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Second Interregional Fertilizer Symposium

Kiev, USSR, 21 September - 1 October 1971
New Delhi, India, 2 - 13 October 1971

Agenda item V/2

EXPERIENCE IN PLANNING THE FERTILIZER INDUSTRY IN INDIA 1/

by

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SUMMARY

EXPERIENCE IN PLANNING THE FERTILIZER INDUSTRY IN INDIA[1]

by

V.N. Kasturirangan

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For India, which has been dependent on imports of foodgrains since 1946 to supplement its own production, it is of paramount importance to achieve self-sufficiency in foodgrains. With limitations on increasing agricultural production by expansion of cultivable land, the achievement of the goal of self-sufficiency in foodgrain production is largely dependent on improvements in productivity by the use of chemical fertilizers along with other inputs like better seeds, water, pesticides, etc. In India, the consumption of the total plant nutrients, namely, NPK, was only of the order of 10 kgs. per hectare of arable land during 1968-69 as against the consumption of as high as 622 kgs. in the Netherlands. There is thus good scope for increased consumption of fertilizers. Corresponding to the levels of production envisaged in the agricultural sector, the targets of consumption for nitrogen and P_2O_5 have been placed at 3.2 million tonnes and 1.4 million tonnes respectively for 1973-74. The tentative demand projections

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for 1978-79 are placed at [illegible] million tonnes of nitrogen and [illegible] million tonnes of P_2O_5. In order to achieve self-sufficiency in fertiliser production, a programme of development has been taken up and it is expected that the country will reach self-sufficiency in the production of nitrogen and P_2O_5 by about 1976. The attainment of the production targets envisaged, as against the present level of [illegible],000 tonnes of nitrogen and 220,000 tonnes of P_2O_5 during the year 1970-71, calls for [illegible] efforts and resources, and the Government of India has given the highest priority to the achievement of these goals. With judicious planning, it is possible to meet fully the requirements of the feedstocks - gaseous, liquid or solid - from within the country. With the development of an equipment fabricating industry in the country, it is expected that, by and large, the foreign exchange expenditure involved in setting up the fertiliser projects, on an average, would be brought down from the present [illegible] percent to [illegible] percent of the capital cost before the end of the nineteen seventies. Necessary expertise has also been developed [in] the design and engineering, construction, erection and commissioning of fertiliser projects. Thus, within the next few years, the country would have not only achieved self-sufficiency in fertiliser production but would have reached near self-reliance in equipment fabrication and would be in a position to make further advances with minimum of external assistance. At the same time, India would also be in a position to offer assistance on a large scale to other developing countries.

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

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1. **Introduction**

1.0 The countries which are bestowed with all the raw materials, leave alone their availability in sufficient quantities, required in the manufacture of primary fertilizers containing nitrogen, phosphorous and potassium are very few. Hence, the choice and development of feedstock and raw material for fertilizer industry, specially in a developing country with problems on foreign exchange resources are complex. The extent of requirements and the choice of the raw materials would depend among other things on factors like -

a) the fertilizer demand and its product pattern to suit to the needs of the soil and crop;

b) availability of raw materials and feedstock and the extent of their availability; and

c) considerations that go into the choice of the raw materials required in the fertilizer production.

1.1 The implications of these aspects in the choice and development of feedstock and raw materials for the fertilizer industry in India have been discussed in brief in the paper presented.

1.2 To achieve a sustained growth rate of 5% for agricultural production in India during seventies, there being limitations in either increasing the agricultural land or developing irrigation, soil conservation and other facilities, it has been recognised that fertilizers constitute the most crucial input of the agricultural production programme. Besides, the consumption of fertilisers in India being very low, i.e. about 10 kg/hectare of arable land in 1968-69, there is an immense scope for introduction of high yielding varieties of foodgrains and increased application of fertilisers. Taking all relevant aspects into consideration, the fertiliser requirements as at the end of Fourth (1973-74) and Fifth (1978-79) Five Year Plans have been placed at the following levels:

(Table I)

(Fertiliser requirements in '000 tonnes)

Year	N	P_2O_5	K_2O
a) 1973-74	3200	1400	900
b) 1978-79	5200	2100	1500

1.3 In order to match the requirements of the nitrogenous and phosphatic fertilisers in 1978-79 with local production, the programme of development is constantly under review. The present status and the programme of development during the next 7 or 8 years to come are briefly as under:

(Table II)

(Figures in '000 tonnes)

Description	N	P_2O_5
1. Planned capacity		
i) present installed capacity	1344	421
ii) Schemes under implementation/firmed up for implementation	1668	431

iii) Schemes approved in principle	1343	491
iv) Schemes under active consideration	334	185
v) Total (i) to (iv)	4039	2030
2. Capacity to be planned further to achieve production matching with targets of consumption by 1978-79	961	870
Total (1) + (2)	5000	2900

1.4 It will be seen from the information furnished that there is still the need to plan for further capacity to meet the fertiliser requirements in the late seventies. However, with these developments, India is likely to emerge as one of the leading producers of fertilisers before the turn of the decade.

1.5 In the absence of any known resources, there is no organised production of potassic fertilisers in the country. A small quantity is recovered in the form of potassium chloride or mixed salt from the salt bitterns.

2.0 __Pattern of fertiliser production.__

2.1 In the early stages of fertiliser production in India, while the production was in the form of single and low neutrient fertilisers, the later development and future programme is more in the form of high nutrient single and complex fertilisers. Also, while the first plant installed in the country was hardly having an annual capacity of 1300 tonnes of nitrogen, the present plants have been planned for production of nitrogen upto 270,000 tonnes per annum in a single stream. In the wake of these developments, the feedstock for nitrogen has also undergone a change from time to time. Similarly, in the production of phosphates, from a few hundred tonnes of P_2O_5 per annum in the form of single super phosphate planned in the early stages, the future plants are expected to produce upto 160,000 tonnes of P_2O_5 per annum at a single location as concentrated and complex fertilisers.

2.2 A break-up of the product pattern for the capacity to the extent planned so far is shown below:

(Table III)

Product	Capacity			
	Nitrogen		P_2O_5	
	'000 tonnes	per-centage	'000 tonnes	per-centage
1. Urea	3799	74.6		
2. Ammonium sulphate	202	4.0		
3. Calcium ammonium nitrate	200	4.0		
4. Ammonium chloride	80	1.6		
5. Ammonium sulphate nitrate	32	0.6		
6. Ammonium sulphate-phosphate	45	0.9	47	2.9
7. Urea ammonium phosphate	128	2.5	128	7.9
8. Nitro-phosphate	253	5.0	244	15.0
9. Diammonium phosphate	125	2.5	290	17.8
10. Complex fertilisers	182	3.6	367	22.5
11. Single superphosphate			216	13.2
12. Triple superphosphate			336	20.6
13. Ammonia	25	0.5		
TOTAL	5059	100.0	1630	100.0

3.0 <u>Raw materials for fertiliser production</u>

3.1 The first fertiliser plant in India was started as early as 1944 with a small installed capacity of 1300 tonnes/year of nitrogen as ammonium which is based on electrolytic hydrogen and sulphuric acid produced from sulphur. This was followed by another plant within the next 3 or 4 years for the manufacture of about 10,000 tonnes/year of nitrogen as ammonium sulphate based on wood gasification. However, it was only with the start up of the fertiliser plant at Sindri in Bihar State during 1951 with an installed capacity of 70,000 tonnes of nitrogen/year as ammonium sulphate, that India was served in the world map of fertilisers. This plant started production based on coke obtained from coal in the adjacent areas and local gypsum.

3.2 The plants planned subsequently in mid-fifties were based on lignite, coke oven gas from the coke ovens of the steel plants and electrolytic hydrogen, fitting into the various developmental programmes for the mining of lignite, production of steel and generation of power taken up at that time. At about the same time, a beginning was also made in planning the production of fertilisers based on naphtha by the adoption of partial oxidation process. However, it was only in the early sixties that a clear picture on the surplus availability of naphtha emerged by which time steam reformation of naphtha also came into vogue resulting in a large scale planning in fertiliser production based on naphtha.

3.3 With increasing requirements of fertilisers and consequently the feedstocks that go into their production, it became apparent that the requirements of naphtha for the planned fertiliser and petrochemical units will far outstrip the availability calling for use of alternative feedstocks. Having already planned for making use of all the available natural/associated gas, attention has been focussed on other feedstocks like coal, fuel oil/heavy stock, imported ammonia, etc.

3.4 There was a simultaneous development in the production of phosphatic fertilisers also from late forties starting with the production of single superphosphate based on imported sulphur and rock phosphate. India is now producing or planned for production of nitro-phosphate, diammonium phosphate, complex fertilisers, ammonium sulphate phosphate, urea ammonium phosphate and triple superphosphate. In planning the production of these fertilisers, wherever possible, the use of sulphur has been either substituted or eliminated by using sulphuric acid from smelter gases of non-ferrous metal plants or pyrites and nitric acid.

3.5 Some of the aspects that have gone in the search for alternative feedstock and raw materials for increased fertiliser production have been brought out in the paras. that follow.

4.0 Raw Materials for Nitrogen.

4.1 In India, presently all the three forms of fossil feedstock, i.e., solid, liquid and gaseous, are used in the manufacture of nitrogenous fertilizers. While coke, lignite, coke oven gas, natural and associated gas, refinery gas, naphtha and electrolytic hydrogen are already being used in the production of nitrogen, plans have been drawn for the direct gasification of coal and the use of LSHS/HSHS/Fuel oil as feedstock in the future fertilizer plants. Besides, production of fertilizers has been planned in a limited way even based on imported ammonia.

4.2 With the fast changing developments in the fertiliser technology, there is a shift in the choice of the feedstock and the order of its preference amongst the available materials. Besides, the choice is also governed by the relative costs of the various feedstocks and the national economics. Presently, while natural gas is the most preferred feedstock followed by naphtha, the others occupy their place only next to these two feedstocks. However, every country is not blessed with the availability of the most preferred feedstock, leave alone in sufficient quantities. As such, in planning the production programme, due consideration has to be given in making use of the feedstocks available locally to the extent possible before considering the production based on imported feedstock involving payment in foreign currency though the latter may be a preferred feedstock.

4.3 The enclosed statement would go to show how the emphasis on feedstock shifted with increasing fertilizer requirements, changing technology and availability of various feedstock. The significant development in future years will be in the direction of using coal for direct gasification and the use of fuel oil/heavy stock for fertilizer production by the adoption of partial oxidation. Though the share of naphtha goes down from its peak level of 71% in 1973-74 to 39% during 1978-79, it will still continue to occupy the first place followed by fuel oil/heavy stock and coal. The basis for the adoption of the future pattern of consumption of fertiliser feedstock is discussed in the paragraphs that follow.

4.4 Natural and associated gas. Nitrogenous fertilizer is already being produced and is further planned for production to the extent of over 600,000tonnes of N per year both in the Western and Eastern regions where the gas is available. On the basis of the proved reserves, there is no scope for planning further production based on this feedstock.

4.5 Naphtha. Besides fertilizers, naphtha is also an important feedstock for the petro-chemical industry. The field for choice of feedstock for petro-chemicals being narrow, in a situation where the availability of naphtha is limited, it will claim for a priority over fertilizers in the allocation of naphtha. The consumption of naphtha by the fertilizer and petro-chemical industry in the country, which, at present, is of the order of about 1.4 to 1.5 million tonnes, is expected to increase to a level of about 3.8 milli n tonnes by the year 1978-79 to meet the requirements of the schems that have been planned so far. As against these requirements, on the basis of the projected refining capacity for petroleum crude, primarily to meet the requirements of the middle distillates, the availability of naphtha may be of the order of 3.0 million to 3.1 million tonnes leaving a deficit for naphtha. Since there is the shortage for naphtha even for the approved projects, there is no possibility for planning further production based on naphtha.

4.6 Coal/coke/lignite. There are already fertilizer plants operating in the country based on coke and lignite. However, the reserves for cooking coal in India are limited and, therefore, whatever is available has to be naturally earmarked for the essential requirements such as steel. India is, however, rich in low grade non-coking coals with medium to high ash content and these deposits can profitably be exploited in the manufacture of nitrogenous fertilizers. The one inhibiting factor in this direction is that arising out of the larger volume of coal that goes into the manufacture of the fertilizer than that of the product itself, the plant necessarily has to be set up near the coal mine itself, whereas the need for further planning additional production of fertilizers, sometimes, arises at locations which are far off from the coal reserves. Besides, the mining facilities for the large quantities of coal required for fertiliser production also have to be developed simultaneously with the fertiliser project involving high capital investment.

4.6.1 In India, the establishment of coal based plants is being watched with great interest. This becomes crucial from the national economic point of view, especially in the context of steep rise in prices of crude oil and consequently other petroleum products. The second factor in favour of coal based plants is the large volume of employment that such schemes generate in the total picture of mining and fertiliser production. This is a vital factor for a developing country. So far, four schemes totalling to a capacity of about 0.9 million tonnes of N per year have been planned based on direct gasification of coal and are expected to be implemented within the next 4 or 5 years' time.

4.7 Coke oven gas. There is an installed capacity to the extent of about 110,000 tonnes of nitrogen/year based on coke oven gas either available from the coke ovens of the steel mills or those of the existing fertiliser plants. Any production of fertilisers based on coke oven gas in India will have to be necessarily tied up with its availability in sufficient quantities from the coke ovens installed in large size steel plants. However, since the cost of other fuels as a source of energy is high compared to coke oven gas to the steel mills, a part of the coke oven gas produced is used for providing the necessary heat energy for certain sections of the plant itself and all the coke oven gas produced is not available to plan for an economic sized fertiliser unit. The scope for development of capacity based on coke oven gas is, therefore, limited.

4.8 <u>Refinery gas</u>. There are limitations in planning fertiliser production based on this as feedstock since the available gas from any of the refineries of the size installed in India is not adequate to plan for an economic sized unit. Further, the fluctuations in the composition of the gas pose a problem in the smooth operation of the fertiliser plant at the optimum level. Presently, there is one unit operating in India supplementing its naphtha consumption with refinery gas.

4.9 <u>Electrolytic hydrogen</u>. As in the case of coal based plants, utilisation of electricity for fertiliser production involves high initial investment for both power and fertiliser plants and calls for the availability of a very cheap power in large quantities at a single location. Further, since no carbon dioxide will be available from the ammonia plant based on electrolytic hydrogen, unlike those based on carbonaceous feedstocks, the products pattern from a fertiliser plant based on electrolytic hydrogen will have to be limited to those which do not require carbon dioxide.

4.9.1 Presently, there are pockets of power shortage in India and even the existing fertilizer plants are experiencing power cuts/failures/dips. The scope of availability of adequate power for fertilizer production based on electrolytic hydrogen in the immediate future is limited. Thermal power being costly, it cannot be considered for the production of electrolytic hydrogen even in future. There is, however, the potential for fertilizer development based on this route provided cheap electricity can be produced either by tapping the available resources for generating hydro-electric power or by the installation of large multi-purpose nuclear power stations and the bi-polar cells, which are presently under development, are commercialised, contributing to a reduction in the initial capital cost and subsequent operating costs by reduced power consumption in the fertilizer plant.

4.10 Imported ammonia. As in the case of the electrolytic hydrogen, this also limits the product pattern to such of the fertilizers which are not dependent on carbon dioxide. Further, considering the problems and effort involved in unloading, handling, transporting and storage of large quantities of liquid ammonia, any production of fertilizers based on this material will have to be ordinarily limited to coastal locations. Also, though the initial investment in setting up a nitrogenous fertilizer plant based on imported ammonia is somewhat less, it involves a recurring expenditure in foreign exchange for importing the ammonia and thus, it cannot be seriously considered as an alternative materials for fertilizer production over long periods of time though it would have its usefulness in planning production based on imported ammonia spread over a period of short duration.

4.11 Fuel Oil/Heavy Stock. In India, this petroleum product is presently used as a source of fuel for various industrial purposes. On the basis of the projected crude throughput, the availability of fuel oil by 1978-79 is expected to be more than 5 million tonnes, while that of heavy stock will be nearly 2 million tonnes.

4.11.1 Though not in India, fuel oil/heavy stock is already being used in the manufacture of fertilisers elsewhere in the world. Also, it is gaining in importance as a feedstock in the fertilizer production with increasing demand for naphtha in the petrochemical industry and changing technology in the use of fuel oil as feedstock resulting in economies in production costs. Taking these aspects, as also the overall availability of fuel oil/heavy stock from the projected programme of crude throughput into consideration, part of the fertilizer production programme is already planned or being planned based on fuel oil.

4.11.2 The projected requirements of fuel oil/heavy stock as feedstock for the fertilizer industry for the capacity that has been planned or proposed to be planned to meet the full requirements until the end of 1978-79 will not be more than 1.4 to 1.5 million tonnes. In India, where steam raising coal is available in plenty, it should be no problem to provide this quantity of heavy stock for fertilizer production, if necessary, even by curbing the growth rate in the consumption of fuel oil/heavy stock for non-essential purposes and instead using coal in its place.

4.12 Other raw materials used in nitrogenous fertilizers

Depending on the end product and process adopted, limestone, gypsum, sulphuric acid and hydrochloric acid are some of the materials that go into the manufacture of certain end products of nitrogen. There is also some production of nitrogen as ammonium sulphate recovered as a by-product from coke oven gas. Mention may also be made here that part of the gypsum that goes into the manufacture of ammonium sulphate in India, at present, comes as a bye-product from the phosphoric acid plants. The only plant at Sindri, Bihar, presently, operating based on mined gypsum is also expected to switch over to the bye-product gypsum during the next two to three years' time when it starts producing phosphoric acid.

5.0 Raw Materials for Phosphatic Fertilizers.

5.1 Until recently, the Indian phosphatic fertilizer industry was completely dependent on imported rock phosphate and sulphur for its production. However, with the commencement of production of nitro-phosphate in the Trombay fertilizer plant from late 1965, a beginning was made in reducing the use of the imported raw materials in the phosphatic fertilizer production. Some production of superphosphate has also been taken up based on the sulphurous gases obtained from the non-ferrous smelter plants and waste sulphuric acid.

5.2 While, in the past, the phosphatic fertilizers produced in the country were containing low and single neutrient, the recent planning has been oriented towards creating capacity for the manufacture of more and more high nutrient straight/complex fertilizers. There has also been a diversification in the raw materials used in the production of the phosphates. Besides rock phosphate and sulphur, the other materials used/planned for use are sulphurous gases from the non-ferrous metal plants/pyrites, waste sulphuric acid, nitric acid and phosphoric acid.

5.3 Rock phosphate. Irrespective of the process adopted in the manufacture of the phosphatic fertilizer, rock phosphate would have to be used as a raw material, the sole exception being the case of fertilizer using imported phosphoric acid.

Until recently, India was completely dependent on imported rock phosphate for its requirements. In the late sixties, deposits of rock phosphate of commercial interest have been discovered in the States of Rajasthan and Uttar Pradesh. Part of the deposits in Rajasthan can be taken up for exploitation without any beneficiation. A beginning has already been made towards the exploitation of the rock phosphate deposits available in the State of Rajasthan and presently, about 300,000 tonnes of rock phosphate are being mined and made available to the fertilizer industry in the country. With the development of facilities for mining and beneficiation of low grade material, it is expected that the local production of rock phosphate will gradually increase to a level of not less than 2 million tonnes per year during the next four or five years. As the requirements of rock phosphate also would constantly go on increasing, the local production will go only to meet a part of the requirements of the country and India may have to continue to import its balance requirements of rock phosphate from different sources.

5.4 Nitric acid in phosphate manufacture.

Nitric acid has been given consideration for acidulation of rock phosphate since India has no resources for sulphur and the sulphur bearing materials are not available in sufficient quantities.

The phosphate cycle, as a whole is long with residual effects on the soil. The nitro-phosphates manufactured by the carbo nitric process (CNC) contain only citrate soluble P_2O_5 for the utilisation of which there are certain reservations, especially for short duration crops. However, the application of nitrophosphates containing not less than 30% water soluble P_2O_5 has shown encouraging response for a variety of crops. In order to conserve on the use of sulphur, manufacture of nitro-phosphates containing partially water soluble P_2O_5 has been planned to the extent of a little over 200,000 tonnes of P_2O_5 over and above the existing capacity of about 45,000 tonnes of P_2O_5 per annum. Adoption of sulphate recycle process, with provision to add phosphoric acid to adjust the N and P ratio is contemplated as a process route for the production of partly water soluble phosphate.

5.5 **Pyrites, smelter gases and waste sulphuric acid**

India has workable deposits of pyrites in Bihar and Rajasthan States. Exploitation of the pyrites in Bihar has been commenced and it is expected that production to the tune of about 160,000 tonnes of P_2O_5 will be taken up by 1973-74 based on pyrites. There is also a programme for taking up the manufacture of complex fertilisers making use of the locally available pyrites and rock phosphate when once programme of mining and beneficiation of the latter available in Rajasthan is finalised.

5.5.1 The sulphurous gases obtained from the smelter gases of the non-ferrous metal plants, wherever available, are being exploited in the manufacture of phosphatic fertilisers.

5.5.2 Similarly, some production of phosphates has also been planned based on waste sulphuric acid wherever available in considerable quantities or where there is scope for its collection from different chemical and dye stuff units.

5.6 Imported phosphoric acid. Presently, there are no phosphatic fertiliser units operating based on imported phosphoric acid. During the period of scarcity for sulphur, when the supply position in the international market was uncertain and the prices were ruling high, phosphate production has been planned to a limited extent at three locations by making use of imported phosphoric acid. As per the arrangements made, the duration of import of the acid is expected to be about 5 years, by which time these units also may be able to create their own facilities for the manufacture of phosphoric acid within the country.

5.7 Elemental Phosphorous. Since the manufacture of elemental phosphorous for fertiliser production would eliminate the use of imported sulphur, consideration has been given for the manufacture of phosphorous within the country. This calls for availability of cheap power in abundance. Even then, it is felt that the economics of manufacture of phosphorous within the country will break even compared with wet phosphoric acid only when the ruling price for sulphur is very high. Though there had been cycles of shortage for sulphur in the international market, by and large, the material is available at reasonable prices and, as such, no production of phosphatic fertilizers based on elemental phosphorous has been planned so far in the country.

5.8 Hydrochloric acid as raw material for acidulation of rock phosphate

Since hydrochloric acid is not available in sufficient quantities at any single location and the chlorine produced is otherwise usefully utilized, no phosphate production has been planned by this route.

5.9 The growth rate in the consumption of phosphates as also the development of production in India was somewhat slow in the past. However, with the increasing consumption of nitrogen, more and more in the form of complex fertilisers and with the programme of development already on hand, the phosphate industry is expected to make rapid progress in the future years. The estimates of production and the requirements of various raw materials for the phosphate industry as at present and in the future years are expected to be as follows:-

(Table IV)

(Figures in '000 tonnes)

Description	Requirements/availability during			
	1971-72	1973-74	1975-76	1978-79
1. Anticipated production expressed as P_2O_5	330	670	1300	2100
2. Anticipated P_2O_5 production based on nitric acid	25	35	200	400

3. Raw materials(other than nitric acid)

a) Rock phosphate(70-72% BPL)	1000	1900	3550	6600
b) Sulphur	225	425	650	1200
c) Sulphur equivalent of smelter gases fron non-ferrous metal plants	10	20	80	100
d) Sulphur equivalent of pyrites	-	50	125	300
e) Sulphur equivalent of waste sulphuric acid	10	20	25	30
f) Phosphoric acid as P_2O_5	25	100	225	100

It will be seen from the information in Table IV that by substitution and diversification of the acidulating medium of rock phosphate, the requirements of sulphur, which is otherwise imported, have been brought down almost by 50%.

6. Potassic fertilizers

6.1 India has no known resources for the manufacture of potassic fertilizers but for small quantities that could be recovered as potassium chloride or mixed salt from the bitterns of salt obtained in the manufacture of common salt from sea water. Since the unit nutrient value of K_2O as potassium chloride is more economical than potassium sulphate, the major portion of the requirements of potassic fertilizers of India is being imported and used as potassium chloride. Some quantities of potassium sulphate also find application for special crops like potato, tobacco, etc. where the presence of chloride is considered to be detrimental to the crop.

6.2 Since the salt works in the country are too small and scattered, there are limitations in recovering the potash from the salt bitterns. Even if all the potassium that is present in the salt bitterns is recovered, still it would amount to only about 100,000 to 125,000 tonnes of K_2O per year as against the requirement of 900,000 tonnes of K_2O by 1973-74 and 1,500,000 tonnes of K_2O by 1978-79. In this context, there is the need to look for alternative methods of recovery of potassium from sea water itself and a search for potassic deposits in the country is also considered to be important.

7.0 Conclusions. The choice of raw material for fertilizer production in any country will have to depend on the relative availability of different feedstocks and other raw materials and the national economics. What is good for one country may not necessarily apply to another. As an example, while India has large reserves of low grade non-cooking coal which can be exploited at a reasonably low cost of not more than $5-6 per tonne at the mine head, this may not prove to be attractive feedstock in countries where its cost is high compared to that in India and other alternative fuels are available comparatively at a cheaper price. Hence, a balance has to be struck between the relative economics of manufacture of the fertilizer based on different feedstocks and raw materials and the national benefit in choosing one or the other for the manufacture of the fertilizer.

STATEMENT

NITROGEN CAPACITY BASED ON DIFFERENT FEEDSTOCKS

	1955-56		1960-61		1965-66		1970-71		1973-74		1978-79	
	Quantity '000 tonnes	Per-centage	Quantity '000 tonnes	Per-centage	Quantity '000 tonnes	Per-centage	Quantity '000 tonnes	Per-centage	Quantity '000 tonnes	Per-centage	Quantity '000 tonnes	Per-centage
1) Naphtha					112	19.1	803	59.7	1668	70.6	3521	58.7
2) Fuel oil/heavy stock							-	-	-	-	1677	27.9
3) Natural/associated gas							131	9.8	233	12.0	560	9.3
4) Coal	10*	10.4	10*	4.0	-	-	-	-	-	-	916	15.3
5) Coke	70	73.0	80	32.3	80	13.7	80	5.9	80	3.4	-	-
6) Lignite					70	12.0	70	5.2	70	3.0	70	1.2
7) Coke oven/refinery gas			47	18.9	212	36.2	152	11.4	152	6.4	115	1.9
8) Electrolytic hydrogen	1	1.0	91	36.7	91	15.6	88	6.6	88	3.7	88	1.5
9) Imported ammonia											225	3.7
10) By-product from coke oven gas	15	15.6	20	8.1	20	3.4	20	1.4	20	0.9	20	0.3
TOTAL	96	100.0	248	100.0	585	100.0	1344	100.0	2361	100.0	6000	100.0

* Wood gasification.

15. 3. 72