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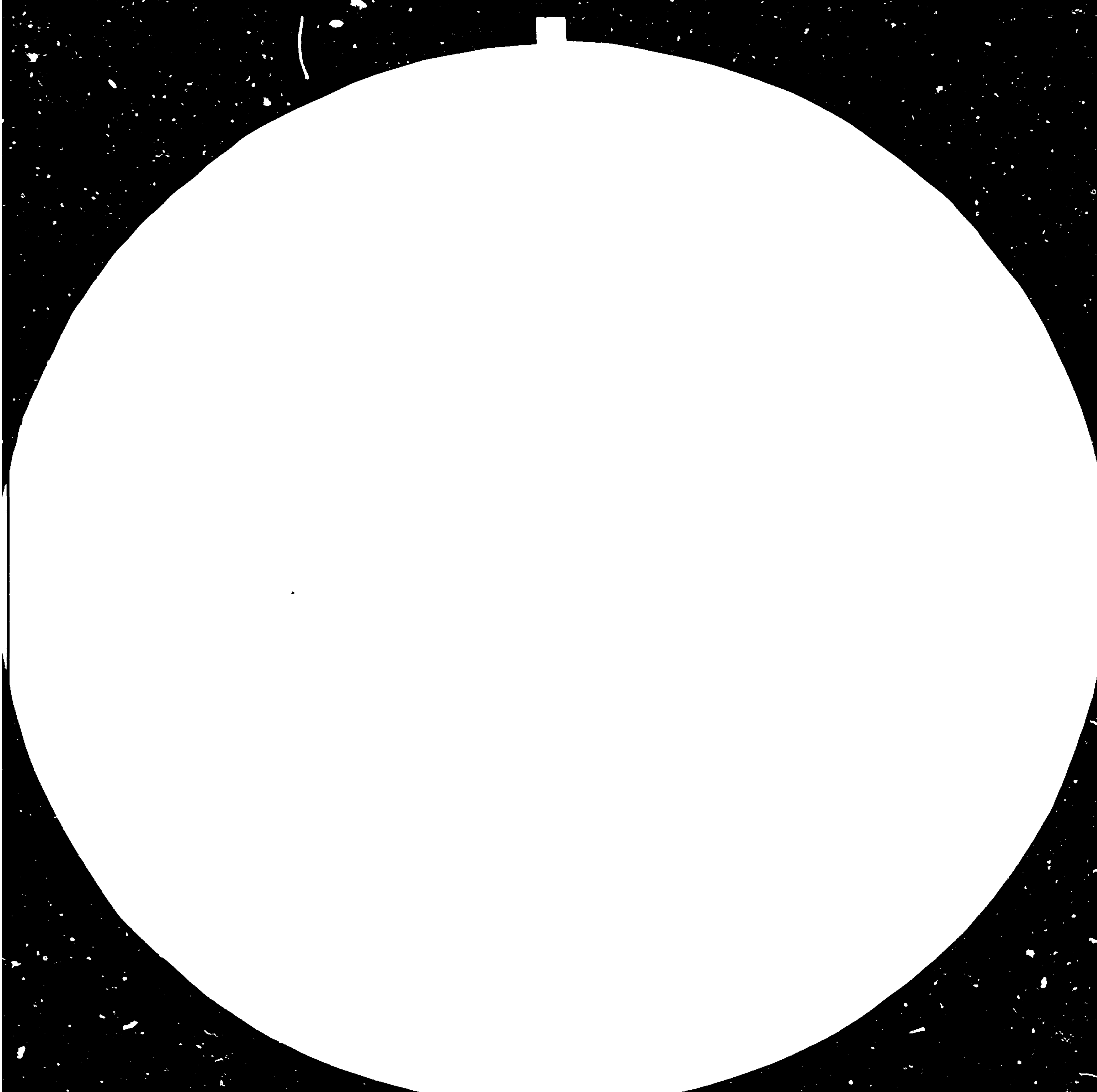
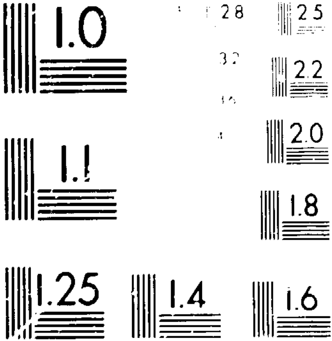
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org





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A CASE STUDY OF FERTILIZER PLANT COSTS IN INDIA

Sectoral Working Paper Series

No. 15

S.M. Kelkar

Sectoral Studies Branch
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SECTORAL WORKING PAPERS

In the course of the work on major sectoral studies carried out by the UNIDO Division for Industrial Studies, several working papers are produced by the secretariat and by outside experts. Selected papers that are believed to be of interest to a wider audience are presented in the Sectoral Working Papers series. These papers are more exploratory and tentative than the sectoral studies. They are therefore subject to revision and modification before being incorporated into the sectoral studies.

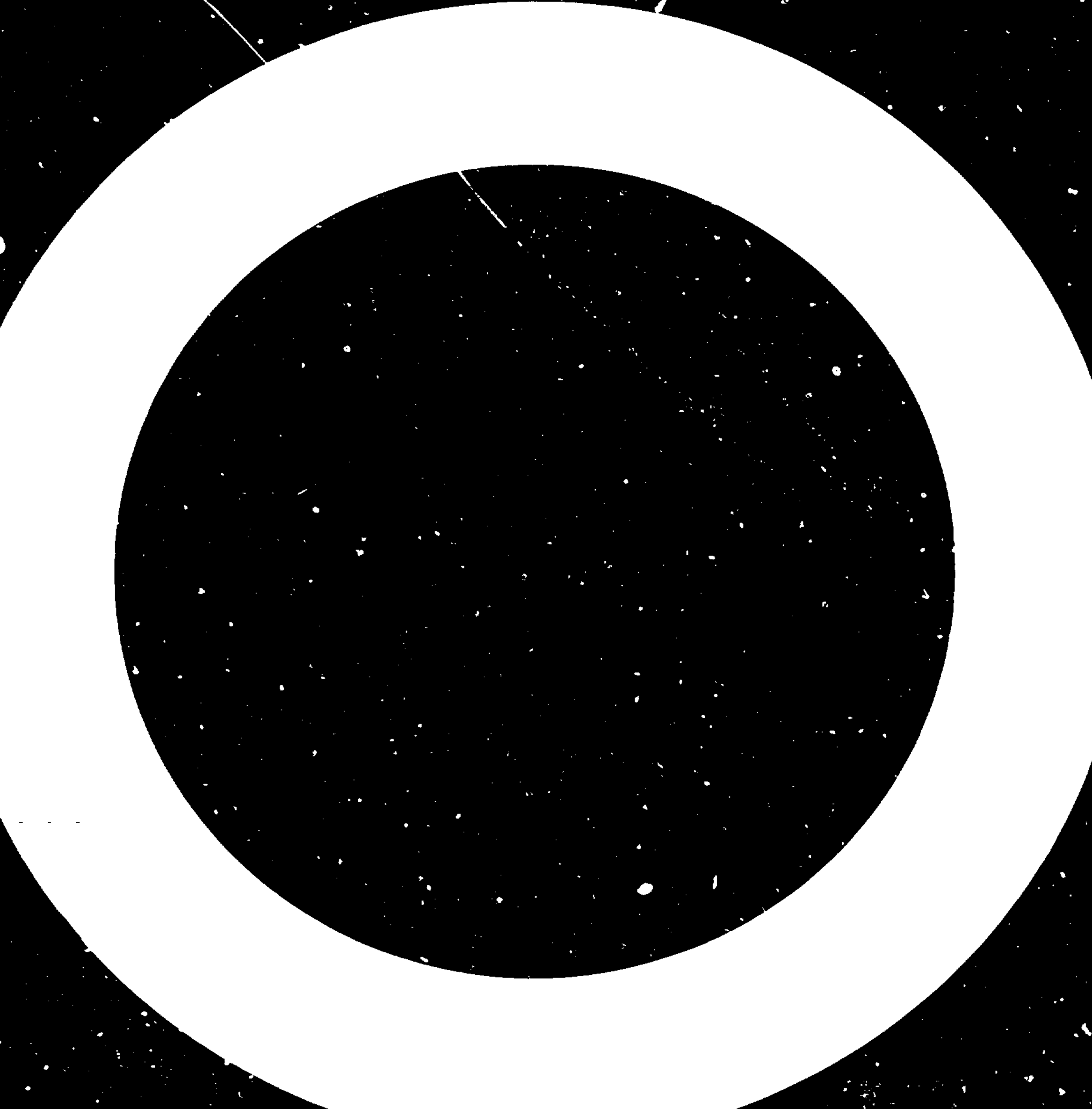
This document was prepared by Mr. S.M. Kelkar, UNIDO consultant. The designations employed, the presentation of material and the views expressed in this document are those of the consultant and do not necessarily reflect the views of the UNIDO secretariat.

Preface

The case study for building eight ammonia/urea fertilizer plants during the 1970s and early 1980s in India is part of the input to a major study on "Capital Cost Control of Fertilizer Plants in Developing Countries" (UNIDO/IS/422, Sectoral Studies Series No. 8), prepared by the UNIDO secretariat for the Fourth Consultation Meeting on the Fertilizer Industry to be held in New Delhi, India, 23-27 January 1984.

However, due to the importance of this study and its originality in reflecting the actual experience of a developing country in the construction of fertilizer projects, it was felt important to make it available to a wide circle of readers. It is hoped that other developing countries embarking on the construction of fertilizer plants will benefit from the experience of a major fertilizer producer from a developing country.

It is also hoped that this case study will be extended in the future to some other developing countries and be covering other nutrients. This would present a realistic picture of development in the construction projects of fertilizer capacities in several regions within the developing countries.



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1. INTRODUCTION

1.1 Objective

This paper studies the capital costs of eight nitrogenous fertilizer plants in India. These plants were taken up for construction during 1970 - 1980.

Apart from bringing out the index of escalation in fertilizer plant costs in India, the paper proposes to ascertain the impact of the following factors towards the increase or decrease in the capital costs of the fertilizer plants:

(i) the provision of off-site and infrastructure developed for the purpose of the plants;
(ii) the type of financing package obtained including consequential constraints on purchase of services and equipment;
(iii) the utilization of indigenous construction, equipment and engineering capabilities;
(iv) the burden of custom duties and excise and other local taxes on the total plant costs;
(v) the delay in construction and commissioning of the plant; the reasons for the delay cover: (a) external factors, i.e. those beyond the control of management and (b) internal factors, i.e. those attributable to management of the project.

The paper indicates at the end the lessons that were learnt from the experience of earlier plants and also the measures adopted in India to contain delays and consequential cost overruns in new plants.

1.2 Background

Fertilizer is the main input for agriculture. It seems clear that the large increases in food production which are needed to ensure world food security by the year 2000 will have to come mainly through increased application of fertilizers. At the same time, farmers, particularly in developing countries, will find it difficult to apply larger doses of fertilizers unless their prices are reasonable. Plant costs, particularly those of nitrogenous fertilizers, contribute significantly to the cost of production. Therefore, if the cost of fertilizer is to be kept within reasonable limits, ways and means have to be found to reduce the increasing cost of fertilizer plants. Various studies have shown that in developing countries fertilizer plant costs tend to be higher than in industrialized countries. An analysis of fertilizer plant costs in a developing country should, therefore, help in identifying problems that are encountered in building fertilizer plants and finding appropriate solutions to overcome them.

A case study of India illustrates the changes that occur in the fertilizer sector in a developing country. The fertilizer consumption in India in 1950-1951 was a mere 55,000 tonnes of nitrogen, 8,000 tonnes of P_2O_5 and a negligible K_2O. It rose to 4.2 million tonnes of nitrogen, 1.4 million tonnes of P_2O_5 and 0.7 million tonnes of K_2O in 1982-1983. This extraordinary growth in consumption can be correlated to a significant rise in food production which rose from 50.8 million tonnes in 1950-1951 to 133 million tonnes in 1981-1982. The fertilizer production in India also rose significantly from a mere 10,000 tonnes of nitrogen and 8,000 tonnes of P_2O_5 by 1982-1983. In the process, a large number of fertilizer plants with different feedstocks were constructed during this period. The eight nitrogenous fertilizer plants chosen for this study are those which were taken up for construction in the 1970's. Similar changes are taking place in the fertilizer sector in other developing countries. World Bank studies have shown that the bulk of new fertilizer plant capacity in the next two decades is likely to come up in developing countries.

It seems appropriate at this stage to analyse the Indian experience in building fertilizer plants which may be of benefit to other developing countries.

This paper is divided into four sections. The first section is introductory and gives objective and background. Section 2 analyzes the plant costs, prepares an index of escalation and compares it with the general Indian and international indices. Section 3 studies the influence of various factors on plant costs. Section 4 sums up the Indian experience and indicates the lessons learnt and remedial measures taken.

2. ANALYSIS OF PLANT COSTS

2.1 Index of escalation

The study covers eight nitrogenous (ammonia-urea) fertilizer plants built in India during the 1970's. The first plant had a capacity of 600 metric tonnes of ammonia per day and 1,000 tonnes of urea per day. The last plant which is due for completion in 1984 has two streams, each with a capacity of 1,350 tonnes per day of ammonia and 2,200 (1,100 x 2) tonnes per day of urea. The first plants built in the 1960's were based on naphtha as feedstock. As locally available naphtha became scarce, alternative feedstocks had to be considered and plants II, III and IV were built with fuel oil as feed- stock. Later, large quantities of natural gas became available and plant V and VIII were based on gas as feedstock.

The plants have been numbered chronologically as plant I to plant VIII. All cost figures are given in million rupees. The total project costs of the eight plants are given in Annex A.1. The costs are sub-divided into the following categories:

- Ammonia plant: This includes equipment, catalysts and chemicals for the ammonia plant.
- Urea plant: This includes equipment, catalysts and chemicals for the urea plant.
- Other plants: This includes steam generation plant, power plant and distribution, coal and ash handling and product storage and handling.
- Off-site facilities: This includes water supply, water treatment plant and distribution, raw material storage and handling, ammonia storage, inert gas generation, fire fighting and safety, yard piping, auxiliary services transport system, effluent treatment and disposal, civil works (for all plants) and ammonia tank wagons.
- Construction equipment
- Spares
- Other costs: This includes ocean freight and insurance, customs and excise duties, and other taxes, etc.

- License and DEP fees: This includes license fees and design, engineering, and procurement charges for ammonia, urea and other plants and off-sites. These charges are inclusive of all taxes.
- Erection and supervision: This includes charges for ammonia, urea, other plants and off-sites and are inclusive of all taxes.
- Infrastructure outside the plant: This includes infrastructure investments outside the battery limits, i.e. the railway siding, power lines, water facilities, etc.
- Others: This includes land, land development, and bank charges. This column gives the total base cost of items no. 1 to 11. This gives the contingency and escalation.
- Pre-operational cost: This includes expenses for commissioning after adjustment, for credits for production and inventory.
- Working capital margin: This is not the total working capital but the margin to be provided for obtaining short-term loans from commercial banks. This forms part of the capital cost.
- Financing charges: These are interest charges paid during the plant construction.
- Total project cost: This gives the total cost of the project.

2.2 Correction for the size

As mentioned earlier, all the plants are not of the same size. The costs given in Annex A.1 are therefore not directly comparable. The capacities of the plants are given in the table below:

Table 1. Fertilizer [illegible]t capacities
(metric tonnes/day)

Plant	Ammonia	Urea
Plant I	600	1 0[illegible]
Plant II	900	1 000
Plant III	900	1 500
Plant IV	900	1 500
Plant V	900	1 000
Plant VI	1 350	1 800
Plant VII	415	682
Plant VIII	Two of 1 350	Four of 1 100

In order to compare the costs of these diverse plants meaningfully, all plant costs have been converted to standard size of 900 TPD of ammonia and 1,500 TPD of urea plants. An index factor of 0.7 has been applied in scaling up the capacities and 0.6 for scaling down the capacities of main plants. For off-site and other plants a lower factor has been applied. Annex A.2 gives the plant costs of the eight plants, after the necessary size modifications have been performed.

2.3 Correction for the feedstock

As mentioned earlier, all the plants under study are not based on the same feedstock. Three plants use fuel oil as feedstock, three use naphtha and two natural gas. The ammonia process route for fuel oil plants is through partial oxidation method. The partial oxidation route requires more process sections and some additional off-site facilities. The cost of plants based on fuel oil cannot be meaningfully compared, therefore, with other plants using steam reformation process. Consequently, adjustments have been made in the cost of fuel oil plants by reducing the ammonia cost of fuel oil plants by 30 per cent and of off-sites by 20 per cent.

Annex A.3 gives information on the eight plants after correction for feedstock. This information contains:

(a) Equipment cost for standard size plants (i.e. as per Annex A.2).
(b) Correction for feedstock in (i) ammonia plant and (ii) other plants and off-sites
(c) Total equipment costs after modification
(d) Other costs (which remain unchanged)
(e) Total project cost after modification
(f) Total modified project costs in US$.

The total equipment costs and total project costs of the plants after size and feedstock modifications are reproduced below:

Table 2. Equipment costs and total project costs

(million Rs)

Plant	Equipment cost	Total project cost
Plant I	737.31	1,187.00
Plant II	651.96	1,303.31
Plant III	967.98	1,937.18
Plant IV	968.03	2,051.81
Plant V	1,196.73	1,933.62
Plant VI	1,198.09	3,237.84
Plant VII	870.47	1,395.23
Plant VIII	1,663.46	4,271.36

2.4 Relevant year for the preparation of index

Most of the equipment for the project being ordered within the first two years, the project costs have by that time stabilised except for additional financing and commissioning charges which may arise because of delays. Therefore, for the purpose of comparison, the year chosen for each plant is the one two years after zero date for plant implementation which itself is defined as a date by which all government approvals have been obtained and major plant contracts are signed.

Following this methodology, the relevant year for plant I is 1970. Giving an index of 100 to plant I, indices have been worked out for the remaining plants. For the sake of comparison, the relevant Indian and international indices in the equipment and machinery sector with 1970 as 100 are given below along with the plant cost indices.

Table 3. Indian fertilizer plant cost indices (Base: 1970)

Relevant year	Project number	Index for plant costs after modifications		Comparable price index for machinery and equipment	
		Total project cost	Equipment only	India	World
1970	I	100	100	100	100
1975	II	110	88	180	163
1977	III	163	131	180	176
1978	IV	173	131	190	193
1979	V	163	162	210	207
1979	VI	273	162	210	207
1980	VII	118	118	240	260
1982	VIII	360	226	280	273

Note: Indian price index: The Reserve Bank of India Bulletin - various issues.
World price index: Chem. Eng.

2.5 Conclusions

A. Total project cost

The cost indices of fertilizer plants in India seem to be consistently below the Indian and international indices with the exception of plants VI and VIII which are higher. The low figures of plant II, V and VII can be explained by the fact that these projects were not executed on greenfield sites and that some advantages of existing plants were available. The advantages were maximum in plant VII where the expansion size was small. Plants II and V on the other hand were fullfledged plants much larger than the earlier plants and, consequently, they could only utilize the facilities of the existing plants to a limited extent.

B. Equipment costs

The equipment costs of Indian plants have been consistently lower than the Indian and international indices. Plant VII had the advantage of a repeat of an older plant and, therefore, the equipment could be duplicated at a lower cost. Plants II and IV had the advantage of a single credit line of World Bank assistance which was reflected in lower equipment prices through international competitive bidding. Plant VIII also had the advantage of World Bank credit but this was combined with two country credits resulting in somewhat higher equipment costs.

The equipment costs of the plants are lower not only with reference to the Indian index but also to the international index. The advantage is particularly evident in projects aided by the World Bank where global tendering was the rule. Equipment was obviously procured from the most competitive source which, in each case, must have been somewhat lower than the international average. The cumulative effect was the much lower equipment cost index, compared to relevant international index figures.

Infrastructure and off-site costs have an important bearing on the total project costs. These have been analysed in detail in the subsequent section.

C. Sub-divisions into different categories

The base plant costs have been further analysed by sub-dividing them into ammonia and urea plants, off-sites, excise and other duties, land development and other charges, and license and DEP (design, engineering and procurement) charges. These costs have been taken after adjustment for size but without any adjustment for feedstock. The percentage weights of the above items in the base plant costs are indicated in table 4.

This table shows that the infrastructure element is high in plants II and II which are based on fuel oil, although they do not have captive power facilities. Plant IV and VIII are steam reformation plants but the off-site element is high on account of captive power facilities. The element of duties and taxes shows some variation. Land development and connected charges are higher for certain sites. The very high ammonia element in the cost of project I is due to classification where the DEP charges have been included in the ammonia and urea plants, whereas ammonia and urea plant elements are

Table 4. Weights of different elements in total project costs

(percentage)

Plant nos.	Ammonia plant	Urea plant	Infra-structure, spares and off-sites	Customs and allied duties and local taxes	Land development, project management and others	DEP + license + erection + supervision	Total
I	36	21	23	-	20	-	100
II	26	16	30	17	4	14	100
III	30	10	31	11	7	11	100
IV	15	7	35	12	14	17	100
V	26	12	28	15	16	3	100
VI	30	8	26	17	7	12	100
VII	32	17	20	12	-	19	100
VIII	13	9	33	17	14	14	100

Note: (a) Taxes and duties, license, DEP, etc. in the case of plant I have been included in the respective plant costs.
(b) In plant VII, land development and allied charges have not been shown separately.

more or less similar except where the large infrstructure element reduces their weights. Some important factors influencing the plant costs are analysed in greater detail in the next section.

D. Index after conversion of project costs into US dollars

The total project cost figures of all plants, after modifications for size and feedstock, have been converted into US dollars and are given in Annex A.3. For the purpose of conversion, the dollar-rupee exchange rate of the relevant year has been applied. The resulting picture is given in table 5:

Table 5. Indian fertilizer plant indices

(US dollars, base 1970 = 100)

Relevant year	Plant No.	Total US$ million	Project costs index	Comparable price index India	World
1970	I	158.27	100	100	100
1975	II	146.44	93	180	163
1977	III	225.25	142	180	176
1978	IV	224.26	142	190	193
1979	V	235.81	149	210	207
1979	VI	394.86	249	210	207
1980	VII	174.40	110	240	260
1982	VIII	435.85	275	280	273

The above table shows that conclusion (1) is valid when the costs are converted into US dollars. In fact, the figures for Plant VI and VIII are lower and closer to the Indian and world price indices when compared in US dollars.

3. FACTORS THAT INFLUENCE PLANT COSTS

This section examines different factors that influence fertilizer plant costs.

3.1 Incidence of infrastructure and off-sites

In a developing country, the overall infrastructure availability near the plant site is often limited. In large fertilizer plants, the requirements of infrastructure are also substantial, i.e. power and water requirements, transport system, land development, port facilities, road network, etc. Heavy investment programme at the national level also puts strain on the available infrastructure of a developing country and the large requirements of a fertilizer plant cannot usually be met by the general systems. Also it is not always safe for a single stream fertilizer plant to depend on outside sources. Power fluctuations and interruptions can very adversely affect the "on-stream factor" of a fertilizer plant and, in turn, result in unprofitable operations. For all these reasons, fertilizer plants are often provided with captive infrastructure facilities.

Table 6 below gives the infrastructure and off-site costs of different plants after making modifications for size and feedstock. The same table also compares for infrastructure cost with national and international indices.

Table 6. Infrastructure and off-site cost indices

Year	Plant Number	Infrastructure and off-site costs		Comparable price index for machinery and equipment	
		Rs, million	Index with 1970=100	India	World
1970	I	212.70	100	100	100
1975	II	363.63	171	180	163
1977	III	538.81	253	180	176
1978	IV	590.75	278	190	193
1979	V	510.64	240	210	207
1979	VI	628.36	295	210	207
1980	VII	254.58	120	240	260
1982	VIII	1 076.88	506	280	273

It can be seen that the cost of infrastructure has gone up much more steeply in recent years than the general index for equipment and machinery in India or abroad. The figure for Plant VII is very low, on account of the considerable use made of the existing infrastructure facilities for this small expansion project. The relatively low figures of Plant II and V are also accounted by the fact that these plants were constructed adjacent to small existing plants. The figures for Project III, IV, and VI are high because of the development of the greenfield sites. Plant VIII has recorded the highest increase in off-site and infrastructure facilities for various reasons. First, this plant is on a greenfield site, somewhat away from the main railway line. The infrastructure costs of the railway lines and water supply development have been high. Secondly, some increase is attributable to captive power facilities for this plant. Thirdly, this is a project which has also provided for large ammonia storage and tank wagons to transport ammonia to one of its sister units.

Table 4 of the previous chapter shows that, except for Project I and VII, the proportion of infrastructure and off-site costs in fertilizer plants in India is quite high at around 30 per cent or more. One of the reasons for higher infrastructure costs in recent plants is the provision of captive power facilities. Earlier plants which depended on outside power supply suffered from power shortages and frequent power trips and fluctuations. This adversely affected the "on-stream" factor, reduced capacity utilization and raised production costs. The additional costs of infrastructure, including captive power facilities, seem on balance, worthwhile in a developing country because these enable the plant to operate at a high rate on a sustained basis, lowering production costs. Since the infrastructure built for a fertilizer project is expensive, consideration must be given to whether such an infrastructure should be financed through soft loans from international agencies or not, so as not to impose heavily on a fertilizer plant.

3.2 Impact of financing package

An ammonia-urea plant is highly capital intensive. Therefore, one of the major problems for a developing country which proposes to build such a project is to secure adequate resources to finance the project. Since the equipment and services available locally are limited, a substantial portion of finance has to be in foreign exchange from one or more of the following main sources:

(a) developing country's own foreign exchange reserves

(b) credits from international and regional organizations like the World Bank and its associates, the Asian Development Bank, etc.

(c) country credits from some developing countries on a country to country basis

(d) country credits, i.e. assistance from developed countries on a country to country basis

(e) suppliers' credits.

While financial arrangements of (a), (b) and (c) are untied and equipment and services financed through them can be procured from anywhere in the world, credits under (d) and (e) are usually tied which means equipment and services thus financed have to be procured from sources in the credit-giving countries alone.

The financing package for the 8 plants under study was as follows:

Plant I - The technology and equipment of the project were mainly obtained through tied credits including suppliers' credits.

Plant II - This was a World Bank-aided project and there were no tied credits.

Plant III - This project was financed through tied country credit and a sizeable portion of free foreign exchange

Plant IV - This was a World Bank-aided project with no tied credits

Plant V - This project was financed through tied country and suppliers' credits and also sizeable amount of free foreign exchange.

Plant VI - This had suppliers and country credits supplemented by free foreign exchange.

Plant VII - This had tied credit and free foreign exchange.

Plant VIII- This was a World Bank-aided project supplemented by tied country credit.

The average rate of interest on long-term loans depends on the type of finance secured for the project. In India, country credits are channelled through the Government and lent to the projects at the prevalent rate. Therefore, the country credits do not affect financing charges. The World Bank loans are sometimes given through the Government and sometimes directly to the project. The difference between the rates of interest on loans secured through country credits, suppliers' credits and the World Bank has not been very wide and expensive commercial borrowings were not used in any of the fertilizer projects. The difference in the financing charges arose more from the debt-equity ratio of the projects and differences in the prevailing rates at the corresponding different time periods.

The adverse impact of the country credits and the suppliers' credits arises from restrictions on procurement of equipment which have to be obtained from suppliers in the aid-giving country. This has two adverse features: (a) the equipment is usually more expensive and (b) it is often not the best available equipment.

It is difficult to correctly quantify the increase in the project cost on account of tied credits. The project authorities, where such credits were used, obtained bids of equipment only from the country concerned and international bid quotations data for the relevant time was not always available. Some quotations obtained in 1977, however, throw some light on this point. These are given below:

Table 7. Quotations obtained through different bidding procedures
(US$ millions)

Item	Quotation for tied credits	International competitive bid quotation
1. Secondary Reformer	1.3	0.7
2. Ammonia Converter Internals	2.2	1.5
3. B.F.W. Pump and Turbine	2.0	0.6
4. High pressure heat exchanger	2.2	1.1
5. R.G. Boiler	4.4	2.5

The equipment costs seem to go up from 50 to 100 per cent on account of the use of country credits.

Another example concerns the bids for Service Boilers for one plant obtained in 1979.

The lowest bid under international competitive bidding	Rs 664 million
The lowest bid when bidding was confined to the country concerned	Rs 828 million

On account of the scarcity of foreign exchange and the consequent necessity to secure country credit, the cost of the plant went up by Rs 164 million.

It appears that the absence of international competition is responsible for the equipment quotations being high when tied credits are used. The quantum of increase would however differ from country to country. Where a large number of equipment sources are available in the country giving credit, the competition within the country can help in reducing the price mark-up. By and large, it can be stated that tied credits would raise the equipment and, in turn, project costs.

The best way to ensure efficient performance of the plant is to procure equipment from the best and proven sources. Tied credits restrict the choice of the project manager and such credit can force him to buy second-rate equipment. For example, the delays in commissioning of Plant I were due to the following defective equipment:

- High pressure boiler feed pump
- Carbamate pumps
- CO_2 compressor

These machines were secured from unproven sources only on credit considerations. The delays in commissioning the plant resulted in raising the plant cost by Rs 11.5 million because of added management financing and commissioning charges.

The World Bank-aided plants viz. II, IV, and VIII had the advantage of enabling the owner to procure equipment from the best and cheapest sources. The next best solution was where credits were secured after ensuring that proven sources existed for the equipment to be bought in the concerned country. This enabled Plants III, V, VI and VII to secure quality equipment. Permission obtained from the Government to allow free foreign exchange for critical equipment in these plants also enabled the owners to ensure quality of equipment in cases where sources in the country concerned were not dependable. Utilisation of credits therefore had no adverse impact on the quality of equipment in these plants though higher prices had often to be paid for utilizing credits.

3.2.1 Suggestions for financing package

The ideal way to finance a fertilizer plant is to have no constraints in procuring equipment. A loan from international institutions like the World Bank or Asean Development Bank or provision of free foreign exchange is, therefore, the best method of building a plant at a lower cost. However, a developing country, in view of constraints of foreign exchange, often has to depend on tied country credits. The Indian experience shows that the tied credit, when unavoidable, should be utilized only if reliable sources of equipment had been located in the country concerned. If the country giving credit does not have proven and dependable sources, the advantages of saving foreign exchange by obtaining tied credits are more than nullified through higher costs of equipment and delays in commissioning the plants on account of sub-standard equipment.

3.3 Impact of indigenization

Indian policies stress the utilization of local equipment, engineering and construction capabilities. Therefore, all the plants have depended substantially on the use of local capabilities wherever available. It is difficult to make an accurate study of the effect produced by the use of Indian material rather than foreign material on the consruction cost of the plant mainly because foreign bids are usually not called wherever Indian capability is already well established. Data are not always available on prices for the same type of local and foreign equipment or services at a given time. However, local and foreign quotations for similar equipment in the same time period occasionally become available. Such examples have been used for making an assessment, but in the nature of things, the conclusions cannot be definite.

3.3.1 Use of local equipment

In a recent plant financed by the World Bank where substantial equipment was bought under International Competitive Bidding (ICB) procedure, Indian manufacturers have won sizeable orders. A comparison was made of the prices for this equipment paid to Indian vendors with the prices which would have been required by foreign vendors, had they been selected. The table below shows the position.

Table 8. Savings on account of use of indigenous equipment
(Rs, million)

Serial Number	Name of equipment	Price of Indian vendor	Total Saving
1.	8 Nos. of H.P. Ammonia Feed pumps) 8 Nos. of H.P. Carbamate pumps)	15.34	7.81
2.	4 Nos. 1st stage vacuum separator	8.63	6.82
	4 Nos. 2nd stage vacuum separator	5.56	3.50
3.	M.P. decomposer separator and solution holder	10.25	5.27
4.	Refrigeration compressors	46.53	18.49
5.	Ash handling plant	22.82	12.03
6.	Coal handling plant	88.01	53.09
7.	Air pre-heater equipments	14.23	20.48
8.	Tower packing for ammonia plant	0.42	0.30
9.	Locomotive Case A - 2 Nos.	10.02	4.52
	Additional - 1 No.	2.88	1.26
		224.69	133.57

The above table shows that there was a saving of as much as 60 per cent for certain machines, when bought locally rather than from foreign sources.

On the other hand, some data available for 1977 shows a different picture. Certain quotations were available for prices in the world market and those quoted by local manufacturers. This data is reproduced below:

Table 9. Higher prices of local manufacturers

(Rs, million)

Serial Number	Equipment	International competitive bid prices	Local prices
1.	Coal fired steam generation plant	6.3	8.1
2.	Synthesis compressor	3.24	4.9
3.	Nitrogen compressor	1.4	2.1
4.	CO_2 compressor	0.9	1.3
5.	Air compressor	1.7	3.5

The above table shows that local prices for certain items were 30 to 100 per cent higher than international quotations.

Obviously, the data given above cannot conclusively show the efect of using local equipment in a fertilizer plant. It appears that in respect of certain items, the use of local equipment reduces the cost while in the case of other equipment, the cost goes up. It is possible that equipment which uses a large number of imported components or specialized imported raw material is more expensive to produce locally. On the other hand, equipment which uses local raw material or when there is considerable value added in the process of manufacture is less expensive in the country than outside. It is also possible that Indian manufacturers as they have gained adequate experience can offer more competitive quotations.

3.3.2 Use of local engineering services

Since adequate data is not available on either local and foreign quotations for the same type of services at a given time, an accurate assessment of the impact of local engineering services is not possible. However, since rates for man-days of different contractors are usually known, it is possible to assess the overall impact from the use of local engineering capabilities in a fertilizer plant.

An analysis has been made on the impact of local engineering services used or a project consisting of 900 TPD ammonia plant (fuel oil based) and 1,000 TPD urea plant. Two alternatives have been considered. In the first one, it was assumed that local engineering capabilities would be utilized to the maximum extent, and essential assistance only from foreign contractor. In the second alternative, it was assumed that participation of foreign contractors would be maximum with limited local capability utilized. The following further assumptions have been made:

(a) In alternative I, i.e. maximum local participation, the local share of man-hours would be 92.5 per cent and foreign 7.5 per cent. In alternative II, the corresponding figures would be 22 per cent and 78 per cent.

(b) Taking into account the higher productivity and greater experience of experts in the foreign team, the man-hours for foreign contractor have been taken at 27 per cent less than the man-hours for local contractors.

(c) In either alternative, license and know-how and design package has been assumed to be foreign.

The table below shows the result of the above analysis:

Table 10. Impact of use of local engineering capabilities

Serial No.	Item	Alternative I	Alternative II
1.	Share of foreign (FC)/local (IC) engineering contracting firm	FC = 7.5% IC = 92.5%	FC = 78.0% IC = 22.0%
2.	Cost of services including process license fees, basic design, detailed engineering and supervision of construction and commissioning	FC = Rs 58.7 million Total = Rs 93.7 million	FC = Rs 97.9 million Total = RS 119.7 million

The table above shows that the cost of engineering services increases by 27.7 per cent when foreign engineering services are utilized. The foreign cost element increases by as much as 66.8 per cent. Further, it appears that the cost of services as percentage of erected cost of ammonia and urea plants goes up from 13 per cent to 16 per cent by utilization of foreign contractors. If process license fees and basic designs, which are common to the alternatives, are excluded in making a comparison, the increases will be even higher. The local engineering services cost much less mainly because the rate for man-hours of local services is much lower than that of foreign contractors. The overall cost of local services is, therefore, lower even after taking into account the larger number of man-hours usually employed by local contractors compared to the foreign ones.

It is clear that the plant cost will go down if local engineering services are utilized instead of foreign services. The important point, however, is that the use of local services would be gradual so that local companies get adequate experience and confidence before taking on greater responsibilities.

3.3.3 Use of indigenous construction capability

The civil construction in the fertilizer plants is almost entirely done by local contractors. Since quotations from foreign contractors are not obtained at all, there is no data for comparison. However, considering the fact that the cost of expatriates' supervision of construction and erection will be substantially higher, the use of indigenous construction and erection capability will certainly reduce the plant costs. A rough estimate is that such costs will go up by at least 25 per cent if the job is entrusted to a foreign contractor.

3.4 Incidence of local duties and taxes

Local duties and taxes form an important element in the cost of fertilizer plants. Information about taxes is not available for plant I, information regarding the remaining plants is given below:

Table 11. Contribution of taxes to the total base costs

Year	Plant Number	Cost (Rs million)	Proportion of taxes in the total base costs (%)
1970	I	n.a.	n.a.
1975	II	207.97	17
1977	III	190.80	11
1978	IV	182.81	12
1979	V	256.35	15
1979	VI	418.96	17
1980	VII	154.80	12
1982	VIII	557.10	17

The above information would show that customs and excise duties, sales tax and other taxes and charges constitute from 11 to 17 per cent of the basic costs.

Considering the fact that fertilizer is an important input for agriculture and that the price of fertilizer needs to be kept at a reasonably low level, there seems to be a case for reducing the tax burden on a fertilizer plant.

3.5 Delays in construction and commissioning - External and internal factors

The consequences of delays in capital-intensive fertilizer plants are serious. Firstly, they raise the costs of management, financing and commissioning charges, thus raising the project cost. Secondly, they affect the viability of the project. And thirdly, they deny the country a valuable output in the form of fertilizers. It should, therefore, be the endeavour of country planners and project managers to contain delays to a minimum. Apart from being a complex project which tests the skills of the project authorities, a fertilizer complex, particularly in a developing country, depends on various authorities responsible for providing reliable sources of water, power, transportation, etc. Disturbances in world market can also affect deliveries of indigenous and imported equipment. The reasons for delays can be divided into two types - (1) those due to external factors which are beyond the control of project authorities and (2) those due to internal factors which are within the control of the project authorities.

The delays in the construction of the eight plants are indicated in the table below. For the sake of convenience, the plants have been grouped into three categories according to the periods of their construction, namely early 1970s, mid-1970s and early 1980s.

Table 12. Project delays

Project Number	Date of scheduled commercial production	Actual date of commercial production	Time overrun (in months)
Category I			
Plant I	October 1971	November 1976	61
Category II			
Plant II	October 1976	November 1978	25
Plant III	November 1978	September 1979	10
Plant IV	December 1979	March 1981	15
Plant V	July 1981	July 1982	12
Plant VI	October 1980	December 1981	14
Category III			
Plant VII	July 1981	September 1981	2
Plant VIII	September 1984	On schedule	-

It is interesting to see that the delay was greatest in the Category I plant which belonged to the early period. The delays reduced progressively and the implementation of Category III plants was efficient. This shows the progressive effectiveness in project implementation.

The table below gives information about some of the factors which led to serious delays in Category 1 plant.

Table 13. Factors contributing to delays

Serial No.	Major activity	Total delay
1.	Acquisition of land and site preparation	12 months
2.	Delivery of imported equipment	50 months
3.	Delivery of indigenous equipment	41 months
4.	Commissioning	24 months
Some of these delays were concurrent		

The external and internal reasons for the delays have been analyzed below separately.

3.5.1 Delays due to external factors

Before appreciating the external factors, it is necessary to note the economic situation in India at the relevant time. The country faced a serious foreign exchange crisis. The government, therefore, decided to maximize the proportion of local equipment and services. The government also had to ration the limited foreign exchange for competing projects and considerable reliance was placed on external assistance, including country and suppliers' credits wherever available.

The factors which affected the project implementation can be summarized as follows:

1. Delays at government level in approving the project estimates, collaboration/supply agreements, foreign exchange resources, etc.
2. Delays in assigning government and suppliers' credits for different equipment and for acquiring process know-how.
3. The deliberate stress on self-reliance which necessitated a thorough search for the possibility of procuring equipment indigenously before imports could be allowed.
4. Impact of international oil crisis which affected deliveries of some of the imported items.

At the relevant time, the experience of the project authorities in the preparation of techno-economic feasibility reports of such large and complex plants was limited. Considerable time was taken, therefore, in preparation and approval of the cost estimates. The severe foreign exchange crisis meant considerable scrutiny and discussion before credits could be earmarked for the project. The same constraint was responsible for the detailed scrutiny of available indigenous supplies before imports could be allowed. In fact, only after all the internal sources were exhausted could imports be considered. The constraint of the large number of tied credits for the plant meant that the project authorities had to investigate the possibility of obtaining different equipment from different sources of tied credits. All these factors contributed to significant delays in tying up credits, ordering indigenous and imported equipment and release of foreign exchange.

The delays in the procurement of equipment were also very significant. Many Indian firms had to take up the manufacture/fabrication of new items of sophisticated equipment for the first time. Many of the firms could not, therefore, honour the commitments of delivery. Sometimes, defective equipment had to be modified before the plant could be commissioned which involved extra time.

The delays in supplies of equipment were not limited to Indian equipment. There were significant delays in receipt of imported equipment as well. This was particularly so where equipment was procured through tied credits and the suppliers were not the best in the world.

3.5.2 Delays due to internal factors

The project authorities and their consultants were not fully experienced in the preparation of estimates which had to be revised a number of times. The lack of experience was also responsible for changing the scope of the project at a later stage, necessitating procurement of new equipment and sometimes making changes in the design and specifications.

On account of the lack of adequate experience, the development of the site posed serious problems which had not been examined and provided for at the time of the project report. Site development held up the erection work for considerable time and caused delays. The project administration was also not adequately equiped to plan the process of implementation and to review and modify the implementation of the plant according to the requirements changed from time to time.

3.5.3 Experience of Category I plant - Conclusion

In building the Category I plant, an ambitious attempt was made at maximizing the use of indigenous technology and manufacturing capacity in an area of India where adequate experience was not available. This was combined with the inability of the project authorities to choose the best sources for technology and equipment on account of the constraints of tied credits. In addition, the project authorities lacked adequate expertise in planning and implementing projects. The result was prolonged project construction and commissioning.

In the situation in which India was placed at the relevant time, stress on indigenization was correct. The difficulties experienced by local manufacturers in mastering the technology involved in the fabrication of critical plant and equipment must be considered as part of a learning curve in developing indigenous capability. The fact that India can now produce more than 70 per cent of the equipment required for a fertilizer plant shows that the efforts have paid off. In retrospect, it seems that the drive towards indigenization was somewhat rigid and the pace too fast. All these deficiencies got progressively corrected.

3.6 Category II plants

In this category, the delay in plant II has been the longest. This was the first fuel oil based plant in India and the number of such plants in the world was also very small. The overall world experience in fuel oil based plants being limited, there were some inherent problems in the construction of plant II. The reasons for the delays in this plant were:

(a) Delay in completion of the designs by the foreign consultant and revisions in specifications.

(b) Inadequate response to global tenders and changes demanded by suppliers in the context of the unsettled international market on account of the oil crisis and resultant delays.

(c) Delays in delivery of indigenous equipment.

(d) Delays in supplies of imported equipment.

(e) Delays in commissioning on account of an explosion in the carbon slurry tank.

Plant III and IV were completed without any serious delay. However, a local transportation problem arose in Northern India in the years 1979 and 1980. On account of this problem, it was not possible to move coal and feedstock to these plants over a long period, thus delaying their commissioning activities. The implementation of Plant V was affected to some extent by the late deliveries of indigenous equipment, but mainly by two infrastructure problems - (i) the unusual port congestion held up imported equipment and (ii) water scarcity held up the commissioning for some time. The delay in Plant VI was on account of delayed imported and indigenous equipment and problems in stabilizing certain equipment.

3.6.1 Delays due to external factors

A number of deficiencies of the earlier plants were corrected during the implementation of Category II plants. Plants II and IV had the advantage of untied credits. In the case of Plants III, V and VI, country credits were utilized. But prior to their utilization, a thorough scrutiny was made of the available sources in the country concerned for supplying equipment. Only equipment where sources were dependable was covered by the tied credit. The stress of indigenization continued, but the adequacy of facilities available with the indigenous suppliers was carefully scrutinized from the point of view of quality and delivery, before orders were placed. Free foreign exchange was made available whenever critical equipment of adequate quality was not available locally or through tied sources. With all these modifications, the plants in the Category II had the advantage of securing good technology.

The years 1979 and 1980 witnessed some serious infrastructure problems in the country which included difficulties in transporting coal and feedstock to the plants, inadequate and unstable power supplies at many places and a serious water shortage at one plant. These problems were the result of many factors which were beyond the control of the project authorities and even the planners. The fact that world experience of fuel oil as feedstock was limited also meant extended commissioning period for fuel oil based plants.

3.6.2 Delays due to internal factors

The project reports and preliminary investigations such as soil conditions testing, etc. were done with adequate care in Category II plants. The project management also, by and large, showed very considerable improvement in the management of the project. In most cases, technology was chosen with care. The equipment was also chosen after adequate scrutiny. In certain cases, where equipment had deficiencies, the project management showed considerable skill in carrying out modifications and improvisation wherever possible.

3.6.3 Experience of Category II plants - conclusion

By and large, Category II plants showed substantial improvement in many areas, compared to earlier plants. While some infrastructure problems arose without warning and could not have been foreseen, some others like power and water could have been anticipated. Though monitoring had generally improved, a stricter control was necessary in procurement of imported and local equipment.

3.7 Category III plants

The delay in the Plant VII of Category III has been marginal. Plant VIII was also on schedule. It can, therefore, be stated that most of the deficiencies noticed in project implementation in the earlier plants have now been corrected. The planners have found optimum solutions in synthesizing conflicting priorities. The policy now stresses development of local capability and conservation of foreign exchange without, in any way, affecting commissioning of the project successfully on time. The various procedures have also been streamlined to give speedy clearance. Indian expertise in project management and operation of fertilizer plants now seems well developed, and the project managers are capable of implementing the projects successfully and in time.

4. THE INDIAN EXPERIENCE - LESSONS AND REMEDIAL MEASURES

The Indian experience in building fertilizer plants brings out a number of issues which are of relevance to many developing countries. Being an important input for agriculture, fertilizers have been given a high priority in the planning process of most of the developing countries. Again, fertilizer being an expensive input, most of the developing countries desire to produce it within the country, particularly where raw material resources are available. However, fertilizer is a highly capital-intensive industry, and penalties for cost and time overrruns are severe. In the case of nitrogenous fertilizer plants, the element of capital costs in the production costs is over 55 per cent. Therefore, the main advantage of producing fertilizers at a reasonable cost within the country from indigenous resources would be lost, if the fertilizer plant suffers from cost and time overruns and/or if the plant does not operate at high levels after commissioning.

4.1 Lessons learnt

The lessons learnt from the Indian experience can be summarized as follows:

(a) The pre-investment studies and techno-economic feasibility report including cost estimates need to be very carefully prepared. A sharp increase in project cost in a capital-intensive project during implementation can create severe strain on the resources position and can lead to delays and selection of sub-optimum equipment. While preparing the initial estimates, the project authorities have to steer clear of two pitfalls. On the one hand, due note needs to be taken of the likely inexperience of the local owners and consultants. On the other hand, the initial rosy estimates prepared by the outside consultant, who often is motivated by his own financial reward, need to be thoroughly scrutinized by independent consultants.

(b) Even a well conceived project can suffer if a financial package is not properly evolved. The ideal form of external financial assistance for a fertilizer plant is untied loans from international institutions like the World Bank, Asian Development Bank, etc. If such assistance is not available in adequate amounts, recourse has to be secured through country credits and suppliers credits. The Indian experience shows that handling more than two or three co-financers throws an unacceptable burden on the project authorities in procurement of services and equipment. It is advantageous to earmark certain equipment against different credits at the initial stages, e.g. the equipment to be bought in one of the newer Indian plants from the country credit and World Bank assistance were separated in the beginning and the procurement, therefore, became easier and faster. Before allocating country credit, a proper evaluation needs to be made of the competence of the manufacturers in that country to produce quality equipment. It is preferable to allocate some free foreign exchange (however scarce it may be) for the purchase of critical items from the best and proven sources when dependable sources do not exist locally or in the aid-giving country.

(c) Encouragement of indigenous suppliers and maximizing indigenous capacity form an important policy framework in any developing country. The effort should be to procure as much material and services from within the country as possible. However, this needs to be done with caution and in stages, taking note of the capacities, capabilities, infrastructural bottlenecks and other relevant factors. If a developing country has plans to build a large number of fertilizer plants, there is a clear advantage in encouraging and developing indigenous capacity.

(d) Local contractors are obviously better placed in carrying out civil construction and erection work than to outside contractors. These areas are easier to master compared to production of sophisticated and complex equipment. The rates of local contractors are usually much lower than those of international companies. Encouragement of local expertise in construction and erection should, therefore, be the logical first step in a developing country. However, care needs to be taken to provide adequate supervision by experienced expatriates in critical areas in the earlier stages of development.

(e) Development of local engineering capability also helps in reducing costs. Man-hours of local consultants are cheaper and these lower rates ensure lower cost of engineering services, apart from saving valuable foreign exchange. Local capability should, however, be built in stages, taking on additional responsibility with successive plants. In the long run, development of local engineering capability enables the country to build efficient plants and introduce modifications, especially suitable to the overall industrial ethos of the country.

(f) If the Government adopts a firm policy for the development of local equipment manufacturing capacity as an objective, it is important that fertilizer plant size and technology are standardized as early as possible. The Indian experience shows that changes in the plant size and technology in the early 1970s created problems even for good Indian manufacturing companies in maintaining quality and delivery schedules of equipment. Standardization helps both engineering and equipment manufacturing companies in doing their work on a repeat basis and thus maintain quality and delivery schedules. If the orders within one country are not likely to be adequate, it should be investigated whether three or four countries within a region can combine their resources and markets to produce equipment on a joint basis.

(g) A fertilizer plant is energy intensive and it is always attractive to choose technology which uses less energy. However, it is very difficuit for a developing country to experiment with new and unproven technology. Such a country is not adequately equipped to solve problems when they suddenly arise. Therefore, while energy savings should be encouraged, developing countries must put emphasis on proven technology. Low cost figures can be obtained only if the plant operates at high loads on a sustained basis. Developing countries need also be very careful and avoid choosing modern and sophisticated instruments and computerized systems unless adequate local expertise is available to run them efficiently.

(h) The infrastructure problems, e.g. water supply, electric power, railway and other transport network are usually more acute in a developing country. Proper note needs to be taken of these likely problems. If the grid system is unstable, it is preferable to have internal power generation in the plant. The loss on account of power interruption in a single-stream capital-intensive fertilizer plant can be very serious indeed. The infrastructure, therefore, needs to be planned along with the project itself.

4.2 Remedial measures taken at macro level

In the light of the experience of earlier plants, the Government of India has taken a number of steps to introduce policy changes and streamline procedures to ensure that fertilizer plants are implemented speedily, commissioned on time and operate well. The corrective measures taken at macro level are indicated below:

(a) A complete and detailed feasibility report is required to be prepared by the project management before investment decision can be taken. Public sector projects are appraised by a body called Public Investment Board and private sector projects are appraised by financial institutions. Moreover, the feasibility report is scrutinised by all the agencies and organizations concerned. This provides an opportunity for correcting possible deficiencies and inadequacies in time. As a result, the estimation of cost and the formulation of the project details are more realistic. A time limit is set for the appraising agencies so that investment decisions are not delayed.

(b) The procedure for Government approvals has been greatly streamlined. The main approvals required are for consultancy and services contracts and imports of equipment. All these proposals are now considered in a composite manner by a special Committee of state secretaries. This enables a single point clearance of all proposals for fertilizer projects.

(c) As a matter of policy, the Government has decided to allocate, as far as possible, a small number of credits for financing fertilizer plants. Free foreign exchange is permitted to enable the project authorities to buy critical equipment from the best and proven sources. The list of equipment to be bought through the use of different credits is settled at the initial stage so that procurement work can proceed smoothly at an early stage.

(d) While the Government's policy continues to give preference to indigenous manufacturers and consultants, adequate attention is paid to the quality of equipment and the delivery schedules. Indian manufacturers have also reached a stage where they can, with minimal support, compete with international suppliers with regard to price, quality and delivery schedules.

(e) The Government has also decided on standardization of feedstock, plant size and technology. This has helped indigenous manufacturers in producing equipment of good quality and maintaining delivery schedules. Standardization also enables new plants to go on stream speedily.

(f) The Ministry of Chemicals and Fertilizers now monitors projects both in public and private sectors on a continuous and systematic basis. The monitoring includes watching the delivery schedules of indigenous suppliers and taking action to expedite deliveries wherever necessary. The problems of infrastructure are also identified through monitoring at the appropriate time and remedial action is taken without delay.

4.3 Remedial measures taken by the project authorities

The project authorities have also taken a number of remedial measures to implement fertilizer projects efficiently. Some of these measures are indicated below:

(a) The initial capital cost estimates are prepared by starting with the cost estimates of the most recent plant which are then reviewed in the light of the relevant data in the international market. The estimates also are prepared in great detail up to "class of equipment or units of work".

(b) Tender enquiries are issued only to a small number of pre-qualified bidders. The pre-qualification is done stringently with a view to the experience of plants in India and outside. Apart from getting adequate data from the vendors, their shops are also inspected, if necessary, to judge their competence.

(c) The bid specifications are clear, detailed and realistic so that the bidder knows exactly what is required with no need to add provisions for contingencies to cover unknown risks.

(d) The evaluation of the bids is done on a pre-determined basis and time limits are prescribed for placing orders.

(e) The physical progress of the project activities is controlled through PERT/CPM charts and reviewed very regularly at site. The management also reviews these activities every month and special attention is paid to critical areas. The problems which are outside the control of the management are brought to the Government level for finding solutions.

4.4 To sum up

1. Inadequate and faulty planning and inefficient implementation of a fertilizer plant results in severe penalties in the form of time and cost overruns and unprofitable operations.

2. Great care needs to be taken in selecting only proven technology and equipment, particularly critical equipment so as to ensure efficient operation of the plant.

3. Untied credit or free foreign exchange should be the preferred method of financing the project, particularly for critical areas. If tied credit becomes necessary, a thorough scrutiny of the technology and equipment available in the aid-giving country should be made so as to cover only proven equipment under credit.

4. Utilisation of local construction and erection, engineering and equipment capabilities which tend to reduce plant costs, should be encouraged. However, the development of local expertise should be gradual. Standardization of technology and plant size helps in building local expertise faster.

5. Infrastructure problems in a developing country need to be studied in great detail and infrastructure should be planned along with the project.

6. Timely completion of the project needs to be given high priority. Total dedication on the part of the project team and strict control at every level is essential to ensure a speedy and successful implementation of the project.

ANNEX A.1

PROJECT COSTS

(Rs/million)

Sr. No.	Description	I	II	III	IV	V	VI	VII	VIII
1.	AMMONIA PLANT EQUIPMENT								
	Including Cooling Towers, Catalyst and Chemicals	247.00	346.00	515.65	251.70	474.10	952.16	232.00	1087.80
2.	UREA PLANT EQUIPMENT								
	Including Cooling Towers, Catalyst and Chemicals	148.00	80.00	167.44	116.46	159.60	213.85	125.00	821.40
3.	OTHER PLANTS								
	i) Steam Generation	-	117.00	150.00	150.50	145.00	219.79	-	357.10
	ii) Power Plant & Distribution	-	11.00	73.00	64.41	16.50	51.50	-	189.00
	iii) Coal & Ash Handling	-	-	25.50	19.12	-	34.34	-	100.00
	iv) Product Storage & Handling	-	8.00	15.60	9.56	-	5.94	-	-
	Sub-Total (3)	-	136.00	238.60	243.63	161.50	311.57	43.60	646.10
4.	OFFSITE FACILITIES								
	i) Water Supply, Treatment & Distribution	-	-	22.50	16.58	10.90	35.12	18.00	111.80
	ii) Raw Material Storage and Handling	-	7.00	6.60	6.43	-	9.96	-	-
	iii) Ammonia Storage	-	-	} Included in (vi)	-	-	6.61	-	-
	iv) Inert Gas Generation	-	-		7.55	-	6.36	} 29.00	15.00
	v) Fire Fighting & Safety	-	-		11.78	2.10	1.45		15.00
	vi) Yard Piping	-	12.00	46.00	12.80	11.80	56.29		37.50
	vii) Auxiliary Services	-	10.00	22.00	21.35	7.30	33.24		87.50
	viii) Transport System	-	9.00	21.90	21.20	4.80	24.38		17.20

contd...

Annex A.1 (continued 1)

Sr. No.	Description	I	II	III	IV	V	VI	VII	VIII
ix)	Effluent Treatment	-	3.00	11.20	2.49	2.90	19.18		12.00
x)	Ammonia Tank Wagons	-	-	-	-	-	-	-	24.50
xi)	Civil Works								
	(a) Plant Civil Works	-	58.00	113.81	92.98	88.00	47.37	53.00	410.40
	(b) Non-Plant Building	-	1.00	-	24.75	2.60	1.71	-	75.50
xii)	Others, if any	-	-	-	22.23	16.20	34.54	-	32.00
	Sub-Total (4)	51.00	100.00	244.01	240.14	146.60	276.21	100.00	838.40
5.	CONSTRUCTION EQUIPMENTS	8.00	6.00	6.10	14.95	9.70	9.12	-	61.50
6.	SPARES	46.00	51.00	47.30	109.07	101.20	80.15	4.00	258.70
7.	OTHER COSTS (Ocean freight, insurance, customs duty, inland handling, excise duty and sales tax)	-	176.00	190.80	182.81	222.90	501.48	90.00	1114.30
8.	LICENCE & DEP FEES INCLUSIVE OF TAXES								
i)	Ammonia Plant	-	-	-	79.96	68.21		-	211.50
ii)	Urea Plant	-	-	-	34.19	34.80		-	164.20
iii)	Other Plants	-	-	-	-	6.20		-	1.30
iv)	Offsites	-	-	-	6.60	4.70		-	16.00
	Sub-Total (8)	-	69.00	158.30	120.75	113.91	356.15	73.90	393.00

contd.....p/3

Sr. No.	Description	I
9.	ERECTION & SUPERVISION INCLUSIVE OF TAXES	
	i) Ammonia Plant	-
	ii) Urea Plant	-
	iii) Other Plants	-
	iv) Offsites	-
	Sub-Total (9)	-
10.	INFRASTRUCTURE OUTSIDE PLANT	-
11.	OTHERS	
	i) Land and Land Development ii) Township	52.00
	iii) Project Management Charges	107.00
	iv) Insurance and Bank Charges	-
	Sub-Total (11)	143.00
12.	TOTAL BASE COST (1 to 11)	714.00
13.	CONTINGENCY AND ESCALATION	1.00
14.	PRE-OPERATIONAL COST	
	i) Expenses	80.00
	ii) Credit for Production and Inventory	22.00
	iii) Net Cost (i) - (ii)	58.00

Annex A.1 (continued 2)

II	III	IV	V	VI	VII	VIII
-	-	71.39	61.29	Included in (8) above	-	211.70
-	-	41.27	27.70		-	97.10
-	-	50.77	26.80		-	188.30
-	-		13.00		-	45.90
82.00	39.00	163.43	128.69		63.00	543.00
-	2.80	-	-	50.22	-	190.00
3.00	13.60	61.35	-	23.44	-	165.00
1.00	46.60	73.01	16.80	46.46	-	175.80
44.00	43.00	88.43	42.20	73.00	-	204.40
-	18.30	10.50	-	38.94	2.50	75.00
48.00	121.50	233.29	59.00	181.84	2.50	620.20
1094.00	1731.60	1668.31	1576.50	2932.75	720.00	6574.40
4.00	115.20	2.50	39.40	-	-	2048.60
-	-	163.01	63.10	405.67	-	-
-	-	110.96	67.60	219.99	-	-
63.00	146.60	52.05	(-)4.50	185.68	-	45.00

contd...

Annex A.1 (continued 3)

Sr. No.	Description	I	II	III	IV	V	VI	VII	VIII
15.	WORKING CAPITAL MARGIN	10.00	15.00	21.00	34.00	25.60	199.37	-	321.00
16.	FINANCING CHARGES	141.00	121.00	174.00	294.95	62.90	950.57	-	814.50
17.	TOTAL PROJECT COST (12 TO 16)	924.00	1297.00	2188.40	2051.81	1699.70	4276.97	720.00	9803.50

Note: (-) denotes that break up is not available and the concerned costs are included under other heads.

Annex A.2

SIZE-ADJUSTED PROJECT COSTS

(Rs/million)

Sr. No.	Description	I	II	III	IV	V	VI	VII	VIII
1.	AMMONIA PLANT EQUIPMENT								
	Including Cooling Towers, Catalyst and Chemicals	328.04	346.00	515.65	251.70	474.10	746.50	398.86	426.44
2.	UREA PLANT EQUIPMENT								
	Including Cooling Towers, Catalyst and Chemicals	196.57	106.25	167.44	116.47	211.99	191.60	217.03	255.14
3.	OTHER PLANTS								
	i) Steam Generation								
	ii) Power Plant & Distribution								
	iii) Coal and Ash Handling								
	iv) Product Storage & Handling								
	Sub-Total (3)	73.05	180.63	238.60	243.63	214.51	279.17	75.70	402.58
4.	OFFSITE FACILITIES								
	i) Water Supply, Treatment and Distribution								
	ii) Raw Material, Storage and Handling								
	iii) Ammonia Storage								
	iv) Inert Gas Generation								
	v) Fire Fighting and Safety								

contd...

Sr. No.	Description	I
	vi) Yard Piping	
	vii) Auxiliary Services	
	viii) Transport System	
	ix) Effluent Treatment	
	x) Ammonia Tank Wagons	
	xi) Civil Works	
	(a) Plant Civil Works	
	(b) Non-Plant Building	
	xii) Others, if any	
	Sub-Total (4)	67.83
5.	CONSTRUCTION EQUIPMENTS	10.64
6.	SPARES	61.18
	TOTAL EQUIPMENTS	737.31
7.	OTHER COSTS (Ocean freight, insurance, customs duty, inland handling, excise duty and sales tax)	-
8.	LICENCE & DEP FEES INCLUSIVE OF TAXES	
	i) Ammonia	
	ii) Urea Plant	

Annex A.2 (continued 1)

II	III	IV	V	VI	VII	VIII
115.00	244.01	223.10	168.59	232.02	172.00	419.20
8.00	6.10	14.95	11.16	7.66	-	30.75
60.00	47.30	109.07	116.38	67.33	6.88	129.35
815.88	1219.10	968.03	1196.73	1524.28	870.47	1663.46
207.97	190.80	182.81	256.34	418.96	154.80	557.10

contd...

Annex A.2 (continued 2)

Sr. No.	Description	I	II	III	IV	V	VI	VII	VIII
	iii) Other Plants								
	iv) Offsites								
	Sub-Total (8)	-	79.00	158.30	120.75	131.00	299.16	127.10	196.50
9.	ERECTION AND SUPERVISION INCLUSIVE OF TAXES								
	i) Ammonia Plant						Included		
	ii) Urea Plant						in (8)		
	iii) Other Plants						above		
	iv) Offsites								
	Sub-Total (9)	-	88.00	39.00	163.43	147.99	-	108.36	271.50
10.	INFRASTRUCTURE OUTSIDE PLANT	-	-	2.80	-	-	42.18	-	95.00
11.	OTHERS								
	i) Land & Land Development	-	3.00	-	-	-	19.70	-	-
	ii) Township	-	1.00	-	-	-	39.03	-	-
	iii) Project Management Charges	-	44.00	-	-	-	73.00	-	-
	iv) Insurance and Bank Charges	-	-	-	-	-	38.94	-	-
	Sub-Total (11)	176.16	48.00	121.50	233.29	61.52	170.67	2.50	449.80
12.	TOTAL BASE COST (1 TO 11)	913.47	1238.85	1731.60	1668.31	1793.58	2455.25	1263.23	3233.36

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Annex A.2 (continued 3)

Sr. No.	Description	I	II	III	IV	V	VI	VII	VIII
13.	CONTINGENCY & ESCALATION	2.00	5.50	115.20	2.50	45.05	-	-	500.00
14.	PRE-OPERATIONAL COST								
	i) Expenses								
	ii) Credits								
	Net Cost (i) - (ii)	77.14	68.00	146.60	52.05	(-)6.00	150.00	50.00	22.50
15.	WORKING CAPITAL MARGIN	13.30	18.00	21.00	34.00	29.44	160.00	30.00	160.50
16.	FINANCING CHARGES	181.09	136.88	174.00	294.95	71.55	798.78	52.00	355.00
17.	TOTAL PROJECT COST (12 TO 16)	1187.00	1467.23	2188.30	2051.81	1933.62	3564.03	1395.23	4271.36

<u>NOTES</u>

1. In case of Plant I Civil Works, Licence & DEP, Erection and Supervision are included in the main plant costs.
2. (-) denotes that break up is not available.

Annex A. 3

SIZE AND FEEDSTOCK ADJUSTED PROJECT COSTS

(Rs/million)

Sr. No.	Description	I	II	III	IV	V	VI	VII	VIII
1.	EQUIPMENT COST (1 to 6 of Annexure-II)	737.31	815.88	1219.10	968.03	1196.73	1524.28	870.47	1663.46
2.	CORRECTION FOR FEED-STOCK (Fuel Oil to Naphtha i.e. partial oxidation to reformation)								
	(a) Ammonia Plant		(103.80)	(154.70)			(223.95)		
	(b) Other Plants and Offsites		(60.12)	(96.42)			(102.24)		
3.	EQUIPMENT COST (after correction)	737.31	651.96	967.98	968.03	1196.73	1198.09	870.47	1663.46
4.	OTHER COSTS (Unchanged from Annex II)	449.69	651.35	969.20	1083.78	736.89	2039.75	524.76	2607.90
5.	TOTAL PROJECT COST AFTER CORRECTION FOR FEED-STOCKS	1187.00	1303.31	1937.18	2051.81	1933.62	3237.84	1395.23	4271.36
6.	TOTAL PROJECT COST IN MILLION (US $)	158.27	146.44	225.25	224.26	235.81	394.86	174.40	435.85

Notes: 1) For correction for feed-stocks, Ammonia plant cost has been reduced by 30% and other plants and offsites by 20%.

2) Plant II, Plant V and Plant VII enjoy the benefits of location near existing plants.

3) The figures in brackets indicate negative amounts.

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Annex A.4

INDICES FOR PLANT COSTS - (categorywise)

A. Total project cost after feedstock adjustment

Year	Plant	Cost (Rs, million))	Index
1970	I	1,187.00	100
1975	II	1,303.31	110
1977	III	1,938.18	163
1978	IV	2,051.81	173
1979	V	1,933.62	163
1979	VI	3,237.84	273
1980	VII	1,395.23	118
1982	VIII	4,271.36	360

B. Total equipment cost after feedstock adjustment

Year	Plant	Cost (Rs, million)	Index
1970	I	737.31	100
1975	II	651.96	88
1977	III	967.98	131
1978	IV	968.03	131
1979	V	1,196.73	162
1979	VI	1,198.09	162
1980	VII	870.47	118
1982	VIII	1,663.46	226

C. Total custom and allied duties

Year	Plant	Cost (Rs, million)
1970	I	737.31
1975	II	651.96
1977	III	967.98
1978	IV	968.03
1979	V	1 196.73
1979	VI	1 198.09
1980	VII	870.47
1982	VIII	1 663.46

D. Total off-sites and infrastructure cost

Year	Plant	Cost (Rs, million)	Index
1970	I	212.70	100
1975	II	363.63	171
1977	III	538.81	253
1978	IV	590.75	278
1979	V	510.64	240
1979	VI	628.36	295
1980	VII	254.58	120
1982	VIII	1 076.88	506

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