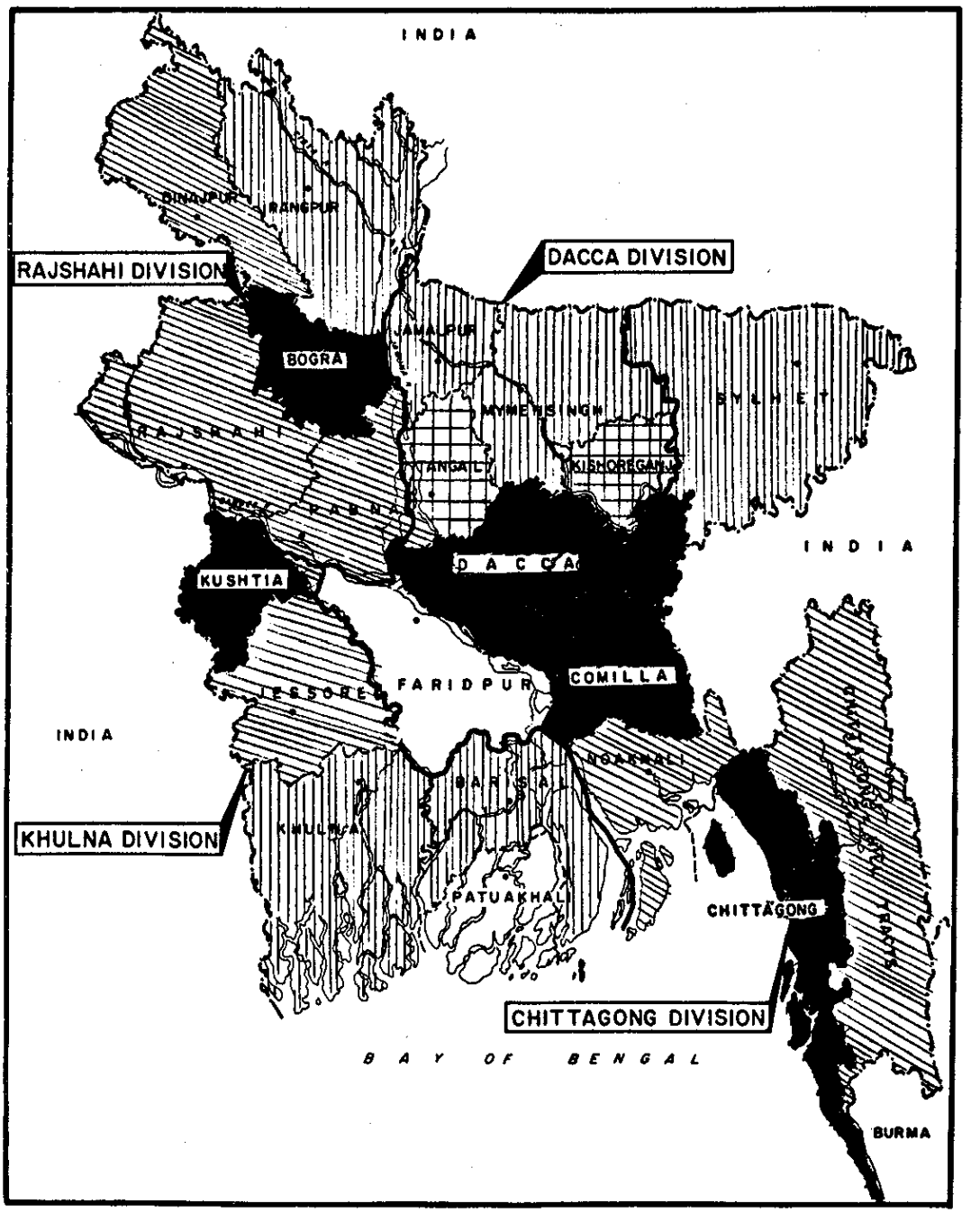


Table 2--Fertilizer consumption in Bangladesh, 1952/53 to 1983/84

Year	Consumption				
	N	P_2O_5	K_2O	Total	$N:P_2O_5:K_2O$
	(1,000 metric tons)				
1952/53	1.8	...	...	1.8	1:0.00:0.00
1953/54	2.7	...	...	2.7	1:0.00:0.00
1954/55	3.6	...	...	3.6	1:0.00:0.00
1955/56	2.3	...	...	2.3	1:0.00:0.00
1956/57	5.2	...	...	5.2	1:0.00:0.00
1957/58	7.1	0.5	...	7.6	1:0.07:0.00
1958/59	8.0	0.5	...	8.5	1:0.06:0.00
1959/60	10.5	0.9	...	11.4	1:0.09:0.00
1961/62	19.3	3.0	0.5	22.8	1:0.16:0.03
1962/63	24.4	2.0	1.0	27.4	1:0.08:0.04
1963/64	36.6	11.1	2.0	49.7	1:0.30:0.05
1964/65	34.5	9.1	2.0	45.6	1:0.26:0.06
1965/66	38.9	9.8	2.3	51.0	1:0.25:0.06
1966/67	56.5	16.1	5.1	77.7	1:0.28:0.09
1967/68	71.1	22.5	7.0	100.6	1:0.32:0.10
1968/69	74.7	24.7	7.6	107.0	1:0.33:0.10
1969/70	91.8	30.6	9.2	131.6	1:0.33:0.10
1970/71	99.2	35.0	10.4	144.6	1:0.35:0.10
1971/72	79.3	28.1	8.5	115.9	1:0.35:0.11
1972/73	128.8	41.5	11.3	181.6	1:0.33:0.09
1973/74	122.3	43.8	11.2	177.3	1:0.36:0.09
1974/75	82.3	35.6	10.7	128.6	1:0.43:0.13
1975/76	145.8	51.4	13.2	210.4	1:0.35:0.09
1976/77	163.2	56.7	13.6	233.5	1:0.35:0.08
1977/78	223.2	89.4	43.3	355.9	1:0.40:0.19
1978/79	219.9	83.0	29.0	331.9	1:0.38:0.13
1979/80	250.5	96.4	53.8	400.7	1:0.38:0.21
1980/81	262.0	100.5	52.3	414.8	1:0.38:0.20
1981/82	242.5	97.4	56.9	396.8	1:0.40:0.23
1982/83	289.4	94.8	74.1	458.3	1:0.33:0.26
1983/84	342.6	163.4	37.5	543.5	1:0.48:0.11

Sources: 1952/53 to 1964/65 data are from Bangladesh Ministry of Agriculture, Bangladesh Agriculture in Statistics (Dhaka, 1974); 1965/66 to 1982/83 from Bangladesh Bureau of Statistics, Ministry of Planning, Statistical Pocket Book of Bangladesh, 1983 (Dhaka: BBS, 1984); and 1983/84 from Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1984.

Total consumption grew from less than 2,000 metric tons of nutrients in 1952/53 to about 11,000 metric tons in 1959/60. Thereafter it accelerated, reaching 145,000 metric tons in 1970/71. More than 60 percent of growth during this period was recorded after 1965/66. Between 1970/71 and 1974/75 there were fluctuations in the upward trend. Fertilizer consumption reached 182,000 metric tons in 1972/73 but then dropped by 1974/75 to 129,000 metric tons, which was lower than in 1970/71.

The period between 1974/75 and 1977/78 recorded impressive growth, from 129,000 to 356,000 metric tons. Consumption in 1977/78 was nearly three times consumption in 1974/75, when fertilizer use was abnormally low owing to a particularly severe supply bottleneck. But growth in sales during the following three years must still be considered rapid. Fertilizer use in 1977/78 was twice that of the previous peak of 1972/73. Between 1977/78 and 1983/84, total consumption further increased from 356,000 to 544,000 metric tons (that is, by 53 percent). More than 75 percent of the growth during this period, however, occurred in the last two years. Yet another noteworthy point is that after reaching 400,000 metric tons in 1979/80, consumption stalled in 1980/81 and 1981/82 before reaching 544,000 metric tons in 1983/84.

These facts clearly indicate that a variety of factors other than changes in crop and fertilizer prices have governed the past growth in fertilizer use. On the demand side, diffusion of fertilizer use at a growing number of locations, accelerated growth of use in the Aus and Aman seasons (in addition to more intensive use during the Boro season), irrigation development, and the spread of high-yielding varieties (HYVs) clearly seem to have been important.

From the supply side, geographical expansion in the distribution system and fairly consistent growth in aggregate fertilizer supplies, as well as the changeover from the old to the new marketing system in the late 1970s, appear to be behind historical trends in the growth of fertilizer consumption. It is especially important to recognize all these forces explicitly while developing policies for sustained rapid growth in fertilizer consumption.

Consumption Vis-à-vis Potential

In 1980, the International Fertilizer Development Center (IFDC) estimated Bangladesh's agronomic potential for fertilizer use to be 1.70 million long tons of urea plus 1.46 million long tons of triple superphosphate or diammonium phosphate (TSP/DAP) and 0.82 million

long tons of muriate of potash (MP), a total of 3.98 million long tons of these fertilizer materials.[2]

In terms of nutrients, the potential works out to a little more than 2 million metric tons. On the basis of total cropped land, the potential amounts to about 150 kilograms of nutrients per hectare. This rate seems quite consistent with information in readily available literature on the response function environment in Bangladesh.[3]

The above estimate of the agronomic potential is not an unchanging number since it is based on cropped area, its distribution among various crops, and fertilizer recommendations. Notwithstanding possible overestimation in such an estimate, it provides a useful backdrop in the process of developing a perspective on the level and growth of actual fertilizer consumption. This is so because growth in fertilizer consumption occurs as a result of the conversion of this potential into actual fertilizer use.

Bangladesh's actual fertilizer consumption in 1983/84 was about 28 percent of the estimated potential--41 percent for urea, 24 percent for TSP/DAP, and only 8 percent for MP. These findings indicate that despite impressive growth in fertilizer consumption, Bangladesh has used less than 30 percent of its estimated agronomic potential of fertilizer use.

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[2]The estimate was based on major soil classifications by thanas, cropped area in 1977/78, and fertilizer recommendations made in 1979 by the Bangladesh Agricultural Research Council (BARC). For details, see International Fertilizer Development Center, Second Evaluation of the Bangladesh New Marketing System (Muscle Shoals, Ala.: IFDC, 1980).

[3]See, for instance, Kazi M. Badruddoza, "Experience in Farmers' Fields--Fertilizer Trials and Use in Bangladesh," in Proceedings: First Review Meeting, I.N.P.U.T.S. Project (Increasing Productivity Under Tight Supplies), ed. Saleem Ahmed and Muhammad Sadiq (Honolulu, Hawaii: East-West Center, 1976), pp. 339-350. The article provides results of more than 10,000 fertilizer trials on farmers' fields conducted by the Soil Fertility and Soil Testing Institute between 1970 and 1975. The trials covered six crops (rice, wheat, sugarcane, potatoes, mustard, and groundnuts). Nearly 80 percent of the trials were on local and improved varieties of paddy grown in Aus, Aman, and Boro seasons under irrigated as well as rainfed land. Nearly 70 percent of all trials were on rainfed land sown with local varieties of paddy.

Badruddoza's results show that net returns to fertilizer use were maximized with nutrient application of around 160 pounds per acre on local varieties of paddy under rainfed conditions, 160 to 240 pounds per acre on improved varieties of rice and wheat, 310 to 375 pounds per acre on sugarcane and potatoes, and 120 to 135 pounds per acre on mustard and groundnuts.

The use of this potential in terms of different nutrients has proceeded at an uneven pace. This is clearly brought out by Table 2, which shows a time series for the consumption of the three nutrients, accompanied by the N:P:K ratio. The N:P:K ratio implied by the potential estimated by IFDC is roughly 1:0.75:0.55.

Thus, although there is substantial untapped potential for further rapid growth in nitrogen consumption, it would be imprudent for efforts to raise fertilizer use to focus indiscriminately on this nutrient alone. This would be the case from the economic, as well as the agronomic, viewpoint, since additional crop production from nitrogen use depends on the use of other nutrients in specific soil groups and at high rates of nitrogen application.

The total fertilizer potential in a country is a summation of the potentials for use on different crops at various locations. Similarly, growth in the aggregate fertilizer consumption is an outcome of growth in use on various crops at different locations. The historical experiences of virtually all countries indicate that fertilizer use grows at different speeds on different crops. Even on the same crop, it grows at a different pace at different locations.[4]

It is, therefore, important to review the past growth in fertilizer use from these angles, since it reveals the composition of use at different times, the factors behind it, and a profile of the potential that has remained untapped. Such an understanding could then be used to evolve policies for further sustained growth in fertilizer use.

Share of Different Crops in Total Consumption

Fertilizer use in Bangladesh began on tea gardens in the early 1950s. It spread to other crops during the second half of the 1950s. Raisuddin Ahmed estimated, under a reasonable set of assumptions, that by 1960/61 rice had emerged with the dominant share of total fertilizer consumption (Table 3). Since Ahmed's estimates exclude application on tea plantations (between 2 and 10 thousand tons per year), the share of rice in the early 1960s could have been less than 70 percent. It grew to about 80 percent by the late 1960s. Thus acceleration in fertilizer consumption during the 1960s was due primarily to rapid growth of fertilizer use on rice.

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[4]Gunvant M. Desai, Sustaining Rapid Growth in India's Fertilizer Consumption: A Perspective Based on Composition of Use, Research Report 31 (Washington, D.C.: International Food Policy Research Institute, 1982); and Gunvant M. Desai and Gurdev Singh, Growth in Fertilizer Use in Districts of India: Performance and Policy Implications (Ahmedabad: Center for Management in Agriculture, Indian Institute of Management, 1973).

Table 3--Share of crops in total fertilizer consumption in Bangladesh, 1960/61 to 1973/74

Year	Total Consumption	Rice				Other Crops	Total
		Aus	Aman	Boro	Total		
	(long tons of nutrients)	(percent of total consumption)					
1960/61	20,183	28.4	34.8	13.6	76.8	23.2	100
1961/62	19,718	26.3	35.1	13.6	75.0	25.0	100
1962/63	24,702	27.9	35.2	13.8	76.9	23.1	100
1963/64	47,924	27.4	34.8	14.3	76.5	23.5	100
1964/65	43,834	28.1	34.7	13.6	76.4	23.6	100
1965/66	50,289	27.1	35.6	14.0	77.7	22.3	100
1966/67	74,668	23.1	33.7	17.3	74.1	25.9	100
1967/68	97,598	23.8	34.9	19.8	78.5	21.5	100
1968/69	104,224	19.8	36.3	23.4	79.5	20.5	100
1969/70	129,626	19.3	34.1	25.3	79.7	20.3	100
1970/71	143,206	19.0	29.7	27.1	75.8	24.2	100
1971/72	114,904	20.0	26.5	29.1	75.6	24.4	100
1972/73	179,230	16.7	24.6	33.5	74.8	25.2	100
1973/74	172,695	18.6	23.4	36.3	78.3	21.7	100

Sources: Developed from Raisuddin Ahmed, Foodgrain Production in Bangladesh: An Analysis of Growth: Its Sources and Related Policies (Dhaka: Bangladesh Agricultural Research Council, 1977), Appendix Tables 1.3(a) and 1.3(b).

Notes: Total consumption excludes application on tea gardens. Comparison of total consumption estimates here with those of the Food and Agricultural Organization of the United Nations suggest that annual consumption on tea plantations must have varied from 2,000 to 10,000 tons. Thus, the shares of crops would actually be lower than those shown here.

Ahmed's estimates show that the relative shares of Aus and Aman paddy in total fertilizer consumption decreased between the early 1960s and the early 1970s. During the same period, the share of Boro paddy increased substantially. This was because the absolute amount of fertilizer used on Boro paddy increased by 22-fold, while the quantity of fertilizer applied to Aus and Aman paddy rose 5- to 6-fold. The growth of fertilizer use on Boro paddy was faster because of the rapid growth in Boro paddy area (which, in turn, was principally due to irrigation development), the diffusion of HYVs of rice in the Boro season, and a strategy of increasing rice production by emphasizing the Boro season.

None of these factors was the main driving force behind the 5- to 6-fold growth in fertilizer consumption on Aus and Aman paddy, which, owing to larger initial area, was associated with a larger absolute increment of fertilizer use than was Boro paddy between 1960/61 and 1973/74. Instead, applications on Aus and Aman paddy grew mainly because much of the untapped potential for fertilizer use began to be converted into farmers' actual demand for fertilizers. This demand was met by the establishment of the East Pakistan Agricultural Development Corporation (now the Bangladesh Agricultural Development Corporation [BADC]) in 1962/63 and the consequent growth in the fertilizer distribution network. Following the introduction of the Rapid Soil Fertility Survey Scheme in 1957 throughout East and West Pakistan, it became scientifically established that in the response function environment of the 1950s, the untapped potential for fertilizer use was sizable.[5] About 4,500 experiments were conducted between 1957 and 1962 in Bangladesh (then East Pakistan).

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[5]Efforts to generate scientific knowledge about the response of crops to fertilizer use through experimentation and testing on farmers' fields were advocated as early as 1947 by M. O. Ghani, who was the Agricultural Chemist to the Government of East Bengal. These efforts, however, did not succeed until the mid-1950s, when the government of Pakistan asked the Food and Agriculture Organization of the United Nations for technical assistance in organizing fertilizer trials on cultivators' fields.

This led to the launching of the Rapid Soil Fertility Survey Scheme in 1957. Its aims were to generate information on crop responses to fertilizer use, to encourage farmers to take up fertilizer use through demonstrations, to make fertilizer recommendations, to obtain information about the potential increase in production that could be achieved through fertilizer use (information required for the formulation of agricultural development plans) and to specify agricultural areas where fertilizers could be used to the best advantage. For details, see J. G. Vermaat, Report to the Government of Pakistan on Soil Fertility Investigation, Report No. 1887, Project PAK/TE/LA (Rome: Food and Agriculture Organization of the United Nations, 1964).

About 90 percent of the experiments were on paddy and the remaining 10 percent were on wheat, sugar, potatoes, and mustard.

The experiments on paddy were conducted in all three seasons and were spread over six soil tracts covering the entire country. Results of these experiments established that the response function environment of rice was quite favorable. Even at 120 pounds of nutrients per acre the average response ratio was 8 to 9 pounds of paddy per pound of nutrient.

While the response of paddy to nitrogen was the highest (12.5 to 14.5 pounds of paddy per pound of nitrogen at 40 pounds of nitrogen per acre), it was also quite high for phosphate and potash (10 to 11 pounds of paddy per pound of phosphate, and 7 to 9 pounds of paddy per pound of potash at 40 pounds of these nutrients per acre).

Similarly, paddy yield response to fertilizer was confined neither to a single season (like Boro) nor to limited land areas or soil types. Since under the prevailing price environment a unit of nutrient did not cost more than 1.66 units of paddy, fertilizer use was perceived to be quite profitable for farmers.[6]

The explanations of acceleration in the growth in Bangladesh's fertilizer consumption during the 1960s usually focus on growth of fertilizer use on Boro paddy and emphasize factors such as growth in Boro paddy area, development of irrigation, and diffusion of HYVs. All this is understandable given the dramatic growth in fertilizer use on Boro paddy. But such explanations bypass the forces that generated growth of fertilizer use on Aus and Aman paddy--forces discussed above.

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[6]Vermaat, who has reported the results of fertilizer trials conducted under the Rapid Soil Fertility Survey Scheme, estimated that East Pakistan's rice production could be raised by 60 to 80 percent through fertilizer use alone. One may debate the accuracy of this estimate, as it involves generalization to all paddy land of average response ratios. But from details of the evidence generated by the scheme and comparable evidence from India, it is clear that in the response function environment in Bangladesh in the late 1950s and the early 1960's there was a large potential for growth in fertilizer use.

There were two main reasons for this. First, fertilizer use had just begun; in the late 1950s, use was less than two kilograms per hectare of total cropped land. Second, because of heavy subsidization of fertilizers, the price environment was extremely favorable. For example, around 1960 a unit of nitrogen was about three times more expensive (in terms of rice) in West Bengal, India than in East Pakistan.

This could be misleading because it is clear from Ahmed's estimates in Table 3 that Boro paddy accounted for only 39 percent of the increment in total fertilizer consumption between 1960/61 and 1973/74. Another 39 percent of the increment was due to growth in consumption of Aus and Aman paddy, and the remaining 22 percent was due to growth in fertilizer consumption for crops other than paddy.

Explicit recognition of the forces behind growth in fertilizer use on these crops could have led to policies to strengthen them and generate even faster growth, particularly on Aus and Aman paddy.

An indicative fertilizer consumption profile by crop can be developed for the 1979-81 period using the proportions of crop areas fertilized, average rates of application based on survey findings available in IFDC-BARC reports, and official statistics about the area under different crops.

Such a profile shows the following distribution of total fertilizer consumption in the early 1980s: rice, 81.5 percent; wheat, 7.4 percent; and the remaining crops, 11.1 percent. The 81.5 percent share of rice is comprised of 21.7 percent on Aus paddy, 39.8 percent on Aman paddy, and 20.0 percent on Boro paddy.

Two important conclusions emerge from the above findings. First, the share of rice in total fertilizer consumption increased marginally during the 1970s. This was because it was already quite high (between 75 and 80 percent) by the late 1960s, as Ahmed's estimates suggest. Second, and more importantly, unlike trends during the 1960s, the relative shares of Aus and Aman paddy in total fertilizer consumption increased during the 1970s, and that of Boro paddy decreased. Of course, total consumption on paddy grown in each season (including Boro) increased substantially in absolute terms because of the vast growth in aggregate fertilizer consumption.

The above reversal of the relative importance of the three paddy crops in total fertilizer consumption in the 1970s is not surprising. Total paddy area was distributed over the three seasons as roughly 30 percent in Aus, 58 percent in Aman, and 12 percent in Boro. Obviously the dominance of Boro paddy, as the dynamic component among shares of total fertilizer consumption, could not long be sustained with such a small share of total paddy area, especially when fertilizer use on Aus and Aman paddy was already under way and gathering momentum during the 1960s.

What other factors facilitated acceleration in the growth of fertilizer use on Aus and Aman paddy during the 1970s?

Available information suggests that this question cannot be answered mainly in terms of HYVs since by 1981/82 they covered only about 16 percent of the rice area in both these seasons. Against this, the findings available from the IFDC-BARC reports show that as

much as 50 to 52 percent of the Aus and Aman rice area was fertilized. Nor does the explanation lie predominantly with irrigation development, inasmuch as rice during these two seasons is grown mainly on rainfed areas.

Thus, diffusion of fertilizer use on local varieties and increases in rates of application emerge as important factors. These two processes were facilitated by rapid growth in aggregate supply of fertilizers (financed to a considerable extent by foreign aid), establishment of a widespread network for delivery of fertilizers to farmers, and continuation of the generally favorable price environment, despite upward adjustments in fertilizer prices.

The last point is brought out by Table 4, which presents a time series of official prices for nitrogen and for procurement of rice and wheat in both Bangladesh and India for the 1967/68 to 1983/84 period. Readily available information also indicates that the fertilizer price environment in Bangladesh has been more favorable than in many other developing countries.

Proportions of Areas Fertilized and Rates of Application

Growth in total fertilizer consumption occurs as a result of increases in proportions of cropped area fertilized and upward movements in rates of application. It is, therefore, useful to examine past growth performance from these angles. However, firm estimates based on large sample surveys were not available for Bangladesh until the late 1970s. Despite their limitations, the following findings for the early and mid-1970s seem worth noting before focusing on evidence available for recent years.

Assuming that farmers who use fertilizers apply 50 percent of the recommended rates, Ahmed estimated that during the 1971-74 period, only 7 percent of Aus areas, 4 percent of Aman areas, and 18 percent of Boro paddy areas were fertilized. However, findings for 1976/77, based on a widespread but small sample survey, indicate that actual rates might have been lower than 50 percent of recommended rates. Correspondingly, proportions of areas fertilized might have been higher than estimated by Ahmed.

In a sample of 20 clusters of 384 farms distributed over 10 out of 20 districts, Jabbar found that in 1976/77 about 70 percent of sample farmers had used fertilizer and that 51 percent of the area under all crops was fertilized.[7] The proportion of area planted with each crop that was fertilized was HYV Boro paddy, 99 percent; local

[7]M. A. Jabbar, "Fertilizing Behaviour of a Sample of Bangladesh Farms," Bangladesh Journal of Agricultural Economics 2 (No. 2, 1979): 57-71.

Table 4--Ratios of official prices of nitrogen to procurement prices of rice and wheat in Bangladesh and India, 1967/68 to 1983/84

Year	Bangladesh		India	
	Rice[a]	Wheat[b]	Rice[a]	Wheat[b]
1967/68	0.78	n.a.	2.19-2.72	1.93-2.82
1968/69	0.74	n.a.	2.24-2.79	2.31-2.46
1969/70	0.74	n.a.	2.37-3.06	2.70
1970/71	0.74	n.a.	2.37-2.99	2.70
1971/72	0.58	n.a.	2.32-2.87	2.64
1972/73	0.81	n.a.	2.40-2.86	2.75
1973/74	1.05	n.a.	2.18	2.78-3.00
1974/75	0.91	n.a.	3.94	4.14
1975/76	0.91	1.51	3.64	3.83
1976/77	1.09	1.76	3.44	3.62
1977/78	0.98	1.63	2.93	3.06
1978/79	1.12	1.77	2.65	2.98
1979/80	1.32	2.27	2.22	2.74
1980/81	1.41	2.17	2.77	3.72
1981/82	1.41	2.12	2.97	3.93
1982/83	1.53	2.38	2.81	3.60
1983/84	n.a.[c]	n.a.	2.24-2.37	3.09

Sources: Based on Raisuddin Ahmed, Foodgrain Production in Bangladesh: An Analysis of Growth: Its Sources and Related Policies (Dhaka: Bangladesh Agricultural Research Council, 1977); Bangladesh Bureau of Statistics, 1982 Statistical Yearbook of Bangladesh (Dhaka: BBS, 1983); Fertilizer Association of India, Fertilizer Statistics, 1982/83 (New Delhi: FAI, 1983); and India, Economic Survey, 1983/84 (New Delhi, Controller of Publications, 1984).

Notes: Nitrogen prices are based on urea for both countries. Where n.a. appears, data are not available.

[a]This is the ratio of the official price of nitrogen to the procurement price of rice.

[b]This is the ratio of the official price of nitrogen to the procurement price of wheat.

[c]Fertilizer prices were decontrolled throughout Bangladesh beginning April 1, 1983.

Boro paddy, 48 percent; Aus paddy, 42 percent; transplanted Aman paddy, 52 percent; jute, 33 percent; and tobacco, 60 percent.

These findings suggest two things. First, the diffusion of fertilizer use was much wider than estimated by Ahmed for 1971-74 and was significant for local varieties of paddy in the Aus and Aman seasons as well as in Boro. Second, Jabbar's findings reveal that even in 1976/77, the actual rates of application on fertilized land were considerably lower than the recommended rates of 50 percent Ahmed assumed for 1971-74. The actual rates were 30 to 37 percent of the recommended rates on Aus, transplanted Aman, and HYV Boro paddy.

Total fertilizer consumption divided by the average rate of application found by Jabbar--100 kilograms of fertilizer materials (about 41 kilograms of nutrients) per hectare of fertilized land--produces an estimate of 5.24 million hectares of fertilized area for 1976/77. This is roughly 42 percent of Bangladesh's gross cropped area in that year. On the other hand, if the average rate on all fertilized land was higher than revealed by Jabbar's small sample survey, then by 1976/77 less than 42 percent of gross cropped area would be fertilized.

Much of the uncertainty about how many farmers used fertilizers, what proportions of crop areas were fertilized, and at what rates has been removed by the farm-level surveys conducted for the IFDC-BARC study on Agricultural Production, Fertilizer Use, and Equity Considerations. These surveys were carried out in 10 cropping seasons from 1979 Aman to 1982 Aman. The survey locations (thanas) were spread all over the country, covering all districts except Patuakhali and the Chittagong Hill Tracts. At each location about 120 farms were selected by stratified random sampling. The following paragraphs highlight some of the major findings of these surveys.

About 65 percent of Bangladesh's farmers used fertilizers during the reference period of the surveys. About 50 percent of the planted area was fertilized. The average rate of application was 74 pounds of nutrients per acre of fertilized area.[8]

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[8]These national findings are reported on page 16 of IFDC, Bangladesh Policy Options for the Development of the Fertilizer Sector (Muscle Shoals, Ala.: IFDC, 1982). One method of checking the reliability of the national figures is to multiply the survey-based estimates of the proportion of area fertilized and the average rates of application per fertilized acre by official estimates of total area, and thus arrive at an estimate of total fertilizer consumption.

There is, however, one difficulty. The definition of "planted area" is not available in the above report. If it is "gross or total cropped area," then the total estimated consumption is about 35

On average, about 77 percent of Bangladesh's wheat area, 57 percent of Boro paddy area, 51 percent of Aman paddy area, 51 percent of Aus paddy area, and 31 percent of jute area were fertilized (Table 5). The average rates of application in terms of fertilizer materials per fertilized acre under these crops were wheat, 155 pounds; Boro paddy, 181 pounds; Aman paddy, 111 pounds; Aus paddy, 131 pounds; and jute, 81 pounds. The percentage of area fertilized was more than the percentage of area sown with HYVs for all crops except wheat, indicating that fertilizer use was not confined to HYVs.

On the other hand, virtually all area under wheat was sown with HYVs, but fertilizer use had spread to only 77 percent of the sown area. The diffusion of fertilizer use on wheat, however, was not confined to irrigated wheat, since only 33 percent of the area under the crop was irrigated. Against this, fertilizer use had not yet spread to all irrigated area under Boro paddy; fertilized area was 21 percentage points lower than the area of Boro paddy irrigated.

These findings are for all sample locations taken together. Within these aggregates, there were vast variations in both the percentages of cropped area fertilized and the average rates of application on the same crop among different locations (Tables 6 through 10 and Figures 3 through 7).

Nor were the changes (in these two determinants of fertilizer use) uniform for all crops or locations. This is stressed because during the three-year survey period, fertilizer prices (in both nominal and relative terms) increased. Despite this escalation in fertilizer prices, there were many locations where either the proportion of area fertilized, or the average rate of application, or both, had increased. Thus the conclusion that emerges from these findings is that temporal changes in fertilizer use are governed by a variety of factors, whose importance varies by location and crop.

Yet another conclusion suggested by the findings is that there were many locations where fertilizer use spread much less than the aggregative findings indicated. Such locations deserve attention in

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(Footnote 8, continued)

percent higher than the official figure of total fertilizer consumption during the reference period of the surveys. On the other hand, if the term "planted area" means "net cropped area," then the total estimated consumption is about 12 percent lower than the official figure for total fertilizer consumption.

After evaluating different alternatives, it seems reasonable to conclude that by around the late 1970s or early 1980s, nearly 50 percent of Bangladesh's gross cropped area was fertilized, at an average rate of 55 to 60 pounds of nutrients per fertilized acre.

Table 5--Findings of IFDC-BARC surveys on percentage of area fertilized and average rates of application for Aus, Aman, and Boro paddy, wheat, and jute, 1979-82

Crop	Season	Year	Number of Sample Locations	Crop Area in Sample (acres)	Crop Area Fertilized (percent)	Average Rate (pounds of materials/ fertilized acre)	Crop Area Irrigated (percent)	Crop Area Sown with HYVs (percent)
Paddy	Aus	1980	15	1,972	47.9	132	10.5	19.5
Paddy	Aus	1981	15	1,759	54.1	132	11.9	22.8
Paddy	Aus	1982	15	1,708	51.7	126	15.4	27.8
Weighted average			15	1,813	51.1	131	12.5	23.1
Paddy	Aman	1979[a]	10	2,274	60.5	117	3.7	20.5
Paddy	Aman	1980	10	2,445	49.7	110	0.8	23.4
Paddy	Aman	1981	10	2,236	44.2	104	4.2	27.1
Weighted average			10	2,318	51.4	111	2.8	23.6
Paddy	Boro	1979/80	8	573	59.5	185	75.0	58.4
Paddy	Boro	1980/81	8	467	57.5	145	79.2	55.7
Paddy	Boro	1981/82	8	488	52.1	213	80.2	50.8
Weighted average			8	509	56.5	181	77.9	55.2
Wheat	...	1979/80	10	661	78.6	155	42.7	95.9
Wheat	...	1980/81	10	542	80.4	163	23.7	99.8
Wheat	...	1981/82	10	337	68.0	141	25.8	92.7
Weighted average			10	513	76.9	155	32.3	96.6
Jute	...	1980	9	414	32.0	77	...	0
Jute	...	1981	9	372	25.1	103	...	0
Jute	...	1982	9	442	35.1	72	...	...
Weighted average			9	409	30.9	81	...	...

Source: Developed from the data in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals, Ala.: IFDC, 1982 and 1984).

Note: Only those locations for which findings are available for three years are considered.

[a]These data are occasionally criticized as less reliable, owing to survey quality control difficulties during the season when the study began.

Table 6--Fertilizer use by sample farmers on Aus paddy in Bangladesh, 1980-82

Location of Sample District and Thana	Aus Paddy 1980					Aus Paddy 1981					Aus Paddy 1982				
	Area					Area					Area				
	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate
	(acres)	(percent of area)			(lbs./ acre)	(acres)	(percent of area)			(lbs./) acre	(acres)	(percent of area)			(lbs./ acre)
Comilla, Chandina	153	0	8	74	195	130	7	23	96	160	127	7	22	96	88
Bogra, Nandigram	128	1	22	97	120	139	23	43	100	151	141	49	64	100	195
Dhaka, Kapasia	95	0	11	51	71	97	0	24	76	86	104	0	15	98	84
Kushtia, Mirpur	309	62	71	73	270	220	69	66	67	307	209	70	69	69	294
Tangail, Modhupur	150	0	4	69	86	97	0	10	55	91	56	0	4	6	83
Mymensingh, Phulpur	154	0	0	87	46	177	0	2	79	54	159	0	1	56	57
Noakhali, Sonagazi	21	0	29	100	109	127	0	45	99	118	130	0	47	98	123
Dinajpur, Chirirbandar	205	0	15	14	64	159	0	13	13	54	175	4	24	12	83
Pabna, Atghoria	151	6	12	15	110	114	0	8	45	84	91	26	28	42	155
Jessore, Jhikargacha	157	0	30	24	117	110	0	19	21	57	146	3	30	23	96
Barisal, Jhalakathi	98	0	0	1	200	56	0	1	5	120	75	0	9	23	157
Rangpur, Kurigram	144	3	4	37	78	166	10	12	21	105	98	3	5	25	60
Sylhet, Balagonj	44	0	0	1	100	52	0	1	2	300	50	0	2	21	50
Faridpur, Nagarkanda	33	0	0	2	100	34	0	0	0	0	65	0	0	3	67
Khulna, Fakirhat	130	0	0	24	125	81	0	0	18	214	82	0	1	46	57

Source: Developed from data in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals, Ala.: IFDC, 1982 and 1984).

Note: The rates are given in terms of fertilizer materials per acre of fertilized land.

Table 7--Fertilizer use by sample farmers on Boro paddy in Bangladesh, 1979/80 - 1981/82

Location of Sample District and Thana	Boro Paddy, 1979/80					Boro Paddy, 1980/81					Boro Paddy, 1981/82				
	Area					Area					Area				
	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate
	(acres)	(percent of area)			(lbs/ acre)	(acres)	(percent of area)			(lbs/ acre)	(acres)	(percent of area)			(lbs/ acre)
Chittagong, Ramu	104	55	100	97	309	95	82	98	99	287	98	97	100	100	262
Dhaka, Kapasia	77	36	36	38	229	66	26	34	32	58	66	4	18	14	157
Tangail, Modhupur	59	98	100	99	252	50	92	100	94	229	56	99	100	98	323
Mymensingh, Phulpur	84	94	77	96	94	41	82	73	96	183	42	90	91	99	187
Jessore, Jhikargacha	27	68	100	98	330	27	100	100	100	327	40	97	100	100	313
Barisal, Jhalakathi	23	93	100	100	312	32	100	100	99	247	4	73	100	100	244
Sylhet, Balagonj	172	98	9	5	140	136	100	3	5	5	162	98	...	4	175
Faridpur, Nagarkanda	27	0	51	50	306	20	0	8	8	12	20	10	0	0	0

Source: Developed from data in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals, Ala.: IFDC, 1982 and 1984).

Note: Rates are given in terms of fertilizer materials per acre of fertilized land.

Table 8--Fertilizer use by sample farmers on Aman paddy in Bangladesh, 1979-81

Location of Sample District and Thana	Aman Paddy, 1979					Aman Paddy, 1980					Aman Paddy, 1981				
	Area					Area					Area				
	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate
	(acres)	(percent of area)			(lbs/ acre)	(acres)	(percent of area)			(lbs/ acre)	(acres)	(percent of area)			(lbs/ acre)
Chittagong, Ramu	353	0	68	78	127	361	0	68	52	133	347	0	76	24	88
Comilla, Chandina	169	2	15	73	160	116	0	14	21	157	136	0	12	76	79
Bogra, Nandigram	388	1	5	89	138	412	0	8	95	94	401	10	17	100	114
Tangail, Modhupur	178	10	45	78	142	176	0	33	77	112	152	0	28	71	94
Noakhali, Sonagazi	134	0	35	97	180	136	0	30	94	93	141	0	38	98	110
Dinajpur, Chirirbandar	286	0	2	19	63	308	0	3	7	43	273	0	7	9	78
Pabna, Atghoria	237	15	17	69	141	217	5	20	59	171	189	13	34	79	167
Jessore, Jhikargacha	132	18	4	70	139	123	8	19	66	8	143	21	9	85	55
Barisal, Jhalakathi	227	0	1	22	68	212	0	0	2	100	155	0	0	13	62
Sylhet, Balagonj	170	0	1	1	30	147	0	0	4	75	161	0	1	3	167
Khulna, Fakirhat	...	...	...	...	...	237	0	43	45	198	138	0	47	49	171

Source: Developed from data in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals, Ala.: IFDC, 1982 and 1984).

Note: Rates are given in terms of fertilizer materials per acre of fertilized land.

Table 9--Fertilizer use by sample farmers on wheat in Bangladesh, 1979/80 - 1981/82

Location of Sample District and Thana	Wheat, 1979/80					Wheat, 1980/81					Wheat, 1981/82				
	Area					Area					Area				
	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate
	(acres)	(percent of area)			(lbs/ acre)	(acres)	(percent of area)			(lbs/ acre)	(acres)	(percent of area)			(lbs/ acre)
Comilla, Chandina	71	0	100	82	254	44	28	99	99	261	40	13	96	97	261
Bogra, Nandigram	11	47	100	100	229	26	79	100	100	258	10	90	97	97	288
Kushtia, Mirpur	52	34	100	97	206	76	0	100	98	135	48	67	100	65	177
Tangail, Modhupur	68	97	100	96	219	58	80	100	96	254	22	93	100	96	272
Mymensingh, Phulpur	25	24	51	92	97	21	7	100	83	78	4	20	100	73	81
Dinajpur, Chirirbandar	93	99	100	95	89	44	0	100	84	119	30	0	100	65	111
Pabna, Atghoria	123	38	100	82	173	89	14	100	89	181	47	24	100	72	147
Jessore, Jhikargacha	96	34	100	78	177	44	59	100	82	189	21	37	100	74	111
Rangpur, Kurigram	59	27	100	81	125	59	16	100	88	124	42	1	86	84	87
Faridpur, Nagarkanda	63	0	76	0	0	81	0	99	18	78	73	0	77	29	41

Source: Developed from data in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals, Ala.: IFDC, 1982 and 1984).

Note: Rates are given in terms of fertilizer materials per acre of fertilized land.

Table 10--Fertilizer use by sample farmers on jute in Bangladesh, 1980-82

Location of Sample District and Thana	Jute 1980					Jute 1981					Jute 1982				
	Area					Area					Area				
	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate	Total	Irri-gated	Under HYVs	Fertil-ized	Rate
	(acres)	(percent of area)			(lbs/ acre)	(acres)	(percent of area)			(lbs/ acre)	(acres)	(percent of area)			(lbs/ acre)
Comilla, Chandina	8	0	0	68	204	13	0	0	100	217	18	0	0	90	111
Kushtia, Mirpur	38	1	0	29	76	29	0	0	2	100	41	...	0	8	125
Tangail, Modhupur	16	0	0	69	83	14	0	0	59	88	11	0	0	3	67
Mymensingh, Phulpur	35	0	0	89	52	22	0	0	48	90	29	0	0	50	44
Dinajpur, Chirirbandar	64	0	0	8	63	41	0	0	13	46	56	0	0	13	54
Pabna, Atghoria	40	0	0	48	125	32	0	0	50	146	42	...	0	52	73
Jessore, Jhikargacha	63	0	0	12	125	78	0	0	29	93	110	0	0	31	100
Rangpur, Kurigram	76	0	0	18	56	61	0	0	16	44	54	0	0	11	36
Faridpur, Nagarkanda	74	0	0	38	42	82	0	0	9	156	81	0	0	64	45

Source: Developed from data in Bangladesh Agricultural Research Council and International Fertilizer Development Center, Agricultural Production, Fertilizer Use and Equity Considerations, Results and Analysis of Farm Survey Data, 1979-80 and 1980-82 (Muscle Shoals, Ala.: IFDC, 1982 and 1984).

Note: Rates are given in terms of fertilizer materials per acre of fertilized land.

Figure 3--Percentage of area fertilized, and average rates of application on Aus paddy by sample farmers at different locations in 1980, 1981, and 1982

(%AF = Percent crop area fertilized, AR = Average rate of application, pounds of materials per fertilized acre)

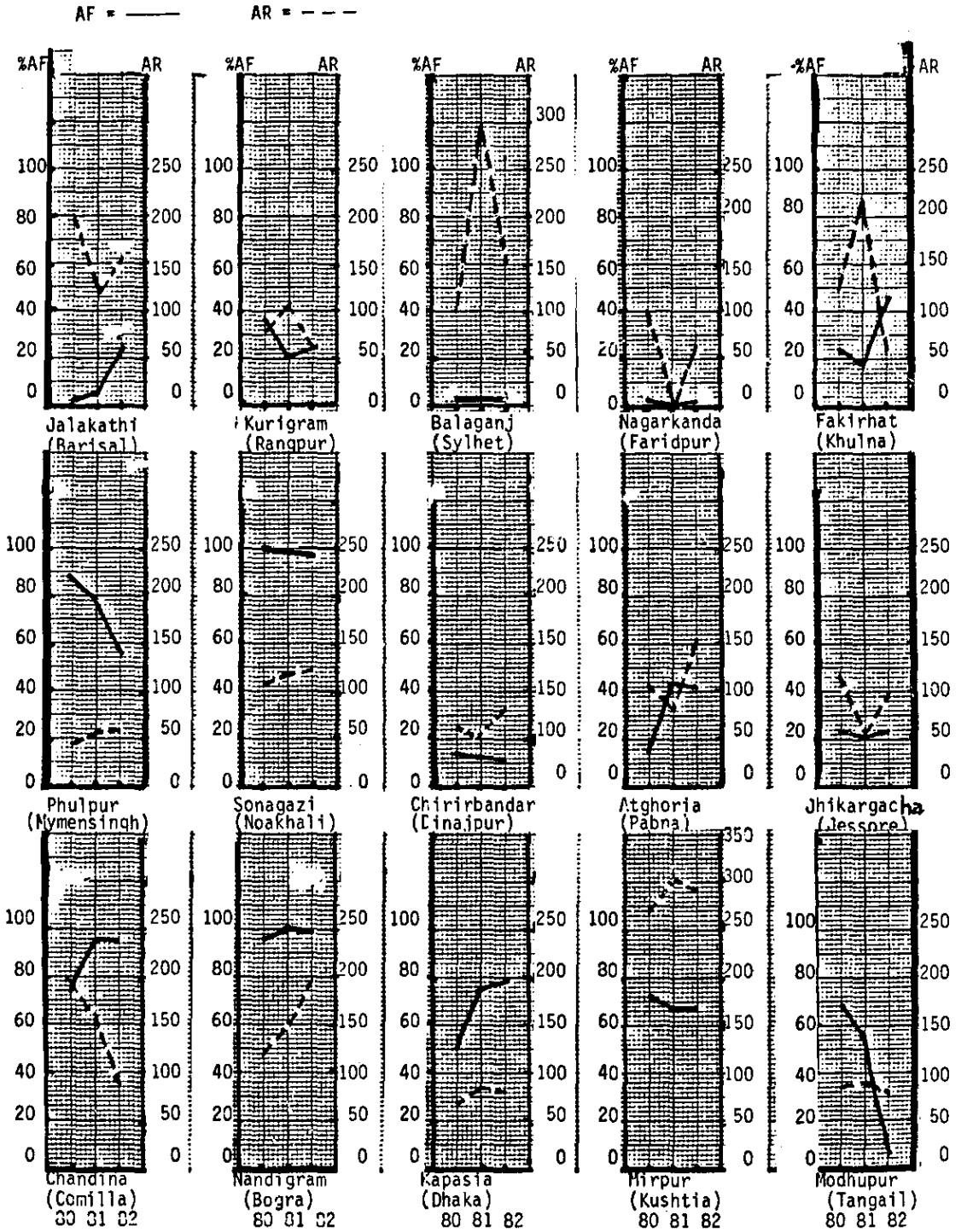


Figure 4--Percentage of area fertilized, and average rates of application on Aman paddy by sample farmers at different locations in 1979, 1980, and 1981

(%AF = Percent crop area fertilized, AR = Average rate of application, pounds of materials per fertilized acre)

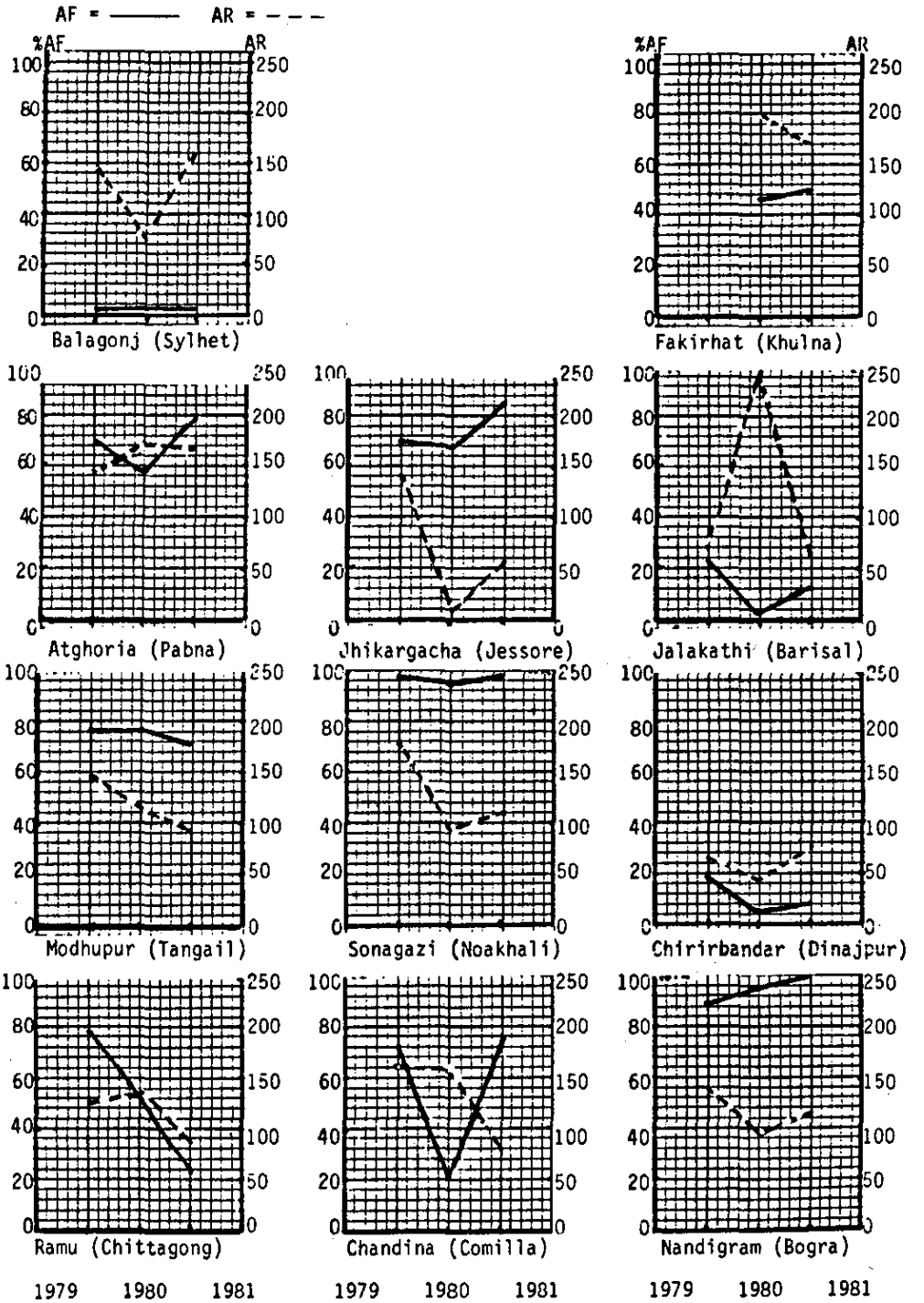


Figure 5--Percentage of area fertilized, and average rates of application on Boro paddy by sample farmers at different locations in 1979/80, 1980/81, and 1981/82

(%AF = Percent crop area fertilized, AR = Average rate of application, pounds of materials per fertilized acre)

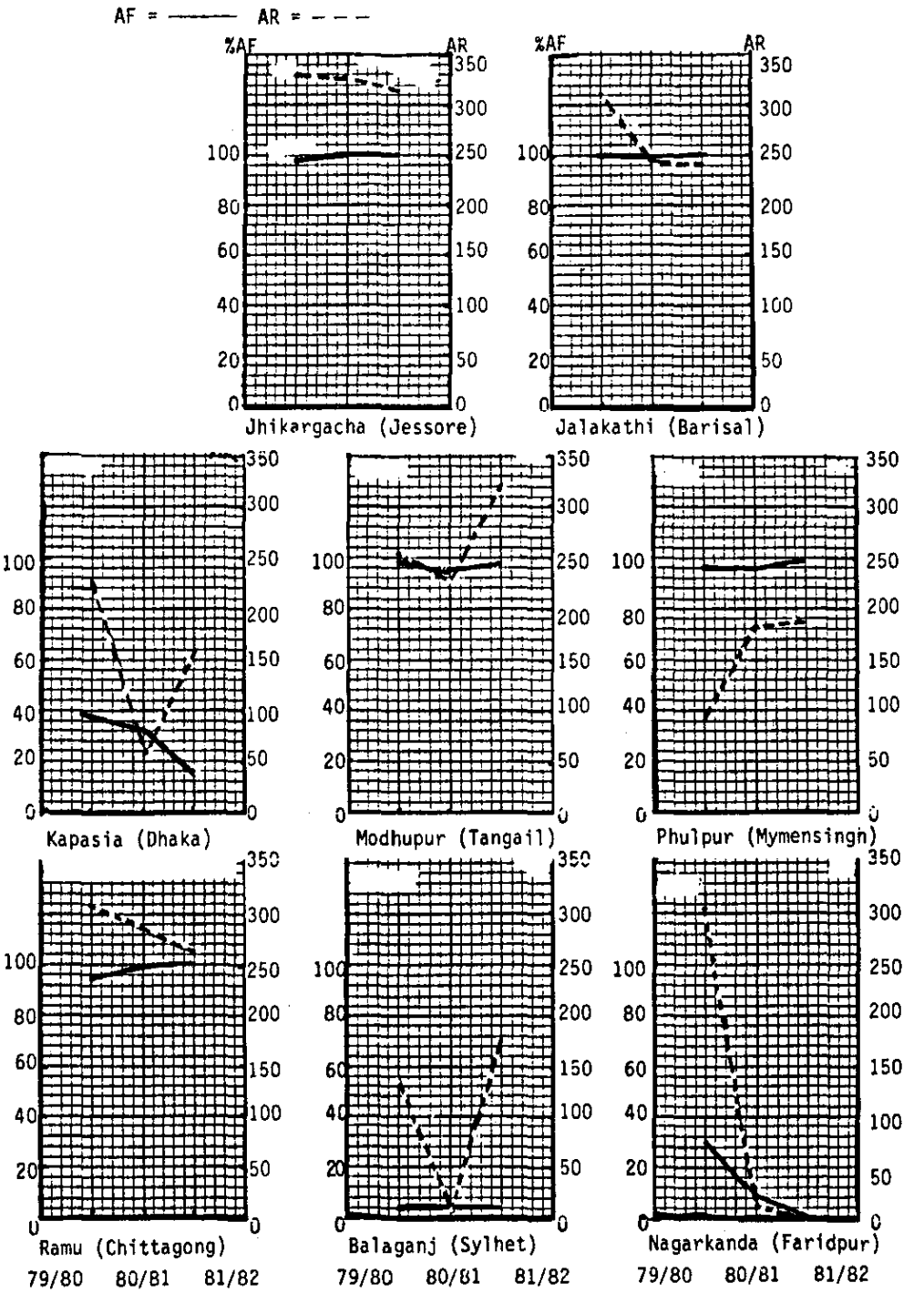


Figure 6--Percentage of area fertilized and average rates of application on wheat by sample farmers at different locations in 1979/80, 1980/81, and 1981/82

(%AF = Percent crop area fertilized, AR = Average rate of application, pounds of materials per fertilized acre)

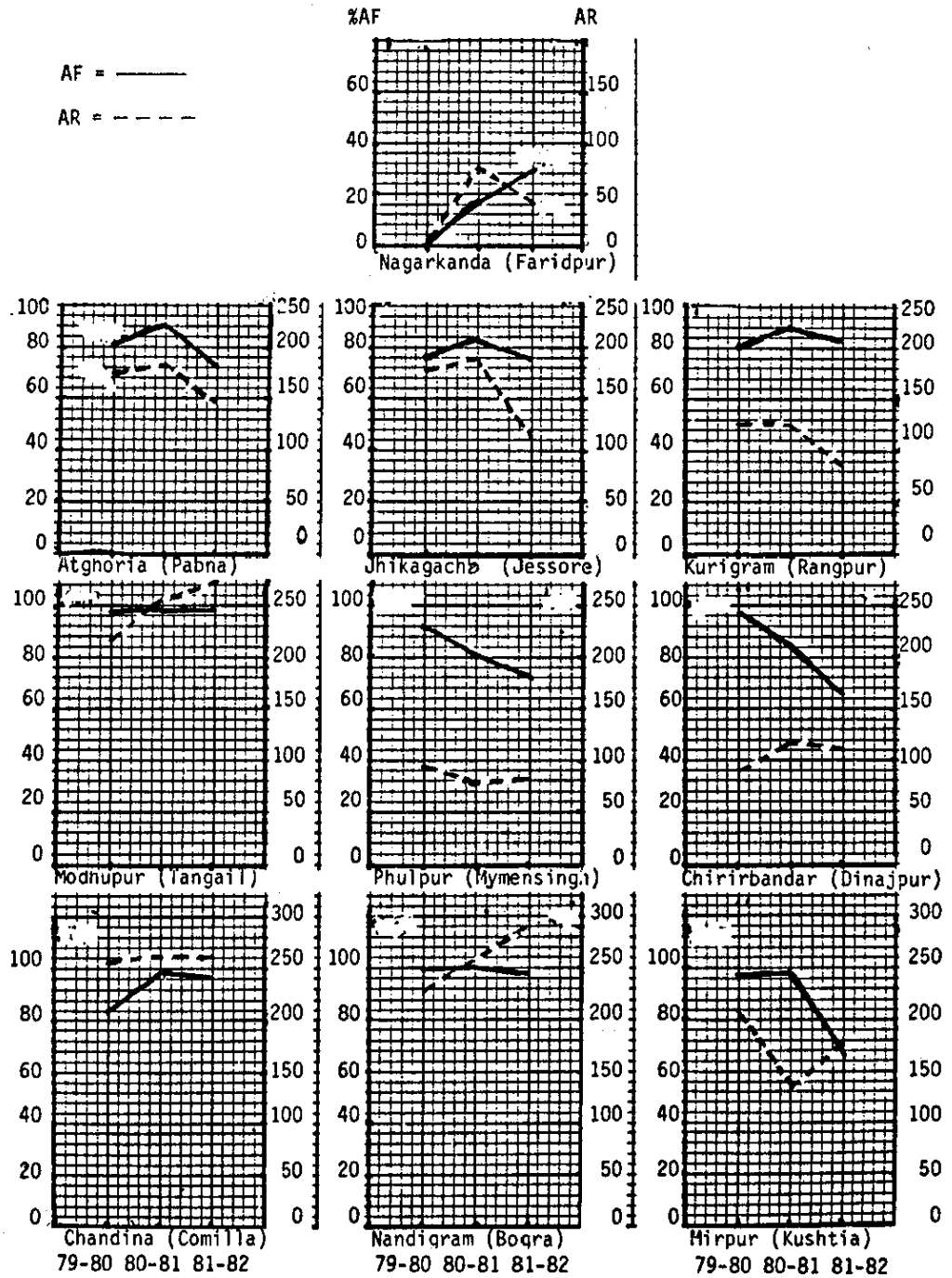
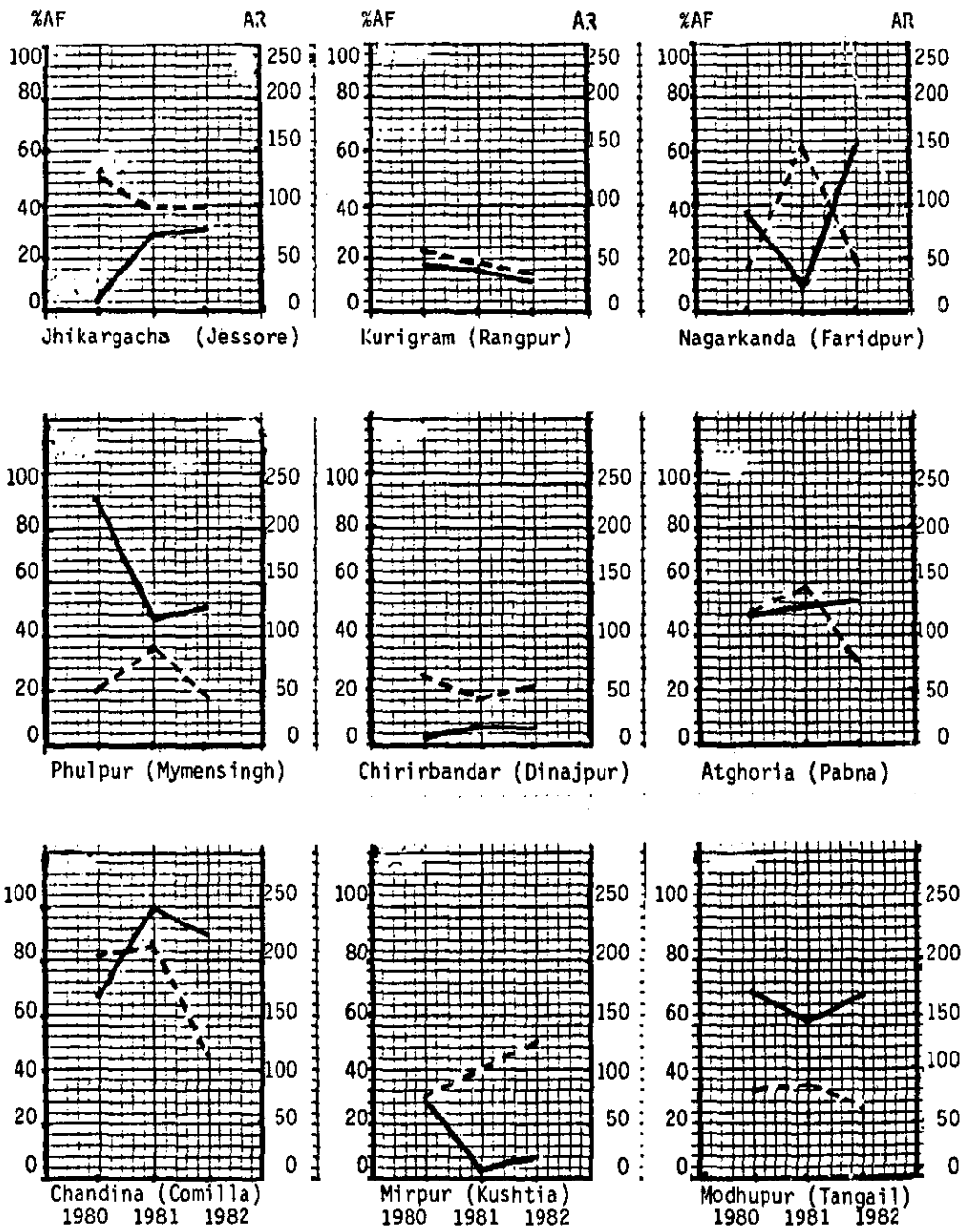


Figure 7--Percentage of area fertilized and average rates of application by sample farmers at different locations in 1980,1981, and 1982

(%AF = Percent crop area fertilized, AR = Average rate of application, pounds of materials per fertilized acre)



developing policies for sustained rapid growth in Bangladesh's fertilizer consumption. This is especially important because both fertilizer diffusion and rates of application are already high in some of the locations that contributed to past growth in consumption.

Growth Performance of Districts in Fertilizer Consumption

On the basis of 1983/84 fertilizer consumption per unit of land, 1969/70 to 1983/84 trends in fertilizer consumption, and the proportion of the agronomic potential of fertilizer use tapped by 1983/84, the 21 districts of Bangladesh can be divided into three groups:

Group A (5 districts): Bogra, Kushtia, Dhaka, Comilla, and Chittagong.

Group B (10 districts): Dinajpur, Rangpur, Jamalpur, Mymensingh, Kishoreganj, Rajshahi, Pabna, Tangail, Jessore, and the Chittagong Hill Tracts.

Group C (6 districts): Sylhet, Faridpur, Khulna, Barisal, Noakhali, and Patuakhali.

Table 11 shows 1983/84 fertilizer consumption by district (in terms of kilograms of fertilizer materials per hectare of total cropped area), total consumption in 1983/84 as a proportion of agronomic potential,[9] the shares of each district in Bangladesh's fertilizer consumption in 1969/70, 1978/79, and 1983/84, and each district's share in total cropped area in 1981/82. Figure 8 shows trends in fertilizer consumption from 1969/70 to 1983/84.[10] Several major points emerge from the table and the figure.

In 1983/84, Group A had the highest fertilizer consumption per hectare of total cropped area--more than 135 kilograms of fertilizer materials. Group B came next with per hectare consumption between 65

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[9]The estimates of agronomic potential of fertilizer use by district in Table 11 were formulated by IFDC in 1980. They are based on major soil classifications by thanas, cropped area in 1977/78, and fertilizer recommendations made by BARC in 1979. Since these might have changed by 1983/84, estimates of potential tapped by 1983/84 must be considered no more than indicative.

[10]Since the objective of Figure 8 is to highlight trends in the total fertilizer consumption of districts, total consumption in each district is divided by its total cropped area in one year (1977/78, for convenience in plotting trends). Therefore, 1983/84 consumption shown in the figure differs marginally from the data in Table 11. Mymensingh district in Figure 8 includes Mymensingh, Jamalpur, and Kishoreganj districts, as separate time-series data are not available for each.

Figure 8--Fertilizer consumption trends in various districts of Bangladesh

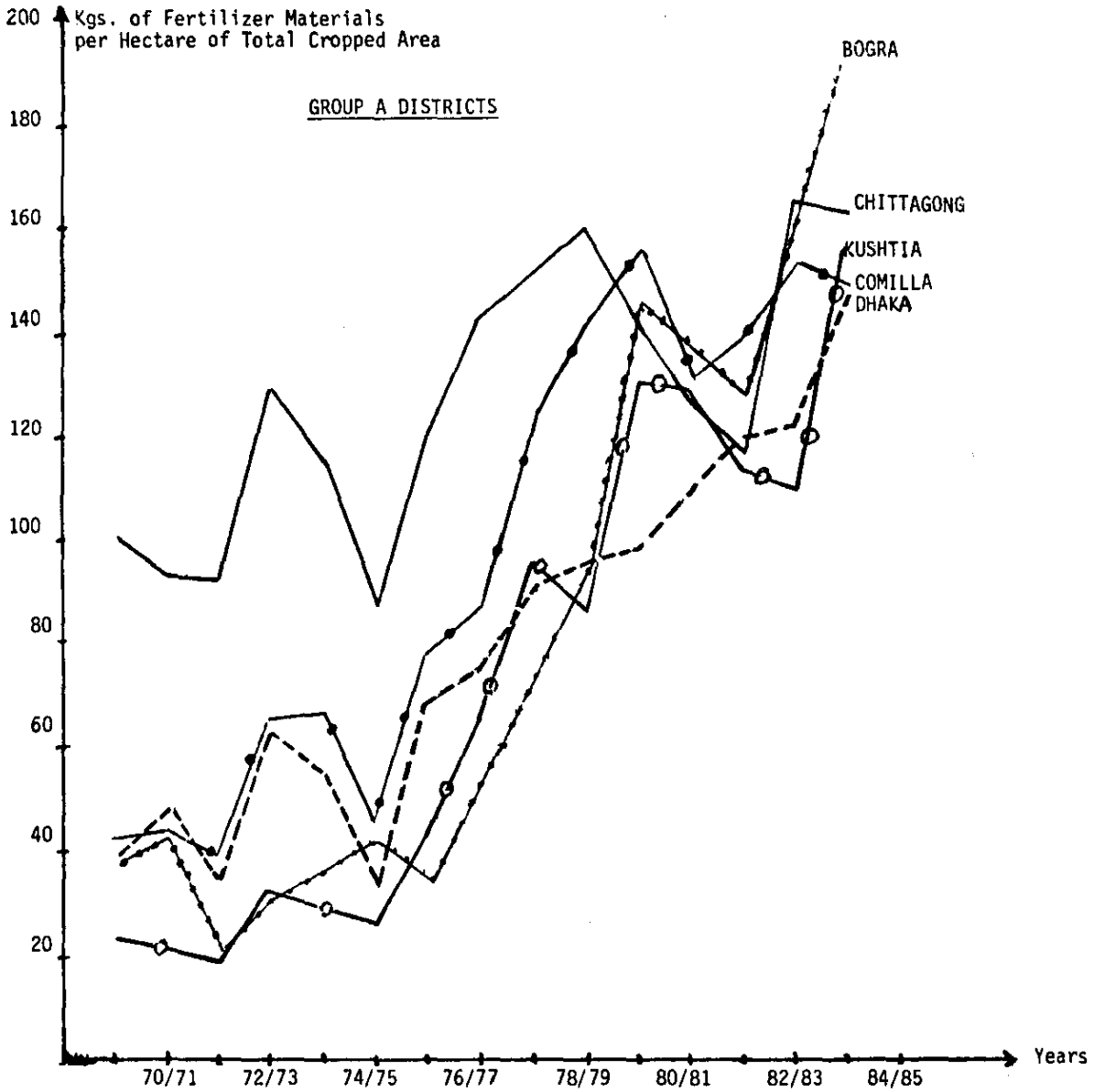
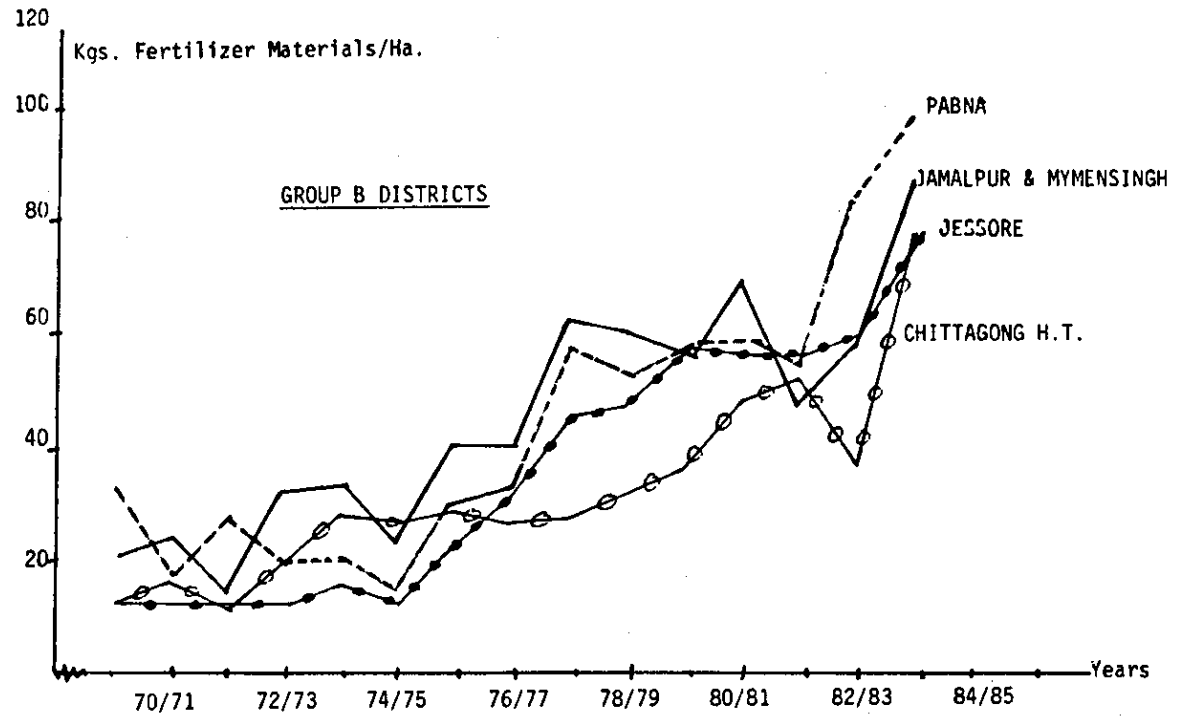


Figure 8--Continued



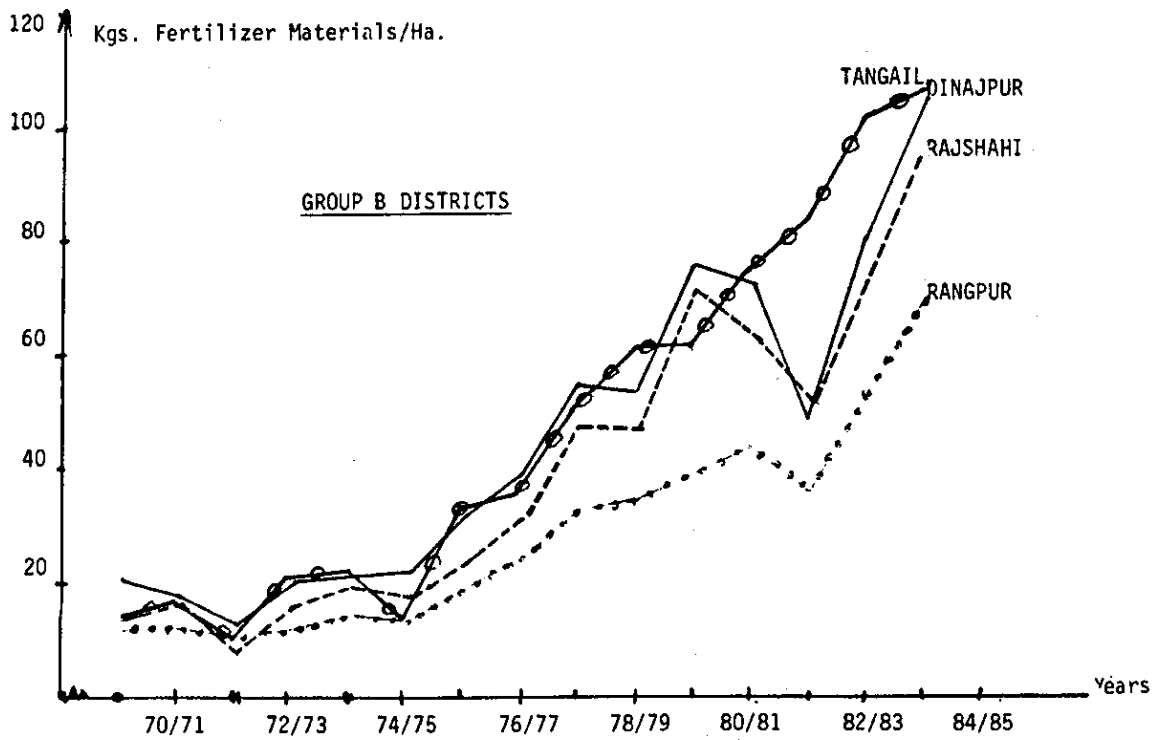
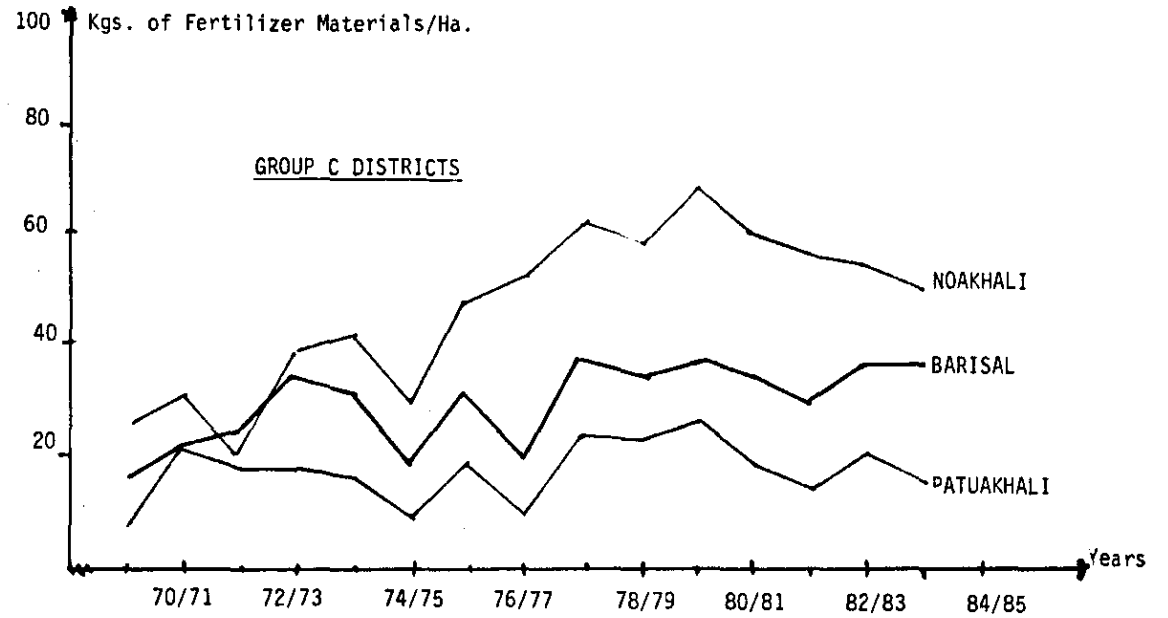
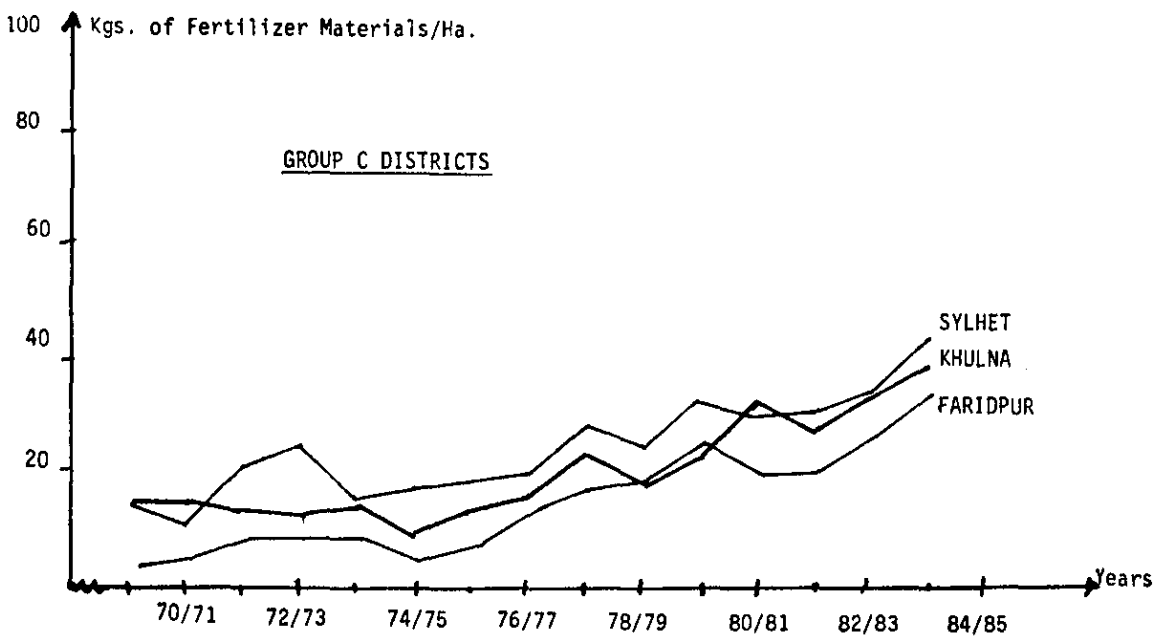


Figure 8--Continued





and 101 kilograms of materials. Group C had the lowest consumption per hectare--14 to 51 kilograms of fertilizer materials.

Thus, there was very wide variation in fertilizer consumption among the districts of Bangladesh. Two consequences of this variation were the geographical concentration of fertilizer use and the wide variation in the extent to which agronomic potential for fertilizer use was tapped in different districts.

The five Group A districts, with 22 percent of the country's total cropped area, had a 40 percent share of total fertilizer consumption in 1983/84. At the other extreme, the six Group C districts had only 13 percent of total fertilizer consumption, even though they accounted for 29 percent of the total cropped area. Only the Group B districts had shares of total fertilizer consumption (48 percent) and total cropped area (49 percent) that were comparable.

Between 1969/70 and 1983/84, the relative shares in total fertilizer consumption of both Group A and Group C declined--that of Group A by 8 percentage points and that of Group C by 6 percentage points. Concurrently, the share of Group B increased by 14 percentage points. Even in more recent years, this trend in the relative shares of the three groups of districts has continued. Thus, for instance, between 1978/79 and 1983/84, the shares of Group A and Group C fell, whereas that of Group B increased. Chittagong and Comilla in Group A and Noakhali and Barisal in Group C were mainly responsible for the decline in the shares of the two groups. In Group B, all districts except the Chittagong Hill Tracts had a higher share in 1983/84 than in 1969/70.

The decline in the relative shares of Chittagong and Comilla is understandable. Growth in fertilizer use gathered momentum in these districts earlier than in most other districts. Consequently, they accounted for as much as 28.4 percent of total fertilizer consumption despite encompassing only 10 percent of the total cropped area. When consumption growth in other districts accelerated, the relative shares of Chittagong and Comilla were bound to decline. More so because the pace of growth in their consumption slackened, once their consumption became relatively high and they used a high proportion of their agronomic potential. No such explanation applies to the decline in shares of Noakhali and Barisal (the two Group C districts), since their consumption in 1983/84 was only 11 to 13 percent of their agronomic potential.

There are now large differences between the three groups of districts in the extent to which they have realized their agronomic potential for fertilizer use. In 1983/84, total fertilizer consumption in Group A was approximated at 47 percent of its agronomic potential. Among the five districts, the proportions varied between 41 and 54 percent. For urea, it was 69 percent, ranging from 65 to 75 percent among the five districts. In contrast, total fertilizer

consumption in Group C was only 12 percent of its agronomic potential, and in none of the districts did the proportion exceed 13 percent. Even in the case of urea, consumption was less than 20 percent of the estimated potential for the group as a whole and did not surpass 22 percent in any district. Group B fell between Groups A and C with total consumption at 28 percent of the total potential and total urea consumption at 47 percent of the estimated potential for urea use. Within Group B, utilization of the total potential ranged from 17 to 36 percent and that of urea from 30 to 52 percent.

One could question the dependability of the above findings by arguing that they are based on district-wide sales data: since there have been no restrictions on movements between districts in recent years, these data may not accurately represent differences in the consumption of the districts. There may be some validity to this criticism, but its importance is limited. Fertilizer movements between districts were begun only after the phased introduction of the New Marketing System, commencing in 1978. As Table 11 demonstrates, the 1978/79 pattern of fertilizer use was similar to the one described above for 1983/84. Changes in the pattern of use between 1969/70 and 1978/79 also appear to have been similar to those implied by the changes between 1978/79 and 1983/84. Most importantly, trends in fertilizer consumption of districts throughout the 1969/70 to 1983/84 period (Figure 8) lend support to the findings in Table 11.

The major features of the 1969/70 to 1981/82 trends in fertilizer consumption of the districts can be summarized as follows. First, for the period as a whole, consumption in Groups A and B was rising far more rapidly than in Group C. In fact, in two out of the six districts of Group C (namely, Barisal and Patuakhali) it hardly grew at all after the early 1970s. Second, there was no growth or very slow growth in fertilizer use for a stretch of three to seven years after the mid-1970s in Chittagong and Comilla (Group A districts) and in Pabna, Jessore, and Mymensingh (including Jamalpur and Kishoreganj). Third, there was a clear downward turn in the consumption trends of Noakhali and Patuakhali (Group C districts) after 1979/80. Finally, trends in total fertilizer consumption growth for Bangladesh were dominated by the consumption trends in Group A districts until the late 1970s. Subsequently, however, national growth trends have been increasingly dominated by acceleration among many of the Group B districts.

These features of the geographical pattern of growth in Bangladesh's fertilizer consumption are not unique. The experiences of India, China, and even the United States have been fundamentally similar. This should not be surprising since fertilizer consumption does not begin and gather momentum at all locations within a country at the same time. The variations in this pattern are governed by a variety of factors--not all of which are behind fertilizer response functions (such as extent of irrigation, cropping patterns, and HYV diffusion).

Many other factors behind supply and distribution (such as fertilizer allocation policy, density of the distribution network, efficiency in the workings of the distribution system at different locations) plus physical infrastructure (road network and warehouse capacity, for example) are also significant. The relative importance of these factors behind the geographical patterns of growth in fertilizer consumption also differs between countries and even between locations within a country.

In order to develop meaningful policies for long-term development of the fertilizer sector in Bangladesh, it is imperative to take account of the above findings. Two points seem particularly important. First, efforts are required to generate momentum in the consumption trends of Group C districts. These districts account for about 32 percent of the country's cultivable area and 29 percent of total cropped area. IFDC estimated their share of the nation's total agronomic potential for fertilizer use to be nearly 30 percent. Only one-eighth of this potential was tapped by 1983/84. Of still greater significance, there is no sign of acceleration in the consumption trends of most of these districts. Even with urea, the most commonly used fertilizer, only 19 percent of the total potential of these districts was tapped by 1983/84. Clearly, long-term future growth in Bangladesh fertilizer consumption cannot be sustained while realization of such a large portion of the potential remains low and stagnant year after year.

It may appear that society's payoff on efforts to raise fertilizer use in these districts is generally lower than in Group A and Group B, because of lower potential in terms of crop responses to fertilizer use. Even if this were true, it is important to note that additional production from one unit of fertilizer use on unfertilized land in Group C may be higher than can be achieved by further raising the high rates of application on fertilized land in Group A. This is an empirical question and can be settled by examining appropriate data. Efforts required to generate momentum could take various directions, discussed in the next section.

The second point to recognize is that even in Groups A and B, where total fertilizer consumption has been increasing rapidly, the pace of growth has been much higher for nitrogen use than for phosphate use, and growth in the use of potash has been sluggish. Thus in some of these districts, where as much as 60 to 70 percent of the agronomic potential for nitrogen has been realized, the proportion of phosphate potential realized is considerably less, and that of potash is negligible. In these districts, further growth of even nitrogen use, especially if it were achieved by raising rates of application on fertilized land, would be dependent on accelerating the application of phosphates and potash.

This growth, in turn, may be more dependent on generating knowledge about the different nutrient requirements of specific

locations, and using this knowledge to convince farmers that higher returns can come from appropriate changes in fertilizer practices, rather than from price subsidies for phosphate and potash fertilizers.

If subsidies, by themselves, could accomplish this task, then fertilizer use in Chittagong would have a more balanced consumption pattern. In 1983/84, urea consumption in the district was 75 percent of its potential, while the proportion for TSP/DAP was only 20 percent, and the proportion for MP was just 6 percent.

POLICIES FOR LONG-TERM GROWTH IN FERTILIZER USE

Policies for long-term growth in fertilizer use should be based on a critical appreciation of the various features of, and the major forces behind, the past pace and pattern of growth in fertilizer consumption. This is especially important if these policies are to generate growth in fertilizer use that is sustained, rapid, and both profitable to farmers and manageable for the society at large.

Before turning to these policies, it may be useful to discuss the major strengths and problem areas in Bangladesh, which are revealed by the overview and the appropriate framework for policy discussions.

Major Strengths and Problem Areas

Both fertilizer consumption per unit of land and growth in aggregate consumption have been higher in Bangladesh than in a majority of the developing countries. Bangladesh's performance is impressive. In less than three decades fertilizer use has been adopted by nearly two-thirds of the nation's farmers (a large majority of whom are poor and operate very small farms), use has spread to about half of the gross cultivated area of the country (most of which is unirrigated), and fertilizer use on even local varieties of the dominant food crop is not uncommon. Few countries can claim such a record.

The above features are considered strengths because they indicate widespread understanding among farmers about the general benefits fertilizer use gives under farming circumstances typical of Bangladesh. Another cause for optimism is that this unusual record indicates the existence of operating processes and systems capable of achieving such fortuitous results.

Yet another positive feature is that much of the agronomic potential of fertilizer use remains untapped. (Even if one discounts by 50 percent the estimate of this potential formulated by IFDC, Bangladesh would have tapped only about half of the discounted potential.) This indicates that even without dramatic breakthroughs

in crop varieties or growth in irrigation, further growth in fertilizer consumption may be possible. Growth in fertilizer use during 1982/83 and also during 1984/85, which occurred despite adverse changes in the price environment, supports such a position.

At the same time, the bulk of past growth in fertilizer consumption resulted from tapping those parts of the total potential on which farmers' returns to fertilizer use were relatively high, because of superior or rapidly improving response functions. Similarly, the bulk of past growth has occurred in places where it was relatively easy to facilitate because the physical and institutional infrastructure relevant to growth in fertilizer use was more developed. While agronomic potential of such locations is by no means exhausted, further growth in consumption may not be as easy to achieve. High marginal returns to fertilizer use through increases in rates of application depend on increasing sophistication in fertilizer use--something which requires location-specific research and extension.

It is also clear from the district findings that sustained rapid growth in future fertilizer use also calls for generating momentum in the consumption trends of Group C districts. Policies required for this effort are apt to be quite different from those required to maintain the momentum of growth in consumption in Group A and Group B districts.

A Framework to Discuss Policy Requirements

Policy requirements for long-term rapid growth in Bangladesh fertilizer consumption can be discussed from two perspectives. One would be to view growth in fertilizer use as driven by growth in farmers' demand for fertilizer, and to consider the latter as being determined by changes in variables that affect farmers' returns on fertilizer use. This approach underlies many empirical studies in which factors governing growth in fertilizer consumption are identified by considering fertilizer consumption as a function of such agroeconomic variables as irrigation, area sown with fertilizer-responsive crop varieties, cropping patterns, and prices of crops as well as fertilizers. The estimated growth parameters of different explanatory variables are then used to draw policy conclusions.

In the context of sustained rapid growth in Bangladesh's fertilizer consumption, the above approach leads to such questions as: How much change is required every year in the variables shifting fertilizer response functions upward, or in the ratios of fertilizer to crop prices, to increase fertilizer consumption by the desired amount? Which policies will produce these changes? Are these policies sustainable?

This approach and the questions it suggests constrain the discussion of policies required to generate the desired rate of

growth in fertilizer consumption. This is mainly because the approach implies the growth in fertilizer use is determined by changes in the variables affecting fertilizer response functions and by changes in the prices of fertilizers and crops to the exclusion of all other dynamic elements. It is absurd to downplay the importance of these variables. But it is one thing to recognize their importance and another to maintain that under all circumstances changes in these variables are necessary to generate growth in fertilizer use. Both a priori reasoning and the experiences of many countries clearly suggest that such an interpretation of growth in fertilizer consumption is mechanistic and could lead to imprudent (if not altogether unrealistic) price policy prescriptions, if the possibilities for continuous upward shifts in response functions are limited.

Yet another limitation of this approach is that it does not explain many features of the past pace and pattern of fertilizer consumption growth in Bangladesh, nor does it provide a useful context for addressing the task of tapping the unrealized fertilizer potential through institutional development and policy formation.

A more comprehensive context for discussing policy requirements for long-term growth would involve recognition of the importance of both variables that affect the economic potential for fertilizer use, and those that affect realization of that potential. The economic potential for fertilizer use in a country is determined by fertilizer response functions, prices of crops, and costs of fertilizer: that is, the agroeconomic variables that determine profitability of fertilizer use. Actual fertilizer use is the combined result of the conversion of this potential into farmers' demand for fertilizer and of satisfaction of this demand by successful operation of fertilizer supply and distribution systems. Thus, besides agroeconomic variables, three types of processes and interactions among them influence actual fertilizer use. First are processes that convert the potential into farmers' fertilizer demand by generating knowledge about fertilizer response functions, spreading this knowledge among farmers, and providing adequate credit to enable them to purchase fertilizers. Second are processes that establish the fertilizer distribution system and govern its operation in making fertilizers available to farmers at geographically dispersed locations. Last are processes that determine the aggregate supply of fertilizers through domestic production and imports.

These three types of processes are governed by the workings of particular subsystems. These include agricultural research and extension, agricultural credit, fertilizer distribution, the domestic fertilizer industry, and fertilizer imports. In these terms, actual fertilizer consumption is determined not only by the agroeconomic variables, but also by the development and operation of all the above subsystems.

Even farmers' decisions about whether to use fertilizers, on which crops, and at what rates are influenced by both agroeconomic variables and the operation of agricultural research, extension, and credit systems. Rationality of farmers does not mean their omniscience. Even rational farmers need knowledge about how crops respond to fertilizer use--knowledge generated by the research system and delivered by the extension system. In addition, an adequate supply of credit is necessary to convert fertilizer response functions into farmers' effective demand schedules for fertilizers. Even this is not enough. Actual use of fertilizers would still depend on whether enough fertilizers are available to farmers at the right place and time--something which depends on the development and efficiency of the operation of the fertilizer distribution and supply systems.

This more comprehensive context appears appropriate to a discussion of the policy requirements of the long-term growth of Bangladesh fertilizer consumption. It does not focus exclusively either on variables like irrigation, HYVs, and the agroclimatic environment, which determine the responses of crops to fertilizer use, or on the prices of crops and fertilizers, which determine the economic potential for and the returns to fertilizer use. Nor does it bypass these variables and their influence on the pace and pattern of growth in fertilizer use. But it does identify processes and systems that convert the potential into farmers' effective demand for fertilizers, as well as those that meet this demand at geographically dispersed locations, thus converting fertilizer potential into actual fertilizer use. In this manner, the approach facilitates meaningful examination of all major elements that bear on sustained rapid growth in fertilizer use and on the healthy development of the entire fertilizer system.

Important Policy Issues and Suggestions

To use the above approach in an empirical analysis, it is necessary to examine the operation of all systems that affect the growth of fertilizer use and interactions between these subsystems, in order to identify deficiencies and work out policies to eliminate them. Such comprehensive research is not undertaken here. Thus, what follows is not a detailed prescription of policies. It is a set of policy issues and suggestions that seem to be relevant on the basis of an examination of readily available information and data.

For continuous growth in farmers' demand for fertilizers, it is just as important to focus on converting unrealized potential as on continuously raising the potential. In these efforts, agricultural research and extension systems are obviously the critical agencies. They need to be strengthened to undertake efforts in the directions discussed below.

In order to generate additional fertilizer demand through conversion of the unrealized potential, the first step would be to develop a profile of this potential (by crops, seasons, locations, agroclimatic conditions, and so forth) and examine its economic viability from farmers' viewpoints. Such an exercise is required in Group C and Group B districts for all three nutrients and in Group A districts for phosphates and potash. The data from fertilizer trials, experiments, and soil fertility investigations carried out so far may be adequate, at least for beginning this exercise. These data must be deliberately analyzed at disaggregated levels to identify when the responses of crops to different nutrients make the application of the nutrients profitable to farmers in various types of localities under existing and anticipated price environments.

From the accumulated agricultural research, critical aspects of fertilizer practices that influence responses of crops to fertilizers must be identified (aspects such as the details of timing and placement, complementarity between different nutrients and micronutrient and soil amendment needs). This knowledge should also be generated for disaggregated locations because of the highly varied agroclimatic environment of Bangladesh. It should then be used to develop location-specific action strategies to shift response functions upwards. The importance of developing such strategies cannot be overemphasized. This differs from concentrating exclusively on the introduction of new crop varieties. The importance of agronomic research for raising the productivity and efficiency of fertilizer use is enhanced, and not reduced, when HYVs are introduced, as the experience of the last 15 years clearly reveals. What is stressed here is that such agronomic research-based strategies might also improve the responses of existing varieties to fertilizer use, and thus do not make upward shifts in response functions dependent exclusively on the adoption of HYVs and water control development.

In a long-term perspective, however, there are no alternatives to shifting response functions upward through such technological changes as the development of new crop varieties and water control potential. Thus there cannot be two opinions about strengthening these efforts.

Location-specific strategies to maintain the momentum of growth in fertilizer consumption in Groups A and B and to accelerate growth in Group C need to be based on knowledge about the response function environment mentioned above. The other important plank of this strategy should be to deliver this knowledge to farmers in a sustained and effective manner. The most appropriate agency for this is the agricultural extension system. While other entities, like the fertilizer dealers, may be encouraged to help deliver such knowledge to farmers, they cannot effectively substitute for the extension system. If experience in other developing countries is any guide in Bangladesh, much remains to be done to improve the efficacy of the

extension system in providing adequate scientific knowledge to farmers about fertilizer practices. This requires a much closer and decentralized interface between agricultural research and extension systems--which is lacking in most developing countries, perhaps including Bangladesh. Development of this interface should proceed as rapidly as possible. Introduction of the Training and Visit System may have made a beginning in this direction, but whether the current manner of operation is adequately serving this objective needs to be examined.

Inadequate provision of institutional credit does not seem to have been a major constraint in the past growth of fertilizer consumption in Bangladesh. Perhaps this was because of high fertilizer subsidies and relatively low rates of application, both of which reduce the cash requirements of fertilizer use. In the future, growth of fertilizer demand will be more dependent on the flow of institutional credit to farmers for the following reasons: the rates of application on fertilized land (especially in Group A) are quite high; the fertilizer subsidy is being phased out; farmers who are not yet using fertilizer may have more severe liquidity constraints; and the initial returns to fertilizer use on land not yet fertilized are likely to be lower than on land already fertilized. Thus there seems to be a clear need to expand flows of institutional credit to farmers in order to sustain rapid growth in fertilizer demand. Efforts to do this, however, need to be coordinated with efforts to generate additional fertilizer demand. They also need to be coordinated with local fertilizer delivery systems. Without such coordination, the budgetary burden of fertilizer subsidies would only be replaced by that of rural loan defaults.

The available information clearly shows that Bangladesh has one of the most widespread and dense networks of fertilizer distribution systems among developing countries. This remains so even if only "active" retailers and wholesalers are considered. Thus, for instance, Bangladesh has four to five times more fertilizer outlets than any Indian state of comparable size. Despite this, a variety of literature has indicated that the timely availability of fertilizers to many farmers has not ceased to be a problem. Although no comprehensive study has been made of this difficulty, discussions with a few dealers and PDP officials suggest that supplies are sometimes inadequate when dealers get fertilizers from BADC thana and district outlets. It appears that this, in turn, may be largely because dealers procure fertilizers as late as possible in order to minimize the cost of carrying inventories. Efforts are being made to remedy this deficiency of the distribution system through providing incentives to dealers to pick up fertilizers during off-seasons. However, the stocking behavior of wholesalers still appears to be minimal when national supplies are normal. The main plank of these efforts should be enlargement of fertilizer distribution credit to dealers. But even this may not suffice everywhere. Thus, there may be no alternative to BADC carrying larger inventories at locations close to the

retail level. It must, however, be recognized that by itself, this strategy will not generate a sustained acceleration of consumption. These efforts by BADC, therefore, must be coordinated with the efforts of the agricultural extension and credit systems to generate growth in fertilizer demand.

The monthly data on opening stocks, supplies, and sales for the seven-year period from 1977/78 to 1983/84 reveal hardly any association with those at the national level (Tables 12-14 and Figures 9 to 14). Thus it cannot be concluded that changes in aggregate demand were driving changes in aggregate supplies or that changes in aggregate supplies were driving changes in aggregate sales. The data also show that the ratios of total monthly availability (monthly opening stocks and monthly supplies) to monthly sales were generally high (Table 15). If, despite these high ratios, the timely availability of fertilizers to farmers in particular localities was still a problem, then much could still be done to improve the workings of the distribution system. Efforts in this direction are required not only to make enough fertilizer available to farmers at the right time and place, but also to lower fertilizer distribution costs and thus lower farmers' fertilizer prices.

Figures 9-14 and Tables 12-15 also show that the aggregate availability of fertilizers was comfortable in most years between 1977/78 and 1983/84. Aggregate growth in fertilizer sales during the period (based on 1977/78) averaged 7.8 percent per year, a respectable rate, but hardly rapid or adequate to Bangladesh's requirements. It is therefore pertinent to ask why sales growth was not more rapid, since it was constrained neither by aggregate supplies nor by the agronomic potential for fertilizer use. The answer cannot lie with the price environment or changes in that environment for two reasons. First, the environment was still quite favorable. As shown in Table 4, the cost of a kilogram of nitrogen was still less than 1.5 kilograms of rice (the cost of a kilogram of urea was less than 1.1 kilograms of paddy). Second, and more important, fertilizer use grew substantially between 1977/78 and 1983/84 despite, on balance, adverse changes in the price environment (Figure 15). Thus, the explanation for the absence of still faster growth of actual fertilizer consumption, despite comfortable aggregate fertilizer availability and sizable untapped potential, seems to lie in a lack of well-coordinated efforts by agricultural research, extension, and credit systems to convert the potential into farmers' demand and by the fertilizer distribution system to meet this demand at geographically dispersed locations. It is important to be aware of these areas of implied deficiencies when formulating future policies. The enlargement of aggregate fertilizer supply is a necessary but not a sufficient condition for generating sustainable rapid growth in fertilizer consumption. It has to be supplemented by well-coordinated demand-creation activities of the nature described above and by continuous improvements in the operations of the fertilizer distribution system.

Table 12--Monthly opening stocks, current supply, availability, sales and closing stocks of urea in Bangladesh, 1977/78 - 1983/84

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks in Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1977/78							
July	65	31	96	20	76	20.8	67.7
August	76	50	126	35	91	27.8	60.3
September	91	25	116	55	61	47.4	78.4
October	61	26	87	33	54	37.9	70.1
November	54	12	66	25	41	37.9	81.8
December	41	62	103	37	66	35.9	39.8
January	66	49	115	41	74	35.7	57.4
February	74	84	158	48	110	30.4	46.8
March	110	71	181	52	129	28.7	61.1
April	129	39	168	34	134	20.2	76.8
May	134	20	154	41	113	26.6	87.0
June	113	13	126	58	68	46.0	89.7
1978/79							
July	68	16	84	23	61	27.4	81.0
August	61	46	107	25	82	23.4	57.0
September	82	68	150	60	90	40.0	54.7
October	90	46	136	52	84	38.2	66.2
November	84	56	140	41	99	29.3	60.0
December	99	77	176	44	132	25.0	56.3
January	132	74	206	39	167	18.9	63.2
February	167	57	224	43	181	19.2	74.6
March	181	53	234	48	186	20.5	77.4
April	186	44	230	26	204	11.3	80.9
May	204	29	233	26	207	11.2	87.6
June	207	51	258	42	216	16.3	80.2

(continued)

Table 12--Continued

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks in Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1979/80							
July	216	17	233	28	205	12.0	92.7
August	205	33	238	25	213	10.5	86.1
September	213	42	255	57	198	22.4	83.5
October	198	46	244	48	196	19.7	81.1
November	196	62	258	39	219	15.1	76.0
December	219	94	313	38	275	12.1	70.0
January	275	76	351	58	293	16.5	78.3
February	293	92	385	62	323	16.1	76.1
March	323	35	358	55	303	15.3	90.2
April	303	30	333	25	308	7.5	91.0
May	308	27	335	37	298	11.0	91.9
June	298	31	329	64	265	19.5	90.6
1980/81							
July	265	31	296	23	273	7.8	89.5
August	273	37	310	33	277	10.6	88.1
September	277	47	324	78	246	24.1	85.5
October	246	14	260	34	226	13.1	94.6
November	226	14	240	36	204	15.0	94.2
December	204	23	227	53	174	23.3	89.9
January	174	28	202	59	143	29.2	86.1
February	143	37	180	54	126	30.0	79.4
March	126	51	177	60	117	33.9	71.2
April	117	43	160	28	132	17.5	73.1
May	132	47	179	49	130	27.4	73.7
June	130	33	163	63	100	38.7	79.8

(continued)

Table 12--Continued

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks in Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1981/82							
July	100	32	132	20	112	15.2	75.8
August	112	32	144	26	118	18.1	77.8
September	118	9	127	74	53	58.3	92.9
October	53	28	81	43	38	53.1	65.4
November	38	24	62	40	22	64.5	61.3
December	22	92	114	33	81	28.9	19.3
January	81	103	184	44	140	23.9	44.0
February	140	74	214	61	153	28.5	65.4
March	153	134	287	67	220	23.3	53.3
April	220	54	274	31	243	11.3	80.3
May	243	49	292	31	261	10.6	83.2
June	261	37	298	49	249	16.4	87.6
1982/83							
July	249	24	273	17	256	6.2	91.2
August	256	23	279	28	251	10.0	91.8
September	251	32	283	79	204	27.9	88.7
October	204	78	282	41	241	14.5	72.3
November	241	39	280	41	239	14.6	86.1
December	239	20	259	47	212	18.1	92.3
January	212	29	241	44	197	18.3	88.0
February	197	39	236	71	165	30.1	83.5
March	165	32	197	96	101	48.7	83.5
April	101	26	127	33	94	26.0	79.5
May	94	57	151	54	97	35.8	62.3
June	97	63	160	67	93	41.9	60.6

(continued)

Table 12--Continued

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks in Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1983/84							
July	89	43	132	13	119	9.8	67.4
August	119	85	204	36	168	17.6	58.4
September	168	49	217	94	123	43.3	77.4
October	123	69	192	37	155	19.3	64.1
November	155	61	216	47	169	21.8	71.8
December	169	58	227	71	156	31.3	74.4
January	156	60	216	50	166	23.1	72.2
February	166	62	228	81	147	35.5	72.8
March	147	54	201	107	94	53.2	73.1
April	94	59	153	57	96	37.3	61.4
May	96	69	165	41	124	24.8	58.2
June	124	54	178	63	115	35.4	69.7

Source: Data developed from Bangladesh Ministry of Agriculture and U.S. Agency for International Development, Joint Bangladesh and U.S. Government Evaluation of the Fertilizer Distribution Improvement Project, USAID Report 388-0024 (Dhaka: November 1982); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1983 and June 1984, issued August 7, 1983 and August 8, 1984, respectively.

Table 13--Monthly opening stocks, current supply, availability, sales, and closing stocks of triple superphosphate (TSP) in Bangladesh, 1977/78 - 1983/84

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks in Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1977/78							
July	114	15	129	11	118	8.5	88.4
August	118	0	118	18	100	15.3	100.0
September	100	0	100	9	91	9.0	100.0
October	91	0	93	16	77	17.2	100.0
November	77	7	84	23	61	27.4	91.7
December	61	14	75	26	49	34.7	81.3
January	49	4	53	18	35	34.0	92.5
February	35	5	40	16	24	40.0	87.5
March	24	43	67	12	55	17.9	35.8
April	55	40	95	18	77	18.9	57.9
May	77	18	95	14	81	14.7	81.1
June	81	4	85	12	73	14.1	95.3
1978/79							
July	73	20	93	11	82	11.8	78.5
August	82	7	89	18	71	20.2	92.5
September	71	12	83	15	68	18.1	85.5
October	68	14	82	30	52	36.6	82.9
November	52	4	56	30	26	53.6	92.9
December	26	62	88	22	66	25.0	29.5
January	66	29	95	16	79	16.8	69.5
February	79	34	113	17	96	15.0	69.9
March	96	15	111	18	93	16.2	86.5
April	93	26	119	17	102	14.3	78.2
May	102	13	115	10	105	8.7	88.7
June	105	7	112	8	104	7.1	93.8

(continued)

Table 13--Continued

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks in Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1979/80							
July	104	7	111	14	97	12.6	93.7
August	97	3	100	19	81	19.0	97.0
September	81	34	115	13	102	11.3	70.4
October	102	47	149	27	122	18.1	68.5
November	122	9	131	41	90	31.3	93.1
December	90	16	106	29	77	27.4	84.9
January	77	18	95	28	67	29.5	81.1
February	67	64	131	20	111	15.3	51.1
March	111	31	142	14	128	9.9	78.2
April	128	22	150	16	134	10.7	85.3
May	134	15	149	14	135	9.4	89.9
June	135	3	138	12	126	8.7	97.8
1980/81							
July	126	7	133	18	115	13.5	94.7
August	115	48	163	20	143	12.3	70.6
September	143	34	177	12	165	6.8	80.8
October	165	18	183	28	155	15.3	90.2
November	155	13	168	41	127	32.3	92.3
December	127	10	137	36	101	26.3	92.7
January	101	22	123	23	100	18.7	82.1
February	100	13	113	22	91	19.5	88.5
March	91	47	138	13	125	9.4	65.9
April	125	38	163	21	142	12.9	76.7
May	142	11	153	13	140	8.5	92.8
June	140	40	180	8	172	4.4	77.8

(continued)

Table 13--Continued

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks in Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1981/82							
July	172	27	146	15	131	10.3	81.5
August	131	7	138	18	120	13.0	94.9
September	120	5	125	12	113	9.6	96.0
October	113	10	123	45	78	36.6	91.9
November	78	7	85	34	51	40.0	91.8
December	51	21	72	18	54	25.0	70.8
January	54	35	89	17	72	19.1	60.7
February	72	19	91	14	77	15.4	79.1
March	77	38	115	9	106	7.8	67.0
April	106	19	125	13	112	10.4	84.8
May	112	5	117	6	111	5.1	95.7
June	111	17	128	8	120	6.3	86.7
1982/83							
July	120	1	121	7	114	5.8	99.2
August	114	4	118	8	110	6.8	96.6
September	110	8	118	6	112	5.1	93.2
October	112	12	124	24	100	19.4	90.3
November	100	10	110	37	73	33.6	90.9
December	73	44	117	28	89	23.9	62.4
January	89	93	182	23	159	12.6	48.9
February	159	14	173	26	147	15.0	91.9
March	147	2	149	12	137	8.1	98.7
April	137	1	138	11	127	8.0	99.3
May	127	5	132	10	122	7.6	96.2
June	122	6	128	13	115	10.2	95.3

(continued)

Table 13--Continued

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks in Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1983/84							
July	118	24	142	7	135	4.9	83.1
August	135	3	138	13	125	9.4	97.8
September	125	22	147	7	140	4.8	85.0
October	140	13	153	22	131	14.4	91.5
November	131	5	136	50	86	36.8	96.3
December	86	25	111	33	78	29.7	77.5
January	78	38	116	27	89	23.3	67.2
February	89	33	122	34	88	27.9	73.0
March	88	6	94	13	81	13.8	93.6
April	81	7	88	17	71	19.3	92.0
May	71	7	78	16	62	20.5	91.0
June	62	13	75	19	56	25.3	82.7

Sources: Data developed from Bangladesh Ministry of Agriculture and U.S. Agency for International Development, Joint Bangladesh and U.S. Government Evaluation of the Fertilizer Distribution Improvement Project, USAID Report 388-0024 (Dhaka: USAID, November 1982); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1983 and June 1984, issued August 7, 1983 and August 8, 1984, respectively.

Table 14--Monthly opening stocks, current supply, availability, sales, and closing stocks of muriate of potash (MP) in Bangladesh, 1977/78 - 1983/84

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1977/78							
July	18	0	18	2	16	11.1	100.0
August	16	10	26	4	22	15.4	61.5
September	22	0	22	2	20	9.1	100.0
October	20	0	20	3	17	15.0	100.0
November	17	0	17	4	13	23.5	100.0
December	13	0	13	5	8	38.5	100.0
January	8	10	18	4	14	22.2	80.0
February	14	9	23	4	19	17.4	60.9
March	19	8	27	4	23	14.8	70.4
April	23	0	23	4	19	17.4	100.0
May	19	1	20	3	17	15.0	95.0
June	17	1	16	2	14	12.5	94.4
1978/79							
July	14	0	14	2	12	14.3	100.0
August	12	5	17	3	14	17.6	70.6
September	14	7	21	2	19	9.5	66.6
October	19	20	39	6	33	15.4	48.7
November	33	1	34	7	27	20.6	97.1
December	27	10	37	6	31	16.2	73.0
January	31	15	46	3	43	6.5	67.4
February	43	1	42	3	39	7.1	97.7
March	39	6	43	6	37	14.0	90.7
April	37	6	43	5	38	11.6	86.0
May	38	0	38	2	36	5.3	100.0
June	36	6	44	1	43	2.3	81.8

(continued)

Table 14--Continued

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1979/80							
July	43	18	61	2	59	3.3	70.5
August	59	13	72	3	69	4.2	81.9
September	69	0	69	2	67	2.9	100.0
October	67	0	67	4	63	6.0	100.0
November	63	0	63	7	56	11.1	100.0
December	56	13	69	6	63	8.7	81.2
January	63	0	63	5	58	7.9	100.0
February	58	0	58	5	53	8.6	100.0
March	53	0	53	3	50	5.7	100.0
April	50	0	50	4	46	8.0	100.0
May	46	8	54	3	51	5.6	85.2
June	51	7	58	2	56	3.4	87.9
1980/81							
July	56	0	56	2	54	3.6	100.0
August	54	0	54	4	50	7.4	100.0
September	50	0	50	2	48	4.0	100.0
October	48	8	56	4	52	7.1	85.7
November	52	0	52	7	45	13.5	100.0
December	45	7	52	7	45	13.5	86.5
January	45	0	45	4	41	8.9	100.0
February	41	6	47	4	43	8.5	87.2
March	43	14	57	3	54	5.3	75.4
April	54	0	54	4	50	7.4	100.0
May	50	0	50	3	47	6.0	100.0
June	47	7	54	1	53	1.9	87.0

(continued)

Table 14--Continued

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1981/82							
July	53	1	54	2	52	3.7	98.1
August	52	0	52	3	49	5.8	100.0
September	49	0	49	2	47	4.1	100.0
October	47	0	47	8	39	17.0	100.0
November	39	0	39	8	31	20.5	100.0
December	31	0	31	5	26	16.1	100.0
January	26	0	26	4	22	15.4	100.0
February	22	5	27	4	23	14.8	81.5
March	23	13	36	2	34	5.6	63.9
April	34	0	34	3	31	8.8	100.0
May	31	8	39	2	37	5.1	79.5
June	37	0	37	2	35	5.4	100.0
1982/83							
July	35	0	35	2	33	5.7	100.0
August	33	0	33	2	31	6.1	100.0
September	31	0	31	1	30	3.2	100.0
October	30	0	30	5	25	16.7	100.0
November	25	5	30	8	22	26.7	83.3
December	22	7	29	6	23	20.7	75.9
January	23	4	27	6	21	22.2	85.2
February	21	8	29	7	22	24.1	72.4
March	22	8	30	3	27	10.0	73.3
April	27	12	39	4	35	10.3	69.2
May	35	0	35	3	32	8.6	100.0
June	32	0	32	3	31	9.4	100.0

(continued)

Table 14--Continued

Year/ Month	Opening Stocks	Current Supply	Total Availability	Sales	Closing Stocks	Share of Sales in Total Availability	Share of Opening Stocks Total Availability
	(1,000 long tons of fertilizer materials)					(percent)	
1983/84							
July	29	0	29	1	28	3.4	100.0
August	28	0	28	3	25	10.7	100.0
September	25	5	30	1	29	3.3	83.3
October	29	19	48	4	44	8.3	60.4
November	44	15	59	11	48	18.6	74.6
December	48	0	48	8	40	16.7	100.0
January	40	10	50	6	44	12.0	80.0
February	44	0	44	10	34	22.7	100.0
March	34	0	34	5	29	14.7	100.0
April	29	1	30	6	24	20.0	96.7
May	24	9	33	4	29	12.1	72.7
June	29	30	4	4	24	13.3	96.7

Sources: Data developed from Bangladesh Ministry of Agriculture and U.S. Agency for International Development, Joint Bangladesh and U.S. Government Evaluation of the Fertilizer Distribution Improvement Project, USAID Report 388-0024 (Dhaka: USAID, 1982); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1983 and June 1984, issued August 7, 1983 and August 8, 1984, respectively.

Figure 9--Opening stocks, current supply, total availability, and sales of urea in Bangladesh from 1977/78 to 1983/84

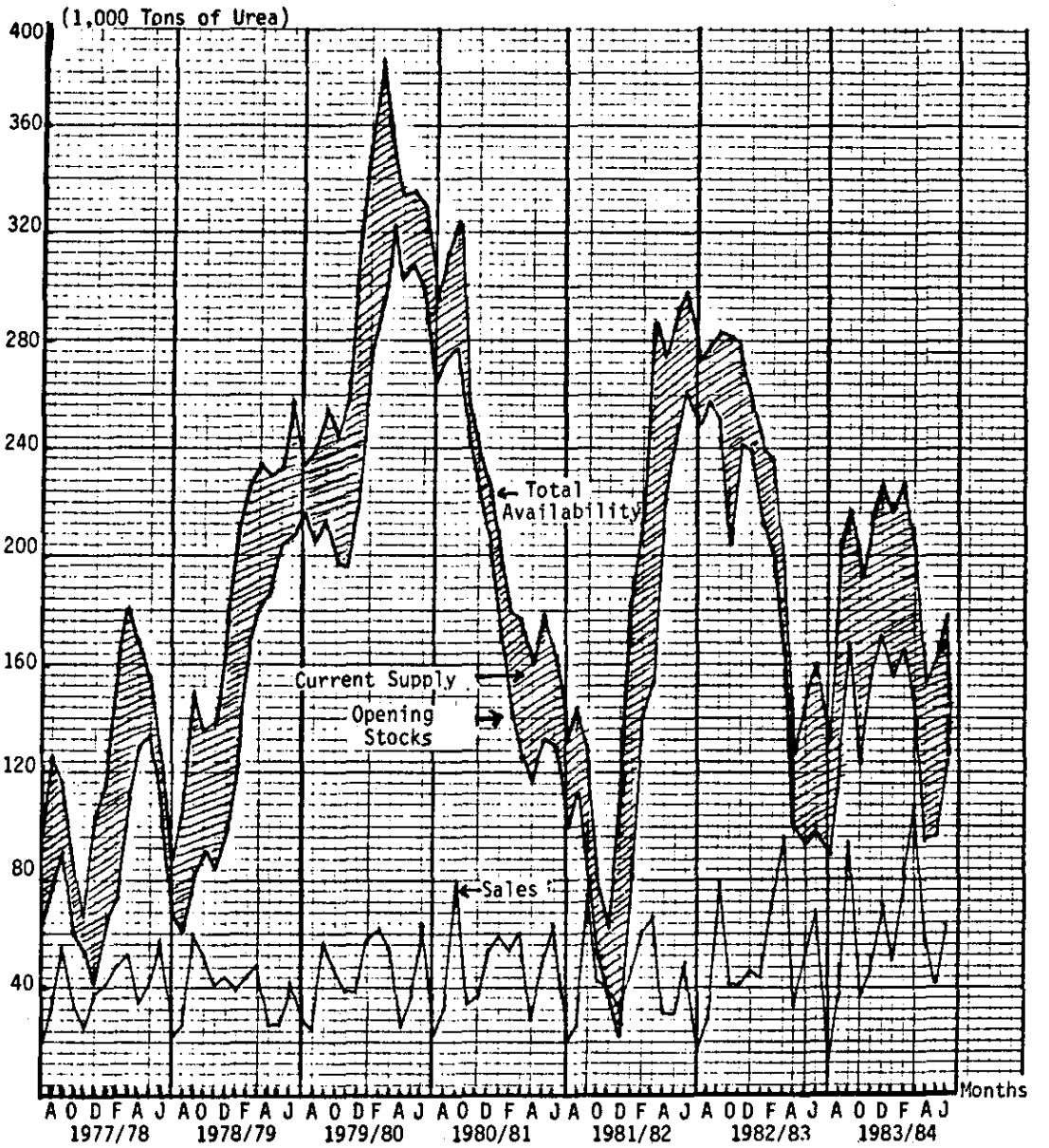


Figure 10--Opening stocks, current supply, total availability, and sales of triple superphosphate (TSP) in Bangladesh from 1977/78 to 1983/84

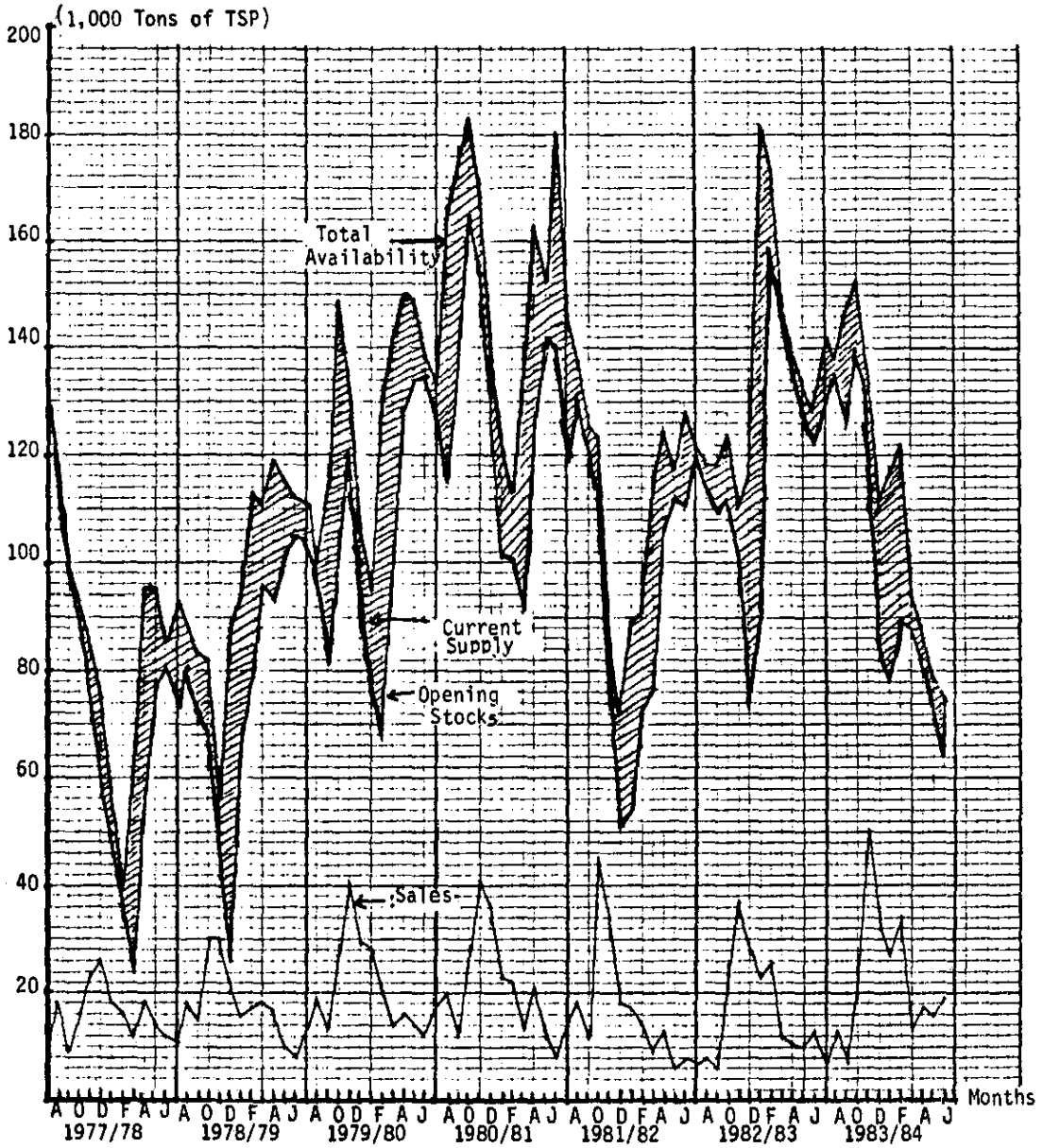


Figure 11--Opening stocks, current supply, total availability, and sales of muriate of potash (MP) in Bangladesh from 1977/78 to 1983/84

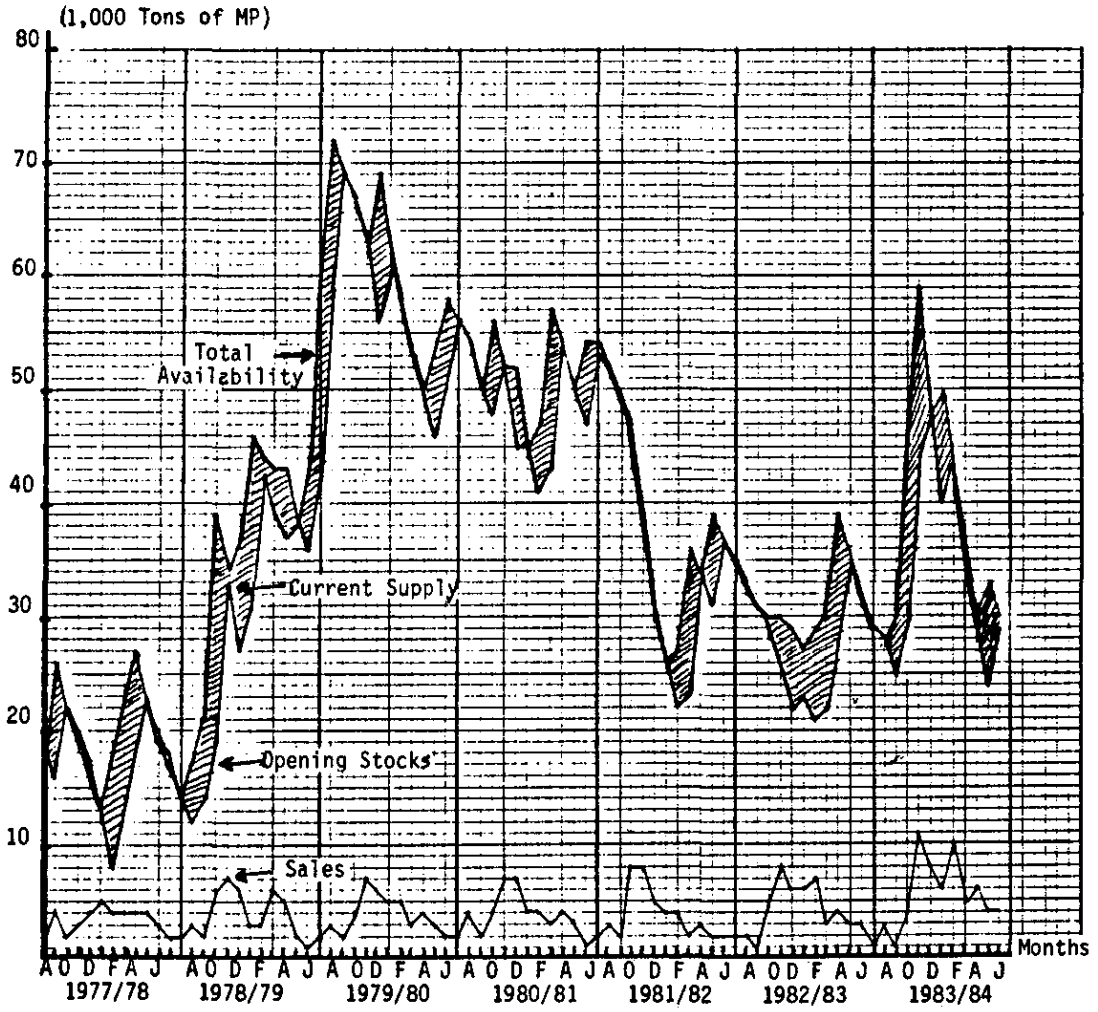
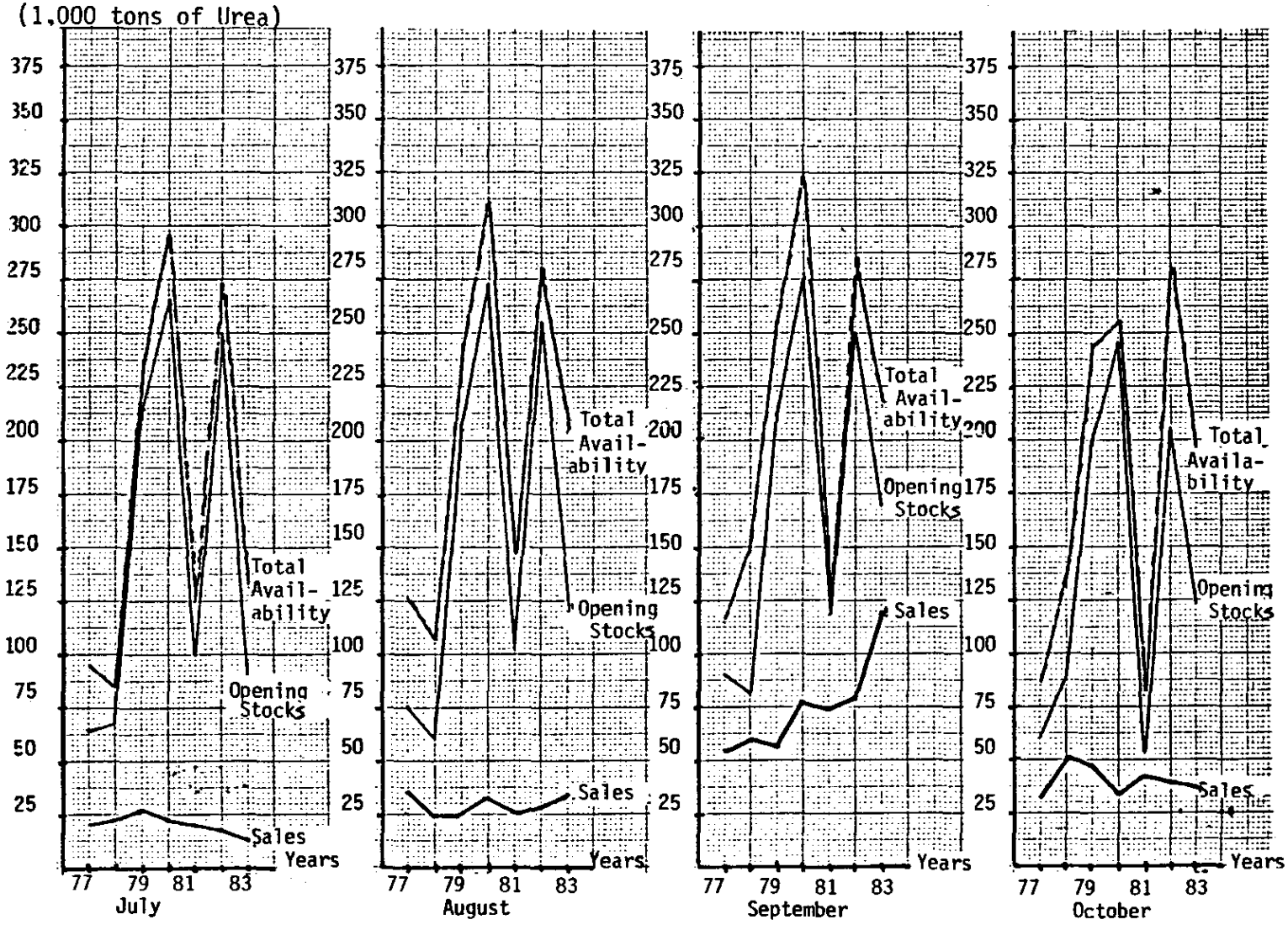


Figure 12--Monthly opening stocks, current supply, total availability, and sales of urea in Bangladesh, July 1977 to June 1984



Note: Current supply (stock replenishment) equals the vertical distance between total availability and opening stocks.

Figure 12--Continued

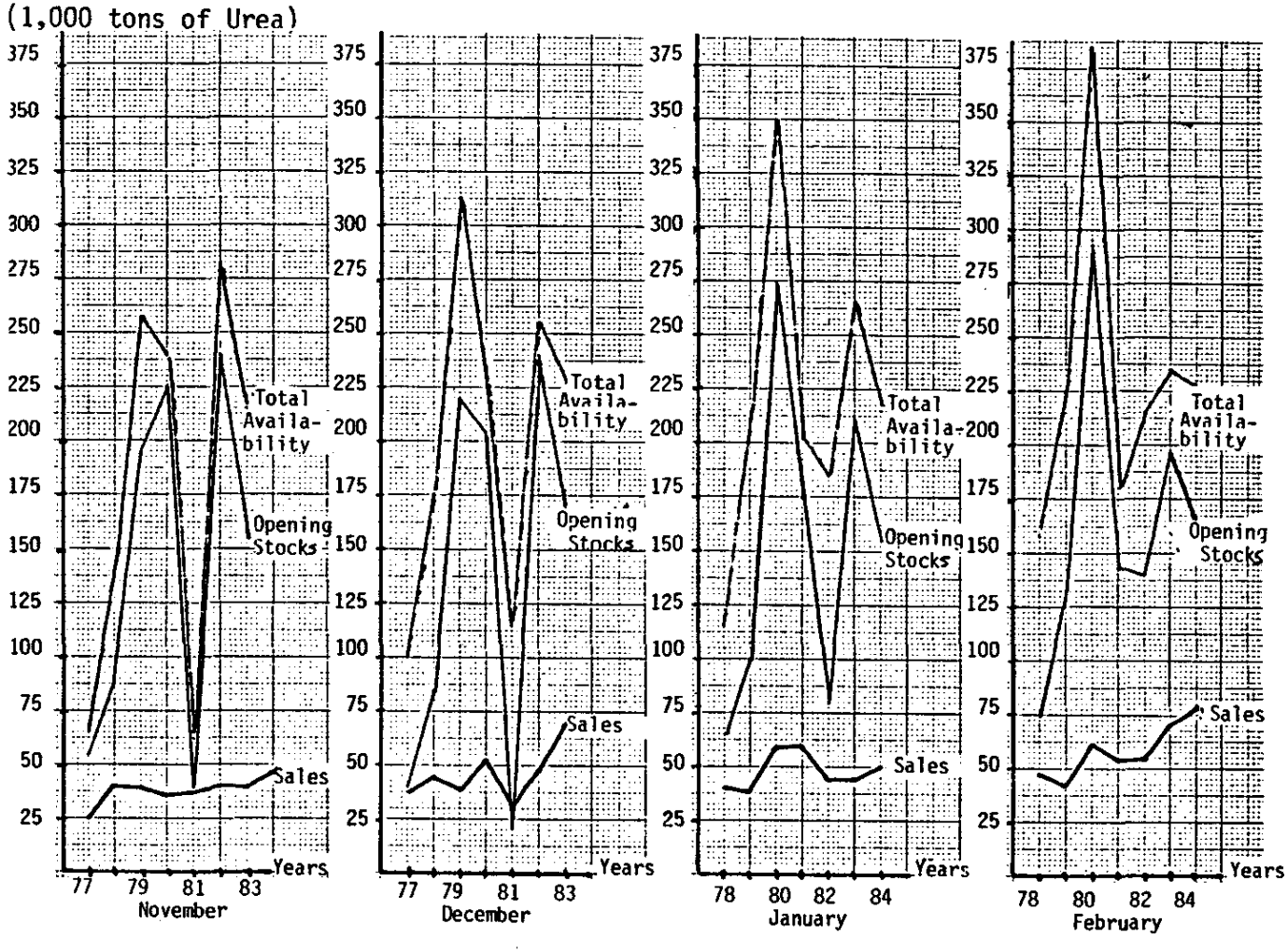


Figure 12--Continued

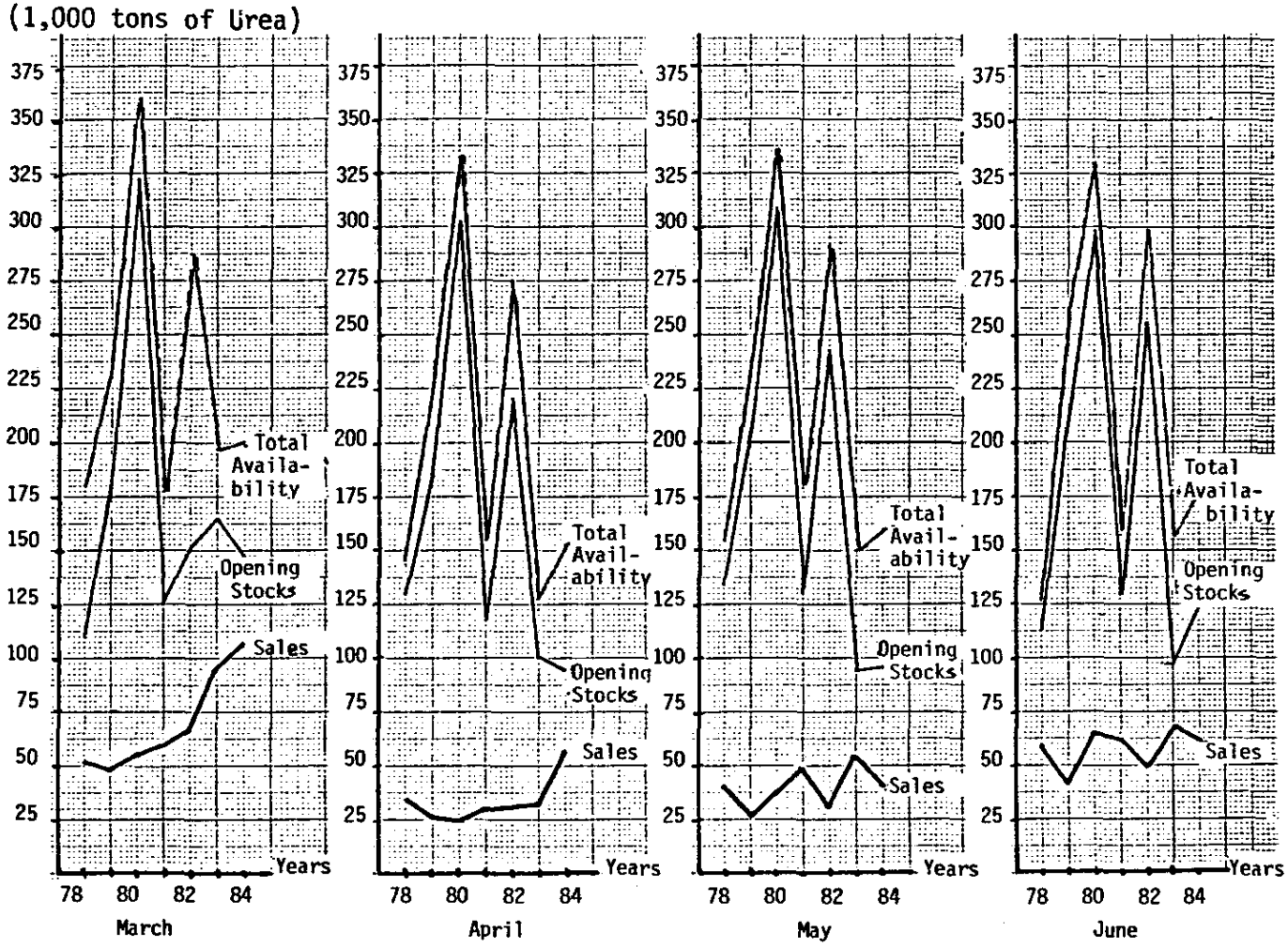
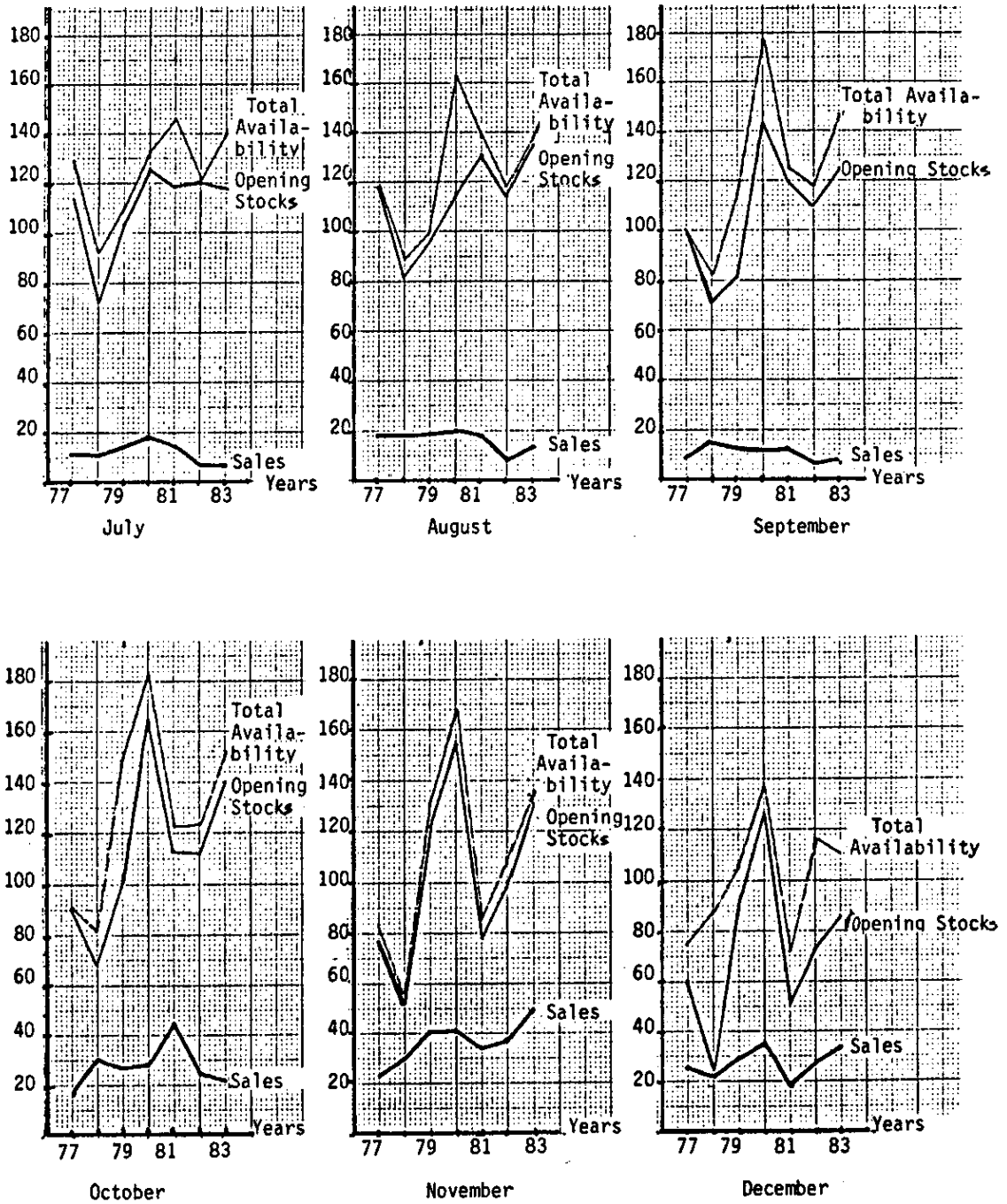


Figure 13--Monthly opening stocks, current supply, total availability, and sales of triple superphosphate (TSP) in Bangladesh, July 1977 to June 1984

(1,000 tons of TSP)



Note: Current supply (stock replenishment) equals the vertical distance between total availability and opening stocks.

Figure 13--Continued

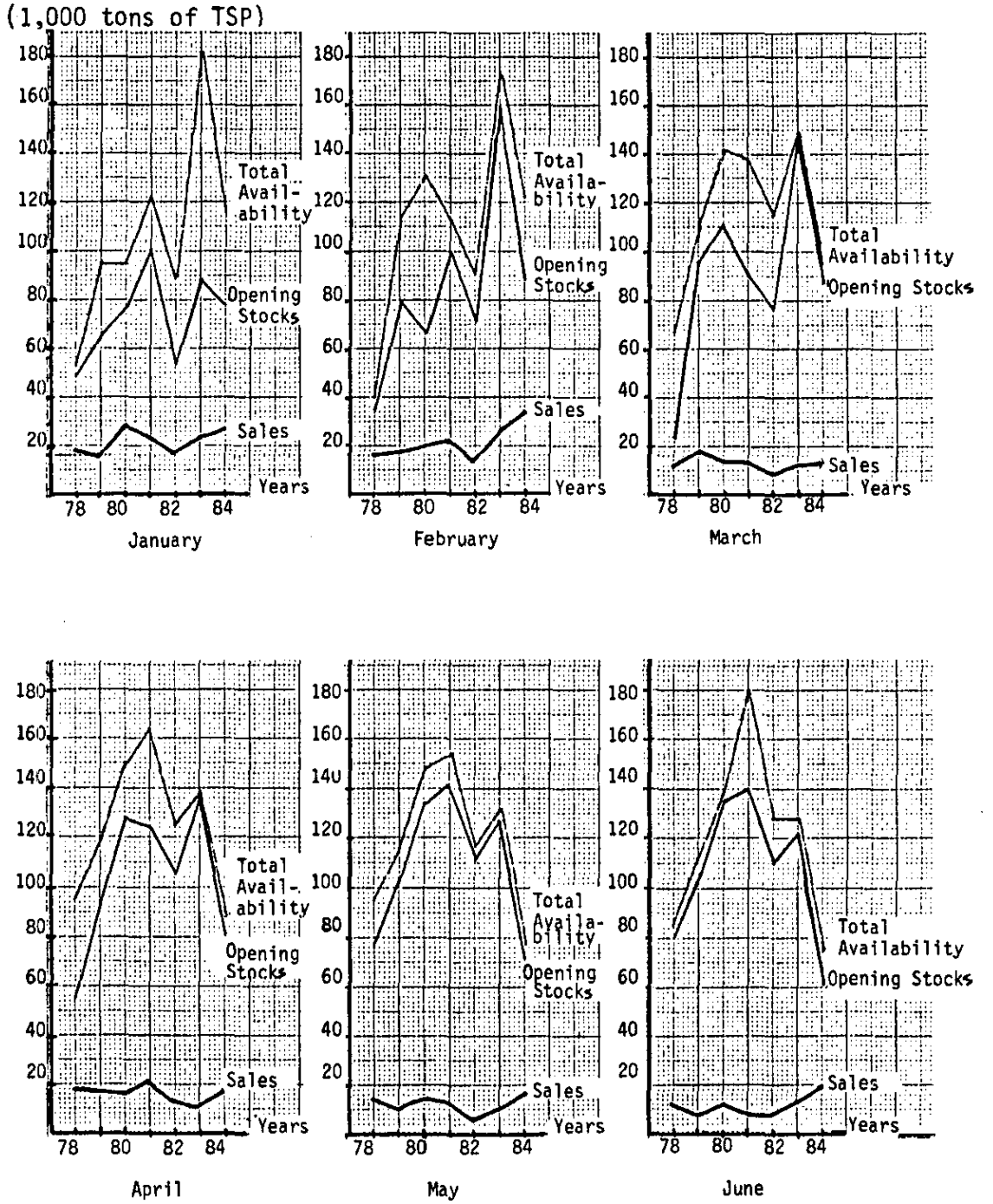
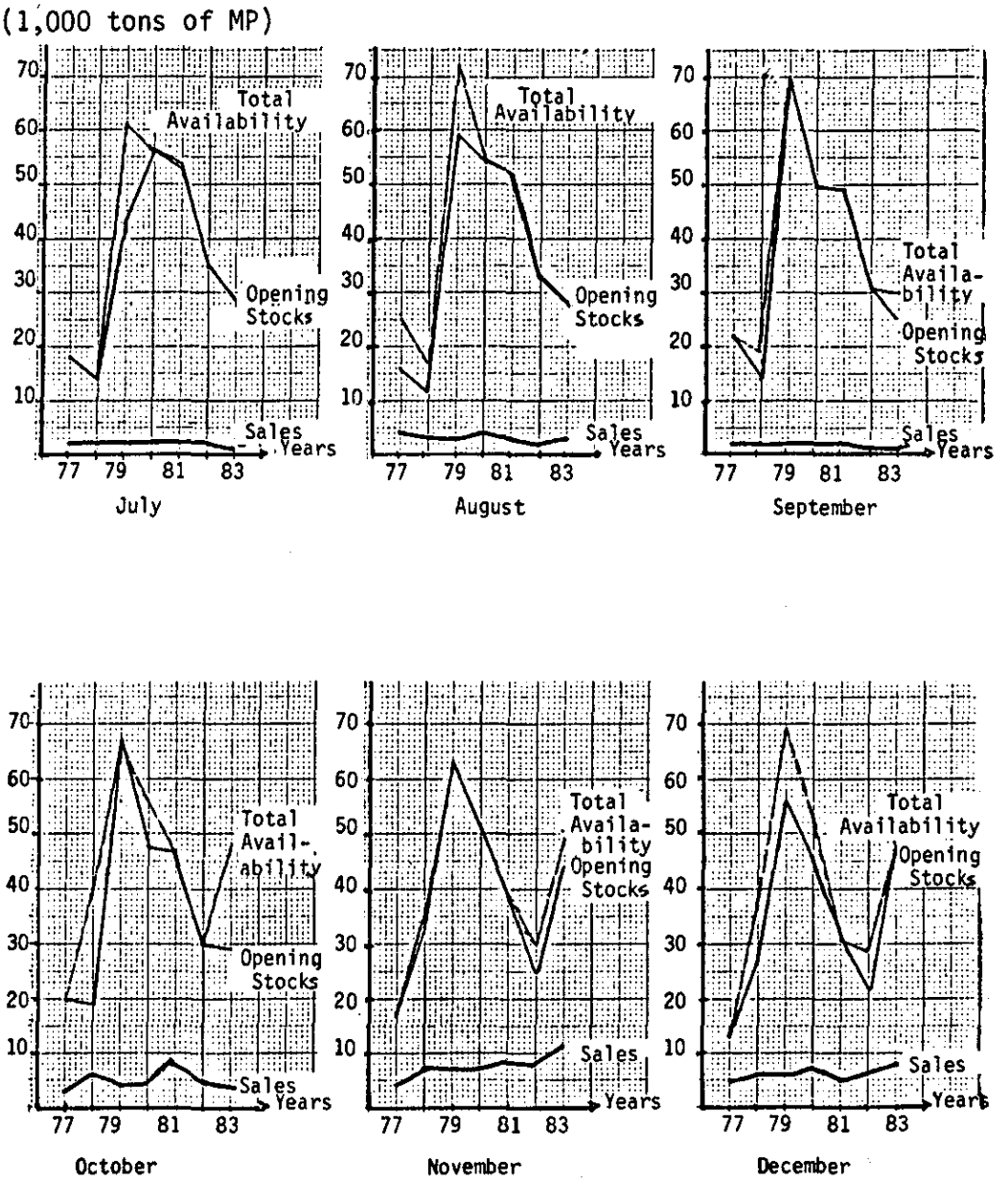


Figure 14--Monthly opening stocks, current supply, total availability, and sales of muriate of potash (MP) in Bangladesh, July 1977 to June 1984



Note: Current supply (stock replenishment) equals the vertical distance between total availability and opening stocks

Figure 14--Continued

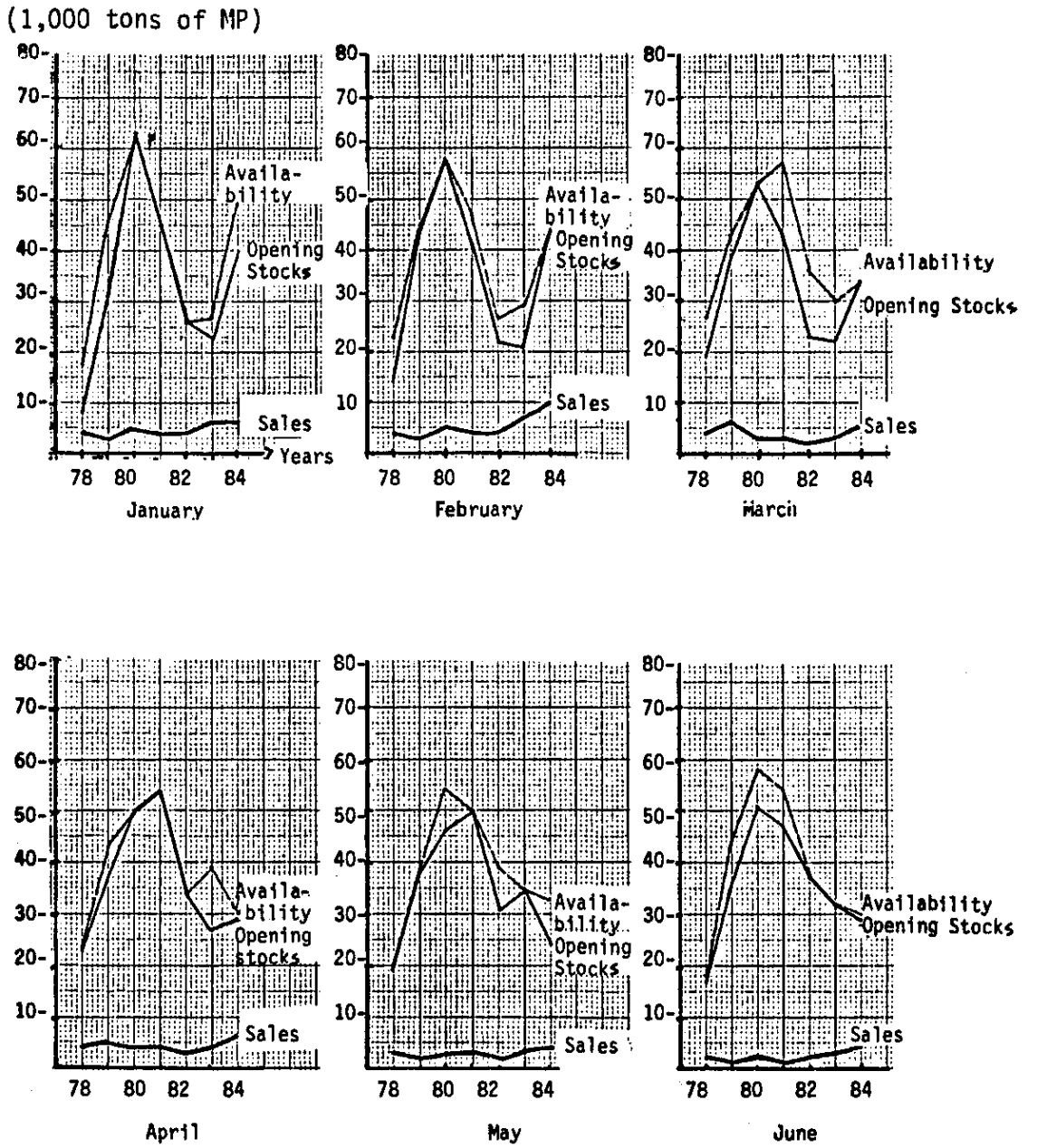


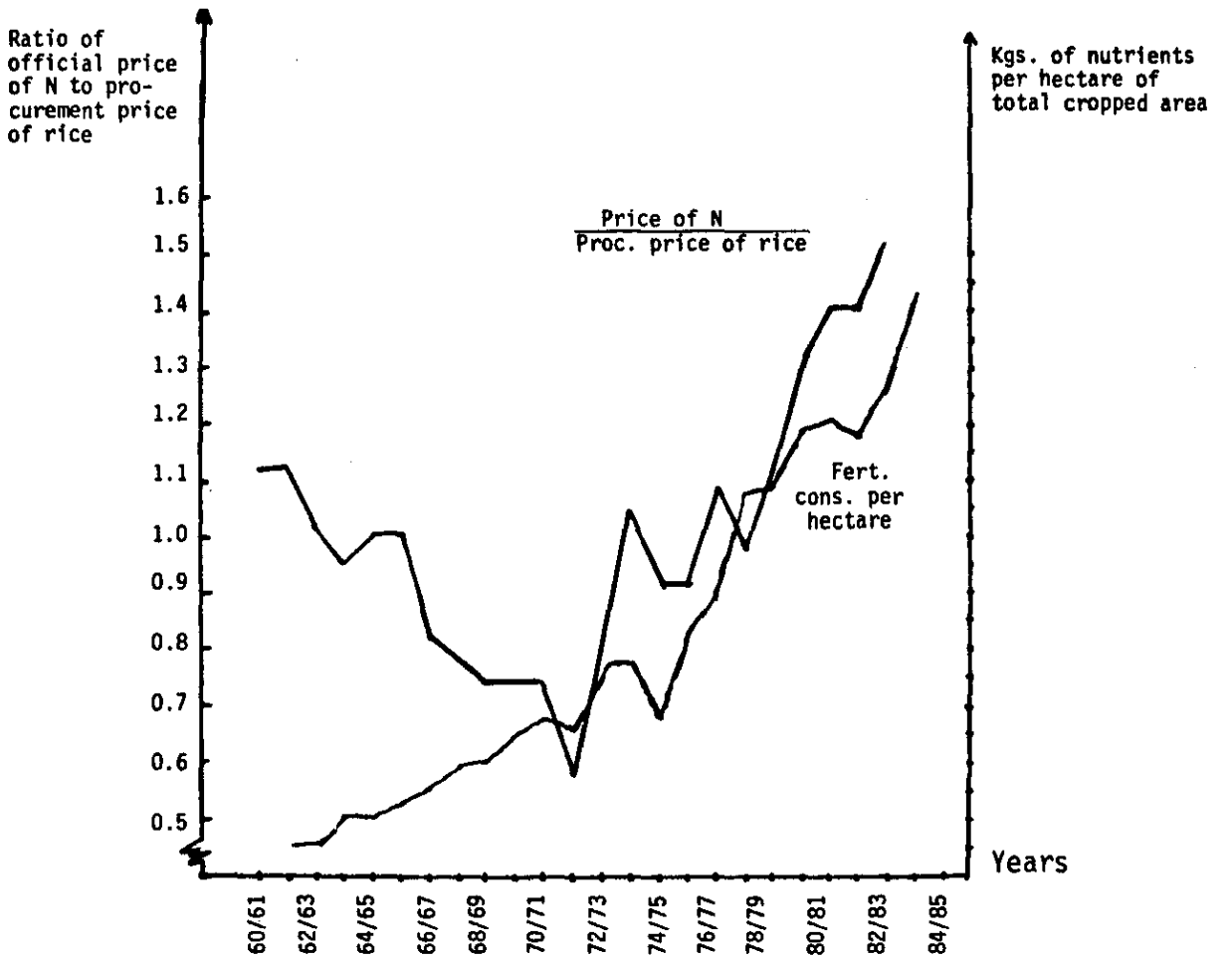
Table 15--Monthly sales, ratios of monthly opening stocks to monthly sales, and ratios of monthly availability to monthly sales of urea, TSP, and MP in Bangladesh, 1977/78 - 1983/84

Year	Product	Sales				Monthly Opening Stock/ Monthly Sales				Monthly Availability/ Monthly Sales			
		Average	Minimum	Maximum	C.V.	Average	Minimum	Maximum	C.V.	Average	Minimum	Maximum	C.V.
		(1,000 metric tons)											
1977/78	Urea	40	20	58	28	2.1	1.1	3.8	35.9	3.3	2.1	5.0	27.5
	TSP	16	9	26	30	5.1	2.0	11.1	58.5	6.0	2.5	11.8	48.1
	MP	4	2	5	25	5.7	2.0	11.0	45.8	6.5	2.6	11.0	32.9
1978/79	Urea	39	23	60	29	3.7	1.4	7.8	54.2	5.0	2.5	8.9	40.7
	TSP	18	8	30	38	5.3	1.2	13.1	61.4	6.6	4.0	14.1	50.4
	MP	4	1	7	51	10.3	3.2	36.0	86.3	12.4	5.7	43.5	83.2
1979/80	Urea	45	25	64	31	6.2	3.7	12.1	37.2	7.4	4.5	13.3	32.0
	TSP	21	12	41	41	6.0	2.8	11.3	46.1	7.1	3.2	11.5	39.7
	MP	4	2	7	41	17.2	9.0	34.5	41.2	19.0	9.0	34.5	43.1
1980/81	Urea	48	23	78	34	4.8	2.1	11.5	59.0	5.5	2.6	12.8	53.7
	TSP	21	8	41	44	7.4	3.5	17.5	53.7	8.9	3.1	22.7	59.1
	MP	4	1	7	46	17.1	6.4	47.0	63.6	18.3	7.4	52.6	65.1
1981/82	Urea	41	20	74	48	3.4	0.7	7.8	69.7	4.8	1.6	9.4	52.5
	TSP	17	6	45	62	7.5	2.3	18.7	63.2	8.9	2.5	19.6	56.9
	MP	4	2	8	51	10.1	3.0	31.0	78.4	10.9	3.8	31.0	69.3
1982/83	Urea	52	17	96	43	4.9	1.4	14.6	74.1	5.7	2.1	16.1	66.7
	TSP	17	7	50	56	6.8	2.6	17.9	76.9	7.8	2.7	20.8	77.4
	MP	4	1	8	51	10.1	3.0	31.0	78.4	10.9	3.8	31.0	69.3
1983/84	Urea	58	13	107	44	2.8	1.4	6.8	49.8	4.1	1.9	10.2	51.9
	TSP	22	7	50	56	6.8	2.6	17.9	76.9	7.8	2.7	20.8	77.4
	MP	5	1	11	58	9.8	4.0	29.0	80.5	11.1	4.4	30.3	78.1

Sources: Developed from data in Bangladesh Ministry of Agriculture and U.S. Agency for International Development, Joint Bangladesh and U.S. Government Evaluation of the Fertilizer Distribution Improvement Project, USAID Report 388-0024 (Dhaka: November 1982); and Bangladesh Agricultural Development Corporation, Monthly Fertilizer Newsletter, June 1983 and June 1984.

Note: C.V. indicates coefficient of variation.

Figure 15--Growth of fertilizer consumption and changes in ratio of official price of nitrogen to procurement price of rice, 1960/61 to 1983/84



Note: Price data not available for 1983/84.

Thus at the present stage a new orientation is required for policies to create sustained rapid growth in Bangladesh's fertilizer consumption. The current emphasis on prices needs to be replaced by an emphasis on productivity and efficiency of fertilizer use as key target variables in policies designed to raise farmers' returns to fertilizer use and supplemented by adequate flows of institutional credit to enable them to buy fertilizers. Different factors affecting growth in actual fertilizer use need to be viewed, not in isolation from each other, but as a set of interacting variables that can be manipulated through appropriate policies. The dominant aim of these policies should be faster development and well-coordinated, efficient operation of systems of agricultural research, extension, and credit and of fertilizer production, import, procurement, stock management, and distribution.