Fertilizer use by crop in India

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Land and Plant Nutrition Management Service
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Preface

This study, commissioned by the Food and Agriculture Organization of the United Nations (FAO), is one of a series of publications on fertilizer use on crops in different countries.

The aim of the series is to examine the factors underlying present fertilizer usage. These factors include the agro-ecological conditions, the structure of farming, cropping patterns, the availability and use of mineral and organic plant nutrients, the economics of fertilizers, and research and advisory requirements. The reports examine those factors that will or should determine the future development of plant nutrition on a country-by-country basis.

In the past two decades, there has been an increasing focus on the adverse environmental impact of both the underuse and the overuse of plant nutrients. The efficient use of plant nutrients, whether from mineral fertilizers or from other sources, involves the shared responsibility of many segments of society including international organizations, governments, the fertilizer industry, agricultural research and advisory bodies, traders and farmers. The publications in the series are addressed to all these parties.

Fertilizer use is not an end in itself. Rather, it is a means of achieving increased food and fibre production. Increased agricultural production and food availability can, in turn, be seen as an objective for the agriculture sector in the context of contributing to the broader macroeconomic objectives of society. The FAO/IFA 1999 publication *Fertilizer strategies* provides a review of the options available to policy-makers.

The contents of the series of studies differ considerably from country to country in view of their different structures, histories and food situation. However, in each case the aim is to arrive at a better understanding of crop nutrition in the country concerned.

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Cover photographs (wheat – background – paddy, cotton and litchi) provided by the FAI.

Abstract

In India, agriculture accounts for about 22 percent of gross domestic product. There are about 116 million farmholdings with an average size of 1.4 ha. The cultivated area is about 141 million ha and has remained constant for the past 30 years although the cropping intensity has increased from 118 to 135 percent during this period. The area of land receiving irrigation from different sources is almost 55 million ha.

The country has been divided into 20 agro-ecological zones and the soils classified into 8 major groups. The organic carbon content of most Indian soils is very low and nitrogen deficiency is universal. Most of the soils are low to medium in phosphorus and potassium, and sulphur deficiencies have developed over time. Soil fertility depletion and the increasing deficiencies of certain micronutrients are causes of concern.

Fertilizer consumption has increased from less than 1 million tonnes of total nutrients in the mid-1960s to almost 17 million tonnes today. The introduction of high-yielding varieties in the 1960s boosted fertilizer use. The high grain and fertilizer prices on the international markets during the oil crisis of 1973–74 provided a further impetus to policies aimed at improving the country's fertilizer supplies and food security. The production of nitrogen and phosphate increased from 1.8 million tonnes of nutrients in 1975/76 to 14.2 million tonnes (K_2O) in 2003/04. In the absence of domestic natural resources, all potash fertilizers are imported; the imports in 2003/04 were to 2.6 million tonnes K_2O compared with 0.4 million tonnes in the mid-1970s.

The intensity of fertilizer consumption varies greatly between the regions, from 40.5 kg/ha of total nutrients in Rajasthan to 184 kg/ha in Punjab. Urea accounts for 82 percent of total nitrogen consumption and di-ammonium phosphate for 63 percent of phosphate consumption.

Organic manures make a significant contribution to the supply of plant nutrients and soil fertility. However, a substantial proportion of cattle manure is used for purposes other than fertilization and the share available for crop nutrition is shrinking. The use of biofertilizers has

increased in recent years although inconsistent crop responses to these products remains a constraint.

Six crops (rice, wheat, cotton, sugar cane, rapeseed and mustard) consume about two-thirds of the fertilizer applied. The irrigated area, accounting for 40 percent of the total agricultural area, receives 60 percent of the fertilizer applied.

The Government of India fixes minimum support prices for the main crops, controls the farm price of urea and issues indicative selling prices of other fertilizers. The prices of fertilizers are subsidized. The Government's aim is that farmers should receive a price for their crops and pay a price for fertilizers that makes the use of fertilizers acceptable and remunerative. The subsidy on fertilizers is channelled through the fertilizer production industry, being calculated to ensure a reasonable return to the industry.

Fertilizer distribution is effected through private channels, cooperatives and certain institutions. There are 283 000 sales outlets in the country.

The population of India exceeds 1 000 million people. It is estimated that it will reach 1 400 million by 2025, requiring 300 million tonnes of foodgrain. Little extra land is available and the increase in production will have to come from higher yields, for which there is ample scope. In order to reach the required yield levels, fertilizer use will need to increase and improve. Present application rates are relatively low in many areas. The efficiency of fertilizer use could be improved through fertilization practices that include an application of macronutrients and micronutrients according to crop requirements. An adequate supply of credit for farmers and distributors is necessary to ensure the availability of fertilizers when and where they are required.

Abbreviations and symbols

AEZ	Agro-ecological zones
Al	Aluminum
B	Boron
C	Carbon
Ca	Calcium
Cu	Copper
ECA	Essential Commodities Act
FAI	Fertiliser Association of India
Fe	Iron
GCA	Gross cropped area
GDP	Gross domestic product
GPS	Group Pricing Scheme
ha	Hectare
HYV	High-yielding variety
ICAR	Indian Council of Agricultural Research
IGP	Indo-Gangetic Plains
INSS	Integrated nutrient supply systems
KCC	Kisan (farmer) credit card scheme
LGP	Lower Gangetic Plain
Mn	Manganese
Mo	Molybdenum
MSP	Minimum Support Price
N	Nitrogen
Na	Sodium
NBSS&LUP	National Bureau of Soil Survey and Land Use Planning
P	Phosphorus

PET	Potential Evapotranspiration
PSB	Phosphate-solubilizing bacteria
RPS	Retention Pricing Scheme
A	Sulphur
TGP	Trans-Gangetic Plain
VCR	Value-cost ratio
Zn	Zinc

Fertilizers

ACl	Ammonium chloride
AN	Ammonium nitrate
AS	Ammonium sulphate
CAN	Calcium ammonium nitrate
DAP	Diammonium phosphate
KNO_3	Potassium nitrate
MAP	Mono-ammonium phosphate
MOP	Muriate of potash (potassium chloride)
SOP	Sulphate of potash (potassium sulphate)
SSP	Single superphosphate
TSP	Triple superphosphate
NPK	Compound fertilizer containing N, P_2O_5 and K_2O
NP	Compound fertilizer containing N and P_2O_5
PK	Compound fertilizer containing P_2O5 and K_2O

N: Nitrogen

P_2O_5 or P: Phosphate*

K_2O or K: Potash*

* Phosphate and potash may be expressed as their elemental forms P and K or as their oxide forms P_2O_5 and K_2O. Nitrogen is expressed as N. In this study, phosphate and potash are expressed in their oxide forms.

Chapter 1
Introduction

India is a country of more than 1 000 million people. It is the seventh largest nation in the world with a geographical area of 328.7 million ha. Agriculture is the mainstay of the Indian economy, contributing about 22 percent of gross domestic product (GDP) and providing a livelihood to two-thirds of the population. The net cultivated area has been about 141 million ha for the last 30 years. However, there has been a progressive increase in the gross cropped area as the cropping intensity has increased from 118 to 135 percent in the last three decades. The total gross cropped area is about 190 million ha. There are 115.6 million farmholdings, with an average size of 1.41/ha.

The country has a diverse landscape and a climate varying from the areas with highest rainfall such as Mawsynram near Cherrapunji (Meghalaya) to the driest parts of western Rajasthan with negligible rain and from a hot and humid southern peninsula to the snowbound Himalayan Mountains. Broadly, the climate of India is of the tropical monsoon type. It has four seasons: winter (January–February), a hot summer (March–May), rainy southwest monsoon (June–September), and post-monsoon (October–December). The climate is affected by two seasonal winds: the southwest monsoon and the northeast monsoon. The distribution of rainfall is very uneven in terms of time and space (Table 1). About 72 percent of the area receives an annual rainfall of no more than 1 150 mm.

India has a net irrigated area (land area that receives irrigation from the different sources) of 54.68 million ha and a gross irrigated area (total area of crops that are irrigated) of 75.14 million ha (the largest in the world). Surface water and groundwater resources

TABLE 1
Distribution of area according to annual rainfall

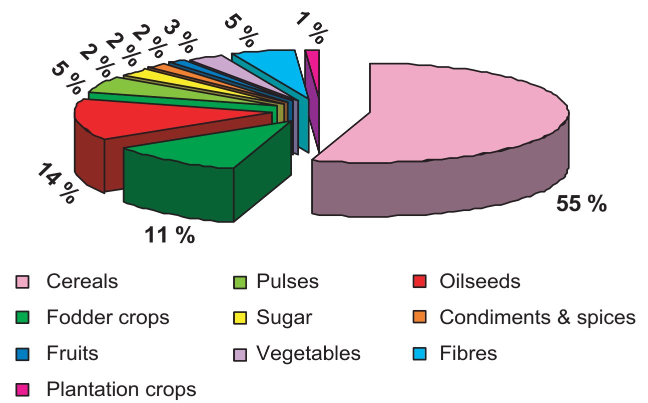
Category	Rainfall (mm)	Area (%)
Dry	0–750	30
Medium	750–1 150	42
	1 150–2 000	20
Assured	> 2 000	8

contribute 46 and 54 percent, respectively, of the total. Food crops occupy 69 percent of the irrigated area, the remaining 31 percent being under non-food crops.

The land in India suffers from varying degrees of degradation. Soil fertility depletion is a cause of concern for Indian agriculture. There exists a gap of about 10 million tonnes of nutrients (NPK) between the removal of nutrients by crops and their addition through fertilizers. The use of plant nutrients per hectare is relatively low and imbalanced, and this is one of the major reasons for low crop yields in India.

There are two main cropping seasons, namely kharif (April–September) and rabi (October–March). The major kharif crops include rice, sorghum, pearl millet, maize, cotton, sugar cane, soybean and groundnut, and the rabi crops are wheat, barley, gram, linseed, rapeseed and mustard. With its good range of climates and soils, India has a good potential for growing a wide range of horticultural crops such as fruits, vegetables, potato, tropical tuber crops, mushrooms, ornamental crops, medicinal and aromatic crops, spices and plantation crops. Foodgrain (cereals and pulses) crops dominate the cropping pattern and account for about 60 percent of total gross cropped area (Figure 1).

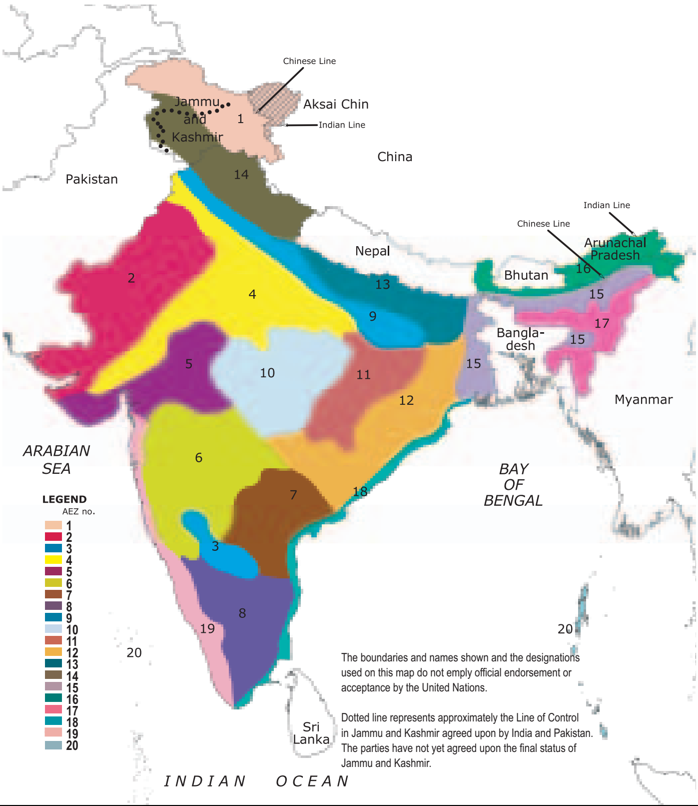
FIGURE 1
Crop groups by cropped area



AGRO-ECOLOGICAL ZONES

Agriculture is highly dependent on soils and climate. The ever-increasing need for food to support the growing population in the country demands a systematic appraisal of its soil and climate resources in order to prepare effective land-use plans. India has a variety of landscapes and climate conditions and this is reflected in the development of different soils and types of vegetation. Based on 50 years of climate data and an up-to-date soil database, the country has been divided into 20 agro-ecological zones (AEZs), as shown in Figure 2.

FIGURE 2
Agro-ecological zones of India



Source: Sehgal *et. al.*, 1992.

Each AEZ is as uniform as possible in terms of physiography, climate, length of growing period and soil type for macrolevel land-use planning and effective transfer of technology. Table 2 gives a brief description of important features of the AEZs.

MAJOR SOIL GROUPS

The great diversity in landforms, geological formations and climate conditions in India has resulted in a large variety of soils (Figure 3). Apart from a few soil orders (Andisols and Spodosols), all the major soils of the world are represented in India. Broadly, Indian soils consist of eight major groups, of which four are of agricultural importance: alluvial soils, black soils, red soils and lateritic soils. The four other broad soil groups that occur fairly extensively in India are: saline and sodic soils, desert soils, forest and hill soils, and peaty and marshy soils. These soil groups are related closely to the geographical character and the climate of the regions in which they occur.

Alluvial soils (Fluvisols)

Alluvial soils constitute the largest and most important soil group of India and contribute most to the agricultural wealth of the country. The soils are derived from the deposition of silt by the numerous river systems. They cover about 75 million ha in the Indo-Gangetic Plains (IGP) and Brahmaputra Valley and are distributed in the states of Punjab, Haryana, Uttaranchal, Uttar Pradesh, Bihar, West Bengal, Assam and the coastal regions of India. These soils are deficient in nitrogen (N), phosphorus and organic matter. Generally, alluvial soils range from near neutral to slightly alkaline in reaction. A wide variety of crops is grown in these soils.

Black soils (Vertisols)

Black soils are very dark and have a very high clay content. They have a high moisture retention capacity. They become extremely hard on drying and sticky on wetting. Hence, they are very difficult to cultivate and manage. These soils cover an area of about 74 million ha, mainly in the central, western and southern states of India. They are inherently very fertile. Under rainfed conditions, they are used for growing cotton, millets, soybean, sorghum, pigeon pea, etc. Under irrigated conditions,

TABLE 2
Important features of agro-ecological zones of India

AEZ No.	Agro-ecological region	Geographical area (million ha)	Gross cropped area (million ha)	Physiography	Precipitation (mm)	PET (mm)	Length of growing period (days)	Major crops
1.	Cold arid ecoregion with shallow skeletal soils	15.2 (4.7%)	0.07	Western Himalayas	< 150	<800	< 90	Vegetables, millets, wheat, fodder, barley, pulses
2.	Hot arid ecoregion with desert and saline soils	31.9 (9.7%)	20.85	Western Plain & Kachchha Peninsula	< 300	1 500–2 000	< 90	Millets, fodder, pulses
3.	Hot arid ecoregion with red and black soils	4.9 (1.9%)	4.18	Deccan Plateau	400–500	1 800–1 900	< 90	Sorghum, safflower, cotton, groundnut, sunflower, sugar cane
4.	Hot semi-arid ecoregion with alluvium-derived soils	32.2 (9.8%)	30.05	Northern Plain & Central Highlands including parts of Gujarat Plains	500–800	1 400–1 900	90–150	Millets, wheat, pulses, maize; irrigated cotton & sugar cane
5.	Hot semi-arid ecoregion with medium and deep black soils	17.6 (5.4%)	11.04	Central (Malwa) Highlands,Gujarat Plains & Kathiawar Peninsula	500–1 000	1 600–2 000	90–150	Millets, wheat, pulses
6.	Hot semi-arid ecoregion with shallow and medium (dominant) black soils	31.0 (9.5%)	25.02	Deccan Plateau	600–1000	1 600–1 800	90–150	Millets, cotton, pulses, sugar cane under irrigation
7.	Hot semi-arid ecoregion with red and black soils	16.5 (5.2%)	6.19	Deccan (Telangana) Plateau & Eastern Ghats	600–1 000	1 600–1 700	90–150	Millets, oilseeds, rice, cotton & sugar cane under irrigation
8.	Hot semi-arid ecoregion with red loamy soils	19.1 (5.8%)	6.96	Eastern Ghats (Tamil Nadu uplands) & Deccan Plateau (Karnataka)	600–1 000	1 300–1 600	90–150	Millets, pulses, oilseeds (groundnut), sugar cane & rice under irrigation

* Slash and burn cultivation.
Source: Sehgal *et al*., 1992.

TABLE 2

Important features of agro-ecological zones of India (continued)

AEZ No.	Agro-ecological region	Geographical area (million ha)	Gross cropped area (million ha)	Physiography	Precipitation (mm)	PET (mm)	Length of growing period (days)	Major crops
9.	Hot subhumid (dry) ecoregion with alluvium-derived soils	12.1 (3.7%)	11.62	Northern Plain	1 000–1 200	1 400–1 800	150–180	Rice, wheat, pigeon pea, sugar cane, mustard, maize
10.	Hot subhumid ecoregion with red and black soils	22.3 (5.8%)	14.55	Central Highlands (Malwa & Bundelkhand)	1 000–1 500	1 300–1 500	150–180	Rice, wheat, sorghum, soybean, gram, pigeon pea
11.	Hot subhumid ecoregion with red and yellow soils	11.1 (4.3%)	6.47	Eastern Plateau (Chhattisgarh Region)	1 200–1 600	1 400–1 500	150–180	Rice, millets, wheat, pigeon pea, green gram, black gram
12.	Hot subhumid ecoregion with red and lateritic soils	26.8 (8.2%)	12.09	Eastern (Chhota Nagpur) Plateau and Eastern Ghats	1 000–1 600	1 400–1 700	150–180	Rice, pulses, millets
13.	Hot subhumid (moist) ecoregion with alluvium-derived soils	11.1 (3.4%)	10.95	Eastern Plains	1 400–1 600	1 300–1 500	180–210	Rice, wheat, sugar cane
14.	Warm subhumid to humid with inclusion of perhumid ecoregion with brown forest and podzolic soils	18.2 (5.6%)	3.20	Western Himalayas	1 600–2 000	800–1 300	180–210	Wheat, millets, maize, rice
15.	Hot subhumid (moist) to humid (inclusion of perhumid) ecoregions with alluvial-derived soils	12.1 (3.7%)	8.99	Bengal Basin and Assam Plain	1 400–2 000	1 000–1 400	> 210	Rice, jute, plantation crops

* Slash and burn cultivation.

Source: Sehgal *et al*., 1992.

TABLE 2

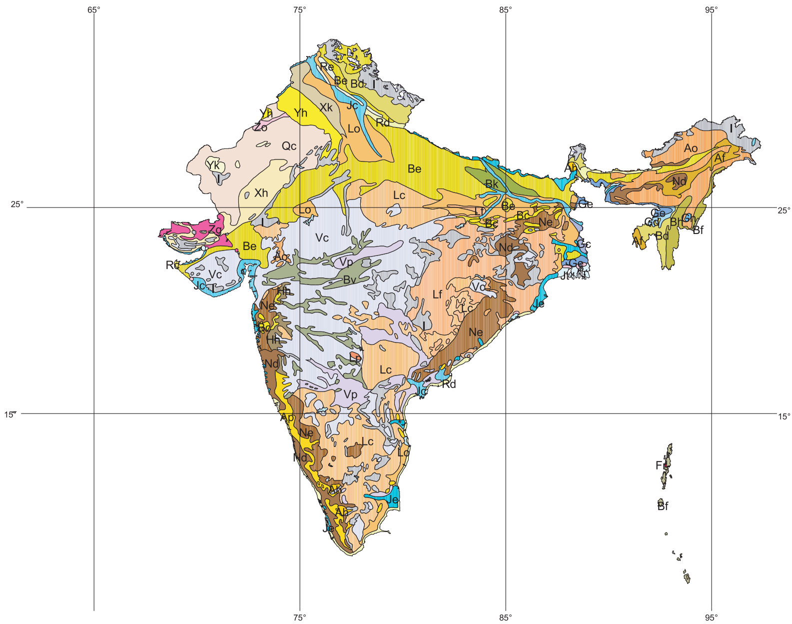
Important features of agro-ecological zones of India (continued)

AEZ No.	Agro-ecological region	Geographical area (million ha)	Gross cropped area (million ha)	Physiography	Precipitation (mm)	PET (mm)	Length of growing period (days)	Major crops
16.	Warm perhumid ecoregion with brown and red hill soils	9.6 (2.9%)	1.37	Eastern Himalayas	2 000–4 000	<1 000	> 210	Rice, millets, potato, maize, sesame, Jhum* cultivation is common
17.	Warm perhumid ecoregion with red and lateritic soils	10.6 (3.3%)	1.56	North-Eastern Hills	1 600–2 600	1 000–1 100	> 210	Rice, millets, potato, plantation crops, Jhum* cultivation is common
18.	Hot subhumid to semi- arid ecoregion with coastal alluvium-derived soils	8.5 (2.6%)	6.12	Eastern Coastal Plains	900–1 600	1 200–1 900	90>210	Rice, coconut, black gram, lentil, sunflower, groundnut
19.	Hot humid perhumid ecoregion with red, lateritic and alluvium-derived soils	11.1 (3.6%)	5.70	Western Ghats and Coastal Plains	2 000–3 200	1 400–1 600	> 210	Rice, tapioca, coconut, spices
20.	Hot humid / perhumid island ecoregion with red loamy and sandy soils	0.8 (0.3%)	0.05	Islands of Andaman & Nicobar and Lakshadweep	1 600–3 000	1 400–1 600	> 210	Rice, coconut, areca nut, oil palm

* Slash and burn cultivation.

Source: Sehgal *et al.*, 1992.

FIGURE 3
Dominant soil map of India



Af – Ferric Acrisols
Ah – Humic Acrisols
Ao – Orthic Acrisols
Ap – Plinthis Acrisols
Bc – Chromic Cambisols
Bd – Dystric Cambisols
Be – Eutric Cambisols
Bf – Ferralic Cambisols
Bh – Humic Cambisols
Bk – Calcic Cambisols
Bv – Vertic Cambisols
Fr – Rhodic Ferralsols
Gc – Calcaric Gleysols
Gd – Dystric Gleysols
Ge – Eutric Gleysols
Gh – Humic Gleysols
Hh – Haplic Phaeozems
I – Lithosols
Jc – Clcaric Fluvisols
Je – Eutric Fluvisols
Jt – Thionic Fluvisols
Lc – Chromic Luvisols
Lf – Ferric Luvisols
Lo – Orthic Luvisols
Lp – Plinthic Luvisols
Nd – Distric Nitosols
Ne – Eutric Nitosols
Qc – Cambic Arenosols
Rc – Calcaric Regosols
Rd – Dystric Regosols
Re – Eutric Regosols
Vc – Chromic Vertisols
Vp – Pellic Vertisols
Xh – Haplic Xerosols
Xk – Calcic Xerosols
Yh – Haplic Yermosols
Yk – Calcic Yermosols
Zg – Gleyic Solonchaks
Zo – Orthic Solonchaks
Waterbodies (WA)
Claciers (GL

Source: DSMW-FAO-UNESCO
Original scale: 1.5 million

they can be used for a variety of other crops, such as sugar cane, wheat, tobacco and citrus crops.

Red soils (Acrisols)

Ancient crystalline and metamorphic rocks have given rise to red soils. These soils are found predominantly in the states of Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Orissa, Goa and in the northeastern states. They have limitations of soil depth, poor water and nutrient-holding capacity, excessive drainage, runoff and are generally poor in N, P, zinc (Zn), sulphur (S) and humus. Under good management, these soils can be used profitably for a variety of crops such as millets, rice, groundnut, maize, soybean, pigeon pea, green gram, jute, tea, cashew, cocoa, grapes, banana, papaya and mango.

Laterite and lateritic soils (Ferralsols and Dystric Nitisols)

Laterite and lateritic soils are deeply weathered soils with a high clay content, having low base and silica owing to pronounced leaching. They are generally found in Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and the northeastern region, and occupy about 25 million ha. The major limitations posed by these soils include deficiency of P, potassium (K), calcium (Ca), Zn and boron (B), high acidity and toxicity of aluminum (Al) and manganese (Ma). The important crops grown on these soils are rice, banana, coconut, areca nut, cocoa, cashew, coffee, tea and rubber.

Desert (arid) soils (Arenosols, Calcisols and Gypsisols)

Desert soils constitute the soils with negligible vegetation in both hot and cold regimes. They cover an area of about 29 million ha. The sandy material results in poor profile development under arid conditions. Water deficiency is the major constraint in cultivating these soils. A gypsic horizon is common in extremely arid areas such as Bikaner and Jaisalmer in Rajasthan. These soils are very prone to wind erosion.

Forest and hill soils (Cambisols and Luvisols)

Forest and hill soils are found at high as well as low elevations where rainfall is sufficiently high to support forest growth. Soil formation is governed mainly by the deposition of organic matter derived from the forest growth. Brown forest and Podzolic soils are common in the Northern Himalayas, while the Deccan Plateau forests have red and lateritic soils.

Saline and sodic soils (Solonchaks and Solonetz)

Saline and sodic soils occur under semi-arid conditions and occupy an area of 10 million ha. They are widely distributed in Rajasthan, Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Maharashtra and Gujarat. The sodic soils pose serious problems of a high sodium (Na) content, poor physical conditions and nutrient deficiency. Despite many limitations, once ameliorated using gypsum, sodic soils are used successfully for growing rice followed by wheat.

Peaty and marshy soils (Histosols)

Peaty and marshy soils are formed by plants growing in the humid regions under permanently waterlogged conditions. They are found in Kerala, Orissa, West Bengal (Sundarbans) and along the South-East coast of Tamil Nadu. Where properly drained and fertilized, these soils often produce a very good rice crop.

SOIL FERTILITY STATUS

Being a tropical country, the organic carbon (C) content of the Indian soils is very low. The deficiency of N is universal in India. Most of the Indian soils are low to medium in P. Over time, K deficiency has also become widespread. The deficiency of S is increasing (Table 3). Besides primary and secondary nutrients, the increasing deficiency of micronutrients is becoming a cause of concern. Among the micronutrients, the deficiency of Zn is the most acute, followed by B (Table 4).

TABLE 3
Extent of macronutrient deficiency in India

Nutrient	No. of samples analysed	Percent are of samples by category		
		Low	Medium	High
N	3 650 004	63	26	11
P	3 650 004	42	38	20
K	3 650 004	13	37	50
S	27 000	40	35	25

Source: Motsara, 2002.

In general, the deficiency of at least five nutrients (N, P, K, S & Zn) has become fairly widespread. There is a need to promote the use of types of fertilizers required to correct the deficiency of all these nutrients. To improve the naturally low organic matter content of the soil, the application of sufficient quantities of organic manures is essential.

TABLE 4
Extent of micronutrient deficiency in India

Nutrient	No. of samples analysed	% of deficient samples
Zn	251 660	49
Fe	251 660	12
Mn	251 660	5
Cu	251 660	3
B	36 825	33
Mo	36 825	13

Source: Singh, 2001.

FARM SIZES

Indian agriculture is characterized by the small size of farmholding and the size is decreasing continuously. There are about 115.6 million holdings in India with an average size of 1.4 ha (Table 5). The size of farmholdings in India fell from 2.3 ha in 1970/71 to 1.47 ha in 1995/96. About 62 percent of the farmholdings are less than 1 ha, covering only 17.2 percent of the agricultural land. The large holdings (10 ha and more) constitute

TABLE 5
Number, area covered and average size of landholdings

Category of holding	Number (million)		Area (million ha)		Average size (ha)	
	1970/71	1995/96	1970/71	1995/96	1970/71	1995/96
Marginal	35.7	71.2	14.5	28.1	0.41	0.40
(< 1 ha)	(50.6)	(61.6)	(9.0)	(17.2)		
Small	13.4	21.6	19.3	30.7	1.44	1.42
(1 – 2 ha)	(19.1)	(18.7)	(11.9)	(18.8)		
Semi-medium	10.7	14.3	30.0	39.0	2.81	2.73
(2 – 4 ha)	(15.2)	(12.3)	(18.5)	(23.8)		
Medium	7.9	7.1	48.2	41.4	6.08	5.84
(4 – 10 ha)	(11.3)	(6.1)	(29.8)	(25.3)		
Large	2.8	1.4	50.1	24.2	18.10	17.21
(> 10 ha)	(3.9)	(1.2)	(30.9)	(14.8)		
Total	**70.5**	**115.6**	**162.1**	**163.4**	**2.30**	**1.41**

( ) = Percentage share of various categories to total number and area.
Source: Fertilizer Association of India, 2003/04.

only 1.2 percent of the total number but cover about 14.8 percent of the total cultivated area. The holdings are also fragmented. This is a serious impediment to the mechanization of Indian agriculture.

Chapter 2
The Fertilizer Sector

The history of the Indian fertilizer industry dates back to 1906, when the first fertilizer factory opened at Ranipet (Tamil Nadu). Since then, there have been major developments in terms of both the quantity and the types of fertilizers produced, the technologies used and the feedstocks employed. The fertilizer industry in India is in the core sector and second to steel in terms of investment.

Prior to 1960/61, India produced only straight nitrogenous fertilizers [ammonium sulphate (AS), urea, calcium ammonium nitrate (CAN), ammonium chloride and single superphosphate (SSP)]. The production of NP complex fertilizers commenced in 1960/61. Currently, India produces a large number of grades of NP / NPK complex fertilizer. These include 16–20–20, 20–20–0, 28–28–0, 15–15–15, 17–17–17, 19–19–19, 10–26–26, 12–32–16, 14–28–14, 14–35–14 and 19–19–19. In addition, India produces various grades of simple and granulated mixtures. Table 6 shows the chronology of fertilizer production in the country.

TABLE 6
Chronology of fertilizer production in India

Year of manufacture	Fertilizer product	Total number of units
1906	SSP	65
1933	AS	10
1959	Ammonium sulphate nitrate	No longer manufactured
1959	Urea	29
1959	Ammonium chloride	1
1960	Ammonium phosphate	3
1961	CAN	3
1965	Nitro phosphate	3
1967	DAP	11
1968	TSP	No longer manufactured
1968	Urea ammonium phosphate	2
1968	NPK complex fertilizers	6

The total indigenous capacity of N and P_2O_5 increased from 17 000 and 21 000 tonnes in 1950/51 to 12 276 million and 5 547 million tonnes in 2004/05.

PRODUCTION

The domestic production of N and P_2O_5 was 29 000 and 10 000 tonnes, respectively, in 1951/52. By 1973/74, this had increased to 1.05 million tonnes N and 0.325 million tonnes P_2O_5. As a result of the oil crisis in the mid-1970s and the consequent sharp increase in the international prices of fertilizers, the Government of India encouraged investment in domestic fertilizer production plants in order to reduce dependence on imports. It introduced a "retention price" subsidy in 1975/76. The scheme led to a sharp increase in domestic capacity and production between the mid-1970s and the early 1990s. The total production of N and P_2O_5 rose from 1.51 million and 0.32 million tonnes respectively in 1975/76 to 7.30 million and 2.56 million tonnes in 1991/92. In 1992/93, phosphatic and potassic fertilizers were decontrolled. As a consequence, the rate of growth in the demand for these products slowed. The total production of N reached 10.6 million tonnes and that of P_2O_5 reached 3.6 million tonnes in 2003/04.

There has been a shift in the product pattern over the years. SSP and AS dominated fertilizer production before the 1960s whereas urea and DAP dominate production at present. In 2003/04, urea accounted for 84.6 percent of total N production and di-ammonium phosphate (DAP) accounted for 59.9 percent of total P_2O_5 production (Table 7).

TABLE 7
Production by product 2003/04

Fertilizer products	Production ('000 tonnes)
Ammonium chloride	79
Ammonium sulphate	601
CAN	141
DAP	4 709
NP / NPK complexes	4 507
SSP	2 483
Urea	19 038
Total	**31 558**

IMPORTS

India imports mainly urea, DAP and potassium chloride (MOP). The country has almost reached self-sufficiency in urea production. As regards DAP, the level of imports was between 1.5 and 2 million tonnes in the 1980s and 1990s. A great deal of DAP capacity came on stream in the early

2000s. Consequently, the importation of DAP fell to less than 1 million tonnes after 2000/01. In 2003/04, DAP imports were 0.73 million tonnes. Imports meet the entire MOP requirement as there are no known natural potash deposits in the country. In 2003/04, MOP imports were 2.58 million tonnes In addition, India also imports a small quantity of mono-ammonium phosphate (MAP) and potassium sulphate (SOP) (65 000 and 10 500 tonnes, respectively, in 2003/04).

CONSUMPTION

Fertilizer consumption was less than 1 million tonnes before the mid-1960s. With the introduction of high-yielding variety (HYV) seeds, there was acceleration in the growth of fertilizer consumption. It reached 12.73 million tonnes in 1991/92 as against 0.78 million tonnes in 1965/66. After the decontrol of P and K fertilizers the growth in consumption slowed. The highest consumption was recorded in 1999/2000 (18.07 million tonnes of nutrients). Since then, the growth in consumption has been erratic. In 2003/04, total nutrient consumption was 16.8 million tonnes. The consumption of N, P_2O_5 and K_2O was 11.08, 4.12 and 1.60 million tones, respectively. Table 8 shows the production, importation and consumption of N, P_2O_5 and K_2O from 1999/2000 to 2003/04.

CONSUMPTION AT STATE LEVEL

The consumption of fertilizers varies significantly from state to state. The all-India per-hectare consumption of total nutrients was 89.8 kg in

TABLE 8
Production, importation and consumption of fertilizers

Fertilizer	Item	Year				
		1999/2000	2000/01	2001/02	2002/03	2003/04
		'000 tonnes				
N	Production	10 873	10 943	10 690	10 508	10 557
	Importation	856	164	283	135	205
	Consumption	11 593	10 920	11 310	10 474	11 076
P_2O_5	Production	3 448	3 734	3 837	3 904	3 617
	Importation	1 534	437	494	228	372
	Consumption	4 798	4 215	4 382	4 019	4 124
K_2O	Production	-	-	-	-	-
	Importation	1 774	1 594	1 697	1 568	1 553
	Consumption	1 678	1 568	1 667	1 601	1 598

2003/04. While the North and South zones have a consumption of more than 100 kg/ha, in the East and West zones the consumption is lower than 80 kg/ha. Among the major states, the per-hectare consumption is more than 100 kg in West Bengal (122 kg), Haryana (167 kg), Punjab (184 kg), Uttar Pradesh and Uttaranchal (127 kg), Andhra Pradesh (138 kg) and Tamil Nadu (112 kg). In the remaining states, the consumption per hectare is lower than the all-India average. Table 9 shows fertilizer consumption per hectare of the gross cropped area in the major states.

NPK CONSUMPTION RATIO

Because the deficiency of N is widespread, the $N:P_2O_5:K_2O$ use ratio has favoured N. This ratio narrowed from 8.9:2.2:1 in 1961/62 to 5.9:

TABLE 9
Consumption of fertilizers by state 2003/04

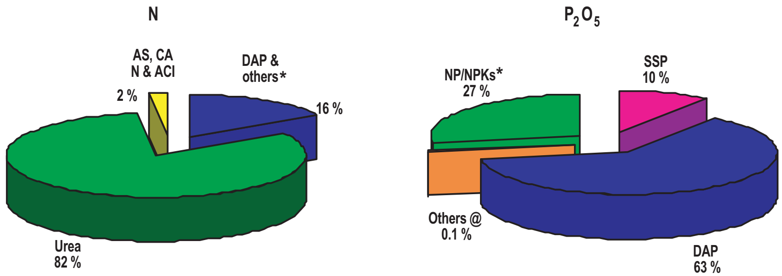
Zone/State	N	P_2O_5	K_2O	$N + P_2O_5 + K_2O$
	(kg/ha)			
East zone	**49**	**15.8**	**11**	**75.8**
Assam	22.2	12.7	11.7	46.6
Bihar & Jharkhand	68.7	8.7	3	80.5
Orissa	26.7	8.5	6.3	41.4
West Bengal	63.8	33.4	25.2	122.4
North zone	**102.9**	**32**	**5.3**	**140.1**
Haryana	125.6	38.9	2.6	167.1
Himachal Pradesh	32.6	9.2	7.6	49.4
Jammu & Kashmir	50	18.1	3.2	71.4
Punjab	139.6	40	4.5	184
Uttar Pradesh & Uttaranchal	91.2	29.4	6.1	126.7
South Zone	**60**	**26.1**	**19.2**	**105.4**
Andhra Pradesh	84.1	35	17.7	136.8
Karnataka	40.1	19.6	15.2	74.9
Kerala	28.3	12.9	22.4	63.6
Tamil Nadu	59.7	25	27.8	112.5
West Zone	**38**	**17.1**	**4.4**	**59.4**
Chhattisgarh	30.7	11.9	3.9	46.5
Gujarat	64.3	23.9	6.9	95.1
Madhya Pradesh	32.8	19.5	2.7	55
Maharashtra	38.9	18.8	7.9	65.7
Rajasthan	29.3	10.6	0.6	40.5
All India	**59.2**	**22.1**	**8.5**	**89.8**

2.4:1 in 1991/92. After decontrol of P and K fertilizers in 1992/93, the ratio widened to 9.7:2.9:1 in 1993/94. Despite the introduction of a price concession on P and K fertilizers and other measures taken to increase their consumption, the ratio remained wide and in 1996/97 it was 10:2.9:1 Subsequently it has tended to improve, reaching 6.9:2.6:1 in 2003/04.

CONSUMPTION BY PRODUCT

While India uses many types of fertilizers, urea accounts for most of the consumption of N and DAP for most of that of P_2O_5. Urea accounts for 82 percent of the total consumption of straight N fertilizers. Other straight N fertilizers, such AS, CAN and ammonium chloride account for only 2 percent. The share of N through DAP and other complex fertilizers is about 16 percent. DAP accounts for 63 percent of total P_2O_5 consumption and other complex fertilizers for 27 percent. Single superphosphate (SSP) accounts for 10 percent of total P_2O_5 consumption. Figure 4 shows the shares of the various fertilizers in total N and P_2O_5 consumption in 2003/04.

FIGURE 4
Share of fertilizers in total N and P_2O_5 consumption, 2003/04



* NP/NPK complex fertilizers (other than DAP)
@ Includes rock phosphate for direct application

Chapter 3
Organic manures and biofertilizers

The use of organic manures (farmyard manure, compost, green manure, etc.) is the oldest and most widely practised means of nutrient replenishment in India. Prior to the 1950s, organic manures were almost the only sources of soil and plant nutrition. Owing to a high animal population, farmyard manure is the most common of the organic manures. Cattle account for 90 percent of total manure production. The proportion of cattle manure available for fertilizing purposes decreased from 70 percent in the early 1970s to 30 percent in the early 1990s. The use of farmyard manure is about 2 tonnes/ha, which is much below the desired rate of 10 tonnes/ha.

At the present production level, the estimated annual production of crop residues is about 300 million tonnes. As two-thirds of all crop residues are used as animal feed, only one-third is available for direct recycling (compost making), which can add 2.5 million tonnes/year. The production of urban compost has been fluctuating around 6–7 million tonnes and the area under green manuring is about 7 million/ha.

Unlike fertilizers, the use of organic material has not increased much in the last two to three decades. The estimated annual available nutrient (NPK) contribution through organic sources is about 5 million tonnes, which could increase to 7.75 million tonnes by 2025. Thus, organic manures have a significant role to play in nutrient supply. In addition to improving soil physico-chemical properties, the supplementary and complementary use of organic manure also improves the efficiency of mineral fertilizer use.

The use of biofertilizers is of relatively recent origin. Biofertilizers consist of N fixers (*Rhizobium, Azotobacter*, blue green algae, *Azolla*), phosphate solubilizing bacteria (PSB) and fungi (*lmycorrhizae*). A contribution of 20–30 kg N/ha has been reported from the use of biofertilizers. There was good growth in biofertilizer production and use in 1990s. At present, biofertilizers use is about 10 000 tonnes (Table 10).

TABLE 10
Growth in biofertilizer production

Year	Capacity	Production	Distribution
	(tonnes)		
1992/93	5 401	2 005	1 600
1995/96	10 680	6 692	6 288
1998/99	16 446	8 010	5 065
2003/04*	20 000	12 000	10 000

* Estimated

Among biofertilizers, most growth has occurred with phosphate-solubilizing micro-organisms, which account for about 45 percent of total biofertilizer production and use. Biofertilizer production and use is concentrated in Maharashtra, Tamil Nadu, Karnataka, Madhya Pradesh and Gujarat.

The Government is promoting the concept of the integrated nutrient supply system (INSS), i.e. the combined use of mineral fertilizers, organic manures and biofertilizers. Farmers are also aware of the advantage of INSS in improving soil health and crop productivity. However, the adoption of INSS is limited by the following constraints:

- increasing trend to use cow manure as a source of fuel in rural areas;
- increasing use of crop residues as animal feed;
- extra cost and time required to grow green-manure crops;
- handling problems with bulky organic manures;
- problems in timely preparation of the field when agricultural waste and green manure have to be incorporated and their decomposition awaited;
- poor and inconsistent crop response to biofertilizers.

Chapter 4
Fertilizer Use by Crop

TABLE 11
Growth in fertilizer consumption in India

Year	Fertilizer (NPK) consumption	
	(million tonnes)	(kg/ha)
1969/70	1.98	11.04
1979/80	5.26	30.99
1989/90	11.57	63.47
1999/2000	18.07	94.90
2000/01	16.70	89.30
2001/02	17.36	92.80
2002/03	16.09	86.01
2003/04	16.80	89.80

Source: Fertiliser Association of India, 2003/04.

Fertilizer consumption in India has increased significantly in the last three decades. Total NPK (N, P_2O_5 and K_2O) consumption increased nine-fold (from 2 million to 18 million tonnes) between 1969/1970 and 1999/2000. Per-hectare NPK consumption increased from 11 to 95 kg in the same period. After reaching a record level in 1999/2000, fertilizer consumption in India has been irregular. It has fluctuated around 17 million tonnes since 2000/01 (Table 11).

FERTILIZER USE BY AGRO-ECOLOGICAL ZONE

Fertilizer consumption varies widely between the AEZ owing to the substantial differences in soil type, fertility status, crop, weather, rainfall, irrigation facilities, etc. (Table 12). AEZ 4 was the most important region in terms of fertilizer use and consumed 3.5 million tonnes of fertilizer (21 percent of the total) in 2003/04 on 30 million ha of cropped area. In six AEZs (Nos. 2, 4, 6, 7, 9 and 13), the annual fertilizer consumption has exceeded one million tonnes and together they accounted for about 63 percent of total fertilizer consumption.

Per-hectare consumption was highest in AEZ 7 followed by AEZ 9 and AEZ 18. The rate of fertilizer consumption was more than 100 kg/ha in six of the AEZs (Nos. 4, 7, 8, 9, 13 and 18), which cover 38.4 percent of gross cropped area (GCA). In ten of the regions (AEZs 1, 2, 3, 5, 6, 12, 14, 15, 16 and 19), covering 49.5 percent of the area, per-hectare fertilizer consumption ranged between 50 and 100 kg, whereas in the remaining

TABLE 12
Fertilizer consumption in agro-ecological zones of India, 2003/04

AEZ No. / Ecosystem	GCA	Fertilizer consumption ('000 tonnes)				Fertilizer consumption (kg/ha)			
	(million ha)	N	P_2O_5	K_2O	Total	N	P_2O_5	K_2O	Total
1	0.07	3.83	0.70	0.21	4.74	55.4	10.2	3.0	68.7
2	20.85	824.20	289.86	23.54	1 137.71	39.5	13.9	1.1	54.6
3	4.18	179.44	85.90	52.90	318.34	42.9	20.6	12.7	76.2
Arid	*25.09*	*1 007.47*	*376.47*	*76.65*	*1 460.78*	*40.1*	*15.0*	*3.1*	*58.2*
4	30.05	2 578.40	870.71	97.78	3 547.00	85.8	29.0	3.3	118.0
5	11.04	553.00	247.97	50.89	851.97	50.1	22.5	4.6	77.2
6	25.02	972.30	465.20	201.98	1 639.58	38.9	18.6	8.1	65.5
7	6.19	674.30	289.67	131.23	1 095.30	109.0	46.8	21.2	177.1
8	6.96	422.19	181.67	206.92	810.87	60.7	26.1	29.7	116.5
Semi-arid	*79.25*	*5 200.20*	*2 055.23*	*688.80*	*7 944.71*	*65.6*	*25.9*	*8.7*	*100.2*
9	11.62	1 482.61	359.05	97.03	1 938.79	127.6	30.9	8.4	166.9
10	14.55	370.93	246.43	30.83	648.29	25.5	16.9	2.1	44.6
11	6.47	211.18	89.08	23.46	323.81	32.6	13.8	3.6	50.0
12	12.09	445.31	197.43	122.16	763.24	36.8	16.3	10.1	63.1
13	10.95	904.02	178.77	55.96	1 138.85	82.5	16.3	5.1	104.0
14	3.20	160.02	48.50	13.74	222.36	50.0	15.2	4.3	69.5
Subhumid	*58.88*	*3 574.07*	*1 119.25*	*343.18*	*5 035.33*	*60.7*	*19.0*	*5.8*	*85.5*
15	8.99	445.12	222.84	182.79	850.85	49.5	24.8	20.3	94.7
16	1.37	54.84	29.25	21.40	105.59	40.0	21.3	15.6	77.1
17	1.56	41.84	9.83	5.08	56.84	26.8	6.3	3.3	36.4
Humid-perhumid	*11.92*	*541.80*	*261.92*	*209.27*	*1 013.29*	*45.5*	*22.0*	*17.6*	*85.0*
18	6.12	521.60	213.53	149.90	885.13	85.3	34.9	24.5	144.7
19	5.70	230.87	97.05	129.69	457.70	40.5	17.0	22.7	80.3
Coastal	*11.82*	*752.47*	*310.58*	*279.59*	*1 342.84*	*63.7*	*26.3*	*23.7*	*113.6*
20	0.05	0.33	0.31	0.06	0.70	6.7	6.3	1.2	14.3
Island	*0.05*	*0.33*	*0.31*	*0.06*	*0.70*	*6.7*	*6.3*	*1.2*	*14.3*
Total (20 AEZs)	**187.01**	**11 076.34**	**4 123.76**	**1 597.55**	**16 797.65**	**59.2**	**22.1**	**8.5**	**89.8**

four regions (AEZs 10, 11, 17 and 20) covering 12.1 percent of the area, the rate of fertilizer consumption was less than 50 kg/ha.

All 20 AEZs of India have been grouped into six broad ecosystems on the basis of bio-climatic factors.

Arid Ecosystem

The arid ecosystem, comprising three eco-regions (AEZs 1 – 3), consumed 1.46 million tonnes of fertilizer ($N+P_2O_5+K_2O$) in 2003/04 and accounted for 8.7 percent of total fertilizer consumption. This ecosystem covers 25.1 million ha, representing 13.4 percent of the total GCA of the country. Per-hectare fertilizer consumption was 58.2 kg, varying from 54.6 kg in AEZ 2 to 76.2 kg in AEZ 3. In terms of nutrients, N, P_2O_5 and K_2O consumption was 40.1, 15.0 and 3.1 kg/ha, respectively. There was a wide variation in nutrient consumption among the AEZs of the arid ecosystem. N consumption varied from 39.5 to 55.4 kg/ha, P_2O_5 consumption from 10.2 to 20.6 kg/ha, and K_2O consumption from 1.1 to 12.7 kg/ha. Fertilizer use and crop productivity are very low in all the regions of the arid ecosystem owing to factors such as rainfed monocropping, the short length of the growing period, and erratic and scanty rainfall.

Semi-arid Ecosystem

The semi-arid ecosystem is the most important ecosystem in terms of area and fertilizer use. Comprising five ecoregions (AEZs 4 – 8), it consumed 7.4 million tonnes of fertilizer ($N+P_2O_5+K_2O$) in 2003/04 and accounted for 47.3 percent of the total fertilizer consumption. The ecosystem covers 79.25 million ha, representing 42.4 percent of total GCA of the country. Per-hectare fertilizer consumption was 100.2 kg, varying from 65.5 kg in AEZ 6 to 177.1 kg in AEZ 7. In terms of nutrients, N, P_2O_5 and K_2O consumption was 65.6, 25.9 and 8.7 kg/ha, respectively. There was a wide variation in nutrient consumption between the AEZs of the semi-arid ecosystem. N consumption varied from 38.9 to 109.0 kg/ha, P_2O_5 consumption from 18.6 to 46.8 kg/ha, and K_2O consumption from 3.3 to 29.7 kg/ha. Although mean annual rainfall is 500 – 1 000 mm in AEZ 4, fertilizer use and crop productivity are moderately high as 65 percent of the region is under irrigated agriculture. In the northern plains, farmers have overcome the drought-prone climate by introducing tubewell irrigation. Fertilizer use and crop yields are low in AEZs 5 and 6 because rainfed farming is the traditional practice. Fertilizer use is highest in AEZ 7 because good rainfall and better irrigation facilities enable farmers to grow higher fertilizer consuming crops in this region.

Subhumid Ecosystem

The subhumid ecosystem, comprising six regions (AEZs 9 – 14), consumed 5.04 million tonnes of fertilizer ($N+P_2O_5+K_2O$) in 2003/04 and accounted for 30 percent of the total fertilizer consumption. The ecosystem covers 58.9 million ha, representing 31.5 percent of the total GCA of the country. Per-hectare fertilizer consumption was 85.5 kg, varying from 44.6 kg in AEZ 10 to 166.9 kg in AEZ 9. In terms of nutrients, N, P_2O_5 and K_2O consumption was 60.7, 19.0 and 5.8 kg/ha, respectively. There was a wide variation in nutrient consumption between the AEZs of the subhumid ecosystem. N consumption varied from 25.5 to 127.6 kg/ha, P_2O_5 consumption from 13.8 to 30.9 kg/ha, and K_2O consumption from 2.1 to 10.1 kg/ha. Fertilizer use and crop productivity are high in AEZ 9 because soils are deep, loamy and have developed on alluvium. Both rainfed and irrigated agriculture are practised in the region. Rice, maize, barley, pigeon pea, wheat, mustard, lentil, sugar cane and cotton are important crops. Fertilizer use is low in AEZs 10, 11 and 12 because the soils are susceptible to severe water erosion and experience partial waterlogging. Rainfed farming is practised and rice, millets, pigeon pea, green gram and black gram crops are grown. Flooding, imperfect drainage, salinity and sodicity in AEZ 13, and a severe climate, soil degradation, soil acidity and droughts in AEZ 14 are major constraints on increasing fertilizer consumption.

Humid-Perhumid Ecosystem

The humid-perhumid ecosystem comprising three regions (AEZs 15 – 17) consumed 1.01 million tonnes of fertilizer ($N+P_2O_5+K_2O$) in 2003/04 and accounted for 6.01 percent of total fertilizer consumption. The ecosystem covers 11.92 million ha, representing 6.37 percent of the total GCA of the country. Per-hectare fertilizer consumption was 85.0 kg, ranging from 36.4 kg in AEZ 17 to 94.7 kg in AEZ 15. In terms of nutrients, N, P_2O_5 and K_2O consumption wass 45.5, 22.0 and 17.6 kg/ha, respectively. There was a wide variation in nutrient consumption between the AEZs of the humid-perhumid ecosystem. N consumption varied from 26.8 to 49.5 kg/ha, P_2O_5 consumption from 6.3 to 24.8 kg/ha, and K_2O consumption from 3.3 to 20.3 kg/ha. Fertilizer use and crop productivity are relatively high in AEZ 15 because there are rice-based cropping systems and the length of growing period is 210 days. Fertilizer use is very low in AEZ 17 owing to adverse climate conditions and Jhum (shifting) cultivation.

Coastal Ecosystem

The coastal ecosystem, comprising two regions (AEZs 18 and 19), consumed 1.34 million tonnes of fertilizer ($N+P_2O_5+K_2O$) in 2003/04 and accounted for 8.0 percent of total fertilizer consumption. The ecosystem covers 11.82 million ha, representing 6.32 percent of the total GCA of the country. Per-hectare fertilizer consumption was 113.6 kg, ranging from 80.3 kg in AEZ 19 to 144.7 kg in AEZ 18. In terms of nutrients, N, P_2O_5 and K_2O consumption was 63.7, 26.3 and 23.7 kg/ha, respectively. There was a wide variation in nutrient consumption among the AEZs of the coastal ecosystem. N consumption varied from 40.5 to 85.3 kg/ha, P_2O_5 consumption from 17.0 to 34.9 kg/ha, and K_2O consumption from 22.7 to 24.5 kg/ha. Fertilizer use and crop productivity are relatively low in AEZ 19 owing to excessive leaching, waterlogging and steep slopes.

Island Ecosystem

The island ecosystem, comprising AEZ 20, consumed only 700 tonnes of fertilizer ($N+P_2O_5+K_2O$) in 2003/04 over an area of 50 000 ha. Per-hectare fertilizer consumption was 14.3 kg. In terms of nutrients, N, P_2O_5 and K_2O consumption was 6.7, 6.3 and 1.2 kg/ha, respectively. Fertilizer use and crop productivity are very low in AEZ 20 owing to severe soil erosion. The land use is dominated by plantation crops.

Fertilizer use by crop

Before the 1950s, fertilizer use was very low and was confined to plantation crops. The introduction of fertilizer-responsive HYVs and expansion in the irrigated area led to a sharp increase in fertilizer application on field crops. Per-hectare fertilizer consumption is higher in the case of crops with a larger proportion of irrigated area. About 40 percent of the agricultural area in India is irrigated, accounting for 68.5 percent of total fertilizer consumption (Table 13). Six crops (rice, wheat, cotton, sugar cane, rapeseed and mustard) are estimated to account for more than two-thirds of the total fertilizer consumption in the country. The fertilizer-use pattern for major crops is discussed below.

TABLE 13

Fertilizer use on important crops, 2003/04

Crop	Gross cropped area (million ha)	Share in fertilizer consumption (%)	Fertilizer consumption (kg/ha)			
			N	P_2O_5	K_2O	Total
Cotton	**8.5**	**6**	**89.5**	**22.6**	**4.8**	**116.8**
Irrigated	2.9	2.7	115.7	30.9	7	153.5
Rainfed	5.6	3.3	75.8	18.2	3.6	97.7
Groundnut	**6.6**	**2.9**	**24.4**	**39.3**	**12.9**	**76.6**
Irrigated	1.2	0.8	35.3	53.8	28.9	118
Rainfed	5.4	2.1	21.9	36	9.2	67.2
Jute	**0.8**	**0.2**	**38**	**11.5**	**5**	**54.4**
Irrigated	0.3	0.1	55.9	22.4	10.2	88.6
Rainfed	0.5	0.1	28.9	6	2.3	37.1
Maize	**6.6**	**2.3**	**41.7**	**14.7**	**3.8**	**60.2**
Irrigated	1.5	0.8	59.6	27.7	4.8	92.1
Rainfed	5.1	1.5	36.6	11	3.6	51.1
Paddy	**44.7**	**31.8**	**81.7**	**24.3**	**13.1**	**119.1**
Irrigated	24	22.2	103.4	32.8	18.8	155
Rainfed	20.7	9.6	56.6	14.5	6.5	77.6
Pearl millet	**9.8**	**1.7**	**21.9**	**5.5**	**0.8**	**28.2**
Irrigated	0.8	0.4	62.2	13.9	3.4	79.5
Rainfed	9	1.3	18.4	4.8	0.6	23.8
Pigeon pea	**3.6**	**0.8**	**20.9**	**13.3**	**2**	**36.2**
Irrigated	0.2	0.1	36.9	20.9	2.2	60
Rainfed	3.5	0.7	19.6	12.6	2	34.2
Rapeseed & mustard	**6**	**3.4**	**69.1**	**25**	**2.9**	**97**
Irrigated	3.8	2.6	81.7	30.4	4.3	116.5
Rainfed	2.2	0.8	45.9	15	0.4	61.3
Sorghum	**9.9**	**2.9**	**29.2**	**14.2**	**4.1**	**47.5**
Irrigated	0.8	0.5	58.5	29.1	10.7	98.3
Rainfed	9.1	2.4	26.9	13	3.6	43.6
Sugar cane	**4.3**	**5.4**	**124.8**	**44**	**38.3**	**207.1**
Irrigated	4.2	5.3	126.4	45	40.6	212
Rainfed	0.1	0.1	106	32	12.4	150.4
Wheat	**25.7**	**21**	**99.6**	**30.2**	**6.9**	**136.7**
Irrigated	22.8	19.7	105.6	32.1	7.3	144.9
Rainfed	2.9	1.3	55.7	15.9	4.3	75.9
Other crops	**60.4**	**21.6**	**34.5**	**18.5**	**7.1**	**60.1**
Irrigated	12.6	13.3	113.5	46.8	16.5	176.7
Rainfed	47.8	8.3	13.6	11	4.7	29.3
All crops	**187**	**100**	**59.2**	**22.1**	**8.5**	**89.8**
Irrigated	75.1	68.5	103.2	35.3	14.5	153.1
Rainfed	111.9	31.5	29.7	13.1	4.5	47.3

Paddy rice

Paddy rice is the most important crop in India in terms of both area and fertilizer use. Occupying an area of 44.7 million ha, it accounted for 31.8 percent (5.34 million tonnes) of total fertilizer consumption in 2003/04. Fertilizer use on irrigated paddy (155 kg/ha) is double that on rainfed paddy (77.6 kg/ha). The shares of irrigated and rainfed paddy in total fertilizer consumption were 22.2 and 9.6 percent, respectively. The average per-hectare use of fertilizer on paddy was 119.1 kg (81.7 kg/ha N, 24.3 kg/ha P_2O_5 and 13.1 kg/ha K_2O).

Wheat

Wheat is the second most important foodgrain crop, grown on an area of 25.7 million ha. It is grown largely under irrigated conditions and accounts for 20.5 percent (3.44 million tonnes) of total fertilizer consumption. Fertilizer use per-hectare is 137 kg (100 kg/ha N, 30 kg/ha P_2O_5 and 7 kg/ha K_2O). Fertilizer use on irrigated wheat (144.9 kg/ha) is almost double that rainfed wheat (75.9 kg/ha) with the same trend for all the nutrients (N, P_2O_5 and K_2O).

Sorghum

Sorghum is an important cereal crop in India. Occupying an area of 9.9 million ha, it accounted for 2.9 percent (0.49 million tonnes) of total fertilizer consumption in 2003/04. Fertilizer use on irrigated sorghum (98.3 kg/ha) was more than double that on rainfed sorghum (43.6 kg/ha). The shares of irrigated and rainfed sorghum in total fertilizer consumption were 0.5 and 2.4 percent, respectively. The verage per-hectare use of fertilizer on sorghum was 47.5 kg (29.2 kg/ha N, 14.2 kg/ha P_2O_5 and 4.1 kg/ha K_2O).

Pearl millet

Pearl millet is another important cereal crop in India. It occupied an area of 9.8 million ha and accounted for 1.7 percent (0.29 million tonnes) of total fertilizer consumption in 2003/04. Fertilizer use on irrigated pearl millet (79.5 kg/ha) was more than three-fold that of rainfed pearl millet

(23.8 kg/ha). The shares of irrigated and rainfed pearl millet in total fertilizer consumption were 0.4 and 1.3 percent, respectively. The average per-hectare use of fertilizer on pearl millet is 28.2 kg (21.9 kg/ha N, 5.5 kg/ha P_2O_5 and 0.8 kg/ha K_2O).

Maize

Occupying 3.5 percent of GCA, maize accounts for 2.3 percent of total fertilizer consumption. Maize is grown mostly under rainfed conditions. Per-hectare fertilizer use is 60.2 kg, which consists of 41.7 kg/ha N, 14.7 kg/ha P_2O_5 and 3.8 kg/ha K_2O. The rate of fertilizer use on irrigated maize is 92 kg/ha compared with 51 kg/ha on rainfed maize. On rainfed maize, N, P_2O_5 and K_2O use is 36.6, 11.0 and 3.6 kg/ha, respectively, and 59.6, 27.7 and 4.8 kg/ha, respectively, on irrigated maize.

Pigeon pea

Pigeon pea is one of the major pulse crops in India. It accounted for 0.8 percent (0.13 million tonnes) of total fertilizer consumption on an area of 3.7 million ha in 2003/04. Fertilizer use on irrigated pigeon pea (60.0 kg/ha) was nearly double that on rainfed pigeon pea (34.2 kg/ha). The shares of irrigated and rainfed pigeon pea in total fertilizer consumption were 0.1 and 0.7 percent, respectively. The average per-hectare use of fertilizer on pigeon pea was 36.2 kg (20.9 kg/ha N, 13.3 kg/ha P_2O_5 and 2.0 kg/ha K_2O).

Rapeseed and Mustard

Rapeseed and mustard are the major oilseed crops of India. They occupied an area of 6.0 million ha and accounted for 3.4 percent (0.57 million tonnes) of total fertilizer consumption in 2003/04. Fertilizer use on irrigated rapeseed and mustard (116.5 kg/ha) was almost double that on rainfed rapeseed and mustard (61.3 kg/ha). The shares of irrigated and rainfed rapeseed and mustard in total fertilizer consumption were 2.6 and 0.8 percent, respectively. The average per-hectare use of fertilizer on rapeseed and mustard is 97.0 kg (69.1 kg/ha N, 25.0 kg/ha P_2O_5 and 2.9 kg/ha K_2O).

Groundnut

Groundnut is the most important oilseed crop of India after rapeseed and mustard. Occupying an area of 6.6 million ha, it accounted for 2.9 percent (0.49 million tonnes) of total fertilizer consumption in 2003/04. The major groundnut-growing states are Gujarat and Karnataka. Fertilizer use on irrigated groundnut (118.0 kg/ha) was higher than on rainfed groundnut (67.2 kg/ha). The shares of irrigated and rainfed groundnut in total fertilizer consumption were 0.8 and 2.1 percent, respectively. The average per-hectare use of fertilizer on groundnut was 76.6 kg (24.4 kg/ha N, 39.3 kg/ha P_2O_5 and 12.9 kg/ha K_2O).

Sugar cane

Sugar cane is the major sugar crop of India. Being a long-duration crop, its nutritional requirements are high. In 2003/04, it occupied an area of 4.3 million ha and accounted for 5.4 percent (0.91 million tonnes) of fertilizer consumption. The major sugar-cane-growing states are Uttar Pradesh, Tamil Nadu, and Maharashtra. Fertilizer use on irrigated sugar cane was 212.0 kg/ha compared with 150.4 kg/ha on rainfed sugar cane. The shares of irrigated and rainfed sugar cane in total fertilizer consumption were 5.3 and 0.1 percent, respectively. The average per-hectare use of fertilizer on sugar cane was 207.1 kg (124.8 kg/ha N, 44.0 kg/ha P_2O_5 and 38.3 kg/ha K_2O).

Cotton

Cotton is the major fibre crop of India. In 2003/04, it occupied an area of 8.5 million ha and accounted for 6.0 percent (1.01 million tonnes) of total fertilizer consumption. Fertilizer use on irrigated cotton (153.5 kg/ha) was higher than on rainfed cotton (97.7 kg/ha). The shares of irrigated and rainfed cotton in total fertilizer consumption were 2.7 and 3.3 percent, respectively. The average per-hectare use of fertilizer on cotton was 116.8 kg (89.5 kg/ha N, 22.6 kg/ha P_2O_5 and 4.8 kg/ha K_2O).

Jute

After cotton, jute is the next most important fibre crop. Occupying an area of 0.8 million ha, it accounted for 0.2 percent (0.03 million tonnes) of total fertilizer consumption in 2003/04. Fertilizer use on irrigated jute (88.6 kg/ha) was more than double that on rainfed jute (37.1 kg/ha). The share of irrigated and rainfed jute in total fertilizer consumption was 0.1 percent. The average per-hectare use of fertilizer on jute was 54.4 kg (38.0 kg/ha N, 11.5 kg/ha P_2O_5 and 5.0 kg/ha K_2O).

Other crops

Crops other than those mentioned above occupied an area of 60.4 million ha and accounted for 22.1 percent (3.71 million tonnes) of total fertilizer consumption in 2003/04. Per-hectare fertilizer use on irrigated crops (182.9 kg/ha) was more than six times that on rainfed crops (29.2 kg/ha). The shares of irrigated and rainfed crops in total fertilizer consumption were 13.7 and 8.4 percent, respectively. The average per-hectare use of fertilizer on other crops was 61.3 kg (34.5 kg/ha N, 18.5 kg/ha P_2O_5 and 8.4 kg/ha K_2O).

Rice–wheat system

Rice–wheat is the most important cropping system in terms of area, fertilizer use and crop productivity. It is practised in various environments and on different soil types and covers an estimated area of about 10 million ha on the IGP. Per-hectare fertilizer use under the rice–wheat

TABLE 14
Fertilizer-use pattern under the rice–wheat cropping system in the Indo-Gangetic Plains

Region	Crop	Fertilizer Use (kg/ha)				Yield
		N	P_2O_5	K_2O	Total	(tonnes/ha)
Lower Gangetic Plain	Rice	85.9	9.9	32.8	128.5	2.34
	Wheat	95.5	6.5	27.6	129.6	2.95
Middle Gangetic Plain	Rice	111.9	36.4	9.8	158.1	2.22
	Wheat	111.6	42.4	11.6	165.6	2.6
Trans Gangetic Plain (Haryana)	Rice	163.2	52.8	0	216	3.6
	Wheat	171.3	56.9	0	228.2	4.55
Trans Gangetic Plain (Punjab)	Rice	141.3	58.5	0	199.8	3.68
	Wheat	143.2	58.7	0	201.9	4.73
Upper Gangetic Plain	Rice	108.3	44.6	2.2	155.1	2.92
	Wheat	109.8	52.2	2.1	164.1	4.48
Indo-Gangetic Plains	**Rice**	**117.3**	**35.2**	**11.8**	**164.2**	**2.95**
	Wheat	**120.3**	**38.2**	**11.1**	**169.7**	**3.95**
	Rice + wheat	**237.6**	**73.4**	**22.9**	**333.9**	**6.9**

Source: Sharma, Subba Rao and Murari, 2004.

cropping system in the IGP is estimated at 334 kg. It varies from 258 kg in the Lower Gangetic Plain (LGP) region to 444 kg in the Trans-Gangetic Plain (TGP) (Haryana) region (Table 14). In the IGP, farmers apply 117.3 kg/ha N, 35.2 kg/ha P_2O_5 and 11.8 kg/ha K_2O on rice and 120.3 kg/ha N, 38.2 kg/ha P_2O_5 and 11.1 kg/ha K_2O on wheat. The productivity of rice and wheat crops in the IGP is estimated to be 2.95 and 3.95 tonnes/ha, respectively. In the IGP, the productivity of rice–wheat cropping systems decreases from west to east.

Chapter 5
Prices and Profitability of Fertilizers

PRICES OF FERTILIZERS

As fertilizer is an essential input for agricultural production, the Government's objective is to make this critical input available to the farmers at affordable prices. Until 24th August 1992, the prices of all the fertilizers were controlled, the Government setting the maximum retail prices of various fertilizers. With effect from 25 August 1992, the prices of phosphate and potash fertilizers were decontrolled. The prices of urea continued to remain under control. Following decontrol, the prices of phosphatic and potassic fertilizers rose sharply. Since 1997/98 the Government has fixed indicative maximum retail prices of decontrolled fertilizers, uniform throughout the country. Tables 15 and 16 show the maximum retail prices of fertilizers for the last 5 years.

TABLE 15
Maximum retail prices of fertilizers, by product

Fertilizer	2000/01	2001/02	2002/03	2003/04	2004/05
	(Rs./tonne product)				
DAP	8 900	8 900	9 350	9 350	9 350
MOP	4 255	4 255	4 455	4 455	4 455
SSP	2 500–3 500	2 500–3 500	2 600–3 500	2 600–3 500	2 600–3 500
Urea	4 600	4 600	4 830	4 830	4 830
10–26–26	7 880	7 880	8 360	8 360	8 360
12–32–16	7 960	7 960	8 480	8 480	8 480
14–28–14	7 820	7 820	8 300	8 300	8 300
14–35–14	8 100	8 100	8 660	8 660	8 660
15–15–15	6 620	6 620	6 980	6 980	6 980
16–20–0	6 740	6 740	7 100	7 100	7 100
17–17–17	7 680	7 680	8 100	8 100	8 100
19–19–19	7 840	7 840	8 300	8 300	8 300
20–20–0	6 880	6 880	7 280	7 280	7 280
23–23–0	7 540	7 540	8 000	8 000	8 000
28–28–0	8 520	8 520	9 080	9 080	9 080

TABLE 16
Maximum retail prices of fertilizers, nutrient basis

Fertilizer	Price per kg of nutrient	Prices				
		2000/01	2001/02	2002/03	2003/04	2004/05
		Rs/kg nutrient				
Urea	N	10.0	10.0	10.5	10.5	10.5
SSP	P_2O_5	15.6–21.9	15.6–21.9	16.3–21.9	16.3–21.9	16.3–21.9
DAP	P_2O_5	15.4	15.4	16.2	16.2	16.2
NP/NPKs	P_2O_5	16.3–28.1	16.3–28.1	17.6–29.7	17.6–29.7	17.6–29.7
MOP	K_2O	7.1	7.1	7.4	7.4	7.4

PRICES OF AGRICULTURAL PRODUCTS

The Government of India fixes procurement / minimum support prices (MSPs) of essential agricultural products for the crop / marketing year in order to keep prices stable. Table 17 shows procurement / support prices of agricultural products for the last 5 years.

Table 18 shows the relationship between fertilizer nutrient prices and output prices. Farmers have to sell more kilograms of paddy rice to buy 1 kg of P_2O_5 than for N and K_2O. In 2004/05, farmers had to sell 2.95 kg of paddy rice to buy 1 kg of P_2O_5 through DAP. In the case of P_2O_5 through SSP and complex fertilizers, the ratio was still higher. The farmers had to sell 1.91 kg of paddy rice to buy 1 kg of N through urea, and 1.35 kg of paddy to buy 1 kg of K_2O through MOP.

PROFITABILITY OF FERTILIZER USE

The profitability of fertilizer use has been calculated on the basis of the value of crop output and the cost of the input (fertilizer). The profitability of P_2O_5 and K_2O use has declined significantly after the decontrol of the

TABLE 17
Procurement/minimum support prices of agricultural products

Crop	2000/01	2001/02	2002/03	2003/04	2004/05
	(Rs/kg)				
Gram	11	12	12.2	14	14.3
Groundnut	12.2	13.4	13.6	14	14.3
Paddy	5.1	5.3	5.3	5.5	5.5
Sorghum	4.5	4.9	4.9	5.1	5.1
Sugar cane	0.6	0.6	0.7	0.7	-
Wheat	6.1	6.2	6.2	6.3	6.4

TABLE 18
Physical returns

	kg of paddy rice required to buy 1 kg of nutrient				
	2000/01	**2001/02**	**2002/03**	**2003/04**	**2004/05**
N through urea	1.96	1.89	1.98	1.91	1.91
P_2O_5 through DAP	3.03	2.91	3.06	2.95	2.95
P_2O_5 through NP/NPKs	3.20–5.51	3.08–5.30	3.32–5.61	3.19–5.40	3.19–5.40
P_2O_5 through SSP	3.06–4.29	2.95–4.13	3.07–4.13	2.95–3.98	2.95–3.98
K_2O through MOP	1.39	1.34	1.40	1.35	1.35

prices of these fertilizers in 1992. However, with the steady increase in the procurement / support prices of crops over the years and almost stable fertilizer prices, the profitability has increased in the past few years in the cases of all the three nutrients (Table 19).

Among the four crops listed in Table 19, in the cases of N and P_2O_5 the value cost ratio is highest for gram, followed by wheat, paddy rice and sorghum. In the case of K_2O, the value-cost ratio is highest for gram, followed by sorghum, wheat and paddy rice.

FERTILIZER SUBSIDY

Over the years, the aim in India has been to become and remain self-sufficient in foodgrain production. Fertilizer is the key input that has made this goal achievable. Historically, the prices of fertilizers have been kept below the cost of production and importation. The prices of fertilizers in India, particularly of urea, are lower than in developed and neighbouring developing countries. The objective behind the low prices is to maintain a favourable input:output ratio. The aim of the Government has been to ensure that the farmer receives a price that makes fertilizer use acceptable and remunerative. The Government provides a fertilizer subsidy to fill the gap between the cost of production / import cost plus distribution of fertilizers, and their retail prices. The objective of the introduction of the fertilizer subsidy was: (i) to provide foodgrains to the people at affordable prices; (ii) to insulate farmers from variations in production costs and to ensure reasonable returns from fertilizer use; and (iii) to ensure a reasonable return to the fertilizer industry.

TABLE 19
Profitability of mineral fertilization for selected crops 2004/05

Nitrogen

	Yield increase in per kg of N (kg)	Value of yield increase (Rs)	Cost of N through urea (Rs/kg)	Value/ cost ratio
Gram	8.0	114.0	10.5	10.9
Paddy rice	12.0	66.0	10.5	6.3
Sorghum	5.6	28.3	10.5	2.7
Wheat	12.0	76.8	10.5	7.3

Phosphate

	Yield increase per kg of P_2O_5 (kg)	Value of yield increase (Rs)	Cost of P_2O_5 through DAP (Rs/kg)	Value/ Cost Ratio
Gram	5	71.2	16.2	4.4
Paddy rice	7	38.5	16.2	2.4
Sorghum	4	20.2	16.2	1.2
Wheat	7	44.8	16.2	2.7

Potash

	Yield increase per kg of K_2O (kg)	Value of yield increase (Rs)	Cost of K_2O through MOP (Rs/kg)	Value/ cost ratio
Gram	11.5	163.9	7.4	22.1
Paddy rice	5.0	27.5	7.4	3.7
Sorghum	11.5	58.1	7.4	7.8
Wheat	5.0	32.0	7.4	4.3

The subsidy on fertilizers is given to the farmers by routing it through fertilizer manufacturers. The Government of India introduced the Retention Pricing Scheme (RPS) on urea in 1977 and on complex fertilizers in 1979. Under the RPS, a normative cost of production was worked out for each company. The difference between the normative cost of production plus the distribution cost and the retail price represents the subsidy to the farmers. Effective from August 1992, P and K fertilizers were decontrolled. This led to high prices of these fertilizers. The Government introduced a concession scheme to mitigate the increased cost of production. However, urea continued to be under the RPS until 31 March 2003. Effective from 1 April 2003, the RPS on urea was replaced

TABLE 20
Subsidies on fertilizers

Year	Indigenous urea	Imported urea	Concession on decontrolled fertilizers	Total
	(Rs million)			
2000/01	94 800	10	43 190	138 000
2001/02	80 440	473	45 040	125 953
2002/03	77 900	-	32 250	110 150
2003/04	81 390	10	36 560	117 960
2004/05	101 432	4 730	50 460	156 622

by the Group Pricing Scheme (GPS). The normative cost of production is now worked out on the GPS basis. Table 20 shows the amount of subsidy provided by the Government on urea and on the concession on P and K fertilizers in the last 5 years.

Chapter 6
Fertilizer distribution and credit

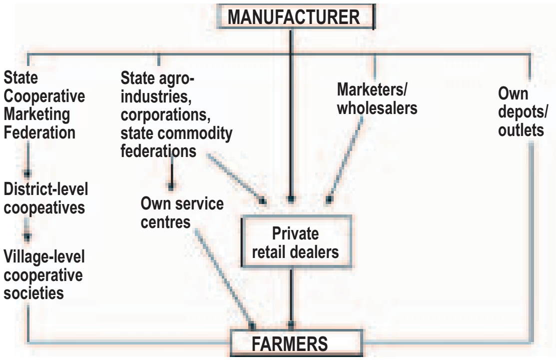
In 1944, the Government of India established the "Central Fertilizer Pool" as the official agency for the distribution of all available fertilizers at fair prices throughout the country. All fertilizers, whether domestically produced or imported, were pooled together and distributed through state agencies. In 1966, manufacturers were allowed to market 50 percent of their production. By 1969, the domestic manufacturers had been given complete freedom in marketing. However, this was short-lived. Fertilizer shortages in the early 1970s led the Government to pass the Fertilizer Movement Control Order in 1973, which brought the distribution of fertilizers under government control.

In the mid-1970s, the supply and distribution of fertilizers were regulated under the Essential Commodities Act (ECA). Manufacturers were allocated a quantity of fertilizers in different states according to a supply plan. All the fertilizers were distributed by the manufacturers according to their ECA allocation during the two cropping seasons, kharif and rabi. This system continued up to August 1992. Thereafter, all P and K fertilizers were decontrolled. AS, CAN and ammonium chloride (ACL) were also decontrolled. All these fertilizers were free from distribution control. Only urea continued to remain under control.

With effect from 1 April 2003, the Government implemented the "New Fertilizer Policy", which allowed urea manufacturers to market initially 25 percent and subsequently 50 percent of their production outside the purview of distribution control. This practice continues today. Urea manufacturers can now market 50 percent of their production as they wish.

The total quantity of fertilizer materials distributed annually increased from 0.3 million tonnes in 1951 to 34.9 million tonnes in 2003/04. This large volume of fertilizer is distributed through a well-developed marketing network spread throughout the country. Cooperatives supply almost 35 percent of the total quantity available from domestic production and importation. Private channels distribute the balance (65 percent). As

FIGURE 5
Fertilizer marketing and distribution channels



on 31 March 2004, the total number of sale points was 282 468. Of these, 77 percent were privately owned and 23 percent were in cooperatives and other institutional channels.

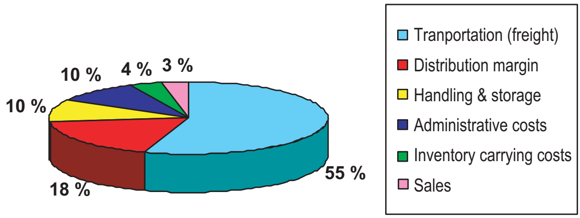
Currently, about 75 percent of the total quantity of fertilizer is moved by rail and the remaining 25 percent by road. The average distance of fertilizers moved by rail is about 850 km. However, within a radius of 200 – 250 km from the plant, most of the fertilizer materials are moved by road. The economics of movement favours road transportation up to this distance.

Figure 5 shows the present system of fertilizer marketing and distribution is presented. Indigenous fertilizers are distributed through institutional channels (cooperative societies, agro-industry corporations, state commodity federations, etc.) and private trade. The cooperative marketing structure varies from state to state (two to four tiers). Handling agents distribute imported urea. State agencies and domestic manufacturers distribute imported DAP and complex fertilizers, MOP and SOP.

COMPONENTS OF MARKETING COSTS

The marketing cost of urea is about Rs 1 000/tonne. Of this, freight accounts for 50 – 55 percent, the distribution margin accounts for 18 percent and handling and storage for 10 percent (Figure 6).

FIGURE 6
Share of various components in marketing cost of urea



While fertilizer production is continuous throughout the year, its use is seasonal. In India, there are two main cropping seasons: (i) kharif (April–September); and (ii) rabi (October–March). Fertilizers are stored before the onset of each season. Consumption is characterized by a peak period followed by lean spells. Therefore, storage is an important factor in fertilizer marketing and distribution. There are about 2 060 central and state warehouses with an aggregate capacity of 30.1 million tonnes. In addition, the Food Corporation of India has a storage capacity of 23.95 million tonnes. The cooperatives have about 65 970 godowns with a capacity of about 14.12 million tonnes. These godowns are used for storage of foodgrains, fertilizer and other commodities.

CREDIT

Most farmers cannot afford to purchase fertilizers on a cash basis. Similarly, not every dealer can pay cash for fertilizers. Therefore, credit plays an important role in fertilizer distribution and use. Generally, two types of credit are available in the fertilizer sector for fertilizer distribution and use. One type is distribution credit, which a dealer uses for buying fertilizers from the manufacturer or wholesaler. The second type is production credit, which a farmer uses for purchasing inputs, of which fertilizer is the major one. Various agencies provide credit to the agriculture sector in different forms. These include cooperative banks, regional rural banks, commercial banks and other agencies. Table 21 shows the credit flow by type of agency for agricultural and allied activities from 2000/01 to 2003/04.

TABLE 21
Credit flow by type of agency for agriculture and allied activities

Agency	2000/01	2001/02	2002/03	2003/04
	(Rs thousand million)			
Commercial banks	278.07	335.87	397.74	438.40
Cooperative banks	207.18	235.24	236.36	300.80
Regional rural banks	42.20	48.54	60.70	60.80
Other agencies	0.82	0.80	0.80	-
Total	**528.27**	**620.45**	**695.60**	**800.00**

Kisan (farmer) credit cards (KCCs) were launched in 1998 to facilitate access by farmers to production credit. These credit cards are issued by 27 commercial banks, about 200 regional rural banks and almost 4 000 cooperative banks. Nine states have issued more than a million cards so far.

Chapter 7
Future prospects

India's foodgrain requirement to feed the estimated population of 1 400 million by 2025 will be 300 million tonnes (based on rice, i.e. unhusked paddy rice). There will be a corresponding increase in requirement of other crops such as cotton, sugarcane, fruits and vegetables. The country will require about 45 million tonne of nutrients (30 million tonnes for foodgrains and 15 million tonnes of nutrients for other crops) from various sources of plant nutrients, i.e. fertilizers, organic manures and biofertilizers. The further increase in crop production will have to come from an increase in yields as there is limited scope for increasing cultivated area. The yields of the majority of the crops are relatively low and there is great potential for increasing them through the increased use of inputs such as fertilizers. Fertilizer use will remain key to the future development of agriculture.

The handling of increasing quantities of fertilizers will put pressure on storage and handling facilities and transport. Products and practices that improve fertilizer-use efficiency will need special encouragement. Fertilizer promotion will have to include activities that promote not only increased rates of use but also better balances between the nutrients and higher efficiency. Attention also needs to focus on the availability of credit, an essential factor in ensuring the availability of fertilizers to farmers.

India will continue to be a major importer of raw materials, intermediates as well as finished products. The fertilizer product pattern is unlikely to change in the near future, and urea and DAP will continue to dominate fertilizer production. Attention will need to focus on ensuring the availability of good-quality micronutrient fertilizers.

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Food security has long been a major concern in India. The promotion of fertilizer production and use in order to increase crop yields has been a major objective of the Government of India for more than 30 years. With 116 million farmholdings and an average farm size of only 1.4 ha, the task is difficult. However, the policy has succeeded and food production in India has kept pace with a rapidly growing population. The population continues to increase and the provision of an adequate supply of food remains a challenge. This can be achieved only through further increases in yields, involving the enhanced use of fertilizers (fertilizer application rates are relatively low in many areas). This also entails selecting products and implementing practices that improve fertilizer-use efficiency.

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