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Demand for Fertilisers in India: Determinants and Outlook for 2020

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I

INTRODUCTION

The role of chemical fertilisers for increased agricultural production, in particular in developing countries, is well established. Some argue that fertiliser was as important as seed in the Green Revolution (Tomich *et al.,* 1995), contributing as much as 50 per cent of the yield growth in Asia (Hopper, 1993 and FAO, 1998). Others have found that one-third of the cereal production worldwide is due to the use of fertiliser and related factors of production (Bumb, 1995).

During the last three decades, India has relied on increasing crop yields to meet an ever increasing demand for food. According to Ministry of Agriculture data, total foodgrain production in the country rose from 151.2 million tonnes in 1980s (1981-82 to 1990-91) to 190.6 million tonnes in the 1990s and 212 million tonnes in 2000s (2001-02 to 2009-10) (Figure 1). Meanwhile, the total area under foodgrains, which accounts for nearly two-third of the total cropped area, has declined by over 4 per cent from its 1980s level and down 7.4 per cent from the peak of 131.16 million hectares in 1983. This increase in foodgrains production was the result of about 46 per cent increase in crop yields between 1980s and 2000s. However, the rate of increase in crop yields has decelerated in the recent decade (12.4 per cent in 2000s compared with over 30 per cent in 1990s). During the last decades, India lost about 2.5 million hectares of net sown area (Figure 1). The options for increasing food production are limited by availability of land as well as water. Increasing population, among other factors, limits any significant expansion of arable land.

Fertiliser consumption in India has been increasing over the years and today India is one of the largest producer and consumer of fertilisers in the world. By 2009-10, total fertiliser consumption in the country was 26.49 million nutrient tonnes. The importance of fertilisers in yield improvement, which is essential for achieving increased agricultural production, further increases because there is little scope for bringing more area under cultivation as well as majority of Indian soils are deficient in many macro and micro nutrients. The application of essential plant nutrients, particularly major and micronutrients in optimum quantity and right proportion,

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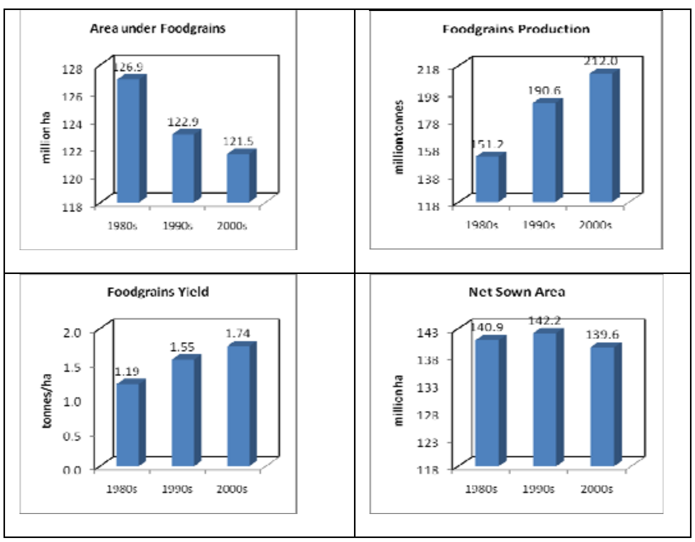
through correct method and time of application, is the key to increased and sustained crop production. Therefore it is important to understand fertiliser use behaviour in the country over time as well as the role of factors influencing fertiliser consumption at the national and regional/state level because the intensity of fertiliser use varies from state to state and area to area. What explains these variations in fertiliser use across states/regions in the country? Why have some states/regions experienced positive growth in fertiliser consumption while others have seen stagnation/decline? What factors (e.g., agro-climatic characteristics, institutional and infrastructure variables, economic factors) play a significant role in shaping fertiliser consumption patterns (Figure 2)? To address some of these issues, fertiliser demand models can be constructed to link fertiliser consumption with price and non-price factors using national and state-level data.



Source: Government of India (2010)

Figure 1. Trends in Foodgrains Acreage, Production and Yield and Net Sown Area in India

Several studies have attempted to examine the role of price and non-price factors in the growth of fertiliser use in India (Raju, 1989; Kundu and Vashist, 1991; Subramaniyan and Nirmala, 1991; Sharma, 1993; Sidhu and Sidhu, 1993; Dholakia and Majumdar, 1995, Sharma, 1999, Schumacher and Sathaye, 1999, Rabobank, 2005). However, most of these studies pertain to pre-reforms period. Therefore, there is a need to examine the likely impacts of the socio-economic, technical and institutional factors on fertiliser consumption and agricultural growth. Some of the problems of fertiliser consumption vary from region to region and need to be studied in their local context but there are others which confront most stakeholders all over the country. In this paper an attempt has been made to understand the factors affecting fertiliser demand at macro level and forecast demand for fertilisers in the

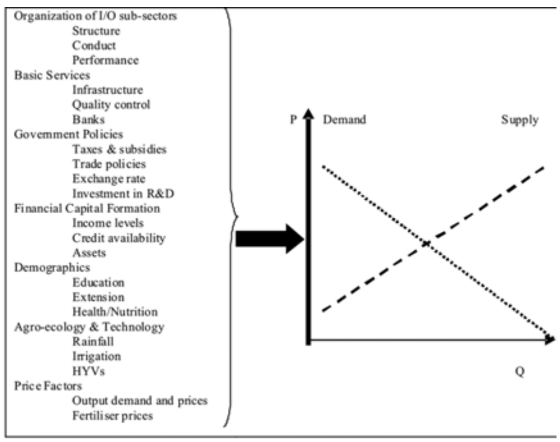


Figure 2. Determinants of Fertiliser Consumption

country by 2020. By estimating demand for fertilisers, one can understand the implications of fertiliser price policy including subsidy and agricultural product price for fertiliser use and their interrelationship.

The paper has the following structure. Section II provides an overview of fertiliser consumption trends in the country. Section III presents a framework used for assessing the determinants of fertiliser demand. Section IV provides an in-depth discussion of the technical, institutional and economic factors that influence fertiliser demand. Summary and conclusions are given in the final section.

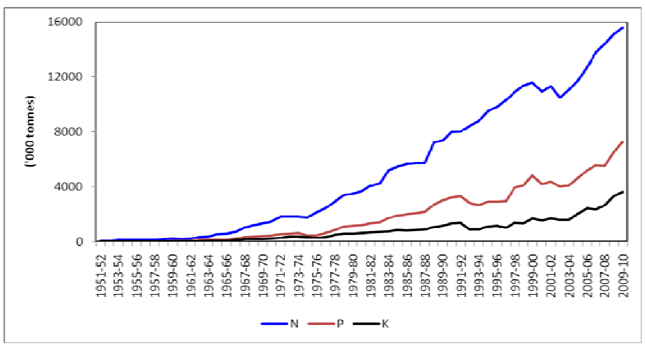
II

FERTILISER CONSUMPTION TRENDS IN INDIA

Fertiliser consumption trends expressed in terms of aggregate quantities consumed and intensity of use (*i.e.,* kg per hectare of total cropped area) reflect both demand and supply decisions. In this section, growth trends in total fertiliser consumption and intensity of use at all-India level as well as regional/state level are discussed.

2.1 *Total Fertiliser Consumption: All-India*

India is the second largest consumer of fertilisers in the world, after China. It accounted for 15.3 per cent of the world's N consumption, 19 per cent of phosphatic (P) and 14.4 per cent of potassic (K) nutrients in 2008 (FAI, 2010). Trends in fertiliser consumption in terms of total quantities in the country are presented in Figure 3. Fertiliser consumption was around 78 thousand tonnes in 1965-66 and it picked up very fast during the late 1960s and 1970s. At the time of onset of green revolution in 1966-67 consumption of fertilisers was about 1 million tonnes. In 1970-71, total fertiliser consumption increased to 2.26 million tonnes, which further increased to 12.73 million tonnes in 1991-92. The rapid expansion of irrigation, spread of HYV seeds, introduction of Retention Price Scheme,[1] distribution of fertilisers to farmers at affordable prices, expansion of dealer's network, improvement in fertiliser availability and virtually no change in farm gate fertiliser prices for 10 years (1981-1991) were the major reasons for increase in fertiliser consumption during 1971 to 1990. During 1990s, total fertiliser consumption fluctuated between 12.15 and 16.8 million tonnes with the exception in 1999-2000, when fertiliser consumption was over 18 million tonnes. The total fertiliser consumption reached a record level of 26.5 million tonnes during 2009-10.



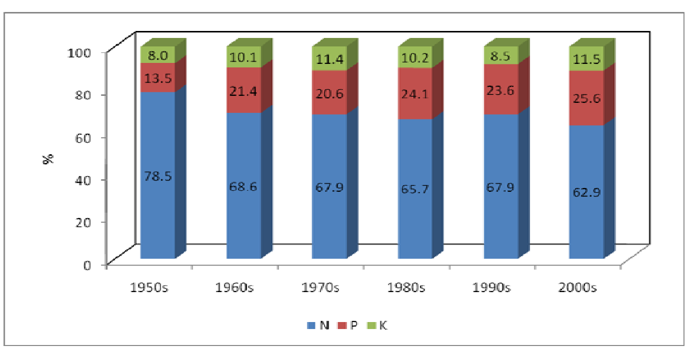
Source: Fertiliser Association of India (2010).

Figure 3. Trends in Fertiliser Consumption (N, P and K) in India: 1950-51 to 2009-10

The fertiliser consumption in India has generally exceeded domestic production in both nitrogenous and phosphatic fertilisers except for few years. The entire requirement of potassic fertilisers is met through imports as India does not have commercially viable sources of potash. During 1950s and 1960s, about two-third of the domestic requirement of N fertilisers was met through imports. The level of P imports was very low in the fifties, which increased significantly during the sixties and seventies. With the introduction of the high-yielding varieties of wheat and rice in the mid-1960s, the fertiliser imports increased significantly in 1966-67 and thereafter. The fertiliser imports increased dramatically in 1977-78 and 1978-79, 1984-85 and again in 1988-89 and 1989-90. However, during the decade of 1990s imports were at low levels except in 1995-96 and 1997-98. Due to low/no addition in domestic capacity coupled with rise in demand for fertilisers during the last two decades, imports have increased significantly in the 2000s. India imported about 10.24 million tonnes (about 41 per cent of total consumption) of NPK fertiliser nutrients in 2008-09 as against 1.93 million tonnes in 2002-03. The growth of imports was rather slow in the eighties and nineties but accelerated in 2000s. The share of imports in total consumption (N+P+K) declined from 57 per cent in 1960s to 43 per cent in 1970s, further to about 24.8 per cent in 1980s, 21.3 per cent in 1990s but increased to 26.2 per cent in 2000s. Almost similar trend was observed in the case of nitrogenous and phosphatic fertilisers. The share of imports in total consumption was

13.8 per cent in the case of N and 23.8 per cent in P during the 2000s. However, in terms of volume of imports, N fertiliser imports declined during the 1980s compared with 1970s, which marginally increased during the 1990s (1.1 million tonnes) and further increased (1.79 million tonnes) in the 2000s, while in the case of phosphatic fertilisers imports have consistently increased over time from 243.2 thousand tonnes in 1970s to 511.3 thousand tonnes in 1980s, 736.9 thousand tonnes in 1990s and 1.25 million tonnes in 2000s. Rising share of imports is a matter of concern as world fertiliser markets are highly volatile and imperfect. So there is a need to increase domestic production to insulate from the international markets.

Seventeen plant food nutrients are essential for proper crop development. Each is equally important to the plant, yet each is required in different amounts. These differences have led to the grouping of these essential elements into three categories; primary (macro) nutrients, secondary nutrients, and micronutrients. Primary (macro) nutrients are nitrogen (N), phosphorus (P), and potassium (K). They are most frequently required in a crop fertilisation programme and are needed in large quanities by plants as fertiliser. The secondary nutrients include calcium, magnesium and sulphur. For most crops, these three are needed in lesser amounts than the primary nutrients. The micronutrients such as boron, chlorine, copper, iron, manganese, molybdenum, zinc etc. are used in small amounts, but they are as important for plant development and profitable crop production as the major nutrients. However, major focus of the Indian fertiliser sector policy has been on primary (macro) nutrients. The changing pattern of three primary nutrients is presented in Figure 4. Nitrogenous fertilisers account for nearly two-third of total nutrient consumption in the country. The share of N was 78.5 per cent in the 1950s, which declined to 68.6 per cent in the 1960s, 67.9 per cent in the 1970s and further to 65.7 per cent in the 1980s. However, the share of N increased to 67.9 per cent in the 1990s, which fell to 62.9 per cent in the 2000s.



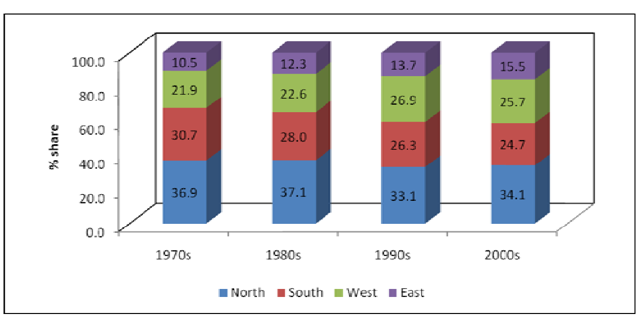
Source: Fertiliser Association of India (2010).

Figure 4. Share of Primary Nutrients (N, P and K) in Total Consumption of Fertilisers

In the case of P fertilisers, the share has increased from 13.5 per cent in 1950s to 21.4 per cent in the 1960s which marginally declined during the 1970s and again picked up during the eighties (24.1 per cent). During the 1990s the share of P in total consumption declined to 23.6 per cent and then increased during the 2000s (25.6 per cent). Likewise, the share of K increased from 8 per cent in 1950s to 11.4 per cent in 1970s, declined to 10.2 per cent in the 1980s and further fell to 8.5 per cent in the 1990s. The share of K increased to 11.5 per cent in the 2000s. The rise in share of N and decline in the share of P and K fertilisers during the decade in nineties was mainly because of slow growth in consumption of P and K fertilisers compared with N fertilisers due to decontrol of P and K fertilisers and relatively high increase in their prices vis-à-vis N fertilisers, which remained almost stable during the decade. Concerned with the problem of increasing imbalance in use of primary nutrients, government introduced a concession scheme on the sale of decontrolled P and K fertilisers to the farmers in the mid-1990s but still prices of these fertilisers were higher than nitrogenous fertilisers. In the late 1990s and early 2000s government hiked the concession rates for P and K fertilisers, which led to increase in their consumption and higher share in total fertiliser use during the 2000s.

2.2 *Fertiliser Consumption Trends at Regional/State Level*

Figure 5 shows the share of total fertiliser consumption by region. The eastern and southern regions generally use less fertiliser while the northern and western regions consumed more. The share of northern zone was the highest (34.1 per cent), followed by west and south accounting for nearly 25 per cent each and the lowest (15.5 per cent) in the eastern region. However, the share of eastern region has increased from about 10 per cent in 1970s to 13.7 per cent in 1990s, which further increased to 15.5 per cent during the 2000s, which is an encouraging trend since fertiliser consumption in the eastern region is quite low compared with the national average as well as other regions. The share of western region has also increased during the last three and half decades. In contrast, the south has lost its share from 30.7 per cent in 1970s to 24.7 per cent in 2000s, while in the case of northern region there is marginal decline in the share (from 36.9 per cent in 1970s to 34.1 per cent in 2000s).



Source: Fertiliser Association of India (2010).

Figure 5. Distribution of Fertiliser Consumption Trends by Regions

These regional figures mask the variability among states. Within each region there are also sharp differences in consumption. Uttar Pradesh (54.6 per cent), Punjab (23.9 per cent) and Haryana (17.4 per cent) accounted for about 96 per cent of the north region's fertiliser consumption during 2009-10 while the share of the remaining three states (Uttarakhand, Jammu & Kashmir and Himachal Pradesh) was 4 per cent. Similarly in the eastern region, West Bengal (41.9 per cent) and Bihar (33.4 per cent) used over three-fourth of the total consumption in the region. In the southern region, about 96 per cent of the fertiliser consumption was in three states: Andhra Pradesh (46.3 per cent), Karnataka (31.1 per cent) and Tamil Nadu (18.1 per cent). Maharashtra (37.6 per cent), Gujarat (22.1 per cent) and Madhya Pradesh (20.4 per cent) consumed nearly 80 per cent of the total fertiliser used in the western region (Sharma and Thaker, 2011).

2.3 *Growth Rates in Fertiliser Consumption and Foodgrain Production*

The growth rates in consumption of fertilisers and foodgrains during different time periods at all-India level are given in Table 1. The table shows that fertiliser consumption increased by more than 19 per cent in the pre-green revolution period (1950-51 to 1966-67) while foodgrain production increased by only 2.56 per cent. The reason for such a high growth in fertiliser consumption was that consumption in the base year (1950-51) was very low. This significant increase in total fertiliser consumption increased per hectare fertiliser use from less than one kg in 1951-52 to about 7 kg in 1966-67.

TABLE 1. GROWTH RATE IN FERTILISER CONSUMPTION AND FOODGRAINS PRODUCTION

(per cent)

Period (1)	Growth rate in fertiliser consumption: Total (2)	Growth rate in fertiliser consumption: Per ha (3).	Growth rate in foodgrains: Production (4)	Growth rate in foodgrains: Yield (5)
Pre-green revolution period (1950-51 – 1966-67)	19.41	18.11	2.56	1.45
Post-green revolution period	8.75	8.49	2.65	2.53
Phase I (1967-68 – 1980-81)	9.90	9.29	2.27	1.87
Phase II (1981-82– 1991-92)	7.39	6.61	2.77	3.13
Post-reforms period (1991-92 to 2009-10)	3.98	3.69	1.33	1.38
8th Five Year Plan	4.51	5.63	1.26	1.10
9th Five Year Plan	1.35	0.43	-2.87	-0.98
10th Five Year Plan	7.57	7.40	2.52	2.05

Source: Fertiliser Association of India (2010).

In the post-green revolution period, fertiliser use increased by 9.9 per cent per year during the first phase of green revolution (1967-68 to 1980-81) when the spread of high-yielding varieties was limited to mainly Punjab, Haryana, western part of Uttar Pradesh and some southern states. Per hectare fertiliser consumption increased from 9.4 kg in 1967-68 to 31.9 kg in 1980-81. Increase in fertiliser use along with increase in area under irrigation and high-yielding varieties increased foodgrain production from 95.5 million tonnes in 1967-68 to about 130 million tonnes in 1980-81 at an annual compound growth rate of 2.27 per cent. However, foodgrains productivity increased at a faster rate (1.87 per cent) in the first phase of green revolution compared with pre-green revolution period (1.45 per cent). During the second phase of green revolution (1981-82 to 1990-91), when technology spread to other parts of the country, total fertiliser consumption increased at an annual growth rate of 7.39 per cent. Per hectare fertiliser consumption more than doubled from 34.3 kg in 1981-82 to 69.8 kg in 1991-92. Total foodgrain production increased by about 2.8 per cent. The impressive growth of consumption of fertiliser in India in the post-green revolution period ensured increase in foodgrain production from 74.3 million tonnes in 1966-67 to 176.4 million tonnes during 1990-91.

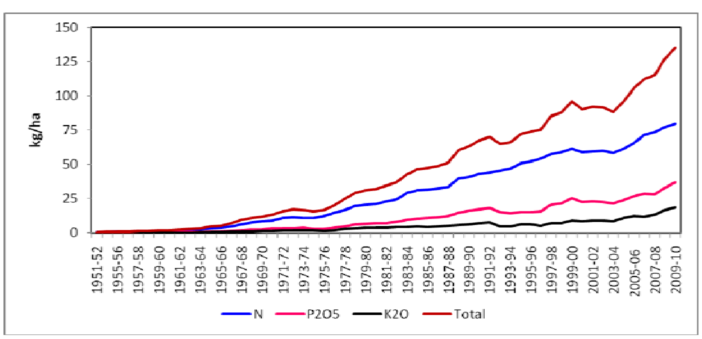
However, in 1991-92, certain policy reforms were initiated in the fertiliser sector as a part of macro-economic reforms. The potassic and phosphatic fertilisers were decontrolled w.e.f. August 25, 1992, the low analysis nitrogenous fertilisers, viz., calcium ammonium nitrate, ammonium chloride and ammonium sulphate were decontrolled and brought under control several times in the past. These fertilisers were last decontrolled w.e.f. June 10, 1994. These policy interventions led to a serious slowdown in fertiliser consumption in the post-reforms period. The total fertiliser consumption declined from about 12.7 million tonnes in 1991-92 to 12.1 million tonnes in 1992-93. Similarly, per hectare fertiliser use also declined from 69.84 kg in 1991-92 to 65.45 kg in 1992-93. This reduction was more pronounced in the case of phosphatic and potassic fertilisers. Total P consumption fell by about 14 per cent (from 3321.2 thousand tonnes in 1991-92 to 2843.8 thousand tonnes in 1992-93) and K by 35 per cent (1360.6 thousand tonnes in 1991-92 to 883.9 thousand tonnes in 1992-93). Similar trend was observed in the case of per hectare fertiliser consumption. Due to introduction of concession scheme on decontrolled phosphatic and potassic fertilisers in 1992-93, fertiliser consumption started picking up and reached a level of 18.1 million tonnes in 1999-2000, declined to 16.7 million tonnes in 2000-01 and remained below this level up to 2003-04. Per hectare fertiliser consumption reached a level of 95.89 kg in 1999-2000 but remained below this level during the next four years. The last six years, viz., 2004-05 to 2009-10 have seen significant recovery in fertiliser use in the country and total consumption reached a record level of 26.5 million tonnes and per hectare consumption at 135.25 kg in 2009-10.

The impact of slow growth of fertiliser consumption on growth of foodgrains production and crop output in the post-reforms period is quite evident from growth rates presented in Table 1. In post-reforms period (1991-92 to 2009-10) growth rate in fertiliser consumption was 3.98 per cent compared with over 8.75 per cent during 1966-67 to 1991-92. The total fertiliser consumption recorded the lowest growth (1.35 per cent) during the 9th Five Year Plan compared with about 7.57 per cent during 10th plan. There seems to be a very high positive association between growth rates of fertiliser consumption and foodgrains production. During 8th plan period fertiliser consumption increased at an annual growth rate of about 4.51 per cent and foodgrain production increased by 1.26 per cent. Fertiliser consumption growth rate fell to 1.35 per cent during the Ninth plan and the foodgrains production growth rate also declined to -2.87 per cent. During 10th five year plan, fertiliser consumption grew by 7.57 per cent and the foodgrains production growth rate increased to about 2.52 per cent. In the post-reforms period (1991-92 to 2009-10) growth rate in fertiliser consumption turned out to be less than half of what was achieved during the post-green revolution period (1966-67 to 1991-92). Similar trend was observed in the case of foodgrains production. Growth rate in foodgrains production declined to about half (1.33 per cent) during 1991-92 to 2009-10 compared with 2.65 per cent during 1967-68 to 1991-92.

2.4 *Intensity of Fertiliser Use*

Looking at the total fertiliser consumption is not a good indicator as there are large differences in the total cropped area across states. It would be more appropriate to examine the trends in fertiliser consumption per hectare of cropped area.

On per hectare basis, fertiliser consumption was less than 2 kg during the 1950s and increased to about 5 kg in 1965-66. However, after the introduction of green revolution in 1966-67, per hectare fertiliser consumption more than doubled in the next five years from about 7 kg in 1966-67 to about 16 kg in 1971-72, which further increased and reached a level of 50 kg in mid-1980s (Figure 6). The average fertiliser consumption on per hectare basis crossed 100 kg in 2005-06 and reached a record level of 135 kg in 2009-10. However, per hectare fertiliser consumption fell during 1973-74 and 1974-75 due to oil shock of 1973 when oil prices quadrupled almost overnight. The next reversal in the intensity of fertiliser use came in 1992-93 when government decontrolled phosphatic and potassic fertilisers and increased fertiliser prices significantly. The decline in the use of fertilisers was the highest (36.3 per cent) in the case of potassic and about 16 per cent in phosphatic fertilisers. The total fertiliser consumption (N+P+K) fell by about 6 per cent from 69.84 kg per hectare to

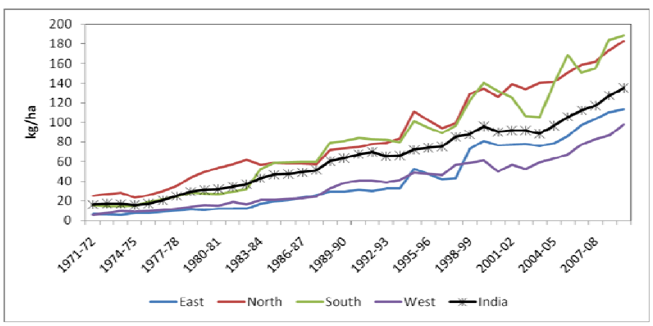


Source: Fertiliser Association of India (2010).

Figure 6. Trends in Consumption of Plant Nutrients (N, P and K) Per Hectare of Gross Cropped Area in India: 1951-52 to 2009-10

65.45 kg per hectare. Due to severe drought in many parts of the country, per hectare fertiliser consumption declined from 91.64 kg in 2002-03 to 88.38 kg per hectare in 2003-04. However, during the last five years, the intensity of fertiliser use has increased substantially (53 per cent) from about 88 kg in 2005-06 to 135 kg per hectare in 2009-10.

Figure 7 examines the trends in the intensity of fertiliser consumption in terms of kg per hectare of total cropped area by region from 1971-72 to 2009-10. Overall, the average intensity of fertiliser use in the country increased from about 16 kg per hectare in 1971-72 to 135 kg per hectare in 2009-10. This level has been lower than that of the north and south regions whose average intensity has been about 91.5 kg per hectare between 1971-72 and 2009-10 with a low of 23.1 kg in 1974-75 and a peak of 182.9 kg per hectare in 2009-10 in the case of north region and about 85 kg per hectare on an average with a low of 14.9 kg in 1973-74 and a peak of 188.3 kg in 2009-10 in south region.

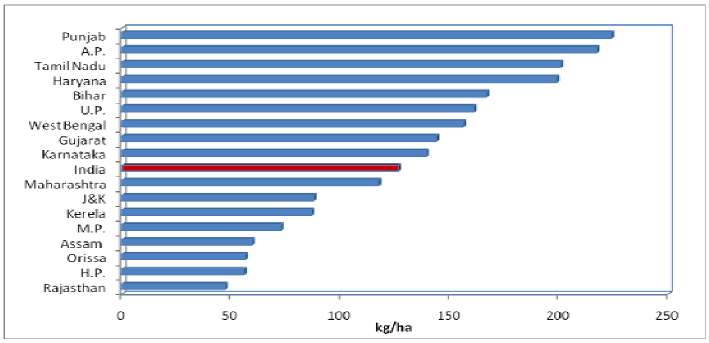


Source: Fertiliser Association of India (2010).

Figure 7. Intensity of Fertiliser Use by Region: 1971-72 to 2009-10

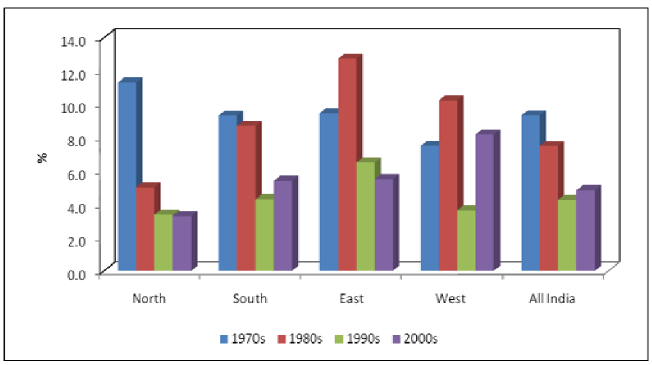
Fertiliser consumption in India is highly skewed, with wide inter-regional, inter-state, inter-district and inter-crop variations. The intensity has generally been higher in the northern (91.5 kg/ha average) and southern (85.3 kg/ha average) regions and lower in the eastern (44.7 kg/ha) and western regions (40.7 kg/ha). Sustained growth in intensity is quite apparent in all the regions. However, some of these regional averages are heavily influenced by individual state observations (Figure 8). For example, during the triennium ending (TE) 2009-10, in the western region, Gujarat had a high rate of 143.8 kg per hectare while Rajasthan had a very low rate of 47.1 kg per hectare. Similarly, in the northern region, Punjab had a very high level of 223.9 kg per hectare while Himachal Pradesh had a low rate of about 55.7 kg. Similar variations are quite apparent in other regions as well.

Region-wise trends in growth rates of per hectare fertiliser use are given in Figure 9. The figure shows that during the 1970s, north zone registered the highest growth (11.3 per cent), while western region had the lowest growth rate (7.5 per cent). The high growth in consumption of fertiliser in the northern region was due to spread of high-yielding varieties and expansion of irrigation facilities in late 1960s and 1970s.



Source: Fertiliser Association of India (2010).

Figure 8. Per Hectare Fertiliser Use by States, TE 2009-10 (kg/ha)



Source: Fertiliser Association of India (2008).

Figure 9: Region-Wise Decennial Growth (CAGR) in Intensity of Fertiliser Consumption in India

During the decade of eighties, new technology spread to other regions of the country (east and western region) which led to increase in the consumption of fertilisers in these regions. The eastern region experienced the highest growth (12.7 per cent), followed by western region (10.2 per cent). During the 1990s, growth in intensity of fertiliser use decelerated in all regions and western region had the highest growth rate (8.2 per cent). This growth in the western region was driven by high rate of growth in states like Gujarat (9.6 per cent) and Madhya Pradesh (8.9 per cent). At the all-India level growth rate in per hectare fertiliser consumption was the highest (9.3 per cent) during the 1970s, which declined to 7.5 per cent in the 1980s and 4.3 per cent in the 1990s. However, the growth rate improved in the 2000s and reached a level of 4.8 per cent.

2.5 *State-Level Trends*

Table 2 shows the fertiliser use trends in different states in the country. The states are sub-divided by row into those with lower versus higher fertiliser use intensity (defined as using less than national average of 126.5 kg per hectare of fertiliser nutrients during the TE 2009-10 versus those using more than national average during that period), and they are sub-divided by column into those with low versus high growth in fertiliser use intensity (defined as having recorded less than or more than national average of 40.5 per cent increase in mean levels of fertiliser use between TE 1999-2000 and 2009-10.

TABLE 2. FERTILISER USE INTENSITY AND GROWTH IN FERTILISER USE INTENSITY, BY STATES

Intensity of fertiliser use (kg/ha) (1)	Per cent growth in fertiliser use intensity	
	≥ National average (40.5 per cent) (2)	< National average (3)
≥ National average during TE 2009-10 (≥126.5)	Puducherry (903.2, 80.1 per cent) Andhra Pradesh (217.2, 43.4 per cent) Haryana (199.0, 40.6 per cent) Bihar (166.7, 83.4 per cent) Gujarat (143.8, 50.9 per cent) Karnataka (139.2, 41.7 per cent)	Punjab (223.9, 27.9 per cent) Tamil Nadu (200.6, 31.3 per cent) Uttar Pradesh (160.8, 34.3 per cent) West Bengal (156.2, 29.6 per cent)
<National average during TE 2009-10 (<126.5)	Maharashtra (117.2, 46.2 per cent) Jammu & Kashmir (87.7, 46.4 per cent) Madhya Pradesh (72.5, 52.7 per cent) Assam (59.3, 172.0 per cent) Orissa (56.2, 55.9 per cent) Himachal Pradesh (55.7, 45.2 per cent) Mizoram (47.4, 341.6 per cent) Tripura (45.8, 110.3 per cent)	Kerala (86.7, 28.2 per cent) Manipur (72.3, -12.2 per cent) Rajasthan (47.1, 26.2 per cent) Meghalaya (13.9, -10.9 per cent) Arunachal Pradesh (2.9, 20.8 per cent) Nagaland (2.3, -24.2 per cent)

Source: Fertiliser Association of India (2010).

Note: Growth in fertiliser use is defined as the per cent increase in mean fertiliser use intensity between the TE 1999-00 and the TE 2009-10. Figures in parentheses are the mean fertiliser use intensity for TE 2009-10, and the per cent increase in fertiliser use intensity as defined above.

Of the 10 states using higher than national average fertiliser use intensity during the TE 2009-10, six of them displayed significant growth (>national average of 40.5 per cent) in fertiliser consumption between TE 1999-2000 and TE 2009-10, while four states (Punjab, Tamil Nadu, Uttar Pradesh and West Bengal) achieved less than national average growth. Per hectare fertiliser use in Bihar achieved the highest growth (83.4 per cent), followed by Puducherry (80.1 per cent), Gujarat (50.96 per cent) and Andhra Pradesh (43.4 per cent). Of the 14 states having less than national average fertiliser intensity, 8 states recorded moderate increase while three north-eastern states, Manipur, Meghalaya and Nagaland recorded negative growth. Of the 11 states having positive growth, 8 states performed well and the average fertiliser use increased more than national average and remaining three states (Kerala, Rajasthan and Arunachal Pradesh) recorded lower than national growth.

At least one encouraging point emerges from this analysis. Even though fertiliser application levels throughout eastern and north-eastern regions generally remain low, almost all states in the region except Manipur, Meghalaya and Nagaland achieved impressive growth in fertiliser use over the past decade. This growth must be sustained, increased, and expanded to achieve levels of productivity growth needed to significantly reduce poverty in the region.

The average intensity of fertiliser use in India at national level is still much lower than in other developing countries but there are many disparities in fertiliser consumption patterns both between and within regions of India. Table 3 presents classification of districts according to range of fertiliser consumption per hectare of cropped area during the last three and half decades. During the TE 1986-87, only three districts were using more than 200 kg per hectare of fertiliser and another 12 districts were consuming between 100 to 150 kg/ha of fertiliser. In contrast, about 60 per cent of the districts were using less than 50 kg fertiliser (N+P+K) per hectare. However, the number of districts in high-fertiliser use category (>200kg/ha) has increased significantly during the second-half of nineties and 2000s. In the TE 1999-2000, out of 470 districts, 31 districts (6.6 per cent) were using more than 200 kg per hectare, while about one-third of the districts were consuming less than 50 kg. Between the TE 2002-03 and TE 2009-10, number of districts consuming higher than 200 kg/ha more than tripled from 36 in TE 2002-03 to 112 in TE 2009-10.

TABLE 3. CLASSIFICATION OF DISTRICTS ACCORDING TO RANGES OF FERTILISER CONSUMPTION (N + P + K)

Consumption (kg/ha) (1)	TE 1986-87 (2)	TE 1989-90 (3)	TE 1993-94 (4)	TE 1996-97 (5)	TE 1999-2000 (6)	TE 2002-03 (7)	TE 2009-10 (8)
Above 200	3	5	9	13	31	36	112
	(0.9)	(1.4)	(2.3)	(3.1)	(6.6)	(7.5)	(20.77)
150-200	12	21	29	36	45	47	76
	(3.4)	(5.7)	(7.4)	(8.6)	(9.6)	(9.7)	(14.20)
100-150	32	42	59	60	94	92	105
	(9.2)	(11.4)	(15.1)	(14.4)	(20.0)	(19.0)	(19.47)
75-100	34	46	56	59	62	61	64
	(9.7)	(12.5)	(14.4)	(14.1)	(13.2)	(12.6)	(11.84)
50-75	55	70	77	73	78	79	63
	(15.8)	(19.0)	(19.7)	(17.5)	(16.6)	(16.4)	11.72)
25-50	92	85	79	93	80	97	66
	(26.4)	(23.1)	(20.3)	(22.2)	(17.1)	(20.1)	(12.28)
<25	121	99	81	84	79	71	52
	(34.7)	(26.9)	(20.8)	(20.1)	(16.8)	(14.7)	(9.73)
Total	349	368	390	418	469	483	538
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Source: Fertiliser Association of India (2008).
Figures in parentheses show per cent to total number of districts.

In TE 2009-10, 112 out of 538 districts (20.8 per cent) consumed more than 200 kg per hectare, 76 districts between 150-200 kg, 105 districts between 100-150 kg and 127 districts between 50-100 kg/ha. About 22 per cent of the districts had less than 50 kg/ha fertiliser use, much lower than recommended levels. Further, less than 20 per cent of the districts accounted for about half of total fertiliser consumption in the country, indicating a high degree of concentration of fertiliser use. So, there are two extremes, (i) districts/areas having consistently high levels of fertiliser use and (ii) areas using less than recommended levels of fertilisers. The low level of fertiliser use is because of lack of awareness, non-availability of credit for buying fertilisers, timely and easy availability of fertilisers and other complementary inputs like irrigation, better seed, etc.

Increasing number of districts consuming consistently higher amounts of fertiliser (>200 kg/ha) is a cause of concern as it might lead to environmental degradation particularly land and water resources. On the other hand, still one-fourth of the districts use less than 50 kg/ha of fertilisers. Therefore, there is a need to have two pronged strategy, (i) to monitor districts with high intensity of consumption and take corrective actions to reduce environmental degradation and (ii) to promote fertiliser consumption in low-use districts to improve crop productivity.

III

FACTORS AFFECTING DEMAND FOR CHEMICAL FERTILISERS IN INDIA

The purpose of this section is to estimate three nutrients and total fertiliser demand functions from time series data and to make demand projections for proper planning for production, imports and supply of feedstocks and raw materials. To this end, separate nutrient demand functions were estimated for nitrogen (N), phosphorous (P), potassium (K) and total fertilisers (N+P+K) in the country. The fertiliser demand function is often referred to as a "derived" demand because it is determined to a large extent by the final demand for the crop produced. In general, the demand for fertiliser depends on (a) the price of the crop(s), (b) the price of fertiliser, (c) prices of other inputs that substitute for or complement fertiliser, and (d) the parameters of the production function that describe the technical transformation of the inputs into an output (i.e., the fertiliser response function) (Debertin, 1986). Though prices may be important in determining fertiliser consumption, they are possibly less important than other non-price factors such as introduction of new technology, high yielding crop varieties, expanded irrigation, availability of credit, changing cropping pattern, etc., causing the derived demand for fertilisers to shift over time.

Specifying a forecasting model is always a challenge, especially the model type and relevant variables. The common models are time series models where the forecast is based on past observations of the variable being forecasted. Causal models and qualitative methods have also been used. Causal models such as simple linear regression model are preferable when projections of the exogenous variables are available. Qualitative methods such as expert opinion are popular when insufficient data is available to estimate a model or when there is a need to augment the results of a quantitative method. In a single equation approach, which has been used widely, typically demand function is estimated using time series of total fertiliser use or per hectare use with some price and non-price variables and often a linear trend. This study uses causal model because time series data on fertiliser consumption as well as variables influencing fertiliser use are available.

We estimated fertiliser demand model using annual time series data, from 1976-77 to 2009-10 using simple linear regression model with ordinary least squares (OLS) method. We hypothesised that the demand for fertiliser is a function of prices (specifically price of fertilisers and foodgrains), subsidy, as well as non-price factors such as irrigated area, coverage of high yielding varieties, area under foodgrains and non-foodgrains, cropping intensity, rainfall, credit availability, etc. Among a large number of factors considered in the study, the following variables were finally used in the model based on their statistical significance and stability of the functional relationship to estimate demand for the period 2010-11 to 2020-21. The empirical model for the fertiliser use is specified as follows:

$$F_{it} = b_0 + b_1\, HYV_t + b_2\, GIA_t + b_3\, Pfert_{it} + b_4\, Pr{+}w_t + b_5\, Credit_t + U_t$$

Where, F_{it} is fertiliser consumption; i denotes three nutrients N, P and K and total (N+P+K) fertiliser consumption in thousand tonnes; t denotes year.

The following independent variables were hypothesised to influence the consumption positively (+), negatively (-), or either negatively or positively (+/-):

HYV = Percentage of area under HYV to gross cropped area (+)

GIA = Percentage of gross irrigated area to gross cropped area (+)

P_{fert} = Prices of fertilisers are represented by price of N through Urea, average price of P through DAP and SSP, price of K through MOP and N+P+K price is the price of N, P and K and weighted by their consumption shares (-)

P_{r+w} = Output price is represented by procurement price of rice and wheat (main users of fertilisers) and weighted by the share of their production (+)

Credit = Short term production credit per hectare of gross cropped area (Rs.)(+).

Two forms of functions, namely, linear and Cobb-Douglas, were tried in this analysis. The results of linear regression equation were used for interpretation as it was found better when compared with Cobb-Douglas production function.

IV

RESULTS AND DISCUSSION

4.1 *Factors Affecting Fertiliser Use*

The regression estimates for total fertiliser consumption equation are reported in Table 4. The high R^2 value (0.99) indicates that explanatory variables in the model have accounted for over 99 per cent variation in fertiliser use and the model best fits when predicting fertiliser demand. The model was significant at 1 per cent level. The Durbin-Watson d statistics (1.909) is higher than the tabulated upper critical value d_U and therefore we can assume that there is no first order linear autocorrelation in the data.

TABLE 4. ESTIMATED REGRESSION EQUATION FOR TOTAL FERTILISER (N+P+K) USE IN INDIA

(1)	Coefficient (2)	Standard error (3)	't' value (4)	Rank† (5)
Constant	-1408.4568	2648.9819	-5.5884	-
HYV	146.9110***	45.9242	3.1990	3
GIA	631.5272***	132.8878	4.7523	1
P_{fert}	-890.2523***	173.7227	-5.1246	2
P_{r+w}	8.4637**	3.7582	2.2520	4
Credit	0.0203**	0.0106	1.9151	5
Adj. R Square	0.9894	-	-	-
F	617.3203***	-	-	-
D-W statistics	1.909	-	-	-

***, ** and * Significant at 1, 5 and 10 per cent level, respectively.

Notes: †Based on standardised coefficients (ignoring signs) given coefficients x (s.d. of X_i/s.d of Y_i), where s.d. is standard deviation, X_i is i-th explanatory variable and Y_i is the dependent variable.

All explanatory variables used in the model were statistically significant and had theoretically expected signs. The price of fertilisers was negatively related with fertilisers demand while area under high-yielding varieties, irrigation, price of output and credit had a positive relationship with fertiliser demand. The results show that non-price factors were more important determinants of fertiliser use. Among the non-price factors, irrigation was the most important factor influencing fertiliser demand. The price of fertilisers was the second important determinant of fertiliser use in the country. Price of output is less important compared with fertiliser price. The results clearly indicate that increase in area under irrigation, and high yielding varieties will accelerate fertiliser consumption in the country. In case of pricing policy instruments, increase in prices of fertilisers would lead to reduction in fertiliser use while output price had a positive impact on fertiliser consumption but was less powerful than input prices. Therefore, it is necessary to prioritise input price policy mechanism over higher output prices as high output price benefits a small proportion of farmers who have net marketed surplus while low and affordable fertiliser prices will increase the fertiliser consumption of millions of marginal and small farmers. As per All India Report on Input Survey 2001-02, percentage of gross irrigated area treated with chemical fertilisers to the corresponding gross irrigated area was the highest (94.2 per cent) in marginal holdings and declined with the increase in size of holdings. In unirrigated areas also, percentage of area treated with chemical fertilisers to the corresponding gross unirrigated area decreased with the increase in size of holdings from small group to large size group (Government of India, 2008).

Table 5 presents results for the N, P and K fertiliser consumption regression analysis. The results from this model suggest that the regression model provided the best fit to the fertiliser consumption data. The R^2 value was highly significant at one per cent level of significance with the value ranging from 0.97 for K fertilisers to 0.99 for N fertilisers, indicating that over 97 per cent of variation in demand for fertilisers was explained by the explanatory variables included in the model.

TABLE 5. ESTIMATED REGRESSION EQUATIONS FOR N, P AND K FERTILISER USE IN INDIA

	N	P	K
(1)	(2)	(3)	(4)
Constant	-9116.5817	-5000.3107	-1319.4242
	(1689.1581)	(1018.6072)	(578.6492)
GIA	105.4004***	19.3220**	2.9352
	(30.2546)	(10.6246)	(8.7962)
HYV	390.3286***	209.2644***	68.3819**
	(42.6439)	(50.4574)	(28.6965)
P_{fert}	-506.3841***	-177.1320***	-88.7616***
	(111.4466)	(30.8959)	(28.4907)
P_{r+w}	2.5956	3.7466***	0.1859
	(2.0189)	(1.4537)	(0.7765)
Credit	0.0113*	0.0001	0.0164***
	(0.0085)	(0.0066)	(0.0034)
Adj. R Square	0.9893	0.9782	0.9677
F	613.5342***	297.1124***	198.6137***
D-W statistics	1.878	1.381	2.153

***, ** and * Significant at 1, 5 and 10 per cent level respectively.

As expected, technological factors such as high-yielding varieties, irrigation and agricultural prices had a positive impact on N fertiliser consumption. Availability of credit also influenced N consumption positively. Price of fertiliser had a significant negative impact on N fertiliser use. Non-price factors, namely, irrigation and high yielding varieties, were more powerful in influencing N consumption compared with price factors. Price of N fertilisers was the third important determinant of fertiliser demand. Between, input price and price of agricultural output, price of input (N fertiliser) was more powerful in influencing the consumption. These results were very similar to total fertiliser consumption results.

For P fertilisers, the variables included in the model explained about 98 per cent of the variation in consumption of phosphatic fertilisers in the country. All the variables included in the model had expected sign (except for credit) and were statistically significant. Irrigation was the most important factor influencing P consumption. The variables included in the K fertilisers consumption model explained about 97 per cent of the total variation in fertiliser use. As expected, irrigation and access to credit had significant positive impact on K fertiliser consumption, while price of fertiliser had an adverse effect on fertiliser consumption. This is logical and expected, as farmers grow fertiliser-intensive crops under irrigated conditions and there is high degree of complementarity between irrigation and fertiliser consumption. Price of K fertilisers was the third important factor affecting fertiliser demand while price of output was less powerful than fertiliser prices in influencing fertiliser demand.

The above results clearly indicate that non-price factors such as irrigation and high-yielding varieties were more powerful in influencing demand for fertilisers compared with price factors. Within price factors, price of fertilisers had an adverse affect on fertiliser consumption and was more powerful than output price. The results suggest that in order to increase fertiliser consumption in the country, the policymakers should prioritise non-price factors like better irrigation facilities, high-yielding varieties, easy access to credit, etc., over agricultural price policy as an instrument. Second, between output and input prices, there is a need to keep fertiliser prices at affordable level as they are more powerful in influencing fertiliser demand than higher output prices.

4.2 *Fertiliser Demand Projections*

Based on the estimated regression results and the projected values of the explanatory variables, we forecasted the demand for fertiliser in the years 2016-17 and 2020-21. The demand forecasts have been made assuming the growth in explanatory factors according to the last five year time trend (2005-06 to 2009-10) except in case of P and K fertiliser prices where we have assumed an increase of about 5 per cent per year. A comparison between the actual fertiliser nutrients consumption and model estimated consumption (Figure 10) shows the model tracks historical data well.

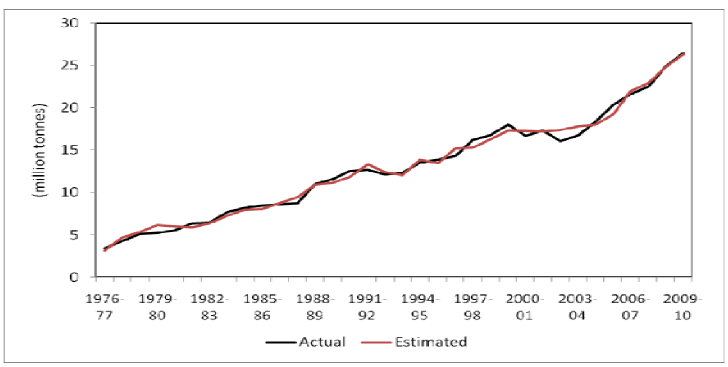


Figure 10. Trends in Actual and Estimated Consumption of Fertiliser Nutrients (million tonnes) in India: 1976-77 to 2009-10

The fertiliser requirement forecasts shown in Table 6 were generated by an estimated model using historical fertiliser consumption data. The total demand for fertilisers (N+P+K) is projected to increase to about 36 million tonnes by 2016-17 and over 41 million tonnes by 2020-21. The demand for N is expected to increase to about 20.6 million tonnes and 23.7 million tonnes during the corresponding period. In case of P fertilisers demand is projected at 9.6 million tonnes in 2016-17 and 10.7 million tonnes in 2020-21. For K fertilisers, the demand is projected to reach about 5.6 million tonnes and 6.8 million tonnes by 2016-17 and 2020-21, respectively.

In view of the recent increase in fertiliser prices, we estimated demand forecasts for fertiliser nutrients assuming 10 per cent increase per annum in N, P and K prices and the results are presented in Table 6. The results clearly show that demand for N fertilisers is more price sensitive compared with P and K fertilisers. The total demand

TABLE 6. ANNUAL FERTILISER NUTRIENT PROJECTIONS FOR 2016-17 AND 2020-21

(*million tonnes*)

	N	P	K	N+P+K	Total*
(1)	(2)	(3)	(4)	(5)	(6)
2010-11	16.0	7.5	3.8	27.3	27.5
	(16.0)	(7.2)	(3.8)	(27.0)	(27.1)
2011-12	16.7	7.9	4.2	28.7	29.0
	(16.2)	(7.4)	(4.1)	(27.7)	(27.7)
2012-13	17.5	8.2	4.5	30.2	30.4
	(16.3)	(7.6)	(4.3)	(28.2)	(28.1)
2013-14	18.3	8.6	4.8	31.6	31.9
	(16.4)	(7.7)	(4.6)	(28.6)	(28.5)
2014-15	19.0	8.9	5.0	33.0	33.3
	(16.4)	(7.8)	(4.8)	(29.0)	(28.7)
2015-16	19.8	9.2	5.3	34.4	34.7
	(16.3)	(7.8)	(5.1)	(29.2)	(28.7)
2016-17	20.6	9.6	5.6	35.8	36.1
	(16.1)	(7.8)	(5.3)	(29.2)	(28.6)
2017-18	21.4	9.9	5.9	37.1	37.5
	(15.9)	(7.7)	(5.5)	(29.1)	(28.3)
2018-19	22.1	10.2	6.2	38.5	38.9
	(15.5)	(7.6)	(5.7)	(28.8)	(27.8)
2019-20	22.9	10.5	6.5	39.9	40.3
	(15.0)	(7.5)	(5.9)	(28.4)	(27.0)
2020-21	23.7	10.7	6.8	41.2	41.6
	(14.4)	(7.2)	(6.0)	(27.7)	(26.1)

Figures in parentheses indicate demand for fertiliser nutrients under the assumption that fertiliser prices will increase by 10 per cent per year.

Notes: *Projections for total nutrients demand is based on regression equation estimated for total fertiliser nutrient consumption while demand forecasts for N+P+K are sum of demand for N, P and K estimated by regression equations for N, P and K separately. Therefore there is a marginal difference between two estimates.

for fertilisers (N+P+K) is projected to stagnate at about 29 million tonnes by 2015-16 and decline after 2016-17 if price increases by about 60-70 per cent. The demand for N is expected to stagnate at about 16.4 million tonnes and P fertilisers at about 7.8 million tonnes by 2013-14 and 2014-15, respectively. The high fertiliser prices are deterrents to affordability and indirectly to accessibility of fertilisers for small and marginal farmers. Therefore, there is a need to make fertilisers available at a price affordable to the farmers since most of them (about 83 per cent) are small and marginal farmers with land holdings less than two hectares. The low fertiliser prices serve twin purpose of making fertiliser consumption more affordable and also keep market prices of foodgrains somewhat low, which benefit the consumers in general. Although affordability is key, promotion of fertiliser use should also emphasise on non-pricing policies such new technologies, better extension services, credit to relieve cash constraints, use of complementary inputs such as irrigation water, improved seeds, etc.

The demand for fertiliser products such as urea, DAP, SSP, MOP and complex fertilisers was estimated by using averages of their percentage shares in N, P and K consumption, respectively, using data over the period 2005-06 to 2009-10 (Table 7). Taking into account the average consumption level of 80.9 per cent of N through urea, 63 per cent of P through DAP, 29.3 per cent through complex fertilisers, 7.2 per cent P through SSP and 70.1 per cent K through MOP during 2005-06 and 2009-10, the product-wise demand for fertiliser products for the period 2016-17 and 2020-21 were worked out and the figures are presented in Table 8.

TABLE 7. SHARE OF MAJOR FERTILISER PRODUCTS IN TOTAL CONSUMPTION OF N, P AND K NUTRIENTS: 2005-06 TO 2009-10

Year (1)	Share of urea in total N (2)	Share of DAP in total P (3)	Share of SSP in total P (4)	Share of MOP in total K (5)	Share of complex fert. in total P (6)
2005-06	80.6	59.8	8.5	67.9	30.1
2006-07	81.3	61.2	8.4	66.4	28.7
2007-08	82.8	63	7	65.6	29.8
2008-09	81.2	65.3	6.4	73.9	28.1
2009-10	78.8	66	6	76.5	27.9
Average	80.9	63.0	7.2	70.1	29.3

Source: FAI (2010).

TABLE 8. FERTILISER PRODUCT DEMAND FORECASTS FOR 2010-11 AND 2020-21

(million tonnes)

(1)	Urea (2)	DAP (3)	SSP (4)	MOP (5)	Complex fertilisers (6)
2010-11	28.1	10.3	3.4	4.5	8.9
2011-12	29.4	10.8	3.5	4.8	9.3
2012-13	30.8	11.3	3.7	5.2	9.8
2013-14	32.1	11.7	3.9	5.6	10.2
2014-15	33.5	12.2	4.0	5.9	10.6
2015-16	34.8	12.6	4.2	6.2	11.0
2016-17	36.2	13.1	4.3	6.6	11.3
2020-21	41.6	14.7	4.8	7.9	12.7

The demand for urea is projected to be around 36.2 million tonnes by 2016-17 and reach a level of 41.6 million tonnes by 2020-21. The demand for DAP, complex fertilisers (excluding DAP) and SSP would be nearly 13.1, 11.3 and 4.3 million tonnes in 2016-17 and 14.7, 12.7 and 4.8 million tonnes by 2020-21. The demand for MOP would be around 6.6 million tonnes by 2016-17 and 7.9 million tonnes in 2020-21. These projections of demand for fertiliser products are based on the existing product nutrient ratio. However, with the introduction of nutrient-based subsidy (NBS) scheme and programmes like national project on Management of Soil and Fertiliser Health to promote balanced use of fertiliser nutrients, the demand for SSP and complex fertiliser might increase at a faster rate in the coming years.

Region-wise Demand for Fertilisers

Table 9 shows the share of different regions in all-India consumption of fertiliser nutrients during the last five years from 2005-06 to 2009-10. The share of consumption of N is the highest (36.2 per cent) in North region, followed by West (27.9 per cent), South (21.8 per cent) and the lowest in East region (14.1 per cent).

TABLE 9. REGION-WISE SHARE TO ALL-INDIA CONSUMPTION OF FERTILISER NUTRIENTS: 2005-06 TO 2009-10 AVERAGE

(*per cent)*

(1)	N (2)	P (3)	K (4)
East	14.1	13.8	21.1
North	36.2	26.7	11.8
South	21.8	26.0	41.1
West	27.9	33.5	26.0

Source: Fertiliser Association of India (2010).

TABLE 10. ZONE-WISE FERTILISER NUTRIENTS DEMAND FORECASTS FOR 2016-17 AND 2020-21

(million tonnes)

(1)	N (2)	P (3)	K (4)	Total (5)
		East Zone		
2010-11	2.3	1.0	0.8	4.1
2011-12	2.4	1.1	0.9	4.3
2012-13	2.5	1.1	0.9	4.6
2013-14	2.6	1.2	1.0	4.8
2014-15	2.7	1.2	1.1	5.0
2015-16	2.8	1.3	1.1	5.2
2016-17	2.9	1.3	1.2	5.4
2020-21	3.4	1.5	1.4	6.3
		North Zone		
2010-11	5.8	2.0	0.5	8.2
2011-12	6.0	2.1	0.5	8.6
2012-13	6.3	2.2	0.5	9.0
2013-14	6.6	2.3	0.6	9.5
2014-15	6.9	2.4	0.6	9.9
2015-16	7.2	2.5	0.6	10.3
2016-17	7.4	2.5	0.7	10.7
2020-21	8.6	2.9	0.8	12.2
		South Zone		
2010-11	3.5	2.0	1.6	7.0
2011-12	3.6	2.0	1.7	7.4
2012-13	3.8	2.1	1.8	7.8
2013-14	4.0	2.2	2.0	8.2
2014-15	4.2	2.3	2.1	8.5
2015-16	4.3	2.4	2.2	8.9
2016-17	4.5	2.5	2.3	9.3
2020-21	5.2	2.8	2.8	10.7
		West Zone		
2010-11	4.4	2.5	1.0	8.0
2011-12	4.7	2.6	1.1	8.4
2012-13	4.9	2.8	1.2	8.8
2013-14	5.1	2.9	1.2	9.2
2014-15	5.3	3.0	1.3	9.6
2015-16	5.5	3.1	1.4	10.0
2016-17	5.7	3.2	1.5	10.4
2020-21	6.6	3.6	1.8	12.0

The share of P in total nutrient consumption is the highest in West zone (35.5 per cent), followed by North (26.7 per cent), South (26.0 per cent) and the East (13.8 per cent). In case of K fertiliser nutrients, the share of South region is the highest (41.1 per cent), followed by West (26 per cent), East (21.1 per cent) and the lowest (11.8

per cent) in North zone. Based on these regional shares, zone-wise demand forecasts of fertiliser nutrients were worked out under different scenarios and the results are presented in Table 10.

Total demand for fertilisers (N+P+K) in the eastern region is projected to reach a level of about 5.4 million tonnes by the end of 2016-17 and 6.3 million tonnes by 2020-21. In case of North region, total fertiliser demand is expected to be about 10.7 million tonnes in 2016-17, and in South and Western region about 9.3 and 10.4 million tonnes, respectively. The demand for fertilisers is projected to reach about 12.2 million tonnes in north, 10.7 million tonnes in South and 12 million tonnes in Western region by 2020-21. But with renewed focus on agricultural development in the eastern region we expect the demand for fertilisers to increase at a faster rate in the region. The highest increase in fertiliser consumption is expected in the southern region, followed by east, north and western regions.

V

SUMMARY AND CONCLUSIONS

With the limited arable land resources and burden of increasing population, development of new technologies and efficient use of available technologies and inputs will continue to play an important role in sustaining food security in India. It is expected that India's available arable land might drop below the current level of about 140 million hectares, if the use of farmland for commercial/non-agricultural purpose is not restricted in the near future. Therefore, the only way to improve food production is to increase crop yields through the scientific use of fertilisers along with other inputs like high-yielding variety seeds, irrigation, etc. using the limited arable land, with an emphasis on protecting the environment.

The Government of India has been consistently pursuing policies conducive to increased availability and consumption of fertilisers in the country. Over the last four and half decades, production and consumption of fertilisers has increased significantly. The country had achieved near self-sufficiency in N and P, with the result that India could manage its requirement of these fertilisers from indigenous industry and imports of all fertilisers except K were nominal. However, during the last 5-6 years there has been a significant increase in imports of N and P as well because there has not been any major domestic capacity addition due to uncertain policy environment. Indian imports, which were about 2 million tonnes in early part of 2000, increased to 10.2 million tonnes of fertilisers in 2008-09.

India was the third largest producer of fertilisers in the world next to China and USA and the second largest consumer after China during 2008. The overall consumption of fertilisers in the country has increased from 65.6 thousand tonnes in 1951-52 to 26.49 million tonnes in 2009-10. Accordingly, per hectare consumption of fertilisers, which was less than one kg in 1951-52, has gone up to the level of 135 kg in 2009-10. The average intensity of fertiliser use in India at the national level is still much lower than in other developing countries but there are many disparities in fertiliser consumption patterns both between and within regions of India. The intensity of fertiliser use varied greatly from about 48 kg per hectare in Rajasthan to as high as 237 kg per hectare in Punjab. The fertiliser use has generally been higher in the northern (91.5 kg/ha average) and southern (85.3 kg/ha average) region and lower in the eastern (44.7 kg/ha) and western region (40.7 kg/ha). In the TE 2009-10, 112 out of 538 districts (20.8 per cent) consumed more than 200 kg per hectare, 76 districts between 150-200 kg, 105 districts between 100-150 kg and 127 districts between 50-100 kg/ha. About 22 per cent of the districts had less than 50 kg/ha fertiliser use, much lower than recommended levels. Between the TE 2002-03 and TE 2009-10, number of districts using more than 200 kg/ha more than tripled from 36 in TE 2002-03 to 112 in TE 2009-10. Further about 18 per cent of the districts in the country account for half of total fertiliser use while bottom half of the districts account for only 15 per cent of total fertiliser used in the country. Therefore, there is a need to have two pronged strategy, (i) to monitor districts with high intensity of consumption and take corrective actions to reduce environmental degradation and (ii) to promote fertiliser consumption in low-use districts to improve crop productivity.

While examining the major determinants of fertiliser use, it was found that non-price factors such as irrigation and high yielding varieties were more important in influencing demand for fertilisers. Of the two price policy instruments, affordable fertiliser prices and higher agricultural commodity prices, the former is more powerful in influencing fertiliser consumption. The high product price support policy benefits large farmers who have net marketed surplus while low input prices benefit all categories of farmers in general and small and marginal farmers in particular. Therefore, in order to ensure self-sufficiency in foodgrain production in the country, availability of fertilisers at affordable prices to the producers is of utmost importance. The government should give due importance to non-price factors like better seeds, irrigation, credit, etc. to increase fertiliser use in the country. For this, more investment in irrigation, agricultural research and development, extension services and infrastructure are indispensable in the context of a country like India. The results also suggest fertiliser subsidy to be more appropriate means to achieve the stated objectives compared with product price support policy. However, there is a need to contain and target these subsidies in a better way.

By 2020, fertiliser demand in the country is projected to increase to about 41 million tonnes 23.7 million tonnes of N, 10.7 million tonnes of P and 6.8 million tonnes of K. However, high fertiliser prices are the deterrents to affordability and indirectly to accessibility of fertilisers for small and marginal farmers. The total demand for fertilisers (N+P+K) is projected to stagnate at about 29 million tonnes by 2015-16 and decline thereafter if price increases significantly. The projected fertiliser demand in the eastern and southern regions is expected to grow at a faster rate compared with north and west. To meet the projected demand of over 41 million tonnes in 2020, additional capacity will be needed. Overall, a conducive and stable policy environment, availability of raw materials, capital resources and price incentives will play a critical role in meeting the fertiliser requirements of the country.

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NOTE

1. The Retention Price Scheme (RPS) for fertiliser Industry was first introduced for nitrogenous fertilisers in November, 1977 and was extended to complex fertilisers in February, 1979 and Single Super Phosphate (SSP) in 1982 and remained in force for urea till 31.3.2003. Under the RPS, Retention Price was fixed for each fertiliser unit by the government based on the capacity utilization, consumption of inputs, etc. This ex-factory price was referred to as Retention Price and a post-tax return of 12 per cent on networth was provided as a reasonable return in this mechanism. The difference between the Retention Price and the maximum retail price was paid as subsidy.

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