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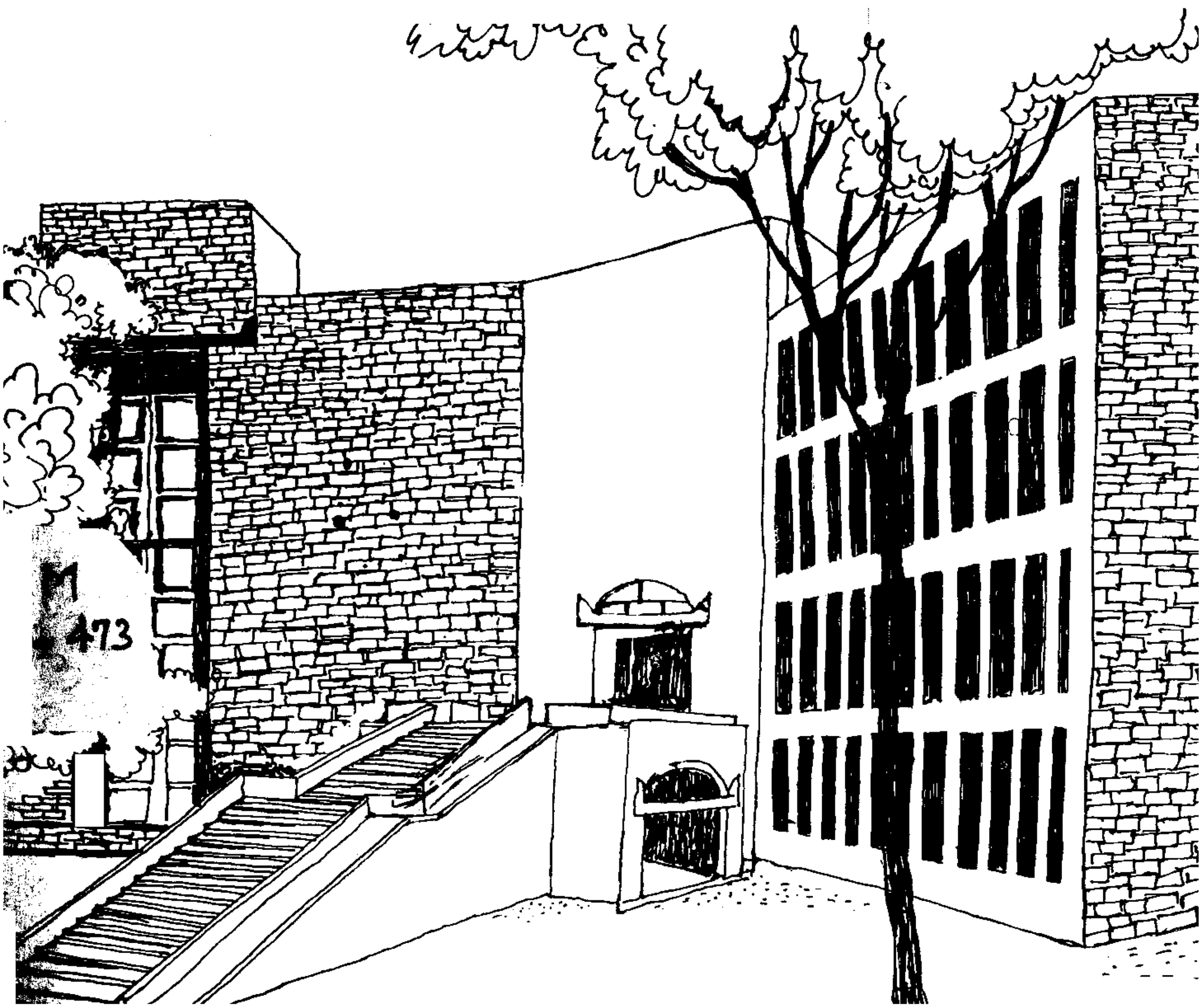

FERTILIZER USE ON INDIA'S UNIRRIGATED AREAS: A PERSPECTIVE BASED ON PAST RECORD AND FUTURE NEEDS

By

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FERTILIZER USE ON INDIA'S UNIRRIGATED AREAS: A PERSPECTIVE BASED ON PAST RECORD AND FUTURE NEEDS

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This paper elaborates four propositions: (1) There is a clear need for sustained rapid growth of fertilizer use in Indian agriculture. (2) This depends, now more than ever before, on accelerated growth in fertilizer use on unirrigated areas.[1] (3) There is already a potential to generate acceleration in fertilizer use on unirrigated areas, and this will increase with technological improvements. (4) Successful exploitation of this potential depends on decisive policies and coordinated efforts in three major directions: (a) generating growth in farmers' demand for fertilizer in unirrigated areas, (b) creating adequate and efficient fertilizer delivery systems in regions with low irrigation, and (c) keeping growth in aggregate supply of fertilizer ahead of growth in fertilizer demand under irrigated conditions.

One may feel somewhat puzzled about the relevance of the above propositions in the seminar on "Technology Options for Dryland Agriculture: Potential and Challenge". Fertilizer use, by itself, can hardly be considered a technology option in the Indian environment of the 1980s. But inasmuch as it is an essential component in most of the technological improvements in Indian agriculture, consideration of the above propositions could be a relevant backdrop to discuss the challenge behind technological options for dryland agriculture.

Paper for the seminar on "Technology Options for Dryland Agriculture: Potential and Challenge" held at ICRISAT, Patancheru, Andhra Pradesh, India from August 22 to 24, 1983.

Need for Sustained Rapid Growth in Fertilizer Use

By 1981/82 India's total fertilizer consumption rose to over 6 million tons of nutrients from less than 100,000 tons in the early 1950s (Table 1). Incidentally, it now ranks fourth after that of the U.S.A., the U.S.S.R., and China.[2]

The need for substantial further growth in India's fertilizer consumption is indicated by its relatively low consumption per hectare in comparison with the levels in countries with high crop yields.[3] More importantly, it is revealed by future requirements of agricultural production since most of these will have to come from continuous increases in yields. For instance, according to the National Commission on Agriculture (NCA), about four-fifth of the additional foodgrain production required by the year 2000 will depend on increased use of fertilizers.[4] This is stressed because it highlights a simple axiom: Limits of growth in yields, whether on irrigated or on unirrigated areas, with or without varietal improvements, are finally determined by soil fertility. Perhaps no one has emphasised this axiom more tellingly than John Augustus Voelcker did nearly a hundred years ago:

> Improvement in the system of land tenure, improvement of the land by expenditure of public and private capital on it, and similar measures, may alleviate the condition of the Indian cultivator, but they will not give him larger crops, and they will not provide the food that the people must have to live upon. For this the soil itself must be looked to, as it alone can produce the crops, and manure alone can enable it to bring forth the necessary increment. The question of manure supply is, accordingly, indissolubly bound up with the well-being and even the bare existence of the people of India.[5]

Widespread deficiency of nitrogen in Indian soils is well-known. Low availability of phosphorus and potash is no more rare, and evidence on deficiency of micro-nutrients at growing number of locations is accumulating.[6] Obviously, yield-based growth in agricultural production cannot be sustained without removing these constraints.

Chemical fertilizers are only one of the sources of plant nutrients but they have become increasingly important in supplying growing quantities of plant nutrients as revealed by the experiences in India and elsewhere. Even China, with its examplary performance in mobilising other sources of plant nutrients, has not been an exception.[7]

Estimates of required fertilizer use by the year 2000 vary between 14 to 16 million tons (NCA's estimate) and about 19 million tons (UNIDO's estimate).[8] To achieve such levels, total consumption will have to grow at 5 to 7 percent every year. These rates are not inordinately high against the past record. On the other hand, to reach the required level of fertilizer use by 2000 A.D., total consumption must go up by 450 to 750 thousand tons every year during the 1980s and 1990s. Only four times in the last three decades annual increment in fertilizer consumption exceeded 500,000 tons (Table 1). More significantly, after 1978/79 fertilizer consumption has increased on an average by only 317,000 tons per year. In fact, the average annual increment during the last four years could well be less than 300,000 tons if 1982/83 is also considered since there was hardly any growth in fertilizer consumption during the *kharif* of 1982/83. Viewed thus, it is pertinent to ask how to increase India's fertilizer consumption by 500,000 tons or more every year during the next two decades.

Why Acceleration of Fertilizer Use on Unirrigated Areas?

The importance of acceleration in fertilizer use on unirrigated areas for achieving growth of the above magnitude emerges from a study I completed recently.[9] An attempt was made in this study to understand major forces behind growth in fertilizer consumption by examining changes in the composition of total fertilizer use. Fertilizer consumption profiles by crops were developed using the findings of nationwide surveys conducted by the National Sample Survey Organisation and the National Council of Applied Economic Research between the early 1950s and the mid-1970s. Wherever possible, separate profiles were also developed for irrigated and unirrigated areas, and areas sown with traditional vis-a-vis improved and high-yielding varieties.

The study confirms what many micro studies have repeatedly revealed, namely the dominant influence of certain crops, irrigated areas and fertilizer responsive varieties on the pace and pattern of growth in fertilizer consumption in the last three decades (Table 2,3,4). But it also reveals two other things which have a bearing on the theme of the present paper. First, one cannot any more rely only on the presently irrigated areas to generate the required annual growth in fertilizer consumption. Second, there is sizable scope to accelerate fertilizer use on unirrigated areas but this will require concerted efforts in certain directions.

Various findings of the above study, taken together with additional consumption of 2.6 million tons in the five years after 1976/77 and also districtwise consumption pattern during these years, suggest that fertilizer use has spread to 85 to 90 percent of the total irrigated area by 1981/82. A substantial proportion of the unfertilized irrigated area are likely to be affected by water-logging and related problems. Thus there is much less scope for additional growth in fertilizer consumption through further <u>diffusion</u> on <u>presently</u> irrigated areas. The average rate on fertilized irrigated areas could also have reached 90 to 100 kilograms per hectare. Consequently, further growth in consumption on irrigated areas through continuous increases in rates may not be as rapid in the short run as in the past. This is especially so because most of the irrigated areas with good water control are already sown with the high-yielding varieties.

One could argue that the rates of application on all irrigated areas are not optimum. But they would not easily go up because of diminishing marginal returns. In fact, attempts to raise these rates only enhance pressures for higher crop prices and fertilizer subsidies as our own experience suggests. What is more, until further upward shifts in the fertilizer response functions on irrigated areas, pressures for such price incentives could become recurring. Since additional production from raising rates on already fertilized areas would not be large due to diminishing marginal physical productivity, higher crop prices or fertilizer subsidies do not make much sense. They contribute more to inflationary pressures than to relieve supply constraints on agricultural output.

Thus for further rapid growth in fertilizer consumption neither we can count on diffusion on already irrigated areas nor would it be prudent to rely excessively on continuous rapid rise in the rates on irrigated areas through price incentives. What this means is that the past forces behind rapid strides in fertilizer consumption cannot reasonably be expected to operate with the same vigour until further technological breakthroughs.

The above argument is not against raising fertilizer use on irrigated land. In fact, one way out of the predicament is to accelerate the development of irrigation potential. But this may not suffice to generate the required growth of 500,000 tons or more every year. Assume irrigated areas increase every year by 2.5 to 3 million hectares, (i.e., by 50 to 75 percent more than the average annual increment in the 1970s). Also assume that they are fertilized without time-lag at 100 Kilograms per hectare. This would raise annual fertilizer consumption by only 250,000 to 300,000 tons. And this too would depend on the newly irrigated areas being unfertilized until they receive irrigation. Hence, there is an unprecedented need for acceleration in the growth of fertilizer use on unirrigated areas for sustained rapid growth in fertilizer use.

There are some other reasons also. More than 70 percent of India's gross cropped area is unirrigated, and about half of this will remain unirrigated even after developing the entire irrigation potential. More than 80 percent of the production of jowar, bajra, small millets, pulses and oilseeds plus two-thirds of the total cotton production come from unirrigated areas under these crops. Even in the case of rice and wheat, unirrigated areas account for 40 and 30 percent of the total production respectively.[10] To sustain yield-based growth in total agricultural production, raising productivity of unirrigated areas is thus crucial. Low soil fertility of these areas appears to be 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, there would be little incentive for private investment in these areas for technological change.

<u>Scope for Acceleration in Fertilizer Use on Unirrigated Areas</u>

While one may not question the <u>need</u>, one could still doubt if acceleration in fertilizer use under unirrigated conditions is possible. The doubt is natural because acceleration in the past growth of fertilizer use was largely governed by irrigated areas and rapid spread of high yielding varieties on them. I have argued below that it is feasible to accelerate fertilizer use on unirrigated areas with evidence on the existence of economic potential of fertilizer use, possibilities to raise it, and certain features of the past record of fertilizer use.

The evidence on potential emerges from economic evaluation of physical responses of crops to fertilizer use. Many researchers have examined the profitability of fertilizer use on unirrigated areas with data on physical responses generated by numerous trials on cultivators' fields and experiments on research stations. The overall impression one gets from these results is that fertilizer use under most unirrigated conditions has been, and continues to remain economically viable, although to a lesser extent than under irrigated conditions.[11] In fact, the main reason for the concentration of fertilizer use on irrigated areas lies in this and in rapid spread of high yielding varieties on them, and not in the lack of profitability in fertilizing unirrigated areas.

It is also possible to raise profitability (and hence, the economic potential) of fertilizer use on unirrigated areas. This has been demonstrated by researches on such technological improvements as varietal change, balance in and method and timing of fertilizer application, moisture conservation and various other agronomic practices.[12]

Certain features of the past pace and pattern of growth in fertilizer use also suggest the scope to accelerate growth of fertilizer use on unirrigated areas. Whereas all available evidence shows that fertilizer use has been more common and at higher rates on irrigated than on unirrigated areas, hardly any micro study shows that it was confined only to irrigated areas at any location during any time in the past three decades. Nor was it confined to only a few crops (Table 3). The scope for acceleration lies in very high proportions of unirrigated areas under virtually all crops being not fertilized until recently and an upward trend in the spread of fertilizer use on unirrigated areas (Table 5). It is worth noting that fertilizer use on unirrigated areas was <u>not</u> restricted to improved or high yielding varieties. At the same time, the impact of superior varieties on both diffusion and rates is clear.

That the upward trend in fertilizer use on unirrigated land <u>could</u> be accelerated is demonstrated by Gujarat's experience. In 1981/82, with less than 20 percent area irrigated, Gujarat had the highest level of fertilizer consumption per hectare among all states and territories with irrigation levels up to 40 percent. This was due to substantial growth in consumption under unirrigated conditions as indicated by Table 6 and findings of the NCAER surveys in the mid-1970s. It is further supported by talukawise fertilizer consumption and irrigation data, and impressive growth rates of yields of major crops grown essentially under unirrigated conditions.[13]

How to Accelerate Growth in Consumption on Unirrigated Areas?

The answer to this question depends on forces behind growth in fertilizer consumption. These forces are commonly identified by estimating fertilizer demand functions from either time-series or cross-section data. Such an approach would be incorrect to answer the above question for two reasons.

First, it would bypass the phenomenon of fertilizer use on unirrigated areas because growth in fertilizer use in most situations, except the rare ones like Gujarat, was governed by fertilizer use on irrigated areas. Thus the statistical results would emphasize that growth in fertilizer use cannot occur without increasing irrigated areas.[14] As the discussion in the previous sections shows, this is obviously incorrect since there is vast scope to generate growth in fertilizer use on unirrigated areas.

The second reason is more basic. Identifying forces behind growth in fertilizer consumption by estimating demand functions implies that the growth is driven only by farmers' demand for this input. Only under most restrictive assumptions would this be correct. Until actual fertilizer consumption is anywhere near the economic potential of its use, it is more correct to view growth in consumption in the following terms: Fertilizer consumption grows as economic potential of its use (which itself could be rising) gets converted into farmers' effective demand for fertilizers, and this being met by fertilizer supply and distribution systems. In this process, fertilizer response functions and prices (the agro-economic variables behind the economic potential) on the one hand, and perception of these variables by farmers, availability of fertilizers from domestic production and imports, arrangements to market them and supporting systems of agricultural research, extension and credit on the other hand are all important. The pace and pattern of growth in actual fertilizer consumption are determined by interactions among these essential elements and how they change over time.

In developing countries economic potential of fertilizer use is not fully tapped, fertilizer supply, distribution and supporting systems are not fully developed, and many interactions in the fertilizer system are not governed by market mechanisms. In such an environment, the above holistic approach to identify forces behind growth in fertilizer consumption is more appropriate than to view mechanically the data on actual fertilizer consumption only in terms of farmers' fertilizer demand. This is especially so because the analysis based on the holistic approach does not bypass the untapped economic potential, or the realities of actual consumption pattern or the workings of the supply, distribution and supporting systems. More significantly, it raises questions about the interplay (or lack of the interplay) between all major forces which govern the growth in fertilizer use.

When the question how to accelerate fertilizer consumption on unirrigated areas is asked using the above framework, certain conclusions emerge.

First, while there is untapped potential of fertilizer use on unirrigated areas, for the country as a whole, its <u>rapid conversion</u> into farmers' effective demand for fertilizer is lacking. This lacuna cannot be filled by crop or fertilizer price policy since what is missing is either the conviction about viable <u>physical</u> responses of crops to fertilizer use under unirrigated conditions or the knowledge about the details of fertilizer practices on which the viable responses depend. Diffusion of fertilizer use on unirrigated areas, therefore, cannot be speeded up by price policy instruments alone. Large scale sustained efforts are required to convince farmers about additional production from fertilizer use under unirrigated conditions. These efforts have to be meaningful because unirrigated areas are spread over low, medium and high rainfall regions.[15] Viable additional production from fertilizer use under such diverse conditions critically depends on location specific details of fertilizer application, sowing time, choice of variety and other agronomic practices. All this calls for strengthening of extension activities in unirrigated areas, continued emphasis on research for such areas, and an effective interface between agricultural extension and research. Another thing required to convert the potential into farmers' effective fertilizer demand is adequate and timely flow of agricultural credit to unirrigated areas.

Second, farmers' effective demand cannot result into actual fertilizer use on unirrigated areas until fertilizers in adequate quantities are made available at right time. Like fertilizer consumption, fertilizer distribution network is also concentrated in districts and talukas with high levels of irrigation. Furthermore, its working reveals clear preference for growth in the locations with high levels of irrigation. Deliberate policy interventions are required to correct this.

Third, it is necessary to recognise that the extent and vigour of the efforts in the above two directions will critically depend on the adequate supply of fertilizers. Unless the growth in total fertilizer supply (i.e., domestic production plus imports) stays ahead of growth in the market for fertilizers under irrigated conditions (i.e., in the presently irrigated areas plus new irrigated areas), there would be little motivation to accelerate the conversion of the untapped potential into farmers' fertilizer demand, or to expand distribution system in unirrigated areas. This is clearly revealed by the past experiences. In fact, Gujarat's success in rapid growth of fertilizer consumption under unirrigated conditions seems as much, if not more, due to pressure from the supply side as pull from the demand side. In practical terms, what this means is that hasty reductions of fertilizer imports, either because of unrealistic expectations about capacity utilisation in the domestic fertilizer industry or to clear inventories, must be stopped. Fertilizer import policy should be based not on short term notions of saving foreign exchange but on an understanding of the role of supply in opening up potential markets through pressures on fertilizer promotion and distribution systems. This is stressed. Until much of the potential on unirrigated areas is converted into actual fertilizer use on them, administrative mechanisms like allocations cannot effectively channelise part of the restricted fertilizer supply to unirrigated areas. This is so because of three reasons. First, geographically irrigated and unirrigated areas coexist at the state, district and even block levels. Second, there is much greater demand pull from the irrigated areas. Third, the workings of the distribution system show a distinct preference for the fertilizer markets in irrigated areas.

Efforts in the three above directions are neither easy or nor inexpensive. But then, what other less costly and feasible alternatives are there to generate sustained yield-based growth in overall agricultural output at more than three percent rate per year? It is useful to ask this question because unirrigated areas account for more than 70 percent of cropped land; they will continue to account for more than half of cultivated areas for many years to come; and most importantly, known technological options to raise their yields also depend on fertilizer use on them.

FOOTNOTES

1 The term "unirrigated areas" instead of "dryland" or "rainfed areas" is deliberately used. Not all unirrigated areas in India have low and uncertain rainfall. In fact, unirrigated net sown areas is about equitably distributed among high (normal rainfall 1,150 mm and above), medium (normal rainfall between 750 mm and 1,150 mm) and low (normal rainfall below 750 mm) rainfall regions. See India, Ministry of Agriculture, Indian Agriculture in Brief, 1980, New Delhi Pp.22-23.

2 Whereas India's fourth rank is largely due to its size, it may be worth noting that until the 1960s, it did not come among the top 15 countries with respect to total fertilizer consumption. Despite India's relatively low consumption per hectare, its record of raising consumption from less than one kg. in the early 1950s to 35 kgs. per hectare in 1981/82 is quite impressive compared to the time taken by many developing and developed countries to raise their per hectare consumption in this range. In fact, it appears more so considering India's vast size, great diversity and low level of economic development.

3 For illustrative data, see Fertiliser Association of India, Fertiliser Statistics, 1981/82, New Delhi, 1982, P.III-36.

4 India, Ministry of Agriculture and Irrigation, Report of the National Commission on Agriculture, New Delhi, 1976, Part III Pp 75-80.

5 Voelcker, John Augustus, Report on the Improvement of Indian Agriculture, Eyre and Spottiswoode, London, 1893, P.41.

6 Randhawa, N.W., and H.L.S. Tandon, "Advances in Soil Fertility and Fertiliser Use Research in India," Fertilizer

News, Vol.27, No.2, February 1982, Pp.11-26. Also see other articles in this Special Number brought out on the occasion of 12th International Congress of Soil Science held in New Delhi, February 8-16, 1982.

7 Tang, Anthony M., and Bruce Stone, Food Production in the People's Republic of China, International Food Policy Research Institute, Washington D.C., May 1980, especially P.47.

8 For NCA's estimate, see source cited in (4) above. For UNIDO's estimate, see UNIDO, Draft Worldwide Study of the Fertilizer Industry: 1975 - 2000, 1976, Chapter 2.

9 Desai, Gunvant M., Sustaining Rapid Growth in India's Fertilizer Consumption: A Perspective Based on Composition of Use, International Food Policy Research Institute, Washington D.C., August 1982.

10 European Nitrogen Service Programme, Fertiliser Use in Dryland Agriculture, New Delhi, 1980, P.6.

11 For evidence on this, see articles in such journals as Indian Journal of Agricultural Economics, Indian Journal of Agronomy, and Fertilizer News. Also see, Panse, V.G., Technical and Economic Possibilities of the Use of Nitrogen Fertiliser in India, IARI, New Delhi, 1964; Panse V.G., T.P. Abraham, and C.R. Leelavathi, Yardsticks of Additional Production of Certain Foodgrain, Commercial and Oilseed Crops, IARI, New Delhi 1964; Hopper, W.David, "Planning Yardsticks for Fertilisers and Irrigation", Agricultural Situation in India, September 1965, Pp.512-522; Rajendran S., D.Jha and J.G. Ryan, Fertilizer Responsiveness of Chickpeas in India, An Analytical Review, ICRISAT, 1982; reports on All India Coordinated Research Projects on different crops and All India Coordinated Agronomic Experiments Scheme; and FAI Group Discussion on Fertilizer Use in Drylands.

One could also argue that with improvements in prices of crops, cultivators' profitability in terms of size of **returns from fertilizer** use has gone up.

12 In addition to the above, see Randhawa N.S., and H.L.S. Tondon, "Advances in Soil Fertility and Fertiliser Use Research in India," Fertiliser News, February, 1982, Pp.11-26; Tandon H.L.S., "Research and Development of Fertiliser Use in Dryland Agriculture," Fertiliser News, June 1981, Pp 25-34; Barker Randoph and Robert W.Herdt, Rainfed Lowland Rice as a Research Priority - An Economist's View, IRRI Research Paper series No. 26, March 1979; Umrani N.K., and C.B. Patil, "Fertiliser Use Efficiency in Relation with Management in Drylands," and Tomar N.K., A.P. Gupta and S.S. Khanna, "Evaluation of Fertiliser Needs for Wheat under Rainfed Conditions," in Fertiliser News, April 1983, Pp.33-39.

13 Between 1949/50 and 1978/79, annual growth rates in yieds (estimated by fitting trends) were: bajra 5.4%, jowar 3.5%, and groundnut 2%. None of these crops had more than 6 percent area under irrigation. See Pathak, Mahesh T. and Haribhai F.Patel, Inter-district Variations in Agricultural Development in Gujarat, Agro-economic Research Centre, Vallabh Vidyanagar, 1982.

14 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 these class 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.

15 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 Gurdev 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.

Table 1: Consumption of fertilizers in India, 1951/52 to 1981/82

Year	Total	Per Hectare	Change in Total	
			Percent	Absolute
	000 Tons[a]	Kilograms[a]		000 Tons
1951/52	66	0.6		
1952/53	66	0.5	0	0
1953/54	105	0.7	59.1	39
1954/55	121	0.8	15.2	16
1955/56	131	0.9	8.2	10
1956/57	154	1.0	17.6	23
1957/58	184	1.3	19.5	30
1958/59	224	1.5	21.7	40
1959/60	305	2.0	35.7	81
1960/61	294	1.9	-3.3	-9
1961/62	338	2.2	15.3	44
1962/63	452	2.9	33.3	114
1963/64	544	3.5	20.6	92
1964/65	773	4.9	41.8	229
1965/66	785	5.1	1.6	12
1966/67	1,101	7.0	40.3	316
1967/68	1,540	9.4	39.9	439
1968/69	1,761	11.1	14.4	221
1969/70	1,982	12.2	12.5	221
1970/71	2,256	13.6	13.8	274
1971/72	2,657	16.1	17.7	401
1972/73	2,768	17.1	4.2	111
1973/74	2,839	16.7	2.6	71
1974/75	2,573	15.7	-9.4	-266
1975/76	2,894	16.9	12.4	321
1976/77	3,411	20.4	17.9	517
1977/78	4,285	24.9	25.7	874
1978/79	5,117	29.2	19.4	832
1979/80	5,255	30.0 b	2.7	138
1980/81	5,516	31.5 b	5.0	261
1981/82	6,067	34.6 b	10.0	551

a In terms of nutrients. Until 1960/61, relates to distribution

b Based on gross cropped area in 1978/79

Source: Fertilizer Statistics, 1981/82, The Fertilizer Association of India, New Delhi, November 1982

Table 2: Cropwise share in total cropped area, fertilizer consumption and growth in total fertilizer consumption between 1955/56 and 1976/77

Crop	Total Cropped Area[a]	Total Fertilizer Consumption			Growth of Fertilizer Consumption between 1955/56 & 1976/77
		1955/56	1970/71	1976/77	
			Percent		
Foodgrains					
Rice	22.4	36.6	30.7	34.9	34.2
Wheat	10.7	3.2	17.0	21.7	22.1
Jowar	10.5	1.5	1.7	3.9	4.0
Bajra	7.3	0.6	1.8	1.2	1.2
Maize	3.2	0.6	2.4	2.4	2.5
Ragi	1.5	0.6	0.6	1.4	1.4
Barley	1.7	0.4	0.6	0.2	0.2
Other Cereals	3.3	0.1	0.1	b	b
Pulses	14.7	0.6	0.9	b	b
Sub-Total	75.4	44.2	55.8	65.7	65.6
Other Food					
Sugarcane	1.5	12.4	6.5	7.5	7.4
Condiments & Spices	1.1	5.1	2.6	2.9	2.9
Sub-Total	2.6	17.5	9.1	10.4	10.3
Nonfood					
Cotton	4.8	1.9	3.9	6.4	6.5
Jute	0.5	0.4	0.2	0.3	0.3
Groundnut	4.1	1.3	5.1	2.8	2.9
Tobacco	0.3	0.7	1.7	1.2	1.2
Sub-Total	9.7	4.3	10.9	10.7	10.9
Other Nonplantation[c]	11.9	8.4	14.4	7.2	7.7
Plantations[d]	0.4	25.6	9.8	6.0	5.5
All Crops	100.0	100.0	100.0	100.0	100.0

a Average of 1955/56, 1970/71 and 1976/77

b Included in "Remaining Nonplantation"

c Includes vegetables and fruits, tapioca, oilseeds other than groundnut, fibres other than cotton and jute, fodder and miscellaneous crops

d Includes tea, cofee and rubber

Source: Based on official area statistics, 11th and 26th Rounds of NSS, and Fertilizer Demand Study of NCAER. For methodology and other details, 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., August 1982.

Table 3: Percent of crop area irrigated and share of irrigation in total fertilizer consumption, 1970/71

Crop	Percent of Crop Area Irrigated	Share in Fert. Consumption: Irrigated Area	Share in Fert. Consumption: Unirrigated Area
Foodgrains			
Rice	38.5	80.4	19.6
Wheat	54.3	90.1	9.9
Jowar	3.6	26.8	73.2
Bajra	4.0	17.5	82.5
Maize	15.9	45.4	54.6
Ragi	13.1	46.9	53.1
Barley	52.0	72.8	27.2
Other cereals and millets	2.2	14.5	85.5
All cereals and millets	27.6	77.6	22.4
Gram	15.6	58.0	42.0
Tur	0.3	0.8	99.2
Other pulses	6.3	18.3	81.7
All pulses	8.8	29.8	70.2
All foodgrains	24.1	76.9	23.1
Other Food			
Sugarcane	72.4	91.8	8.2
Condiments and spices	35.4	54.7	45.3
Above other food	56.9	81.5	18.5
Nonfood			
Cotton	17.3	60.5	39.5
Jute	10.9	53.7	46.3
Groundnuts	7.5	18.1	81.9
Rapeseed and mustard	25.2	84.5	15.5
Sesamum	2.6	6.9	93.1
Tobacco	23.7	31.1	68.9
Above nonfood	12.7	38.2	67.8
Other nonplantation	22.3	70.0	30.0
All Crops	23.0	71.2	28.8

Source: Based on official irrigation statistics and 26th Round of NSS. For methodology and other details, 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., August 1982.

Table 4: Share of different categories of area in total fertilizer consumption on selected crops, 1976/77

Crop	Category				Total
	IA-HY & IV	IA-TV	UA-HY & IV	UA-TV	
	Percent				
Rice	53.0	33.2	1.9	11.9	100
Wheat	80.3	17.5	0.8	1.4	100
Jowar	21.0	23.4	33.6	22.0	100
Bajra	28.2	33.7	10.0	28.1	100
Maize	26.2	57.2	6.2	10.4	100
Sugarcane	50.7	47.3	1.3	0.7	100
Cotton	50.8	11.4	26.5	11.3	100
Groundnut	50.0	33.5	3.9	57.6	100
All above crops	56.8	28.8	4.8	9.6	100

IA = Irrigated Area; UA = Unirrigated Area; HY & IV = High Yielding and Improved Varieties; TV = Traditional Varieties.

Source: Based on Fertilizer Demand Study of NCAER. For methodology and other details, 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., August 1982.

Table 5: Estimates of diffusion and rates of application on unirrigated areas sown to different crops and crop varieties in 1970/71 and 1976/77

Crop	1970/71		1976/77 (NCAER)					
	Percent Area Ferti- lized	Rate (Kgs/ Hectare)	Percent Area Ferti- lized			Rate (Kgs/Hectare)		
			H & I	T	Both	H & I	T	Both
Foodgrains								
Rice	17.7	29	63.1	19.0	20.6	56	43	45
Wheat	11.5	35	19.4	9.1	10.5	47	28	33
Jowar	4.7	27	61.8	7.6	13.0	64	37	50
Bajra	6.1	34	21.5	6.4	7.3	33	32	32
Maize	15.5	34	61.5	12.8	18.0	30	29	30
Ragi	10.0	29						
Barley	4.7	58						
Other Cereals	1.2	33						
Gram	0.6	61						
Tur	3.5	38						
Other Pulses	1.4	34						
Other Food								
Sugarcane	24.3	61	52.0	18.8	34.5	47	67	53
Condiments & Spices	24.3	83						
Nonfood								
Cotton	11.0	41	76.9	13.5	27.0	87	56	75
Jute	9.0	34						
Groundnuts	18.7	52	68.4	34.7	35.4	53	32	32
Rapeseed & Mustard	3.7	35						
Sesamum	2.6	21						
Tobacco	76.3	75						
Other Nonplantation	3.9	101						
All Crops Above	9.3	38	53.3	15.7	18.8	64	39	45

Notes: 1. H & I = High Yielding/Improved Varieties, T= Traditional Varieties

2. Other nonplantation crops include vegetables, potatoes, tapioca, fruits, oilseeds other than groundnuts, rapeseed and mustard and sesamum, fibers other than cotton and jute, fodder crops and miscellaneous crops

Source: Based on 26th Round of NSS and Fertilizer Demand Study of NCAER. For methodology and other details, 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., August 1982

Table 6: Districtwise irrigation and fertilizer consumption levels in Gujarat, early 1960s and late 1970s/early 1980s

District	Irrigated Area as Percent of cropped Area		Fertilizer Consumption Kgs. per Hectare		Average Annual Growth Rate in Fertilizer Consumption
	1960/61 - 1962/63	1975/76 - 1977/78	1960/61 - 1962/63	1979/80 - 1981/82	
Rajkot	5.7	14.6	1.6	69.5	22.0
Sabarkantha	10.0	27.1	0.7	63.5	26.8
Kheda	8.3	37.3	6.2	62.2	12.9
Junagadh	12.1	13.5	2.8	57.0	17.2
Amreli	6.6	7.3	2.1	55.9	18.9
Surat+Valsad	3.3	21.0	2.4	54.1	17.7
Vadodara	2.8	20.0	4.9	48.0	12.8
Bhavnagar	8.4	11.1	2.1	41.6	17.1
Jamnagar	4.8	10.3	0.7	37.9	23.8
Ahmedabad[a]	8.0	16.6	1.0	24.1	18.2
Mehsana	17.6	36.4	0.9	23.4	18.9
Bharuch	1.5	8.8	1.4	19.0	14.7
Panchmahals	2.1	5.8	0.5	12.7	18.2
Surendranagar	2.9	8.2	0.1	11.6	27.8
Banaskantha	8.3	19.4	0.2	10.4	22.8
Kutch	14.5	10.0	0.1	5.7	26.0
Average for State	7.4	17.4	1.7	36.1	17.5
C.V. (Among Districts)	60.8%	56.5%	106%	65%	24%

a Includes Gandhinagar

Source: Mahesh T. Pathak and Haribhai F. Patel, Inter-District Variations in Agricultural Development in Gujarat, 1949/50 - 1978/79, Agro-Economic Research Centre, Vallabh Vidyanagar, 1982, and Government of Gujarat, Report of the Working Group on Fertilizer Distribution System in Gujarat, April 1983.