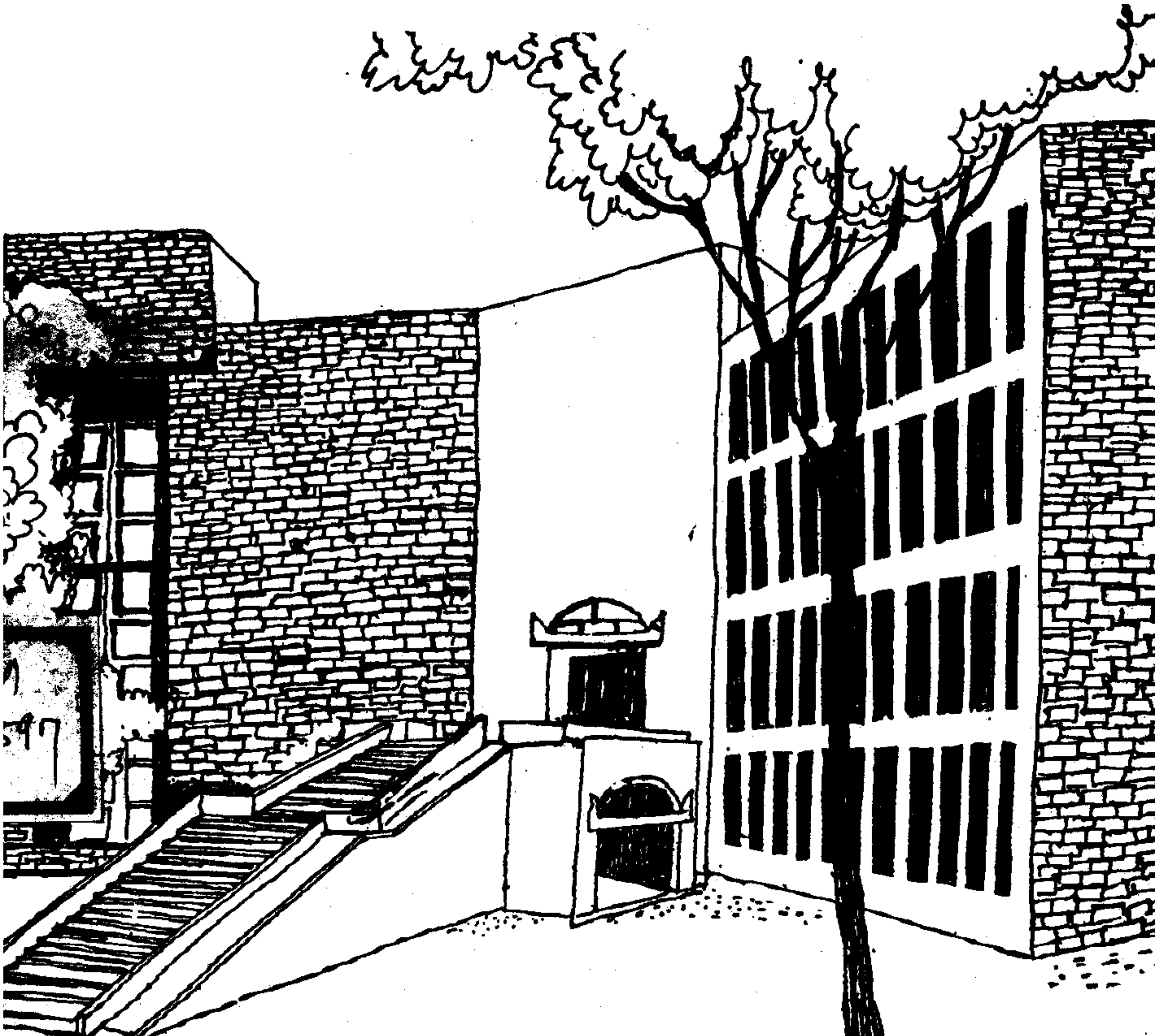
विद्याविनियोगाद्विकासः

IIM
AHMEDABAD

W.P. 59

Working Paper



MARKET CHANNELS AND GROWTH OF FERTILIZER USE IN RAINFED AGRICULTURE: CONCEPTUAL CONSIDERATIONS AND EXPERIENCE IN INDIA

By

Gunvant M. Desai

W P No. 597

January 1986

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380015
INDIA

MARKET CHANNELS AND GROWTH OF FERTILIZER USE IN RAINFED AGRICULTURE : CONCEPTUAL CONSIDERATIONS AND EXPERIENCE IN INDIA*

Gunvant M. Desai
Professor, Centre for Management in Agriculture
Indian Institute of Management, Ahmedabad

Empirical research on fertilizer use in developing countries is replete with evidence on deficiencies in fertilizer supply and marketing systems. But this evidence is usually bypassed in research that aims at identifying factors behind growth in fertilizer consumption, especially when the focus is on rainfed agriculture. Poor growth in fertilizer use under rainfed agriculture is commonly and more emphatically attributed to low and uncertain returns and lack of breakthroughs in dry-land technologies than to lack of adequate and efficient fertilizer marketing channels.

This hiatus in our understanding of forces behind growth in fertilizer consumption is mainly due to considering such growth as being driven by growth in farmers' demand for fertilizers. Factors behind fertilizer demand are usually identified by estimating some variant of a functional relationship between fertilizer consumption and such explanatory variables as prices of crops and fertilizer, level of irrigation, and nature of cropping pattern and crop varieties. Such an approach cannot but bypass the deficiencies in fertilizer supply and distribution systems, especially in developing countries, where supply and prices of fertilizers are seldom determined by free play of market forces.

---

*Paper for the International Workshop on "Agricultural Markets in the Semi-Arid Tropics" organized by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) held at ICRISAT Center, Patancheru, Andhra Pradesh, India from October 24-28, 1983.

This paper argues that identifying forces behind growth in fertilizer consumption by focusing only on changes in agroeconomic variables behind farmers' demand for fertilizers is not only a partial but also a quite inappropriate approach. Of course these variables and fertilizer demand are crucially important. But changes in agroeconomic variables are not the only determinants of the pace and pattern of growth in fertilizer consumption. Even when fertilizer price is administratively determined, fertilizer supply and marketing systems could exert a causal influence on growth in fertilizer consumption. The first section of this paper elaborates this argument with the help of a heuristic conceptualization which encompasses all essential elements involved in governing growth of fertilizer consumption 1/. Section 2 discusses India's experience of growth in fertilizer consumption, keeping in mind this conceptualization. In the third section, lessons emerging from past experience are presented to accelerate growth of fertilizer consumption under rainfed conditions.

FORCES BEHIND GROWTH IN FERTILIZER CONSUMPTION: CONCEPTUALIZATION

The economic potential of fertilizer use in a country is determined by fertilizer response functions, prices of crops, and cost of fertilizer. Actual fertilizer use is is an outcome of the conversion of the economic potential into farmers' demand for fertilizer and this demand being met by fertilizer supply and distribution systems.

Fertilizer use in any country begins with a few farmers at some locations; i.e., way below the economic potential. Over time it grows towards the potential, which itself could be changing due to shifts in fertilizer response functions and changes in prices of crops and fertilizers.

1/ For a complete exposition of the conceptualization, see Desai (1985), forthcoming IFPRI research report.

Viewed thus, it is incorrect to consider growth in fertilizer consumption as being governed only by agroeconomic variables behind response function-cum-price environment, or changes in them. Also important are the behavioral and institutional variables behind these processes. First, the processes that convert the potential into farmers' effective demand for fertilizers (generating knowledge about fertilizer response functions, spreading knowledge about profitability of fertilizer use among farmers, and enabling them to purchase fertilizers by providing credit). Second, the processes that establish and geographically expand the fertilizer distribution system as well as determine its *modus operandi*. And third, the processes that enlarge aggregate availability of fertilizers through domestic production and import of fertilizers.

The pace and pattern of growth in fertilizer consumption are an outcome of the initial conditions with respect to agroeconomic variables behind response function-cum-price environment as well as behavioral and institutional variables behind the above three processes and how these variables change over time. Equally important are interactions among all these variables in the course of growth in fertilizer consumption.

Both *a priori* reasoning and empirical evidence suggest that there could be many, and quite different, variables behind the three processes. Accordingly, the pace at which these processes operate over time and the way they interact could also be quite different. Thus, for instance, the pace of conversion of potential into farmers' demand for fertilizer would vary with the crop and the agroclimatic situation, and such variation would be due to many factors besides differences in the profitability of fertilizer. Some of these factors are: effectiveness of the agricultural research and extension systems in generating and spreading the relevant knowledge; the priorities of the government in increasing fertilizer use; the promotion efforts of the fertilizer supply systems; and the working of the agricultural credit system. Similarly, geographical expansion and workings of the fertilizer supply and distribution systems could differ over time and space, depending on the nature of the agencies involved and their motivations.

It could also be shown that the interactions among all elements involved in growth of fertilizer consumption could be quite different. Thus, for instance, dramatic increase in profitability of fertilizer use due to breakthrough in agricultural production technologies would not only accelerate growth of fertilizer demand but also induce rapid expansion in fertilizer supply and geographical spread of the distribution system. The chain reactions could work the other way also -- substantial increase in fertilizer supply leading to acceleration in efforts to convert untapped potential into farmers' demand, expand the fertilizer distribution system, and raise its efficiency in moving fertilizers from factories and ports to farms.

Appreciable fertilizer use in many developing countries is relatively recent. Their low levels of fertilizer use per unit of land suggest that much of the cropland is not yet fertilized[2/]. Trials conducted in many countries indicate substantial untapped economic potential of fertilizer use[3/]. There is also growing evidence of deficiencies in agricultural research extension, and credit, as well as in fertilizer distribution

---

2/ For a large majority of developing countries, fertilizer consumption per hectare of arable land is less than 15 kg of nutrients. For details see FAO (1981b).

3/ See FAO (1981a). Also see Saleem Ahmed and Nazir Ahmed. Current consumption as a percentage of estimated potential ranges from 4 to 7 in Africa, 10 to 20 in Asia, and 20 to 30 in Latin America.

and supply systems[4/].

Against such a backdrop, the above conceptualization seems appropriate to understanding the process of growth in fertilizer consumption because of four main reasons. First, it avoids mechanistic interpretation of growth in fertilizer consumption. In fact, it reveals lacunae in such interpretations, especially in those based only on changes in agroeconomic variables, while at the same time it fully recognizes the importance of these variables. Second, it draws attention to the three behavioral and institutional processes that are no less important than the agroeconomic variables in influencing the pace and pattern of growth in fertilizer consumption. Third, it emphasizes the role of interactions among all essential elements involved in the process, showing that compartmentalizing our knowledge of different aspects of fertilizer use restricts our understanding of the forces behind growth in fertilizer consumption. Finally, it points out that the "causal" relationships behind growth in fertilizer consumption are not only complex but varied.

As for growth in fertilizer use in rainfed agriculture, the above conceptualization raises three pertinent questions for specific situations. First, how does actual fertilizer consumption compare with viable economic potential for its use? Second, to what extent could poor growth in fertilizer use under rainfed conditions be attributed to the relevant agroeconomic variables, vis-a-vis inadequate efforts to convert the potential into farmers' fertilizer demand and various deficiencies in fertilizer supply and marketing systems? Third, what are the deficiencies in systems concerned with growth in fertilizer use in rainfed agriculture and what are their root causes? Obviously, we cannot

4/ Literature on this subject is quite extensive. For illustrations see, Mathieu and de la Vega (1978) and various country studies published by TVA (Tennessee Valley Authority) and IFDC (International Fertilizer Development Centre).

meaningfully discuss the significance of fertilizer market channels for rainfed agriculture unless we address these questions.

INDIA'S EXPERIENCE

By 1982/83 India's fertilizer consumption rose to about 6.4 million tonnes of nutrients. It now ranks fourth, after the USA, the USSR, and China. Although its consumption of 37 kg of nutrients per hectare of cropped land is considerably less than in these three and many other countries, India's performance in raising fertilizer consumption compares quite favourably with a majority of the developing, and even some of the developed countries.

This section briefly reviews India's experience[5/]. The focus is on some features of the past growth in fertilizer consumption under irrigated versus rainfed conditions. Particular attention is drawn to the varying pace of growth under rainfed conditions in different states, and also to the experience of one state where fertilizer supply and distribution systems have exerted a decisive influence on accelerating the growth in rainfed agriculture despite poor rainfall environment.

Beginnings of Fertilizer Use

Fertilizer use in India began in the 1920s on tea plantations. There is no evidence of its use outside the plantation agriculture until the 1930s when it began to spread to sugarcane, tobacco, and rice at a few locations. Three factors were mainly responsible for this extension: (1) development of the domestic sugar industry due to tariff protection, (2) fixation of minimum sugarcane prices by the governments of Bihar and Uttar Pradesh, (3) efforts of the firms importing fertilizers to develop markets outside

5/ Vast literature exists on the subject, covering different facets of growth in India's fertilizer consumption. For selected bibliographies see Desai (1982) and Bumb (1979). A fairly detailed account of growth in India's fertilizer consumption is available in these publications, plus Desai (1979).

the plantations[6/]. While the amount of total fertilizers used in British India was quite small (about 20,000 tonnes of nutrients in 1940), the period is also marked by the beginnings of domestic fertilizer production.

Broadening of the Base

With the Grow More Food Campaign launched by the Government of India in 1943, a new phase in growth of fertilizer use began. The campaign originated during the Second World War, when imports of rice from Burma were cut off, and gathered momentum due to the Bengal famine. The campaign aimed at accelerating food production in the quickest manner. Raising fertilizer use was one of the most important planks of the strategy behind the GMFC. Fertilizer supplies were enhanced and controlled, supplies were allocated between plantation boards and state governments, which were to promote its use in nonplantation agriculture; and a fertilizer distribution system was developed which included the use of the agricultural extension system to deliver fertilizers to farmers.

These efforts continued to grow after political independence in 1947, since partition of the country not only increased India's food deficit but also made it import-dependent in cotton and jute. Two early significant developments are also worth noting. First, a systematic large-scale program was undertaken to generate knowledge on crop response to fertilizer use under field conditions. Second, a many-fold expansion in the extension system was initiated under the Community Development Programme and the National Extension Service.

These developments had a decisive impact on the pattern of fertilizer consumption by the early 1950s, although total fertilizer consumption was less than 100,000 tonnes of nutrients (i.e., less than 1 kg/ha). Findings of the National Sample Survey for

---

6/ See Report of the Royal Commission on Agriculture in India (1928). Also see Knight (1954).

1953/54 and 1955/56 reveal beginnings of fertilizer use on virtually all crops grown under irrigated as well as unirrigated conditions[7/]. This contrasts very sharply with the first two decades of growth in India's fertilizer consumption.

Growth in Consumption after the Mid-1950s

Total fertilizer consumption grew from less than 100,000 tonnes of nutrients in the early 1950s to about 300,000 by 1960; 1 million by 1967; 3.4 million by 1977; and 6.4 million tonnes by 1983. Whereas more data related to fertilizer consumption are available for India than most other developing countries, they are insufficient to answer all questions. For instance, time-series on fertilizer consumption by crops, crop varieties, and irrigated versus rainfed areas are not available. Only findings of two nationwide surveys are available for 1970/71 and 1976/77.

The above findings confirm two major features of the fertilizer consumption pattern repeatedly revealed by many micro studies conducted in different parts of the country: (1) unequal share of different crops in total fertilizer consumption (Table 1) and (2) concentration of fertilizer use on irrigated areas and areas sown to improved and high-yielding varieties of crops (Tables 2 and 3). These features were mainly due to: (1) the uneven pace of diffusion of fertilizer use on different crops, (2) faster diffusion on the same crop under irrigated than in unirrigated conditions, and (3) faster diffusion in areas sown to improved and high yielding varieties than in areas sown to traditional varieties.

This is not surprising. What is instructive is that in unirrigated areas fertilizer use was not confined either to a few crops or only to areas sown with superior varieties.

7/ For details of these and subsequent discussion of the composition of total fertilizer consumption, see Desai (1982).

More significantly still, it was growing over time on all crops, albeit at a slow pace (Table 4). And this was so even though diffusion of fertilizer use on irrigated areas was not complete. By 1976/77, fertilizer use had spread to about 18 percent of total unirrigated area, even though about one-third of the irrigated areas was still available for further diffusion of fertilizer. A similar pattern was true for each and every crop.

While these findings reveal the dominant influence of certain agroeconomic factors, they also suggest the importance of the three processes mentioned in the previous section in influencing the pace and pattern of growth in fertilizer consumption.

Under the prevailing conditions of fertilizer response functions and prices, there was sufficient scope for a faster growth in fertilizer use than actually occurred. This is indicated by substantially less than complete diffusion of fertilizer use on all crops, even in irrigated areas, by the mid-1970s. 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 it is to emphasize the importance of irrigation and high-yielding varieties in governing the past growth. The answer to this question lies in inadequate efforts to convert potential of fertilizer use into farmers' demand for fertilizers especially on food grains other than rice and wheat and oilseeds; 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[8/].

The relevance of the above factors could also be shown from variation in the pace and pattern of growth in fertilizer use among different states of India. Once again while irrigation,

8/ For details, see Desai (1982).

cropping pattern, and crop varieties "explain" much of this variation, there are important exceptions. Among these, Gujarat stands out (Table 5). 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 territories with irrigation levels up to 40 percent.

Gujarat's Experience

Gujarat's remarkable growth in fertilizer consumption was due to relatively faster diffusion of fertilizer use under rain-fed conditions than in many other parts of the country rather than to very high rates of application on limited irrigated area (Table 6). This conclusion, based on the survey data of the National Council of Applied Economics Research (NCAER) is supported by Gujarat's Agricultural Census for 1976/77, according to which about 53% of total fertilizer consumption was on un-irrigated areas.

Rapid diffusion of fertilizer use in rainfed agriculture in Gujarat was mainly due to certain strengths of the fertilizer distribution system and pressure from the fertilizer supply side, especially from the fertilizer factories located in the state.

In 1981, for the country as a whole, there were 280 fertilizer distribution outlets per districts, 22 outlets per block, and one outlet per five villages. Against this, Gujarat had 325 outlets per district, 34 outlets per taluka (a unit comparable to a block) and one outlet per less than three villages[9/]

9/ The average number of villages served by a fertilizer outlet in 1981 varied from less than three in Punjab, Tamil Nadu, Haryana, Gujarat, Kerala, West Bengal, and Manipur to more than ten in Bihar, Madhya Pradesh, Meghalaya, Rajasthan, Tripura, Assam, and Nagaland. Four of the seven states in the former category had higher per hectare fertilizer consumption than the all-India average, and it was only marginally lower in two of the remaining three. Against this, per hectare consumption in all seven states in the latter category was below half the national average.

These outlets were geographically well spread out within Gujarat and covered regions with high as well as low irrigation. For instance, about a quarter of the total outlets were located in one-thirds of the total talukas with less than 10 percent irrigation[10/].

As in other parts of India, Gujarat's fertilizer distribution system also comprise different types of agencies, such as cooperative, private dealers, state agro-industries corporations and outlets run by the fertilizer factories themselves. A large majority of talukas have at least three types of agencies involved in fertilizer distribution.

For the state as a whole, cooperatives dominate, with nearly three-fourths of the share in total outlets and total fertilizers supplied. In this respect also Gujarat seems unique, since cooperatives have lost ground to private dealers in all major fertilizer-consuming states after the mid-1960s, when fertilizer distribution policy was liberalized by the government. This has been so because of the following five major strengths of the cooperative sector's involvement in fertilizer distribution in Gujarat.

First, it is a reasonably well-knit system comprising village level credit societies (PACs), taluka and district level marketing societies (TPSUs and DPSUs), and a state-level federation of marketing cooperatives (Gujarat State Cooperative Marketing Federation, GSCMF). Fertilizer distribution is very important in the activities of the marketing cooperatives; thus, for instance, it accounted for 54 percent of the federation's total turnover of Rs.2890 million in 1981/82.

10/ Details such as this and the ones which follow emerge from the Report of the Working Group on the fertilizer distribution system in Gujarat, Government of Gujarat(1983). This study examines not only characteristic features but also the working of the fertilizer distribution system with a view to identifying its strengths and problem areas. There is probably no other study that goes into these issues with block-level data.

Second, the federation nurtures involvement of the lower level of cooperatives in fertilizer distribution by passing on a substantial proportion of the distribution margin to them. It also passes on the "credit period" to them which it receives from fertilizer manufacturers for storage of fertilizers.

Third, fertilizers are supplied to PACs, TPSUs, and DPSUs in response to their indents. The bulk of these supplies are made directly from the godowns and silos of the fertilizer factories to the locations of indenting cooperatives. This minimizes storage cost and avoids storage at intermediate locations as well as cross transportation.

Fourth, the working capital requirements of PACs, TPSUs, and DPSUs are largely met either by the district cooperative banks by providing them cash credit limits or under the bank guarantee scheme evolved by the federation. Experience reveals that the bank guarantee scheme has played a vital role in the fertilizer distribution system of the cooperative sector. Finally, because of its financial strength and the ability to handle a growing volume of fertilizer supplies, many fertilizer manufacturers have preferred to deal with the marketing federation rather than a large number of private dealers and appointed the federation sole or principal distributor of their products in Gujarat.

The strengths of the cooperative system plus the policy of multiple agency approach have played a crucial role in providing a well-spread and fairly efficient fertilizer distribution to Gujarat - a system which was capable of accelerating fertilizer consumption in response to either a pull from the demand side or a push from the supply side.

As in other parts of India, pull from the demand side in Gujarat has come from the processes which have converted untapped potential into farmers' demand for fertilizers. This includes growing awareness of fertilizers among farmers, upward pressures on prices of crops, improvements in response function environment (especially for crops like pearl millet, irrigated wheat, and irrigated cotton) and growth in the supply of production credit to farmers.

But in addition to this, the push from the supply side has also worked in Gujarat, mainly due to the location of a few major fertilizer companies in Gujarat (e.g., GSFC, IFFCO, and more recently GNFC). Total production of these companies plus some small companies far exceeds Gujarat's total consumption. This has created an environment in which the state government and the marketing federation perceive no constraints in fertilizer supply to raise its use rapidly, and the fertilizer manufacturers find it convenient to channelize their products through a well-spread and reasonably efficient fertilizer distribution system. What further adds to the supply pressure is IFFCO's policy of marketing their fertilizers through cooperative channels only, and the preference of many fertilizer factories located in other states for the expanding fertilizer market in Gujarat.

EMERGING LESSONS

Three major lessons emerge from the discussion in the previous two sections.

First, to appreciate the true significance of the fertilizer marketing system, it is important to have a conceptualization which treats it as an integral part of the overall process of growth in fertilizer consumption. In other words, it is important to avoid focusing on market channels alone.

Second, even when fertilizer prices are administratively determined, fertilizer supply and marketing systems could (and usually do) exert a causal influence on the pace and pattern of growth in fertilizer consumption. This is so because of the untapped viable potential of fertilizer use under both irrigated and rainfed conditions, and various deficiencies in the processes which convert this potential into actual consumption. Thus, market channels for growth of fertilizer use in rainfed agriculture can be more meaningfully discussed in the context of growth in fertilizer use under both irrigated and rainfed conditions.

Third, it is not enough to focus only on such features of the fertilizer marketing system as its density and the types of agencies involved in it. It is also important to take into consideration its modus operandi and interface with fertilizer demand on the one hand and the supply system on the other. This is especially necessary to avoid stereotyped prescriptions such as increasing the number of outlets, encouraging the participation of some institutional agencies in fertilizer distribution, and raising the margins on fertilizer distribution. In themselves, these measures are often inadequate to remove the deficiencies in the fertilizer marketing systems for rainfed agriculture.

What may be more critically required is to accelerate the efforts to convince farmers about the profitability of fertilizer use under rainfed conditions and improve the working of the agricultural credit system with a view to speeding up fertilizer diffusion, and thus enlarge the volume of business for the marketing channels. Similarly, many deficiencies in the marketing channels for rainfed regions cannot be removed unless growth in total fertilizer supply keeps ahead of growth in the market for fertilizers under irrigated conditions.

References

Ahmed, S., and Ahmed, N. Calculating the potential annual global fertilizer requirements using the recommended rate method: some tentative results. Resource Systems Institute, East-West Center, Honolulu, Hawaii, USA. (Mimeographed).

Bumb, B. 1979. Survey of the fertilizer sector in India. Washington DC, USA: The World Bank.

Comptroller General of the United States. 1977. Restrictions on using more fertilizer for food crops in developing countries. Report of the Comptroller General to the Congress. Washington DC, USA: Government Printing Office.

Desai, G.M. 1979. Fertilizer in India's agricultural development. Pages 377-426 in Agricultural development of India - policy and problems (ed. C.M. Shah). Bombay, India: Orient Longman.

Desai, G.M. 1982. Sustaining rapid growth in India's fertilizer consumption: a perspective based on composition of use. Washington DC, USA: International Food Policy Research Institute.

Desai, G.M. 1983. Understanding the process of growth in fertilizer consumption: a conceptualization. IFPRI research report. Washington DC, USA: International Food Policy Research Institute.

FAI (Fertiliser Association of India). 1982. Fertiliser Statistics, 1981/82. New Delhi, India: FAI.

FAO (Food and Agriculture Organisation). 1981a. FAO fertilizer programme: 20 years of increasing crop yields, 1961-1981. Rome, Italy: FAO.

FAO (Food and Agriculture Organisation). 1981b. Fertilizer yearbook. Rome, Italy: FAO.

Government of Gujarat. 1983. Report of the Working Group on fertilizer distribution system in Gujarat.

Knight, Sir Henry. 1954. Food administration in India, 1939-47. Stanford, Calif, USA: Stanford University Press.

Mathieu, M., and de la vega, J. 1978. Constraints to increased fertilizer use in developing countries and means to overcome them. In Proceedings No.173, The Fertilizer Society, London, UK.

Ministry of Agriculture, Government of India. 1982. Indian agriculture in brief, 1982. New Delhi, India: Government Printing Press.

NCAER (National Council of Applied Economic Research). Fertilizer demand study. New Delhi, India: NCAER.

Royal Commission on Agriculture in India. 1928. Report of the Royal Commission on Agriculture in India. Bombay: The Government Central Place.

Table 1. Cropwise share in total cropped area, fertilizer consumption and growth in total fertilizer consumption between 1955 and 1977.

Crop	Percent of total cropped area[1]	Total fertilizer consumption(%) 1955/56	1970/71	1976/77	Growth of fertilizer consumption %
Food Crops					
Food grains					
Rice	22.4	36.6	30.7	34.9	34.2
Wheat	10.7	3.2	17.0	21.7	22.1
Sorghum	10.5	1.5	1.7	3.9	4.0
Pearl millet	7.3	0.6	1.8	1.2	1.2
Maize	3.2	0.6	2.4	2.4	2.5
Finger millet	1.5	0.6	0.6	1.4	1.4
Barley	1.7	0.4	0.6	0.2	0.2
Other cereals[2]	3.3	0.1	0.1	–	–
Pulses[2]	14.7	0.6	0.9	–	–
Subtotal	75.4	44.2	55.8	65.7	65.6
Other					
Sugarcane	1.5	12.4	6.5	7.5	7.4
Condiments and spices	1.1	5.1	2.6	2.9	2.9
Subtotal	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
Subtotal	9.7	4.3	10.9	10.7	10.9
Other Nonplantation[3]	11.9	8.4	14.4	7.2	7.7
Plantation[4]	0.4	25.6	9.8	6.0	5.5
All crops	100.0	100.0	100.0	100.0	100.0

1. Average of 1955/56, 1970/71 and 1976/77.
2. Included in "Other nonplantation" in the 1976/77 and in the growth of fertilizer columns.
3. Includes vegetables and fruits, tapioca, oilseeds other than groundnut, fibers other than cotton and jute, fodder, and miscellaneous crops.
4. Includes tea, coffee, and rubber.

Source: Based on official area statistics, 11th and 26th rounds of NSS, and Fertilizer Demand Study of the NCAER. For methodology and details, see Desai (1982).

Table 2. Percent of crop area irrigated and share of irrigated area in total fertilizer consumption, 1970/71.

Crop	Percent of crop area irrigated	Share in fert. consumption	
		Irrigated area	Unirrigated area
Foodcrops			
Food grains			
Rice	38.5	80.4	19.6
Wheat	54.3	90.1	9.9
Sorghum	3.6	26.8	73.2
Pearl millet	4.0	17.5	82.5
Maize	15.9	45.4	54.6
Finger millet	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
Chickpea	15.6	58.0	42.0
Pigeonpea	0.3	0.8	99.2
Other pulses	6.3	18.3	81.7
All pulses	8.8	29.8	70.2
All food grains	24.1	76.9	23.1
Other food crops			
Sugarcane	72.4	91.8	8.2
Condiments and spices	35.4	54.7	45.3
Other food	56.9	81.5	18.5
Nonfood crops			
Cotton	17.3	60.5	39.5
Jute	10.9	53.7	46.3
Groundnut	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
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 Desai (1982).

Table 3. Share (%) of different categories of area in total fertilizer consumption, selected crops, 1976/77.

Crop	Category				Total
	IA-HY and IV	IA-TV	UA-HY and IV	UA-TV	
Rice	53.0	33.2	1.9	11.9	100
Wheat	80.3	17.5	0.8	1.4	100
Sorghum	21.0	23.4	33.6	22.0	100
Pearl millet	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 and IV = high-yielding and improved varieties; TV = traditional varieties.

Source: Based on Fertilizer Demand Study of NCAER. For methodology and other details, see Desai (1982).

Table 4. Estimates of diffusion and rates of application of fertilizer on unirrigated areas sown to different crops and crop varieties in 1970/71 and 1976/77.

Crop	1970/71		1976/77 (NCAER)1					
	Percent area fertilized	Rate of application (kg/ha)	Percent area fertilized			Rate of application (kg/ha)		
			H and I	T	Both	H & I	T	Both
Food grains								
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
Sorghum	4.7	27	61.8	7.6	13.0	64	37	50
Pearl millet	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
Finger millet	10.0	29						
Barley	4.7	58						
Other cereals	1.2	33						
Chickpea	0.6	61						
Pigeonpea	3.5	38						
Other pulses	1.4	34						
Other food								
Sugarcane	24.3	61	52.0	18.8	34.5	47	67	53
Condiments and spices	24.3	83						
Nonfood								
Cotton	11.0	41	76.9	13.5	27.0	87	56	75
Jute	9.0	34						
Groundnut	18.7	52	68.4	34.7	35.4	53	32	32
Rapeseed and mustard	3.7	35						
Sesamum	2.6	21						
Tobacco	76.3	75						
Other nonplantation[2]	3.9	101						
All crops above	9.3	38	53.3	15.7	18.8	64	39	45

1. H and I = high-yielding/improved varieties; T = traditional varieties.

2. Other nonplantation crops include vegetables, potatoes, tapioca, fruits, oilseeds other than groundnut, 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 Desai (1982).

Table 5. Fertilizer consumption, rainfall environment, irrigation, and spread of high-yielding varieties (HYVs) in different states of India.

State/ Territory	Fertilizer Consumption (kg/ha (1981/82)	Percent cropped area with normal rainfall (mm) of			percent cropped area irrigated (1978/79)	percent area covered by HYVs[1] (1980/81)
		Below 750	750 - 1150	Above 1150		
Pondicherry	256	0	0	100	77	NA
Punjab	124	85	15	0	83	91
Delhi	75	100	0	0	55	NA
Tamil Nadu	67	0	82	18	50	93
Uttar Pradesh	52	15	74	11	44	50
Andhra Pradesh	50	0	67	33	36	57
Haryana	46	93	7	0	54	71
Gujarat	39	68	25	7	19	54
Karnataka	34	65	25	10	15	51
Kerala	33	0	0	100	12	46
West Bengal	33	0	0	100	20	44
Goa	31	0	0	100	9	NA
Maharashtra	27	36	43	21	12	49
Jammu and Kashmir	22	11	51	38	41	59
Himachal Pradesh	20	0	81	19	17	59
Bihar	18	0	22	78	33	45
Manipur	15	0	0	100	35	30
Madhya Pradesh	11	4	39	57	11	33
Orissa	10	0	0	100	19	28
Meghalaya	10	0	0	100	22	NA
Rajasthan	8	87	13	0	20	25
Tripura	7	0	0	100	8	55
Assam	3	[illegible]	0	100	17	29
Nagaland	2	0	0	100	36	15
All India	35	32	36	32	28	48

[1]Area under HYVs as percent of total area under rice, wheat, sorghum, pearl millet, and maize.

Sources: FAI (1982); and Ministry of Agriculture (1982).

Table 6. Diffusion of fertilizer use and average rates of application on selected crops in Gujarat, and all India by 1977.

Crop	All India			Gujarat		
	Area irrigated (%)	Area fertilized (%)	Rate of application (kg/ha)	Area irrigated (%)	Area fertilized (%)	Rate of application (kg/ha)
Rice	38.3	44.9	78	29.9	63.4	54
Wheat	65.0	55.1	73	52.4	61.9	41
Sorghum	4.5	17.3	57	4.2	19.3	39
Pearl millet	5.4	11.5	39	11.2	26.8	33
Sugarcane	79.9	69.7	146	100.0	68.3	115
Cotton	21.8	42.4	85	12.7	33.9	60
Groundnut	6.0	38.5	40	2.4	57.2	29
All crops	26.8	28.7	76	13.5	38.2	44

Source: Based on NCAER fertilizer demand study. For methodology and other details, see Desai (1982).