THE PHILIPPINE FERTILIZER INDUSTRY: A DOMESTIC RESOURCE COST ANALYSIS

By

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Introduction

The introduction of a new seed-fertilizer technology designed to boost food production has emphasized the role which fertilizer can play in the Philippine food program. To the farmers, the extensive campaign for the new technology has brought about increased awareness of the profitability of the promised higher yields. Encouraged by reported dramatic yield increases and by government programs, farmers readily took to the high-yielding seed varieties. However, their acceptance of fertilizers has come about slowly. In contrast, sugarcane growers have always been heavy fertilizer users. They absorb about 52 per cent of total fertilizer consumed while ricegrowers account for 26 per cent, and other cropgrowers, 22 per cent [Paje, Kunkel, and Alcasid (1974)]. The fertilizer industry is, therefore, servicing dollar-earning crop production and, more importantly, food production. Moreover, the industry is expected to receive strong growth impulses as agricultural sector's effective demand for fertilizer is projected to increase over time [Shields and Gray (1971)].

The industry, however, has links not only with the agricultural sector but with other industries as well. Its raw materials come from oil and gas refineries (feedstock) and the mining industry (elemental sulphur), although a significant portion of the industry's raw materials is imported. In return, it produces sulphuric acid which is used in recovering copper from copper oxide ores. Its ammonia plant has liquified carbon dioxide and refrigeration grade ammonia as by-products; its phosphoric acid plants supply gypsum to the cement industry, and pyrite cinders are marketed commercially [Hignett and Achorn (1974)].

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In view of these linkages and the expected rise in effective demand for fertilizers, the argument for the expansion of existing fertilizer plants seems plausible. Such a move, however, would be dependent on various factors affecting the local industry. For one, the local industry faces strong competition from imported fertilizers. It is also very vulnerable to fluctuations in the price of imported inputs and the available supply of the same in the world market. These problems are aggravated by the tax-free importation of fertilizer, a policy which aims to assist the farmers secure cheap fertilizer. But the policy package does not really ignore the producers. Imported fertilizer raw materials are also exempted from taxes and the payment of import duty. Furthermore, the government, through the Fertilizer and Pesticide Authority (FPA), subsidizes the fertilizer industry by the amount of actual losses incurred in spite of the tax and duty exemptions on imported fertilizer and fertilizer inputs.

The issue of expanding the fertilizer industry in the Philippines brings up a number of questions, some of which will be investigated in this paper. They are: How competitive is the industry with respect to imported fertilizer? Would the Philippine economy be benefited by the channelling of resources to increased fertilizer production as against the resources needed to import them?

The Philippine Market for Fertilizers

As in any commodity market, that for fertilizers is affected directly by decisions made by consumers (crop growers), producers, and the government. Indirectly, it is also determined by natural conditions (e.g., floods or drought), availability of domestic inputs, changes in the price of imported inputs, freight rates, technological breakthrough in fertilizer production in other countries, and general world and domestic economic conditions.

Demand for fertilizers

Fertilizer consumption has been estimated to have grown by 16.8 per cent (compounded) annually between 1958 and 1968 [Crisostomo and Barker (1972)]. In terms of tonnage of fertilizer output purchases, fertilizer consumption increased from about 57,000 tons in 1958 to about 279,000 tons in 1968. In terms of plant nutrients, 170,000 metric tons were consumed in 1970 as compared to 80,000 metric tons in 1965 or 20,000 metric tons in 1964. Shields and Gray (1971) project effective demand for plant nutrients to reach 299,000 metric tons in 1975 to about 423,000 metric tons in 1980, with 56 per cent in the form of demand for nitrogen, 24 per cent for potassium, and 20 per cent for phosphorous. It is further expected that urea, ammonium sulphate, and mixed fertilizers will supply the majority of plant nutrients consumed in the Philippines.

The mid-70 shortage of fertilizer supply in the world market increased the price of nitrogenous fertilizers. This could have caused the 1975 plant nutrient consumption to fall below the projected 299,000 metric tons and will not probably meet likewise the forecast for 1980 of 350,000 metric tons. Exceeding the effects of the international monetary crisis in the early years of this decade, world shortage of nitrogen and the energy crisis caused the price of urea, for instance, to leap from about $70 per metric ton in 1972 to $371 in 1975 (see Table 1).

TABLE 1

C.I.F. Price Per Metric Ton of Selected Fertilizer Grades: 1972 - 1976 (in US dollar)

Year	Urea	Ammonium sulphate	Mixed (NPK)
1972	70.50	38.69	(a)
1973	105.54	57.87	58.85
1974	277.98	168.04	162.17
1975	371.37	219.35	—
1976	125.47	69.03	60.85
1977	132.63	87.01	74.71

[a] Not available.

Sources: Philippines (Republic). National Census and Statistics Office; Foreign Trade Statistics of the Philippines, 1972-1976; Fertilizer and Pesticides Authority, for the 1977 figure.

Pressures on the price of fertilizer appear to have been relaxed sufficiently to stop further price increases, and to permit the sharp decline in 1976. Although 1977 prices appear to be picking up again, there seems to be no immediate reason to suppose that fertilizer prices will behave as they did in the 1973-1975 period. One could, however, speculate that any future price change will tend to be upward, unless increased supply of nitrogen is assured or freight rates substantially reduced (particularly in connection with phosphate rock imports), and/or the world price of crude and fuel oil stabilized at reasonably low levels.

Supply of fertilizer

Domestic production started in 1956 with the Maria Cristina plant in Iligan (Mindanao) built in 1951 and the superphosphate and complex fertilizer plant in Manila by Chemical Industries of the Philippines in 1953. Additional capacity was made possible by the construction of Atlas Fertilizer Corporation's plants in Toledo City, Cebu, and those of Planter's Products (formerly Esso Standard Fertilizer and Agricultural Chemical Co., Inc.) in Limay, Bataan. The industry has a combined rated capacity of 700,000 metric tons of fertilizer materials, with Planters' Products having the largest facility and the only presently operating urea plant in the Philippines. Complex fertilizers and ammonium sulphate account for nearly 80 per cent of the total production capacity of the four plants [Shields and Gray (1971)]. Until the mid-60's local fertilizer has been faced with stiff competition from imported grades which enter the economy through the different farmers' cooperatives. These imports are purchased by the cooperatives tax-free, and sold at a much lower price than the commercial retail price. Moreover, demand for fertilizer has been constrained by inadequate credit facilities, a problem which was tackled on a large scale only in 1973 when the government launched its Masagana 99 program. The industry also encountered problems in its plant operations, and in its inability to match fertilizer demand on a grade-by-grade basis. Probably because of any one or more of the conditions cited, the local fertilizer firms never operated at more than 47 per cent of rated capacity although the different plants did accomplish higher rates of capacity utilization in different years. For instance, ammonium sulphate plants operated at 69.4 per cent in 1964 while complex fertilizer plants operated at 75.4 per cent in 1968. The urea plant, however, could only achieve 40.1 per cent in 1969 and 39.8 per cent in 1975. We could not estimate the highest rate of capital utilization for the superphosphate plant since superphosphate products have been us largely in the production of complex fertilizers.

Before 1966, more than three-fifths of total fertilizer supply cam from imports, a situation slightly reversed from 1966 to 1972 wh local fertilizers accounted for about 53 per cent of fertilizer availab in the Philippine market. When the world price for fertilizer start to climb in 1973, the industry undertook massive importation i 1974 for hedging purposes. F.O.B. value of imported manufactur fertilizers rose from $14.6 million in 1973 to $83.7 million in 197 Expectations were realized in 1975 as price of fertilizers rose furth The following year, however, saw a sharp decline in fertilizer pric amounting to $150 to $250 per metric ton. These speculati activities were reflected in the composition of fertilizer inventories, large part of which were unsold 1974 importations. Thus th industry found itself as late as 1977 with unsold inventories ex ceeding their three-month inventory target.

Government policies on fertilizer

The first postwar legislation concerning fertilizer was Republic A 701, which was passed in 1952 and which amended the Cooperativ Act of 1927. These two Acts provide for the organization o agricultural marketing cooperatives, and for their exemption fro payment of sales, income and percentage taxes, including advan sales tax on imported fertilizers.

In 1955, RA 1609 appropriated ₱45.5 million for the purcha and distribution of fertilizer over the period of seven crop yea (starting 1956/57) from local firms. These fertilizers were to b distributed at subsidized prices through the farmer's cooperativ From this time until the late 1960's, a two-tiered pricing syst existed in the domestic fertilizer market: the commercial firm price, and the subsidized price charged by cooperatives. The subsid contained in RA 1609 was estimated to be more than 50 per cent the commercial retail price [Barker (1969)].

In 1964, the Agricultural Credit Administration (ACA) terminat its fertilizer subsidy program but continued to sell fertilizer throu cooperatives at rates lower than the prevailing commercial lev Three years earlier, RA 3050 removed import duties on fertiliz imported by farming cooperatives, but this tariff (ad valorem, per cent of C.I.F. value) was reinstated for cooperatives in 1965. T same Act restated the exemption clause in RA 702 with respect to the payment of advance sales tax for imports by cooperatives.

In 1973, the government launched the Masagana 99 program, which provided for supervised credit covering the purchase of recommended farm inputs including fertilizers. In the same year the Fertilizer Industry Authority (FIA) was created through Presidential Decree (PD) 135. Four years later, FIA was expanded to supervise the pesticide industry, too. PD 1144 amended PD 135 and created, in turn, the Fertilizer and Pesticide Authority (FPA). The two decrees which articulated the current fertilizer subsidy program, contains the following elements: (a) tax- and duty-free importation of finished fertilizer and/or its raw materials; (b) direct or cash subsidies to enable fertilizer companies to recover actual losses incurred in spite of tax and duty exemption; and (c) exemption from the 50 per cent marginal deposit on the value of the import letters of credit as required by the Monetary Board of other importers. The program is, therefore, two-pronged, aiming to assist both fertilizer users and producers in the country. The two tiered pricing system was replaced by FPA's policy to set a uniform ex-warehouse price for fertilizers. Within this scheme, the retail price is expected to vary by area depending on the transport cost involved.

The Competitiveness of the Philippines Fertilizer Industry

To the questions raised earlier, we shall look into the competitiveness of the fertilizer industry. "Competitiveness" means the relationship between the cost of producing fertilizer in the country and the cost of importing it. Of particular interest here are costs to be borne by society if resources are redirected toward increased production of fertilizer. To do this, the paper follows the domestic resource cost (DRC) approach which was developed to evaluate, in social opportunity cost terms, the domestic resources involved in an effort to save or earn one unit of foreign exchange [Bruno (1972)]. Some of the applications of this concept are the following: Krueger (1966) evaluated the cost of the Turkish exchange control on the performance of potential export producers and import-substituting industries; Hansen and Nashashibi (1975) investigated the competitiveness of traditional and new Egyptian industries, including fertilizer; Herdt and Lacsina (1976) applied the concept of increasing rice production in the Philippines, while Akrasanee and Watanunukit (1977), used the concept to increase rice production in Thailand. Subjecting the DRC estimates to sensitivity analysis gave interesting information like the relative effect of price change of different inputs on comparative advantage positions, changes in the input price structure which can shift an industry from a dollar-saver to a dollar earning one, and the inefficiency of protectionist policies in directing domestic resources to industries with greatest comparative advantage.

Methodology

The domestic resource cost (DRC) of fertilizer production measures the value of local resources used to save one unit of foreign exchange (US dollar) which could have been spent had the country imported the product and not produced it domestically. When compared with the shadow price of foreign exchange (SFX), the DRC gives an indication of the competitive position of the industry [c.f. Bautista (1978)]. Where the DRC exceeds the shadow exchange rate, the industry is said to suffer from comparative disadvantage, local production being more costly to society than importation. Where the reverse holds, the locally produced fertilizer is favorably competitive, and enjoys a position of comparative advantage. Where, in the margin, DRC equals SFX, society could choose between the locally produced and the imported fertilizers with no loss at all. We can roughly take this as the marginal condition for an industry to be deemed competitive.

The DRC of producing fertilizer may be calculated as follows:

$$\mathrm{DRC} = \frac{\sum_{d} q_{df}\, v_d + \sum_{i} a_{if}\, p_i}{p_f^* - \sum_{j} b_{jf}\, p_j^*} \qquad (1)$$

where

q_{df} = amount of domestic primary factor d used in the production of one ton of fertilizer;

v_d = peso price, in opportunity cost terms, of the primary factor d (e.g., shadow wage rate);

a_{if} = amount of the domestic material input i used in the production of one ton of fertilizer;

p_i = peso price, in opportunity cost terms, of domestic material input i;

p_f^* = C.I.F. price (in US$) of imported fertilizer per metric ton;

b_{jf} = amount of the foreign input j used to produce one ton of fertilizer;

p_j^* = C.I.F. price (in US$) of the foreign input j.

DRC calculations ideally call for cost figures which have been purged of taxes and which are costs to the producer but not to society. Although the original intention has been to adjust the data to remove the tax elements, the aggregative nature of the available data made calculations extremely difficult. Different types of capital assets with their associated tax arrangements have been lumped together. Moreover, domestic taxes (i.e., percentage and specific taxes), unlike tariffs, do not lend themselves easily to averages or generalizations. In view of these problems, the cost items have been left unadjusted except for the removal of the tariff element in the foreign components of capital cost. This is done by applying the average tariff pertaining to the commodity (asset) group.

The Data

Firm-level cost data have been availed of. Input coefficients are taken from input usages calculated by the firm after a given production period. Thus, the analysis will be based on realized material input usages (see Tables 2 and 3). Data pertinent to the calculation of domestic resource cost in the production of two grades of fertilizers, urea, and mixed and nitrophosphatic fertilizers, are described below.

Labor. Contrary to expectations, the laborers involved in the production process of either grade of fertilizer are semi-skilled, at the least. Workers in the company's payroll are all classifiable as skilled at the time of interview. Hence, the market wage (or the wage paid them) can be taken as reflective of the labor's opportunity cost. Although contractual (or seasonal) laborers are usually employed during the plants' peak period, they are hired by a contracting firm which, our informant revealed, have them in the latter's payroll (not the plant's). The available cost data for these contractual workers reflect the total service contract cost, including the 30 per cent or so charged by the contractor-firm as overhead expenses. To extract the actual labor cost, the service contract cost is multiplied by 70 per cent. With respect to the plants' workers included in the payroll,

TABLE 2

Estimated Average Material Input Usages per Metric Ton of Product

Input	Unit of measure	Product line							
		16-20-0	14-14-14	18-46-0	12-12-12	Urea	Ammonia	Sulphuric acid	Phosphoric acid
Ammonia	MT	0.238	0.204	0.2825	0.1805	0.755	-	-	- -
P_2O_5	MT	0.230	0.161	0.5315	0.1445	-	-	-	-
H_2SO_4	MT	0.424	0.402	-	0.3405	-	-	-	-
Potash	MT	-	0.245	-	0.236	-	-	-	-
Sand	MT	0.092	0.006	0.016	0.146	-	-	-	-
Fuel	Kl	0.02553	0.0232	0.0322	0.018	-	-	0.00321	-
Steam	MT	0.903	0.730	1.396	0.5502	1.944	4.982	-	-
Defoamer	Lit.	0.1287	0.1287	0.2423	0.1287	-	-	-	0.20
Coating agent	MT	0.011	0.021	-	0.021	-	-	-	-
Electricity	Kw.hr	60.18	53.35	111.35	49.37	222.88	1013.08	93.68	217.36
Raw CO_2	MT	-	-	-	-	0.853	-	-	-
Ref. feed gas	Kl	-	-	-	-	-	0.673	-	-
Fuel, IDO	Kl	-	-	-	-	-	0.303	-	-
Fuel, Gas	Kl	-	-	-	-	-	0.0953	-	-
NaOH, 50 per cent	Kg.	-	-	-	-	-	2.195	-	-
Monoethanolamine	Kg.	-	-	-	-	-	1.563	-	-
Pyrite	MT	-	-	-	-	-	-	0.3603	-
Phosrock	MT	-	-	-	-	-	-	-	3.16
Sulphuric acid	MT	-	-	-	-	-	-	-	2.64

TABLE 3

Breakdown of Fertilizer Manufacturing Costs: of a Typical Fertilizer-Producing Firm 1975

Item	1975
I. *Material Usages*	
A. H_2SO_4 Plant	
Pyrite per ton H_2SO_4	.350
B. P_2O_5 Plant	
1. Phosphate rock per ton P_2O_5	3.090
2. H_2SO_4 per ton P_2O_5	2.772
C. Ammosul Plant	
1. NH_3 per ton Ammosul	
2. H_2SO_4 per ton Ammosul	-
D. Granulation Plant	
1. NP	
(a) NH_3 per ton NP	
18-46-0	.266
16-20-0	.255
(b) P_2O_5 per ton NP	
18-46-0	.527
16-20-0	.213
(c) H_2SO_4 per ton NP	
16-20-0	.358
2. NPK	
(a) NH_3 per ton NPK	
14-14-14	.193
12-12-12	.149
(b) P_2O_5 per ton NPK	
14-14-14	.162
12-12-12	.134

(c) K_2O per ton NPK	
14-14-14	.246
12-12-12	.258
(d) H_2SO_4 per ton NPK	
14-14-14	.384
12-12-12	.369
E. NH_3 Plant	
1. BTU per ton NH_3 (IDO)	12.414
2. Ref. Gas, Feed and Fuel	30.597
F. Urea Plant	
NH_3 per ton of Urea	
II. *Operating Costs Per Production Unit*	
A. Direct labor per ton of product	₱ 1.55
B. Manufacturing overhead per ton of product	
1. NH_3	334.09
2. H_2SO_4	100.97
3. P_2O_5	498.68
4. Urea	497.58
16-20-0	309.16
18-46-0	462.36
14-14-14	271.37
12-12-12	247.10
C. Total utility consumption (₱) per ton product	
1. NH_3	₱650.95
2. H_2SO_4	(1.81)
3. P_2O_5	32.94
4. Urea	128.47
16-20-0	61.12
18-46-0	100.96
14-14-14	58.27
12-12-12	49.67

almost all are skilled. The hiring policy of the firm being such that workers who already have the skills are the ones taken in.

The fertilizer company has no unpaid labor. All who work, either in the plants or in the administrative branch of the operations, draw a salary from the firm.

Capital. This factor of production usually takes the form of fixed assets (e.g., buildings and structures, equipment), inventories, and "other" assets (e.g., furniture and fixtures). Associated with capital are two costs: depreciation and interest. While depreciation costs are normally charged only against fixed and "other" assets, interest costs are shared by all capital items. To represent the opportunity cost of capital, two rates of interest are assumed. Following Herdt and Lacsina (1976), 15 per cent is taken as the "best" estimate, and 20 per cent, the "high" estimate. DRC calculations have been done using these alternative rates. The type of financing on imported materials is such that 100 per cent of the interest cost on inventories is classified as domestic.

Two kinds of data have been collected for fixed and "other" assets. The first set reports the appraised value of lumpy investment goods like buildings, structures, plant machinery and equipment. For this group, calculations of interest and depreciation cost are straight-forward. The second set consists of assets valued at their purchase cost; adjustments on these data had to be made prior to computation of the capital cost (described fully in a separate Appendix available from the author on request). Table 4 presents a schedule of capital assets of one fertilizer manufacturing firm.

Apart from the valuation problem, capital data are not as disaggregated as would have been desirable. They have been grouped into five broad classes: plant buildings and structures, administration buildings and structures, transport equipment, office furniture and office equipment. Thus, assumptions about the firm's capital investment had to be made, particularly in connection with depreciation rates, acquisition year, and source (or country of origin) of the asset. An average depreciation rate has been calculated for each group. Similarly, the sources of the asset items have been approximately identified. To establish the year of acquisition and the value of new assets, the firm's annual reports were examined and the increment from the previous year's figure was taken as the amount of assets purchased during the year. Setting the year of acquisition of the assets which have not been recently appraised is important in the calculation of their replacement cost, on which is based the assets' interest and depreciation cost computations.

To allocate the opportunity costs of capital into its domestic and foreign components, two sets of information are needed. Source of financing is necessary to identify the domestic-foreign distribution of interest costs. For depreciation costs, the source of the equipment, machinery, and other assets have to be established. These information have been gathered from interviews with finance experts and, to some extent, from annual reports on the firm's performance.

The foreign component of capital costs, as with other foreign costs, are converted into US$ using P7.50, the selling and importation rate of 1975, as the exchange rate. To derive the tariff-free equivalent of the peso cost, adjust the initial estimate by removing the tariff elements as follows:

$$c_j^* = \frac{c_j}{r(1 + t_j)}, \text{ for all } j \qquad (2)$$

where

c_j^* = adjusted US$ value of the foreign component of cost item j;

c_j = unadjusted P value of the foreign component of cost item j;

r = selling exchange rate;

t_j = average tariff applicable to the particular asset group.

Land. The land on which the whole production complex is built is owned by the fertilizer firm. It has been appraised last year and, according to real-estate and land-appraisal experts, the value determined during the appraisal (unless it is done for tax purposes) reflects the market value of the land at that particular point in time.

The opportunity cost of the land may be determined at least in two ways. One way is to take the rate of return to land used for

TABLE 4

Schedule of Estimated Value of Fixed Assets by Unit Found in a Typical Fertilizer Production Complex
(in thousand pesos)

Asset Class	Unit					
	Administrative	Urea plant	Sulphuric acid plant	Phosphoric acid plant	Granulation plant	Ammonia plant
Buildings and Structures	11,585	970	231	2,764	358	1,665
Plant machinery and equipment	-	32,647	46,866	23,200	32,099	95,875
Transport equipment	229	-	-	-	-	-
Office furniture and fixtures	(a)	25	22	21	17	14
Land	(Total land holding valued at ₱6,699,000)					

[a]Included in the value of buildings and structures.

agricultural purposes in the same area; the other is to take the rate at which the land could be leased for industrial activities. The first method involves the calculation of the average rent paid by cultivators to the landowner. Herdt and Lacsina (1976) discuss several estimates of agricultural land rental applicable to different parts of the Philippines. Had the data on the total land area covered by the manufacturing complex been available, the agricultural rate of return to land could have been used to estimate the opportunity cost of the land owned by the manufacturing firms.

As a second-best solution, real estate agencies were interviewed to establish the lease arrangements covering land earmarked for industrial purposes. It was gathered that land-owners usually prefer a flexible lease scheme which allows for changes in the rate when the rate of return to other forms of earning assets are fluctuating. Nevertheless, an "average" rate of return to industrial land has been identified to be 10 per cent per annum of the market value of the land. In this exercise, we set the opportunity cost of the land at 10 per cent, considering that this is what the firm would probably get if it decides to have other manufacturing firms rent its land.

Material inputs. The inputs for the different intermediate products (ammonia, sulphuric and phosphoric acid) and for the different grades of fertilizer are shown in Table 2. A cursory inspection of the raw materials, either of the intermediate products or of the finished fertilizers, reveals that a significant portion of the material inputs is imported (see Table 5). The allocation into domestic and foreign cost is relatively straight-forward, except for intermediate products supplied by the other units of the industrial complex where the division into local and foreign component depends on its respective cost breakdown. Although the acids produced by the complex are mainly used in granulation and urea plants, they are also sold in considerable amounts as acids to other industries. For these products, the C.I.F. price (in P) of imported acids is used in the DRC calculations for the finished fertilizers. The same is done for ammonia, but here we use the C.I.F. price (in P too) of imported aqua ammonia. That is to say, society has alternative sources for these inputs and their costs constitute the opportunity costs of the fertilizer industry's intermediate products.

For refinery gas, a by-product of another industry, we assume at least a 60 per cent - 40 per cent distribution of costs into domestic and foreign, and the purchase price as the opportunity cost of the in-

TABLE 5

Estimated Percentage of Raw Materials Imported, and
Major Raw Material Supplier(s) for 1975

Raw Material	Per cent imported/foreign	C.I.F. unit value of imports	Major sources of supply
Ammonia	29	US$ 69.56	Japan
P_2O_5 (Phosphate)	76	505.81[a]	(own-produced)
Sulphuric acid	34	41.25[a]	(own-produced)
Potash	100	90.29	United States Canada
Defoamer (liter)	100	0.70	United States Japan
Monoethanolamine (kilogram)	100	1.12	Japan
Pyrite	-	-[b]	Philippines
Phosphate rock	100	89.70	United States

[a]Importable but not imported by the plant. The price given refers to the unit value (C.I.F.) of imported pure sulphuric acid, and, for phosphate, to unit value of phosphate and phosphoric acid combined.

[b]F.O.B. price for exported pyrites (crude) is $15.39, or P115.42 per metric ton in 1975.

put. We could probably use alternative feedstocks' (e.g., naptha or natural gas) price as the opportunity cost for using refinery gas, but the appropriateness of such an assumption may be questioned in as much as the plant equipment required by the different feedstocks vary significantly.

Domestic resource cost analysis was conducted primarily for urea and nitrophosphatic (and mixed) fertilizers, and for the intermediate products manufactured by the complex as well. The latter was done because intermediate products affect the prospects of expanding the fertilizer plant operations. DRC analysis was also conducted for two levels of capacity utilization: at the highest capacity usage during the past five years; and the other, at 90 per cent capacity utilization. We assume throughout that the firm's designed capacity remains the same (see Figure 1) such that "expansion" of the fertilizer industry would refer primarily to increase utilization of existing facilities. Furthermore, cost data of the firms' marketable industrial products (e.g., gypsum, liquefied carbon dioxide, pyrite cinders, refrigerated ammonia) were not available. Hence, these were left out of the DRC calculations. The interpretation of the results would, therefore, have this as a caveat.

DRC of Expanding Urea Production in the Philippines

The dependence of urea production on the availability of ammonia warrants the discussion of ammonia production prior to that of urea. This becomes particularly important in the face of an integrated industry where its ammonia production is absorbed mainly, if not wholly, by the fertilizer plants. An evaluation of the competitiveness of a local ammonia plant will be done, which will, in effect, be a comparison between cost of local ammonia and the price of imported aqua ammonia.

Ammonia production. The industry's largest ammonia plant has a rated capacity of 310 metric tons per day, or the ability to produce 93,000 metric tons of ammonia per year if the plant will operate at full capacity. However, in 1975, for which we have data, the ammonia plant operated only at 60 per cent capacity. Reported reasons for underutilization of capacity are shortage of feedstock, maintenance downtime, and power outages. The first two reasons account for 45 per cent each of the downtime, while power failure contributes 10 per cent [Hignett and Achorn (1974)].

TABLE [illegible]

Estimated Cost of Producing One Metric Ton of Ammonia[a]

Cost Item	Production cost[b]	Cost with capital valued at[c]			
		High		Best	
		Domestic	Foreign	Domestic	Foreign
Primary factors					
Labor	₱ 25	₱ 25	$64	₱ 25	$
Land	1	1	-	1	-
Capital costs					
Interest	277	213	17	160	13
Depreciation	153	17	15	17	15
Material inputs					
Refinery gas	576	346	25	346	25
Utilities (including industrial diesel oil)	651	651	-	651	-
Totals	₱1,683	₱1,253	$57	₱1,200	$53

[a]The costs are computed following the procedure outlined in Appendix A.

[b]Production costs are estimated using rate of return to capital equal to 15 per cent.

[c]Two alternatively assumed rates of return to capital (rr_k) are 20 and 15 per cent as "high" and "best" estimates, respectively [Herdt and Lacsina (1976)].

TABLE 7

Estimated Cost of Producing One Metric Ton of Urea[a]

Cost item	Production cost[b]	Cost with capital valued at[c]			
		High		Best	
		Domestic	Foreign	Domestic	Foreign
Primary factors					
Labor	₱ 84	₱ 84	$	₱ 84	[illegible]
Land	5	5	-	5	[illegible]
Capital					
Interest cost	276	245	14	184	[illegible]
Depreciation	121	108	1	108	[illegible]
Rentals	17	17	-	17	[illegible]
Material inputs					
Ammonia	403	286	13	286	[illegible]
Utilities	128	128	-	128	[illegible]
Totals	₱1,034	₱873	$28	₱812	[illegible]

[a]The costs are computed following the procedure outlined in Appendix A.

[b]Production costs are estimated using rate of return to capital equal to 15 per cent.

[c]Two alternatively assumed rates of return to capital (rr_k) are 20 and 15 per cent as "high" and "best" estimates, respectively [Herdt and Lacsina (1976)].

TABLE 8

Estimated Cost of Producing One Metric Ton of Sulphuric Acid[a]

Cost Item	Production cost[b]	Cost with capital valued at[c]			
		High		Best	
		Domestic	Foreign	Domestic	Foreign
Primary factors					
Labor	₱ 3	₱ 3	$	₱. 3	$
Land	d	d	-	d	-
Capital costs					
Interest	79	75	3	56	3
Depreciation	30	3	3	3	3
Material inputs					
Pyrite (net)	41	41	-	41	-
Totals	₱153	₱122	$6	₱103	$6

[a]The costs are computed following the procedure outlined in Appendix A.

[b]Production costs are estimated using rate of return to capital equal to 15 per cent.

[c]Two alternatively assumed rates of return to capital (r_k) are 20 and 15 per cent as "high" and "best" estimates, respectively [Herdt and Lacsina (1976)].

[d]Negligible.

TABLE 9

Estimated Cost of Producing One Metric Ton of Phosphoric Acid[a]
(in terms of P_2O_5)

Cost item	Production cost[b]	Cost with capital valued at[c]			
		High		Best	
		Domestic	Foreign	Domestic	Foreign
Primary factors					
Labor	₱ 62	₱ 62	$	₱ 62	$
Land 1	4	4	-	4	-
Capital costs					
Interest	158	141	8	106	[illegible]
Depreciation	65	10	6	10	[illegible]
Material inputs					
Phosphate rock	2,202	-	294	-	294
Utilities	33	33	-	-	-
Sulphuric acid	858	566	30	566	[illegible]
Totals	₱3,382	₱816	$338	₱781	$[illegible]

[a]The costs are computed following the procedure outlined in Appendix A.

[b]Production costs are estimated using rate of return to capital equal to 15 per cent.

[c]Two alternatively assumed rates of return to capital (rr_k) are 20 and 15 per cent as "high" and "best" estimates, respectively [Herdt and Lacsina (1976)].

TABLE 10

Estimated Cost of Producing One Metric Ton of Nitrophosphatic (and mixed) Fertilizer[a]

Item	Total production cost[b]	Costs with capital valued at[c]			
		High		Best	
		Domestic	Foreign	Domestic	Foreign
Primary factors					
Labor	₱ 38	₱ 38	$	₱ 38	$
Land	2	2	-	2	-
Capital costs					
Interest	332	431	2	323	2
Depreciation	21	21	2	21	2
Machine rentals	8	8	-	8	-
Material inputs					
Ammonia	123	86	4	86	4
Phosphate					
(H_3pO x 2322)	273	169	13	169	13
Sulphuric acid	101	67	3	67	3
Potash	61	-	7	-	7
Utilities	164	164	-	164	-
Totals	₱1,123	₱968	$31	₱860	$31

[a]The costs are computed following the procedure outlined in Appendix A.

[b]Production costs are estimated using rate of return to capital equal to 15 per cent.

[c]Two alternatively assumed rates of return to capital (rr_k) are 20 and 15 per cent as "high" and "best" estimates, respectively [Herdt and Lacsina (1976)].

Ammonia is produced by combining atmospheric nitrogen with hydrogen obtained from some hydrocarbon feedstock. Refinery gas from a nearby refinery is used as feedstock. The process of steam reforming of hydrocarbon is practiced [PES (1971); Hignett and Achorn (1974)]. Some 43,000 kilograms of refinery gas were used to produce 56,200 metric tons of ammonia in 1975. Increasing capacity utilization to 90 per cent would require 64,000 kilograms of refinery gas. Whether that much gas would be made available or not could not be determined. It is assumed here, however, that it could be supplied to the ammonia plant if and when needed.

At 1975 prices, one metric ton of ammonia was produced for ₱1683 assuming that the rate of return to capital was 15 per cent. Of this, 71 per cent was identified as domestic cost. At a higher interest cost (say, 20 per cent), the cost of producing one ton of ammonia amounted to about ₱1790 with the domestic-cost portion declining by 4 percentage points. With the C.I.F. price of aqua ammonia at $70 per metric ton, domestic production of ammonia was definitely noncompetitive. If prices of inputs are maintained at 1975 levels, increasing the rate of capacity utilization of the ammonia plant would still be disadvantageous.

Urea production. Full (i.e., 100 per cent) utilization of the industry's urea plant would yield 61,500 metric tons of urea or 27,67[illegible] metric tons of nitrogen. Such level of production requires about 47,000 metric tons of ammonia, or 51 per cent of the full-capacity production level of the ammonia plant. To allow for breakdown, 90 per cent capacity can be assumed as "full" utilization with the corresponding output of 55,000 metric tons of urea.

In the same year that the ammonia plant operations were most brisk, urea was produced at ₱1034 per metric ton with ammonia cost taken to be its *import* price. If we take the higher-cost ammonia produced by the firm, the cost of urea per metric ton would have been ₱1932, or $258. Although urea cost was high, its world price ($371) in 1975 was much higher, causing the urea plant to become competitive with imported urea.

DRC analysis done for 1976 when urea price was $125 reveals that the industry was still competitive even when a higher rate of return to capital has been assumed (see Table 11). Indeed, the computed DRC's with 15 per cent and 20 per cent as alternative rates of return to capital were 8.0 and 9.0, respectively, which compare favorably with the shadow foreign exchange rate of ₱9: US$1. With the lower import price of urea, however, production with the locally produced ammonia clearly involves a loss to Philippine society since to save one dollar we have to use more than ₱9.00 worth of domestic resources. Hence, with the 1975 rate of capital utilization, local urea production remains to be competitive if import price of urea stays above $125, imported ammonia is used, and the price of inputs and the foreign exchange rate are maintained at the 1975 level. A rise in the shadow foreign exchange rate from ₱9.00 in 1975 to ₱8.80 in 1977 surely eliminates the competitive position of local urea production once the opportunity cost of capital rises from 15 to 20 per cent. Nonetheless, as long as greater ammonia supply is forthcoming at a price approximating the 1975 level, expansion of urea production seems to be socially profitable, the ratio between DRC and SFX (when the rate of capital utilization is 90 per cent) being less than one (or DRC < SFX). The insistence on imported ammonia is supported by the comparatively disadvantageous position which the local ammonia plant faces *even if it were to operate at 90 per cent capacity*. Its full-capacity DRC of 19.3 is more than twice the SFX when the opportunity cost of capital is assumed to be 15 per cent.

In terms of 1975 and 1976 imported prices, the DRC of producing one dollar worth of urea is most sensitive to a 10-per cent change in the import price of urea. An increase in urea's import price will generate an improvement in the local urea's competitiveness which is four percentage point greater than the initial 10-per cent change in urea price. Any comparative advantage enjoyed by the Philippine urea production is also somewhat enhanced by increased production, but not by any change in the opportunity cost of capital confined to 10 per cent below or above the best estimate of 15 per cent, nor by a 10-per cent deviation from the 1975 or 1976 import price of ammonia (see Table 12).

As a summary, the social profitability of expanded urea production depends on the price of imported urea. Moreover, future increases in the level of capital utilization are unquestionably linked with ammonia supply and with the decision regarding the output mix of the whole manufacturing complex. Ammonia, it must be remembered, is also used in the production of nitrophosphatic fertilizers, and the limited ammonia supply would then have to be allocated between urea and the other grades produced by the firm. How much will be used for each line of fertilizer product would largely depend on the priorities set by the local market, the firm, and government policy.

DRC of Expanding Nitrophosphatic (NP/NPK) Fertilizer Production in the Philippines

The granulation unit, which turns out four fertilizer grades (i.e. 18-46-0, 16-20-0, 14-14-14, and 12-12-12), has a rated capacity of 250,000 metric tons per year. In 1975, the unit operated at 56 per cent capacity with the following output mix:

Grade	Quantity (m.t.)	%
18-46-0	15,402	11
16-20-0	72,717	52
14-14-14	47,062	33
12-12-12	5,346	4
Total	140,527	100

The operation of this unit depends on the output of three other plants plus an imported raw material, potash. While there is no constraint with respect to sulphuric acid, this being produced most competitively by the firm, ammonia and phosphoric acid supplies place real limitations on the scale of operation of the granulation unit. As stated earlier, nitrophosphatic fertilizers compete with urea in the available ammonia supply. Thus, NP/NPK production is actually limited by the level of demand for ammonia by the urea plant, output of the ammonia unit *and* volume of ammonia which can be bought from the world market, and the price of competing imported fertilizers. Tables 8 to 10 present the opportunity cost of producing one metric ton of two intermediate products — phosphoric and sulphuric acids — and the cost of producing an equivalent amount of NP/NPK fertilizer. The DRC estimates for these outputs are given in Table 11.

In opportunity cost terms, sulphuric acid, is being cheaply produced locally by burning pyrites at ₱153 per metric ton. In 1975, the price of imported (pure) sulphuric acid was about $41, or ₱309, per metric ton. The DRC associated with this product (2.9 at 15 per cent rate of return to capital; 3.5 at 20 per cent) clearly accentuates its comparative-advantage position.

Although phosphoric acid seems to use less than ₱9 worth of domestic resources to save a dollar, its competitive position is not as dramatically defined as that of sulphuric acid. The total (opportu-

…mestic Resource Cost of Increasing Intermediate and Finished Fertilizer Products: 1975

Item	At actual plant utilization		At full capacity utiliza tion (90 per cent)	
	Best[a]	High[b]	Best[a]	High[b]
…ntermediate products				
… Ammonia				
At 1975 C.I.F. price	72.5	99.8	19.3	21.6
C.I.F. price of aqua ammonia per m.t.		$69.56		
… Phosphoric acid/phosphate				
At 1975 C.I.F. price	4.6	4.9	1.5	1.6
C.I.F. price of phosphoric acid per m.t.		$505.85		
… Sulphuric acid				
At 1975 C.I.F. price	2.9	3.5	2.0	2.2
C.I.F. price of sulphuric acid per m.t.		$41.25		
…nished fertilizers				
… Urea				
At 1975 C.I.F. price	2.3	2.5	1.0	1.0
C.I.F. price of urea per m.t.:1975		$371.37		
At 1976 C.I.F. price	8.0	9.0	3.1	3.4
C.I.F. price of urea per m.t.:1976		$125.47		
… Nitrophosphatic fertilizer (NP/NPK)				
At 1974 C.I.F. price	6.6	7.4	3.8	4.2
C.I.F. price of nitrophosphatic fertilizers per m.t.:1974		$162.17		
At 1976 C.I.F. price	28.8	32.4	12.9	14.6
C.I.F. price of nitrophosphatic fertilizers per m.t.:1976		$60.85		

…fficial foreign exchange rate (1975) ₱7.50 = $1.00
…adow exchange rate (SFX) ₱9.00 = $1.00

[a] …ate of return to capital is assumed to be 15 per cent.

[b] …ate of return to capital is assumed to be 20 per cent.

nity) cost per ton of the acid product is ₱3382, or ₱55 lower than the import price per ton of phosphoric acid. Since all the DRC analyses shown in this paper refer strictly to the production and storage of the products within the compound, the addition of packaging and similar expenses would likely narrow this (and urea's) lead. Nonetheless, there remains some evidence that the phosphate-rock importing plant could compete with imported phosphoric acid at the high price of $506 per metric ton. But, as in the case of urea, the comparative advantage enjoyed by a phosphoric acid plant appears to be a temporary one which is closely tied up with the upward pressure on the imported product's price. At both the 56 and 90 per cent rates of capacity utilization, DRC estimates for the NP/NPK fertilizer products lie safely below the shadow foreign exchange rate of ₱9:$1. However, this holds only as long as the price of imported NP/NPK is held above $130 per metric ton. When the price falls below this, as happened in 1976 when the import price was just $61, not even the increased level of local production to 90 per cent capacity could dispel the noncompetitiveness of the local grades.

Similar to local urea, NP/NPK fertilizers display elastic response to a 10-per cent change in the import price of the product. But, unlike local urea, a greater shift in comparative advantage could be brought about by a 10-per cent rise or decline in the volume of production of the firm's granulation unit (see Table 12). With respect to variations in the rate of capital and input (import) prices, nitro-phosphatic fertilizer DRCs show the same inelastic response demonstrated by urea DRCs.

On the whole, therefore, fertilizer products of local firms are very sensitive to fluctuations in the world market: an increase in the world price for fertilizer brings a disproportionate improvement in their competitiveness; a decline, also a disproportionate deterioration in comparative-advantage position. Expanded fertilizer production appears to be socially feasible as long as the world price for fertilizer is kept above identified levels, and as long as supply of inputs, particularly ammonia, is guaranteed from lower-cost sources.

Concluding Remarks

The objectives of this paper are two-fold: one is to investigate whether the fertilizer industry in the Philippines is competitive with imported grades; the other, to see how competitive the industry is.

[illegible]

Sensitivity of DRC with Respect to Change in Selected Parameters at two Rates of Capital Utilization[a]

Item	Urea Actual	Urea 90 per cent	Nitrophosphatic fertilizer[b] Actual	Nitrophosphatic fertilizer[b] 90 per cent
1. *At 1975 C.I.F. price of fertilizer*				
Capital interest cost	0.42	0.18	0.32	0.28
Production level	0.82	0.98	1.16	1.11
C.I.F. price of imported fertilizer	1.38	1.10	1.34	1.17
C.I.F. price of imported inputs				
Ammonia	0.57	0.31	0.06	0.01
Phosphate	-	-	0.23	0.15
Potash	-	-	0.01	0.07
2. *At 1976 C.I.F. price of fertilizer*				
Capital interest cost	0.33	0.34	0.45	0.44
Production level	1.10	0.92	1.69	1.25
C.I.F. price of imported fertilizer	1.41	1.31	2.56	1.76
C.I.F. price of imported inputs				
Ammonia	0.49	0.48	0.24	0.20
Phosphate	-	-	0.66	0.44
Potash	-	-	0.24	0.14

[a]The figures in the table refer to percentage change in DRC as a result of a 10-per cent change in the selected parameters. Except for the C.I.F. price of imported fertilizer, the assumed change in the parameter is upward (e.g., increase in the price of imported inputs, increase in the interest rate).

[b]C.I.F. prices used are those for 1974 and 1976.

Mainly because of the disturbances in the world fertilizer market between 1973 and 1975, local production at slightly higher than half of rated capacity proved to be profitable in a social sense, with the possible exception of ammonia production. Artificially protected by the high fertilizer prices that prevailed in the world market, local urea and nitrophosphatic fertilizers were clearly competitive, even at 20 per cent rate of return to capital. The limiting factors to the social feasibility of increasing local fertilizer production are the fluctuations in the imported price of the fertilizer grade, the shadow foreign exchange rate, and the supply of ammonia from low-cost foreign sources.

With more intensive utilization of existing capacity, a long-run price of $75 would permit the expanding urea production to be competitive. Below this, it would pay for the Philippines to import urea. Were the long-run price remain at the 1976 level of $125 per metric ton, 90-per cent rate of capital utilization could even permit the Philippines to export fertilizers. Mobilizing the same level of capacity utilization in the granulation unit would permit competitiveness in local nitrophosphatic fertilizer production at long-run import price of $80 per metric ton. Thus, if the price remains below $80, it would be more profitable if the Philippines just imports NP/NPK fertilizers. In contrast, if the urea import price were to remain at the present level or to increase further, local urea production is clearly competitive not only in the local but in the world market as well. The long-term prospects of increased urea and/or nitrophosphatic fertilizer production is heavily dependent on the availability of imported ammonia. Continued reliance on locally produced ammonia is not only inefficient but also highly unstable.

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