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Policy Issues for Rapid Growth in Use of Modern Agricultural Inputs

The Case of Fertilizers in India

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INTRODUCTION

Accelerated growth in agricultural production is one of the highest priority goals of the developing countries. Achievement of this goal depends on fuller utilization of the existing production potential in agriculture and continuously raising it through technological changes. This calls for sustained growth in the use of modern inputs like fertilizers, pesticides, better quality seeds and farm implements and machinery. Thus, the real question is how to generate and maintain the desired growth rates in the use of these inputs.

Discussion of this question usually begins with factors affecting cultivators' decisions about the use of inputs. Among these, prices of crops and inputs generally receive maximum attention since they affect farmers' returns and could be altered by policy interventions. While inputs' prices (in either nominal or real terms) and price policy issues are obviously important, it would be unfortunate if they dominate the discussion on how to generate sustained rapid growth in the use of modern inputs in developing countries.

In developing countries, growth in the use of modern agricultural inputs is often influenced more powerfully by factors other than prices of either crops or inputs. These other factors are those which influence agricultural research, extension and credit systems plus supply and distribution systems for inputs. It is the well-coordinated development and working of all these systems which bring about growth

in inputs' use through conversion of the untapped potential into farmers' effective demand for inputs, and this demand being met by supply and distribution systems at growing number of geographically dispersed locations. This is stressed because of the following reasons.

Appreciable use of modern inputs in the developing world is of relatively recent origin. Although many countries have achieved impressive growth in their use, in virtually all of them there is still untapped viable potential for further growth in the use of inputs. On the other hand, agricultural research, extension and credit as well as input supply and distribution systems are inadequately developed, and there are many shortcomings in their working. Under these circumstances, exclusive or even excessive concern with price policy issues in discussing how to generate and maintain rapid growth in the use of inputs seems rather simple-minded. This is especially so when one recognises that input price policies are often deeply embedded in input supply and distribution policies and governed by constraints in these systems plus various socio-political compulsions.

An attempt is made in this paper to show the relevance of the above considerations by discussing the policy requirements of sustained rapid growth in India's fertilizer consumption. As in India, fertilizer is the dominant modern input in contemporary agriculture of most of the developing countries, and a substantial proportion of growth in agricultural production is expected from raising its use. Similarly, the Indian experience relates to raising its use from less than one kilogram per hectare to about 40 kilograms per hectare over a period of three decades--levels which are typical to many developing countries. Yet other major similarities between India and other developing countries

relate to wide geographical variations in levels of fertilizer use and circumstances affecting the development of fertilizer distribution and supply systems. Thus the framework used in the paper and some of the broad conclusions emerging from the experience in India may be useful in raising policy issues for other countries.

FERTILIZER USE IN INDIA: PAST GROWTH AND FUTURE NEEDS

Fertilizer use began in India on tea plantations in the 1920s. It grew little outside the plantation sector until 1943 when the government launched the Grow More Food Campaign in the wake of the Japanese occupation of Burma (from where India was importing rice) and the Bengal Famine. This marked the beginnings of efforts to promote fertilizer use in the nonplantation sector to raise food production rapidly. These efforts, which gathered momentum after India became independent in 1947, aimed at creation of farmers' demand for fertilizers as well as development of fertilizer supply and distribution systems. Some of the major features of these efforts have been generating and spreading the knowledge about responses of crops to fertilizer use through thousands of fertilizer trials on farmers' fields, emphasis on development of irrigation and fertilizer responsive varieties to improve responses of crops to fertilizer use, development of a fairly widespread fertilizer distribution system and its interface with agricultural credit system, state monopoly in fertilizer imports, and development of fertilizer industry in public, private, cooperative and joint sectors[1]. On the price policy front, two major features have been uniform prices of fertilizer all over the country, and virtual absence of fertilizer subsidies until the mid-1970s and growing burden of these subsidies in recent years[2].

India was using less than 50,000 metric tons of plant nutrients in the form of chemical fertilizers in the late 1940s (i.e., less than 0.5 kilogram per hectare). This grew to about 800,000 tons by 1965/66, 2.8 million tons by 1973/74, and more than 7 million tons by 1983/84 (Table 1). Incidentally, India now ranks fourth in total fertilizer consumption after the U.S.A., the U.S.S.R., and China[3].

The need for substantial further growth in India's fertilizer consumption is indicated by its relatively low consumption per hectare as compared to the levels in countries with high crop yields[4]. More importantly, it is revealed by future requirements of agricultural production as most of these will have to come from continuous increases in per hectare yields. For instance, according to the National Commission on Agriculture, about four-fifths of the additional foodgrain production required by the year 2000 will depend on increased use of fertilizers[5].

The estimates of required fertilizer use by the year 2000 vary between 15 and 20 million tons[6]. To achieve such levels, total consumption must go up by 450 to 750 thousand tons <u>every year</u> during the 1980s and 1990s. So far annual increment in fertilizer consumption exceeded 500,000 tons only five times. It is, therefore, pertinent to ask what policies are required to generate sustained growth in fertilizer use by the desired magnitude.

HEURISTIC FRAMEWORK TO DISCUSS THE POLICY REQUIREMENTS[7/]

One way to discuss the above question would be to view growth in fertilizer consumption as an outcome of growth in farmers' demand for fertilizers due to <u>changes</u> in variables which affect their returns on

its 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 agro-economic variables as irrigation, fertilizer responsive crop varieties, cropping pattern, and prices of crops as well as fertilizers. The estimated growth parameters of different explanatory variables are then used to draw policy conclusions to generate further growth in fertilizer use[8/].

Viewed thus, the question what requires to be done to increase India's fertilizer consumption by more than 500,000 tons every year leads to the following three major questions: What changes in fertilizer response functions-cum-price environment are continuously necessary to generate the required pace of growth in fertilizer consumption? What is the relative importance of changes in agronomic variables like irrigation and crop varieties which shift the fertilizer response function upwards vis-a-vis prices of crops and fertilizers? Which policies are necessary to bring about the required changes in different agro-economic variables?

Without belittling the importance of the above questions, it must be said that the above approach constrains the discussion of policies required to generate the desired rate of growth in fertilizer use. This is mainly because it considers growth in fertilizer use as causally determined by only changes in agro-economic variables behind fertilizer response functions-cum-price environment. This is not to downplay the importance of these variables. But to recognize their importance is quite different from concluding that under all circumstances growth in fertilizer use is causally determined by changes in these variables alone. Both *a priori* reasoning and historical experiences of many countries

(including India) clearly suggest that such an interpretation of the process of growth in fertilizer consumption is extremely lopsided, and could lead to unrealistic (if not altogether imprudent) policy prescriptions, especially on the price front if possibilities of upward shifts in response functions are limited in the short run.

The economic potential of fertilizer use in a country is determined by fertilizer response functions, prices of crops and cost of fertilizer, i.e., the agro-economic variables which determine profitability of fertilizer use. Actual fertilizer use is an outcome of the conversion of the potential into farmers' demand for fertilizer, and this demand being met by fertilizer supply and distribution systems. Thus, besides agro-economic variables, three types of processes influence actual fertilizer use. First, the processes which convert the potential into farmers' fertilizer demand by generating knowledge about fertilizer response functions, spreading this knowledge among farmers, and enabling them to purchase fertilizer by providing credit. Second, processes which establish fertilizer distribution system, and govern its working in making fertilizers available to farmers at geographically dispersed locations. Third, processes which determine aggregate supply of fertilizers through domestic production and imports. These three processes are governed by the workings of certain sub-systems. These are agricultural research, agricultural credit, fertilizer distribution, domestic fertilizer industry, and the sub-system involved in fertilizer imports. Viewed thus, it is clear that actual level of fertilizer consumption is determined not only by the agro-economic variables but also by the level of development and workings of all these sub-systems.

Even farmers' decisions about whether, on which crops and at what rates to use fertilizers are influenced by both agro-economic variables and the workings of agricultural research, extension and credit systems. Afterall, rationality of farmers does not mean that they are omniscient and would overcome all constraints on availability of credit. Similarly, given the farmers' decisions, actual fertilizer use depends on whether adequate fertilizers are available to them at the right place and time--something which depends on the level of development and efficiency in the workings of fertilizer distribution and supply systems.

Since it was invented in the middle of the last century, fertilizer use in every country has begun at some time with a few farmers fertilizing selected crops at limited locations. Such beginnings of fertilizer use imply vast untapped potential of fertilizer use under the prevailing response functions and prices. Empirically, the existence of the untapped potential of fertilizer use is manifested as less than complete diffusion of fertilizer use on land where it is potentially profitable, and in sub-optimal rates of application on fertilized land. In country after country growth in fertilizer consumption has been an outcome of further spread of fertilizer use and upward movements in rates of application from sub-optimal to optimum levels. The pace and pattern of growth in fertilizer consumption have been governed by the rate at which the sub-systems behind the three processes have developed, and the efficiency with which they have operated to spread fertilizer use and raise rates of application.

The various sub-systems have influenced growth in fertilizer consumption not only by exploiting the untapped potential but also by

raising the profitability and potential of fertilizer use. Thus, for instance, agricultural research and extension systems have been behind upward shifts in response functions by developing and spreading new technologies in crop production. Similarly, reductions in farmers' fertilizer cost have been governed by technological breakthroughs and operational efficiencies in fertilizer supply and distribution systems. Historical experiences clearly reveal that sustained growth in fertilizer use has occurred through these types of developments coupled with higher prices of crops resulting from rapid economic growth. They cannot be substituted indefinitely by propping up prices of crops or lowering fertilizer prices through subsidies to raise profitability of fertilizer use. Besides being infeasible, such measures distract attention from real tasks of generating sustained growth in fertilizer consumption.

The above framework to understand forces governing growth in fertilizer consumption is especially relevant for developing countries because (a) aggregate fertilizer consumption in most of them is below the potential (as determined by prevailing response functions-cum-price environment), (b) sub-systems which influence growth in fertilizer use are inadequately developed and have many inefficiencies in their working, and (c) interactions between these sub-systems are usually not governed by the price mechanism.

Viewed thus, it is clear that we cannot meaningfully discuss policy requirements of further growth in India's fertilizer consumption by raising only the questions about changes in agro-economic variables spelled out at the outset of this section. It is equally important to interpret the past growth in fertilizer consumption in the framework

outlined above to identify forces which have governed it and thus arrive at key policies required to strengthen them.

MAJOR FEATURES OF PAST GROWTH AND THEIR IMPLICATIONS

This section highlights certain major features of growth in India's fertilizer consumption which have important implications while discussing policies for further rapid growth in the use of this input.

All available evidence suggests that despite impressive growth, actual total fertilizer consumption has been below the potential indicated by the response functions-cum-price environment[9]. This means that growth in fertilizer consumption could have been faster than it occurred. That there was sufficient scope for this is indicated by less than complete diffusion of fertilizer use on all crops, even on irrigated areas, until at least the mid-1970s[10]. Similarly slow but steady growth in fertilizer use under unirrigated conditions, even on traditional varieties, clearly suggests a viable potential and farmers' willingness to use it. Thus, it is just as necessary to ask why the past growth in fertilizer use was not faster as to figure out the forces behind the observed pace and pattern of growth. Obviously, answer to this question lies in various deficiencies in fertilizer promotion, distribution and supply systems. Among these, inadequate efforts to convert potential of fertilizer use on unirrigated areas, slow expansion of and various inefficiencies in the distribution system, repeated shortfalls in domestic fertilizer production, and wide year-to-year fluctuations in fertilizer imports clearly stand out.

Virtually all empirical research shows far greater influence of variables behind fertilizer response functions than that of prices (either of crops or of fertilizers) on the observed pace and pattern of growth in fertilizer use. This is clearly revealed by close positive association between physical responses of different crops to fertilizer use and the pace of fertilizer diffusion on them. It is also revealed by concentration of fertilizer use on irrigated areas and the impact of fertilizer responsive varieties on growth of fertilizer use. Slower growth in fertilizer use on oilseeds and pulses despite faster rise in prices of these crops as compared to many others, and faster diffusion of fertilizer use on the same crop on irrigated areas than on unirrigated areas further confirm that variables behind fertilizer response functions have been more important than prices.

It is equally instructive to note that despite greater profitability of fertilizer use under irrigated conditions and on areas sown with HYVs, the use was not confined to such situations. As mentioned above, there was slow but steady growth of fertilizer use on unirrigated areas under virtually all crops. And this was so even though diffusion on irrigated areas was not complete. Thus, for instance, by 1976/77 fertilizer use had spread to about 18 percent of total unirrigated areas even though about one-third of the irrigated area was still not fertilized, i.e., it was available for further diffusion of fertilizer use under irrigated conditions. The explanation for this lies in relatively better development of the sub-systems influencing growth in fertilizer consumption in certain regions with low irrigation than in those with high levels of irrigation. The experience of Gujarat state clearly reveals this.

In 1981/82, with less than 20 percent area irrigated and relatively poor rainfall environment, Gujarat had the highest level of fertilizer consumption per hectare among all states and union territories with irrigation levels up to 40 percent. This was an outcome of faster diffusion of fertilizer use on unirrigated areas which accounted for more than half of total fertilizer consumption in the state in the mid-1970s. Against this, the share of unirrigated areas in the country's total fertilizer consumption was only about 20 percent. Relatively impressive growth of fertilizer use on unirrigated areas of Gujarat has been mainly due to certain strengths of the fertilizer distribution system and pressure from the supply side, especially from the fertilizer factories located in the state[11].

Yet another feature which deserves attention is the geographical concentration in fertilizer use resulting from wide variation in the pace of growth in fertilizer consumption among different states, and also among different districts within states[12]. This has been commonly attributed to inter-district variations in irrigation, cropping pattern and spread of high yielding varieties. What is not so commonly recognized is that it is also associated with inter-state and inter-district differences in development of different sub-systems, especially fertilizer distribution and promotion systems. The persistent regional concentration in fertilizer use suggests that both fertilizer diffusion and rates have reached fairly high levels in regions which have accounted for bulk of the past growth in fertilizer use[13]. This being so, continued dependence on these same regions for further growth in fertilizer consumption has started generating pressures for higher prices

of crops and lower prices of fertilizers because of diminishing marginal production from additional fertilizer use. The dependence on regions which dominate fertilizer consumption for further growth in total consumption cannot be broken without developing fertilizer promotion and distribution systems in the other regions in a vigorous and sustained manner.

KEY POLICY ISSUES AND CONCLUSIONS

The pace of further growth in India's fertilizer consumption would depend on converting the untapped potential into actual fertilizer consumption, and continuously raising the potential of fertilizer use. Accordingly, the key policy issues for generating the desired rate of growth in fertilizer use could be identified by asking two central questions: First, what efforts are required to convert the untapped potential into actual fertilizer use? Second, what policies are required to continuously raise the potential of fertilizer use? The following discussion indicates why it is important to ask both these questions at this stage of growth in India's fertilizer consumption and its future role in growth of agricultural production.

Generating growth in fertilizer consumption through tapping the unexploited potential would depend on (1) diffusion of fertilizer use on land which has remained unfertilized even though it is potentially profitable from farmers' viewpoint, (2) raising rates of application from sub-optimal to optimum levels on already fertilized land.

Most of the scope for further diffusion of fertilizer use is on more than 70 percent of India's cultivated land[14]. Over 80 percent of

the production of jowar, bajra, small millets, pulses and oilseeds plus two-thirds of cotton come from unirrigated areas. Even in the case of rice and wheat, unirrigated areas account for 30 to 40 percent of total production. Therefore, raising productivity of unirrigated areas is crucial to sustain yield-based growth in India's agricultural production. Low soil fertility of these areas is as important a constraint as any other to raise their productivity. In fact, one could argue that unless concerted efforts are made to raise their soil fertility through rapidly promoting judicious fertilizer use, there would be little incentive on the part of farmers for investment in dryland technologies.

Since unirrigated areas are spread all over India in different agro-climatic environments, to speed up fertilizer diffusion in these areas, location specific knowledge on fertilizer response functions, details of fertilizer practices and other agronomic matters need to be generated and spread among farmers[15]. This cannot be overemphasized. For sustained growth in farmers' demand for fertilizers under unirrigated conditions, what is lacking is widespread conviction among farmers about significant additional production from fertilizer use and the knowledge about how to use fertilizers most advantageously under rainfed conditions. These efforts should be simultaneously supplemented by adequate and timely flow of credit to farmers, and development of efficient fertilizer distribution system. Small increases in distribution margins will not suffice to accelerate geographical exparsion of fertilizer distribution system in rainfed areas if vigorous efforts to promote fertilizer use are absent and fertilizer turnover remains low. Hence, the emphasis

should be on strengthening agricultural research, extension and credit activities to rapidly raise farmers' fertilizer demand.

Meaningful efforts to generate growth in fertilizer use on unirrigated areas will not sustain unless growth in total fertilizer supply stays ahead of growth in market for fertilizers under irrigated conditions (i.e., in the presently and newly irrigated areas). For quite some time to come, this would depend on fertilizer import policy. It should be based on an understanding of the role of the supply side in converting untapped potential into actual fertilizer use under rainfed conditions through pressures on fertilizer promotion and distribution systems rather than on short-term considerations of clearing inventories and saving foreign exchange, or long-term policy of self-sufficiency in domestic production of fertilizers. The experience of Gujarat state (referred to in the previous section) clearly demonstrates how sustained pressure from the supply side works in opening up fertilizer markets in rainfed regions. Obviously, a policy of "liberal" imports of fertilizers will be resented by the domestic fertilizer industry and may even lead to an increase in inventories in the short-run. But this calls for evolving effective mechanisms to resolve conflicts of interest between different segments of the fertilizer system rather than foregoing the use of an instrument on the fertilizer supply side to raise production of such commodities as oilseeds and pulses in which unirrigated areas dominate and domestic demand exceeds domestic production.

Raising rates of application on fertilized land from sub-optimal to optimum levels is another way of generating growth in fertilizer consumption through tapping the unexploited potential. Efforts in this

direction should concentrate on farmers' education in various details of fertilizer practices like balance among different nutrients, correct timing and placement of fertilizers, and use of micro-nutrients and soil amendments wherever they are necessary. All available research indicates that changes in fertilizer practices resulting from these efforts will increase the efficiency of fertilizers in crop production. This would benefit both farmers and society as a whole. Conversely, raising rates of application through injudicious use of price policy will only increase fertilizer subsidies and inflationary pressures in the economy.

For sustained rapid growth in fertilizer consumption, tapping of unexploited potential through above efforts is not enough. It is also important to raise the potential of fertilizer use. The urgency of this is clear from the need to increase fertilizer consumption by more than 500,000 tons every year when diffusion of both fertilizer and HYVs is virtually complete on presently irrigated land. This is stressed because the desired annual increments in fertilizer use are derived from the required growth in agricultural production. Thus raising the potential of fertilizer use is intimately tied up with raising the agricultural production potential since about four-fifths of the additional production is expected through vast growth in fertilizer use.

One could agrue that notwithstanding the complete diffusion of both fertilizer and HYVs on presently irrigated land, there is still scope to generate growth in agricultural production on this land through increasing rates of fertilizer application. This, of course, is true. But as already pointed out, this must come from upward shifts in response functions caused by improvements in fertilizer practices and

better water management rather than through movements along the existing response functions. Rates of fertilizer use on irrigated land sown to HYVs are fairly high. Efforts to increase them without improving the efficiency of fertilizer use add marginally to yields. This, in turn, leads to pressures for lowering the prices of fertilizers and raising the support prices of agricultural commodities as the experience in recent years clearly indicates.

Besides shifting the response functions of already fertilized land upwards through efforts mentioned above, it is also crucial to accelerate the development of irrigation potential and its fuller utilization to increase the potential of fertilizer use. Since there is no more backlog of irrigated land for further diffusion of fertilizers and HYVs, its urgency is obvious. Yet another direction in which accelerated efforts are required to raise the potential of fertilizer use is to improve the response function environment on unirrigated land through strengthening the agricultural research and extension systems for rainfed agriculture. Unirrigated land accounts for more than 70 percent of total cultivated land at present. More importantly, nearly half of the land will remain unirrigated even after developing the entire irrigation potential. Thus, improving the response function environment on unirrigated land is no less important than accelerating the development of irrigation potential.

Concerted efforts in the above directions would continuously raise the <u>potential</u> of fertilizer use. Its conversion into sustained rapid growth in fertilizer use, however, would depend on simultaneous development and coordinated functioning of the fertilizer promotion, distribution and supply systems. In view of the past experience of time-lags in covering

even irrigated areas by fertilizer use and pushing optimal fertilizer practices on them, it is important to distinguish between policies which raise the potential of fertilizer use and those which convert it into actual fertilizer consumption.

The above discussion points at the nature of efforts required to convert the untapped potential into actual fertilizer use and increase the potential continuously. Efforts in both these directions are simultaneously required to raise fertilizer consumption by more than 500,000 tons every year. This can be seen easily. Assume irrigated areas increase every year by 2.5 to 3 million hectares, that is by 50 to 75 percent more than the average annual increment in the 1970s. Further assume that the newly fertilized areas are unfertilized until they receive irrigation and that upon receiving irrigation they are fertilized without any time-lag at 100 kilograms per hectare. Even with these heroic assumptions, fertilizer consumption would go up by only 250,000 to 300,000 tons every year. Thus to achieve the need-based target of fertilizer use, it is just as important to convert the untapped potential into actual fertilizer use as to raise it continuously.

Thus far the discussion has focused on a wide range of non-price policy issues relevant to sustained rapid growth in India's fertilizer consumption. This emphasis is mainly due to two reasons.

As suggested by the heuristic framework, until actual fertilizer consumption approaches the potential of its use (as determined by the prevailing response functions-cum-price environment), acceleration in the growth of fertilizer use is more dependent on appropriate non-price policies than on lowering the prices of fertilizers or raising the

prices of crops. These non-price policies are in the spheres of agricultural research, extension and credit plus fertilizer supply and distribution. They are preferable to price policy because what constrains the pace of growth in fertilizer use is not lack of potential opportunities for profitable fertilizer use but lack of adequate knowledge about these opportunities among farmers, inadequate availability of credit, and lack of adequate and timely supplies of fertilizers at micro-locations. Lowering of fertilizer prices (in either nominal or real terms) is a poor substitute to remove the above constraints on sustained rapid growth in fertilizer use.

While the above argument would apply to any developing country with untapped potential of fertilizer use, it becomes more important in the Indian context because tapping of the remaining unexploited potential of fertilizer use calls for accelerated efforts, of the nature described above, to push fertilizer use on unirrigated areas and to raise rates of application on fertilized land through upward shifts in response functions. Urgency in developing the remaining irrigation potential and also in accelerating the pace of technological change in rainfed agriculture to raise the potential of fertilizer use further tilt the balance in favor of non-price policies.

All above arguments are further strengthened when one recognizes that at least in the short-run India does not seem to have much scope to lower fertilizer prices to accelerate growth in its use. This is clear from the rapidly rising burden of fertilizer subsidies on the budgetary resources of the government. These subsidies, introduced in 1974/75 in the wake of the dramatic impact of the Oil Crisis on the

cost of imported fertilizers, have reached Rs. 10,480 million in 1983/84. This amounts to about 2.7 percent of the total disbursement of the central government. There is a general agreement that with growth in fertilizer consumption, the burden of fertilizer subsidy will rise. This will be so because increasing proportions of fertilizer requirements will come from new domestic plants with higher unit cost of production due to enhanced capital investment in them. Thus, more than ever before, non-price policies will crucially determine whether India's fertilizer consumption will grow at the pace required for growth in agricultural production.

Table 1: Consumption of Fertilizers in India, 1951/52 to 1983/84

Year	N	P_2O_5	K_2O	Total	Per Ha. Consumption[a]	Annual Change in Total Consumption	
						000 MTs	Percent
		(000 Metric Tons)			(Kgs.)		
1951/52	59	7	8	74	0.6		
1952/53	58	5	3	66	0.5	-8	-10.8
1953/54	89	8	8	105	0.7	39	59.1
1954/55	95	15	11	121	0.8	16	15.2
1955/56	108	13	10	131	0.9	10	8.2
1956/57	123	16	15	154	1.0	23	17.6
1957/58	149	22	13	184	1.3	30	19.5
1958/59	172	30	22	224	1.5	40	21.7
1959/60	229	54	21	304	2.0	80	35.7
1960/61	212	53	29	294	1.9	-10	-3.3
1961/62	250	61	28	339	2.2	45	15.3
1962/63	333	83	36	452	2.9	113	33.3
1963/64	377	117	51	545	3.5	93	20.6
1964/65	555	149	69	773	4.9	228	41.8
1965/66	575	133	77	785	5.1	12	1.6
1966/67	738	249	114	1101	7.0	316	40.3
1967/68	1035	335	170	1540	9.4	439	39.9
1968/69	1209	382	170	1761	11.1	221	14.4
1969/70	1356	416	210	1982	12.2	221	12.5
1970/71	1479	541	236	2256	13.6	274	13.8
1971/72	1798	558	300	2656	16.1	400	17.7
1972/73	1839	581	348	2768	17.1	112	4.2
1973/74	1830	650	360	2840	16.7	72	2.6
1974/75	1766	472	336	2574	15.7	-266	-9.4
1975/76	2149	467	278	2894	16.9	320	12.4
1976/77	2457	635	319	3411	20.4	517	17.9
1977/78	2913	867	506	4286	24.9	875	25.7
1978/79	3420	1106	592	5118	29.2	832	19.4
1979/80	3499	1150	607	5256	30.0	138	2.7
1980/81	3678	1214	624	5516	31.5	260	4.9
1981/82	4069	1322	676	6067	34.6	551	10.0
1982/83(b)	4263	1420	735	6418	36.6	351	5.8
1983/84(c)	4750	1619	811	7180	40.9	762	11.9

(a) Based on "Gross Cropped Area". Estimates for the last five years are based on gross cropped area in 1978/79

(b) Provisional

(c) Estimated

Source: Fertiliser Statistics, 1982/83, and Fertiliser News, Dec.1983

FOOTNOTES

[1]For an historical perspective, see Gunvant M. Desai, Growth of Fertilizer Use in Indian Agriculture, Past Trends and Future Demands, International Agricultural Development Bulletin No. 18 (Ithaca, N.Y.: Cornell University Press, 1969), Chapter 2; and Gunvant M. Desai, "Fertiliser in India's Agricultural Development" in Agricultural Development of India - Policy and Problems, ed. C.H. Shah (Bombay: Orient Longman Ltd., 1979), pp. 377-426.

[2]For evolution of fertilizer price policy in India, especially factors which have led to rapidly growing burden of fertilizer subsidies in recent years, see Gunvant M. Desai, "Price and Non-Price Policies For Future Growth in India's Fertilizer Consumption." Paper presented at the international seminar on Fertilizer Pricing organized by the World Bank in Washington, D.C., March 27-30, 1984.

[3]India's fourth rank is of course due to its large size. But the same applies to the U.S.A., the U.S.S.R., and China because they also rank much lower on a per hectare basis. What is important to note, however, is that until the 1960s, neither China nor India came in the top 15 countries. India's record in raising its fertilizer consumption from less than one kilogram per hectare in the early 1950s to 41 kgs. per hectare by 1983/84 is quite impressive when compared with the time taken by many developing and developed countries to raise their per hectare fertilizer consumption in this range. On the other hand, it is considerably poorer than that of China.

[4]This is clear from data on yields of different crops and fertilizer consumption per hectare of arable land available from FAO's Production Yearbook and Fertilizer Yearbook respectively. It may, however, be noted that comparisons of fertilizer consumption per hectare of arable land based on FAO's data exaggerates the differences between India and many other countries, notably those where a substantial proportion of total fertilizer consumption is on pasture land as in some European countries, Australia, and New Zealand, and those with a high degree of multiple cropping as in some Asian countries, including China. There is hardly any fertilizer use on hay and pastures in India. The data for India in the FAO statistics relate to gross cropped area (which includes multiple cropped area) whereas those for many other countries (including China) relate to arable land which excludes multiple cropped area.

[5]The estimates made by the National Commission on Agriculture show that 102 million tons out of 126 million tons of additional foodgrain production would depend on raising fertilizer consumption. Against this, the contribution of increased irrigation, command area development and dry farming programme taken together is estimated at 24 million tons. For details, see India, Ministry of Agriculture and Irrigation, Report of the National Commission on Agriculture, New Delhi, 1976, Part III, pp. 75-80.

[6]For example, see the estimates made by NCA and UNIDO. For NCA's estimates, see source cited in (4) above. For UNIDO's estimate, see UNIDO, Draft Worldwide Study of the Fertiliser Industry: 1975-2000, 1976, Chapter 2.

[7]Complete exposition of this approach would appear in Gunvant M. Desai, Understanding the Process of Growth in Fertilizer Consumption: A Conceptualization, International Food Policy Research Institute, Washington D.C., forthcoming research report.

[8]For example, see researches on fertilizer demand in India during the last two decades. For a more recent example, see the fertilizer demand study of NCAER. For a discussion of the "specification error" in this type of models, see Gunvant M. Desai, Sustaining Rapid Growth in India's Fertilizer Consumption: A Perspective Based on Composition of Use, International Food Policy Research Institute, Washington, D.C., 1982, Chapter 6 and Appendix.

[9]For instance, under the fertilizer response functions-cum-price environment prevailing in the early 1960s, Panse estimated that it was possible to use 3.57 million tons of nitrogen. (See V. G. Panse, Technical and Economic Possibilities of the Use of Nitrogen Fertiliser in India, IARI, New Delhi, 1964). Actual nitrogen consumption in the early 1960s was about 300,000 tons. It crossed 3.57 million tons (Panse's estimate of potential which must have gone up considerably because of growth in irrigation and widespread diffusion of HYVs) in only 1980/81.

[10]For this, such other findings, and elaboration of the arguments of this section, see Gunvant M. Desai, Sustaining Rapid Growth in India's Fertilizer Consumption: A Perspective Based on Composition of Use, International Food Policy Research Institute, Washington D.C., 1982.

[11]For details, see Report of the Working Group on Fertiliser Distribution System in Gujarat, Government of Gujarat, 1983.

[12]See various issues of Fertiliser Statistics, Fertilizer Association of India, New Delhi, for data on fertilizer consumption by states and districts.

[13]Thus, for instance, districts accounting for about one-fifth of the country's gross cultivated area have been dominant in the past growth of fertilizer consumption with a share of about 55 percent. Average rates of fertilizer application in these districts have reached more than 50 kgs. per hectare by the late 1970s. In one-fourth of these districts, they have crossed 100 kgs. per hectare. Since all cultivated land in a district seldom comes under fertilizer use, rates of application on fertilized land in these districts, which have dominated the past growth, must have reached considerably higher levels (probably 75 to 80 kgs. per hectare) by late 1970s.

[14]The problem of raising fertilizer consumption under unirrigated conditions should not be viewed as occurring only with low rainfall. A study based in the fertilizer growth performance of districts during the 1960s clearly showed that districts with low irrigation located in high rainfall regions, particularly in eastern India (including parts of Madhya Pradesh), performed the worst among all districts with little irrigation. See, Gunvant M. Desai and Gurdey Singh, Growth of Fertilizer Use in Districts of India, Performance and Policy Implications, Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad, 1973, Chapter 4. Scrutiny of the trends in the 1970s indicates a similar pattern. Also, see Gunvant M. Desai, "Fertilizer Use on India's Unirrigated Areas: A Perspective Based on Past Record and Future Needs." Paper presented at the seminar on "Technology Options for Dryland Agriculture: Potential

and Challenge," jointly organized by ICRISAT and Indian Society of Agricultural Economics in Hydrabad from August 22 to 24, 1983.

[15]This cannot be overemphasized because the quantum of additional production due to fertilizer use depends on such things as timing and method of fertilizer application, balance among nutrients, sowing time, choice of variety and plant population. What makes these considerations critical in rainfed areas is that without appropriate agronomic practices, returns on fertilizer use are considerably lower and more uncertain than on irrigated areas. On the other hand, available research clearly indicates that with appropriate practices, returns to fertilizer use on rainfed areas could be considerably enhanced.