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UREA AS A NITROGEN FERTILIZER

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The total cost of chemical fertilizers imported into this country in 1966 was approximately Rs. 90 million. Of this figure, some 68% or over 60 million, was spent on nitrogenous fertilizers, principally ammonium sulphate, with marginal quantities of urea and calcium ammonium nitrate.

The total tonnage of these compounds imported was slightly more than 195,000 tons, but the quantity of the essential nutrient contained in this vast tonnage was only some 43,000 tons of nitrogen.

By comparison, the estimated requirements of nitrogen in 1966 for only our primary crops, namely, tea, rubber, coconut and paddy, was of the order of 130,000 tons.

If we add to this the nitrogen requirements of other crops, such as sugar cane, and essential food crops, like chillies, onions, potatoes, vegetables, and fruits, the total figure would probably be closer to 140,000 tons.

Foreign exchange limitations, high prices, the burden of a correspondingly high local subsidy, and certain other factors, all contribute to the continuance of the large gap between recommended levels of usage and actual imports of nitrogen.

The serious economic plight of our export crops at the present time, coupled with the desperate need for both extensive and intensive cultivation of essential food crops, makes it imperative that we should do everything possible to maximise output and at the same time, minimise cost of production.

Sine Qua Non

There are undoubtedly, many factors that would have to contribute towards the achievement of this objective, but more so than any, perhaps, is the importance of the role that fertilizers could play.

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Since nitrogen is a very significant constituent of our fertilizer mixtures, the procurement of adequate supplies of nitrogen from the cheapest possible source would appear to be a sine qua non in our quest for agricultural sufficiency.

The purpose of this article is to draw attention to the many advantages of urea as a cheap and efficient source of nitrogen, and in this context to explain briefly the plans of the Corporation responsible for undertaking the manufacture of nitrogeous fertilizer in Ceylon.

World Trends

Ammonium sulphate—a compound of ammonia and sulphuric acid—which contains 21 per cent by weight of nitrogen, has been our traditional source of nitrogen for many years.

Because of its relatively low nitrogen content, it is by no means the cheapest source of this nutrient, but it has been and continues to be, used on a large scale.

Urea, on the other hand—a compound of ammonia and carbon dioxide—contains 46 percent nitrogen and although it is the most concentrated solid nitrogen fertilizer known, it is a comparative new-comer into the field.

Its high nitrogen content, however, makes it a cheap source of this nutrient, and, as the following figures show, for this reason alone, urea is rapidly replacing other forms of nitrogen fertilizer in the world market:—

World Exports of Straight Nitrogen Fertilizers
(1000 metric tons of nitrogen)

Form	1961/62	1965/66	*% Increase*
Ammonium sulphate ...	1,045	1,337	+ 28
Ammonium nitrate and CAN ...	788	627	— 20
Urea	520	947	+ 82
Others	516	601	+ 16

Production

This increase in exports of urea has taken place simultaneously with an equally significant increase in manufacturing capacities within the importing countries themselves. This is particularly true of countries in the Asian region.

The following figures show production capacities in 1964, and planned increases by 1970, in respect of ECAFE countries:—

Country	*Production* 1964 (1000 *metric tons nitrogen*)		*Planned Increase* 1970	
	Am. Sulph.	*Urea*	*Am. Sulph.*	*Urea*
India	118	52	42	415
Pakistan	11	76	11	156
Japan	1,047	524	—	150
Others	95	169	139	454
All countries	1,271	821	190	1,175
% Increase			15	143

The trend towards increased production of urea is unmistakably seen.

The prospect of manufacturing nitrogenous fertilizers in Ceylon became a reality when the Government's plans for the establishment of an oil refinery were finalised.

Naphtha, a by-product of the refinery, is an excellent raw material for the production of ammonia, which is the starting point in the manufacture of all nitrogenous fertilizers.

When the State Fertilizer Manufacturing Corporation was set up in May 1966, it received a mandate from the Government to manufacture 220,000 tons of ammonium sulphate and 40,000 tons of urea. This pattern of end-products was decided upon, having regard, purely, to the traditional use of ammonium sulphate in Ceylon, and the possibility that some urea could, with advantage be used on paddy.

No Imports

The conversion of ammonia into ammonium sulphate was found to require the importation of large quantities of sulphur, which has to be converted into sulphuric acid before being reacted with the ammonia.

The manufacture of urea, on the other hand, requires no importation of raw materials whatsoever, but utilises the carbon dioxide already available in the process of producing ammonia. The question then arose whether the end-products decided upon were in fact the best having regard to a variety of factors.

On the one hand, both tea and paddy growers appeared to be looking out for an alternative to ammonium sulphate—tea, because of the long-term acidifying effects of this fertilizer, and paddy, in order to eliminate certain toxic effects produced by the sulphate ion in the wet zone.

On the other hand, world shortages of sulphur, and consequent rising prices, as well as the disadvantage of having to incur foreign expenditure and depend on imports of raw material for a local manufacture, led to serious doubts whether ammonium sulphate should be included as an end-product at all.

In fact, the cost of imported sulphur would have involved the continued expenditure of foreign exchange amounting to more than 30 per cent of the manufactured cost of ammonium sulphate. This would to a great extent, have defeated the object of local manufacture, which was to save foreign exchange.

Alternatives

Detailed studies were, therefore, undertaken of various alternative sources of nitrogen fertilizer, with a view to determining the most advantageous end-products to be manufactured locally.

Because of the tremendous importance to our economy of our primary crops and the fact that all of them, with the exception of paddy, are long-term crops, where a mistake made now may take years to correct, the choice was by no means easy.

Besides ammonium sulphate, the alternatives considered were ammonium nitrate, ammonium chloride, and urea. Economically, the choice of urea was undisputed, but other considerations had obviously to be taken into account, particularly the acceptance of urea, agronomically, under local conditions.

After many months of investigation and discussion with various authorities, both local and foreign, a decision was eventually taken to confine the local manufacture to urea alone.

The following are among the reasons that led to the choice of urea as a single end-product :—

(1) Being the most concentrated solid nitrogen fertilizer, it is the cheapest source of nitrogen. The practical significance of this high nitrogen content may be seen from the following figures of the quantities of the various fertilizers which yield 100 lbs. of nitrogen :—

Calcium ammonium—Nitrate (20. 6 p.c.) ...	486 lbs.
Ammonium sulphate	471 ,,
Ammonium chloride	378 ,,
Ammonium nitrate	286 ,,
Urea	214 ,,

The high concentration of urea also enables savings to be made on containers, storage, transport, and handling.

(2) No imported raw materials are required for the manufacture of urea, other than very small quantities of chemicals. Virtually no foreign exchange costs are therefore, involved in its manufacture locally.

(3) It has been established by trials in Ceylon, as well as in other countries, that urea is as effective as a source of nitrogen, as any other nitrogen fertilizer. It has no harmful effects on crops or soil, and, under certain conditions is, in fact, more readily assimilated. Its acidifying effect on the soil is some 20 per cent less than that of ammonium sulphate.

(4) Recent developments overseas indicate that urea could also be satisfactorily incorporated in manufacture of complex NPK fertilizer compounds. It has, therefore, this flexibility, should future trends in Ceylon require the manufacture of high-analysis complex fertilizers.

(5) The manufacture of a single end-product reduces the capital investment, as well as the manufacturing costs per ton of nitrogen.

Difficulties

There are, however, certain physical difficulties associated with the use and application of urea in the field, which cannot be overlooked in an objective assessment of its value as a fertilizer.

The very fact of its high nitrogen content raises at once the problem of ensuring uniformity of application of the smaller quantity of fertilizer material involved.

This is, at most, a problem of adequate field control, and is by no means insurmountable. More serious, however, is the high solubility of urea, which renders its handling somewhat more troublesome than, for example, is the case with ammonium sulphate.

This is overcome to some extent, by manufacturing urea in pills, coating the pills with some inert substance, and packing in water-tight, polythene or polythene-lined bags.

Under these conditions, urea has been stored in Ceylon for as long as six months, without deterioration.

A third difficulty is that urea does not lend itself to mixing with P and K compounds, but recent developments suggest that this will not remain a problem for long.

In any case, a fair amount of nitrogen is already applied direct in Ceylon in other forms, so that urea should present no particular problem in this regard.

Capacity

The review of the choice of end-products led inevitably to a second look being taken at the planned capacity of the factory.

The original plan visualised the production of some 66,000 tons of nitrogen annually (in the form of ammonium sulphate and urea), which though representing an increase of approximately 50 per cent on the current level of imports, was still far short of the optimum requirements of nitrogen, namely, 130,000 tons.

The factory would take anything up to 3 years to build, and is expected to be commissioned by 1970/71. To reach full production would perhaps take another year or two. It was necessary therefore, in planning its capacity, to anticipate Ceylon's requirements of nitrogen sufficiently ahead into the future, so that production would not fall short of demand within a short time after the commencement of manufacture.

Tons Nitrogen	*Form*	*Cost (Rs. Million)*
43,000 (actual imports in 1966)	Imported amm. sulphate	62
	Imported urea	49
	Manufactured urea	28
130,000 (optimum requirements)	Imported amm. sulphate	188
	Imported urea	147
	Manufactured urea	85

	(*Costs in Rupees*)	
Ammonium Sulphate	*Imported* (1966) (*CIF Cost*)	*Manufactured*
Cost per ton	303	245
Cost of equiv. nitrogen/ton	1,443	1,166
Cost of 100 lbs. nitrogen	66	53
UREA		
Cost/ton	520	300
Cost of equiv. nitrogen/ton	1,130	652
Cost of 100 lbs. nitrogen	51	30

There are always difficulties in making projections for the future but past experience in industrial development in the public sector has shown that it is more expensive to err on the low side, than to overestimate demand in the future.

The choice of urea as the end-product has the advantage that any initial surplus would be easily exportable to Asian countries, such as India or China, where the demand for urea is not likely to be satisfied for a long time to come.

Availability

In order to take advantage of certain recent technological advances which have resulted in reducing investment costs as well as manufacturing costs, the capacity of the projected factory has now been fixed at the equivalent of approximately 145,000 tons of nitrogen per annum.

While this may seem inordinately high in relation to our current level of usage, namely 43,000 tons per annum, it is very little higher than what we need to use on our primary crops, namely 130,000 tons.

The latter will, undoubtedly, increase *per se*, as it has done in the past, and added to this increase will be the new demand resulting from increased acreages and the intensification of subsidiary food production.

It is more than likely that when urea is manufactured locally, demand will be determined by availability, rather than, as is now the case, that demand is inhibited by high prices, and availability depends on what foreign exchange the country can afford.

Despite these limitations, imports of nitrogen have more than doubled during the last 10 years. It would be more than pessimistic to doubt that the consumption of nitrogen would treble itself during the next decade, when urea is manufactured locally and becomes freely available at prices, certainly lower than current levels.

Economics

The costs of importing ammonium sulphate and urea are compared below with the estimated costs of manufacturing them locally. In each case, the cost of nitrogen per ton appropriate to the products is given.

The estimated cost of manufacture includes the cost of bags (for comparison with imported costs), and is some 20 per cent higher than the figure computed by our consultants. Nevertheless, the cost of nitrogen in urea is seen to be very much lower than that in ammonium sulphate, when the costs of local manufacture are compared.

Put in more readily understood terms, a farmer who applies 100 lbs. nitrogen now in the form of imported ammonium sulphate, will, for the same cost, be able to apply more than twice that quantity in the form of urea, when it is manufactured locally.

Lest this seems too much like counting the chickens before they are hatched, it is only necessary to note that even if the cost difference noted above is halved for any reason, the saving on urea would still be considerable.

Cheaper

It is known that under certain conditions, such as a hot, dry climate, nitrogen losses from urea are somewhat greater than from ammonium sulphate, because of the different form in which nitrogen is made available to the plant in the two cases.

This is sometimes offered as a criticism of urea, but simple arithmetic should show that since nitrogen in urea is very much cheaper than the nitrogen in ammonium sulphate—in fact, close on 50 per cent cheaper—a corresponding extra quantity of urea can be applied to make good the nitrogen loss, while still keeping it cheaper than ammonium sulphate.

The cost implications of having to apply urea separately from the P and K components of fertilizer can, similarly, be worked out quite simply, to show that it would not affect the overall economics of using urea.

In the case of tea, for instance, the cost of applying fertilizer is understood to be about 5 per cent of the cost of the fertilizer applied.

It is, perhaps less in the case of other crops. With the considerable reduction in the cost of nitrogen on changing from imported ammonium sulphate to locally manufactured urea (in effect, Rs. 36 for every 100 lbs. nitrogen) the additional 5 per cent of cost should make little difference.

Savings

Savings in foreign exchange are found to be quite considerable when urea manufactured locally is substituted for imported ammonium sulphate. They are appreciable even when imported urea replaces imported ammonium sulphate, as the following figures show.

Our actual imports in 1966 cost Rs. 62 million. Had we imported urea instead, it would have cost us only Rs. 49 million in foreign exchange. The manufacture of equivalent urea would cost Rs. 28 million of which approximately Rs. 4 million would represent the foreign exchange cost of bags.

Switching from imported ammonium sulphate to locally manufactured urea would thus result in a foreign exchange saving of Rs. 58 million each year. As against imported urea, the saving on manufactured urea would be Rs. 45 million, and had we imported urea in 1966 instead of ammonium sulphate, we would have saved Rs. 13 million.

The table also shows that it would have cost us Rs. 188 million to import our optimum requirements of nitrogen in the form of ammonium sulphate.

The cost of importing these requirements as urea would have been Rs. 147 million, a saving of Rs. 41 million merely by the switch of imports.

On the other hand, local production of urea would have cost Rs. 85 million, of which only some Rs. 12 million would have been the foreign exchange cost of bags.

The very large savings that can result from local manufacture, both in basic costs per ton of nitrogen and in foreign exchange should be evident from these figures, without labouring the point any further.

Substitution

To ensure that the urea to be manufactured in 1970-71 will be fully utilised, it is necessary that all crop growers should be progressively introduced to it, starting as soon as possible.

The tendency of all farmers to resist change is well known, but there is no doubt that with the marked economic advantages of urea, a smooth change-over can be achieved with adequate propaganda and the education of farmers in the field.

The earlier paragraphs drew attention to the immediate savings of foreign exchange that can be realized by the switching of imports from ammonium sulphate to urea, and the Ministry of Agriculture, in consultation with importers and the various research institutes, is working out a program for the progressive replacement of ammonium sulphate by urea, so that the shift from imported urea to the locally manufactured product can take place without difficulty when the factory comes into production.

It is hoped that this article would help in placing before the public the overall advantages of urea, from the individual farmer's point of view as well as in the interests of the country.