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**Evaluating  
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in Developing Countries**

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9. ABSTRACT <p>Traditionally, subsidies have been provided in less developed countries to encourage farmers to use fertilizers and thereby expand food production. However, the recent increase in international fertilizer prices threatens to limit constant and widespread adoption of soil enrichment techniques. After a brief historical background, this report evaluates such subsidies on the basis of economic factors influencing demand and use. Policy alternatives and tradeoffs are discussed. While no ultimate conclusions are provided, the author does suggest that long term subsidies may be expensive and ultimately detrimental. Possible alternatives include: short-term subsidies, higher food prices that reflect increased fertilizer costs, and a channeling of subsidy money to research programs devoted to seeking other solutions to the fertilizer problem.</p>
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## AID DISCUSSION PAPERS

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EVALUATING FERTILIZER SUBSIDIES

IN DEVELOPING COUNTRIES

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## ABSTRACT

Recent increases in international fertilizer prices threaten to slow the pace of expansion of agricultural output in the less developed countries (LDC's). Higher prices may limit both the initial adoption of fertilizer and the rate of use by LDC farmers.

Subsidies have traditionally been used in LDC's to encourage adoption of fertilizers. Recently they have been increasingly used as a way of insulating farmers from at least part of the fertilizer price increases. Both courses of action can, depending on how they are handled, be expensive for developing nations. Despite the substantial budgetary costs involved, little evaluation of subsidies has been done.

This report represents a preliminary attempt to evaluate subsidies in LDC's on the basis of secondary data and information. It is the first known review of the subject. The report first introduces and describes fertilizer subsidies. Relevant economic factors influencing demand and use are examined next. The information on subsidies and economics is then woven into a discussion of policy alternatives and tradeoffs.

The study does not attempt to provide categorical conclusions about subsidies. But the evidence reviewed does raise considerable question as to their general merit, except as a temporary means of encouraging adoption or for poorer/smaller farms. In any case, subsidies are seldom a panacea; they need to be accompanied by other policy and technical actions. And in many instances, these other approaches may provide a more efficient solution to the fertilizer price problem.

## PREFACE

The Agency for International Development has a substantial interest in fertilizer. Over the nine-year period from fiscal 1966 to 1974, it loaned a total of \$869.6 million (or an average of \$96.6 million a year) to developing nations to pay for fertilizer imports. 1/ In addition, it loaned money for the construction of fertilizer manufacturing plants and related activities.

That interest continues. In FY 1975, AID expects to loan about \$210 million for fertilizer procurement. It helped finance a new fertilizer plant in Bangladesh and is expected to provide a similar loan to Pakistan. 2/ Substantial additional funds will be spent on fertilizer research, largely at the International Fertilizer Development Center currently being established at TVA.

Within its fertilizer program, AID normally has not become heavily involved in distribution policies. There have, however, been several exceptions with respect to distribution (as in Afghanistan) and subsidies. Examples of the latter include:

- In Chile, from November 1967 through December 1968, a \$10 million credit from AID was used to provide an extra bonus or subsidy to fertilizers. 3/
- In South Vietnam, in FY 1975, the equivalent of about \$52 million (34 billion piasters) in counterpart funds - local currencies accumulated through U.S. sales and grant programs - was spent to support a fertilizer subsidy. 4/

There may be further involvement in distribution policies in the near future: the proposed AID development assistance program for Pakistan, for instance, suggests that future fertilizer loans "will be conditioned on identifiable self-help conditions in areas such as distribution and price policy." 5/

And with the sharp increase in fertilizer prices of the last year two, more governments in the developing world are giving the matter of price renewed thought. Some AID Missions have requested assistance in analyzing the subsidy question. And in at least one AID airgram (to Latin America) the question of need for subsidies was raised. 6/

Hence it appeared desirable to prepare some educational materials on subsidies which might be used by AID country missions. The issue turned out to be less well explored and more complex than anticipated. Therefore, this report might be viewed as an introduction to a fairly involved subject-- the first step in an analytical process.

Some of the materials and ideas presented grew out of a workshop on fertilizer sponsored by the Agricultural Development Council and the World Bank in June 1974 in Princeton, N.J. Among the many individuals who provided assistance, I am particularly indebted to Costantine Michalopoulos of AID for his careful and constructive reviews of earlier drafts. Others who also provided helpful review comments included John Eriksson of AID, K. Wierer of FAO, and G. R. Allen of the University of Aberdeen (U.K.)

The paper was prepared while I was on part-time detail to AID from the Foreign Development Division, Economic Research Service, U.S. Department of Agriculture. The several drafts of the manuscript were typed by Karen Rich.

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## I. INTRODUCTION

As of 1974 and early 1975, the world fertilizer situation was one of crisis proportions for many less developed countries (LDC's). Fertilizer supplies were short relative to demand. The cost of manufacture, principally due to increases in raw product and energy costs, was up. As a result, prices soared.

Since the LDC's import a large portion of the fertilizer they use (about 58% for the non-communist LDC's in 1972 <sup>1</sup>/\*), they were in a particularly vulnerable situation. Not only must they use large amounts of their scarce foreign exchange for fertilizer, but they are faced with high landed costs. This high cost, if passed directly on to farmers, could result in decreased fertilizer use at a time when there is a desperate need to increase food production.

While the problem may be severe in the short run, the longer run is expected to be more favorable. Numerous efforts are underway to expand fertilizer supply and these are expected to begin to bear fruit within the next few years. But it is doubtful that raw material and energy prices will return to the low levels of the late 1960's. Thus while fertilizer prices are likely to drop in time, they promise only to settle back to a higher plateau.

Faced with the current realities of sharply higher fertilizer costs and the prospect of only moderately lower costs in the medium to long run, many developing nations have been confronted with the severe domestic policy problem of what to do about domestic fertilizer prices. While, as we shall see, several potential courses of action are open, there is a tendency for national governments to think immediately and solely of a subsidy program. Some LDC's have used fertilizer subsidies for years and so need "only" expand current programs. Others may not have had them and may be unaware of their advantages and disadvantages. In any case, more attention may be given to alleviating short run problems than to laying the basis for long run solutions. <sup>3</sup>/

Subsidies will not, of course, immediately increase the world's total supply of fertilizer. Nor will they reduce the total foreign exchange cost of fertilizer; in fact they could actually increase it by stimulating fertilizer use. Basically all they do immediately is to keep domestic fertilizer prices below levels which might otherwise exist (or more precisely, below the equilibrium which might exist in a free market).

To the extent that this process stimulates domestic food production, however, subsidized fertilizer may reduce the subsequent need for food imports, which could be considerably more demanding of foreign exchange (it is generally thought that the use of 1 pound of fertilizer on high-yielding varieties of wheat or rice will lead to the production of 5 to 15 pounds or more of grain <sup>4</sup>/).

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\* References and notes are provided in Chapter VI.

Considering their potential importance, or at least their potential cost, it is surprising how little information is currently available on the pros and cons of subsidies. Fragments of information can be found, but there doesn't appear to be any one work of consequence currently available. The Food and Agriculture Organization of the United Nations (FAO) has been conducting some preliminary studies of subsidy programs, but the work is still in its early stages. 4/ Hence this study attempts to provide an interim and preliminary evaluation of fertilizer subsidies based on what little information is at hand. It is to be hoped that it will provide the basis for subsequent more detailed and scholarly study. In the final analysis, however, program decisions have to be made at the country level; no one general analysis will provide all the answers.

The paper does not consider the question of financing fertilizer imports by developing countries on concessional terms. 5/ Nor does it examine the problem of overall supply. Rather it focuses solely on the use of subsidies to influence prices to farmers within individual LDC's. And though the discussion is cast in terms of fertilizers, portions of it could be applied to subsidies of other inputs.

The study is composed of three main sections: fertilizer subsidies, fertilizer economics, and policy alternatives. 6/ The first chapter provides an introduction to fertilizer subsidies, noting their general nature, extent, and limitations. The following chapter reviews the basic features of fertilizer economics as they relate to subsidy programs. Subsequently, policy alternatives - including price policies and other policy options - are discussed in terms of tradeoffs. The final chapter offers some concluding remarks.

## II. FERTILIZER SUBSIDIES

Although the currently available information on fertilizer subsidies in the LDC's is scattered, it is sufficient to give an idea of most of their basic characteristics. The fact that little has been written about subsidies on fertilizer reflects in part their brief history.

### A. Brief Historical Background

It is not known when fertilizer subsidies were first used in the LDC's. The earliest subsidy noted so far occurred in Taiwan. Chemical fertilizer was introduced by the Japanese government in 1902 and initially was distributed to sugarcane growers free of charge. Beginning in 1904, sugarcane corporations supplied fertilizer to growers at subsidized prices. This practice was discontinued in 1916, when growers had reportedly come to recognize the value of fertilizer in stepping up crop yields. 1/

Since fertilizer use in the developing world was at first largely limited to plantation crops, it is likely that any subsidies were also limited to these crops. In India, for instance, while the manufacture of fertilizer began in 1906, 2/ it was evidently not used in appreciable quantities until the 1920's, and then only on tea plantations. Desai states that "...there is no evidence of its use outside plantation agriculture until the 1930's when its use was extended to sugarcane and in 'economically favorable areas' to rice." 3/

During the 1930's, the main LDC growth in fertilizer production and use appears to have occurred in northeast Asia. Two fertilizer plants were built in China (Darien, Nanking) in the mid 1930's and production reached 227,000 tons by 1941. 4/ About 560,000 tons of fertilizer were reportedly used in Korea in 1938. 5/

In most of the LDC's, however, significant quantities of fertilizer have been used only since World War II. Consumption, for example, rose as follows in South Asian countries (in nutrient tons):

	From		To	
	Year	Metric Tons	Year	Metric Tons
India <u>6/</u>	1952	66,000	1973/74	1,835,000
Pakistan <u>7/</u>	1955/56	6,000	1972/73	436,500
Bangladesh <u>8/</u>	1955/56	11,000	1972/73	378,000

Thus there is some reason for thinking that there was relatively little general use of subsidies until two decades or so ago. The first general direct subsidy of which I have so far found record was started in Chile in 1952. 9/ Another was initiated in the Philippines during the 1956-57 season. 10/ If this pattern was repeated elsewhere, then the use of subsidies for food crops is a comparatively recent happening in historical terms.

## B. Nature of Subsidies

Fertilizer subsidies serve a variety of purposes and take a vast variety of forms. A complete taxonomy is beyond the scope of this paper, but a few of the major characteristics can readily be noted.

### 1. Purpose of Subsidies

The major traditional purpose of subsidies in the less developed nations has been to encourage farmers to use fertilizer and thereby expand total production. 11/ Since chemical fertilizer is new to many of the farmers in the developing world, most will, so the argument goes, start with a low rate of application on a very limited area. A subsidy is one way of stimulating this process. In terms of the usual S-shaped adoption curve for technology it might be aimed at the innovators and early adopters (Figure 1).

There may be a greater economic need to use a subsidy in the LDC's than in the DC's because (as we shall note in Chapter III) fertilizer prices are often higher while product prices may be lower. 12/ This fact, together with the recent sharp rise in fertilizer prices, may lead to a second and relatively new reason for using subsidies: to help maintain fertilizer use in cases where product prices have not (for a variety of reasons) been raised, or raised correspondingly. There has been, as noted in the first chapter, some concern that the higher fertilizer prices will mean a reduction in demand for fertilizer and hence lower use on key crops. 13/

Other reasons for subsidies are more mixed. It has been suggested, on the assumption that fertilizer production exhibits economics of scale, that subsidies may help expand the total domestic market for fertilizers and make the establishment of fertilizer manufacturing and distribution facilities economical. 14/ A rather unusual argument has been noted in the context of West African countries:

...The justification for the subsidy is the high export taxes which are charged on export crops for which the fertilizers are used. Through the subsidization of fertilizers these tax revenues are partly channelled back to the more progressive farmers. 15/

In other cases fertilizer subsidies may be just part of a package to increase food production: in Korea and Bangladesh, for example, fertilizer is part of a program of input subsidies which also includes other farm chemicals, credit, and seeds. 16/

In virtually all of these instances, the unstated assumption is that the subsidy is a temporary measure and that it would eventually be withdrawn. But, as with any subsidy, there is resistance to its reduction from those who immediately benefit, and the subsidy tends to remain much longer than anticipated. At least, it is thought by some, subsidies on fertilizer inputs are easier to phase down than subsidies on product prices.

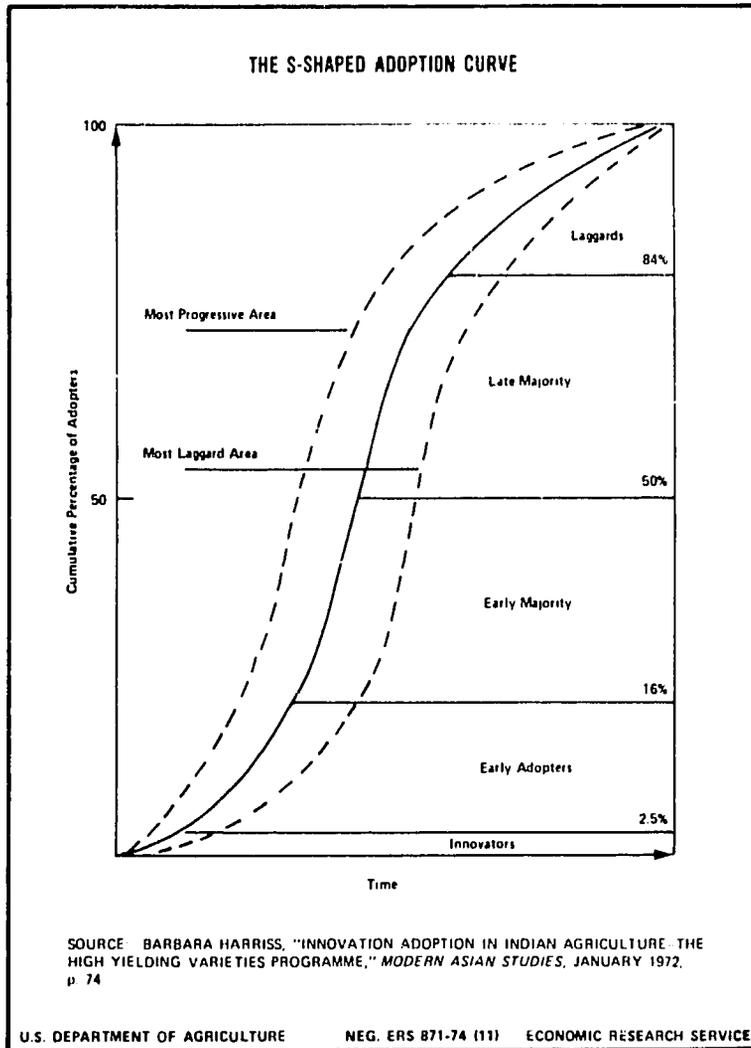


Figure 1

## 2. Types of Subsidies

Fertilizer subsidies take such a wide variety of forms that they almost defy ready classification.

### a. Difficulties in Classification

In some cases what might appear to be a subsidy at certain geographic points or for certain types of fertilizer may be only part of an overall balancing or equalization of prices; an actual government subsidy is not involved. This was the case for many years in India where prices were controlled to (a) equalize prices of imported and domestically manufactured fertilizer, and (b) to provide price uniformity in different parts of the country. 17/ Some subsidies may simply compensate the farmer for some other form of discriminatory treatment.

There are several other cases where it is difficult to tell whether a direct subsidy is involved. In the West African case noted previously, the government in effect takes money out of one pocket and puts it in another: it levies duties or taxes on imports or production and then returns an approximately equal sum as a fertilizer subsidy. A government may also place a price ceiling on domestically-produced fertilizer which is below the price that it might receive on the world market. 18/ Some subsidies may be in the form of exchange rate adjustments. 19/

Where imports, production and/or distribution are largely in government hands, as is often the case, the price charged may be below the actual cost. In some cases this deficit is known, in others it is not. As an example of the former, the fertilizer prices in India remained essentially unchanged from 1969 to May 1974, with the exception of one adjustment in October 1973 to cover increased naptha prices. With the increase in price of imports during the early 1970's, a stage was reached when the cost of imported urea "was nearly three times the statutorily controlled price at which it was being sold to the farmer." The difference was made up by the government. 20/ On the other hand, some deficits are harder to trace. For example, Hertford reports that in Mexico:

Guanos y Fertilizantes SA (Guanomex), a government-owned corporation...operates with import protection but sets farm prices of fertilizers well below production costs. The resulting losses are absorbed by the Government petrochemical monopoly, PEMEX (Petroleos Mexicanos) 21/

An additional set of classification problems arises because the subsidies may be applied at many different points: from producer or importer to final user. Also the subsidies may apply to only certain types of crops, or fertilizer, or in certain regions of the country. 22/ Despite these complexities, it is usually possible to differentiate between direct and indirect subsidies.

b. Direct Subsidies

Direct subsidies involve a government payment to some group in the fertilizer production and marketing chain. The major groups are manufacturers, importers, transport firms, distributors (including cooperatives), and farmers. The latter two groups, however, appear to be the most prevalent. This is documented in Table 1, which summarizes three different tabulations:

Table 1. POINTS OF APPLICATION OF FERTILIZER SUBSIDIES

<u>Recipient</u>	<u>OECD</u> <u>(1968)*</u>	<u>FAO</u> <u>(1974)*</u>	<u>FAO/FIAC</u> <u>(1975)*</u>
	- number of cases -		
Fertilizer manufacturer	1	6	10
Importers	1	1	4
Internal transporters	3	3	6
Distributors (inc. coops)	3	5	14
Farmers	9	22	7
Unidentified	0	0	11
<u>Total**</u>	<u>17</u>	<u>37**</u>	<u>52**</u>
Number of countries	17	35	43

\* The year stated is the year the data were reported; they presumably apply to the previous year or years.

\*\*Payments were sometimes made to more than one of the above recipients.

Sources:

OECD. Supply and Demand Prospects for Fertilizers in Developing Countries, OECD, Development Center, Paris, 1968; p. 169.

FAO. "Note on Fertilizer Subsidies," FAO, Rome, January or February 1974, Table 3, Col. 3.

FAO/FIAC. "Possibilities for the Development of Guidelines for the Use of Fertilizer Subsidies in Agricultural Development," FAO/FIAC Working Party on the Economics of Fertilizer Use, Rome, March 17, 1975, Chp. I, p. 3.

While the data are not complete and not entirely comparable, it would appear that from 1968 to 1974 there was an increase in the number of subsidies applied at the manufacturing and farm levels, while from 1974 to 1975 there was an increase in the number of subsidies applied at the distributor level and a decrease at the farm level. 23/

In certain cases there are restrictions on the type of farm and/or type of crop subsidized. Sometimes subsidies are limited to small farmers (Morocco and Korea). In others they are limited to producers of specific crops (Ceylon, Ivory Coast). And elsewhere differential pricing for fertilizer by type of crop has been applied (Ceylon, Philippines, and Uruguay Uruguay 24/). Some of these selective subsidies will be discussed in greater detail in subsequent sections.

c. Indirect Subsidies

Many of the indirect forms of government assistance discussed in section (a) may be difficult to classify as subsidies. Others are more obvious. One of the more common is a fertilizer transport subsidy, which can take the form of a subsidy on costs to remote areas. 25/ In some cases, credit has been available at concessional terms (in the case of Brazil in the 1960's the interest rates on fertilizer loans varied from 0 to 7% while the rate of inflation went as high as 30% 26/). In Argentina, a double tax writeoff has been allowed farmers on their fertilizer costs; 27/ other forms of tax concessions have been used in Chile. 28/ In the 1950's Brazil used a package involving a favorable exchange rate for fertilizer imports, tariff exemptions, state and federal tax exemptions, and highly preferential rail freight rates and port fees. 29/ But perhaps the most important form of indirect help, which many might not put in the subsidy category, is the set of fertilization services which can be provided by government infrastructure (particularly the extension service); these services, however, have generally not been highly developed.

C. Frequency and Size of Direct Subsidies

Given these general characteristics of subsidies, it may be helpful to review their frequency and their magnitude.

1. Prevalance of Direct Subsidies

Data cited in the previous section suggest that direct subsidies are fairly common among the LDC's. They have been most prevalent in Africa, followed by Asia, and (at some distance) by Latin America. FAO and other data for the late 1960's and for early 1970's provide the following breakdown: 30/

<u>Region</u>	<u>Number of Countries</u>	<u>Country</u>
Africa	20	Cameroon, Botswana, Dahomey, Ethiopia, Gambia, Ghana, Ivory Coast, Kenya, Lesotho, Libya, Madagascar, Malawi, Mali, Nigeria, Senegal, Sierra Leone, Tunisia, Uganda, Upper Volta, Zambia.
Asia	12	Afghanistan, Bangladesh, India, Indonesia, Iran, Khmer Rep., South Korea, Nepal, Pakistan, Philippines, South Vietnam, Sri Lanka.
<u>Latin America</u>	<u>3</u>	<u>Chile, Jamaica, Uruguay</u>
Total	35	

In some cases, the subsidies were quite limited or restricted. Several of the countries confined their subsidies to regional development projects (Ethiopia, Iran). 31/

A more recent FAO tabulation, noted earlier, suggests that in 1974 more than 43 developing countries had fertilizer subsidy programs. 32/ Just how many subsidy programs are in operation in 1975 is unknown. In view of the fertilizer price rise, however, the list may have lengthened (Tanzania, for one, was added).

## 2. Size of Direct Subsidies

As might be expected, the size of the subsidies varies enormously - from small indirect subsidies to some amounting to a virtually complete subsidy. Most fall into the range of 10 to 50% of the farm gate price. It is difficult to make ready and precise comparisons because the subsidies apply at different points and vary by individual types of fertilizer. Some fertilizers are only subsidized if their price rises over a certain base figure.

Still, at least one summarization, based on fairly well standardized and comprehensive FAO tabulations, is available for 28 countries (Table 2). 33/ Some countries subsidize only a few fertilizers (in some cases possibly the only ones imported in quantity) while others support a wider range. In some countries (Cameroon, Libya, Sri Lanka, and Uganda) the percentage is a constant amount, while in others the proportion varies by type of fertilizer - in some cases rather widely (in Mali the range was from a low of 13.9% to a high of 35.7%, and in Pakistan the range was from 13.6% to 54.5%).

In addition to the subsidy levels cited in the table, some supplementary information is noted for several of the countries listed, as well as for a few others which are not included (Supplement to Table 2).

## D. Limitations of Subsidy Programs

While the concept of many subsidy programs is relatively simple, their operation and effective implementation appears to be a much more complex business. Although we really know very little about how the programs are administered, 43/ there is sufficient evidence to suggest that the process is not without its limitations and difficulties.

### 1. Management Problems

Given a subsidy program, the administrators are apt to face at least two major problems: reaching the intended recipient and establishing the appropriate subsidy level.

Table 2. RATE OF FERTILIZER SUBSIDY IN THE DEVELOPING COUNTRIES  
1968/69 - 1971/72

(Percent of Unsubsidized Retail Price)

	Nitrogenous			Phosphate		Potash	
	Ammonium Sulphate	Ammonium Nitrate	Urea	Single S.P.	Triple S.P.	Potassium Sulfate	Muriate of Potash
Bangladesh	50.0		56.3		55.1		64.5
Botswana				28.7			
Cameroon <u>1/</u>	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Chile	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Gambia				23.8			
Ghana	37.4			38.4		35.6	28.0
India <u>2/</u> 25-50%							
Ivory Coast <u>3/</u>	33.0	33.0	33.0	33.0	33.0	33.0	33.0
Kenya				23.6			
Khmer	34.0		34.0			34.0	34.0
Lesotho	11.0		11.8	23.7			
Libya	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Madagascar	0.6		5.6				24.8
Mali	35.7		14.9	20.0	13.9		30.2
Nigeria <u>4/</u>							
Pakistan	54.4	23.2	29.5	56.2	31.0	31.0	13.6
Senegal	47.8		47.6		45.6	27.4	
Sierra Leone	29.8			39.9			
Sri Lanka	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Tunisia	18.2	17.9	20.0				
Uganda	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Uruguay	19.7		81.4	35.3			
Zambia	33.6	33.9	54.6	29.3	28.2	41.4	51.4

Notes:

- 1/ 10% on all fertilizers used for cotton and coffee.  
2/ 25 to 50% on all fertilizers depending on the region.  
3/ 33% for cocoa, coffee and rice crops.  
4/ About 50% of the state store price on all fertilizers.

Source:

"Note on Fertilizer Subsidies", FAO, 1974, Table 1.

Supplement to Table 2. DETAILS ON FERTILIZER SUBSIDIES IN SELECTED COUNTRIES

Countries Listed in Table 2.

Bangladesh. The subsidy level indicated for urea has subsequently been reduced: as of the fall of 1973 it was about 19%; as of April 1974 there was no subsidy on domestically produced urea (in fact there was a surplus) but there was a subsidy on imported urea. The phosphate and potash subsidies continued at roughly the same levels. 34/

Chile. The subsidy level as stated may be too high. A 1972 OECD report indicates that when a subsidy program was begun in 1952 the level was 50%, but that it was reduced to 10% in 1956 and discontinued between 1957 and 1959. A subsidy system was resumed in 1960 but by 1969 was discontinued, and as of the time the bulletin was written "...the only bonuses left in force today are tax advantages." 35/

Pakistan. It is likely that the levels stated refer only to imported fertilizer. My own investigations in Pakistan in November 1973 suggested subsidy rates of 18.1% on imported urea and 25.9% on imported DAP. At the same time, domestic urea production at two privately-owned plants was levied surcharges which were higher than the subsidy on the urea import. Thus the subsidy on the imports was offset, as of that time, by a surcharge on the domestic product. Whether this was a complete offset is not known. In any case, imported urea prices have gone up substantially since then and the price to farmers was raised 36% in April 1974. 36/

Sri Lanka. The subsidy program was terminated in mid-1974. Rising import prices, however, led to the reestablishment of a 33% subsidy in late 1974. As of early 1975, it consisted - as partly noted earlier - of a 30% subsidy on fertilizer to be applied to rice and a 50% subsidy for fertilizer to be used on crops of tea and coconut. 37/

Countries Not Listed in Table 2.

Afghanistan. As of 1967 or 1968 the subsidy was about 55% of the cost of fertilizer at the port of importation. In 1974 the subsidy was still over 50%. 38/

Indonesia. The subsidy in recent years has been as follows, as a proportion of total cost (presumably to the farmer): 39/

	<u>Urea</u>	<u>Triple Superphosphate</u> - percent -	<u>Not Stated</u>
1970/71	36.1	39.7	29.3
1971/72	36.1	39.7	
1972/73	42.9	38.5	

Korea, South. The subsidy, as of the early 1970's, was calculated as 12% of the manufacturer's price. In 1968 and 1969, the subsidy was roughly about 10%. 40/

Upper Volta. Little is known of the program in this country except that "the price of fertilizer to the farmer is heavily subsidized in the amount of approximately CFA 60 million (\$250,000) in 1973." 41/

Vietnam, South. The Vietnamese subsidy program began in 1967 and involved an exchange rate subsidy. The subsidy amounted to the difference between the exchange rate used in the commercial import program (CIP) and the official rate of exchange. At its peak, the subsidy was about 33% of the price (300 piasters vs 445). It was progressively reduced over time as the difference in the exchange rates narrowed and was virtually eliminated by early 1974. As of mid 1974, the exchange rate began to widen again and a new subsidy program, as noted in the Preface, was established. 42/

a. Reaching the Intended Recipient

The establishment of a subsidy does not automatically mean that it will benefit the group for whom it was intended. Since the subsidy can represent a sizeable source of income, many people would like to profit from it. In the process, the benefits to the intended recipient may be substantially reduced.

Two of the most striking examples recently occurred in Asia. In South Vietnam, under the first of two subsidy programs (noted in Table 2), subsidized fertilizer was sold through authorized wholesalers and retailers at official prices. However, a South Vietnamese Senate Committee reportedly found that:

up to 70% of the fertilizer got into outside hands at one time and was hoarded to force the price up. By early this year [1974] farmers - for whom the fertilizer was vital at the time - were often forced to pay double or more the subsidized [official] price. 44/

(The difficulties may have in part been related to a change in the distribution system 45/). Merchants have reportedly been one of the major beneficiaries of the subsidy program in Bangladesh. 46/ In each case there are also stories of smuggling to, respectively, North Vietnam and India.

Fortunately, other programs have not suffered the same fate. A TVA study of the fertilizer program in Afghanistan stated that:

Since the importation, distribution, and sales of fertilizer to farmers have remained in the hands of the government, there has been no problem in assuring that the recipient of this subsidy was the farmer. 47/

One might want to corroborate such statements before taking them at full face value, but there may well be a number of subsidy programs which are successful in reaching the intended target.

But even if the fertilizer subsidy does reach the farmer, there is the problem, common to many government programs in agriculture around the world, that some farmers may benefit more than others. In Bangladesh, for instance, there is concern that it is the more economically and politically influential farmers who reap the most benefit from the subsidies. It has been suggested, therefore, that the removal of the subsidies should "neither dampen fertilizer demand significantly nor cause undue hardship to the poorer farmers." 48/ Whether such a statement would be true of other countries is unclear; there may be some, however, where subsidies are very important to poorer farmers.

b. Establishing Subsidy Levels

One of the other major management problems of these and other programs is the establishment of the proper subsidy level. This is in large part a

matter of fertilizer economics, which will be discussed in greater detail in the next chapter, but a few of the major problems might be noted here. If the subsidy is too low, it may not accomplish its intended purpose of encouraging farmers to take up or maintain fertilizer use. If the subsidy is too high it may lead to wasteful resource allocation. In either case, fertilizer use may be more profitable on some crops than others - and these may not be the ones for which it was intended.

Just how the subsidy level is actually established in most LDC's is, at this point, a matter of some mystery. It would appear, however, that in at least some countries there is an effort to strike a balance between official fertilizer and product prices. Indonesia and Vietnam have for several years adjusted one or both prices to keep the fertilizer-rice price ratio in a certain range; in Vietnam the subsidy was designed to maintain a 2 to 1 ratio between the price paid by the farmers for a kilo of fertilizer and the price received by farmers for a kilo of paddy rice. <sup>49/</sup> In other cases, as fertilizer prices have shot up, the subsidy level may have been set at a level which would maintain an earlier level of farmer purchasing power.

Virtually by definition, a subsidy means that the official price of fertilizer is less than it would be otherwise. This differential is apt to lead to the establishment of a black market. The black market, in turn, may thwart the original purpose of the subsidy. The problem has been particularly severe, for instance, in Bangladesh. <sup>50/</sup> Other black markets may not have been so pernicious. Examples of prices paid on such markets are noted in Chapter III.

In some cases the subsidy has been restricted to certain crops, or a differential pricing system has been established.

- In Ceylon, for instance, the subsidy was restricted to rice, tea and coconut farmers; other farmers reportedly repurchased the subsidized fertilizer from these farmers at a price below the unsubsidized rate, but still, at a high enough price to provide a substantial profit to the rice and coconut growers. Hence "it is believed that a substantial proportion of the fertilizer supplied at subsidized rates to rice growers is not finally applied on rice land." Attempts to control the use of fertilizer have led to difficult administrative problems. <sup>51/</sup>

- In the Philippines the fertilizer price for export crops has been roughly twice as high as for the subsidized price for rice. Enforcement is attempted by making fertilizer intended for rice available through a series of procurement vouchers. There are several reports of fertilizer being black marketed and being moved from one crop to another. <sup>52/</sup>

All of this may not be entirely undesirable in that most of the fertilizer probably eventually reaches those farmers with the greatest effective demand. However, small or poor farmers with potentially high response rates but with limited purchasing power or market access may lose out in the process. Hence the result of the subsidy program may be quite different from what the governments wanted and/or the public was promised.

## 2. Financial Problems

Subsidy programs for fertilizer can be very expensive for the modest agricultural budgets of many LDC's. One of the earlier programs, in Chile, was discontinued several times due to lack of funds. 53/ In Uruguay from 1961 to 1966, the annual cost of a relatively modest subsidization program was \$2.53 million and the government "from time to time" had difficulty in meeting payments. 54/ The cost of subsidies in countries with more extensive subsidy programs is substantial: in South Korea the fertilizer subsidy cost \$8.84 million in 1968 and \$17 million in 1969; 55/ the expected cost of the fertilizer subsidy program in Afghanistan in 1975 is \$15.1 million, while in Bangladesh the proposed subsidy in the Five Year Plan totals \$50 million. 56/

Where governments have tried to maintain relatively constant prices to the farmer in the face of increasing costs the budget burden can be immense. Examples follow (in some cases changes in volume would be involved):

-In Sri Lanka the subsidy was discontinued in 1974 because, in part, "the rising cost of the subsidy had become an excessive burden on the GSL budget." 56/

-Indonesia has found that the cost of its fertilizer program could go from Rp. 2.54 billion (\$6.1 million) in 1971 to Rp. 30.0 billion (\$71.9 million) in 1973/74, nearly a twelvefold increase. This is viewed as "A burden clearly which would pose very serious financial problems for the country." 58/

-A December 1973 news item from the Philippines states that:

The Philippines in an effort to keep controls on fertilizer prices at the retail level, has paid out more than \$30 million in direct and indirect subsidies to importers, but government officials say that subsidies cannot be maintained through 1974. 59/

A subsequent (February 1974) news item cited the Philippine Secretary of Agriculture as saying that \$15 million in subsidies was committed for the fiscal year to cushion the shock of rising prices. 60/

-Had India continued subsidizing fertilizer at previous levels in 1974/75 the cost would have been about \$500 million (nearly Rs. 400 crores)--"an amount which the government can ill-afford to bear." 61/

-The cost of the fertilizer subsidy program in Iran increased from at least \$22.5 million a year during the 1968-72 period to about \$113.5 million a year in 1974. 62/

Even with these immense expenditures, LDC governments may not be able to keep pace with the costs. Despite the sharp increase in subsidy costs in Indonesia noted above, it is reported that farmers in 1973/74 had to pay about 50.4% more for fertilizers than the year before. 63/ In the Philippines, as of November 1974, the government subsidies had absorbed only about half of the 350% rise in fertilizer prices during the previous 18 months. 64/ Even with a 30% subsidy on rice, farmers in Sri Lanka had to pay 250% more for fertilizer in early 1975 than a year earlier. 65/

Curiously, there does not seem to be a great deal of evidence available to demonstrate the effectiveness of these vast expenditures in stimulating fertilizer use. This absence has been noted in at least several nations - Brazil, Jamaica, Kenya, and Tunisia. 66/ This is not to say that subsidies have been ineffective, only that remarkably little evidence seems to be available considering the substantial funds which have been involved. FAO has begun some studies in this area. 67/

Clearly, on balance, subsidies may have profound financial cost implications for developing nations. And while the precise nature of the cost of subsidies is not entirely clear, neither in many cases are the benefits.

### 3. Withdrawing or Reducing Subsidies

Even if subsidies are established to encourage initial adoption, there is the problem, previously noted, of reducing or withdrawing the subsidy when the initial purpose is served. This may be particularly difficult with the current fertilizer price hikes. FAO has noted that even though many developed countries have used high rates of direct subsidy at one time,

they have reduced or phased them out  
and have supplemented or replaced them  
with government controlled fertilizer  
and crop prices to maintain favorable  
fertilizer/crop price relationships. 68/

FAO's Indicative World Plan, in fact, suggested that subsidies be reduced over time, but acknowledged that both the magnitude and speed of reduction would vary between countries, "according to their specific situation." 69/

Bangladesh provides a recent example of the difficulties in lowering a subsidy. As noted earlier, a substantial subsidy was set on fertilizer which turned out to be very expensive, ineffective, and possibly counter-productive. Accordingly, the government began to eliminate the subsidies on a phased basis over a five year period. While the phase-out may have been criticized by some as being too slow, it turned out to be too fast for various vested interests (including large farmers) and consequently ran into stiff political opposition in Parliament in June 1973. Consequently the reduction is being "delayed somewhat." 70/

It may be naive to think that one can get around such problems very easily, but perhaps they would be ameliorated somewhat if their temporary nature were made known at the outset and a phase-out schedule adopted and publicized. For instance, a subsidy for fertilizer on coffee in the Cameroon was scheduled to be phased out as follows: 71/

Year	Subsidy
1 (1969)	75%
2 (1970)	50
3 (1971)	25
4 (1972)	0

Or perhaps the phasing out could be differentiated by group. An interesting example is provided by Ghana. In studying how to reduce the cost of the subsidy:

The National Fertilizer Committee recommended that large commercial farms and certain other farms should pay the full cost of fertilizer in 1973 and that the subsidy to small farmers should be reduced to zero over an 8-year period, starting in 1973. 72/

Such actions are, of course, not without administrative difficulties but they are well worth considering.

No government should consider establishing fertilizer subsidies without at the same time considering how to phase them out or to eliminate them when their assigned task is accomplished.

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Many of the management and financial problems discussed here might be more clearly anticipated and understood if the nations involved broadened their analytical view. Much more needs to be known about the economics of fertilizer use at the farm level. In addition, more than economics is involved in farm decision making and productivity. We shall turn to a brief review of some of these factors in the next chapters.

### III. FERTILIZER ECONOMICS

Relatively little seems to be known of fertilizer economics at the farm level in the LDC's. Yet such information is of vital importance in designing and operating an effective and efficient subsidy program. In this chapter we will briefly review some of the fragments of information which have been found concerning fertilizer prices, demand, and uses. Fertilizer supply is covered in numerous other publications and will not be discussed in detail here; suffice it to say that it is currently rather inelastic in most LDC's in the short run.

#### A. Prices

Fertilizer prices will be viewed in terms of their absolute values and then in comparison to product prices.

##### 1. Fertilizer Prices

It was noted in the previous chapter that fertilizer costs in the LDC's are typically higher than in the DC's. The existence of the gap in prices was confirmed by FAO's Annual Fertilizer Review, 1972, which went on to note that "with rising prices in the world and some local shortages this gap has widened somewhat this year." 1/ It has undoubtedly increased even more in subsequent years.

##### a. Relative Production Costs in LDC's

The higher prices of fertilizers in LDC's are related to several cost factors. Parker and Christensen have summarized several of these:

Most of the developing countries depend on imported supplies and pay much higher prices because of the additional transportation and distribution costs. Furthermore, efficient distribution and handling systems are not as well developed in the developing nations. 2/

It has also been suggested that the cost of producing fertilizers in the LDC's is comparatively high. Two other writers noted in the mid-1960's that

In India, for example, production costs are 50% higher than in the United States. Capital costs, involving imported machinery, are high, the lowest cost methods of production are not always used, an inefficient management frequently increases operating costs 3/

There is some question as to the generality of this statement today. The newer commercial plants in Pakistan, for instance, are as efficient as urea plants anywhere; some of the older government facilities, however, are considerably less efficient. <sup>4/</sup> In some cases, government-run plants are felt to be less efficient than those operated by private industry and are running at considerably less than full capacity. The general picture is, therefore, more likely one of sharply varying costs, depending on the age of plants and, in some cases, the degree of government involvement.

Still, as Parker and Christensen suggested, the cost of distribution and marketing may be higher. A recent FAO study notes that while total marketing costs and margins in Europe are on the order of 10 to 20% of the retail price, in many developing countries the corresponding margins amount to more than 20% and even range up to 30% in spite of relatively low wage rates. <sup>5/</sup> Some representative total margins (including transportation) during the 1970 to 1972 period were as follows: <sup>6/</sup>

Margin %	Region		
	<u>Africa</u>	<u>Latin America</u>	<u>Asia</u>
0-9	--	--	--
10-19	--	Mexico, Venezuela	India, Iran
20-29	Kenya, Zambia	Colombia	Nepal
30-39	Ethiopia, Morocco, Senegal	Argentina	Thailand
40-49	Nigeria (48)	--	--
50-59	Ghana (51)	Brazil (57)	--

Based on this rather incomplete sample, it would appear that the margins tended to be highest, on average, in Africa.

Thus because of higher import, production, or distribution costs, fertilizer prices may be considerably higher in the LDC's than in the DC's. Subsidies in many cases, are meant to bring down the ensuing prices to farmers.

#### b. Official and Unofficial Prices

Since the costs and subsidies vary, there is a considerable variation in prices actually paid by farmers in the LDC's. These are reported annually by FAO in its Production Yearbook. Examples of the upper and lower boundaries of official prices paid for several fertilizers as reported in the 1972 Yearbook follow: <sup>7/</sup>

	<u>Africa</u>	<u>Latin America</u>	<u>Asia</u>
	- U.S. dollars per 100 kg of plant nutrients -		
Ammonium Sulfate	15.4 - 57.9	23.2 - 68.0	20.1 - 46.1
Urea	9.9 - 36.5	13.1 - 35.7	12.4 - 28.8
Superphosphate*	9.9 - 39.7	14.3 - 56.8	12.4 - 27.8
Potassium Sulfate	6.5 - 35.8	8.6 - 32.2	9.9 - 20.8

\*Above 25%

Both the variation and the upper level of prices might have been even higher if it were possible to report actual prices paid by farmers. An unofficial or black market exists for fertilizers in many LDC's, at least during periods of relative shortage. It is understandably difficult to get widespread documentation of these unofficial prices, but some examples are available.

- Bangladesh. When fertilizers were subsidized up to 50% or more, "a black market selling fertilizer up to three times the official price flourished." Part of the problem is that Indian fertilizer prices are considerably higher, providing a strong incentive for smuggling. 8/
- India. Three different village studies in the early 1970's reported market prices ranging from 36% to 57% above official prices. 9/ A prominent American agronomist who has worked for AID in India has stated that "farmers are accustomed to buying nutrients on the black market at inflated prices." 10/
- Pakistan. Informal estimates which I received while in Pakistan in November 1973 suggested that on average about 25% of the fertilizer was sold on the black market the previous year or two (30% in the kharif season and 20% in the rabi season). The actual premium for urea in the Punjab was thought to range from 3.5 to 14.5%. It was considered to be higher for other types of fertilizers in other provinces. 16/
- Philippines. A study of farmers in Central Luzon in the early 1970's revealed that farmers were paying about 1/3 more than the published market prices. 12/
- Vietnam. A committee of the South Vietnamese Senate, as noted previously, stated that farmers were often forced to pay double or more the subsidized price. 13/

The difficulty with the Bangladesh and Vietnamese estimates is to have some idea of what proportion of the fertilizer they apply to and to know what the average, not maximum, premiums were.

Still, the existence of a pronounced black market for fertilizer suggests that demand exceeds supply. Since the short-term supply situation is relatively inelastic in most LDC's, the higher prices are not likely to call forth increased quantities. Hence one might question the wisdom of a subsidy when a sizeable black market develops.

Moreover, it is clear that the official price for fertilizer may be only the lower bound of actual prices paid in some countries in some years.

## 2. Fertilizer/Product Price Ratios

Even if the actual rather than official prices were known, it would be difficult to make very precise international comparisons because of comparable variations in the price received by the farmer for his product. Some countries support product and/or fertilizer prices; other keep them below world levels. One rather extreme example is Argentina:

While grain prices are substantially below world market levels at the farm gate in Argentina... nitrogen prices are about three times higher at the farm level in Argentina than in the United States. 14/

To get around some of these problems, and in order to more accurately reflect the economic situation facing the farmer, some economists have made use of a ratio based on a comparison of product prices and fertilizer prices. It is assumed that this ratio is a critical factor in determining actual fertilizer use. The major limitation is that it normally makes use of official, rather than actual, price for both fertilizer and food crops; if both are higher they may balance out; if not, the ratio may be high or low. They may also be influenced by weather variations from year to year.

### a. Examples of Ratios

Many economists have calculated fertilizer-product price ratios for major crops such as wheat and rice, both within and between countries. Only a few will be cited here.

Several international comparisons of ratios for wheat and rice were made in the 1960's. One of the best known showed the following ratios in terms of a kilogram of increased production required to equal the cost of a kilogram of fertilizer nutrient: 15/

	Wheat		Rice	
	1963	1964	1963	1964
UAR	4.88	NA	6.46	NA
India	3.62	2.79	3.97	4.35
Thailand	--	--	3.56	4.55
Spain	2.16	2.12	--	--
Japan	1.76	1.62	1.20	1.16
Pakistan	1.81	1.56	1.47	1.56
Philippines	--	--	NA	2.50
United States	2.63	2.40	1.67	1.72

These data show the wide variations in the ratios between nations. During this period, the most favorable balance (for fertilizer use) was found in Japan and the least favorable balance (in 1963) was in the UAR, and to a lesser extent in India and Thailand. A similar breakdown for 1960-61 showed roughly the same story. 16/

Numerous calculations of price ratios for rice are available. A set of ratios for rice in Japan is perhaps the longest available for any crop. They show the following changes: 17/

<u>Period</u>	<u>Ratio</u>	<u>Yields(mt/h)</u>
1883-87	10.7	NA
1893-97	9.7	2.6
1903-07	7.7	3.1
1913-17	6.4	3.5
1923-27	3.7	3.6
1933-37	2.7	3.8
1953-57	1.5	4.2
1958-62	1.2	4.9

Clearly the price ratios moved in favor of fertilizer use. More recent ratios computed for Asian nations for 1970 by Falcon and Timmer are as follows: 18/

	<u>Ratio</u>	<u>Yield(mt/h)</u>
Burma	8.10	1.70
Thailand	3.18 to 11.1	1.97
Indonesia	3.38	2.14
Philippines	2.47	1.72
Malaysia	2.31	2.72
Taiwan	2.24	4.16
Ceylon	1.40	2.64
South Korea	1.04	4.55
Japan	0.70	5.64

Japan presented the most favorable price conditions for fertilizer use, while Thailand and Burma provided the most unfavorable. 19/

#### b. Significance of Ratios

The ratios are of significance from at least two points of view: their correlation with production, and their use in price policy programs.

##### (1) Correlation With Yield and Fertilizer Use

It might be expected that price relationships which favored fertilizer use might in turn be related to yield increases, other factors being equal. This was shown for the historical data for Japan from 1883 to 1962; as the fertilizer ratio became more favorable, yields went up.

Similarly, the cross-sectional data for rice in Asia calculated by Falcon and Timmer suggested a close correlation. The authors went on to statistically relate the ratios with fertilizer use per unit of land and found, somewhat to their surprise, that the variations in price ratios

"explained" 85% of the variation in rates of application ( $R^2=0.85$ )! 20/

They concluded that "prices may be more important in the development process than many of us realized." But they also suggested in a footnote that "perhaps only developed countries can afford high prices of rice relative to fertilizer." 21/ There have been, on the other hand, cases where a more favorable ratio did not seem to be associated with a particular increase in yields. 22/

## (2) Policy Use of Price Ratios

Fertilizer/product price ratios have been used as guides for more general price policy programs in several countries. Several, such as Indonesia and South Vietnam, have made adjustments in their fertilizer subsidies in order to more nearly reach the official or desired fertilizer/paddy ratio (in the case of Vietnam this is 2 to 1). 23/ In at least one other country, Taiwan, farmers have long exchanged rice for fertilizer at specified ratios (they paid 40% of the rice at the time they received the fertilizer and the other 60% after the rice was harvested); the system, however, was abolished on January 1, 1973. 24/

In the Indicative World Plan, FAO calculated some benefit-cost ratios which are the reciprocals of ratios cited above. They indicate the value of additional output resulting from fertilizer use divided by the cost fertilizer; thus the higher the ratio, the more favorable the price conditions for fertilizer use. The ratios were derived for three regions in 1962 and then projected to 1975 and 1985. 25/

<u>Region</u>	<u>1962</u>	<u>1975</u>	<u>1985</u>
South America	2.8	1.9	1.7
Africa (S. of Sahara)	4.4	3.3	3.7
Asia & Far East	4.7	4.5	4.5

The ranks appeared most favorable in Asia and the Far East and least favorable in South America. FAO stated "Widespread experience suggests that benefit/cost ratios for fertilizers below 2.0 or 2.5 are usually insufficient to create a strong impetus for rapid increase in use." Latin America is projected to fall below these levels.

In terms of the current fertilizer price situation, it would be important to know how the ratios have changed. To judge from press and other accounts, one would presume that the ratio has turned against fertilizer. FAO has recently compiled some benefit-cost ratios (or as they now refer to them, value/cost ratios) for before and after the recent fertilizer price increases (although the precise dates varied, they were generally considered to be 1973 and 1974 respectively). Of 12 cases, from 10 countries, the ratio declined in 9 and increased in 2;

in one case the result depended on whether farmers were able to get fertilizer at government controlled prices. When the data were further broken down by individual crops, out of 54 entries the ratio declined in 41, remained the same in one, and rose in 12. Still, the number of crop cases for which the ratio dropped below 2.0 increased only from 7 to 17; of the latter, 10 were in countries where free market prices existed and 7 where government controlled prices were the rule. Thus for most crops in most areas, fertilizer use continued to be profitable in terms of the FAO guidelines. 26/

These, however, are only a partial measure. They may, in fact, not be highly correlated with profitability of fertilizer use. Data compiled by the International Potash Institute for six countries in 1972 and 1974 indicate that while the ratio declined in five countries, net returns remained the same or even increased. 27/ Similarly, FAO data show that in some areas where ratios have declined moderately, such as in Java, net returns actually increased. 28/

The answer to what might seem a paradox lies in the physical response function to fertilizer and in the influence of other factors. As Mellor has stated:

- First, and most important, price relationships are only one of several factors which affect profitability of fertilizer use. The physical response is also important...
- Second, variations in grade and variety of crop and fertilizer within a country are as important as international price differences in determining relative profitability.
- Third, the specific conditions of the domestic economy are probably more important in determining fertilizer pricing policy than what other countries are doing. 29/

Thus, it is probably true, as OECD stated in 1968: "no general ratio between cost and return can be laid down as being necessary to promote fertilizer use in the developing countries as a whole." 30/ A number of other factors are involved, some of which we will discuss in the next section.

## B. Fertilizer Demand

Astonishingly little seems to have been written about the nature of demand for fertilizer at the farm level. Price, as the previous section has suggested is a principal factor, but there are others.

## 1. Price Elasticity of Demand\*

### a. Elasticities in the Short and Long Run

As might be expected, the farm demand for fertilizers is inelastic in the short run and elastic in the longer run. On the basis of data summarized by Timmer (Table 3), one could anticipate that:

- The immediate impact of a relative price rise of 10% will be reduced fertilizer consumption of anywhere from 5 to 10%;
- In the longer run, if the same relative prices are maintained, the reduction could be 2 to 3 times greater. 31/

Timmer is quick to add that in the longer run the same relative prices may not likely to be maintained: a decline in fertilizer use may lead to a drop in food production which, in the absence of greater imports, "will force food prices to rise relative to fertilizer prices thus causing higher fertilizer application." 32/

The short and long term relationships noted here are in part based on the farmers' likely position on the S-shaped total physical product curve (Figure 2). In areas of long-standing fertilizer use, farmers may have reached the upper level of the total product curve (e.g. section BC on curve TP in Figure 2; the marginal product curve declines in this zone). In areas where fertilizer use is more recent, farmers may be on the steeper part of the total product curve (e.g. section AB on curve TP). Thus, the newer adopters are more apt to get a larger response for a given input of fertilizer than the older adopters (the marginal physical product, curve MP, is greater). Because of this greater response, as de Guia has put it, "newer fertilizer users would be less sensitive to fluctuations in prices than those for whom the use of fertilizer has become routine." 33/

### b. Policy Implications of Elasticities

One must be cautious in drawing policy conclusions from the elasticities cited in Table 2 because (1) the data show rather wide ranges, (2) they are derived demands and in turn are influenced by the demand for the crop involved (see discussion in fn. 32), and (3) it is difficult to isolate and measure long-run demand. Still, the price elasticities of demand cited here raise some immediate general questions concerning the justification for subsidies.

\*Price elasticity of demand is the relationship between percentage variations in prices paid for a product and consequent variations in the quantity purchased.

If price variations of say 10% lead to changes in the quantity purchased of less than 10%, the demand is considered inelastic. Similarly, if the result of the same price variation is a variation of more than 10%, the demand is considered elastic. Generally the elasticity of demand in the short run is less than it is in the longer run.

Table 3. ESTIMATED PRICE ELASTICITIES OF DEMAND FOR FERTILIZER IN DEVELOPING NATIONS

<u>Country</u>	<u>Time Period</u>	<u>Price Elasticity of Demand</u>	
		<u>Short-Run</u>	<u>Long-Run</u>
Brazil	1949-71	-1.12***	--
		-0.33**	-1.94
India	1953/54-67/68	-0.31*	-0.43
		-0.53**	-6.63
	1958/59-63/64	-1.20*	-2.5
Japan	1883-1937	--	-0.74
Korea	1960-72	-0.17	-0.88
	1971	-0.70***	--
Philippines	1958-72	-0.59***	--
Taiwan	1950-66	-2.03***	-2.99

Significance levels:

- \*\*\* Significant at 0.9 or higher.
- \*\* Significant between 0.8 to 0.9.
- \* Significant between 0.7 and 0.8.

Source:

Studies summarized by C. Peter Timmer, "The Demand for Fertilizer in Developing Countries," Stanford University, Food Research Institute, Rice Project, Paper No. 5, June 1974, pp. 12a, 12b. Citations of the original sources are contained in Timmer's paper.

GENERALIZED PRODUCTION FUNCTION

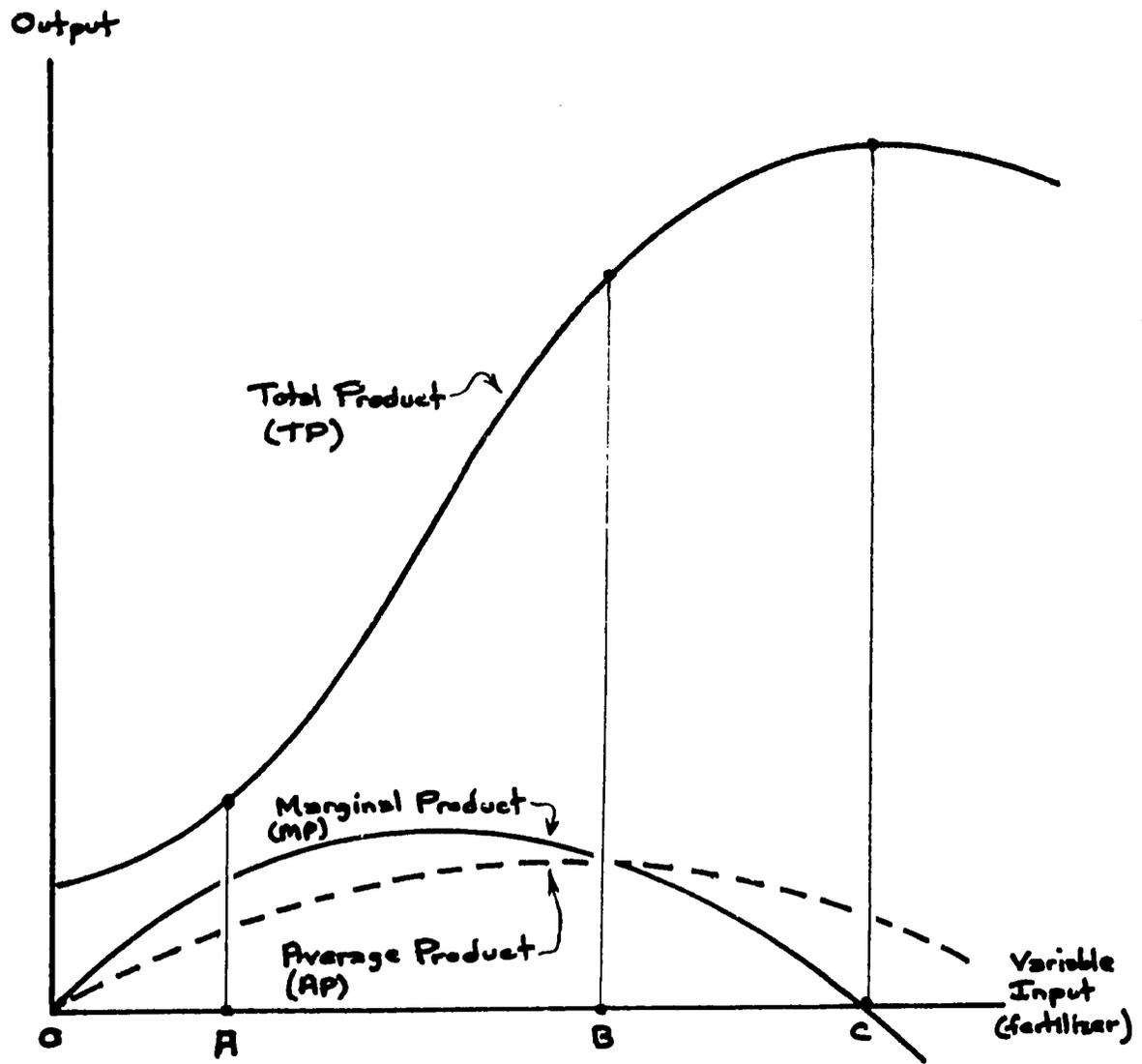


Figure 2

If in short run the demand for fertilizer is relatively inelastic, and increases in prices are not likely to lead to proportionate declines in purchases, one might wonder if the argument for subsidies is as strong as in the longer run where a more elastic demand situation exists. It could seem that the usually recommended practice of using subsidies in the short run and removing them in the long run 34/ is reversed; perhaps on this basis, subsidies would be more appropriate in the longer run.

Two factors, however, may lead to higher elasticities in certain cases in the short run than the data cited in Table 2 suggest:

-First, the very stage of the standard S-shaped total product curve (section OA on curve TP in Figure 2) does not increase as sharply as the subsequent stages (section AB on curve TP in Figure 2). This lower response rate may lead to a more elastic demand for fertilizer than is found farther along on the total product curve.\*

-Secondly, if farms which have not used fertilizer are also very low income farms, they simply may not be in a position to buy higher-priced fertilizer, no matter how high the potential response. Thus, the demand for fertilizer might be more elastic in a low income community than a high income one. With increased access to credit, the demand by the low income group might become less elastic.

The relatively more elastic demand for fertilizer on smaller and poorer farms could lead to a less productive use of fertilizer resources. An additional unit of fertilizer may produce a larger physical response on the farms which have just adopted fertilizer than those which have utilized it for some time (because of their relative location on the total response curve). But if the newer adopters have a much lower income level, they are, in the face of price increases, less likely to maintain the same quantity of fertilizer purchases as the more experienced farmers. Thus the higher priced fertilizer may be directed into relatively less productive use on the more established farms. 35/

\*There are two major deficiencies of this argument:

- First, both the marginal and average physical products for fertilizer are increasing in stage OA (in Figure 2). The farmer who is unfamiliar with fertilizer, however, may be unaware of this increase or for other reasons unable to capitalize on it.
- Secondly, most of the published output response curves do not show a section like OA. Indeed they seem to start between A and B (as is shown in Figure 4 which follows). While most soils have some inherent fertility, many of these curves may be based on experiment station plots where fertility may be higher than on many farms. Examples of response curves based on village studies in Asia are provided in Appendix B.

The matter is discussed in greater detail in Appendix A.

This very preliminary analysis, if correct, suggests that a theoretical justification for subsidies may be found principally at the very early stages of the response curve (in the very short run) and/or for poorer farmers. It may be, however, that the same results could be achieved by other means, such as increased availability of credit. In any case, it seems likely that the current high prices for fertilizer will, as Timmer has put it, "hit the poor farmers and nations with high physical response rates relatively harder" than the wealthier farmers or nations. 36/

Fertilizer prices and farm income are not the only economic factors influencing the demand for fertilizer. The prices of other purchased inputs and or the price of farm products (as noted earlier) may also be important factors. We will not attempt, however, to pursue all them here. Instead, we will turn to a review of other factors.

## 2. Non-Price Factors Influencing Demand

A number of non-price factors may provide an important influence on the demand for fertilizer. They range from personal factors to technological efficiency.

### a. Personal Factors

Aside from the income level of the farmer, noted in the previous section, other general constraints are imposed by his related ability to carry, and his attitude toward, risk. Chemical fertilizers represent an additional expense in the production process. Should the rains not come, irrigation water be short, or some other natural calamity befall the farmer, he might not recover his investment.

A related factor is the type of tenancy arrangement involved. According to Millikan and Hapgood:

A typical tenancy arrangement forces the farmer to pay for all inputs and deliver half the crop to the landlord; so that the tenant who uses fertilizer loses half the return on his investment 37/

There is also a problem of insecurity of tenure; the benefit of fertilizer may extend beyond one crop. 38/ In such cases, the subsidy paid by the government only serves to re-establish the return that prevails for the farmer who works his own land, and in the opinion of one OECD report, may be justified on these grounds. 39/

### b. Institutional Factors

The farmer's ability to buy fertilizer in the first place may be limited by several institutional factors. One is simply that fertilizer is often not available at the right time and place and in the right form. Distribution channels may not be adequate. In some countries, only one nutrient is provided whereas a blend of nutrients is needed. 40/

The availability of credit, or the availability at a reasonable interest rate, is a commonly noted restraint for smaller farmers. In a recent study in India, for instance, the "inadequacy of funds and credit" was the most frequently cited reason for not using fertilizer. 41/ While traditional sources of credit may be sufficient in the very early stages of adoption when the quantities of fertilizer involved are small, subsequent needs during the period of maximum production response may outstrip available supplies. Schluter found that on small irrigated farms in Surat District in India in 1971-72, when most farms had adopted fertilizer, capital [credit] availability was "the main factor influencing rates of application for a given cropping pattern." 42/

Another problem is lack of knowledge. Many farmers simply do not have enough information about the value of fertilizer or about how to use it profitably. De Janryrv has noted that in Argentina:

...the major limiting factor is the real unavailability of the fertilizer technology to farmers in the sense that technical and economic information on its use are almost totally non-existent. 43/

Schluter has cited the practice of applying nitrogen without phosphorus on groundnuts in the district studied as an example of a practice which is inappropriate under Indian conditions. 44/

Greater and/or more enlightened use of field trials might be a way around these problems. A recent general study in India led to the observation that:

If the knowledge and practices associated with the responses obtained from the simple fertilizer trials could be spread widely [along with greater use of HYV's and irrigation]... the output targets of the Fifth Plan can be met with relatively modest use of chemical fertilizers. 45/

It acknowledges, however, that expansion of knowledge is difficult and time consuming. And there can be problems with the structuring of trials themselves, as noted in Bangladesh:

Although countless fertilizer trials have been carried out, they have not been constructed to enable determination of the quantity and mix of nutrients which is economically optimal for farmers in different areas and for different areas and for different crops under conditions of great uncertainty. 46/

Clearly a substantial education job remains to be done.

The availability of irrigation water may also be a significant restraint on fertilizer use. In the Indian study cited above, it ranked second after credit, and for some individual crops was the major restraint. 47/ To the extent that potential water supplies are available and can be provided through government action or assistance, this is an institutional problem.

Fertilizer subsidies may only touch on a few of these factors. Their effect is immediate and direct. But other factors may have important indirect, as well as direct effects in the short and long run. If they don't affect the immediate adoption of fertilizer, they may have some influence on the rate of adjustment of fertilizer use. 48/

### c. Technology

One of the major factors influencing the use of fertilizer is the effectiveness with which it is utilized by the plants. The fertilizer-responsive wheat and rice varieties that have constituted the backbone of the "Green Revolution" are ample proof of the value of such innovations. They raise the response curve for fertilizer; a given quantity of fertilizer will generally lead to greater levels of crop production with the high-yielding varieties than with the traditional varieties (Figure 3). The gap widens at higher levels of application. Because of the generally low levels of application use on food crops in LDC's a considerable technical potential exists. And improved plant types and other technologies are likely to be developed.

### 3. Summary of Demand Factors

On balance, we might well agree with Desai when he suggests that the maximum quantity of fertilizer profitable for cultivators to use depends on: 49/

- a. Price relationships between crops and fertilizers;
- b. The availability of complementary inputs, and
- c. The state of technology

Actions to increase the use of fertilizer by modifying only one of these sets of factors may not be sufficient. A package incorporating the three may be needed. Just how it should be balanced, however, is a question which may require considerable additional study within individual nations. After looking at certain other factors which affect fertilizer use at the farm level, we will return to a discussion of the policy problems involved in assembling a "package" approach.

### C. Consumption

The interaction of supply and demand factors has led to generally low levels of fertilizer consumption in the LDC's. The disposition and rates of use of fertilizer, however, appear to vary sharply between crops and countries. Both economic and non-economic factors influence the resulting pattern.

### GENERALIZED FERTILIZER RESPONSE CURVES

#### Rice and Wheat

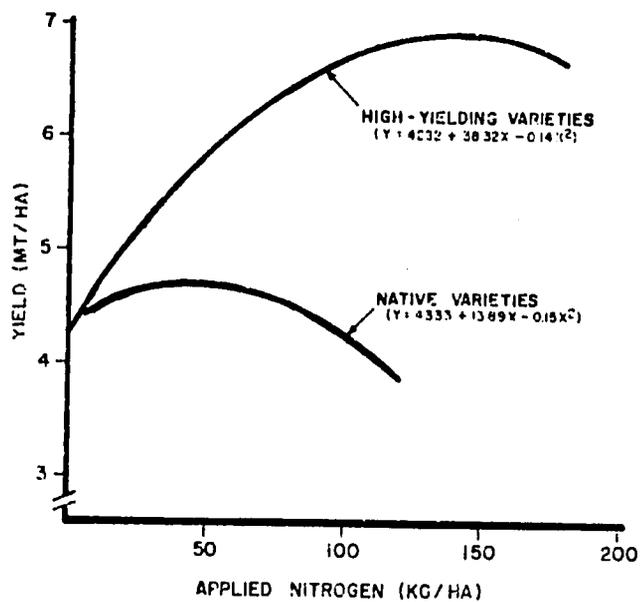


Figure 1. Generalized curve for the response of rice to nitrogen applications in the dry season.

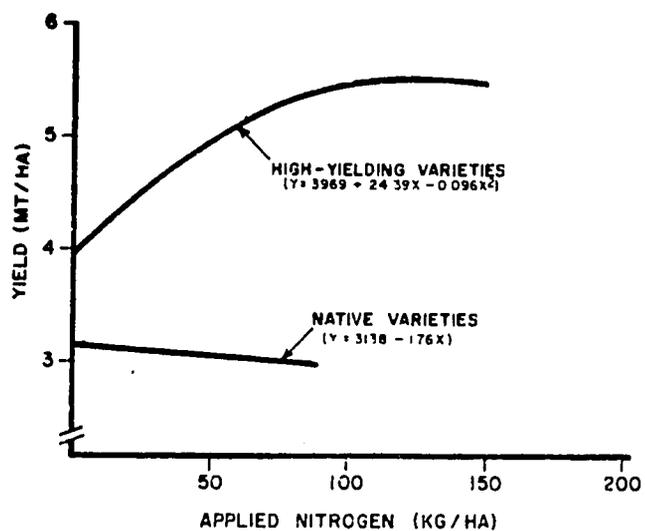


Figure 2. Generalized curve for the response of rice to nitrogen applications in the wet season.

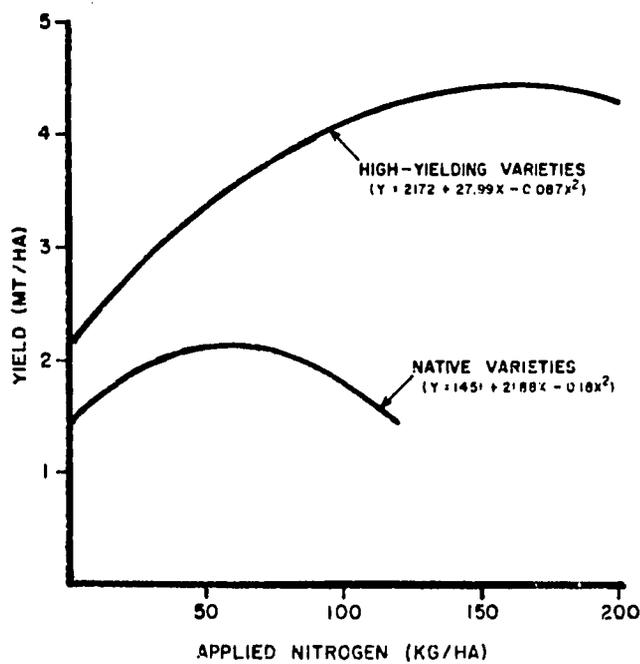


Figure 3. Generalized curve for the response of wheat to nitrogen applications.

Source: High-Yielding Cereals and Fertilizer Demand, TVA, 1970, Bulletin Y-4, pp. 6, 7, 8.

## 1. Relative Levels of Consumption

Levels of chemical fertilizer use vary widely in the LDC's but in general are well below those in the DC's. In 1971/72, for instance, total chemical fertilizer use in the non-communist LDC's was (a) only 15% of the DC's in terms of application per unit of arable land, and (b) only 10.5% of the DC's application per capita. 50/

Within the LDC category, overall fertilizer use was highest in Latin America and lowest in Africa; Asia fell in between. 51/ There are further subvariations. In addition to Africa, other regions with relatively low levels of use include the traditional agricultural spheres in Indian populated areas of Latin America, in Nepal, and large parts of South-east Asia. In Latin America, fertilizer use levels were particularly high in Venezuela and Southern Brazil. 52/

Within individual LDC's, there is a range from large areas which use little or no chemical fertilizer to relatively smaller areas which may be heavily fertilized (some of the reasons for this variation will be discussed below). In the cases where fertilizer is used on the high-yielding varieties of wheat and rice, application levels are generally below those which are recommended. 53/

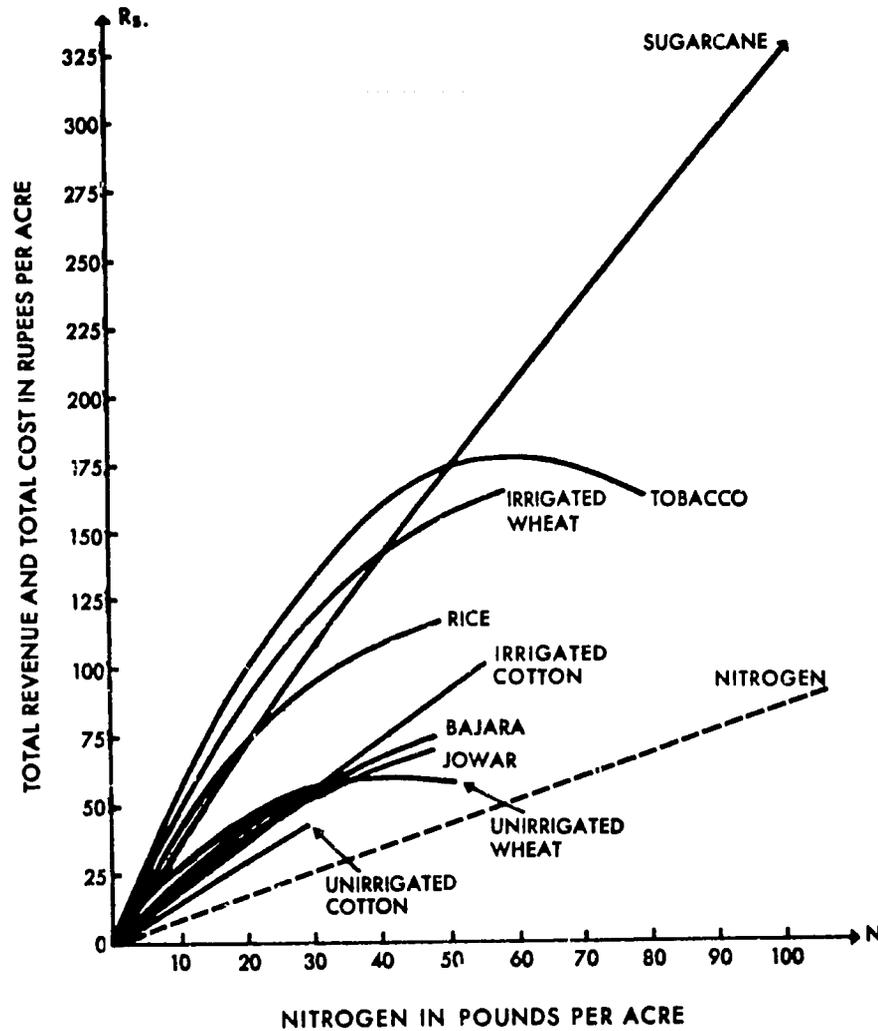
## 2. Variations in Consumption by Crop

While many types of statistics are available on fertilizers, data on their actual utilization by crop are very scarce. As an early section of this report suggested, much of the early use in LDC's seems to have been on plantation crops for export. That situation appears to have changed gradually over the last few decades.

As of the mid-1960's, the pattern was somewhat more mixed. On one hand, Millikan and Hapgood suggested that fertilizer was still being used more on higher-priced cash crops than on food crops. 54/ On the other hand, the Indicative World Plan suggested that over the 1961-63 period, about one half of the total fertilizer supply was applied to cereals - though in certain countries its use on export crops was significant (examples of the latter included: Ceylon, 56% on tea; Malaysia, 71% on rubber and oil palm; Peru, 51% on cotton and sugarcane; Kenya, 80%, on coffee and tea; Senegal, 52% on grounds; and Uganda, 84% on sugarcane and tea). 55/

Fertilizer naturally was used where it was best known and where it was most profitable. While the relationships varied widely in individual countries and regions, some relationships calculated by Desai for Gujarat State in India in the mid-1960's, may be indicative of the variations among crops. Figure 4 indicates (a) the total revenue for various crops (solid lines) at increasing levels of nitrogen fertilization, and (b) the associated cost of nitrogen (broken line). The difference between the two lines, other things being equal, is net revenue.

TOTAL REVENUE AND COST OF USING NITROGEN ON DIFFERENT CROPS, GUJARAT STATE, INDIA, MID-1960's



\*Three groups of cultivators. 1963-64 crop prices; 1964-65 fertilizer prices.

Source: Guntant M. Desai, Growth of Fertilizer Use in Indian Agriculture: Past Trends and Future Demand, Cornell University, International Agricultural Development Bulletin 18, July 1971, p. 40.

Figure 4

Clearly the greatest returns were from sugarcane and tobacco. But irrigated wheat and rice rated high. Unirrigated wheat and cotton, bajara and jowar ranked the lowest. Elsewhere in India, Desai found the most profitable category, in addition to the four crops listed here, to also include certain fruits (e.g. banana) and vegetables. Cotton, oilseeds, and other foodgrains were in the least profitable category. 56/

With the subsequent introduction of the highly fertilizer-responsive varieties of wheat and rice in India, along with improved fertilizer/product price relationships, their relative profitability in terms of fertilizer use may well have expanded further. Estimates of fertilizer use by crop in India in 1970/71 showed the following breakdown: 57/

<u>Crop</u>	<u>Percent</u>
Rice	31.4
Wheat	19.2
Other grains*	14.4
Sugarcane	18.2
Cotton	7.9
Oilseeds	3.6
Pulses	0.7
Other crops**	4.6
<u>Total</u>	<u>100.0</u>

\* Including jowar (sorghum) 5.3, and maize 4.0

\*\* Composition and breakdown not indicated

While one might wonder if plantation crops are fully represented 58/, the breakdown does suggest that wheat and rice were not being neglected during this period.

Still, there are other areas of the world - and perhaps some regions in India in more recent times - where plantation or export crops tend to absorb most of the fertilizer available. A recent survey in Central America, for instance, suggested that "small farmers growing the basic food grains are using less than 20% of the fertilizer nutrients;" in Honduras the estimated proportion was less than 10%. 59/

In view of the variations in profitability of fertilizer applications, it is not surprising that quite different rates of application are found between crops. In a relatively free economy or one with few market imperfections, the fertilizer will find its way into its most profitable use. In reality, however, many market imperfections do exist and fertilizer may flow to those buyers with the greatest economic, social, or political power.

Both sets of factors are apt to provide the planner or aid agency which is trying to use the fertilizer for, say, a grains program with substantial frustrations and complexities. Recently, for instance, the Indonesian government attempted to channel scarce supplies of fertilizer towards rice; this proved to be difficult because of diversion of fertilizer to other more profitable uses. <sup>60/</sup> We have earlier noted similar problems of diversion in the Philippines and elsewhere.

All of this has very profound implications for subsidy programs. It means, simply, that fertilizer subsidy programs intended to increase production of a certain crop may have little impact unless that crop is among the most profitable of the available alternatives. If it isn't, the farmer may just resell the fertilizer to others who have more profitable uses awaiting. Or the fertilizer may simply be diverted before it gets to the farm level. The farmer and others may in the process receive a little income support, but the anticipated effect on crop production may not come about. <sup>61/</sup> It appears, therefore, that much more than subsidies will be needed to encourage added production of certain crops.

### 3. Variable Need for Fertilizer

We have noted a number of economic and other factors which influence the demand for chemical fertilizer. It should be recognized, of course, that there is a variable need for fertilizer by region and crop.

One reason is that fertilizer is not the only yield-increasing input; in some cases other inputs may be more appropriate. This point was well made by FAO in the Indicative World Plan:

...in some regions (and this especially applies to Africa South of the Sahara) it was assumed that, as long as land utilization remains extensive, there would be opportunities to substitute other yield increasing inputs for fertilizers. Under these circumstances it was proposed that the moderate yield increases postulated for most food crops could be reached by use of better plant varieties, improved methods of cultivation and plant protection measures. <sup>62/</sup>

A somewhat similar situation may be found in more intensive areas. A survey of a number of rice farmers in Asia in 1971/72 for instance, has revealed that they see their major yield restraints as diseases, insects, and other pests. The problems of obtaining fertilizers and other farm chemicals came in second. Irrigation was also a major need. <sup>63/</sup> To be sure, the farmers may change their opinions some as they begin to feel the effect of higher fertilizer prices. But if this response is representative of other areas, it adds further evidence of the need for a package program of assistance as opposed to putting a very large proportion of government resources in fertilizer subsidies.

It must not be overlooked, of course, that chemical fertilizers are not the only source of nutrients. Animal manures are still important sources in some areas. Legume crops are a source of residual nutrients. Other plant and animal forms are either in use or being studied.

Finally, it should be recalled that HYV's usually do as well as traditional varieties without fertilizer, and may even yield slightly more (e.g. Table 3). For a given level of fertilizer use, they usually yield more than the traditional varieties. Thus some farmers can obtain a slight boost at no cost, by using the HYV's or can reach the most sharply rising portion of the HYV response curve without using the recommended levels of fertilizer use.

For these reasons, it may be that the major challenge over the longer run will be - as IRRI has put it - to better identify and remove constraints so that returns to fertilizer become more profitable and involve less risk. 64/ The whole management package must be examined. These actions may well be essential if farmers are to effectively use more chemical fertilizer in the future.

#### IV. POLICY ALTERNATIVES

National Fertilizer policies, when they are considered at all, are usually cast in terms of price options or of cost-benefit analysis. A much wider initial focus is needed.

Indeed, one might start with a broader set of questions and follow a deductive process to determine the most appropriate point of program entry. The ordering of the questions might be, for example, as follows:

- What is the major agricultural problem of the LDC?
- If the need is to expand crop production, what are the main constraints?
- If the major constraint is soil fertility, what are the technical options open in the short and long run?
- If chemical fertilizer is the most promising solution to the fertility problem route, what are the major limitations on its use?

The constraints on fertilizer use can take many forms, ranging from physical delivery problems to lack of farmer knowledge about its potential payoff. Of the literally dozens of limitations that might be noted, only a few will be noted here. Initial attention will be focused on the fertilizer cost and product price relationship. This will be followed by a brief review of some non-price policy options.

The two areas are interrelated to some extent. This is because the demand for fertilizer, as we have noted, is composed of the relationship between three major components: (1) fertilizer price, and (2) product price, and (3) the nature of the crop's physical response function to fertilizer. The third, though of vital importance, often tends to be overlooked. The response function in turn is related to several other non-price factors, such as the state of technology and the availability of complementary inputs.

The relative importance of these and other components will be influenced by at least three factors. One is the stage of agricultural development with respect to fertilizer. Is the key problem the introduction of fertilizers, or is it one of offsetting current price increases to farmers who are well acquainted with fertilizers? A second factor is the time available; price policies can have virtually immediate reactions, whereas efforts to improve the domestic fertilizer supply and/or the physical response function may take years or decades. A third factor is the stage of economic development of the country: the more advanced and urban nations will have greater financial and technical resources to support such programs than the least developed nations.

## A. Price Policies

As suggested, most of the rather limited analysis of subsidy programs is concerned with the question of the ratio between fertilizer prices and product prices. Since both are inherently variable, the policy questions in many cases are: (1) what balance should be kept as a goal, (2) what approach should be taken to maintain this balance? Obviously in some countries the ratio may be sufficiently favorable that a subsidy is not needed. Where this is not the case, and the ratios have been out of balance, the discussions have been cast in terms of whether it is better to subsidize the fertilizer itself or to exercise some control over the product price. We will briefly note some of the main considerations in each option, and in doing so will cite some of the arguments for a joint approach.

### 1. Fertilizer Prices

The two main ways of reducing relative fertilizer prices in the short run are to (a) lower fertilizer prices through the use of a subsidy, or (b) to raise product prices (or allow them to rise). In the longer run it might be possible to reduce the cost of fertilizer in several ways, such as: importing raw materials and mixing fertilizers, expanded domestic production, and more efficient distribution.

#### a. Subsidize Fertilizer Prices

Subsidies on fertilizers, like any public policy, may be expected to have positive and negative social effects of varying strengths beyond their immediate impact on output. An analysis of policy options in Mexico, for instance, has suggested that a 30% subsidy on chemical fertilizer might have: 1/

- strongly positive effects on crop production and consumers surplus,
- positive effects on exports and producers income,
- a negative effect on the budget

Subsidies on fertilizers have been favored in many quarters because, as Krishna puts it:

the benefit of government expenditure can be derived by the peasants only in proportion to their use of improved inputs. Input subsidization also avoids raising food and raw material prices against the growing industrial sector. 2/

Input subsidies may be less costly than product price subsidies and are probably more easily reduced than product price subsidies.

There are, however, several contrary arguments. First, where improved inputs are unfamiliar to the peasants, their price may be less important than the product price. Secondly, input subsidies cover only part of the total cost of production and do not provide insurance against downward fluctuations in price. Thirdly, a fertilizer subsidy will cover only part of the cost of several needed, purchased inputs. Fourthly, input price manipulation cannot discriminate between products (some examples of the latter problem have been noted) or income groups of users. 3/

Fertilizer subsidies have several other limitations. One, noted previously, is the potentially high budget cost to the government, especially if the subsidies are carried beyond the initial adoption period (product subsidies of course share this problem). Another is that if the subsidy is applied to imports, it may discourage the development of a local fertilizer industry. 4/

A more general problem is that subsidies, as Binswanger has noted, may "distort both the choice of commodities and the choice of technique for each commodity." 5/ Subsidies, therefore, may encourage uneconomic use of fertilizers; they may be used at the wrong time, in the wrong amounts, on the wrong crops. They may lead to an inefficient choice of cropping patterns.

The subsidy, moreover, may never reach the farmer, or at least the small farmer. Thus, if the subsidy is designed with half an eye or more to income transfer, it may not prove to be an efficient or equitable vehicle.

#### b. Allow Prices to Increase

If the price of fertilizer to the farmer were allowed to increase, three major interrelated results might be expected to follow: (1) the amount of fertilizer applied might fall, (2) the pattern of utilization might change, and/or (3) the price of food to the consumer, reflecting both the higher input cost and/or lower yield due to lower level of fertilizer use, might rise. The relative importance of each would depend on the nature of the various price elasticities and cross elasticities of demand.

Factor (1) might be of particular concern to the small farmer with limited financial resources. He might, as suggested earlier, cut back on fertilizer use on the high-yielding varieties (HYV's) of wheat and rice. This would not necessarily be because the HYV's became unprofitable - studies in Bangladesh, Ghana, and Sri Lanka have suggested that unsubsidized fertilizer would still more than pay for itself. 6/ Rather, the problem would more likely be that poor small farmers would have greater difficulty in obtaining credit to buy fertilizer and other needed inputs than wealthier or larger farmers.

With respect to factor (2), the general tendency for fertilizer to flow to the crops with highest returns would be accelerated. In the case of Brazil, for instance, it has been suggested that (a) fertilizer

use would fall least on crops like coffee, sugarcane, and cocoa (where it has been used for a long time, where there is a good understanding of fertilization practices, and where product price risk is less due to greater government intervention), and that (b) there would be some shift in cropping patterns (to the above crops and to legume crops like soybeans which generate much of their own nitrogen). 7/

In addition, allowing the price of fertilizer to increase would reduce the incentive for black marketing and smuggling (though the latter might also be influenced by relative exchange rates).

The severity of the effect of fertilizer price increases depends to some extent on the rapidity with which they come about. Part of the current problem is that the prices have increased so much and so quickly that there hasn't been time to work out rational adjustments. In Sri Lanka, for instance, farm gate prices rose 400% in 18 months, leading the country to reimpose a previously discontinued subsidy. 8/ On the other hand it was calculated that a 15% increase in fertilizer prices, compounded annually, would result in elimination of the existing subsidy in 4 years; a 10% increase would eliminate the subsidy in 6 years. 9/

But fertilizer prices are only half of the equation that influences farmer action. The other half is product price.

## 2. Product Prices

Relative product prices, like those of fertilizers, vary sharply around the world. In some areas, product prices are held well below world market levels in order to keep consumer prices, at least in the short run, at artificially low levels. In other cases, prices are supported above world market levels. Clearly an increase in product prices would result in fewer distortions in the former case than it would in the latter. Aside from removing export taxes and the like from domestic production, an LDC government might more actively raise the product price through adjustments in the price support level and/or in official wholesale/retail prices.

The main advantages of raising product prices, compared to input subsidies, are that: (1) they are of major importance and are well recognized by all but self-sufficient (non-market) farmers, (2) a rise, because of the cushion it provides, reduces the danger from downward price fluctuations, (3) a rise rewards the increased use of an array of inputs, and (4) an adjustment can be easily applied to specific or individual crops. 10/

The main operational difficulties of the product price approach center about their lack of linkage to specific inputs. As Krishna and others have put it, if product prices are raised, some peasants "may or may not take to improved cultivation. They may simply spend the extra income on consumption..." 11/ All farmers will benefit -- noninnovators as well as innovators -- and there is no assurance that the desired increase in output will be attained.

At the same time, an increase in product price may reward the farmer with higher yields more than the farmer with lower yields. While one effect of this imbalance would be to encourage farmers to increase yields through the use of fertilizer, there may be a host of biological and institutional factors which limit his ability to expand yields. Thus he may benefit less than the farmer who is more fortunately endowed.

The potential for product price adjustments may be limited when an LDC does not have price support programs (or a effective program). Where they exist there may be practical and political limits as to how far product prices could be adjusted to offset increased fertilizer prices. And, on the other hand, it can be politically very difficult to reduce price supports; this is of special importance if the stated product or intent of subsidies was only to stimulate initial use of fertilizers. The governmental costs, in any case, could be enormous for the effect which is obtained.

If the increased prices are wholly passed on to the consumer, a number of obvious social and political problems would result. Few governments--DC or LDC--care to face the consumer reaction to higher prices or the inflationary pressures they bring about; there is often a strong desire to keep prices down in urban areas. And if prices are raised the nutritional status of lower income groups is apt to be worsened. Still, it may be better to face these problems directly, and to think out ways to ameliorate them (such as subsidized food distribution or direct welfare payments to the very poor) rather than to implement subsidy programs which may be even more difficult or costly in the longer run.

### 3. Joint Price Policy Action

It should be quite clear that programs which affect either fertilizer or product prices have their own advantages and disadvantages. One option may rank favorably only when the comparison is made with the other (a fertilizer subsidy may be less expensive than a general subsidy, but still may entail a substantial budget cost). It is doubtful whether there are many locations whether either program could by itself be sufficient to efficiently bring about an increase in fertilizer use.

For these and other reasons, the 1967 statement by Millikan and Hapgood that "No blanket preference can in our opinion be given either to general price supports or to input subsidies" still appears valid. <sup>12/</sup> The relative efficiency of each as a method for improving the price ratio of outputs to inputs depends on many factors which must be examined in the context of each individual country.

Moreover, it is not usually a matter of indifference whether the profitability of a practice is increased by one or the other action. As Krishna has pointed out, there are a number of reasons why the same responses cannot be obtained by manipulating each. In fact, he states, "both are needed as complementary instruments of policy, for different reasons." <sup>13/</sup>

Also there is need to put the matter in a fuller time perspective.  
In Krishna's words:

It is true that input price subsidization avoids an immediate increase in food and raw material prices, but this will not prevent a long-run step increase in their prices if input subsidization does not succeed in stepping up agricultural output at the same rate as price guarantees would. In other words, input subsidization may seem cheaper than product price support in the short run, but product price support may prove cheaper for the city in the long run. 14/

For these and other reasons, it may be that where a price policy program is needed, it should be joint price policy program. And in actual practice, the recent increases in fertilizer prices have commonly led to adjustments in both fertilizer and in product prices. The problem is that they are often not adjusted at the same time; product price increases tend to lag behind those for fertilizer. In Pakistan, for instance, prior to September 1974 "crop prices were not permitted to follow as rapidly and incentives for fertilizer use in major crops declined." 15/

de Guia has suggested an interesting and relatively sophisticated three-step process which partially integrates the two types of price policy: 16/

Step I. Introduction (when availability and farmer awareness are of primary importance). Subsidize heavily at the retail point to encourage initial trials with fertilizers. Regulate retail margins.

Step II. Reinforcement (when credit is of primary importance). Subsidize transport costs rather than retail prices. Attack distribution cost structure but permit dealer margins to grow.

Step III. Maintenance (when price is of primary importance). Eliminate subsidies (except possibly where they are used to affect crop growing patterns). Encourage price competition among dealers to push retail margins downwards.

While it is often recommended that fertilizer subsidies be reduced over time, this has proved difficult. Perhaps a sequence of the above sort, in a period of relative fertilizer price stability, might provide a useful thought framework.

Another alternative might be to have a two-price plan both for fertilizer and product. In the poorer areas, higher subsidies and price supports might be maintained than in the more prosperous areas. The great difficulty, of course, would be to keep the fertilizer from being diverted to other farms and other uses.

## B. Non-Price Policy Options

While many efforts designed to increase the adoption and utilization of fertilizer have been cast in terms of fertilizer/product price ratio programs, there are (as suggested at the beginning of this chapter) a number of other actions which might be taken.

If we were certain that soil fertility was the key limiting factor, we might first think of two basic types of actions (the choice depending in part on the nature of the limiting factor, and the time available). One would be to use limited government funds to expand lower cost domestic supplies (if possible) and reduce distribution and marketing costs. The second would be to increase the efficiency of fertilizer use or response, and/or remove other factors constraining or limiting fertilizer use.

The first point is generally well recognized; the second may be of increasing importance in the future. In the latter case, the approaches can be subdivided into (1) those influencing the type form, timing, and placement of the fertilizer itself, and/or (2) the genetic ability of the plant itself to efficiently utilize fertilizer. Substantial efforts are underway on both counts and the successes recorded with the high-yielding, fertilizer-responsive varieties of wheat and rice are well known; development of other such crops is needed.

Two recent statements of future needs parallel these views. The International Rice Research Institute suggests that once more adequate fertilizer supplies are available, "...the major task will be to encourage increased use of fertilizer other than through higher food grain prices." To this end, they see a need to redirect rice research toward the goal of greater efficiency in fertilizer use. <sup>17/</sup> Similarly, Meyer and Wright suggest that in Brazil:

...the real bottleneck in raising yields of many important crops may well be the underlying responsiveness and profitability of fertilizer use rather than the diffusion and adoption by farmers. This would imply a need to shift away from costly promotion programs to basic research on fertilization. <sup>18/</sup>

The situation in each country may, of course, vary.

While the initial thrust for improving the efficiency of fertilizer use might well come from the DC's and international research centers, there is much that could be done by the LDC's themselves. If, for instance, the LDC's who have recently spent millions of dollars on subsidies had instead devoted these same quantities to indigenous research and educational work on crop fertility and fertilization practices, they might be able to make far better use of fertilizer in the coming years.

It may be that the limiting factors lay beyond fertilizer itself. Improved complementary cultural practices -- such as better weed control and water-management practices -- may be of great value. When, for instance, the U.S. AID mission in Saigon was considering supporting a subsidy program for FY 1975, members of AID/Washington suggested that the intended funding:

...might be more effectively used by providing better varieties of seed, improving extension work, providing for the more efficient utilization of water, etc...Thus alternative uses of funds would probably be more effective in helping to keep the prices paid by the consumers down, which seems to be the major goal of the fertilizer subsidy. 19/

Similarly, a recent analysis of the Bangladesh economy has taken the view that

If the objective is to improve the agricultural production and farm income, there are obviously much more profitable ways to spend the same amount of money... . An expanded agricultural extension program would probably be a far more efficient way to encourage increased fertilizer use, and particularly to get farmers to have their soils tested and to follow the best practices for their particular soil conditions. 20/

The authors may be a bit sanguine about the relative effectiveness of these alternate uses. And quicker action may be called for. But they are certainly well worth thinking about where conditions permit.

Subsidy programs, in other words, may entail very substantial, perhaps even crippling, (a) direct costs, as well as (b) opportunity costs in terms of alternative programs foregone or neglected. And it may be that fertilizer supplies are not the major constraint on production. Yet subsidies are sometimes used as a panacea rather than just one possible element in a package of efforts needed to get agriculture moving. Complex matters such as agricultural production are seldom amenable to one-shot solutions.

## V. CONCLUDING REMARKS

It is difficult to draw many conclusions about subsidies for fertilizers in developing nations. The types of subsidies and range of conditions are too diverse for easy generalization. Still, some comments are possible. These should be prefaced with the acknowledgment that while I had a fairly open mind about fertilizer subsidies when I began this review, I am now considerably more skeptical about them.

The traditional argument for subsidies in LDC's has been to encourage fertilizer use. There may well be justification for temporary use of subsidies at the very earliest stages of the adoption process--if it has been determined that a lowered price will provide a significant boost to adoption. This, however, is a significant condition. It is more of a generally accepted nostrum than well-proven fact. Still, it could be true in some cases. And since relatively small numbers of farmers may be involved for only a year or so, the government cost theoretically would not be great. The problem comes if the government doesn't make it clear in advance that the subsidy is temporary and if it doesn't withdraw it quickly enough. As with any subsidy, political pressures can force its continuation long past its period of peak usefulness.\*

The burden carried by the subsidy process has become immeasurably greater with the recent rises in fertilizer prices. These not only make the introduction process more difficult (to the extent that fertilizer price is important), but can add significantly to the cost of production of the adopting farmer. Since the farm demand for fertilizer appears to be more elastic over the long run than in the short run, farmers may let up on their level of fertilizer use over time. The short-run problems however, may be particularly severe for small farmers with limited credit. Thus there may be some need for financial relief at the farm level if fertilizer, and in turn crop output, is not to drop off.

The question is then whether a fertilizer subsidy is the most efficient and appropriate general vehicle. Subsidies can be very expensive in terms of limited LDC budgets and they do not necessarily insure that the fertilizer reaches its intended use. Increased prices of certain crops could help draw the fertilizer into that use. But to do this entirely by subsidizing the price of the crops could also be expensive. One alternative, where the government has some control over wholesale and/or retail prices, would be to simply allow increased fertilizer costs to be reflected in increased food prices. This would raise the incentive to apply fertilizer (though it would not guarantee its use) and the "taxing" would be done by the higher consumer prices. Since the lowest income groups would suffer in this process, an expanded food subsidy program might be needed to keep nutrition levels from dropping. And additional credit may need to be provided small farmers lest they be unduly disadvantaged.

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\*When this happens, the subsidy could become an agent of income transfer. Subsidies, however, may not be the most efficient or equitable vehicle for carrying out this process.

Some of the funds that would otherwise be spent on fertilizer subsidies could go for an expanded feeding program, but a substantial sum should also be devoted to (1) the development of expanded local supplies, where appropriate, (2) research and education work on increasing the effectiveness of fertilizer use, (3) study of factors which constrain fertilizer use, and (4) study and correction of other factors which constrain the expansion of food output.

Such an alternative program may be unrealistic and open to criticism. It is idealized in that few politicians would carry it out in the face of increased complaints about the retail price. If they did, they might not correspondingly increase the budget for other programs. Also the program might be considered inflationary. But the sad fact is that unless prices at the farm level are allowed to rise, there will be little incentive for farmers to increase output and prices will rise even more.

More general government price subsidies could moderate increased crop prices, but there is always the danger that they might represent an even larger budgetary cost than fertilizer subsidies. This is not to say, however, that there isn't any place where price supports couldn't be useful; a small program might well provide an initial incentive for fertilizer use on certain crops. And if an extensive subsidy program is to be set up, both input and product prices may need to be wrapped up together. Most countries, however, will not be able to afford a highly subsidized program for very long.

Furthermore, there can be a substantial opportunity cost in devoting many resources to subsidy programs. To the extent that policy personnel are engaged in the many complexities of such programs, they may overlook or underfund important other longer-term ways of meeting the fertilizer problem. These ways, in turn, could lead the way for developing a more rationally-based program of fertilizer use on LDC farms in the future.

The problem, as always in the times of crisis, is to escape the present. I see no easy way out. Retail food prices in the LDC's are going to have to be allowed to rise to reflect the higher fertilizer cost. To do otherwise by resorting to extensive subsidies is not going to do the trick very long; it is simply too expensive in budget terms. And it does not lay the economic and technical base for continued production increases in the future.

Thus my own view is that subsidies should be used very cautiously and very selectively. There may be a few cases where they can help introduce fertilizer or be of needed assistance to small and/or poor farmers. And there may be instances where adjustments in product prices can help direct their use on certain crops. But on the whole I would tend to allow product prices to rise and, where time permits, turn my thinking and limited funding elsewhere -- to the better identification of constraints on fertilizer use, to increasing the efficiency of fertilizer distribution and its use by plants. In short I would try to make the best possible utilization of what little fertilizer I had. This would, however, require much more knowledge about the fertilizer situation at the farm level than presently exists in most developing nations.

VI. REFERENCES AND NOTES

Preface

- 1/ "LDC Fertilizer Requirements and A.I.D. Fertilizer Programs", Submission before the Subcommittee on Agricultural Credit and Rural Electrification on the Senate Agriculture and Forestry Committee, July 24, 1974, p. 8.
- 2/ "Fertilizer Problems and Policy for FY 1976 and Beyond", AID/ACC, April 23, 1975, pp. 1,6.
- 3/ C. Clavel, S. Maturria, and E. DeGuia, Fertilizer Distribution in Chile, OECD, Development Center, Paris, 1972, p. 77.
- 4/ Information provided by John Hill, former Chief of the Agricultural Inputs Branch, Food and Agriculture Division, US/AID, Saigon, May 9, 1975. About 18 billion piasters were spent through December 31 under an Fertilizer Stabilization Fund (set up as Project No. 730-11-120-418, September 9, 1974). Roughly another 16 billion piasters were spent under another arrangement from January 1 to April 1, 1975.
- 5/ "Development Assistance Program, FY 1975, Pakistan", AID, Bureau for Near East and South Asia, December 1974, p. 51.
- 6/ AIDTO Circular A-397 (Airgram), May 29, 1974, p. 1.

## Chapter I

- 1/ R.B. Riedinger, "World Fertilizer Shortage Could Ease by Late 1975", Foreign Agriculture, January 28, 1974, p. 4.
- 2/ The International Rice Research Institute (IRRI) feels, for example, that in the intermediate run (5 to 15 years) the important goal is to increase the efficiency of fertilizer use, both directly and indirectly ("The Implications of the World Fertilizer Situation for New Rice Technology," IRRI, June 1974, pp. 1, 12). We will say more about this in Chapter IV.
- 3/ One can find all kinds of ratios depending on the variety, the level of fertilizer use, the season, and a host of other factors. IRRI observed ratios for rice varying from 1 to 4 to 1 to 35 in Asian villages in 1971/72; the average was 1 to 16 ("The Implications...", op. cit., Table 1). Schuh and Stillman have estimated that the marginal product of an additional unit of fertilizer might produce the following numbers of wheat units in 1971/72: Argentina 154.6, Pakistan 44.4, Colombia 23.4, India 19.7, Brazil 16.9, Netherlands 6.6, United States 4.7, France 3.8 (G. Edward Schuh and Robert Stillman, "Should We Restrict Our Exports of Fertilizer or Should We Allow the Market to Work?" Council of Economic Advisors, Washington, October 8, 1974, p. 13, Table 2).
- 4/ Some of this material is summarized in a very preliminary form in "Possibilities for the Development of Guidelines for the Use of Fertilizers in Agricultural Development," FAO/FIAC Working Party on the Economics of Fertilizer Use, March 17, 1975.
- 5/ A fertilizer pool was established in June 1974 under FAO auspices and as of September 1974 had accumulated some \$15 million from AID donors. It is not immediately clear to what extent this has been used as loans or grants to subsidize the price paid by national governments. However, the coordinator of the project is quoted as saying that the only answer to higher prices is to provide fertilizer "through an international effort at costs that farmers find economic. That means a subsidy fund. In view of the pressing needs...this fund would require over \$1 billion for minimal supplies." (Juan de Onis, "F.A.O. is Battling Fertilizer Crisis," New York Times, September 23, 1974, p. 32.)
- 6/ My inclination was to start with the economics section and then show how it provided a base for past and present subsidy programs. But the more I read and thought about subsidies, the greater became my suspicion that they were built as much or more on other factors, particularly political. Because of this assumption, and because fertilizer subsidies have not heretofore been well reported, I elected to start with them.

Chapter II

- 1/ Raymond P. Christensen, Taiwan's Agricultural Development; Its Relevance for Developing Countries Today, U.S. Department of Agriculture, Economic Research Service, Foreign Agricultural Economic Report No. 39, April 1968, p. 70.
- 2/ D. R. Gulati, "India's Food Requirements to Test Fertilizer Industry," Foreign Agriculture, December 10, 1973. By comparison, the first mixed chemical fertilizers manufactured commercially in the United States were placed on the market in 1849; by 1860 there were seven fertilizer factories (Wayne D. Rasmussen, Readings in the History of American Agriculture, University of Illinois Press, 1960, p. 86).
- 3/ Gunvant M. Desai, Growth of Fertilizer Use in Indian Agriculture; Past Trends and Future Demand, Cornell University, International Agricultural Development Bulletin 18, June 1971, p. 7. "Plantation" agriculture as used by Desai includes tea, coffee, and rubber.
- 4/ Jung-Chao Liu, China's Fertilizer Economy, Aldine, Chicago, 1970, p. 7 (details on the plants are provided on pp. 7-10).
- 5/ Rehabilitation and Development of Agriculture, Forestry, and Fisheries in South Korea, UNKRA, Columbia University Press, 1954, p. 94.
- 6/ Fertilizer Statistics, 1972/73, Fertilizer Association of India, Tables 7.02, 7.04 (as summarized by Industrial Projects Department, World Bank, October 1974).
- 7/ F. Kahnert, et al., Agriculture and Related Industries in Pakistan, OECD Development Center Studies, Paris, 1970, p. 367; "Development Assistance Program, FY 1975, Pakistan," AID, December 1974, p. 9 ("Food and Nutrition Sector").
- 8/ "Bangladesh Loan Paper," AID, Bureau for Near East and South Asia, 1974, Annex D.
- 9/ S. Clavel, S. Maturria, and E. Du Guia, Fertilizer Distribution in Chile, OECD, Development Center, Paris, 1972, p. 75.
- 10/ M. P. Paje, D. E. Kunkel, and A. C. Alcasid, "The Fertilizer Supply Situation and Marketing System in the Philippines," Bureau of Agricultural Economics (with the College of Agriculture and the Economic Research Service), Manila, Working Paper No. 4, January 1974, p. 34. This program established under Republic Act No. 1609, extended from 1956/57 to 1962/63; under it the government purchased fertilizers from domestic manufacturers for distribution at subsidized prices through the farmers cooperatives. The subsidy represented more than 50% of the commercial retail prices. A subsequent program established under Republic Act No. 2084, provided fertilizer to rice and corn farmers at a 50% subsidy (p. 35).

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- 11/ By contrast, the main purpose of subsidies in many developed nations has been income redistribution (letter from K. Wierer, Agricultural Services Division, FAO, Rome, March 3, 1975).
- 12/ On the differential in fertilizer prices, see: Annual Fertilizer Review, 1972, FAO, 1973, p. 10; Frank W. Parker and Raymond P. Christensen, "Fertilizers and the Economics of Crop Production," Fertilizer Production, Technology and Use, United Nations, 1968, pp. 358, 359.
- 13/ As of the spring of 1975 I have received several reports of a dropoff in demand for fertilizer because of higher prices. In some cases, supplies were adequate and were beginning to build up.
- 14/ Parker and Christensen, op. cit., p. 359.
- 15/ H. J. Mittendorf and K. Wierer, "The Scope for Improving Fertilizer Marketing and Credit Systems in Developing Countries," FAO, Rome, January 25, 1974 (draft), pp. 31, 32. The same point has been made by Mittendorf in The Scope for Improving Fertilizer Marketing and Credit Systems in Developing Countries, FAO, 1974, p. 30.
- 16/ Korean Agricultural Sector Analysis and Recommended Development Strategies, 1971-1985, Korean Agricultural Sector Study Team, Michigan State University, Dept. of Agricultural Economics, 1972, p. 116.
- 17/ Desai, op. cit., p. 13. Further details are provided in A Study on Fertilizer Demand and Marketing, Fertilizer Association of India, New Delhi, Vol. III, December 1974, pp. 46-47. Due to a disinclination of the government to change fertilizer prices as import costs rose in the 1970's, this program took on a significant subsidy aspect (Ibid., pp. 47-48).
- 18/ This was the case in Togo in 1962-65 and UAR in 1960-65 (Supply and Demand Prospects for Fertilizers in Developing Countries, OECD, Development Center, Paris, 1968, p. 169). This is also true in Tunisia: Both single and concentrated super-phosphate are produced and distributed by state-controlled companies. To the extent that the fixed price is less than the world price or a free market, the difference is an indirect subsidy. (Robert C. Gray, "Fertilizer Marketing and Distribution in Tunisia," TVA, September 1974, draft, p. 29).
- 19/ This has been done in Vietnam for several years and will be noted in a subsequent section. Exchange subsidies in Brazil in the 1950's are said to have been especially favorable for fertilizer (G. Edward Schuh, The Agricultural Development of Brazil, Praeger, 1970, p. 294).
- 20/ A Study on Fertilizer Demand and Marketing, op. cit., pp. 47, 48.

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- 21/ Reed Hertford, Sources of Change in Mexican Agricultural Production, 1940-65, USDA, ERS, FAER No. 73, August 1971, p. 21.
- 22/ In India, the central government made provision for a subsidy on phosphatic fertilizers on the condition that the cost be shared by the state government. Only a few states did so. (Desai, op. cit., p. 13.)
- 23/ Even if all the unidentified recipients for 1975 in Table 1 were farmers, the total (and proportion) would be less than in 1974.
- 24/ Russell H. Brannon, The Agricultural Development of Uruguay, Praeger, 1967, p. 123.
- 25/ For further comment, see Mittendorf and Wierer, op. cit., p. 32.
- 26/ Richard L. Meyer and Charles L. Wright, "Fertilizer Prices and Brazilian Agricultural Development," Ohio State University, Dept. of Agricultural Economics, August 1974, p. 3. Also see Schuh, op. cit., p. 295, and Charles L. Wright, et al., Fertilizer Response for Annual Crops in Brazil, Ohio State University, Dept. of Agricultural Economics, Occasional Paper No. 210, November 1974, p. 3. It is not immediately known what the interest rate was on other types of loans.
- 27/ Alain de Janvry, "Optimal Levels of Fertilization Under Risk: The Potential for Corn and Wheat Fertilization Under Alternative Price Policies in Argentina," American Journal of Agricultural Economics, February 1972, p. 7. Ironically, the tax write-off approach as an incentive to fertilizer use has been irrelevant for both small and large farmers: the small farmers typically have incomes below taxable levels and large farmers do not need fertilizers.
- 28/ Clavel, op. cit., p. 77.
- 29/ Schuh, op. cit., p. 295.
- 30/ Compiled from data presented in: Production Yearbook, 1972, FAO 1973, Table 134, pp. 335-367 (data on the subsidies are provided in the footnotes): "Note on Fertilizer Subsidies," FAO, Rome, January or February 1974, Table 1; and AID sources.
- 31/ Mittendorf and Wierer, op. cit., p. 31, Table 10. The Iranian government pays all transportation, storage, and other handling costs incurred in moving the fertilizer to the farm gate ("Possibilities for the Development of Guidelines for the Use of Fertilizer Subsidies in Agricultural Development," FAO/FIAC Working Party on the Economics of Fertilizer Use, March 17, 1975, p. II/A/2/9).
- 32/ "Possibilities for the Development of...", op. cit., pp. I/1-3.

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- 33/ Similar calculations could be made on the basis of the data presented in the Production Yearbook noted above. Comparable information is summarized for earlier years in Supply and Demand..., op. cit., p. 169.
- 34/ M. Mathieu, "Fertilizer Subsidies in Developing Nations," FAO, Rome, February 25, 1974, p. 4, and other sources.
- 35/ Clavel, op. cit., pp. 75, 77.
- 36/ Based on Dana G. Dalrymple, et al., The Pricing of Agricultural Capital Inputs in Pakistan, Pakistan Institute of Development Economics, Islamabad, Monograph No. 18, 1974, Table 9. Further details on the subsidy program in the 1960's are provided in F. Kahnert, et al., Agriculture and Related Industries in Pakistan, OECD, Paris,; 1970, pp. 128, 375, 376.
- 37/ "Sri-Lanka--Agricultural Inputs Loan," AID, Bureau for Near East and South Asia, December 1974, pp. 8, 10; Lawrence Rosen, "Sri Lanka; Income Distribution Issues and Pricing Policy for Fertilizer and Other Inputs in Paddy Farming," AID, Bureau for Near East and South Asia, March 24, 1975, p. 4.
- 38/ Harold G. Walkup, et al., The Role of Fertilizer in the Agricultural Development of Afghanistan, TVA, 1958, p. 20; "Project Paper - Management Support for the Afghan Fertilizer Company," Dept. of State Airgram from Kabul TOAID, December 8, 1974, p. 16.
- 39/ Mathieu, op. cit., pp. 4, 5.
- 40/ Korean Agricultural..., op. cit., p. 116; Gilbert T. Brown, Korean Pricing Policies and Economic Development in the 1960's, Johns Hopkins, 1973, p. 127. To be more precise, the deficit accruing to NACF on its fertilizer operation in 1968 and 1969 was roughly equal to 10% of its fertilizer sales.
- 41/ "Upper Volta Seed Multiplication PROP," AID (African Bureau), June 5, 1974.
- 42/ Memo from John A. Foti to Lane E. Holdcroft, AID, (Bureau for Supporting Assistance), October 24, 1974, p. 1. The exchange rate subsidy was not limited to fertilizer in recent years; it also applied to other items imported under AID's commodity import program. Fertilizer and only one other group (POL), however, were eligible for 100% commercial bank financing.
- 43/ This point is reinforced by the findings of an FAO Working Party which stated that their review "turned up limited information on countries using subsidies, their rates and at what point they are applied, but nothing on how they are administered" ("Note on Fertilizer Subsidies," op. cit., p. 1).

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44/ George McArthur, "Report on Fertilizer Scandal Attacks Saigon Aids, Officers," International Herald Tribune, Paris, July, 1974, p. 5. Also carried in somewhat longer form under the title of "Generals, Viet Officials Linked to New Scandal," Los Angeles Times, June 30, 1974, part 1, p. 4.
- 45/ In September 1973, the government decided to move from a free market fertilizer distribution system to a government controlled system administered by policy committees.
- 46/ Joseph F. Stepanek, "Agricultural Input Pricing in Bangladesh," AID, Dacca, December 1973, p. 5.
- 47/ Walkup, op. cit., p. 21.
- 48/ Based on a reliable source which prefers to remain anonymous. Also see Stepanek, op. cit., p. 5.
- 49/ "The Indonesian Economy: Recent Developments and Prospects for 1974/75," IBRD, November 26, 1973, p. 10; memo from E. G. Schiffman and J. A. Foti to Donald Goodwin, AID (Bureau for Supporting Assistance), August 12, 1974, p. 3.
- 50/ Mathieu, op. cit., p. 4.
- 51/ Supply and Demand..., op. cit., p. 67 (source of quote); Rosen, op. cit.
- 52/ Letter from Robert W. Herdt, Agricultural Economist, IRRI, September 5, 1974. According to Paje, et al., "a Socialized pricing policy was instituted in April 1973, whereby the prices of fertilizer intended for use in the production of food crops were reduced and those used for export crops increased" (p. 9). Furthermore,  
The Fertilizer Industry Commission estimated that the fertilizer industry would incur a total loss in year 1973 in spite of the tax exemption on raw material imports granted by the President in February 1973. To cover these losses, the President has approved a subsidy plan to enable fertilizer manufacturers to break even...(p. 9).
- 53/ Clavel, op. cit., pp. 75, 77.
- 54/ Brannon, op. cit., pp. 122, 123.
- 55/ Compiled from data reported in: the Korean Times, February 20, 1969 and March 29, 1969, and the Korean Herald, February 20, 1969 (from files of Gilbert T. Brown). The totals in won appeared to be: 1968, 2.6 billion; 1969, 5.0 billion. These were converted on the basis of 1 billion won = \$3.4 million.

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- 56/ "Project Paper - Afghan...", op. cit., p. 35; Stepanek, op. cit., p. 4. The Afghan subsidy could rise as high as \$27.7 to \$36.8 million by 1979.
- 57/ "Sri-Lanka - Agricultural...", op. cit., p. 8. The subsidy, as noted earlier, was subsequently reinstated.
- 58/ Mathieu, op. cit., pp. 4, 5.
- 59/ Arnold P. Issacs, "Fertilizer Shortage Threatens Famine in East Asia," The Sun (Baltimore), December 3, 1973.
- 60/ H. D. S. Greenway, "Manila Sees Oil Crisis as Long-Range Aid," Washington Post, February 12, 1974.
- 61/ A Study on Fertilizer Demand and Marketing, op. cit., pp. 47-48.
- 62/ National Petrochemical Company, Teheran, 1974; as cited in "Possibilities for the Development of...", op. cit., chp. 2, p. 9.
- 63/ Mathieu, op. cit., p. 5.
- 64/ Peter R. Kann, "'Green Revolution' Is Easing Hunger Slower Than Had Been Hoped," The Wall Street Journal, November 18, 1974, p. 1.
- 65/ Rosen, op. cit., p. 4.
- 66/ Schuh, op. cit., p. 295; Mathieu, op. cit., p. 4; Gray, op. cit., p. 28.
- 67/ "Possibilities for the Development of...", op. cit. The work reported in this paper is very preliminary and rather aggregate.
- 68/ "Note on Fertilizer Subsidies," op. cit., p. 1.
- 69/ Provisional Indicative World Plan for Agricultural Development, FAO Rome, Vol. 1, 1970, p. 199.
- 70/ Based on a reliable source which prefers to remain anonymous. The government has recently confirmed its policy of phased reductions of subsidies ("Bangladesh Agricultural Inputs Loan Paper," AID, Bureau for Near East and South Asia, 1974, p. 9; also see Annex G).
- 71/ Mathieu, op. cit., pp. 1, 3.
- 72/ Darrell A. Russel, et al., Fertilizer Alternatives for Ghana, TVA, Bulletin Y-56, March 1973, pp. 330.

Chapter III

- 1/ Frank W. Parker and Raymond P. Christensen, "Fertilizers and the Economics of Crop Production," in Fertilizer Production, Technology and Use, United Nations, 1968, p. 359.
- 2/ Annual Fertilizer Review, 1972, FAO, 1973, p. 10.
- 3/ Max F. Milliken and David Hapgood, No Easy Harvest; the Dilemma of Agriculture in Underdeveloped Countries, Little Brown and Co., Cambridge, 1967, p. 32.
- 4/ As noted in the previous chapter, a surcharge is levied on the urea production from the newer urea plants in Pakistan and is presumably used to offset the cost of imported fertilizer. No such surcharge was levied on the higher-cost production from the older government plants.
- 5/ H. J. Mittendorf, The Scope for Improving Fertilizer Marketing and Credit Systems in Developing Countries, FAO, Rome, 1974, p. 11.
- 6/ H. J. Mittendorf and K. Wierer, "The Scope for Improving Fertilizer Market and Credit Systems in Developing Countries, FAO, Rome January 25, 1974 (draft). pp. 11, 12.
- 7/ These data are summarized from a more laborious summarization of data from the Production Yearbook, 1972, FAO, 1973, Table 134, pp. 335-367. The period covered varied for individual nations but was generally in the period from 1969/70 to 1971/72.
- 8/ M. Mathieu, "Fertilizer Subsidies in Developing Nations," FAO, Rome, February 25, 1974, p. 4.
- 9/ Indian Journal of Agricultural Economics, October-November 1973:
  - D.P. Sharma and V.V. Desai, "Efficiency of Fertilizers Supply System," p. 108;
  - V. Rajagopalan, et al., "Marketing Efficiency in Fertilizer Retailing," p. 141.
  - J.S. Chawla, et al., "Input Requirements (Fertilizers) of Different Sized Farms in District Amritsar (An Assessment)," p. 153.
- 10/ Cited by Donna Russell in "Fertilizer Shortage Impact on India's Wheat Crop Will be Known in March," Journal of Commerce, February 13, 1974.
- 11/ Dana G. Dalrymple, et al., The Pricing of Agricultural Capital Inputs in Pakistan, Pakistan Institute of Development Economics, Islamabad, Monograph No. 18, 1974, p. 18.

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- 12/ David Kunkel and L. Jay Atkinson, "HYV in the Philippines: Progress of the Seed-Fertilizer Revolution, USDA, ERS, preliminary draft, December 11, 1973, p. 9.
- 13/ George McArthur, "Report on Fertilizer Scandal Attacks Saigon Aids, Officers," International Herald Tribune, Paris, July 1, 1974, p. 5.
- 14/ Alain de Janvry, "Optimal Levels of Fertilization Under Risk: The Potential for Corn and Wheat Fertilization Under Alternative Price Policies in Argentina," American Journal of Agricultural Economics, February 1972, p. 5.
- 15/ "Projected Trends of Trade in Agricultural Products," The World Food Problem, The White House, Vol. II, May 1967, p. 156.
- 16/ Changes in Agriculture in 26 Developing Nations, 1948 to 1963, USDA, ERS, FAER No. 27, November 1965, p. 56.
- 17/ Yujiro Hayami and Vernon W. Ruttan, Agricultural Development; An International Perspective, Johns Hopkins University Press, Baltimore, 1971, p. 195. Price of metric ton of nitrogen divided by the price per ton of milled rice.
- 18/ Walter P. Falcon and C. Peter Timmer, "The Political Economy of Rice Production and Trade in Asia" Stanford University, Food Research Institute, May 1973, p. 3a. Actually Falcon and Timmer presented a reciprocal ratio; I have recalculated it.
- 19/ This was noted at least as early as the mid 1960's by Millikan and Hapgood, op. cit., p. 120.
- 20/ Falcon and Timmer, op. cit., p. 11.
- 21/ Ibid., p. 11.
- 22/ The substantial decline in the ratio from 1955-57 to 1963-65 in four Asian countries noted in the previous section in the text was associated with small gains in rice yield (Hayami and Ruttan, op. cit., p. 196).
- 23/ "The Indonesian Economy: Recent Developments and Prospects for 1974/75," IBRD, November 26, 1973, p. 10; memo from E.G. Schiffman and J.A. Foti to Donald Goodwin, AID, Bureau for Supporting Assistance, August 12, 1974, p. 3. In Indonesia the actual paddy prices were significantly above the official support level.
- 24/ Raymond P. Christensen, Taiwan's Agricultural Development; Its Relevance for Developing Countries Today, U.S. Department of Agriculture, Economic Research Service, Foreign Agricultural Economic Report No. 39, April 1968, p. 62; George Sweeney Jr., "Certain Aspects of Fertilizer Distribution in Developing Countries," in Fertilizer Production..., op. cit., p. 299; John T. Shields and Curtis L. Ahrens, The Fertilizer Marketing System in Taiwan, TVA, Bulletin Y-58, May 1973, p. 11.

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- 25/ Provisional Indicative World Plan for Agricultural Development, FAO Vol. 1, 1970, pp. 199-201.
- 26/ "Economics of Fertilizer Use Under Conditions of Limited Supplies and High Prices," FAO, Agricultural Services Division, Agricultural Inputs Economics Unit [March 1975], pp. 3-5. (Prepared for the FAO/FIAC Working Party on the Economics of Fertilizer Use.)
- 27/ Data compiled by the International Potash Institute, Berne, March 14, 1975, for the FAO/FIAC Working Party on the Economics of Fertilizer Use (Point 6 of the agenda of the meeting of March 17, 1975), 3 pp.
- 28/ "Economics of...", op. cit., p. 4.
- 29/ John W. Mellor, "The Evaluation of Rural Development Policy," in Developing Rural India: Plan and Practice (ed. by Mellor, et al.), Cornell University Press, 1968, p. 106.
- 30/ Supply and Demand Prospects for Fertilizers in Developing Countries, OECD, Development Center, Paris, 1968, p. 68.
- 31/ C. Peter Timmer, "The Demand for Fertilizer in Developing Countries," Stanford University, Food Research Institute Rice Project, Paper No. 5, June 1974, p. 36. Underlining of "immediate" and "longer run" added; original underlining of "if the same relative prices are maintained" removed.
- 32/ The nature and speed of this response mechanism will be influenced by the price elasticity of demand for the final product. The demand for fertilizer, like that for other inputs, is a derived demand: it is a function of the demand for the product it is used on. Thus, in times of crop shortages, prices are likely to rise most for those with more inelastic demand; this price rise is in turn likely to be reflected in a more inelastic demand for fertilizer. On the other hand, in times of crop surpluses, prices are apt to drop most for crops with more inelastic demands; this feature is also apt to be reflected in a more elastic demand for fertilizer.
- 33/ Eric O. de Guia, A Comparative Study of Fertilizer; Distribution Systems in Five Developing Countries, OECD, Development Center Studies, 1972, p. 13.
- 34/ As suggested, for example in the Provisional Indicative World Plan..., op. cit., p. 201.
- 35/ This paragraph draws in part on Timmer (Ibid, pp. 19, 20).
- 36/ Ibid.
- 37/ Millikan and Hapgood, op. cit., p. 32.

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- 38/ Ibid.; Supply and Demand Prospects..., op. cit., p. 67.
- 39/ Supply and Demand Prospects..., op. cit., p. 67.
- 40/ This matter is discussed in the "Bangladesh Loan Paper," AID Bureau for Near East and South Asia, 1974, p. 4.
- 41/ Optimum Requirement of Fertilizer for the Fifth Plan Period, published jointly by the Indian Statistical Institute and the Fertilizer Association of India, New Delhi, December 1974, pp. 51, T-127 (Table 126).
- 42/ Michael C.G. Schluter, The International of Credit and Uncertainty in Determining Resource Allocation and Incomes on Small Farms, Surat District, India, Cornell University, Dept. of Agricultural Economics, Occasional Paper No. 68, February 1974, p. 26.
- 43/ de Janvry, op. cit., p. 10.
- 44/ Schluter, op. cit., pp. 26, 27.
- 45/ Optimum Requirement, op. cit., p. 6. Also see p. ii.
- 46/ Taken from a reliable source which prefers to remain anonymous.
- 47/ Optimum Requirement, op. cit., pp. 40-46, 51, T-127 (Table 126).
- 48/ Some of these points have been borrowed from Timmer, op. cit., pp. 51, 19, 26, 27.
- 49/ Gunvant M. Desai, Growth of Fertilizer Use in Indian Agriculture: Past Trends and Future Demand, Cornell University, International Agricultural Development Bulletin 18, June 1971, p. 6.
- 50/ Based on data compiled from the Annual Fertilizer Review, 1972, FAO, Rome, 1973, pp. 48-49.
- 51/ Ibid.
- 52/ Mittendorf and Wierer, op. cit., p. 2.
- 53/ I have documented some of the evidence for this point in "The Green Revolution: Past and Prospects," USDA/ERS and AID/PPC, July 1974, pp. 45, 46.
- 54/ Millikan and Hapgood, op. cit., p. 32.
- 55/ Indicative World Plan..., op. cit., Vol. I, p. 195.
- 56/ Desai, op. cit., p. 136.

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- 57/ Fertilizer Use on Selected Crops in India, published jointly by the National Council of Applied Economic Research and the National Fertilizer Association of India, New Delhi, September 1974, p. 37, Table 35. Total for N, P, & K.
- 58/ Plantation crops include tea, rubber, cashewnut, cardamon, and pepper. "Inputs like fertilizers and plant protection chemicals have been used on these crops from comparatively early days" (A Study on Fertilizer Demand and Marketing, Fertilizer Association of India, New Delhi, Vol. III, December 1974, p. 11).
- 59/ "Appraisal of Fertilizer Marketing and Distribution Systems in Central America, With Emphasis on Small Farmers," TVA, draft, pp. 2, 69, 132. A study in Guatemala revealed that about 1/2 of the chemical fertilizer was used on coffee, 1/4 on cotton, and 1/4 for all other export and domestic crops (L.B. Fletcher, et al., Guatemala's Economic Development: The Role of Agriculture, Iowa State, 1970, p. 40).
- 60/ "The Indonesian Economy...", op. cit., p. 10.
- 61/ Some economists may not lament this diversion. When the point was raised at the workshop on fertilizer sponsored by the Agricultural Development Council and the World Bank in June 1974, several economists argued that the fertilizer is ultimately used in its economically most useful form. In the absence of input market imperfections this may be true, but the final utilization might be quite different from what the planner envisaged and what the fertilizer was technically designed to do best or most efficiently.
- 62/ Indicative World Plan, op. cit., p. 197.
- 63/ "The Implications of the World Fertilizer Situation for New Rice Technology," IRRI, June 1974, p. 11.
- 64/ Ibid.; Randolph Barker, "The Place of Agricultural Economics in the Developing Countries of Southeast Asia, With Special Reference to Fertilizer Use," IRRI, June 1972, p. 4.

#### Chapter IV

- 1/ John H. Dujoy and Roger D. Norton, "CHAC Results: Economic Alternatives for Mexican Agriculture," in Multi-Level Planning: Case Studies in Mexico (ed. by L. M. Goreux and A. S. Manne), North Holland/American Elsevier, 1973, pp. 394, 397.
- 2/ Raj Krishna, "Agricultural Price Policy in Economic Development," in Agricultural Development and Economic Growth (ed. by H. M. Southworth and B. F. Johnston), Cornell University Press, 1967, p. 526.
- 3/ Ibid., p. 527.
- 4/ Schuh feit that this may have been one of the results of Brazil's program of exchange rate subsidies in the 1950's. (G. Edward Schuh, The Agricultural Development of Brazil, Praeger, 1970, p. 295).

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- 5/ Hans P. Binswanger, "Measuring the Impact of Economic Factors on the Direction of Technical Change," paper prepared for the Conference on Resource Allocation and Productivity in International Agricultural Research, Airlie House, Virginia, January 1975 (draft dated September 25, 1974), p. 2. Also see his article "The Measurement of Technical Change Biases With Many Factors of Production," American Economic Review, December 1974, 964-976.
- 6/ "Bangladesh Loan Paper," AID, Bureau for the Near East and South Asia, 1974, pp. 10-12 (rice); Darrell A. Russel, et al., Fertilizer Alternatives for Ghana, TVA, Bulletin Y-56, March 1973, pp. 36,38 (maize); and "Sri Lanka - Agricultural Inputs Loan Paper," AID, Bureau for the Near East and South Asia, December 1974, pp. 17, 18 (Table 6), 19 (Table 7) (rice).
- 7/ "Sri Lanka Loan Paper," op. cit., p. 8. A widening differential in the exchange rate in Vietnam exacerbated the world price increase.
- 8/ Russel, op. cit., p. 5.
- 9/ Richard L. Meyer and Charles L. Wright, "Fertilizer Prices and Brazilian Agricultural Development," Ohio State University, Dept. of Agricultural Economics, August 1974, p. 8.
- 10/ Krishna, op. cit., p. 527.
- 11/ Ibid., p. 526.
- 12/ Max F. Millikan and David Hapgood, No Easy Harvest; the Dilemma of Agriculture in Underdeveloped Countries, Little Brown and Co., Cambridge, 1967, p. 55.
- 13/ Krishna, op. cit., p. 526.
- 14/ Ibid., p. 527.
- 15/ "Development Assistance Program, FY 1975, Pakistan," AID, December 1974, p. 11.
- 16/ Eric O. de Guia, A Comparative Study of Fertilizer Distribution Systems in Five Developing Countries, OECD, Development Center Studies, 1972, pp. 15-23.
- 17/ "The Implications of the World Fertilizer Situation for New Rice Technology," IRRI, June 1974, p. 1. In this vein, IRRI scientists have recently prepared a report on Increasing Efficiency of Fertilizer Nitrogen in Flooded Tropical Rice, December 1974, 24 pp.
- 18/ Meyer & Wright, op. cit., p. 10.
- 19/ Memo from E. G. Schiffman to Lane Holdcroft, AID, Bureau for Supporting Assistance, March 19, 1974, p. 2.
- 20/ Taken from a reliable source which prefers to remain anonymous.

## VII. APPENDIX

### A. An Economic Justification For An Innovator Subsidy

One argument for a subsidy to innovators can be developed from the adoption curves depicted in Figure 1 and the production function shown in Figure 2. Consider the implications of the early portion of each curve (both of which are S-shaped).

In the adoption curve, about 2.5% of the farmers were classed as "innovators" and another 13.5% as "early adopters." Generally those who are the first adopters of a technology take the greatest risk. They also stand to make the greatest gains, because (1) their production is increased and (2) their increased output will not affect the total supply very much and hence price may not be much reduced. As more farmers adopt the technology, supply increases and price declines, resulting in the maximum advantage to society. <sup>1/</sup> Thus some social purpose can be served by encouraging the innovators--if they need it.

The first portion of the total product curve (OA) does not rise as rapidly as it does later on (AB):

This illustrates the situation in which a very small quantity of a variable resource used with a given quantity of a fixed resource will tend to be inefficient, or, in other words, the variable resource is being used too sparsely with the given amount of fixed resource. <sup>2/</sup>

The problem in the case of fertilizer, therefore, is that in the very early stages of the production function too little may be applied: larger doses are needed to get a significant response (and to maximize marginal product).

The point of overlap in the context of this paper may be the need to use subsidies to encourage the "innovators" and "early adopters" to use a sufficiently large amount of fertilizer to get over this early stage. At least this might help reduce or remove one potential restraint to adoption of "recommended" levels of fertilizer application.

There are, however, several problems with this argument. Perhaps the most important, as previously noted, is that most of the physical response curves noted by the author have not shown this phase; rather they have started later on the total product curve. The major reason is probably that most soils have some inherent productivity. Another limitation may be that factors other than fertilizer price are restraining use.

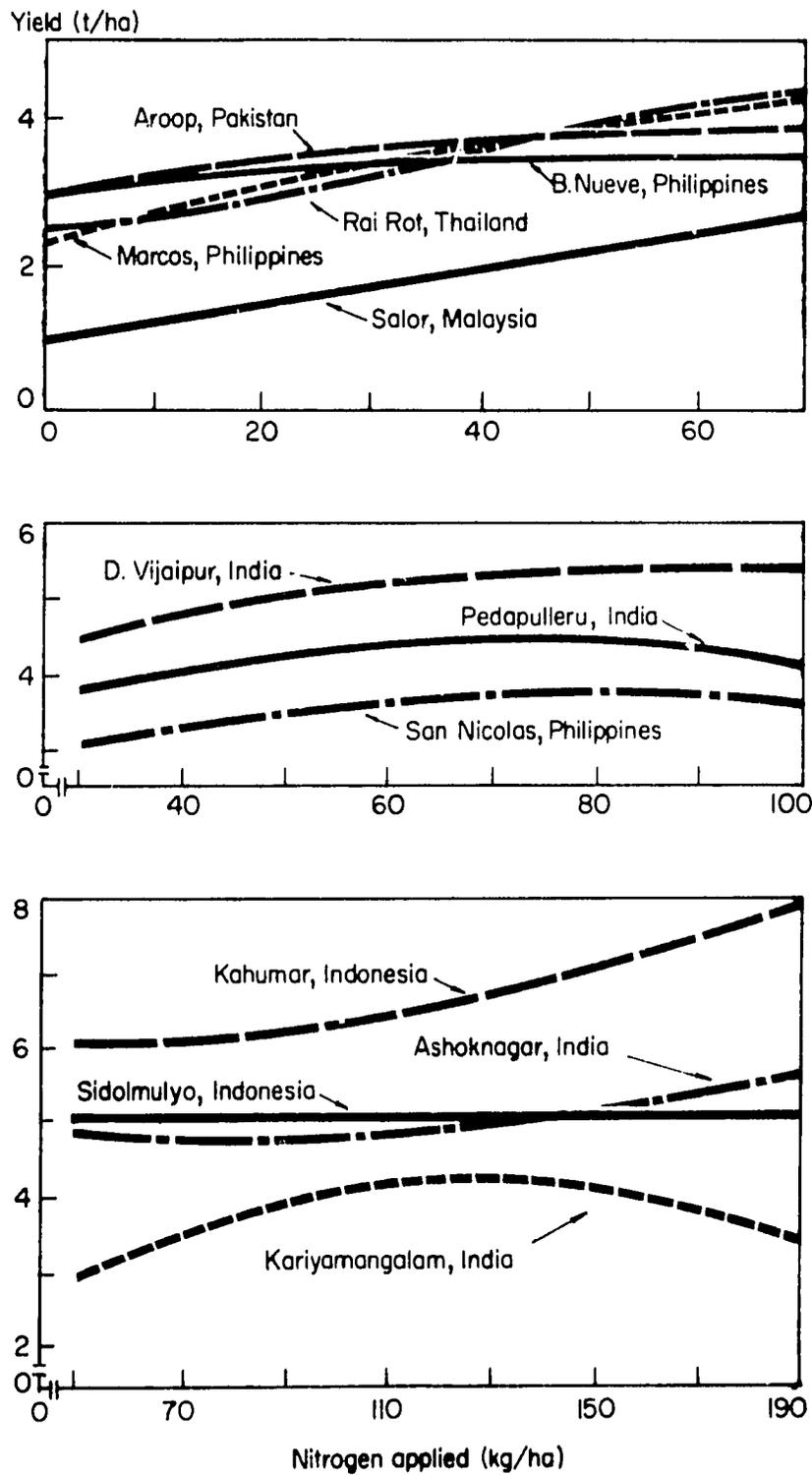
Still there may be some situations where an S-shaped production function holds, such as illustrated in Appendix B, and perhaps then this subsidy argument would hold also (and if not for fertilizer, perhaps for some other factor).

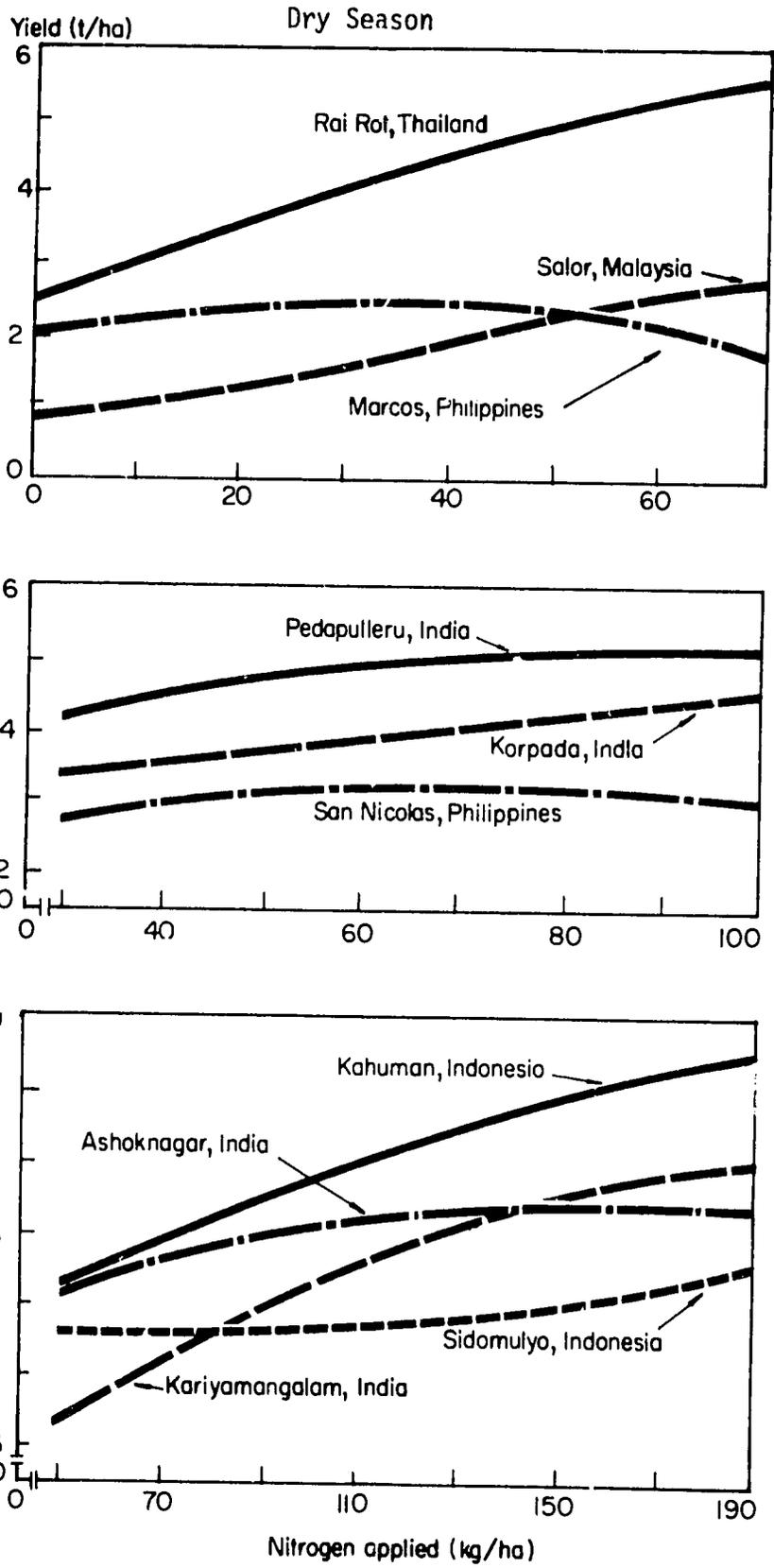
<sup>1/</sup> This process is described in greater detail in Dana G. Dalrymple, Technological Change in Agriculture; Effects and Implications for the Developing Nations, U.S. Department of Agriculture, Foreign Agricultural Service, April 1969, pp. 5-34.

<sup>2/</sup> Richard H. Leftwich, The Price System and Resource Allocation, Rinehart & Co., New York, 1955, p. 108.

B. Nitrogen Response Curves, Rice Selected Villages In Asia, 1971/72.

Wet Season





Source: Teresa Anden and Randolph Barker, "Changes in Rice Farming in Selected Areas of Asia," IRRI, December 1, 1973, Figures 9 and 10.