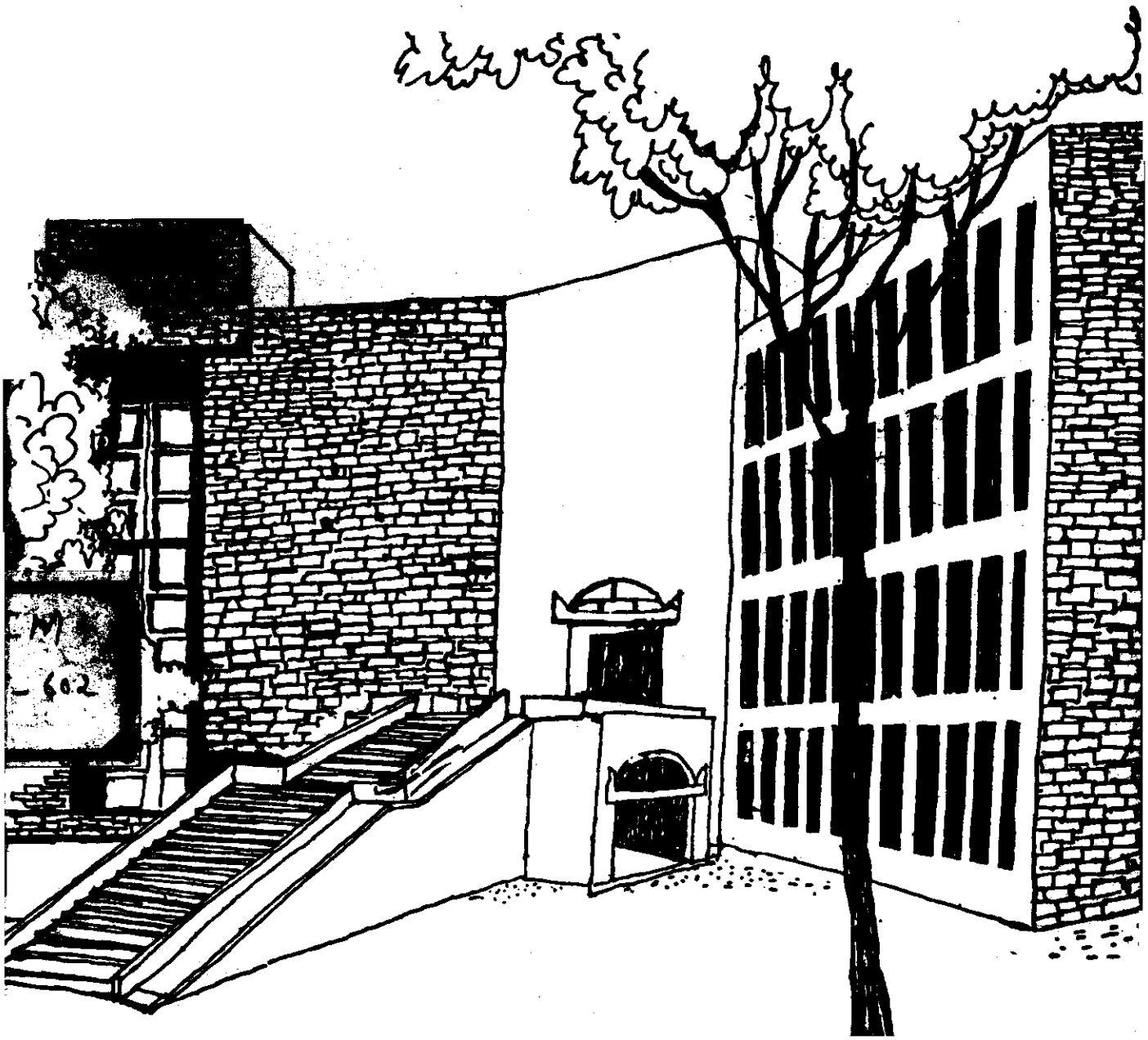
Working Paper



POLICIES FOR GROWTH IN FERTILIZER CONSUMPTION: THE NEXT STAGE

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Abstract

Annual consumption of fertilizers has increased from less than 100,000 metric tons of nutrients in the early 1950s to 8.2 million metric tons (mmts) by 1984/85. The Seventh Five Year Plan aims at raising it to 14 mmts by 1989/90. The task of accelerating growth in fertilizer consumption extends beyond the Seventh Plan period because virtually all further growth in crop production will have to come from continuous increases in yields and all proven yield-increasing technologies depend on high levels of fertilizer application. Thus the real question concerning the future is not whether but how to accelerate growth in fertilizer use and ensure its maximum effectiveness in crop production.

This paper discusses the above question by examining the past experience within a heuristic framework. The framework identifies all variables behind economic potential and farmers' profitability of fertilizer use. More importantly, it also incorporates interactions between processes which influence the pace and pattern of growth in actual fertilizer consumption through conversion of the potential into farmers' effective demand for fertilizers, timely delivery of fertilizers at geographically dispersed locations, and creation of adequate aggregate supply of fertilizers.

The single most important conclusion of the paper is as follows: Because of the constraints on lowering prices of fertilizers and also on raising support prices of crops, non-price policies will be more crucial than ever before in determining the pace of future growth in fertilizer consumption. This, however, is no ground for pessimism about acceleration in future growth of fertilizer consumption or defeatist attitude in evolving policies required for the purpose. Under the present price environment, there is a vast scope to accelerate growth in fertilizer consumption through non-price policies which improve efficiency of fertilizer use, shift response functions upwards, and remove deficiencies in agricultural research, extension, and credit as well as fertilizer supply and distribution systems.

Annual consumption of fertilizers has increased from less than 100,000 metric tons of nutrients in the early 1950s to about five million metric tons (mmts) by the late 1970s. During the Sixth Plan period, it further went up by about three mmts reaching 8.2 mmts in 1984/85 (Table 1). The Seventh Five Year Plan aims at raising the consumption to about 14 mmts by 1989/90. Thus fertilizer consumption must grow by 1.12 mmts every year between 1984/85 and 1989/90. This is nearly twice the average annual increment in actual consumption during the Sixth Plan period. Moreover, annual growth in consumption has exceeded 500,000 tons only six times and one mmts only once so far. This, then, is the magnitude of the task of increasing fertilizer consumption during the Seventh Plan[1].

The task of accelerating growth in fertilizer consumption extends beyond the Seventh Plan period. Virtually all further growth in crop production will have to come from continuous increases in yields as opposed to expansion of arable land. All proven yield-increasing technologies, whether for irrigated or unirrigated land, depend on high levels of fertilizer application. This is not surprising because the limits of growth in yields are eventually determined by soil fertility. In raising soil fertility, chemical fertilizers have become increasingly important as the experience world over suggests. Even China, with its exemplary performance in mobilizing organic sources of nutrients, is no exception[2]. Incidentally, fertilizer consumption in China had crossed 18 mmts in 1983/84 even though in the early 1950s it was no more than in India namely, less than 100,000 tons. The wide-

spread deficiency of nitrogen in Indian soils is well-known. The availability of phosphorus and potash is also low and there is growing evidence of deficiencies in sulphur and micro-nutrients at growing number of locations[3]. Obviously yield-based growth in agricultural production cannot be sustained without removing these constraints[4]. Thus the real question concerning the future is not whether but how to accelerate growth in fertilizer use and ensure its maximum effectiveness in crop production.

To discuss the above question meaningfully, it is necessary to identify the factors behind past growth in fertilizer consumption, critically assess their strength and weaknesses, and then arrive at the required modifications in policies to accelerate growth in fertilizer consumption.

One approach repeatedly used for this purpose has been to estimate a relationship in which fertilizer consumption is considered a function of such agro-economic variables as weather conditions, irrigation, area sown to fertilizer responsive varieties, cropping pattern, and relative prices of crops to fertilizers, that is, the variables which determine farmers' returns on and hence their demand for fertilizers. The estimated coefficients of different explanatory variables are then used to draw policy conclusions.

Quite apart from the instability of statistical results obtained in such exercises, the above approach seems inappropriate because of three main reasons. First, it views growth in fertilizer consumption as a sole outcome of growth in farmers' demand

for fertilizers. This implies that fertilizer supply and distribution systems exert no influence of their own on growth in fertilizer consumption except through fertilizer prices, and that these systems respond instantaneously to changes in farmers' demand for fertilizers. Such an assumption is clearly unrealistic. Moreover, with such an assumption one bypasses the consideration of policies required to remove deficiencies in fertilizer supply and distribution systems which constrain the pace of growth in fertilizer consumption. This would be most unfortunate as argued later. Second, important as variables which determine farmers' returns on fertilizer use are, it seems absurd to say that continuous changes in them are necessary to sustain growth in fertilizer demand under all circumstances. Both a priori reasoning and empirical evidence clearly suggest that such an interpretation of growth in fertilizer demand is mechanistic. Third, the approach outlined in the previous paragraph could lead to imprudent -- if not altogether unrealistic -- price policy prescriptions since growth in fertilizer consumption is specified as a function of the relative prices of fertilizers to crops besides variables behind fertilizer response functions like irrigation, area under HYVs etc[5].

Viewed thus, to discuss policies required for acceleration in fertilizer use, one needs an approach which incorporates all essential elements and relationships which determine growth in fertilizer consumption. This is what is attempted in the rest of the paper. The next section presents a heuristic framework to

understand forces behind growth in fertilizer consumption[6]. Its usefulness is demonstrated in the subsequent section by focussing on the past growth in India's fertilizer consumption. Policy requirements for future growth in consumption emerging from such an analysis are presented in the final section.

A Heuristic Framework

The agronomic potential of fertilizer use in a country is determined by factors like soil quality, climatic environment, cropping pattern, genetic characteristics of crops, and use of inputs other than fertilizers. Together, these factors determine physical responses of crops to fertilizer use, and thus the maximum amount of fertilizer which could be used to increase agricultural production. The economic potential of fertilizer use is determined by both the above factors behind fertilizer response functions and prices of crops as well as fertilizers. These determinants of economic potential we shall call agro-economic variables. Each set of these variables determines the maximum amount of fertilizer which could be used most profitably. The economic potential is less than agronomic potential because fertilizer is not a free input. It may be added that the term "potential" as defined above clearly implies that it is not a fixed quantity.

Actual fertilizer use is an outcome of both the conversion of the economic potential into farmers' effective demand for fertilizers and fulfilment of this demand by fertilizer supply and distribution systems. Besides agro-economic variables,

three processes and their interactions influence the level of actual fertilizer use. These processes are (i) the conversion of the economic potential into farmers' effective demand for fertilizers, (ii) timely delivery of fertilizers to farmers at geographically dispersed locations, and (iii) the creation of adequate aggregate supply of fertilizers through domestic production and imports.

Empirical evidence consistently indicates that in virtually all countries (including India as shown later) fertilizer use has begun with a few farmers using it on selected crops at limited locations. There was less than complete diffusion of fertilizer use on land where it was potentially profitable, and rates of application on fertilized land were sub-optimal. This implies that when the use began there was a vast untapped economic potential of use under the prevailing response functions and prices. Actual fertilizer consumption then grew over time as a result of the spread of use on unfertilized land and increase in rates of application on fertilized land.

The evidence also shows that the pace and pattern of growth in fertilizer use were influenced more decisively by the developments of the agricultural research, extension, credit, and fertilizer distribution plus supply systems than by marginal changes in prices of either crops or fertilizers. This is not surprising because farmers, though rational, are not omniscient. They need location-specific information on the responses of crops to fertilizer use to judge which of the crops

could be profitably fertilized and to work out details of fertilizer practices. Agricultural research system which generates such information and the extension system which delivers it to farmers influence these decisions of farmers. Similarly, sufficient credit is often necessary to convert farmers' perceptions of profitability on fertilizer use into their effective demand for fertilizers. But even this is not enough. Actual use of fertilizers would still depend on whether adequate fertilizers are available at the right place and time. This depends on the level of development and efficiency in the workings of fertilizer distribution, production, and import systems.

Development of the above systems have influenced growth in fertilizer consumption not only by tapping the unexploited potential but also by raising the profitability and economic potential of fertilizer use. Agricultural research and extension systems have been behind upward shifts in response functions by developing and spreading new technologies in crop production and educating farmers in efficient use of fertilizers. Reductions in farmers' fertilizer cost have resulted from technological breakthroughs and operational efficiencies in supply and distribution systems coupled with higher prices of crops resulting from expansion in demand due to rapid economic growth. Propping up prices of crops or lowering fertilizer prices through subsidies are not effective substitutes. Instead such measures have usually distracted attention of the policy makers from the more demanding tasks of developing the systems which generate

sustained growth in fertilizer consumption.

The above framework is especially relevant for developing countries like India for three reasons. First, aggregate fertilizer consumption in most of them is below the potential as determined by prevailing response functions — price environment. Second, systems which influence growth in fertilizer use are inadequately developed and inefficient. And third, interactions between these systems are usually not governed by the price mechanism. Hence, policy interventions for the real tasks of adequately developing them have to be varied and based on correct understanding of what governs the development and workings of these systems.

The policy requirements of accelerated growth in fertilizer consumption cannot be correctly identified without interpreting the past growth in fertilizer consumption in the framework outlined.

The Indian Experience

Fertilizer use began in India on tea plantations in the 1920s. It spread 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. Efforts to promote fertilizer use in the non-plantation sector to raise food production rapidly gathered momentum after India became independent in 1947. The major aims were: (1) To create farmers' demand by generating and spreading the knowledge about

responses of crops to fertilizer use through thousands of trials on farmers' fields. (2) To improve the response function environment through development of irrigation and spread of high yielding varieties. The latter began in the mid 1960s. (3) To develop a fertilizer distribution system linked with agricultural credit system. (4) To enlarge fertilizer supplies by developing domestic fertilizer industry and imports. (5) To control fertilizer prices.

The major features of the fertilizer price policy were uniform prices throughout the country, virtual absence of subsidies until the mid-1970s, and the growing fiscal burden of these subsidies in recent years (Table 2 and 3). Incidentally, the real price of fertilizer (that is price of fertilizer relative to prices of crops) in India has been generally higher than in many countries during the last three and a half decades. It may also be noted that the substantial increase in fertilizer subsidies between 1977/78 and 1984/85 has not lowered the "real" price of fertilizer paid by farmers over time (Table 4). The increased burden of fertilizer subsidies has been mainly due to vast growth in fertilizer consumption.

Because of the above efforts and the vast untapped potential which further increased due to growth in irrigated areas and spread of HYVs, fertilizer use in India grew from 0.5 kilograms of nutrients per hectare in the late 1940s to 46 kilograms in 1984/85. India now ranks fourth in total fertilizer consumption after the USA, the USSR, and China.

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. All rank much lower on a per hectare basis. India's record in raising its fertilizer consumption to about 46 kilograms per hectare by 1984/85 is impressive compared with the time taken by many developing and developed countries to make similar increases. On the other hand, it is much less impressive than that of China. It is important to note that farmers' real price of fertilizer has been higher in China than in India throughout the last three and a half decades.

Despite such impressive growth, total fertilizer consumption has been below the potential indicated by the response functions-price environment[7]. That there was sufficient scope for faster growth is indicated by less than complete diffusion of fertilizer use on all crops, even on irrigated areas, until at least the mid-1970s[8]. Similarly, fertilizer use under unirrigated conditions, even on traditional varieties grew slowly but steadily. The reason why past growth in fertilizer use was not faster lies in the various deficiencies in fertilizer promotion, distribution, and supply systems. These include inadequate efforts to convert the potential into farmers' demand for fertilizers through meaningful extension activities, slow expansion of and various inefficiencies in the fertilizer distribution system, repeated shortfalls in planned domestic fertilizer production, and wide annual fluctuations in fertilizer imports.

Fertilizer diffusion has been most rapid on crops and varieties which respond to fertilizer use dramatically, even though they did not have the best price environment. Concentration of fertilizer use on irrigated areas and HYVs also indicates the strong influence of fertilizer response functions on growth of fertilizer use. Growth in fertilizer use on oilseeds and pulses has been slower than on rice and wheat despite better price environment for the former. Also diffusion of fertilizer use has been faster in irrigated areas than on the same crops in unirrigated areas, further confirming that variables behind fertilizer response functions have been more important than prices.

Although fertilizer use was more profitable on irrigated areas, it was not confined to them. More important, fertilizer use on unirrigated areas under virtually all crops grew steadily even when there was scope for further diffusion on irrigated areas. For instance, by 1976/77 use had spread to about 18 percent of total unirrigated areas, even though about one-third of the irrigated areas was still not fertilized. The explanation for this is that the systems influencing growth in fertilizer consumption in certain regions with low irrigation were relatively better developed than in those with high levels of irrigation. The experience of Gujarat State clearly reveals this.

With less than 20 percent of its area irrigated and relatively poor rainfall, Gujarat in 1981/82 had the highest level

of fertilizer consumption per hectare among all states and union territories in which up to 40 percent of arable land was irrigated. Fertilizer use on unirrigated areas accounted for more than half of total fertilizer consumption in the state in the mid-1970s. This was double the share of unirrigated areas for the country as a whole. Relatively faster growth on unirrigated areas of Gujarat was mainly due to certain strengths of the fertilizer distribution system and to pressure from the supply side, especially from the fertilizer factories in the State[9].

Wide variation in the rates of growth in fertilizer consumption among different districts within states has been commonly attributed to the inter-district variations in irrigation, cropping pattern, and spread of HYVs. In addition, differences among districts in the development of fertilizer distribution system and supply of agricultural credit have also been responsible. Recognition of this is obviously useful in evolving policies to broaden the geographical base of growth in fertilizer use.

Both fertilizer diffusion and rates have reached fairly high levels in regions which have accounted for bulk of the past growth in fertilizer use. Thus, for instance, districts accounting for about one-fifth of the country's 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 had reached more

than 50 kgs. per hectare by the late 1970s. In one-fourth of these districts, they had exceeded 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 must have reached considerably higher levels. This being so, continued dependence of the government machinery and fertilizer industry on these regions for further growth in fertilizer consumption has started to generate pressure for higher prices of crops and lower prices of fertilizers because of diminishing marginal production from additional fertilizer use as the experience of the last few years indicates. Such pressures could be effectively countered only if promotion and distribution systems are developed in other regions and fertilizer response functions are shifted upwards through training of farmers in details of agronomic practices in regions where fertilizer use is concentrated.

Policy Requirements for Accelerated Growth in Consumption

Policies to accelerate growth in fertilizer consumption should be based on a strategy which aims at both rapidly converting the untapped potential into actual use and continuously raising the economic potential of fertilizer use through upwards shifts in response functions.

Most of the unexploited potential is on more than 70 per cent of unirrigated land[10]. This land accounts for more than 80 percent of the production of jowar, bajra, pulses, and oil-

seeds, about 67 percent of cotton production, and 30 to 40 per cent of the production of rice and wheat. Therefore, raising productivity of unirrigated areas is crucial to sustain yield-based growth in agricultural production. Among the constraints on efforts to raise productivity of unirrigated areas, low soil fertility is as severe as any other. Unless concerted efforts are made to raise soil fertility through judicious use of fertilizers, farmers would have little incentive to invest in other dryland technologies.

Since agro-climatic environments of unirrigated areas differ, location specific knowledge on fertilizer response functions, fertilizer practices and other agro-economic matters need to be generated through strengthened, decentralized research. Improved coordination between agricultural research and extension systems also is needed so that research information can be effectively spread among farmers. This cannot be overemphasized because additional production due to fertilizer use depends on such things as timing and method of 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.

The above 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 (a price policy measure) may not suffice to accelerate expansion of fertilizer distribution system in rainfed areas especially if vigorous efforts to promote fertilizer use are absent and fertilizer turnover remains low.

Neither promotional efforts nor expansion of distribution system in unirrigated regions would sustain growth unless the aggregate fertilizer supply stays ahead of growth in market for fertilizers in current and newly irrigated areas. Even during the Seventh Plan period, this would depend on fertilizer import policy. More often than not, this policy has been governed by short-term considerations of clearing inventories and savings in foreign exchange. This needs to be replaced by an understanding of the role of the supply side in converting the untapped potential into actual fertilizer use. The experience of Gujarat state clearly demonstrates how sustained pressure from the supply side opens up fertilizer markets in rainfed regions. A policy of "liberal" imports of fertilizers will most likely be resented by the domestic fertilizer industry. It may also lead to an increase in inventories in the short-run. But this calls for developing effective mechanisms to resolve conflicts of interest between different segments of the fertilizer system rather than rejecting a policy which would accelerate

diffusion of fertilizer on unirrigated areas and thus raise production of commodities like oilseeds and pulses which are in short supply.

Raising rates of application on fertilized land to optimum levels is another way to generate growth in consumption. Efforts to tap this unexploited potential should concentrate on educating farmers in efficient fertilizer practices such as balanced use of nutrients, correct timing and placement of fertilizers, and wherever necessary, use of micro-nutrients and soil amendments. There is ample evidence of deficiencies in these practices, even in states and districts with high levels of fertilizer use. Adoption of correct practices would increase the efficiency of fertilizer use and thus raise returns on it. Clearly, this is a superior alternative to using price policy to raise rates of fertilizer application.

The economic potential of fertilizer use must be increased if sizeable growth in fertilizer consumption is to be sustained. Diffusion of fertilizer and currently available high yielding varieties on presently irrigated land seems virtually complete. Rates of application are also fairly high at many locations. While there is scope to raise them further, efforts to do so should be accompanied by improvements in fertilizer and other agronomic practices and better water management. Without such efforts, the strategy to increase fertilizer use on land which is already fertilized at fairly high rates would aggravate the pressure for lower fertilizer prices and higher support prices of crops.

To increase the economic potential of fertilizer use, accelerated development of irrigation potential and its fuller utilization are a must. In addition, the agricultural research system needs to be strengthened to improve the response functions on both irrigated and unirrigated areas. The importance of these policies is well recognized and needs no elaboration. In order to exploit the economic potential of these policies, however, deficiencies in agricultural extension (especially with respect to its interface with the research system) and credit as well as in fertilizer supply and distribution systems must be removed. Thus, in discussing policies it is necessary to distinguish between policies which aim at increasing the potential (through say growth in irrigation and research on varieties) and those which aim at rapidly converting it into actual fertilizer use through removing deficiencies in extension, credit, distribution and supply system. Past experience indicates that inadequate appreciation of the complementarity of these sets of policies eventually results into long time lags in full exploitation of the potential.

The discussion thus far has focused on non-price policies for three reasons. First, past growth in fertilizer consumption was determined more by the non-price factors and processes than by changes in prices of either crops or fertilizers. Second, rapid growth in consumption crucially depends on further development of these systems and on continuing technological change which raises the fertilizer potential. Third, India does not

seem to have much scope to continuously lower prices of fertilizers relative to those of crops, at least in the short run.

Since 1943 when it launched the efforts to increase fertilizer use on food crops, the government has statutorily controlled prices of most fertilizers at factory, port, and farm-gate levels[11]. Besides keeping them at reasonable levels, two features of the policy have been equalization of the cost of domestic and imported fertilizers, and pooling transportation cost and fixing distribution margins so that farm-gate prices were uniform over the country. Until the early 1970s, there was no major budgetary subsidy on fertilizers (Tables 2 and 3). In fact, there was surplus in all but a few years. Incidentally, this distinguished India from many other developing countries.

The situation has changed since 1973/74 and fertilizer subsidies in the budget of the central government have crossed Rs.2,000 crores (Table 3). Initially, subsidies were necessitated by the hike in the cost of imported fertilizers. After 1975/76, however, both imported and domestic fertilizers were subsidised. The latter accounted for 78 percent of total fertilizer subsidies in 1985/86. The mounting burden of subsidies on domestic fertilizers has been due to introduction of fertilizer retention price scheme from 1977, high investment cost of new fertilizer factories, escalation in the prices of fuel and feedstocks, increased cost of fertilizer distribution, and nearly four-fold growth in fertilizer production.

The retention price scheme originated in the enhanced cost of fertilizer production after the oil crisis of the early 1970s and the strategy to meet fertilizer requirements through growth of domestic fertilizer industry. The scheme assures a manufacturer 12 percent post-tax returns on net worth provided certain norms are achieved. The average cost of supplying domestic fertilizers has been higher than prices fixed for farmers. In recent years, it has also been higher than the cost of imported fertilizers. Unless the cost of domestic production falls or prices charged to farmers are raised, the targeted growth in fertilizer consumption will cause fertilizer subsidies to rise to Rs.7,000 crores by 1990[12]. There is scope to lower cost of production through (a) raising the capacity utilization and efficiency of many fertilizer plants, (b) by rationalization in the pricing and fiscal policies for fertilizer raw materials, feedstocks and equipments, and (c) through better planning, speedier implementation and sound economic analysis in taking up new projects[13]. On the other hand, even with concerted efforts in all these directions, the average cost of fertilizers supplied by the domestic industry may rise over time because the investment costs of newer plants are higher.

Discussion of the merits of meeting fertilizer requirements from expansion in domestic fertilizer industry is beyond the scope of this paper. The issue is complex, involving the technological capability and experience gained in fertilizer production,[14] the place of fertilizer industry in the economic deve-

lopment strategy, and foreign exchange requirements of large-scale imports every year. At present, India ranks either first or second to China in net imports of fertilizer among all countries. Thus, India's presence in the world fertilizer market influences the price. One thing, however, seems clear: Given the strategy of fertilizer supply, the growing burden of fertilizer subsidies on the budgetary resources clearly suggests that there is hardly any scope to lower the prices of fertilizers charged to farmers, at least in the short run. This is also clear from the Long Term Fiscal Policy Paper of the Government of India.

In the past, the price policy for crops has played a key role in accelerating the spread of HYVs and thus increasing farmers' demand for fertilizers. In the absence of public procurement operations, large marketable surplus might have lowered the prices and slowed down diffusion of HYVs with consequent adverse impact on growth in demand for fertilizers. But this kind of impact of agricultural price policy on demand for fertilizer seems to be over. Currently available HYVs are widely diffused and rates of fertilizer application on them have reached fairly high levels. Another constraint on the policy of supporting prices of crops at higher and higher levels is the relatively slow growth in effective demand for foodgrains. This has resulted in larger procurement and stock holding by the government and growing burden of food subsidies. Removal of demand constraints depends on rapid growth in employment,

and this calls for containing upward pressures on agricultural prices.

Because of these constraints on lowering real prices of fertilizers, non-price policies will be more crucial than ever before in determining the pace of future growth in India's fertilizer consumption. This, however, is no ground for pessimism about acceleration in future growth of fertilizer consumption or defeatist attitude in evolving policies required for this purpose as the above analysis shows. It is also demonstrated by the experience of the Sixth Plan period.

Between 1979/80 and 1984/85, fertilizer consumption increased by nearly 3 million metric tons. This amounts to an average annual increment of about 600,000 tons which is 32 percent larger than in the Fifth Plan period[15]. Notwithstanding the increased burden of fertilizer subsidies, this acceleration in growth of consumption cannot be attributed to the relative prices of fertilizers to crops becoming more favourable to farmers than what they were in the late 1970s. In fact, the Sixth Plan began with about 40 percent increase in fertilizer prices. They were further increased by about 15 percent in 1981/82. The reduction of about 10 percent in 1983/84 should be viewed in this context. While the prices of crops also went up, the increase was not commensurate with the upward revisions in fertilizer prices, at least for the major fertilizer consuming crops. Consequently farmers needed more units of crops to buy a unit of fertilizer than in the years immediately preceding the Sixth Plan period (Table 4).

This is not to argue that prices of fertilizers and crops do not matter in growth of fertilizer consumption. That would be preposterous. What is stressed is that if fertilizer use is significantly profitable under a given price environment (as it indeed was in the late 1970s), it need not become more profitable for growth in consumption to continue. In fact, the growth could continue even if there are some unfavourable changes in the price environment (as demonstrated by the Sixth Plan experience) provided other factors facilitating growth in consumption are operating.

What other factors were operating during the Sixth Plan period? Between 1979/80 and 1984/85, gross irrigated area most likely increased by 6 to 7 million hectares and area sown to HYVs by 16 to 17 million hectares. Together these might have contributed about half of the growth in fertilizer consumption between 1979/80 and 1984/85 through increased rates of application due to upward shifts in response functions[16]. Thus the remaining growth in fertilizer consumption must be due to (a) increments in rates of application on land already fertilized by 1979/80, and (b) spread of fertilizer use on land not fertilized by 1979/80. That there was ample scope for these is obvious from the evidence on past growth discussed in the previous section. What is noteworthy is that these processes operated in a period during which price environment did not become more favourable to farmers than what it was in the late 1970s.

Identification of all factors behind the above processes requires considerably more information than what is readily available. But an interpretation of the available information within the framework of this paper suggests that the following must have played a major role: (1) Pressure from the supply side on fertilizer industry and distribution system to push fertilizer consumption. The pressure resulted from substantial growth in domestic production and enhanced imports in 1979/80, 1980/81, 1981/82 and again in 1984/85. That such pressure did exist was evident from repeated complaints by the industry about "excess" supply. (2) Improvements in fertilizer distribution system especially with respect to growth in number of sale points, delivery of fertilizers at locations without rail-heads, and upward revision of outdated distribution margins. (3) Substantial increase in institutional credit supplied to farmers. (4) Improvements in agricultural extension system prompted by the spread of T & V system. And (5) More than seven-fold increase in the supply of quality seeds.

It is not our contention that all was well with the above factors and policies behind them. That would be an exaggeration in the face of vast differences in the levels of fertilizer use among states and districts, various inefficiencies in farmers' fertilizer practices, and many deficiencies which still persist in the systems which affect growth in fertilizer consumption. But one cannot deny that factors listed above contributed significantly to growth in fertilizer consumption

during the Sixth Plan period. The absence of favourable changes in the relative prices of fertilizers to crops over what they were in the late 1970s underscores the role these non-price factors and policies could play in sustaining rapid growth in fertilizer consumption.

Thus, to conclude, the task ahead is to further evolve and strengthen the non-price policies which affect the pace of growth in fertilizer consumption. Inasmuch as relative prices of fertilizers and crops are still reasonable, and there is a vast scope to improve efficiency of fertilizer use, shift response functions upwards, and remove deficiencies in fertilizer supply and distribution systems, the task is clearly feasible. Its urgency is obvious from the magnitude of acceleration in growth of fertilizer consumption required to raise agricultural production to desired levels and the mounting budgetary burden of of food and fertilizer subsidies[17].

Table 1: Fertilizer Consumption in India, 1951/52 to 1984/85

Year	Consumption[a] (000 Tons)				Consumption[b] per Ha.(Kgs)
	N	P_2O_5	K_2O	Total	
1951/52	59	7	8	74	0.6
1956/57	123	16	15	154	1.0
1961/62	250	61	28	339	2.2
1966/67	738	249	114	1,101	7.0
1973/74	1,830	650	360	2,839	16.7
1974/75	1,766	472	336	2,573	15.7
1975/76	2,149	467	278	2,894	16.9
1976/77	2,457	635	319	3,411	20.4
1977/78	2,913	867	506	4,286	24.9
1978/79	3,420	1,106	592	5,117	29.3
1979/80	3,498	1,151	606	5,255	31.0
1980/81	3,678	1,214	624	5,516	31.8
1981/82	4,069	1,322	676	6,067	34.3
1982/83	4,224	1,436	727	6,387	36.2[c]
1983/84	5,204	1,730	775	7,710	43.6[c]
1984/85	5,486	1,886	839	8,211	46.4[c]

a Distribution taken as consumption for 1951/52 and 1956/57

b Based on gross cropped area

c Based on gross cropped area in 1981/82

Source: Fertiliser Statistics, 1984-85, Fertiliser Association of India, New Delhi, 1985.

Table 2 : Profits and Losses under the Scheme for the "Purchase of Chemical Fertilizers," 1944/45 - 1963/64

Year	Net Profit or Loss
	Rupees
1944/45	671,583
1945/46	2,564,061
1946/47	-440,316
1947/48	1,429,857
1948/49	142,639
1949/50	1,963,799
1950/51	1,143,466
1951/52	444,627
1952/53	340,158
1953/54	6,870,760
1954/55	-4,547,472
1955/56	875,985
1956/57	2,258,216
1957/58	15,478,413
1958/59	35,050,140
1959/60	63,707,000
1960/61	74,481,063
1961/62	94,719,930
1962/63	85,006,580
1963/64	51,433,663
Total (1951/52 - 1963/64)	426,119,053

Source: Report of the Committee on Fertilisers, Government of India, New Delhi, 1965, p.184.

Table 3: Fertilizer Subsidies in the Budgets of the Central Government

Year	Imported fertilizers	Domestic fertilizers	Total
		Rs. in crores	
1971/72	-20	-	-20
1972/73	-18	-	-18
1973/74	33	-	33
1974/75	371	-	371
1975/76	242	-	242
1976/77	52	60	112
1977/78	159	107	266
1978/79	169	173	342
1979/80	282	321	603
1980/81	335	170	505
1981/82	100	275	375
1982/83	55	550	605
1983/84	142	900	1,042
1984/85	632	1,200	1,832
1985/86 RE	450	1,600	2,050
1986/87 BE	250	1,700	1,950

RE = Revised, BE = Budget estimates.

Sources: Compiled from Report of the Committee on Controls and Subsidies, May 1979, and budget documents.

Table 4 : Relative Prices of Fertilizers to Crops, 1977/78 to 1984/85

Year	Ratio of Urea based Nitrogen Price to Min. Support Price of								Ratio of I. Nos. of Fertilizer price to Wholesale Price of	
	Paddy[a]	Wheat	Coarse Grains	Gram	Ground-nut(Shell)	Sugar-cane	Seed Cotton	Jute	Food	Nonfood
1977/78	4.38	3.00	4.55	3.55	2.11	39.65	1.32	2.39	1.02	0.99
1978/79	3.96	2.93	3.96	2.70	1.93	33.70	1.32	2.25	1.02	1.03
1979/80	3.32	2.69	3.32	2.25	1.66	25.20	1.15	2.03	0.89	0.86
1980/81	4.14	3.35	4.14	3.00	2.11	33.46	1.43	2.72	1.20	1.11
1981/82	4.44	3.65	4.41	b	1.89	39.31	b	2.92	1.17	1.14
1982/83	4.19	3.38	4.33	b	1.73	39.31	1.34	2.92	1.11	1.13
1983/84	3.53	3.07	3.77	1.99	1.48	34.59	1.17	2.52	0.95	0.95
1984/85	3.41	2.97	3.59	1.95	1.37	33.36	1.14	2.39	NA	NA

a Coarse variety of paddy

b Minimum price not announced

Source: Developed from information available in Indian Agriculture in Brief (20th Edition), Economic Survey, 1984/85, and Fertiliser Statistics, 1984/85.

Notes

1 The magnitude of the task is highlighted in absolute rather than in percentage terms because of vast changes in the base level in recent years. There is yet another advantage of using absolute terms. Growth in total consumption results from two forces: (i) fertilizer use spreading to unfertilized land, and (ii) increments in rates of application on land which is already fertilized. What combinations of these two forces could raise fertilizer consumption to some target level can be readily surmised when required growth is specified in absolute terms. This, in turn, is helpful to infer the implied dimensions of many tasks in such systems as agricultural research, extension, credit, and fertilizer distribution and supply.

2 See Tang and Stone (1980, P.47).

3 See Randhawa and Tandon (February 1982).

4 This is no less applicable to unirrigated than to irrigated land. See Tandon (June 1981); Tomar, Gupta, and Khanna (April 1983), and Desai (August 1983).

5 For a discussion of the "specification error" in this type of models, see Desai (1982, Chapter 6 and Appendix).

6 For elaboration, see Desai (Forthcoming).

7 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 metric tons of nitrogen (Panse, 1964). Actual nitrogen consumption in the early 1960s was about 300,000 tons. It crossed 3.57 million tons in only 1980/81. Clearly, by then the potential must have gone up substantially because of vast growth in irrigated area and widespread diffusion of high yielding varieties. That the level of fertilizer use is still below the potential is suggested by findings of all India Coordinated Agronomic Project on crop responses to fertilizers in different soil and agro-climatic regions and fertilizer consumption statistics by districts and states. See Pillai et al. (1985), and Fertiliser Association of India (1985).

8 See Desai (1982) for these and such other findings as well as elaboration of the arguments in this and next two paragraphs.

9 For details, see Government of Gujarat (1983).

10 The problem of raising fertilizer consumption under unirrigated conditions should not be viewed as occurring only with low rainfall. During the 1960s, districts with low irrigation located in high rainfall regions, particularly in eastern India, performed the worst among all districts with little irrigation. See Desai and Singh (1973, Chapter 4). Scrutiny of fertilizer consumption trends by districts

during the 1970s and early 1980s also suggests a similar pattern. Available evidence also reveals that the districts in eastern India have in general the least developed fertilizer distribution and agricultural extension and credit systems. For the importance of market channels in growth of fertilizer use in rainfed agriculture, see Desai (October 1983).

11 For evolution of fertilizer price policy, its interrelationships with fertilizer supply and distribution policies, and circumstances leading to rapidly growing burden of fertilizer subsidies in recent years, see Desai (March 1984).

12 See the articles in The Economic Times, January 3 and 4, 1984.

13 See Jain and Satya Nand (December 1980) and Venkitramanan (May 1983).

14 See Fertiliser Association of India (1980).

15 This shows that the trend of fertilizer consumption had not decelerated as some researchers contended in the early 1980s. It also belied the fears of those who maintained that the upward revisions of fertiliser prices during 1980/81 and 1981/82 would slow down growth in fertilizer consumption.

16 This estimate is based on the assumption that the 16 to 17 million hectares of additional area sown to HYVs included 6 to 7 million hectares of additional gross irrigated area and that rates of fertilizer application on these areas

increased, on an average, by 100 kilograms per hectare over what it was in 1979/80. The increment in rate of application due to additional areas under irrigation and HYVs could be significantly smaller than 100 kgs per hectare assumed here. (It seems unlikely to have been larger.) In this case the contribution of additional gross irrigated area and further spread of HYVs to 3 million metric tons of growth in fertilizer consumption between 1979/80 and 1984/85 would be lower.

17 The following observations of the Union Finance Minister are pertinent in this context:"Food and fertilizer subsidies have now reached Rs.3,700 crores and have increased by over 40 per cent per annum in the last three years. Even with buoyant tax revenues, this order of increase is simply not sustainable. At present rates of growth, these subsidies would have reached Rs.14,000 crores by the end of the Seventh Plan. At this rate, total subsidies would exceed Rs.41,000 crores for the Plan period. This is equal to the entire Central Plan for the first two years. To put it in another way, this amount would be sufficient to provide one deep tube-well and one primary school building in each village of the country. The issue is what balance to strike." (See, Speech of Shri Vishwanath Pratap Singh, Union Finance Minister, Presenting Central Government's Budget for 1986-87, Part A, Paragraph 17, February 1986).

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