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Fertiliser Growth, Imbalances and Subsidies : Trends and Implications

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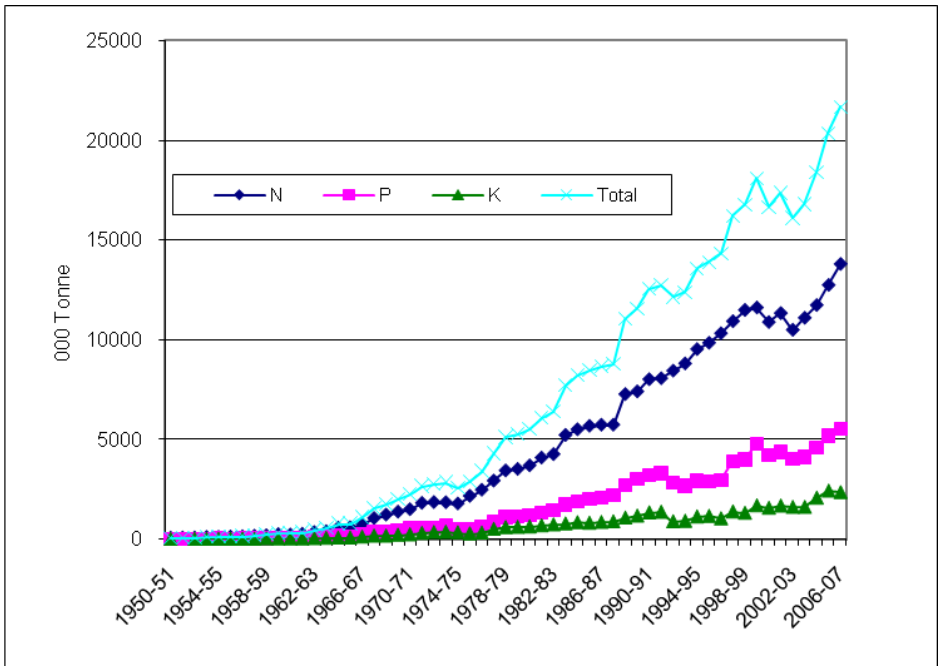
Introduction

Role of fertiliser in increasing agricultural productivity and production during the last five and half decades has been well documented. A very close association is observed between growth of fertiliser and crop productivity in almost all the states of the country. No input in agriculture has seen as much growth as witnessed in the use of fertiliser in the recent history of agriculture. Fertiliser consumption was around 67 thousand tonnes in early 1950s and it picked up very fast during mid 1950s. By early 1960s consumption of NPK crossed 400 thousand tonne and at the time of onset of green revolution consumption of fertiliser approached 1 million tonne. On per hectare basis, fertiliser consumption in India increased from 0.5 kg in early 1950s to 7 kg at the time of onset of green revolution in 1966-67. It is worth mentioning that in the pre green revolution post Independence period fertiliser consumption remained quite low but its growth rate was higher than that of crop production. Average growth rate in crop production (index) during 1950-51 to 1966-67 was 2.48 percent whereas average growth rate in fertiliser consumption in the same period was 19.41 percent. This shows that even in the pre green revolution period fertiliser was used as an important input for raising agricultural production.

The main reason for low use of fertiliser in pre green revolution period was that the use of this input was confined to a few cash crops. Principal crops like cereals and pulses which occupied more than 70 percent of gross area under cultivation were hardly applied inorganic fertiliser. Such crops were grown mainly for subsistence purpose based on low input requiring technology. Traditional varieties of crops grown at that time were not responsive to chemical fertilisers. The traditional varieties and methods of their production were sustainable but output was not large enough to meet the requirement of country.

New strains of wheat and paddy developed around mid 1960s were highly responsive to use of chemical fertilisers and offered much higher yield potential as compared to the traditional varieties. A big jump in use of fertiliser took place in the first two years of adoption of new varieties of paddy and wheat when fertiliser consumption increased from 784 thousand tonne during 1965-66 to 1539 thousand tonne during 1967-68. Since then fertiliser use in the country has moved on a continuously rising trend except a few short breaks (see Figure 1.1). Fertiliser use remained sluggish during the oil crisis around mid 1970s but again recovered to robust growth path which continued till 1990-91. After this, growth in fertiliser use in the country has not been smooth. There has been a progressive deceleration in growth rates in fertiliser consumption and even a decline in some years. The slowdown in fertiliser use has been accompanied by sharp slowdown in growth rate of crop sector after 1996-97. Growth in fertiliser consumption dropped below 2 percent during 1997-98 to 2005-06 and growth of crop sector went below 1 percent. This is causing a serious concern to policy makers and all others concerned with growth of agriculture sector.

Fig. 1.1: Trend in fertilizer use in India



In this context it is highly pertinent to find out how growth in agriculture output can be raised by increasing use of fertiliser. Use of fertiliser is quite low in most of the states of India and in most of the crops. Thus, considerable scope exists to raise agricultural production by raising fertiliser use. Further, use of plant nutrients in many parts of the country is highly concentrated towards nitrogenous fertiliser and a large imbalance has emerged between ratio of N, P and K as applied by farmers and the ratio that is considered optimum. This is raising all sorts of concerns regarding soil fertility, productivity and efficiency of fertiliser use. It is often contended that structure of subsidy on fertiliser is responsible for distortions in use of N, P and K which in turn is causing adverse effect on soil fertility and productivity. However, empirical evidence on this is missing. Besides, issue of subsidy on fertiliser is also being debated for its impact on fiscal resources. It is felt that due to rising bill of fertiliser subsidies resources are being diverted from investments in agriculture sector to meet subsidy bill. On one hand, the structure of fertiliser subsidy is alleged to cause distortions in soil nutrients and, on the other hand, these subsidies are considered deleterious for growth of agriculture sector due to their adverse impact on public sector investments in agriculture. The counter argument is that if subsidies are slashed it would cause adverse impact on agricultural production and food security and raise food and agricultural prices. These are all very complex but highly relevant issues. This paper makes an attempt to address such issues. It examines trend in fertiliser use at national and state level and estimates imbalances in use of plant nutrients in different regions. The paper estimates regional disparities in fertiliser use and in benefits of fertiliser subsidy from different angles. Trend in fertiliser subsidy is presented in nominal and real terms and distortions caused by the subsidies are discussed at length. Productivity of fertiliser is compared across states to find out the pockets where fertiliser use needs to be promoted most to get the best return. Finally, implications of reduction in fertiliser subsidies are seen on growth of output and food security, and a way out is explored to contain subsidy bill without causing adverse impact on production.

2

Growth and Imbalances in Fertiliser Use

Fertiliser has to play an important role in future growth of Indian agriculture as the net area available for cultivation is shrinking due to rising demand for new houses, factories, infrastructure and other commercial uses. It seems that practically all increase in farm output in future has to come from the increase in productivity. This would require improved technology and increased application of yield enhancing plant nutrients. A large number of studies have shown that most of the increase in foodgrain output during the first two decades of green revolution are attributable to chemical fertilisers (Desai and Vaidyanathan 1995). Therefore, growth in fertiliser consumption in the country is of paramount importance to raise agricultural production and to meet future requirements of the Country.

2.1 FERTILISER GROWTH AT ALL INDIA LEVEL

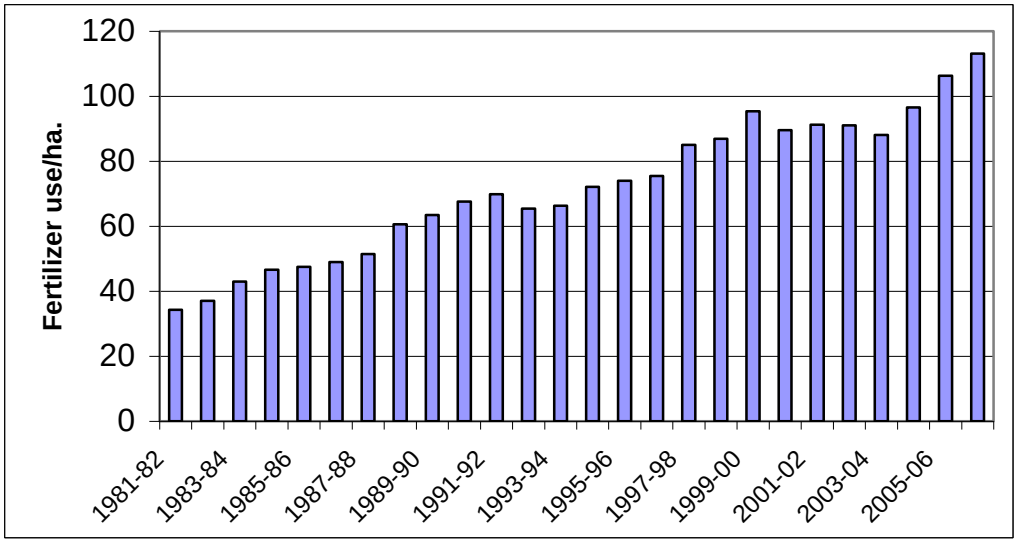
Fertiliser use increased by more than 19 percent during 1950-51 to 1960-67. The reason for such a high growth rate was that fertiliser use in the base was quite low. This growth rate raised per hectare use of fertiliser to 7 Kg/ ha by the year 1966-67 which is the beginning year of green revolution in India. Fertiliser use increased by more than 10 percent per year during initial years of green revolution which raised per hectare use of NPK to 32 Kg by the year 1980-81. There was a small deceleration in growth of fertiliser after 1980-81 but rate of growth was still quite high, close to 8 percent, which doubled per hectare use of fertiliser by the year 1991-92 (Table 2.1). The serious slowdown started after 1991-92 which was further exacerbated after 1999-00. This can be seen from Fig. 2.1 and Appendix 2.1 which present total and per hectare use of NPK for the period 1950-51 to 2006-07.

Table 2.1: Growth rate in fertiliser use and crop output

Period	Trend growth rate (%/year) Fertiliser	Crop output	NPK/ ha. GCA Kg. Range
1950-51 to 1966-67	17.7	2.4	0.5 to 7.0
1966-67 to 1991-92	9.2	2.8	7 to 70
1991-92 to 2006-07	3.4	1.3	70 to 113
1998-99 to 2006-07	2.6	1.1 NS	86.9 to 113

All growth rates except NS were significant at 0.1 to 5% level.
NS- Not significant upto 20% level.
Note: 1 Growth rate in fertiliser refers to quantity of NPK and growth rate in crop output refer to index number of production of all crops.

Fig. 2.1: Fertiliser consumption per hectare of gross sown area, 1980-1 to 2006-7



Total fertiliser consumption in the country reached a level of 18.069 million tonne during 1999-00 and in next four years it ranged between 16.09 to 17.35 million tonne. Similarly, per hectare use of NPK reached 95.4 kg during 1999-00 but it remained below 92 kg during next four years. Last three years viz., 2004-5 to 2006-7 have seen some recovery in fertiliser use in the country.

The impact of slowdown in growth of fertiliser on growth of agricultural output can be seen from the growth rates presented in Table 1. After 1991 -92 growth rate in fertiliser consumption turned out to be only a little more than one third of what it was during 1966-67 to 1991-92 and growth rate in crop sector declined to less than half in the

corresponding periods. The growth rate in fertiliser consumption declined further after 1998-99, the growth rate in output of crop sector became statistically non significant.

2.2 FERTILISER USE AT STATE LEVEL

Fertiliser use per hectare of net sown area was 42.5 kg during early 1980's at country level however there was very large variation across states. Punjab took a very big and early lead with close to 200 kg fertiliser application per hectare of net sown area. The second place was occupied by Tamil Nadu where 85.6 kg fertiliser was used on one hectare of net sown area in early 1980's. Farmers in Assam, Orissa, Madhya Pradesh, Rajasthan and north eastern states applied less than 15 kg fertiliser per hectare of NSA. Coefficient of variation in fertiliser use turned out to be 104.4 percent. Fertiliser use witnessed very strong growth during the ten years between early 1980s and 1990s. The rate of growth was more than 10 percent in the states of Madhya Pradesh, Bihar, Rajasthan and Assam. Lowest growth was experienced in the case of Punjab where fertiliser use had already reached high level. High growth in fertiliser use in the states with low application of fertiliser helped in reducing inter state variations – coefficient of variation decline to 78.9 percent during early 1990s as compared to 104.4 percent during early 1980s. Punjab continued to be far ahead of other states with per hectare application of 290 kg of NPK as compared to 87.4 kg at national level during triennium ending with 1993-94. Haryana and Andhra Pradesh emerged as second and third in per hectare application of fertiliser. The other states with more than 100 kg of fertiliser use were Tamil Nadu, West Bengal and Uttar Pradesh. Assam, Orissa and Rajasthan remained at the bottom with less than 32 kg fertiliser use per hectare of area.

Table 2.2: Statewise fertiliser use (Kg / ha NSA)

	Year Triennium Ending with			Growth rate(%)	
State	1983	1994	2006	1983 to 1994	1994 to 2006
Andhra Pradesh	59.7	145.6	205.0	8.44	2.89
Assam	4.1	12.9	66.4	11.00	14.64
Bihar	26.4	80.6	121.1	10.67	3.45
Gujarat	38.9	75.0	119.3	6.14	3.95
Haryana	69.7	182.7	302.1	9.16	4.28
Himachal Pradesh	30.4	54.1	86.3	5.37	3.97
Jammu & Kashmir	34.5	60.4	110.3	5.23	5.14
Karnataka	35.7	77.2	122.5	7.25	3.93
Kerala	45.3	89.9	92.2	6.42	0.21
Madhya Pradesh	12.0	40.5	67.1	11.73	4.29
Maharashtra	26.6	66.7	98.4	8.73	3.29
Orissa	13.9	31.7	63.8	7.74	6.01
Punjab	195.8	289.9	380.0	3.63	2.28
Rajasthan	9.7	29.5	47.6	10.59	4.07
Tamil Nadu	85.6	138.7	183.9	4.48	2.38
Uttar Pradesh	75.0	129.7	197.8	5.11	3.58
West Bengal	48.8	136.9	218.4	9.82	3.97
North East State	9.0	22.1	30.5	8.47	2.75
All India	42.5	87.4	131.1	6.77	3.43
C.V. (%)	104.4	78.9	70.6	—	—

Growth rate of fertiliser slowed down sharply during TE 1993-94 and TE 2005-06. Assam alone experienced more than 10 percent annual growth rate in fertiliser use while remaining states realized less than 6.1 percent growth rates. For most of the states growth rate varied between 3 to 4 percent. There was little increase in fertiliser use in Kerala after TE 1993-94. In the recent three years, per hectare fertiliser use was more than 300 kg in Punjab and Haryana and more than 200 kg in Andhra Pradesh and West Bengal. Uttar Pradesh has almost approached level of 200 kg. Orissa and Rajasthan continue to be at the bottom. There was only small decline in inter state variation in fertiliser use after TE 1993-94.

2.3 IMBALNACES IN FERTILISER USE

The common perception about fertiliser use in India is that use of nitrogenous fertiliser has increased at a relatively faster rate compared to the use of potassic and phosphatic

fertiliser and this has increased the imbalance in use of plant nutrients, which, in the long run, is considered to cause adverse impact on soil fertility and crop productivity. Research conducted under the "All India Coordinated Research Project on Long Term Fertiliser Experiments" of ICAR provides strong evidence of this. It shows that continuous use of N alone produced decline in yield and has deleterious effect on long term fertility and sustainability (Indian Institute of Soil Science, 2000). This imbalance is often attributed to the structure of subsidy on various fertilisers. This issue is highly important but its complexity and veracity have not been addressed adequately.

We proceed by looking at imbalance in fertiliser use, first at the Country level and then at state level, by examining the trend in use of N, P and K during last 4-5 decades. During 1960-61, total consumption of N in the country was 212 thousand tonne and total consumption of P and K was 53 and 29 thousand tonne. During next 25 years, consumption of N increased annually by close to 20 percent while P and K recorded 23 and 24 percent annual growth. The annual series is presented in Fig. 2.2. A cursory look at this figure shows that absolute gap between use of different nutrients has seen very large increase. However, this is a misleading indicator of unbalanced use of fertiliser. The imbalance is better captured by relative growth and ratios which are presented in tables 2.3 and 2.4 and in figures 2.2 and 2.3.

Figure 2.3 shows series on use of N, P and K in terms of log of quantity of these plant nutrients since 1960-61. This figure is in contrast to Fig. 2.2. It shows that pace of growth in consumption of N, P and K is only slightly different. There were dips in the use of P and K around 1974-75 and 1992-93. Growth rate in fertiliser use in different periods corresponding to these dips and for entire period of 47 years beginning 1961 are provided in Table 2.3. These growth rates shows that growth in consumption of all the three plant nutrients have sharply decelerated with the passage of time. In all the three phases growth rate in P was higher than growth rate in N. Similarly, growth rate in use of K was higher than that of N during 1961 to 1974 and 1991 to 2007. During last 47 years consumption of P increased by 9.41 percent per year while use of N and K increased by around 8.50

percent. These growth rates show that, over time, fertiliser use in India has moved somewhat in favour of P and, there is no evidence of fertiliser use moving in favour of N.

Fig. 2.2: Use of N, P and K, tonne, 1960-61 to 2006-07

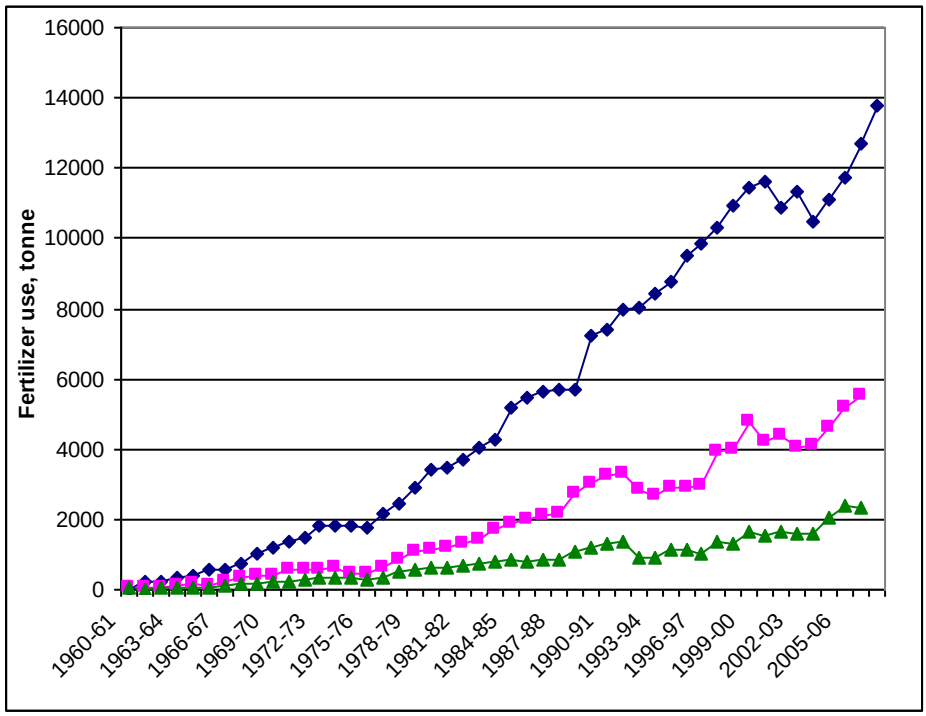


Fig. 2.3: Use of N, P and K, log (quantity), 1960-61 to 2006-07

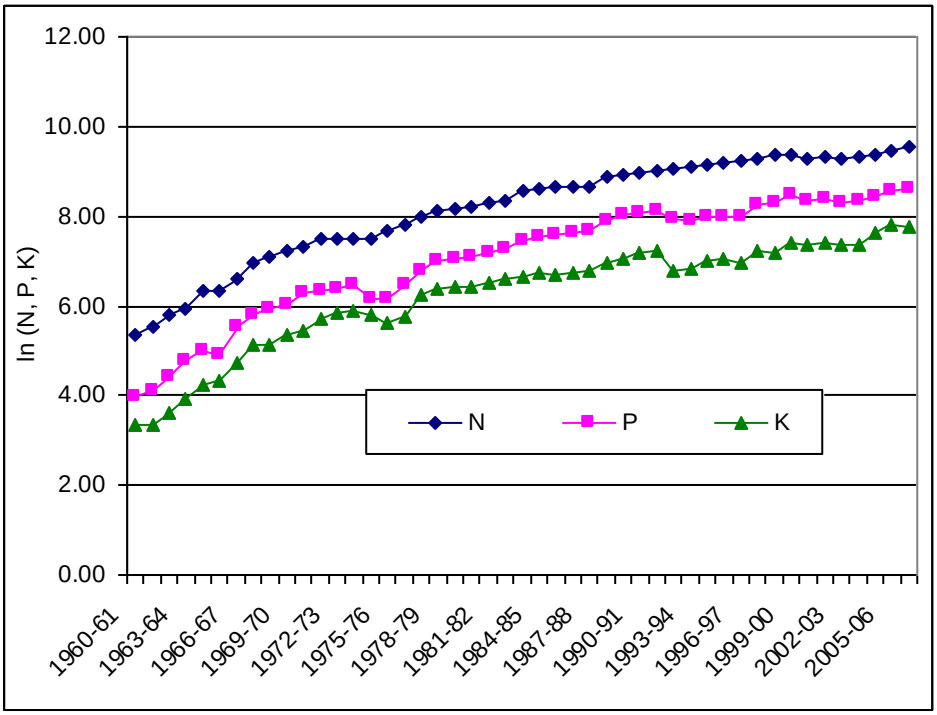


Table 2.3: Growth rate in consumption of N, P and K (% per year)

Period	N	P	K	NPK
1961 to 1974	19.69	22.94	24.19	20.80
1974 to 1991	9.12	11.70	8.46	9.59
1991 to 2007	2.90	3.99	5.01	3.35
1961 to 2007	8.52	9.41	8.50	8.72

Table 2.4: Share of N, P and K in total consumption of N+P+K

	Share of NPK in total (%)			Ratio of N, P and K		
Period	N	P	K	N	P	K
1961 to 1965	71.9	19.2	8.9	8.09	2.16	1.00
1966 to 1970	68.5	21.1	10.3	6.63	2.04	1.00
1971 to 1975	66.5	21.4	12.1	5.51	1.77	1.00
1976 to 1980	68.9	20.2	11.0	6.28	1.84	1.00
1981 to 1985	66.9	22.4	10.7	6.23	2.08	1.00
1986 to 1990	65.4	24.7	9.8	6.65	2.51	1.00
1991 to 1995	67.5	23.7	8.8	7.63	2.67	1.00
1996 to 2000	68.3	23.5	8.3	8.27	2.84	1.00
2001 to 2005	65.0	25.0	9.9	6.53	2.52	1.00
2004 to 2007	64.1	25.2	10.7	5.97	2.35	1.00

This prompted us to estimate exact nature of imbalance in fertiliser use against norm of balance use of N, P and K which is recommended to be in the ratio of 4:2:1. This was estimated by using an indicator of imbalance adopted in earlier studies (Mehta 2007) as under:

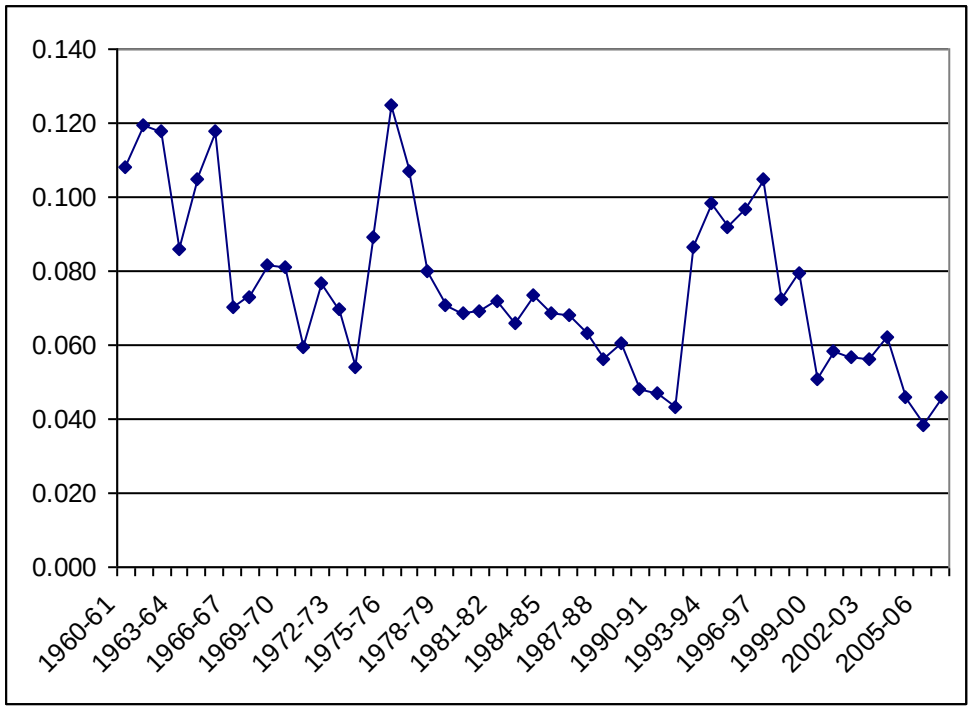
$$I = \sqrt{\{(N_a - N_n)^2 + (P_a - P_n)^2 + (K_a - K_n)^2\}/3}$$

Where I is the measure of deviation in proportion of actual use of N, P and K from the norm and subscript `a' indicates actual and subscript `n' indicates norm. Value of I away from zero measures the magnitude of imbalance. When N, P and K are used in the recommended ratio then I is 0. If entire amount of fertiliser is in the form of K, which is the lowest digit in the norm, then I reach the value of 0.6. Thus I would lie between "0 and 0.49" or "0 percent and 49 percent" representing perfect balance and extreme imbalance.

The imbalance (I) estimated as above is presented in Fig. 2.4. The figure shows that at country level actual proportion of N, P and K used by farmers deviated significantly from the norm. The imbalance was very high when fertiliser use was low. The overall trend in imbalance at country level shows a decline over time but it is still far away from the ratio considered optimum for the country.

Another indicator of imbalance in fertiliser use is provided by share of N, P and K in total fertiliser use presented in Table 2.5. During 1961 to 1965, nitrogen accounted for more than 70 percent while P and K constituted 19.2 and 8.9 percent of the of total consumption of major plant nutrients in the country. Share of K reached 12.1 percent during early 1970s but declined thereafter. There is some improvement in share of K After 2001. Share of P has gradually increased but its ratio is found higher relative to K and lower relative to N. Though in the recent years ratio of N, P and K used in India has moved towards the norm but it is still away from what is considered optimum.

Fig. 2.4: Imbalance in use of N, P and K, 1960-61 to 2006-07



Here it is pertinent to raise two important issues relating to observed imbalance in fertiliser use. One, even if the imbalance is declining the cumulative effect could worsen the situation. Two, in a large country like India country level ratio may be far away from the ratio at disaggregate level which is more relevant to field situation. Third, there is a need to analyze what are the factors related to unbalanced use of N, P and K.

2.4 IMBALANCE AT STATE LEVEL

State wise application of N, P and K per hectare of net sown area and estimate of imbalance in fertiliser use are provided in Table 5. Punjab ranks at the top in use of N and P but use of K in this state is lower than the national average. Haryana ranks second in per hectare use of N and P, and like Punjab, use of K in this state is very low. West Bengal and Tamil Nadu are at the top in application of K (47.8 kg/ ha. of net sown area). It is interesting to observe that per hectare application of K in southern states was more than double the use of K in other states except West Bengal and Assam. Lowest use of all the three plant nutrients is observed in north east region.

Table 2.5: Statewise use of N, P and K per hectare of net sown area, average of 2003-4, 2004-5 and 2005-6

Unit kilogram

State	N	P	K	Total
Andhra Pradesh	122.4	54.6	28.0	205.0
Assam	31.5	18.9	16.0	66.4
Bihar	96.2	16.7	8.1	121.1
Gujarat	78.9	30.5	9.9	119.3
Haryana	227.0	69.0	6.1	302.1
Himachal Pradesh	56.3	16.5	13.5	86.3
Jammu & Kashmir	75.0	30.2	5.1	110.3
Karnataka	62.4	34.1	26.1	122.5
Kerala	39.5	19.3	33.3	92.2
Madhya Pradesh	40.4	22.4	4.3	67.1
Maharashtra	54.9	29.0	14.5	98.4
Orissa	40.1	14.0	9.7	63.8
Punjab	287.6	81.0	11.4	380.0
Rajasthan	33.9	12.8	0.9	47.6
Tamil Nadu	94.5	41.7	47.8	183.9
Uttar Pradesh	141.6	45.6	10.7	197.8
West Bengal	110.1	60.5	47.8	218.0
North East States	22.0	5.8	2.8	30.5
Others	75.3	36.2	29.4	141.0
All India	83.8	32.9	14.3	131.1

There are very large variations in proportion of N, P and K used across states. The deviation in actual use of N, P and K from the recommended proportion are found in all directions i.e. higher level of N and P relative to K, lower level of N and P relative to K and higher or lower level of N relative to P as against the norm. The balanced use of fertiliser is recommended in the ratio of 4:2:1 for N, P and K. In percent terms, balanced fertiliser should contain 58% nitrogen, 28 percent P and 14 percent K. Actual share of N, P and K, in total fertiliser use and the resulting imbalance are presented in Table 2.6.

Highest share of nitrogen in total fertiliser is found in Bihar where about 80 percent of total fertiliser use consists of nitrogen. In Punjab and Haryana three-fourth of total fertiliser is in the form of N as against 57 percent required for balanced use. In all the southern states except Andhra Pradesh share of nitrogen in total fertiliser is lower than the recommended for balanced use. While share of N in Bihar is quite high, the share of P is half of what it should be, which is lowest among all the states. Share of P is found

more than the norm (27%) only in Madhya Pradesh. In Andhra Pradesh, Assam, Jammu and Kashmir, Karnataka, Maharashtra, West Bengal and Rajasthan share of P in total fertiliser use did not deviate much from the norm. In the remaining states share of P was lower than 27 percent.

Table 2.6: Imbalances in fertiliser use in various states during TE 2005-06

	Share of N, P and K in total			Ratios of N, P and K			Imbalance
State	N	P	K	N/K	P/K	N/P	index
Andhra Pradesh	59.7	26.6	13.6	4.4	2.0	2.2	0.02
Assam	47.4	28.5	24.1	2.0	1.2	1.7	0.08
Bihar	79.5	13.8	6.7	11.8	2.0	5.8	0.16
Gujarat	66.1	25.6	8.3	7.9	3.1	2.6	0.06
Haryana	75.1	22.8	2.0	37.5	11.4	3.3	0.13
Himachal Pradesh	65.2	19.1	15.7	4.2	1.2	3.4	0.07
Jammu & Kashmir	68.0	27.4	4.6	14.8	6.0	2.5	0.08
Karnataka	50.9	27.8	21.3	2.4	1.3	1.8	0.05
Kerala	42.9	20.9	36.2	1.2	0.6	2.0	0.16
Madhya Pradesh	60.1	33.4	6.5	9.3	5.2	1.8	0.06
Maharashtra	55.8	29.5	14.8	3.8	2.0	1.9	0.01
Orissa	62.9	21.9	15.2	4.1	1.4	2.9	0.05
Punjab	75.7	21.3	3.0	25.1	7.1	3.6	0.13
Rajasthan	71.2	26.9	1.9	36.8	13.9	2.7	0.11
Tamil Nadu	51.4	22.6	26.0	2.0	0.9	2.3	0.08
Uttar Pradesh	71.6	23.0	5.4	13.2	4.3	3.1	0.10
West Bengal	50.5	27.7	21.9	2.3	1.3	1.8	0.06
North East State	72.0	19.0	9.0	8.0	2.1	3.8	0.11
Others	53.4	25.7	20.8	2.6	1.2	2.1	0.05
All India	63.9	25.1	10.9	5.8	2.3	2.5	0.05

Share of K in total fertiliser ranges from about 2 percent in Haryana and Rajasthan to 36 percent in Kerala. Share of K was close to the norm in Andhra Pradesh, Himachal Pradesh, Maharashtra and Orissa. Fertiliser mix shows lower than recommended share of nitrogen in Kerala, Karnataka, Tamil Nadu, West Bengal and Assam.

Ratios of N, P and K with one another indicate the imbalance in any two nutrients. Use of N is most skewed in Rajasthan and Haryana where farmers apply more than 36 kg N for 1 kg application of K which is 9 times the use of N for balanced requirement. Punjab comes next with N, P and K ratio of 25:7:1. Similarly, share of N is higher than norm in

Jammu and Kashmir, Uttar Pradesh, Bihar, Gujarat and Madhya Pradesh. Here it is pertinent to mention that this imbalance does not imply that farmers are making excessive use of N. Rather, what it implies is that farmers are making very small use of P and K. For instance, corresponding to the use of N, farmers in Rajasthan and Haryana use only one ninth of K needed for balanced use. Ratio of N and P shows much smaller variation as compared to the ratio of N and K and P and K. Bihar topped in imbalance between N and P. Against the ideal ratio of 2, Bihar farmers apply about 5.8 times N as compared to P. Ratio of N to P was close to norm in Kerala, Madhya Pradesh, Karnataka, Maharashtra, West Bengal and Andhra Pradesh.

A composite index of imbalance in use of N, P and K shows that Bihar and Kerala topped the imbalance in fertiliser use followed by Haryana and Punjab. In order to reduce the imbalance in fertiliser use there is a need to increase use of P and K in Bihar, Punjab, Haryana, Rajasthan, Uttar Pradesh and Gujarat. In Madhya Pradesh N and P are balanced but there is serious imbalance against K. In contrast to these states there is a need to increase use of nitrogen and phosphorus in Kerala, Karnataka, West Bengal. The minimum imbalance in use of N, P and K is observed in Maharashtra and Andhra Pradesh. The imbalance is moderate in Karnataka, Madhya Pradesh, Orissa and West Bengal.

These results show that except a few states there is imbalance in use of fertiliser. This is not confined only to higher relative use of N; in some states proportion of N is much lower than recommended. Therefore, while at country level fertiliser imbalance is skewed towards N, at state level there are various patterns. These vary from severe imbalance in favour of N to severe imbalance in favour of P as well as K. As there is lot of variation in status of soil fertility in various parts of the country the imbalances at micro level can be better understood and addressed by developing location specific norms for balanced use of fertiliser.

Per hectare use of fertilizer shows that, except Punjab, the imbalance exists with lower than optimum use of fertiliser per unit of area. In such situation, imbalance needs to be

addressed not by lowering use of plant nutrients having share higher than norm but by increasing use of those plant nutrients which have lower share than the norm. In Punjab, nitrogen not only has higher share than norm, its per hectare application is also found higher than what is considered optimum for wheat –paddy rotation, which represent crop system in Punjab. In a situation like this, imbalance can cause adverse impact on yield. In other situations, where imbalance coexists with sub optimal use of N or P or K, the impact of imbalance on crop productivity is not clear. Our conjecture is that in such situation imbalance in fertiliser use does not cause detrimental effect on productivity, though balanced use would improve response to fertiliser.

3

Prices and Subsidies

Imbalances in fertiliser use are generally attributed to price structure of fertiliser and variations in subsidies available on different types of fertilisers. This section examines changes in relative prices of N,P and K also study change in fertiliser prices relative to prices of agricultural output. Level of subsidies is examined from various angles.

3.1 PRICES OF NPK AND OUTPUT

Nominal prices of N, P and K in major fertiliser since 1980-81 are presented in Table 3.1. Prices of nitrogen in urea fluctuated around Rs. 5.11 per kg during 1980-81 to 1990-91. During the decade of 1990's nominal prices of N witnessed large increase. Since 2000-01 prices of nitrogen varied between Rs. 10 and 10.50 except in year 2002-03 when they were slightly higher. In the last 4 years, i.e. 2003-04 to 2006-07, prices of urea have been kept at the same level as during 2001-02.

Prices of P varied between Rs. 5.27 to Rs. 5.94 during 1980-81 to 1985-86. During the 6 years period from 1985-86 to 1990-91 prices of P as well as N and K were kept at the same level. With the economic reforms started during 1991 prices of P and K were decontrolled in August 1992 and subsidy on these fertilisers was severely reduced. This led to a very sharp increase in prices of P and K. Per kg. price of P during 1992-93 increased to 16.25 as compared to Rs. 5.94 during 1990-91. Similarly, prices of K in these 2 years increased from Rs. 2.17 to Rs. 7.50. By the end of 1990 price of P increased to Rs. 17.19 per kg. and price K came down to Rs. 6.63 per kg. After this prices of P increased slowly to reach level of Rs. 21.81 per kg while prices of K hovered around Rs. 7.43 per kg. During last 27 years nominal prices of N increased by about 4 percent as compared to about 7 percent growth rate in nominal prices of P and K.

Table 3.1: Maximum retail prices of fertilisers in terms of nutrients (50 kg pack) exclusive of central VAT,/ state sales tax and local taxes

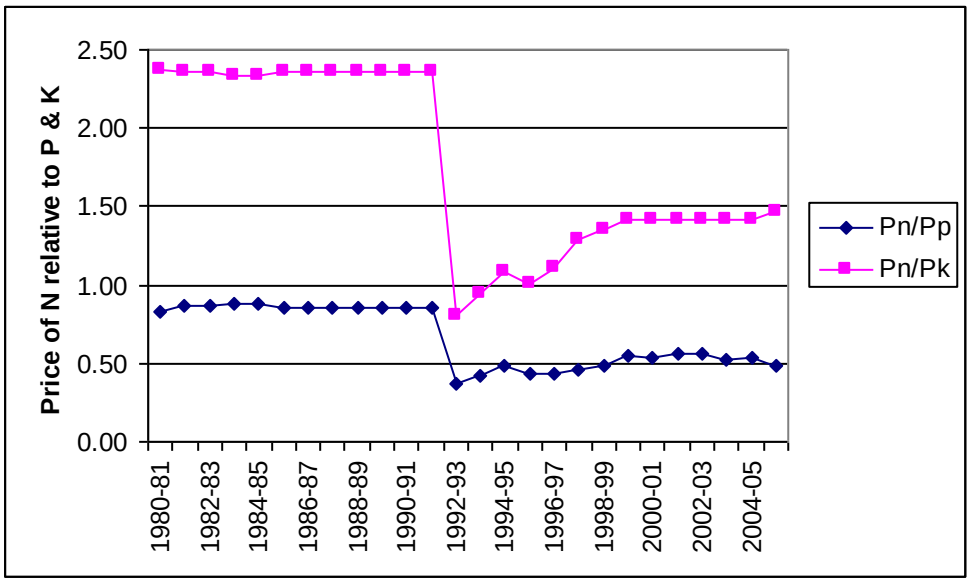
Year	Urea (46% N)	Single Super Phosphate (16% w.s. P2O5)	Muriate of Potash (60% K2O)
1980-81	4.35	5.27	1.83
1981-82	5.11	5.85	2.17
1982-83	5.11	5.85	2.17
1983-84	4.67	5.31	2.00
1984-85	4.67	5.31	2.00
1985-86	5.11	5.94	2.17
1986-87	5.11	5.94	2.17
1987-88	5.11	5.94	2.17
1988-89	5.11	5.94	2.17
1989-90	5.11	5.94	2.17
1990-91	5.11	5.94	2.17
1991-92	6.91	8.07	2.93
1992-93	6.00	16.25	7.50
1993-94	6.00	14.25	6.34
1994-95	6.81	14.13	6.26
1995-96	7.22	16.60	7.15
1996-97	7.46	17.36	6.73
1997-98	7.96	17.19	6.17
1998-99	8.33	17.19	6.17
1999-00	9.35	17.19	6.63
2000-01	10.00	18.75	7.09
2001-02	10.50	18.75	7.43
2002-03	10.76	19.06	7.59
2003-04	10.50	20.09	7.43
2004-05	10.50	19.81	7.43
2005-06	10.50	21.56	7.13
2006-07	10.50	21.81	7.43
Annual growth rate %	3.94	6.95	6.97

Source: Fertiliser Statistics, The Association of India, New Delhi, various issues.

During 1980-81 to 1990-91 prices of all the three types of fertilisers changed almost in the same way. This can be seen from the ratio of P to N and K to N presented in Fig. 3.1. Serious distortion was caused in relative prices of N, P and K during 1990-91 which turned price of nitrogen lower than that of K, whereas, it was more than double the price

of K during 1980's. Similarly, price of N, which ruled only marginally lower than price of P during 1980's, turned out to be half of price of P after 1991. After the big change in price ratio during 1992-93, price of P and K increased at a lower rate than that of N but prices of N relative to P and K are far lower than those prevailed during 1980's. Thus, year 1991 made a distinct change in fertiliser prices in favour of N just in one stroke. This is an important factor in shifting balance of fertiliser use in favour of N and against P and K.

Fig. 3.1: Prices of N relative to prices of P and K, 1980-81 to 2005-06



Prices of N, P and K relative to one another are important in affecting substitution among the three types of fertiliser. The second important dimension of prices is prices of fertiliser with respect to prices of output. This was analysed by looking at movement in prices of N, P and K relative to minimum support price (MSP) of wheat and paddy and by looking at aggregate price of N, P and K taken together relative to price index of crop sector.

In the beginning of 1980's, price of one kg. of nitrogen derived from urea was close to 4 times the price of one kg. of wheat. Price of P_2O_5 was 4.5 times and that of K_2O was about 1.6 times during (Table 3.2). By the end of the decade, prices of N, P and K

relative to MSP of wheat declined to 2.27, 2.64 and 0.96. Similar decline is seen in the case of N,P and K prices relative to MSP of paddy. It required around 4 kg of paddy to buy one kg. of N and 5 kg. to buy one kg. of phosphorous in early 1980s. Amount of paddy needed to buy one kg. of K was 1.74 kg. By 1990-91, amount of paddy required to buy one kg. of N,P and K declined to 2.5, 2.9 and 1.1 kg respectively. This shows that prices of N, P and K relative to MSP of wheat and paddy declined very sharply during 1980-81 to 1990-91.

Table 3.2: Prices of N, P and K relative to MSP of wheat and paddy

Year	Pn/Pw	Pp/Pw	Pk/Pw	Pn/Pr	Pp/Pr	Pk/Pr
1980-81	3.72	4.50	1.56	4.14	5.02	1.74
1981-82	3.93	4.50	1.67	4.41	5.04	1.87
1982-83	3.60	4.12	1.53	4.19	4.80	1.78
1983-84	3.09	3.52	1.32	3.54	4.02	1.52
1984-85	3.07	3.49	1.32	3.41	3.88	1.46
1985-86	3.25	3.78	1.38	3.60	4.18	1.53
1986-87	3.15	3.67	1.34	3.50	4.07	1.49
1987-88	3.08	3.58	1.31	3.41	3.96	1.45
1988-89	2.95	3.43	1.25	3.19	3.71	1.36
1989-90	2.79	3.25	1.19	2.76	3.21	1.17
1990-91	2.27	2.64	0.96	2.49	2.90	1.06
1991-92	2.51	2.93	1.07	3.00	3.51	1.27
1992-93	1.82	4.92	2.27	2.22	6.02	2.78
1993-94	1.71	4.07	1.81	1.94	4.60	2.05
1994-95	1.89	3.93	1.74	2.00	4.16	1.84
1995-96	1.90	4.37	1.88	2.01	4.61	1.99
1996-97	1.57	3.65	1.42	1.96	4.57	1.77
1997-98	1.56	3.37	1.21	1.92	4.14	1.49
1998-99	1.51	3.13	1.12	1.89	3.91	1.40
1999-00	1.61	2.96	1.14	1.91	3.51	1.35
2000-01	1.64	3.07	1.16	1.96	3.68	1.39
2001-02	1.69	3.02	1.20	1.98	3.54	1.40
2002-03	1.71	3.03	1.20	1.96	3.47	1.38
2003-04	1.67	3.19	1.18	1.91	3.65	1.35
2004-05	1.64	3.10	1.16	1.88	3.54	1.33
2005-06	1.62	3.32	1.10	1.84	3.78	1.25
2006-07	1.24	2.57	0.87	1.69	3.52	1.20

Note: P denotes price and the subscript n, p, k, w and r denote nitrogen, phosphorous, potash, wheat and paddy respectively.

As mentioned before, fertiliser pricing policy was thoroughly reformed during 1990-91 and this changed the equation between prices of fertiliser, particularly P and K, and prices of wheat and paddy. During early 1990's quantity of wheat and paddy required to buy one kg. of P and K turned out to be roughly same as during early 1980's. After mid 1990s, hike given to MSP of wheat and paddy remained higher than the increase in prices of N, P and K (Fig. 3.2 and 3.3). Thus, except for a big upward spurt in early 1990's prices of P and K relative to MSP of wheat and paddy showed a decline.

Fig. 3.2: Prices of N,P and K relative to MSP of wheat

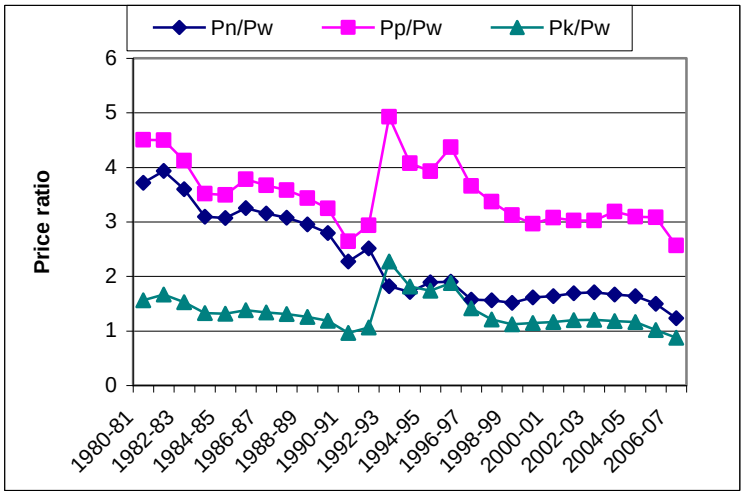
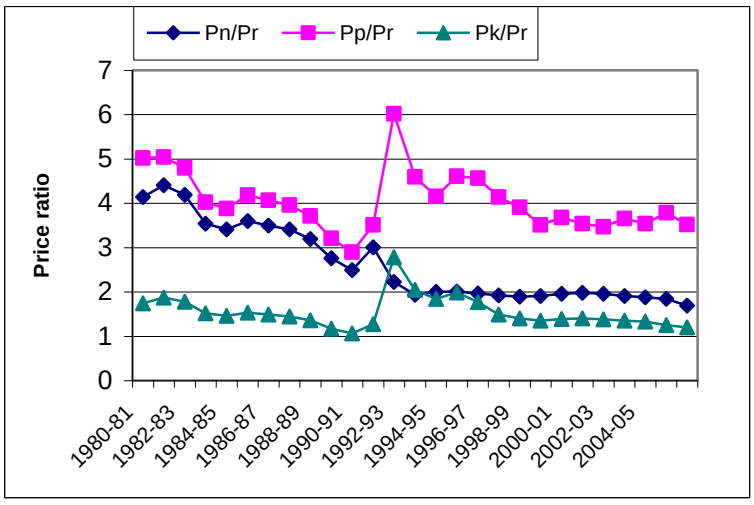


Fig. 3.3: Prices of N, P and K relative to MSP of paddy



The exact changes in real prices of N, P and K relative to MSP of wheat and paddy can be captured from growth rate in relative prices during different periods. Prices of N, P and K relative to MSP of wheat declined annually by close to 4 % during 1980-81 to 1990-91 (Table 3.3). The rate of decline was more than 4.6 percent relative to MSP of paddy. Real prices of fertiliser fluctuated widely during early 1990s as major changes in prices of fertiliser were affected during 1991-92 and 1992-93 and some increase was rolled back. These years are not included in estimating growth rate in the second period which covered only recent 10 years ending with 2006-07. Nominal prices of N, P and K deflated by MSP of Wheat and paddy declined during last 10 years also but the rate of decline was much lower compared to the decade of 1980s. Considering the entire period of study, prices of N declined annually by 4 percent when deflated by the MSP of wheat and by 3.6 percent when deflated by MSP of paddy. The rate of decline in prices of P and K varied around 1 percent.

Table 3.3: Growth rates in prices of N,P and K relative to MSP of wheat and paddy

Growth rates in prices of N,P and K relative to MSP of wheat and paddy

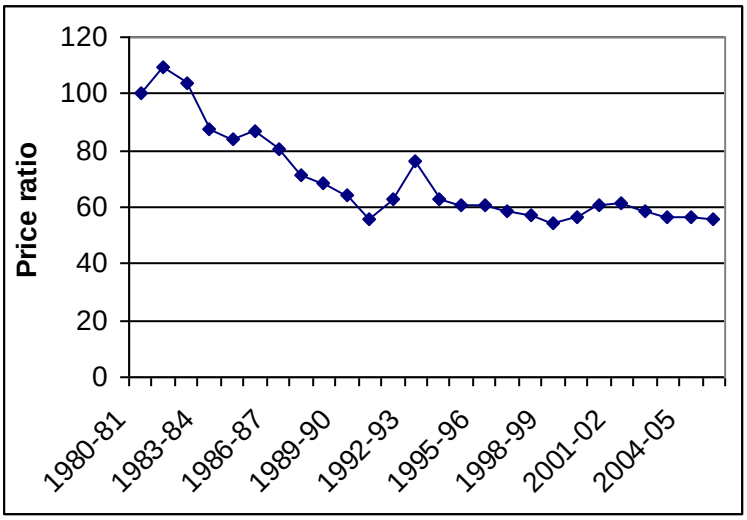
Period	Pn/Pw	Pp/Pw	Pk/Pw	Pn/Pr	Pp/Pr	Pk/Pr
1980-81 to 1990-91	-3.93	-3.96	-3.91	-4.68	-4.71	-4.66
1997-98 to 2006-07	-1.22	-1.34	-2.08	-0.90	-1.02	-1.77
1980-81 to 2006-07	-4.01	-1.23	-1.21	-3.60	-0.81	-0.79

Weighted price of NPK relative to the implicit price index of crop sector with base shifted from 1999-2000 to 1980-81 is presented in Table 3.4 and Fig. 3.4. This shows that real price of fertiliser (relative to crop sector prices) increased by 9 percent during 1981-82 but started declining from 1983-84. Since then the real prices of fertiliser have moved on a declining trend till 1990-91. There was no significant decline in real prices of fertiliser after 1990-91 – the index fluctuated around 58 during last 11 years and the recent figure is same as in 1990-91. During the entire period of 1980-81 to 2005-06 real prices of fertiliser declined annually by 2.39 percent.

Table 3.4: Prices of NPK relative to price of crop sector

Year	Index of relative price
1980-81	100
1981-82	109
1982-83	104
1983-84	87
1984-85	84
1985-86	87
1986-87	81
1987-88	71
1988-89	69
1989-90	64
1990-91	56
1991-92	63
1992-93	76
1993-94	63
1994-95	61
1995-96	61
1996-97	58
1997-98	57
1998-99	54
1999-00	57
2000-01	61
2001-02	61
2002-03	59
2003-04	57
2004-05	56
2005-06	56
Annual rate of growth %	2.39

Fig. 3.4: Index of fertiliser prices relative to implicit price index of crop sector



3.2 SUBSIDIES

Subsidy given by Central government on various fertilisers increased from Rs. 891 crore during early 1980s to 22452 crore during 2006-07. A major part of this increase is on account of inflation. However, even in real terms subsidy on fertiliser has been increasing in leaps and bounds. Level of subsidy at 1999-00 prices was about Rs. 3.5 thousand crore in early 1980s which increased to more than 7.7 thousand crores in the later half of 1980s. The level of subsidies in real terms almost doubled during the fifteen years after 1990. The increase resulted from both increase in fertiliser use as well as increase in subsidy content per unit of fertiliser.

Subsidies have also grown faster than growth of crop sector in monetary terms. This is evident from the share of subsidies at current price in the value of output of crop sector (Table 3.5). During the second half of 1980s fertiliser subsidies were equal to 2.87 percent of value of crop output. In next 10 years ratio of subsidies increased to 3.03 percent and it is approaching to 4% in the recent years.

Table 3.5: Central subsidy on fertiliser, Rs. crore

Period	Subsidy at current price	Deflated by crop sector price index base 1999-00	As % of Value of crop output
1981 to 1985	891	3481	1.41
1986 to 1990	2746	7715	2.87
1990 to 1995	5202	9067	2.94
1996 to 2000	9814	10879	3.03
2001 to 2005	13027	12178	3.16
2005-06	18460	15705	3.73
2006-07	22452		

3.2.1 Statewise Subsidies

Amount of fertiliser subsidies going to different states depend upon size of the state i.e. area under cultivation, amount of fertiliser used per hectare and composition of fertiliser used. Out of total subsidy on fertiliser in the country, largest chunk (18.1) goes to Uttar Pradesh followed by Andhra Pradesh (11.41 percent). Around 9 percent of total subsidies go to Maharashtra and Punjab each. Share of Assam, Himachal Pradesh, Jammu and Kashmir, and Uttaranchal was below 1 percent (Table 3.6). This distribution does not indicate which states benefit more from subsidies because of variation in the size of state. Fertiliser subsidy on per hectare basis varies in the range of Rs. 393 in Rajasthan to Rs. 3167 in Punjab. After Punjab, the second most benefited state is Haryana with subsidy of Rs. 2516 per hectare of net sown area. Farmers in West Bengal, Uttar Pradesh and Andhra Pradesh are estimated to get per hectare subsidy between Rs. 1626 and Rs. 1730. Among other states, per hectare subsidy was above Rs. 1000 in Uttaranchal, Bihar and Tamil Nadu. States with less than Rs. 600 subsidy are Assam, Chattisgarh, Jharkhand, Madhya Pradesh, Orissa and Rajasthan. One limitation of this measure, as an indicator of disparity in subsidies, is that it ignores variation in productivity resulting from variation in use of fertiliser. For instance Punjab and Haryana, which rank at the top in per hectare subsidy, also rank among the top states in productivity.

Table 3.6: Statewise subsidies on fertiliser, TE 2005-06

	State's share in all India subsidy %	Subsidy/ ha. Rupees	Subsidy as % of value of crop output
Andhra Pradesh	11.41	1655	4.73
Assam	0.74	517	1.43
Bihar	4.22	1115	3.63
Chhattisgarh	1.77	559	3.25
Gujarat	6.23	975	3.12
Haryana	5.89	2516	4.75
Himachal Pradesh	0.25	704	0.91
Jammu & Kashmir	0.45	905	1.43
Jharkhand	0.67	572	1.66
Karnataka	6.55	971	3.57
Kerala	1.03	719	1.05
Madhya Pradesh	5.38	543	2.71
Maharashtra	9.11	788	2.44
Orissa	1.93	518	1.77
Punjab	8.83	3167	4.92
Rajasthan	4.42	393	2.45
Tamil Nadu	4.85	1460	3.90
Uttar Pradesh	18.13	1626	3.93
Uttarakhand	0.66	1286	2.57
West Bengal	6.34	1730	2.39
All India	100.00	1067	3.16

In order to take care of variations in productivity and to see whether fertiliser subsidy is distributed according to crop productivity, another indicator was computed. This refers to subsidy as percent of value of crop output in a state. This indicator also shows that Punjab and Haryana receives highest benefit from fertiliser subsidy closely followed by Andhra Pradesh. Fertiliser subsidy constitutes close to 5 percent of value of crop output (VCO) in these three states. Tamil Nadu and Uttar Pradesh come next with subsidy level close to 4 per cent of crop output. In Bihar and Karnataka fertiliser subsidy was around 3.5 percent of VCO. Other states where fertiliser subsidy was more than 3 percent are Chattisgarh and Gujarat. Fertiliser subsidy comprises less than 1 percent of VCO in Assam, Himachal Pradesh, Jammu and Kashmir and Kerala.

3.2.2 Impact on Production

Subsidies are often criticized for their financial burden and for the imbalance in use of different plant nutrients. Some researchers assert to the extent that these subsidies are causing adverse impact on production. On the other hand there is a fear that food and agriculture production would decline if subsidies are curtailed. These are very important issues and need serious investigation. It is particularly important to know how food security of the country would be affected by reduction in fertiliser subsidies.

We have tried to understand impact of reduction in fertiliser subsidy on food security by estimating relationship between fertiliser price and foodgrains production. This was done by using a two equations model as under:

Equation 1: FGPROD = C(1) +C(2)*FGFERT+C(3)*GCAIR+C(4)*FGREALPR+ C(5)*RAIN

Equation 2: FGFERT =C(11) + C(12)*GCAIR+C(13)*FERTRWPI+C(14)*CRST

Where

FGPROD is foodgrain production;

FGFERT is fertiliser use in foodgrains

GCAIR is gross cropped area under irrigation

FGREALPR is real price of foodgrains

RAIN is rainfall

FERTRWPI is real price of fertiliser i.e. Fertiliser price deflated by index of crop price index

CRST is supply of short term credit to agriculture sector in real terms

Equation 1 is the aggregate production function which estimates impact of fertiliser, irrigation, irrigation, foodgrain price and rainfall on foodgrain production and equation 2 estimates impact of fertiliser price, irrigation, and short term institutional credit supplied to agriculture sector on use of fertiliser. All variables were expressed in log form. These two equations were estimated simultaneously using SURE technique of regression

analysis by using statistical package EVIEWS. The estimates were based on data for the period 1980-81 to 2004-05. Results are presented in Table 3.7.

Table 3.7: Estimates of impact of fertiliser price and other factors on foodgrain production

Simultaneous Equation Model of 2 equations
Estimation Method: Seemingly Unrelated Regression
Sample: 1981 2005
Included observations: 25
Total system (balanced) observations 50

		Coefficient	Std. Error	t-Statistic	Prob.
Eq.1: Dep. Variable: Foodgrain Output					
Constant	C(1)	8.453	0.420	20.115	0.000
Fertiliser	C(2)	0.206	0.096	2.149	0.038
Irrigated area	C(3)	0.420	0.260	1.617	0.114
Real price of foodgrain	C(4)	0.246	0.152	1.622	0.113
Rainfall	C(5)	0.294	0.064	4.604	0.000
Eq.2: Dep. Variable: Fertiliser use					
Constant	C(11)	4.746	0.355	13.358	0.000
Area irrigated	C(12)	1.456	0.117	12.440	0.000
Real price	C(13)	-0.616	0.075	-8.219	0.000
ST credit	C(14)	0.098	0.024	4.090	0.000

Determinant residual covariance 1.43E-06

Equation: FGPROD=C(1)+C(2)*FERT+C(3)*GCAIR+C(4)*FGREALPR +C(5)*RAIN
Observations: 25

R-squared	0.957	Mean dependent var	12.050
Adjusted R-squared	0.949	S.D. dependent var	0.157
S.E. of regression	0.036	Sum squared resid	0.025
Durbin-Watson stat	2.219		

Equation: FERT =C(11)+C(12)*GCAIR +C(13)*FERTRPRICE+C(14)*CRST
Observations: 25

R-squared	0.990	Mean dependent var	7.073
Adjusted R-squared	0.988	S.D. dependent var	0.375
S.E. of regression	0.041	Sum squared resid	0.035
Durbin-Watson stat	1.856		

The estimated parameters presented in Table 3.7 are elasticities. These show that 1 percent increase in use of fertiliser increases foodgrain production by 0.20 percent. Elasticity of foodgrain production with respect to irrigated area and real price of foodgrain was 0.40 and 0.246 respectively. The second equation shows that 1 percent increase in real price of fertiliser reduces fertiliser use by 0.616 percent. Product of

elasticity of foodgrain with respect to fertiliser and elasticity of fertiliser use with respect to fertiliser price gives elasticity of foodgrain production with respect to fertiliser price. This comes to -0.1266, i.e. [(0.206)*(-0.616)], which shows that 1 percent change in fertiliser price in real terms cause 0.1205 percent change in foodgrain production in opposite direction. This estimate can be used to prepare impact of change in fertiliser subsidy on fertiliser use.

Average price of fertiliser (weighted for N.P and K) was Rs. 12.5 per kg and subsidy works out to Rs. 8.63 (Table 3.8). If subsidy on fertiliser is removed completely then price of fertiliser increase by 69 percent and this would cause close to 9 percent reduction in foodgrain production in the country.

Table 3.8 : Impact of removal of fertiliser subsidy on foodgrain production

Particular	Dimension
Elasticity of foodgrain wrt fertilizer	0.2056
Elasticity of fertiliser use wrt real price of fertilizer	-0.6159
Elasticity of foodgrain production wrt real price of fertilizser	-0.1266
Weighted price of NPK 2004-05 Rs/kg NPK	12.5
Fertiliser subsidy in 2004-05: total Rs. Crore	15879
Fertiliser use 2004-05: thousand tone	18398
Subsidy per kg NPK	8.63
Increase in fertiliser price due to removal of subsidy %	69.04
Impact of removal of fertiliser subsidy on foodgrain output %	-8.74

These estimates indicate that if subsidy on fertiliser is taken away in one go it is going to cause very serious adverse effect on foodgrain production and consequently on food security. Our foodgrain production is growing at a very slow rate compared to growth rate in demand and there is an urgency in the country to accelerate growth in foodgrain production. In this kind of situation any drastic action on fertiliser subsidy seems to be highly undesirable. On the other hand ballooning subsidy bill is a matter of concern and, slow growth in fertiliser production is another matter of serious concern. What could be done in this kind of a situation?

One way out to keep some check on further growth of subsidy without adverse impact on foodgrain and agricultural production is to increase fertiliser prices at a rate lower than the increase in foodgrain prices received by farmers. This would ensure that real price of fertiliser is declining whereas nominal price is increasing. During last two years foodgrain prices have risen substantially whereas fertiliser prices have been kept at almost the same level. In this kind of situation when foodgrain prices are rising there is a scope to raise prices of fertiliser. Therefore, in our view the best option to keep a check on growth of fertiliser subsidy without causing adverse effect on foodgrain production is to increase prices of fertiliser by suitable fraction of increase in foodgrain prices. This ensures that real prices of fertiliser are still declining, and, it is the real price of fertiliser which determines fertiliser use.

Freezing nominal prices of fertiliser at the same level over a period of time also causes adverse impact on fertiliser production. Prices of inputs that go into production of fertiliser have increased sharply and international prices of all kind of fertilisers have also witnessed sharp increase in the recent years. In this kind of situation, if increase in cost of production is not passed on to price it is bound to increase subsidy. If subsidy does not compensate for the entire increase in cost of production it would affect the incentive of fertiliser producers to expand production. India's fertiliser industry seems to be facing this kind of situation.

After 1998-99, production of N in the country increased merely at about 1 percent per year which is lowest in the last five decades. This growth was not enough to meet the demand and India had to meet scarcity of fertiliser through import. The level of import of N was below 2 lakh tonne during 2000-01 whereas it has reached 2.7 million tonne during 2006-07. This slowdown in domestic production of N in the country is experienced in those years when nominal price of N remained frozen around Rs. 10.5/ kg for six years.

Table 3.9: Domestic production and import of fertiliser (000 tons), 1990-91 to 2006-07

Year	N		P		K	NPK		Import share (%) in total consumption
	Production	Import	Production	Import	Import	Production	Import	
1990-91	6993	412	2051	1016	1326	9044	2754	23.3
1991-92	7302	566	2562	968	1236	9863	2770	21.9
1992-93	7431	1152	2321	727	1081	9751	2961	23.3
1993-94	7231	1589	1874	722	863	9106	3173	25.8
1994-95	7944	1473	2557	376	1282	10501	3131	23.0
1995-96	8769	2008	2594	686	1424	11362	4119	26.6
1996-97	8593	1156	2579	219	667	11172	2041	15.4
1997-98	10083	1377	3076	716	1437	13159	3531	21.2
1998-99	10477	657	3205	985	1558	13682	3200	19.0
1999-00	10873	856	3448	1534	1774	14321	4164	22.5
2000-01	10943	164	3734	437	1594	14677	2194	13.0
2001-02	10690	283	3837	494	1697	14527	2474	14.6
2002-03	10508	135	3908	228	1568	14415	1932	11.8
2003-04	10557	205	3627	372	1553	14183	2129	13.1
2004-05	11305	413	4038	307	2058	15343	2779	15.3
2005-06	11333	1390	4203	1145	2764	15536	5299	25.4
2006-07	11525	2704	4440	1373	2076	15965	6153	27.8

Source: Fertiliser Statistics, The Association of India, New Delhi, various issues.

Though there is no slowdown in growth of production of phosphatic fertiliser in the country, which could be due to the reason that prices of phosphatic fertiliser are decontrolled, but level of application of P is much lower than what is recommended and what is considered optimum for balanced fertiliser use. There is thus need to expand production of phosphatic fertiliser also. India does not produce any potassic fertiliser and entire requirement is met from import.

Share of imported fertiliser in total fertiliser consumption in the country has increased in the recent years mainly on account of increase in import of urea. The import as such should not be a cause of worry but if import costs more than what is the supply price of domestic production then it is a matter of concern. As could be seen from Table 3.10, cif price paid for import of urea is higher than the price paid (MRP plus subsidy) to domestic producers of urea. Domestic producers were paid Rs. 10243 to 10454 per tonne including subsidy whereas cif price of import was Rs. 10693 to 11422 during last three years. Imported urea during the year 2007-08 would turn out to be much more costlier as

international prices of urea between March 2007 and December 2007 have increased by more than 20 percent.

Table 3.10: Comparison of cost of domestic and imported urea

Year	Domestic production 000 tonne	Subsidy on indigenous fertiliser Rs. crore	Maximum retail price Rs/tone	Price paid to indigenous producer (MRP + subsidy)	Import 000 tonne	Subsidy on Imported urea Rs. crore	Price paid for import Cif Rs./tonne
2004-05	20239	10243	4830	9891	641	494	10693
2005-06	20085	10653	4830	10134	2057	1211	11422
2006-07	20271	11400	4830	10454	4719	2704	10770

As imports are turning costlier than domestic production, it is important to expand domestic production which is cheaper than imports. This would require expansion of production in the existing plants and investments in new fertiliser plants. This is not likely to happen unless pricing environment for fertiliser is improved.

4

Summary and Conclusions

Fertiliser is the single most important input underlying the growth in food and other crops during last four decades and it holds key to future growth in agricultural output in the country. Fertilizer use has witnessed spectacular growth in some parts of the country but its use is quite low in many states where it offers considerable scope to raise agricultural production. Further, fertiliser use at country level and in many states is highly concentrated towards nitrogenous fertiliser and a large imbalance has emerged between ratio of N, P and K applied by farmers and the ratio that is considered optimum. This is raising concerns regarding soil fertility, productivity and efficiency of fertiliser use. Structure of subsidy on fertiliser is often held responsible for distortions in use of N, P and K but empirical evidence on this is missing. Issue of subsidy on fertiliser is also being debated for its impact on fiscal resources. It is felt that due to rising bill of fertiliser subsidies resources are being diverted from investments in agriculture sector to meet subsidy bill which cause adverse impact on long term growth of the sector. On the other hand there is a danger that slashing subsidies would cause adverse impact on agricultural production and food security and would raise food prices. This calls for striking a balance between fertiliser use and level of subsidy.

Fertiliser use increased by more than 10 percent per year during initial years of green revolution which raised per hectare use of NPK to 32 Kg by the year 1980-81. There was a small deceleration in growth of fertiliser after 1980-81 but rate of growth was still quite high, close to 8 percent, which doubled per hectare use of fertiliser by the year 1991-92. The serious slowdown started after 1991-92 which was further exacerbated after 1999-00. Per hectare use of NPK declined from 95.4 kg during 1999-00 to below 92 kg during next four years. There is some recovery during 2004-5 to 2006-7. These patterns in growth rate of fertiliser use are closely associated with the pattern in growth of crop output at national level.

Among states, Punjab took a very big and early lead in fertiliser application. Interstate variation in per hectare application of fertiliser declined after early 1980s but large difference still exists. Punjab continues to be at the top with more than 300 kg use of fertiliser per hectare per year followed by Haryana. Fertiliser use is more than 200 kg in Andhra Pradesh and West Bengal. Uttar Pradesh has almost approached level of 200 kg. Orissa and Rajasthan continue to be at the bottom.

Relative use of N, P and K used to compare imbalance in fertiliser use presents a very interesting picture. If we look at absolute figures of per hectare use of N, P and K the gap between any two pairs has increased very much over time. However, growth rate in consumption of N, P and K presents a different picture. Growth rate in use of P was higher than the growth rate in N. Similarly, growth rate in use of K was higher than N during 1961 to 1974 and 1991 to 2007. During last 47 years consumption of P increased by 9.41 percent per year while use of N and K increased by around 8.50 percent. These growth rates and share of different nutrients in total fertiliser use show that fertiliser use in India has moved somewhat in favour of P, and there is no evidence of fertiliser use moving in favour of N. Similarly, index of imbalance between actual ratios of N, P and K and the ratios as per the norm (4:2:1) showed significant imbalance but it followed a decline except occasional increase in mid 1970s and early 1990s.

More insights about imbalance can be obtained by looking at disaggregate i.e. state level data. The deviation from the recommended proportion are found in all directions i.e. higher level of N and P relative to K, lower level of N and P relative to K and higher or lower level of N relative to P as against the norm. Highest share of nitrogen in total fertiliser is found in Bihar where about 80 percent of total fertiliser use consists of nitrogen. In Punjab and Haryana three-fourth of total fertiliser is in the form of N as against 57 percent required for balanced use. In all the southern states except Andhra Pradesh share of nitrogen in total fertiliser is lower than the recommended for balanced use. While share of N in Bihar is quite high, the share of P is half of what it should be, which is lowest among all the states. Share of P is found more than the norm (27%) only in Madhya Pradesh. In Andhra Pradesh, Assam, Jammu and Kashmir, Karnataka,

Maharashtra, West Bengal and Rajasthan share of P in total fertiliser use did not deviate much from the norm. In the remaining states share of P was lower than 27 percent. Share of K in total fertiliser ranges from about 2 percent in Haryana and Rajasthan to 36 percent in Kerala. Share of K was close to the norm in Andhra Pradesh, Himachal Pradesh, Maharashtra and Orissa. Fertiliser mix show lower than recommended share of nitrogen in Kerala, Karnataka, Tamil Nadu, West Bengal and Assam.

Use of N is most skewed in Rajasthan and Haryana where farmers apply more than 36 kg N for 1 kg application of K which is 9 times the use of N for balanced requirement. Punjab comes next with N, P and K ratio of 25:7:1. Similarly, share of N is higher than norm in Jammu and Kashmir, Uttar Pradesh, Bihar, Gujarat and Madhya Pradesh. Ratio of N and P shows much smaller variation as compared to the ratio of N and K and P and K. Bihar topped in imbalance between N and P. Against the ideal ratio of 2, Bihar farmers apply about 5.8 times N as compared to P. Ratio of N to P was close to norm in Kerala, Madhya Pradesh, Karnataka, Maharashtra, West Bengal and Andhra Pradesh.

A composite index of imbalance in use of N, P and K shows that Bihar and Kerala topped the imbalance in fertiliser use followed by Haryana and Punjab. In order to reduce the imbalance in fertiliser use there is a need to increase use of P and K in Bihar, Punjab, Haryana, Rajasthan, Uttar Pradesh and Gujarat. In Madhya Pradesh N and P are balanced but there is serious imbalance against K.

Except a few states there is imbalance in use of fertiliser. This is not confined only to higher relative use of N; in some states proportion of N is much lower than recommended. Therefore, while at country level fertiliser imbalance is skewed towards N, at state level there are various patterns. These vary from severe imbalance in favour of N to severe imbalance in favour of P as well as K.

Here it is pertinent to clarify some aspects of imbalance in fertiliser use. Except Punjab, the imbalance exists with lower than optimum use of fertiliser per unit of area. In such situation, imbalance needs to be addressed not by lowering use of plant nutrients having

share higher than norm but by increasing use of those plant nutrients which have lower share than the norm. In Punjab, nitrogen not only has higher share than norm, its per hectare application is also found higher than what is considered optimum for wheat – paddy rotation, which represent crop system in Punjab. In a situation like this, imbalance can cause adverse impact on yield. In other situations, where imbalance coexists with sub optimal use of N or P or K, the impact of imbalance on crop productivity is not clear. Our conjecture is that in such situation imbalance in fertiliser use does not cause detrimental effect on productivity, though balanced use would improve response to fertiliser.

Prices of nitrogen in urea fluctuated around Rs. 5.11 per kg. during 1980-81 to 1990-91. During the decade of 1990's nominal prices of N witnessed large increase. Since 2000-01 prices of nitrogen varied between Rs. 10 and 10.50 except in year 2002-03 when they were slightly higher. During last 4 years i.e. 2003-04 to 2006-07 prices of urea has been kept at the level 2001-02. With the economic reforms started during 1991 prices of P and K were decontrolled in August 1992 and subsidy on these fertilisers was severely reduced. This led to a very sharp increase in prices of P and K.

During 1980-81 to 1990-91 prices of all the three types of fertilisers changed almost in the same way. Serious distortion was caused in relative prices of N, P and K during 1990-91 which turned price of nitrogen lower than that of K, whereas, it was more than double the price of K during 1980's. Similarly, price of N, which ruled only marginally lower than price of P during 1980's, turned out to be half of price of P after 1991. After the big change in price ratio during 1992-93, price of P and K increased at a lower rate than that of N but prices of N relative to P and K are far lower than those prevailed during 1980's. Thus, year 1991 made a distinct change in fertiliser prices in favour of N just in one stroke. This is an important factor in shifting balance of fertiliser use in favour of N and against P and K.

Prices of N, P and K relative to one another are important in affecting substitution among the three types of fertiliser. The second important dimension of prices is prices of fertiliser with respect to prices of output. Prices of N, P and K relative to MSP of wheat

and paddy declined very sharply during 1980-81 to 1990-91. During early 1990's quantity of wheat and paddy required to buy one kg. of P and K increased to roughly same level as during early 1980's. After mid 1990s, hike given to MSP of wheat and paddy remained higher than the increase in prices of N, P and K. Thus, except for a big upward spurt in early 1990's, prices of P and K relative to MSP of wheat and paddy also showed a decline. During last 26 years beginning with 1980-81prices of N declined annually by 4 percent when deflated by price of wheat and by 3.6 percent when deflated by MSP of paddy. The rate of decline in prices of P and K varied around 1 percent.

Index of prices of all the three fertiliser relative to price index of crop sector followed a big decline during 1983-84 to 1990-91. There was no significant decline in real prices of fertiliser after this.

Subsidy given by Central government on various fertilisers increased from Rs. 891 crore during early 1980s to 22452 crore during 2006-07. Though a major part of this increase is on account of inflation, even in real terms subsidy on fertiliser has been increasing in leaps and bounds. Level of subsidy at 1999-00 prices was about Rs. 3.5 thousand crore in early 1980s which increased to more than 7.7 thousand crores in the later half of 1980s. The level of subsidies in real terms almost doubled during the fifteen years after 1990. The increase resulted from both increase in fertiliser use as well as increase in subsidy content per unit of fertiliser.

Subsidies have also grown faster than growth of crop sector. In monetary terms the share of subsidies at current price in the value of output of crop sector has been increasing and is approaching to 4% in the recent years.

Among states, fertiliser subsidy per hectare of net cultivated area varies in the range of Rs. 393 in Rajasthan to Rs. 3167 in Punjab. Fertiliser subsidy as percent of value of crop output show that Punjab and Haryana receives highest benefit from fertiliser subsidy closely followed by Andhra Pradesh. The level is close to 5 percent of value of crop output (VCO). Tamil Nadu and Uttar Pradesh comes next with subsidy level close to 4

per cent of crop output. In Bihar and Karnataka fertiliser subsidy was around 3.5 percent of VCO. Other states where fertiliser subsidy was more than 3 percent are Chattisgarh, and Gujarat. Fertiliser subsidy comprises less than 1 percent of VCO in Assam, Himachal Pradesh, Jammu and Kashmir and Kerala.

Subsidies are often criticized for their financial burden and for the imbalance in use of different plant nutrients. Some researchers assert to the extent that these subsidies are causing adverse impact on production. On the other hand there is concern about decline in production if subsidies are curtailed. These are very important issues and need serious investigation. We have tried to understand impact of reduction in fertiliser subsidy on food security by estimating relationship between fertiliser price and foodgrains production by using a two equations model linking subsidy to fertiliser use and fertiliser use to foodgrain production. Estimates show that 1 percent increase in use of fertiliser increases foodgrain production by 0.20 percent and elasticity of foodgrain production with respect to irrigated area and real price of foodgrain was 0.40 and 0.246 respectively. The second equation shows that 1 percent increase in real price of fertiliser reduces fertiliser use by 0.616 percent. Product of elasticity of foodgrain with respect to fertiliser and elasticity of fertiliser use with respect to fertiliser price gives elasticity of foodgrain production with respect to fertiliser price. This comes to -0.1205 implying that that 1 percent change in fertiliser price in real terms cause 0.1205 percent change in foodgrain production in opposite direction. These estimates indicate that complete removal of subsidy on fertiliser would cause 9 percent reduction in foodgrain production in the country.

Thus, if subsidy on fertiliser is taken away in one go it is going to cause very serious adverse effect on foodgrain production and consequently on food security. Our foodgrain production is growing at a very slow rate compare to growth rate in demand and there are serious concerns to accelerate growth in foodgrain production. In this kind of situation any drastic action on fertiliser subsidy seems to be highly undesirable. On the other hand ballooning subsidy bill is a matter of concern and, slow growth in fertiliser production is another matter of serious concern. One way out to keep some check on further growth of

subsidy without adverse impact on foodgrain and agricultural production is to increase fertiliser prices at a rate lower than the increase in foodgrain prices received by farmers. This would ensure that real price of fertiliser is declining whereas nominal price is increasing. During last two years foodgrain prices have risen substantially whereas fertiliser prices have been kept at almost the same level. In this kind of situation when foodgrain prices are rising there is a scope to raise prices of fertiliser. Therefore, in our view the best option to keep a check on growth of fertiliser subsidy without causing adverse effect on foodgrain production is to increase prices of fertiliser by suitable fraction of increase in foodgrain prices.

Freezing nominal prices of fertiliser at the same level over a period of time also causes adverse impact on fertiliser production. Prices of inputs that go into production of fertiliser have increased sharply and international prices of all kind of fertilisers have also witnessed sharp increase in the recent years. In this kind of situation, if increase in cost of production is not passed on to price it is bound to increase subsidy, and, if subsidy does not compensate for the entire increase in cost of production it would affect the incentive of fertiliser producers to expand production. India's fertiliser industry seems to be facing this kind of situation.

After 1998-99, production of N in the country increased merely at about 1 percent per year which is lowest in the last five decades. This growth was not enough to meet the demand and India had to meet scarcity of fertiliser through import. The level of import of N was below 2 lakh tonne during 2000-01 whereas it has reached 2.7 million tonne during 2006-07. This slowdown in domestic production of N in the country is experienced in those years when nominal price of N remained frozen around Rs. 10.5/ kg for six years.

Though there is no slowdown in growth of production of phosphatic fertiliser in the country, which could be due to the reason that prices of phosphatic fertiliser are decontrolled, but level of application of P is much lower than what is recommended and what is considered optimum for balanced fertiliser use. There is thus need to expand

production of phosphatic fertiliser also. India does not produce any potassic fertiliser and entire requirement is met from import.

There is increase in share of imported fertiliser in total fertiliser consumption in the country in the recent years mainly on account of increase in import of urea. These imports are turning costlier than domestic production. It is thus important to expand domestic production and to improve pricing environment for fertiliser to attract investments in fertiliser production.

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APPENDIX Table 2.1

Fertiliser Use in India Since 1950-51

	000 tonne				Kilogram	
Year	**N**	**P**	**K**	**Total**	**NPK/ha GCA**	**NPK/ha NSA**
1950-51	55	9	6	70	0.53	0.59
1951-52	59	7		66	0.49	0.55
1952-53	58	5	3	66	0.48	0.53
1953-54	89	8	8	105	0.74	0.83
1954-55	95	15	11	121	0.84	0.95
1955-56	108	13	10	131	0.89	1.01
1956-57	123	16	15	154	1.03	1.18
1957-58	149	22	13	184	1.26	1.42
1958-59	172	30	22	224	1.48	1.70
1959-60	229	54	21	305	1.99	2.29
1960-61	212	53	29	294	1.92	2.21
1961-62	250	61	28	338	2.17	2.50
1962-63	333	83	36	452	2.88	3.32
1963-64	376	117	51	543	3.46	3.98
1964-65	555	149	69	773	4.86	5.60
1965-66	575	133	77	785	5.05	5.76
1966-67	738	249	114	1101	6.99	8.02
1967-68	1035	335	170	1539	9.40	11.00
1968-69	1209	382	170	1761	11.0	12.8
1969-70	1356	416	210	1982	12.2	14.3
1970-71	1479	541	236	2256	13.6	16.1
1971-72	1798	558	301	2657	16.1	19.0
1972-73	1838	581	348	2767	17.1	20.2
1973-74	1829	650	360	2839	16.7	19.9
1974-75	1766	472	336	2574	15.7	18.7
1975-76	2149	467	278	2894	16.9	20.4
1976-77	2457	635	319	3411	20.4	24.5
1977-78	2913	867	506	4286	24.9	30.2
1978-79	3420	1106	591	5117	29.3	35.8
1979-80	3498	1151	606	5255	31.0	37.8
1980-81	3678	1214	624	5516	32	39
1981-82	4069	1322	676	6067	34	43
1982-83	4242	1433	726	6401	37	46
1983-84	5204	1730	775	7709	43	54
1984-85	5486	1886	838	8210	47	58
1985-86	5661	2005	808	8474	47	60
1986-87	5716	2079	850	8645	49	62
1987-88	5717	2187	880	8784	51	66
1988-89	7251	2721	1068	11040	61	78
1989-90	7386	3014	1168	11568	63	81
1990-91	7997	3221	1328	12546	68	88
1991-92	8046	3321	1361	12728	70	90
1992-93	8427	2844	884	12155	65	85
1993-94	8788	2669	909	12366	66	87
1994-95	9507	2932	1125	13564	72	95

1995-96	9823	2898	1156	13877	74	98
1996-97	10302	2977	1030	14309	75	100
1997-98	10905	3917	1373	16195	85	114
1998-99	11466	4001	1305	16772	87	118
1999-00	11593	4798	1679	18070	95	128
2000-01	10862	4212	1557	16631	90	118
2001-02	11310	4382	1667	17359	91	123
2002-03	10474	4019	1601	16094	91	121
2003-04	11076	4124	1598	16798	88	119
2004-05	11714	4624	2061	18399	97	130
2005-06	12723	5204	2413	20340	106	144
2006-07	13774	5543	2334	21651	113	153

Source: Fertiliser Statistics, Fertiliser Association of India, New Delhi, various issues.