Chapter IV :

LOCATION OF FERTILISER PLANTS

In this chapter we would discuss the existing location pattern of fertiliser plants in India, and would then proceed to examine, with the help of a simple index, the locational efficiency of these plants in respect of various sources of their raw materials and various points of despatches of their products.

Pattern of plant location

Location of existing fertiliser plants, types of products manufactured, process of production adopted, raw materials or intermediates used and sources of their supply are presented in Appendix Table 4.I. It should be noted here that the process used for the manufacture of single superphosphate (SSP) fertiliser is conventional. Phosphate rock is acidulated with sulphuric acid for the manufacture of SSP fertiliser. Nitrogenous and NP/NPK complex fertiliser plants, of course, use latest process technology.

All the nitrogenous fertiliser plants, which were established until the end of 1960's, were located very near to the sources of raw materials. The production of ammonium sulphate (AS) fertiliser at FACT, Alwaye in 1947, was based on wood charcoal due to non-availability of any other source of raw-material in the neighbouring areas. The production of fertiliser at Sindri factory was based on coke which was available from the coal mines in that area. It was decided to produce fertiliser from Lignite at Neyveli factory, and from electrolysis of water process at Nangal fertiliser plant. Lignite was available in large quantities at the lignite mines near Neyvali, and electricity and water were available from Bhakhra Nangal Dam. During early 1960's various petroleum refineries were commissioned as a result of which, large quantities of naphtha and associated gas were available from there. As the use of naphtha in the fertiliser plants received prime importance, various fertiliser plants such as RCF Trombay, CFL Vizag, GSFC Baroda, MFL Madras, etc., were established in the neighbourhood or petroleum refineries. The Government's feedstock policies for fertiliser plants have also affected the location of fertiliser plants. The switchover of feedstock policy from naphtha and fuel oil to natural gas and coal has changed the location pattern of fertiliser plants.

Since large quantities of phosphoric acid or phosphate rock and sulphur as well as potash are imported for the production of complex fertilisers, almost all the complex fertiliser plants were established near the ports. It is but natural that plants which produce fertilisers as by-products, were also located near the sources of inputs.

Superphosphate fertiliser plants also import sulphur and phosphate rock. Some manufacturers purchase sulphuric acid from the local market and import phosphate rock or get their phosphate rock supplies from indigenous sources. It can be seen from the Appendix that majority of superphosphate factories were also concentrated in the port-based States only.

The availability of process technology also influences the plant location. In fact, the location of a fertiliser plant is determined by the process technology. The presence of raw-material deposits are of no use, if the technology to process them is not developed. Even if the technology is available, the sources will not be exploited if processing cost is higher than the revenue from sale of the product. In 1976, with the modification of process technology-RCF, Trombay succeeded in producing phosphoric acid from indigenous phosphate rock, obtained from Udaipur (Rajasthan) mines.[1] Formerly indigenous rock phosphate was considered to be unsuitable for phosphoric acid production. In 1979, following RCF's lead, Hindustan Zinc Ltd., Debari also started manufacturing phosphoric acid from Maton (Rajasthan) phosphate rock.

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1 Agarwal, M.R. "Technical Innovations and Their Application at RCF Complex", Fertiliser News, May 1981, p.38.

It is apparent from the above discussion that, majority of the existing fertiliser plants in the country were located very near to the sources of raw-materials. Since fertilisers are moved over longer distances, under the prevailing system of distribution, it is of great importance to examine how far the existing locations of fertiliser plants are efficient in terms of their despatches to various locations. While a transport cost minimisation model has been attempted to obtain an optimal pattern of despatches from various plants to various locations of demand, and is presented in Chapter VI, here it might be interesting to throw some light on the locational efficiency of these plants in respect of their sources of raw materials and their despatches of final products to various locations of demand.

Locational efficiency

The location of a firm or plant is governed by various factors such as the availability of raw materials, utilities, labour, market for the products, cost of transportation, etc. The regional disparity in the availability of raw materials as well as in the demand for final products necessitates the movement of factors and materials from one place to another. The movement of factors of production (labour and capital) as well as of other goods (raw materials, intermediates and final products) ultimately manifests into cost of transportation.

According to Weber, "there are two kinds of transport costs. Transportation costs in the sense of political economy and the transportation costs as understood by the businessman paying for the shipment of goods. The former costs are total amount of goods and labour that are absorbed in affecting such a shipment and the latter costs are the monetary payment made to those furnishing the transportation (rate or the price of transportation)".[2] Thus, the cost incurred on the factors of production - land, labour and capital - which are essential for affecting transportation business, is the real or economic cost, while the freight paid for such movement is the monetary cost. Apparently, it is difficult to measure the real transportation costs, as we do not know the real cost of each factor in affecting such movement. Hence, as the second best approximation, one could still rely on the freight rates. Alternatively, in a transport cost minimization model, one could minimize the distance, i.e., average lead of transportation as an approximation to minimize the real cost of transportation.

The question of locational efficiency can be posed from two angles. One is a normative approach, i.e., if a firm or plant is going to be established, which would be the best location for its establishment. The second angle would be looking at already

2 Friedrich, C.J. : Alfred Weber's Theory of the Location of Industries, The University of Chicago Press, 1929, p.41.

established firms or plants to find out whether they are locationally efficient or not. In our context of the existing fertiliser plants, the question of locational efficiency is posed from the second angle. There are already established fertiliser plants, and we will examine whether locationally they are efficient or not.

An input-output-cum-linear programming approach is the most comprehensive approach for dealing with the locational problem as it takes into account the technological as well as spatial interdependence of all the economic activities. However, the approach is best suitable for the normative question. Still one could work out, based on this approach, an ideal location pattern and then compare it with the existing ones as has been done by a number of scholars.[3] But in our context, looking to the nature of data available, it was considered desirable to use a simpler technique for examining the locational efficiency. This technique is based on Weber's material index.[4] We would call our index a "modified form of Weber's material Index".

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3 Henderson, J.M., "The Efficiency of Coal Industry - An Application of Linear Programming," Harvard University Press, Cambridge Massachusetts, 1958; Mathur, P.N. and Hashim, S.R., "A Model for Optimum Location and Flows", published in "Economic Analysis in Input-Output Framework", Vol.2, P.N. Mathur and P. Venkataramaiah (ed.), Input-Output Research Association, Poona; A. Ghosh and A. Chakrabarti, "Programming and Integral Input-Output Analysis, an Application to the Problem of Industrial Location in India", Cambridge University Press, 1973.

4 Gerald, J. Karaska, "The Partial Equilibrium Approach to Location Theory - Graphic Solutions", Published in "Locational Analysis for Manufacturing - A Selection of Readings", by Gerald J. Karaska and David F. Bramhall (ed.), The MIT Press, USA, 1969, pp.28-29.

Weber's Material index and its modified form

The material index, which Weber formulated for examining the location of a plant is computed on the basis of "ideal weights" for the raw materials and the final product. The ideal weight for the raw material is given by the formula :

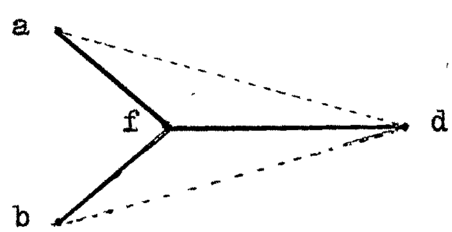
$$\frac{\text{Freight rate of one tonne of raw material}}{\text{Freight rate of one tonne of final product}} \times \text{Quantity of raw material required for the production of one tonne of final product}$$

The ideal weight for the final product is taken to be one. The ratio of ideal weight of raw material to the ideal weight of final product gives us the 'Weber's material index'.

This index only states whether the location of a plant should be raw material oriented or market oriented, depending upon whether the value of the material index is greater than or less than one. It should be noted here that while computing the Weber's material index, the ideal weights for labour and other inputs such as utilities, etc., can also be taken into account, and these may influence the location of a firm significantly. "A location can be moved from the point of minimum transportation costs to a more favourable labour location only if the savings in the cost of labour, which this new place makes possible, are larger than the additional costs of transportation which it involves."[5]

5 Friedrich C.J., op.cit., p.103.

However, in our context we are examining already established plants and would like to know whether they are locationally efficient or not. Weber's index does not answer this question directly, as it is based on a unit cost of transportation of raw material as well as finished products. There is yet amother point and that is that, Weber's index presumes a single raw material and a single output. Even if we are able to consider a single and homogenous output, to produce that output there would be many raw materials. Our problem is of the following type. Suppose there is a factory at location f, producing one type of fertiliser and despatching it to location d. This factory uses two raw materials - one is obtained from location a and the other is obtained from location b. This example can be presented diagrammatically as shown below :



Now we pose the following question: Suppose the fertiliser was produced at d instead of f, using the same process and the same sources of raw materials, i.e., a and b, Would there be a saving in the overall cost of transportation? To answer this question, we can do the following exercise. Suppose for producing a tonne of fertiliser, the coefficients of raw materials are C_1 and C_2 obtained from location a and location b respectively. Then the cost of transportation involved in producing the fertiliser at d is :

$$C_1 \, r_{ad} + C_2 \, r_{bd}$$

where r_{ad} is the transport cost involved in transporting a tonne of raw material from location a to location d. r_{bd} is similarly interpreted.

We have to compare this cost against the existing cost. The existing cost of transportation is :

$$r_{fd} + C_1 r_{af} + C_2 r_{bf}$$

where r_{fd} is the cost of transporting one tonne of fertiliser from location f to d.

Now we can define an index (I) of efficiency of existing locations as :

$$I = \frac{C_1 r_{ad} + C_2 r_{bd}}{r_{fd} + C_1 r_{af} + C_2 r_{bf}}$$

If this index is more than one, then the existing location is efficient. If this is less than one, then the location at the point of demand would be more efficient. If the index is just one, then both the situations are equally good.

A limitation of this index is that it ignores the movement of other inputs like labour, water, energy, etc. Also there is an assumption that fertilisers are transported from a plant to one point in space, i.e., one focal point. That focal point, in turn, might be distributing fertilisers over a whole region. Thus the cost of intra-regional movements are ignored.

There is yet another major limitation of this index. It ignores the economies of scale, if any. However, economies of scale could be taken care of separately by regrouping the locations of demand in a way to make a fertiliser unit viable. We are not going into this issue for the moment.

Construction of material index

Since the data pertaining to input coefficients are available only for a few existing fertiliser plants, we could not construct the material indices for all the plants in the country. Because the output of a plant is despatched to various marketing regions, we have computed the material indices for all the marketing regions in order to examine the locational efficiency of a particular fertiliser plant with respect to each marketing region. Each marketing region is represented by a focal point, i.e., a town.

Some of the fertiliser plants produce two or more fertiliser products. For each type of fertiliser product a different material index is constructed. While calculating the material index, we have taken into consideration the existing sources of raw materials, existing locations of fertiliser plants and a given point, i.e., focal point in each of the marketing regions.

It should be noted here that, we have assumed that, fertilisers as well as raw materials are despatched only by railways and that too in wagon loads. These assumptions are made because (i) over long distances, fertiliser despatches are made by railways and (ii) the railways charge discriminating rates for despatches made in wagon loads and non-wagon loads, i.e., smalls. Raw material naphtha is of two types : (i) naphtha having flashing point above 24.4°C and (ii) naphtha having flashing point below 24.4°C. The latter being more explosive, is charged higher freight rate. Since we do not know which fertiliser plant uses naphtha having flashing point above 24.4°C or below 24.4°C, two material indices are constructed for each naphtha-using fertiliser plant.

Indian Railways have classified fertilisers, raw materials and intermediate products into seven categories for charging freight rates. This classification is shown in Table 4.1 and the freight rates applicable for wagon loads of each class of goods, for various distances, are given in Table 4.2.On the basis of these freight rates and input coefficients available for a particular fertiliser plant (as given in Chapter III),

Table 4.1 : Railway general classification of fertilisers and fertiliser raw materials for wagon loading during 1976-77 to 1979-80

Sr. No.	Article	General classification number			
		1976-77	1977-78	1978-79	1979-80
1.	Ammonium chloride	45.0	45.0	45.0	45.0
2.	Ammonium sulphate	45.0	45.0	45.0	45.0
3.	Ammonium sulphate nitrate	45.0	45.0	45.0	45.0
4.	Calcium ammonium nitrate	45.0	45.0	45.0	45.0
5.	(Ground) rock phosphate	45.0	45.0	45.0	45.0
	Rock Phosphate	45.0	47.5	45.0	45.0
6.	Manure mixture	45.0	45.0	45.0	45.0
7.	Mineral Phosphate	45.0	45.0	45.0	45.0
8.	Muriate of Potash	45.0	45.0	45.0	45.0
9.	Gypsum: Powder broken	42.5	42.5	45.0	45.0
	Modules			42.5	42.5
10.	Lime stone	42.5	42.5	42.5	42.5
11.	Single superphosphate	45.0	45.0	45.0	45.0
12.	Diammonium Phosphate	52.5	52.5	52.5	52.5
13.	Monoammonium phosphate	52.5	52.5	52.5	52.5
14.	Urea	52.5	52.5	52.5	52.5
15.	Ammonium Phosphate	52.5	52.5	52.5	52.5
16.	Ammonium Nitrophosphate	52.5	52.5	52.5	52.5
17.	NPK complex fertilisers	52.5	52.5	52.5	52.5
18.	Zinc sulphate	52.5	52.5	52.5	52.5
19.	Nitrophosphate	52.5	52.5	52.5	52.5
20.	Triple superphosphate	52.5	52.5	52.5	52.5
21.	Sulphate of Potash	52.5	52.5	52.5	52.5
22.	Sulphur	52.5	52.5	52.5	52.5
23.	Furnace oil	62.5	62.5	62.5	62.5
24.	Naphtha: Flashing point at or above 24.4°C	62.5	62.5	62.5	62.5
	Flashing point below 24.4°C	100.0	100.0	100.0	100.0
25.	Fuel oil	110.0	110.0	110.0	110.0
26.	Coal/soft coke	37.5	37.5	37.5	37.5
	Hard coke	42.5	42.5	42.5	42.5
27.	Sulphuric acid	100.0	100.0	100.0	100.0
28.	Phosphoric acid	110.0	110.0	110.0	110.0

Source: Fertiliser Statistics, 1979-80, Fertiliser Association of India, New Delhi, P.I-234.

Table 4.2 : Railway freight rates for fertilisers and fertiliser raw material/intermediates (Rate in Rs. per tonne)

Distance (km.)	Fertiliser Raw Materials/Intermediate															
	42.5				45.0				52.5				37.5			
	1976-77	1977-78	1978-79	1979-80	1976-77	1977-78	1978-79	1979-80	1976-77	1977-78	1978-79	1979-80	1976-77	1977-78	1978-79	1979-80
100	14.40	14.40	14.40	15.90	15.10	15.10	15.10	16.61	17.20	17.20	17.20	19.00	13.65	13.65	13.65	16.50
200	21.10	21.10	21.10	23.30	22.20	22.20	22.20	24.50	25.40	25.40	25.40	28.00	19.85	19.85	19.85	24.00
300	27.40	27.40	27.40	30.20	28.80	28.80	28.80	31.75	33.10	33.10	33.10	36.50	25.75	25.75	25.75	31.10
500	38.90	38.90	38.90	42.90	41.00	41.00	41.00	45.30	47.10	47.10	47.10	52.30	36.40	36.40	36.40	44.00
750	54.70	54.70	54.70	66.20	57.70	57.70	57.70	69.85	66.70	66.70	66.70	80.75	53.60	53.60	53.60	67.85
1000	68.10	68.10	68.10	82.40	71.90	71.90	71.90	87.00	83.20	82.30	83.20	100.70	66.60	66.60	66.60	84.30
1500	92.50	92.50	92.50	111.95	97.70	97.70	97.70	118.35	113.50	113.50	113.50	137.35	90.30	90.30	90.30	114.25
2000	113.60	113.60	113.60	137.50	120.00	120.00	120.00	145.20	139.40	139.10	139.40	168.70	110.80	110.80	110.80	140.25
2500	130.10	130.10	130.10	[illegible]	137.50	137.50	137.50	166.40	159.70	159.70	159.70	19? 25	126.75	126.75	126.75	[illegible]

Distance (km.)	42.5				45.0				52.5				62.5			
	1976-77	1977-78	1978-79	1979-80	1976-77	1977-78	1978-79	1979-80	1976-77	1977-78	1978-79	1979-80	1976-77	1977-78	1978-79	1979-80
100	14.40	14.40	14.40	16.30	15.10	15.10	15.10	19.15	18.10	18.10	18.10	21.85	21.00	21.00	21.00	25.35
200	21.10	21.10	21.10	26.80	22.20	22.20	22.20	28.20	26.70	26.70	26.70	32.20	31.30	31.30	31.30	37.65
300	27.40	27.40	27.40	34.75	28.80	28.80	28.80	36.50	34.75	34.75	34.75	42.00	40.85	40.85	40.85	49.35
500	38.90	38.90	38.90	43.35	41.00	41.00	41.00	52.10	49.30	49.30	49.30	60.15	58.60	58.60	58.60	70.80
750	54.70	54.70	54.70	76.15	57.70	57.70	57.70	80.35	73.40	73.40	73.40	92.90	86.70	86.70	86.70	109.70
1000	68.10	68.10	68.10	94.80	71.90	71.90	71.90	100.05	91.50	91.50	91.50	115.80	108.35	108.35	108.35	137.00
1500	92.50	92.50	92.50	128.75	97.70	97.70	97.70	136.10	124.90	124.90	124.90	167.95	147.35	147.25	147.35	167.05
2000	113.60	113.60	113.60	158.15	120.00	120.00	120.00	167.00	153.90	153.90	153.90	194.00	181.85	181.85	181.85	230.05
2500	130.10	130.10	130.10	181.10	137.50	137.50	137.50	191.40	175.70	175.70	175.70	222.25	208.45	208.45	208.45	263.70

Distance (km.)	100.0				105				110			
	1976-77	1977-78	1978-79	1979-80	1976-77	1977-78	1978-79	1979-80	1976-77	1977-78	1978-79	1979-80
100	32.00	32.00	32.00	38.65	33.50	33.50	33.50	40.50	35.90	35.90	35.90	43.35
200	48.30	48.30	48.30	58.40	50.60	50.60	50.60	61.15	52.90	52.90	52.90	63.90
300	63.40	63.40	63.40	76.60	66.60	66.60	66.60	80.45	69.50	69.50	69.50	83.95
500	91.65	91.65	91.65	110.70	96.10	96.10	96.10	116.05	100.50	100.50	100.50	121.40
750	136.50	136.50	136.50	172.70	143.10	143.10	143.10	181.10	149.85	149.85	149.85	189.60
1000	170.85	170.85	170.85	216.15	179.20	179.20	179.20	226.75	187.45	187.45	187.45	237.15
1500	234.20	234.20	234.20	296.30	245.75	245.75	245.75	310.90	246.30	236.30	236.30	311.60
2000	288.65	288.65	288.65	365.20	302.95	302.95	302.95	383.25	317.15	317.15	317.15	401.25
2500	331.20	331.20	331.20	419.00	347.60	347.60	347.60	439.80	364.00	364.00	364.00	460.50

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

we have computed the material indices for each product produced by a plant, and for each marketing region served.

For the purpose of computation, we have grouped the States and Union Territories into 17 consuming regions. In each region we have selected a point which is almost centrally located and also connected with the railway station. Railway connected points are selected since we allow the despatches of fertilisers and raw materials only by railways, from the respective sources. We call the destination point a 'focal point'. Hence, there are 17 focal points in all the 17 marketing regions. States and Union Territories which consume small quantities of fertilisers are clubbed together with the neighbouring State. Marketing regions and their respective focal points are shown in Columns 1 and 2 of Table 4.3 to 4.6.

Analysis of results

Table 4.3 shows the material index of NP/NPK fertilisers. It is evident from this table that the location of plant A for NP grade 20-20-20 distribution is economical only for two marketing regions, if raw material naphtha having flashing point above (FPA) 24.4°C is used, and economical for four marketing regions, if naphtha having flashing point below (FPB) 24.4°C is used. For NPK grade 15-15-15 distribution, the existing location is inefficient for all the marketing regions

Table 4.3 : Material index of NP/NPK fertilisers from various fertiliser plants to various consuming centres.

Marketing region	Focal Point	PLANT A (20-20-0)* I	PLANT A (20-20-0)* II	PLANT A (15-15-15)* I	PLANT A (15-15-15)* II	PLANT B (14-35-14)* I	PLANT B (14-35-14)* II	PLANT C (14-28-14)* I	PLANT C (14-28-14)* II	PLANT C (17-17-17)* I	PLANT C (17-17-17)* II
1. Jammu & Kashmir and Himachal P.	Pathankot	-	-	-	-	-	-	-	-	-	-
2. Punjab & Chandigarh	Ludhiana	-	-	-	-	-	-	-	-	-	-
3. Haryana & Delhi	Jind	-	-	-	-	-	-	0.98	1.12	-	-
4. Rajasthan	Phullera	0.74	0.88	0.83	0.93	-	-	-	-	-	-
5. Madhya Pradesh	Bhopal	0.81	0.94	0.84	0.94	1.98	2.09	0.90	1.03	0.83	1.00
6. Uttar Pradesh	Shahjahanpur	0.80	0.93	0.83	0.94	1.98	2.09	0.97	1.11	-	-
7. Gujarat	Ahmedabad	0.84	0.97	0.84	0.94	-	-	-	-	-	-
8. Maharashtra	Manmad	1.30	1.43	0.90	1.00	-	-	0.91	1.04	0.83	1.00
9. Goa, Daman & Diu	Kolamb	-	-	-	-	-	-	-	-	-	-
10. Karnataka	Hospet	1.07	1.21	0.84	0.94	1.99	2.09	0.77	0.88	0.71	0.85
11. Kerala & Lakshadweep	Shoranur	-	-	-	-	-	-	1.95	2.22	1.79	2.15
12. Tamilnadu & Pondicherry	Tiruchchirapalli	0.94	1.08	0.85	0.96	-	-	2.15	2.45	1.97	2.37
13. Andhra Pradesh	Vijayawada	0.71	0.85	0.85	0.95	1.99	2.10	0.65	0.74	0.60	0.72
14. Orissa	Cuttak	0.88	1.02	-	-	1.99	2.09	0.91	1.00	0.80	0.97
15. West Bengal, Andaman & Nicobar Islands	Azimganj	0.85	0.99	0.85	0.95	1.98	2.09	-	-	-	-
16. Bihar	Luckeesarai	0.85	0.99	0.84	0.94	-	-	-	-	-	-
17. Assam, Sikkim, Bhutan, Meghalaya, Arunachal, Nagaland, Manipur, Tripura and Mizoram	Lumding	0.86	1.00	0.86	0.96	-	-	-	-	-	-

I = If naphtha at Flashing point at or above 24.4°C is used.
II = If naphtha at Flashing point below 24.4°C is used.
* Fertiliser Grade.

and it is feasible for only one marketing region if and only if naphtha having FPB 24.4°C is to be used as raw material. The location of plant B is efficient for all the marketing regions to which it supplies fertiliser 14-35-14 grade. Similarly, plant C is efficiently located only for two marketing regions from the view point of NPK 14-28-14 fertilisers distribution, if raw material naphtha having FPA 24.4°C is used, and is efficiently located for all but two of its marketing regions, if naphtha having FPB 24.4°C is used. If fertiliser 17-17-17 grade is to be distributed from Plant C, then the location is efficient for two marketing regions and is just feasible for two of its other marketing regions as the material index is 1.00 in their case.

Table 4.4 gives the material index of UAP and DAP fertilisers. Plants A and B produce and distribute UAP fertilisers and Plants C and D produce and distribute DAP fertilisers. The location of plant A which manufactures UAP grade 28-28-0 fertiliser is efficient for all its marketing regions. The location of Plant B which manufactures UAP grade 24-24-0 fertiliser is inefficient for all of its marketing regions, if raw material naphtha having FPA 24.4°C is used, and is efficient for all but one marketing regions, if raw-material naphtha having FPB 24.4°C is used. The location of Plant C is efficient

Table 4.4 : Material index of UAP and DAP fertilisers from various fertiliser plants to various consuming centres.

Marketing region	Focal point	Plant-A UAP 28-28-0 I	Plant-A UAP 28-28-0 II	Plant-B UAP 24-24-0 I	Plant-B UAP 24-24-0 II	Plant-C DAP 18-46-0 I	Plant-C DAP 18-46-0 II	Plant-D DAP 18-46-0 I	Plant-D DAP 18-46-0 II
1. Jammu & Kashmir and Himachal P.	Pathankot	-	-	-	-	-	-	-	-
2. Punjab & Chandigarh	Ludhiana	-	-	0.96	1.23	1.32	1.50	-	-
3. Haryana and Delhi	Jind	-	-	0.94	1.20	1.29	1.47	-	-
4. Rajasthan	Phullera	-	-	-	-	-	-	-	-
5. Madhya Pradesh	Bhopal	1.70	1.99	0.86	1.10	1.18	1.34	-	-
6. Uttar Pradesh	Shahjahanpur	1.70	1.99	0.93	1.18	1.27	1.45	-	-
7. Gujarat	Ahmedabad	-	-	-	-	-	-	-	-
8. Maharashtra	Manmad	-	-	0.87	1.11	-	-	2.06	2.24
9. Goa, Daman and Diu	Kolamb	-	-	-	-	-	-	-	-
10. Karnataka	Hospet	1.14	1.42	-	-	-	-	2.05	2.22
11. Kerala & Lakshadweep	Shoranur	-	-	-	-	-	-	1.97	2.05
12. Tamilnadu&Pondichery	Tiruchchi-rapalli	-	-	-	-	2.80	3.19	2.19	2.44
13. Andhra Pradesh	Vijayawada	1.70	1.98	0.62	0.79	0.85	0.97	2.05	2.20
14. Orissa	Cuttak	1.70	1.98	0.84	1.07	1.15	1.31	-	-
15. West Bengal, Andaman and Nicobar islands	Azimganj	1.70	1.98	-	-	-	-	-	-
16. Bihar	Luckeesarai								
17. Assam, Sikkim, Bhutan, Meghalaya, Arunachal, Nagaland, Manipur Tripura and Mizoram	Lumding								

I = If naphtha at flashing point at or above 24.4°C is used.
II = If naphtha at flashing point below 24.4°C is used.

Table 4.5 : Material index of urea fertiliser from various fertiliser plants to various consuming centres

Marketing region	Focal point	Plant A Coal based plant	Plant B I	Plant B II	Plant C I	Plant C II	Plant D I	Plant D II	Plant E I	Plant E II	Plant F I	Plant F II	Plant G I	Plant G II
1. Jammu & Kashmir and Himachal P.	Pathankot	1.57	-	-	-	-	-	-	-	-	-	-	-	-
2. Punjab & Chandigarh	Ludhiana	1.57	-	-	-	-	-	-	0.95	1.51	-	-	-	-
3. Haryana and Delhi	Jind	1.57	-	-	-	-	-	-	1.06	1.68	-	-	-	-
4. Rajasthan	Phullera	1.57	-	-	-	-	-	-	-	-	-	-	-	-
5. Madhya Pradesh	Bhopal	1.59	0.58	0.92	0.57	0.88	-	-	1.09	1.72	0.73	1.16	-	-
6. Uttar Pradesh	Shahajahanpur	1.57	-	-	-	-	1.49	3.20	1.14	2.46	-	-	-	-
7. Gujarat	Ahmedabad	1.57	0.58	0.91	-	-	-	-	-	-	-	-	-	-
8. Maharashtra	Manmad	1.58	0.58	0.90	-	-	-	-	-	-	0.74	1.17	0.48	0.89
9. Goa, Daman and Diu	Kolamb	1.58	-	-	-	-	-	-	-	-	-	-	-	-
10. Karnataka	Hospet	1.58	0.58	0.92	0.55	0.87	-	-	-	-	0.63	0.99	0.46	0.85
11. Kerala &Lakshadweep	Shoranpur	1.57	-	-	0.55	0.85	-	-	-	-	1.53	2.49	0.23	0.41
12. Tamilnadu and Pndichery	Tiruchchi-rapalli	1.57	-	-	0.55	0.87	-	-	-	-	1.76	2.75	0.73	1.34
13. Andhra Pradesh	Vijayawada	1.61	0.59	0.93	0.55	0.87	-	-	-	-	0.54	0.83	0.43	0.80
14. Orissa	Cuttak	1.58	-	-	-	-	-	-	-	-	0.72	1.13	-	-
15. WestBengal, Andaman & Nicobar islands	Azimganj	1.57	-	-	-	-	-	-	-	-	-	-	-	-
16. Bihar	Luckeesarai	1.58	-	-	-	-	-	-	0.15	0.23	-	-	-	-
17. Assam, Sikkim, Bhutan, Meghalaya, Arunachal, Nagaland, Manipur, Tripura and Mizoram	Lumding	1.57	-	-	-	-	-	-	-	-	-	-	-	-

I = If Naphtha at flashing point at or above 24.4°C is used.
II = If Naphtha at flashing point below 24.4°C is used.

for all but one of its marketing regions and the location of plant D is efficient for all of its marketing regions.

Table 4.5 shows the material index of urea fertiliser from seven different plants to their respective marketing regions. Plant A is a newly commissioned fertiliser plant. Since we do not know its marketing regions, its material index is computed for all the marketing regions of the country. Plant A is based on raw material-coal, while all the other plants use naphtha for the production of fertiliser urea. Since substantial quantities (about 2.172 tonnes) of coal are required for the production (one tonne) of fertiliser urea, material index of urea from Plant A to majority of consuming areas varies around 1.57 to 1.58 which means that, the transport cost of raw materials is about 57% to 58% higher than the transport cost of fertiliser urea. Hence, this plant is efficiently located. The locations of plants B and C are inefficient as the value of material indices are less than one for all of their marketing regions. Plant D is efficiently located since it markets in its neighbouring areas only. Plant E is efficiently located for all but one of its marketing regions, if naphtha having FPA 24.4°C is used and is efficiently located for all of its marketing regions, if naphtha having FPB 24.4°C is used for the manufacture of urea. Plant F is efficiently located for only two of its marketing regions, if naphtha having FPA 24.4°C is used and is efficiently located for all but two of its marketing regions, if naphtha having FPB 24.4°C is used. The location of plant G is inefficient for all of its marketing regions, if naphtha having FPA 24.4°C is used and is efficient for only one of itsmarketing regions, if naphtha having FPB 24.4°C is used for the manufacture of urea.

Table 4.6 shows the material index for single super-phosphate fertiliser. The process used for the production of single-superphosphate (SSP) fertiliser is conventional. About 0.60 tonnes of rock-phosphate is acidulated with about 0.36 tonnes of sulphuric acid to produce one tonne of SSP. About 0.124 tonnes of sulphur is required for the production of 0.36 tonnes of sulphuric acid. In plants A and B sulphuric acid is manufactured as a by-product. Since the freight cost of transporting sulphuric acid is substantial due to extra costs incurred for handling, special tankers for loading,etc., the material index for SSP fertiliser distributed from plants A and B is quite high. Hence, the locations of plants A and B are efficient. Plant C's location is efficient only for two of its marketing regions. The locations of plants D, E, F, G, H and I are inefficient for all of their marketing regions. The location of plant J is efficient only for one of its marketing regions and plant K's location is inefficient for all of its marketing regions.

Table 4.6 : Material index of single-superphosphate fertiliser from various plants to various consuming centres

Marketing region	Focal point	Plants										
		A	B	C	D	E	F	G	H	I	J	K
1. Jammu & Kashmir and Himachal Pradesh	Pathankot	-	-	-	-	-	-	-	-	-	-	-
2. Punjab & Chandigarh	Ludhiana	2.02	1.38	0.60	-	-	-	[illegible]	0.73	-	0.57	-
3. Haryana and Delhi	Jind	-	-	-	-	-	-	-	-	-	-	-
4. Rajasthan	Phullera	1.66	1.36	-	-	-	-	-	0.72	-	-	-
5. Madhya Pradesh	Bhopal	1.22	1.37	0.71	-	-	0.72	-	0.78	0.74	0.75	-
6. Uttar Pradesh	Shahjahanpur	1.82	1.38	0.72	-	0.73	0.71	-	-	-	0.77	-
7. Gujarat	Ahmedabad	-	-	1.11	-	-	-	-	0.66	0.56	-	-
8. Maharashtra	Manmad	-	-	1.30	-	-	-	0.75	0.85	0.51	0.90	-
9. Goa, Daman and Diu	Kolamb	-	-	-	-	-	-	-	-	0.74	-	-
10. Karnataka	Hospet	-	-	-	0.75	-	-	-	0.80	0.73	-	0.77
11. Kerala & Lakshadweep	Shoranur	-	-	-	-	-	-	0.95	-	-	-	-
12. Tamilnadu and Pondichery	Tiruchchirapalli	-	-	-	0.76	-	-	0.86	-	-	-	0.93
13. Andhra Pradesh	Vijayawada	-	-	-	0.75	-	-	-	0.77	0.86	-	0.70
14. Orissa	Cuttak	-	-	-	-	0.72	0.67	-	-	-	1.21	-
15. WestBengal, Andaman & Nicobar Islands	Azimganj	-	-	-	-	0.71	0.62	-	-	-	-	-
16. Bihar	Luckeesarai	-	-	-	-	0.72	0.67	-	-	-	0.94	-
17. Assam, Sikkim, Bhutan, Meghalaya, Arunachal, Nagaland, Manipur, Tripura & Mizoram	Lumding	-	-	-	-	0.74	0.72	-	-	-	-	-

Conclusion

On the basis of the modified Weber's material index we find that the locations of a number of the existing fertiliser plants in the country, are inefficient from the point of view of areas of their markets. For some plants the location is efficient only for a few of their marketing regions. Since the cost of transportation of raw material is lower than the transportation cost of fertiliser for many marketing regions, it would be advisable for the setting up of fertiliser plants in such areas which save the transportation cost substantially.

Appendix 4.I : Raw materials used, processes of production adopted and types of fertilisers produced in fertiliser plants in India.

Sr. No.	Year of commissioning	Name of the fertiliser plant	Name of the Product	Process of production/licensees etc.	Principal raw-material/feed stock
(A) NITROGENOUS AND COMPLEX FERTILISER PLANTS					
1.	1916	Tata Iron & Steel Co.Ltd.,Jamshedpur (Bihar)	AS	-NA-	Coke oven gas and sulphur by import.
2.	1947	FACT,Alwaye (Kerala)	June 1947 - AS 1st Stage:Dec.'60 - APS 2nd Stage:Nov.'62 20-20-0 3rd Stage: Nov.'67 16-20-0 4th Stage:Sept.'71 A/Cl	Taxaco gasfication of naphtha; ICI for syn--esis; Taxaco/Selas/ICI for reformers Monsanto and chemico for sulphuric acid; Prayan/Dorr-Oliver for phosphoric acid; ICI/FACT for AS;Linde for oxygen; Dorr-Oliver for NP,Krebs for ammonium chloride.	Power from hydel station and naphtha from Cochin refinery. Sulphur and rock by import. By-product gypsum for AS.
3.	1947	IISCO, Burnpurkulti (West Bengal)	AS	Neutralisation of NH_3.	Coke-oven gas and sulphur by-import.
4.	1947	Hindustan Steel Ltd.,Rourkela (Orissa)	AS	Neutralisation of NH_3.	Coke-oven gas and sulphur by import.
5.	1951	FCI,Sindri(Bihar)	Nov.1951 AS 1959 Urea 1959 ASN Modernisation Oct.1979 Urea	Powergas corporation(PGC),for gasification; Selas/ICI for naphtha reformer, Chemico for Ammonia; Simon Carves for sulphuric acid, ICI for AS; Montedison for gas-reformation,ammonia, urea and ASN.	Gypsum from Rajasthan,Coal from neighbouring mines at Jharia,pyrites from amjhore, and naphtha from Barauni refinery.
6.	1959	New Central Jute Mill Co.Ltd., Varanasi(U.P.)	A/CI	Modified Solvay process; Haber Process for NH_3.	Coke and common salt.
7.	1960	Hindustan Steel Ltd.,Durgapur (West Bengal)	AS	-NA-	Coke-oven gas and sulphur by import.
8.	1959	Hindustan Steel Ltd.,Bhilai(M.P.)	1 AS	Neutralisation of NH_3	Coke oven gas and sulphur by import.
9.	1961	NFL,Nangal(Punjab)	April 1961 CAN Exp.Apr.'78 Urea	De Nora for electrolysis of water; Grand Paroisse for ammonia;Bamag for Nitric acid; St.Gobain for CAN;Linde for heavy water; shell gasification of fuel oil; Lurgi for gas purification; Montedison for NH_3 and Urea.	Lime stone from nearby mines, Power from Nangal, Fuel Oil.

Appendix 4.1 (contd.)

Sr. No.	Year of commissioning	Name of the Fertiliser Plant	Name of the Product	Process of Production/licensees etc.	Principal raw-material/feed stock
10.	1962	Hindustan Steel Ltd. (Fertiliser Plant), Rourkela(Orissa)	Dec.1962 CAN Ex.1969 CAN 2nd Naphtha-Reformer 1978-79 CAN	Linde for Gasification of CoG, Otto for Naphtha reforming; Uhde for NH_3; P&D for Nitric acid and CAN.	Lime stone from nearby mines, coke oven gas from steel factory, Naphtha.
11.	1963	E.I.D.Parry Ltd., Ennore(Tamilnadu)	March 1963 APS 16-20-0 Jan.1968 AS	Shell gasification of naphtha, Simon Carves for Sulphuric acid.	Formerly Naphtha from Visakhapatnam, now from Madras Refinery, Sulphur and Rock by import.
12.	1965	RCF, Trombay (Maharashtra)	Oct.1965 Urea Nov.1965 Nitrophosphate 15-15-15 July 1976 Ammonium 4th Stage: Nitrophosphate 20-20-0 Exp.July 1978 APSN 20-20-0 Exp. 5th Stage Urea	Shell gasification; Chemico for ammonia and urea; Girdler for reformer, Topsoe synthesis for methanol, PEC process modified by FCI for nitrophosphate; Nissan for Phosphoric acid.	Naphtha, refinery gas and fuel oil from Trombay refinery; Rockphosphate imported as well as indigenous and potash by import. Switchover to natural gas in 1979.
13.	1966	The Neyveli Lignite Corporation Ltd., Neyveli(Tamilnadu)	Urea	Winkler gasification process; vetrocoke for CO_2 removal; Bamag for Ammonia; Linde for oxygen; Montedison for urea.	Lignite from corporation's mines and power from their own thermal station. Switchover to fuel oil in August, 1979
14.	1967	Coromandel Fertilisers Ltd., Visakhapatnam(A.P.)	Dec.1967 Urea Feb.1968 UAP/NPK 28-28-0 14-35-14 18-46-0 Ex.1978 UAP/NPK	ICI/Kellog for steam reformer and NH_3; Dorr Oliver for phosphoric acid; Chemico for sulphuric acid; Wellman Lord for UAP & NPK; TVA(modified).	Naphtha from Visakhapatnam refinery and rock and sulphur by import.
15.	1967	G.S.F.C., Baroda (Gujarat)	Phase-I, May 1967 Tech Grade Urea, DAP, AS Phase-II, June 1969 Urea, AS Phase-III Aug.1974 DAP (18-46-0)	ICI/PGC as well as ICI/H&G for reformer; Casale for NH_3; Vetrocoke for CO_2 removal; Mitsui Toatsu for Urea, Chemico for sulphuric acid and DAP; Nissan for H_3PO_4; ICI for AS; Inventa for know-how of Caprolactum plant.	Refinery (associated natural) gas supplemented with naphtha from Gujarat Refinery. Rock phosphate imported as well as indigenous, sulphur imported.
16.	1967	Indian Explosives Ltd., Panki(U.P.)	Urea	ICI steam reforming process for synthesis gas and NH_3; Mitsui Toatsu for Urea.	Naphtha and fuel oil from Barauni Refinery.
17.	1969	FCI, Gorakhpur(U.P.)	Urea Ex.Dec.1975	Shell gasification; Chemico for NH_3; TEC for expansion of ammonia plant, Mitsui Toatsu for Urea.	Naphtha from Barauni refinery and coal from Bihar coal fields.

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Appendix 4.I (contd.)

Sr. No.	Year of commissioning	Name of the Fertiliser Plant	Name of the product	Process of production/licensees etc.	Principal raw-material/feed stock
18.	1969	FCL, Namrup(Assam)	Urea AS Ex. April 1976	Steam reforming of natural gas, Selas for reformer, NH_3, Urea, Montedison for Expansion of NH_3 and Urea plants; Vetrocoke for CO_2 removal.	Natural gas from Close by fields and sulphur by import.
19.	1969	Shriram Fertilisers and Chemicals, Kota (Rajasthan)	Urea Ex. Dec. 1974	Topsoe for steam reformer and NH_3 and Stamicarbon for Urea.	Naphtha from Gujarat Refinery.
20.	1971	Madras Fertiliser Ltd., Manali (Tamil-Nadu)	Oct. 1971 Urea III Stream NP/NPK's Oct. 1975 17-17-17 14-28-14 28-28-0 18-36-0 11-22-[illegible] 24-24-0 18-46-0	Chemico for steam reforming and Urea; Catacarb for CO_2; Topsoe for NH_3; Dorr Oliver for NPK's.	Naphtha and fuel oil from Madras refinery; Phosphoric acid and potash by import.
21.	1972	SAIL, Bokaro (Bihar)	AS Ist Expan. Nov. 1973 IInd Expan. Mar. 1977	-NA-	Coke oven gas and sulphur by import.
22.	1973	FACT, Ambalamedu (Cochin Phase-I) (Kerala)	Urea	Steam reforming of naphtha; ICI/PGC for reformer; Vetrocoke for CO_2 removal; Montedison for ammonia and Urea.	Naphtha from Cochin refinery.
23.	1973	Zuari Agro-Chemicals Co. Ltd., San-Joale (Goa)	May 1973 Urea March, 1975 NP/NPKs 28-28-0 19-19-19 18-46-0 14-35-14	ICI/PGC for steam reformer; Vetrocoke for CO_2 removal; TEC for NH_3 and NPK; Mitsui Toatsu for urea.	I.O.C. to supply fuel oil and naphtha from its refineries; phosphoric acid and potash by import.
24.	1974	HFCL, Durgapur (West Bengal)	Urea	ICI/PGC for steam reforming; Vetrocoke for CO_2 removal; Montedison for ammonia and urea.	Initially naphtha from Barauni Refinery, later from Haldia refinery.
25.	1974 & 1975	IFFCO, Kandla, & IFFCO, Kalol. (Gujarat)	Jan. 1975 Urea Nov. 1974 NP/NPKs 10-26-26 12-32-16 14-36-12	M.W. Kellogg for steam reforming and NH_3; Dorr-Oliver for NPK; Stamicarbon for Urea.	Natural gas from the nearby fields, phosphoric acid and potash by import.
26.	1975	Southern Petrochemical Industries Corporation Ltd. (SPIC), Tuticorin (Tamil Nadu)	June 1975 Urea Nov. 1976 NP/NPK's 18-46-0 10-26-26 15-15-15 28-28-0	ICI for steam reforming; Vetrocoke for CO_2 removal; Mitsui Toatsu for urea and DAP; TVA process for NPK's; Nissan process for sulphuric acid and phosphoric acid.	Initially naphtha by import, later through I.O.C., Rockphosphate, sulphur and potash by import.

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Appendix 4.1 (contd.)

Sr. No.	Year of commis-sioning	Name of the Fertiliser Plant	Name of the Product	Process of production/licensees etc.	Principal raw-material/feed stock
27.	1975	Mangalore Chemicals and Fertilisers Ltd., Mangalore(Karnataka)	Urea	ICI/H&G for steam reforming; ICI for NH_3; Stamicarbon for Urea.	Naphtha and fuel oil through I.O.C.
28.	1976	FACT, Ambalamedu (Cochin) Phase-II (Kerala)	NP/NPKs 17-17-17 28-28-20 18-46-0	LPG/Wellman Lord for NP/NPKs, [illegible] for H_3PO_4; Power GAS corporation for process design.	Imported liquid ammonia, ph[illegible] rock and sulphur.
29.	1979	Kothari(Madras), Ennore (Tamilnadu)	Ammonium Chloride (A/Cl)	-NA-	Imported ammonia, common salt.
30.	1979	NFL, Bhatinda (Punjab)	Urea	Partial oxidation of fuel oil by Shell gasification; Lurgi for gas purification; Topsoe for NH_3 synthesis; Mitsui Toatsu total recycle process for urea.	Fuel oil from Gujarat refinery, later from Mathura refinery.
31.	1979	NFL, Panipat, (Haryana)	Urea	Partial oxidation of fuel oil by Shell gasification; Lurgi for gas purification; Topsoe for NH_3 synthesis; Mitsui Toatsu total recycle process for urea.	Fuel oil from Gujarat refinery, later from Mathura refinery.
32.	1979	FCI, Ramagundam (Andhra Pradesh)	Urea	Koppers for gasification; Lurgi for gas purification; Montedison for NH_3 and urea.	Coal (out of 3000 tonnes per day coal requirement, 1700 tonnes would be used for gasification and production of NH_3 and the balance for steam generation).
33.	1979	FCI, Talcher (Orissa)	Urea	Koppers for gasification; Lurgi for gas purification; Montedison for NH_3 and urea.	Coal
34.	1979	IFFCO, Phulpur (U.P.)	Urea	Kellogg for NH_3; Snamprogetti for Urea.	Naphtha from Barauni refinery and coal from Singrauli mines.
35.	1981	Gujarat Narmada Valley Fertilisers Co., Bharuch (Gujarat)	Urea	Taxaco for gasification, Rectisol process for sulphur removal and CO_2 recovery; Topsoe for NH_3 synthesis, Snamprogetti for urea.	Fuel oil.
36.	1981	HFCL, Haldia (West Bengal)	Urea Nitrophosphate 20-20-0	Shell gasification; Lurgi for gas purification; Montedison for NH_3 and urea; Stamicarbon for NPK; FCI for sulphuric acid; Nissan for phosphoric acid; Topsoe for methanol; CLE for soda ash.	Fuel oil, phosphate rock and sulphur.
37.	1985	Krishak Bharatiya Co-operation Ltd., Hazira (Gujarat)	Two plants: Urea	-NA-	Bombay High Gas.
38.	1985	RCFL, Thal-Vaishat (Maharashtra)	Two plants: Urea	-NA-	Bombay High gas.

Appendix 4.I (contd.)

Sr. No.	Year of commissioning	Name of the Fertiliser Plant	Name of the Product	Process of production/ licensees etc.	Principal raw material/feedstock
(B)	SUPERPHOSPHATE FERTILISER PLANTS				
1.	1906	EID Parry Ltd., Ranipet (Tamil Nadu)	SSP	Acidulation of phosphate rock with sulphuric acid (H_2SO_4)	At present rock phosphate both from imported and indigenous sources and sulphur by import.
2.	1924	The Dharmsi Morarji Chemical Co.Ltd. Ambernath (Maharashtra)	SSP & TSP	---do--- Treating rock phosphate with phosphoric acid.	Rock phosphate and sulphur by import; Phosphoric acid from Albright Morarji and Pandit Ltd.
3.	1940	Hyderabad Chemicals & Fertilisers Ltd., Maula Ali* (A.P.) (*Plant was shifted from Belampalli to Maula Ali in 1963)	SSP	Acidulating phosphate rock with sulphuric acid.	Rock phosphate and sulphur by import.
4.	1946	D.C.M. Chemical Works, Delhi.	SSP	-do-	Imported as well as indigenous rock phosphate and imported sulphur.
5.	1947	Anil Starch Products Ltd., Bhavnagar*, (Gujarat). (*Plant was shifted its site from Ahmedabad to Bhavnagar in April 1964)	SSP	-do-	-do-
6.	1948	Fertilisers & Chemicals Travancore Ltd., Alwaye (Kerala)	SSP	-do-	-do-
7.	1948	Western Chemical Industries, Bombay (Maharashtra)	SSP	-do-	-do-
8.	1950	Ramakrishi Rasayan (Formerly West India Chemicals) Loni-Kalbhore* (Maharashtra). (*Shifted its site from Mundhwa to Loni-Kalbhore in 1967)	SSP	-do-	-do-
9.	1950	Phosphate Co.Ltd., Rishra (West Bengal)	SSP	-do-	-do-
10.	1951	Paushak (Alembic), Baroda (Gujarat)	SSP	-do-	-do-
11.	1958	Bihar State Superphosphate Factory, Sindri Institute (Bihar)	SSP	-do-	Phosphate rock and sulphur by import.
12.	1960	Andhra Fertilisers, Tadepalli (Andhra Pradesh)	SSP	-do-	Rock phosphate from both import and indigenous sources and sulphur by import
13.	1960	Andhra Sugars Ltd., Tanuku (Andhra Pradesh)	SSP	-do-	-do-
14.	1961	The Dharamsi Morarji Chemical Co.Ltd., Kumhari (Madhya Pradesh)	SSP	-do-	-do-
15.	1961	Jayshree Chemicals & Fertilisers, Khardah (West Bengal)	SSP	Acidulation of rock-phosphate with sulphuric acid.	Rock phosphate from both import and indigenous sources and sulphur by import.

Appendix 4.I (contd.)

Sr. No.	Year of commissioning	Name of the Fertiliser Plant	Name of the Product	Process of production/ licensees etc.	Principal raw material/feedstock
16.	1962	Adarsh Chemicals & Fertilisers Ltd., Udhna (Gujarat)	SSP	Acidulation of rock-phosphate with sulphuric acid.	Rock phosphate from both import and indigenous sources and sulphur by import.
17.	1962	Kothari(Madras)Ltd., Ennore(Tamilnadu)	SSP	-do-	-do-
18.	1962	Ralli Chemicals Ltd., Magarwara(U.P.)	SSP	-do-	-do
19.	1963	Chamundi Chemicals & Fertilisers Ltd., Munirabad (Karnataka)	SSP	-do-	-do-
20.	1963	Associated Industries Assam Ltd., (Chemical Unit), Chandrapur(Assam)	SSP	-do-	-do-
21.	1963	Premier Fertilisers Ltd., Cuddalore (Tamilnadu)	SSP	-do-	-do-
22.	1964	Krishna Industrial Corporation Ltd., Nidadavole (Andhra Pradesh)	SSP	-do-	-do-
23.	1966	Coimbatore Pioneer Fertilisers Ltd. Coimbatore(Tamilnadu)	SSP	-do-	-do-
24.	1967	Shaw Wallace & Co.Ltd., Avadi(Tamilnadu)	SSP	-do-	-do-
25.	1967	Hindustan Zinc Ltd., Debari(Rajasthan)	SSP	-do-	Udaipur rock, by-product sulphuric acid from zinc smelter.
26.	1968	Bharat Fertiliser Industries Ltd., Bombay (Maharashtra)	SSP	-do-	Rock phosphate by import and waste sulphuric acid from local market, phosphate rock.
27.	1972	Anish Chemicals, Ahmedabad*(Gujarat) (*Plant shifted from Vapi to Ahmedabad in 1977).	SSP	-do-	Phosphate rock, sulphuric acid from local market.
28.	1974	Maharashtra Agro Industries Dev. Corporation, Panvel(Maharashtra)	SSP	-do-	Rock phosphate through import and indigenous sources and by-product sulphuric acid.
29.	1974	Viraj Chemicals, Nandesari (Gujarat)	SSP	-do-	Phosphate rock and sulphur.
30.	1976	Gammon Fertilisers & Chemicals, Belagula (Karnataka)	SSP	-do-	Phosphate rock and sulphur.
31.	1976	Hindustan Copper Ltd., Khatri(Rajasthan)	SSP & TSP	For SSP production acidulation of phosphate rock with sulphuric acid. For TSP production, acidulation of phosphate rock with phosphoric acid.	Phosphate rock: by-product sulphuric acid from copper smeter gas at Khatri.

Appendix 4.I (contd.)

Sr. No.	Year of commis-sioning	Name of the Fertiliser Plant	Name of the product	Process of production/ licensees etc.	Principal raw material/feedstock
32.	1977	Hindustan Fertiliser Industries, Madri (Rajasthan)	SSP	Acidulation of phosphate rock with sulphuric acid.	Phosphate rock.
33.	1977	Liberty Pesticides and Fertilisers, Madri (Rajasthan)	SSP	Acidulation of phosphate rock with sulphuric acid.	-NA-
34.	1977	Madhuvan Chemicals and Fertilisers, Dabok (Rajasthan)	SSP	-do-	-NA-
35.	1979	FCI, Sindri (Rationalisation)(Bihar)	TSP	Rayon process for phosphoric acid and acidulation of phosphoric acid with phosphate rock.	Phosphate rock, pyrites and sulphur.
36.	1979	Girraj Fertilisers & Chemicals, Shikohabad (U.P.)	SSP	Acidulation of phosphate rock with sulphuric acid.	-NA-
37.	1979	J.K.Chemical Works, Pandesara(Gujarat)	SSP	-do-	-NA-
38.	1979	Liberty Pesticides & Fertilisers, Visakhapatnam (Andhra Pradesh)	SSP	-do-	-NA-
39.	1979	Maharana Khanij Udyog, Madri(Rajasthan)	SSP	-do-	-NA-
40.	1980	Bharat Alums and Chemicals, Alwar(Rajasthan)	SSP	-do-	-NA-
41.	1980	Hindustan Chemicals, Bhilwara(Rajasthan)	SSP	-do-	-NA-
42.	1980	Khicha Industries, Udaipur(Rajasthan)	SSP	-do-	-NA-
43.	1980	Noble Chemicals, Ghatkopar(Maharashtra)	SSP	-do-	-NA-
44.	1973	Orissa Fertilisers & Chemicals, Rourkela (Orissa)	Pelofos	Acidulation of phosphate rock mixing it with basic slag.	Phosphate rock; sulphuric acid basic slag from H.S.L., Rourkela.
45.	1981 (Appr x.)	Dharuhera Chemicals, Dharuhera(Haryana)	SSP	Acidulation of phosphate rock with sulphuric acid.	-NA-
46.	1981	Shivalik Fertilisers, Hoshiarpur (Punjab)	SSP	-do-	-NA-

NA = Not Available

Source: 1. Fertiliser Statistics, 1971-72, Fertiliser Association of India.
2. Fertiliser Production in India, Fertiliser Association of India, December 1977.