PN-ABC-435
PN 61030

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AGRICULTURE AND FERTILIZER POLICY

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August 1988

Prepared for ANE/TR/ARD Strategy Symposium
"Agriculture in the 1990s"

ABSTRACT

Agriculture and Fertilizer Policy

Fertilizer is a unique input. Its large contribution to agricultural production makes fertilizer crucial to any strategy designed to speed the modernization of the rural economy. Its volatile prices in the international market create linkages to the macro economy through the balance of payments and government budget, as well as through instability in food supplies if the international prices are routinely passed through to farmers. A country that chooses to produce its own fertilizer to circumvent instability in world markets faces a technology with increasing returns to scale, large capital costs, and requirements for guaranteed access to low-cost feedstocks. Whether fertilizer is imported or produced domestically, an efficient marketing infrastructure is needed to ensure widespread and timely dissemination and distribution. Farmers must know about the use of fertilizer and be able to afford to buy it in optimal amounts.

These issues must be resolved simultaneously, a daunting task for policy makers seeking to develop a coherent fertilizer policy. In the face of significant market imperfections, the unique features of fertilizer require governments to intervene and establish an efficient fertilizer strategy. This paper emphasizes the importance of pricing policy as the crucial link to the three primary levels of concern: domestic production or imports as a source of supply; the nature of government involvement in marketing and distribution; and the role of government policy in stimulating farm-level demand for fertilizer and a more dynamic agricultural economy. No government will leave all of these concerns to the free market. The key question is which interventions will improve efficiency and set the domestic fertilizer economy on a sustainable path. Given the importance of the industry and the large sums of money involved, the answer must deal with both the economics and the politics of the question.

This paper analyzes different aspects of government intervention in the fertilizer sector. Emphasis is on the effects of the various pricing policies undertaken by

governments, their justifications, and long-run impact. Experience of different Asian countries is stressed, and general policy conclusions are put forward based on the lessons learned since the mid-1960s. A case is made that government intervention in the fertilizer sector is not only pervasive, but that some of it has an underlying economic rationale. This paper provides guidance on the types of intervention that are consistent with such a rationale, the feasibility of their implementation, and the economic and fiscal costs likely to be incurred. The types of interventions likely to be counterproductive are also identified. The primary sources of market failures that justify government intervention occur at the supply and demand ends of the fertilizer system. Government interventions in marketing and distribution have often been counterproductive. Designing a fertilizer strategy that copes with the mixed roles of government and the private sector in such circumstances has eluded most countries in Asia and the Near East.

There are only three ways for a country to supply its nutrient requirements for the agricultural sector: import from the world market, produce the fertilizer in a modern domestic plant, or use organic techniques of nutrient recycling. No country has been able to use the latter approach to sustain rapid increases in agricultural output, and most policy makers see the choice of supply as between imports and domestic production. If a decision is made to produce domestically, and this is nearly always a policy decision even if the private sector will own and operate the plants, then issues about timing and sources of investment arise, along with associated issues of domestic producer prices relative to fertilizer prices in the world market. Many developing countries since the mid-1960s have accelerated domestic investment to promote self-sufficiency in fertilizer production. In developing countries, fertilizer production has increased from 13 percent of the world total in 1975 to 32 percent in 1985.

For countries that have the necessary natural resources and a growing internal demand for fertilizer, domestic production can be efficient if the economy's exposure to fertilizer price instability in the world market is reduced and its subsequent macro effects dampened. But such benefits can be negated by improper timing of investment in

domestic plant capacity and inefficient producer pricing. Because of increasing returns to scale in fertilizer production, domestic plants that come on stream substantially before there is adequate growth in domestic demand results in production inefficiencies and capacity underutilization. If the government subsidizes the export of domestically produced fertilizer, improper timing of investment can lead to large budgetary outlays. Likewise, if the government's pricing policy is one of setting ex-factory prices that sustain inefficient production, the policy may succeed in buffering the economy from short-run fluctuations in the world market, but at significant economic cost. An efficient and effective fertilizer supply policy thus requires a delicate balance of policies for trade, investment, and producer pricing.

On the demand side, the use of a fertilizer subsidy for farmers has been justified most often to increase agricultural production, particularly in countries in which food self-sufficiency is a major policy objective. Policy makers usually see the fertilizer subsidy as a tool for offsetting the effects of low agricultural prices and for improving income in the rural sector. At the same time, fertilizer subsidies are heavily criticized on the basis of neoclassical models of economic efficiency for their distortions of incentives and adverse impact on income distribution.

In a textbook world of complete and perfect markets, there is no need for taxes or subsidies to promote economic efficiency. In the presence of certain types of market failures, however, a potential case for government intervention can be made. In fertilizer use, policy analysts point to three potential sources of market disequilibrium: risk-averse behavior on the part of farmers, inadequate knowledge about the productivity of fertilizer use, and imperfections in capital markets. As a result, it is argued that farmers will underinvest in fertilizer. A fertilizer subsidy can be used to compensate, at least partially, for these various sources of disequilibrium. A subsidy serves to some extent as a substitute for crop insurance and a rural credit market. It also provides incentives for farmers to experiment with higher levels of fertilizer, thereby speeding the learning process about optimal applications. To the extent that risk aversion, inadequate

information, and imperfections in capital markets lead to a departure in fertilizer use from the social optimum, a fertilizer subsidy should *improve* the efficiency of resource allocation.

The actual implementation of fertilizer policy in Asia and the Near East presents a major puzzle to economic analysts. Analytically, the potential for intervention into the fertilizer sector to improve economic welfare has been demonstrated in country after country. No country has ignored this message. All the countries in Asia and the Near East intervene into their fertilizer sector in one way or another, and most intervene massively. State control of fertilizer imports and exports, state-owned or licensed fertilizer factories, monopoly distribution rights for a government firm or restricted set of semi-private firms, and controls over fertilizer use by farmers are the norm throughout the region. Interventions at the level of farm use are especially popular, with price subsidies, extension workers, model farmers, and village leaders all encouraging farmers to use more fertilizer.

Despite the apparent match between analytical design and policy implementation, the record of the fertilizer sector in these countries is strewn with the wreckage of repeated failures. In virtually every country and in virtually every arena of government intervention, the actual results have usually been dramatically worse than promised by the models. If government intervention is necessary to create a modern fertilizer sector in a developing country, why do governments in fact do it so badly? The answer must be found in models of political economy and public choice rather than narrower models of project costs and benefits. The two together, however, provide ample insights into why things go wrong so often.

The fertilizer sector is an irresistable source of funds for government officials, off-budget operations, and favored clientele in the private sector. No country can do without fertilizer. *Some* mechanism must be found to supply it to farmers if agricultural output is to grow. Even in relatively small countries where domestic production of fertilizer does not make economic sense, controlling imports provides lucrative opportunities for over-

invoicing, side-payments for distribution licenses, and informal taxes throughout the marketing chain. The task for fertilizer policy in the 1990s is to find a path through the minefield of market failures *and* government failures by limiting interventions to those areas where both analytics and potential to control corruption are promising. Experience of the last several decades provides some insights.

First, there are substantial benefits from domestic production of fertilizer if the basic natural resources are available to permit reasonable costs of production. Ownership of the plants is not the key element in determining the efficiency of operation; ex-factory pricing policy is. Aid donors have not always been as helpful in reaching the right decisions in this arena as they might be. Fertilizer factories make marvelous aid projects. They are discrete entities, absorb lots of money, can use Western machinery and technology, and require little donor monitoring. To guarantee a reasonable rate of return on the investment, however, donors often insist on guaranteed ex-factory prices. Such a pricing policy has very negative effects on choice of technique and operating efficiency.

Second, once a country has the domestic capacity to produce fertilizer, beneficial pressures are generated to develop an effective distribution system to deliver it to farmers. One argument for domestic production is the reduced exposure to instability of fertilizer prices in world markets, but the enhanced regularity of supply to farmers because of domestic production is a separate factor. In political terms, the fertilizer producers are an additional weight in the balance between farmers' desires for regular and low-cost supplies as opposed to government officials' desires to control and extract rents. Tipping the balance in favor of farmers by fostering a more effective distribution system has helped avoid fertilizer shortages when foreign exchange crises occur. Farmers who are totally dependent on imports for their supplies do not have this added support for their interests.

Last, "pure" solutions are guaranteed not to work. Total government control of the fertilizer sector has proven very high cost and insufficiently effective in delivering supplies to farmers. The dynamic losses in efficiency are larger than either the allocative

or X-efficiency losses, although the latter can be extremely large in some circumstances. A free-market approach solves some of these problems but creates others, including the likelihood that no fertilizer industry at all will emerge from domestic investors. The resulting instability may dampen the entire growth process as well as threaten the political survival of any government that attempts such a strategy. Some combination of market forces and government interventions is needed, with the market providing allocative signals, the government stabilizing them around a market trend, and a competitive private sector delivering the goods at low cost. The challenge is to see if any country can find and sustain this magical combination.

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AGRICULTURE AND FERTILIZER POLICY

The importance of fertilizer in the agricultural sector of developing countries is now universally acknowledged. Its direct impact on food production and indirect influence on the government budget and the balance of payments have given fertilizer policy a central role in the overall agricultural strategy of many developing countries. Not surprisingly, government intervention in the fertilizer sector has been pervasive, and administered ex-factory prices, subsidies to farmers, and government marketing monopolies are often the norm. Equally not surprising has been the consistent donor criticisms of these interventions: fertilizer policies seem to be a classic model of what not to do!

This paper analyzes different aspects of government intervention in the fertilizer sector. Emphasis is on the effects of the various pricing policies undertaken by governments, their justifications, and long-run impact. Experience of different Asian countries is stressed, and general policy conclusions are put forward based on the lessons learned since the mid-1960s. A case is made that government intervention in the fertilizer sector is not only pervasive, it often has an underlying economic rationale. This paper provides guidance on the types of intervention that are consistent with such a rationale, the feasibility of their implementation, and the economic and fiscal costs likely to be incurred. The types of interventions likely to be counterproductive are also identified.

The discussion is organized around policy issues at three levels: how to supply the fertilizer needs of a country, how to distribute fertilizer to farmers, and how to encourage farmers to use socially optimal amounts. The primary sources of market failures that justify government intervention occur at the supply and demand ends of the fertilizer system. Government interventions in marketing and distribution have often been counterproductive. Designing a fertilizer strategy that copes with the mixed roles of government and the private sector in such circumstances has eluded most countries in Asia and the Near East. The paper concludes with speculations on why this is so.

Fertilizer Policy and Agricultural Development

The consumption and production of fertilizer have grown steadily since the mid-1960s in many developing countries. Consumption has increased from 8.6 million metric tons in 1967 to 46.6 million tons in 1985--an increase from 15 percent of world consumption to about 36 percent (see Table 1). Similarly, the share of developing countries in production over the same period has grown from 8 percent of global production to about 27 percent. The growth in production and consumption has varied across regions. Asian countries have accounted for most of the growth in consumption, whereas increases in production are more widespread.

Changes in fertilizer consumption and production for several countries in Asia and the Near East since the mid-1960s are summarized in Tables 2 and 3. Data from individual countries reveal the rapid growth in both production and consumption and the same wide variation seen between regions at the aggregate level. According to available estimates, approximately 20 to 30 percent of the incremental agricultural production in Asia can be attributed to fertilizer use.[1] For countries where policy makers perceive that foreign-exchange constraints exist, the possibility of increasing domestic production of fertilizer is doubly important because of the reliability of supply and links to the establishment of efficient marketing channels. In addition, world grain prices would soar if India or Indonesia were to substitute the increases in wheat and rice production generated from greater fertilizer use with imports from international markets. For many Asian countries facing land scarcities, future increases in food production can come only from yield increases. It is not surprising that fertilizer use is projected to more than double by the year 2000.[2]

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1. See Herdt and Capule (1983). In the case of Pakistan, Nias (1986) suggests the number may be closer to 50 percent. The FAO (1987) study, Agriculture: Toward the Year 2000 also suggests that fertiliser might have contributed over 50 percent of the increase in agricultural production of developing countries between 1965 and 1976.

2. FAO (1987) reports that fertiliser use is expected to increase from 25.8 million tons in 1982/84 to 56 million tons by the year 2000 for developing countries as a whole, and from 13.8 to 28.2 million metric tons for Asian countries excluding China.

Table 1. Fertilizer Consumption and Production by Region

Region	Fertilizer Consumption (thousand metric tons)			Annual Rate of Growth (percent)		Fertilizer Production (thousand metric tons)			Annual Rate of Growth (percent)		Self-Sufficiency Index[a]		
	1967-68	1975-76	1985	1967-75	1975-85	1967-68	1975-76	1985	1967-75	1975-85	1967-68	1975-76	1985
Developed	47,251	69,881	81,984	4.4	1.6	55,499	84,575	99,669	4.8	1.7	117	121	122
Developing	8,691	20,109	46,688	9.8	8.8	4,672	15,071	36,630	13.9	9.3	54	75	78
Africa	451	999	1,817	9.2	6.2	345	833	1,602	10.3	6.8	77	83	88
Latin America	2,005	4,438	7,394	9.2	5.2	993	2,231	4,544	9.4	7.4	50	50	61
Near East	772	2,050	4,316	11.5	7.7	369	1,534	5,031	17.2	12.6	48	75	117
Far East[b]	2,504	5,812	15,017	9.81	10.0	994	3,432	11,094	14.8	12.5	40	59	74
Asian CPE[b]	2,955	6,790	18,124	9.7	10.3	1,969	5,193	14,333	11.4	10.7	67	76	79
Other	6	18	19	13.1	0.8	0	52	25					

[a]Self-sufficiency index = (Production - Consumption)*100.

[b]Regions of the Far East and Asian Centrally Planned Economies include most of the countries in Asia.

Source: Food and Agriculture Organization of the United Nations (FAO), Fertilizer Yearbook for 1979, 1982, 1985 (Rome).

Table 2. Fertilizer Consumption in Asia and North Africa, 1967-1985

Region Country	Fertilizer Consumption (thousand metric tons)			Annual Rate of Growth (percent)		Consumption Per Hectare of Arable Land and Permanent Crops (kilograms)			Annual Rate of Growth (percent)	
	1967	1975	1985	1967-75	1975-85	1966	1975	1985	1966-75	1975-85
East Asia										
South Korea	463	786	779	6.8	-0.1	184.6	386.4	392.4	8.6	0.2
Southeast Asia										
Indonesia	164	494	1,789	14.8	13.7	6.8	24.8	94.7	15.5	14.3
Malaysia	85	256	544	14.8	7.8	21.5	59.1	116.5	11.9	7.0
Philippines	124	260	301	9.7	1.5	11.3	30.9	35.8	11.8	1.5
Thailand	89	206	454	11.1	8.2	5.2	10.8	21.0	8.5	6.9
Subtotal	440	1,156	2,937	12.8	9.8					
South Asia										
Bangladesh	93	195	563	9.7	11.2	8.4	23.6	59.2	12.2	9.6
India	1,347	2,959	7,708	10.3	10.1	7.4	14.9	50.3	8.1	12.9
Nepal	3	13	41	20.1	12.2	1.9	5.3	18.7	12.1	13.4
Pakistan	182	537	1,323	14.5	9.4	5.7	27.9	73.7	19.3	10.2
Sri Lanka	116	101	185	- 1.5	6.2	NA	34.3	88.7	NA	10.0
Subtotal	1,741	3,805	9,819	10.3	9.9					
North Africa[a]										
Algeria	47	172	216	17.6	2.3	7.3	16.4	37.2	9.4	8.5
Egypt	301	476	871	5.9	6.2	114.6	177.4	347.3	5.0	7.0
Morocco	87	167	264	8.5	4.7	13.0	21.5	35.6	5.8	5.2
Subtotal	435	815	1,351	8.2	5.2					

Note: Data are three-year averages, centered on the years shown.

[a]1968 data used for North African countries.

Source: Food and Agriculture Organization of the United Nations (FAO), Fertilizer Yearbook for 1979 and 1986 (Rome).

Table 3. Fertilizer Production in Asia and North Africa and Degree of Self-Sufficiency, 1967-1985

Region Country	Fertilizer Production (thousand metric tons)			Annual Rate of Growth (percent)		Self-Sufficiency Index (percent)		
	1967	1975	1985	1967-75	1975-85	1967	1975	1985
East Asia								
South Korea	220	721	1,114	16.0	4.4	47.4	91.8	143.0
Southeast Asia								
Indonesia	23	186	1,840	30.0	25.8	13.9	37.7	102.9
Malaysia	12	37	50	15.0	3.2	14.1	14.3	9.3
Philippines	42	89	92	10.0	0.3	33.5	34.2	30.6
Thailand	6	6	0	0.1	0.0	6.7	2.91	0.0
Subtotal	76	312	1,982	19.2	20.3			
South Asia								
Bangladesh	45	115	393	12.5	13.0	48.2	59.2	70.0
India	374	1,896	5,206	22.5	10.6	27.7	64.1	67.5
Pakistan	42	318	1,117	28.9	13.4	23.0	59.3	84.0
Subtotal	460	2,329	6,715	22.5	11.2			
North Africa								
Algeria	17	111	152	26.9	3.2	35.1	64.5	70.4
Egypt	197	222	738	1.5	12.8	65.5	46.6	84.7
Morocco	134	140	486	0.6	13.3	153.5	83.6	184.2
Subtotal	347	473	1,376	3.9	14.3			

Source: Food and Agriculture Organization of the United Nations (FAO), Fertilizer Yearbook, for 1979, 1980, and 1985 (Rome).

Because of the importance of fertilizer to agricultural development, governments have been reluctant to leave the domestic fertilizer sector to the volatility of market forces, and government interventions in fertilizer production, distribution, and pricing are pervasive (see Table 4). The discussion of these issues is divided into three parts. The next section analyzes the main levels of the economy at which interventions significantly affect the fertilizer sector. The goal is to understand which policy instruments can be used for various purposes at each level. The section following then analyzes the major policy issues facing countries in Asia and the Near East. Price subsidies for fertilizer, the role of government in fertilizer marketing, and appropriate policies with respect to domestic production and imports receive the primary attention. The paper closes with observations on the importance of fertilizer policy to agricultural development and the forces in most countries' political economies that keep the fertilizer sector from making its maximum contribution.

Levels of Policy Intervention

Government interventions in the fertilizer sector are nearly universal in Asia and the Near East, and they are not limited to fertilizer pricing. Many countries also intervene directly, often at the farm-gate, producer, and distribution levels simultaneously. Comparisons across countries of the degree of such interventions are presented in this paper, although data limitations severely limit the analysis.

Fertilizer Supply Issues

There are only three ways for a country to supply its nutrient requirements for the agricultural sector: import from the world market, produce the fertilizer in a modern domestic plant, or use organic techniques of nutrient recycling. No country has been able to use the latter approach to sustain rapid increases in agricultural output, and most policy makers see the choice of supply as between imports and domestic production. If a

Table 4

FERTILIZER PRICING POLICIES IN SELECTED COUNTRIES

Country	Price Regulation Ex-Factory	Price Regulation Retail	Retail Price[1] Uniformity	Subsidy Farmer	Subsidy Producer
Bangladesh	Yes	No	No	Yes	Yes
India	Yes	Yes	Yes	Yes	Yes
Indonesia	Yes	Yes	Yes	Yes	Yes
Pakistan	Yes	Yes	Yes	Yes	Yes
S.Korea	Yes	Yes	Yes	No[2]	Yes
Egypt	Yes	Yes	-	Yes	Yes

Source: M.S.Mudahar and E.C.Kapusta, (1987).

[1] This column refers to the official policy. In practise, uniform prices are hard to achieve at the retail level.

[2] Korea is a marginal exporter and charges its farmers a price higher than the fob price.

decision is made to produce domestically, and this is nearly always a policy decision even if the private sector will own and operate the plants, then issues about timing and sources of investment arise, along with associated issues of domestic producer prices relative to fertilizer prices in the world market.

Imports versus Self-Sufficiency.-- Many developing countries since the mid-1960s have accelerated domestic investment to promote self-sufficiency in fertilizer production. In developing countries, fertilizer production has increased from 13 percent of the world total in 1975 to 32 percent in 1985. Domestic production in countries such as India, Bangladesh, Pakistan, and Indonesia now account for over 60 percent of local consumption, up from an average of 35 percent in the early 1970s. In many cases, the emphasis on import-substitution has superseded concerns for economic efficiency or fiscal prudence. A recent World Bank study concluded that fertilizer producer policy in a majority of developing countries was *least* influenced by the relative cost of supplying fertilizer from domestic industry vis-a-vis imports.[3] This strong emphasis on domestic production has been motivated largely by the extreme volatility of international fertilizer prices and the potential adverse effect on foreign exchange reserves.[4]

Since the mid-1960s, prices (in 1982 U. S. dollars per metric ton) fluctuated from peaks of $310 and $520 in 1965 and 1974 to lows of $130 and $70 in 1976 and 1987, respectively. As a consequence, expenditures for imports of fertilizer by India, China, and Indonesia reached staggering sums in 1974. India is projected to require between $0.8 billion and $1 billion in foreign exchange for urea imports in 1991, between $0.8 billion and $2 billion in 1995, and between $1.1 billion and $2.4 billion by the turn of the century.[5] Despite the uncertainty regarding the accuracy of the number, the orders of

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3 See Segura, Shetty, and Nishimisu (1986).

4. The coefficient of variation (CV) for urea prices since the mid-1960s, for example, has been around 50 percent, a figure much higher than the CV reported for most commodities in the study done by Newbery and Stiglitz (1981) on commodity price stabilization. Only sugar and sisal have greater price instability. See Pradhan (1988).

5. See Pradhan (1988).

magnitude clearly demonstrate the likely impact on foreign exchange requirements. Furthermore, the uncertainty is precisely part of the problem.

In addition to their direct impact on foreign exchange, fluctuations in fertilizer prices have other macroeconomic consequences. First, in the absence of perfect credit, stock, or insurance markets, instability in fertilizer prices and uncertainty are likely to lead to suboptimal levels of private investment and consequently larger-than-optimal level of exposure to world markets. Pradhan (1988) analyzes why the uncertainty and variability of fertilizer prices deter private investment. Because of various market imperfections, large capital requirements for fertilizer plants, and riskiness of the fertilizer stock or bond, private investors must provide a substantial share of the investment as equity to attract and raise capital, thus forgoing opportunities for diversification of their portfolio. Furthermore, in the face of sustained peaks and troughs in international prices, investors face the possibility of bankruptcy. In the presence of imperfect capital markets, very low prices sustained over time create unmanageable problems of cash flow for investors. Second, depending on their impact on the demand for fertilizer, fluctuating prices of fertilizer lead to fluctuations in food production, prices, and imports, and this further destabilizes the macro economy.[6] On the other hand, if governments pursue a policy of stabilizing the farm-gate price of fertilizer, the volatility of the world price results in higher budgetary outlays, or even monetary accommodation, and this too has the potential to destabilize the macro economy. Not surprisingly in view of the perception that fluctuations in world prices for imported fertilizer create such serious problems for domestic economic stability, governments in developing countries have often intervened to promote fertilizer production and ensure a stable supply from domestic resources.

Timing of Investments.-- A decision to produce fertilizer domestically raises a host of complicated issues. Assuming for the moment that several technical and financial criteria for economic viability are met, and these are discussed below, a key tactical

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6. See Pradhan (1988) and Timmer (1988).

question is when to invest. In most countries in Asia fertilizer demand has been rising rapidly and steadily--at over 10 percent per year since the mid-1960s. Because of the large scale and capital intensity of efficient fertilizer plants, it does not make sense to build too far ahead of domestic demand (unless the country is export competitive even in years of low world prices). High capacity utilization is the single most important factor in successful economic returns from investment in a fertilizer factory. The actual utilization rate achieved is subject to many factors, but there is an immediate connection between pricing policy and capacity utilization. For countries that have average costs of production that are below the world price, limited domestic markets need not prevent the exploitation of economies of scale in production. Export markets can be profitably used to expand production and capacity utilization at world prices. An extreme example would be the Arab-Gulf producers, which have the strongest comparative advantage in fertilizer production and a limited internal demand.

The situation is different for a country such as Indonesia, which has a growing internal market for fertilizer and access to local feedstock. Costs of urea production in Indonesia have been competitive with most producers in other countries except in periods of surplus when the marginal costs of Arab-Gulf producers were below those of all other suppliers. Given the volatility of world fertilizer prices, Indonesia may or may not be a profitable exporter. Investments in fertilizer production for a country like Indonesia need not be based on potential export benefits. The objective can be to meet growing domestic demand as efficiently as possible while protecting the economy from price instability of fertilizer and its subsequent macroeconomic effects.

The issue becomes one of determining the right time to invest in local production to satisfy domestic needs and reduce the economy's exposure to world markets. Given the increasing returns to scale in fertilizer technology, investments ahead of domestic demand lead to underutilized capacity unless government policy allows exports and subsidizes them when necessary. Plants can then be run at full capacity, with a majority of production for local consumption and the rest exported with subsidies. With a growing

internal market, the subsidized exports should soon be absorbed into the domestic market. The cost of running a subsidy initially may well be compensated by allowing the plants to operate at their efficient scale. More important, the exposure of the economy to volatile prices would be reduced. At times of high prices in the international market, exports may not require any subsidies.

As domestic demand grows beyond the initial plant capacity, policy makers must decide whether the additional fertilizer should be imported or produced domestically in a new fertilizer plant. The decision is likely to depend on the rate of growth in the demand for fertilizer, the extent to which the world price of fertilizer is destabilizing, the time lag for making a fertilizer plant fully operational, and any existing underutilized capacity. The timing of new investments thus significantly influences the cost of supplying fertilizer to farmers. As a result, countries may find it socially profitable to meet domestic demand by going through cycles of fertilizer imports followed by investment in domestic production and, if necessary, exports of fertilizer.

It must be emphasized that such a strategy presupposes that the costs of domestic production compares relatively favorably with those of the more efficient international producers. India, Bangladesh, and Indonesia have access to local natural gas, a growing internal demand for fertilizer, and the transportation advantage of supplying it locally. A cost-effective strategy of producing urea can be implemented. These countries may not have similar advantages for producing triple-super-phosphate, for example, and it may be socially profitable to find alternative mechanisms for ensuring a steady supply.

A case for domestic production might also be established for countries that have a growing internal market but are dependent on imported feedstock. Unlike Bangladesh or Indonesia, the Philippines does not have access to significant deposits of natural gas. A growing demand for fertilizer can potentially expose the country to the volatility of world fertilizer prices and its subsequent macroeconomic effects. It may be socially profitable for the Philippines to import natural gas on a long-term contract from such countries as Malaysia or Indonesia as the raw material for a domestic fertilizer industry.

Long-term contracts for fertilizer, or investments in regional plants such as the ASEAN urea factory in Aceh, Indonesia, are other alternatives for stabilizing access to supplies of fertilizer.

Producer Pricing.-- No country in Asia or the Near East exposes its domestic fertilizer industry to the full brunt of competition from world prices. Ostensibly the reason is the very wide fluctuations in world prices for competitive products and the necessity to protect producers from supplies available at marginal costs of production during periods of glut and to protect domestic farmers from high prices when shortages occur in world markets and domestic fertilizer producers would be able to export profitably. In return for controls over exports, fertilizer producers receive ex-factory prices that guarantee a favorable rate of return on investment.

To appreciate the validity of this argument, it is necessary to understand the factors that have contributed to the large fluctuations in world fertilizer prices.[7] Fertilizer technology is characterized by increasing returns to scale, indivisibilities, and long lags in gestation.[8] It takes several years to bring new plants on stream, and large adjustments in supply thus entail long time lags. As a result, prices rather than quantities adjust more rapidly to changes in demand, causing the sharp price fluctuations observed in the world market. In addition, given the limited scope of adjustment in the short run through changed investments, a part of the adjustment is borne by fluctuating capacity utilization. This, as was noted above, sharply affects profits.

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7. Segura, Shetty, and Nishimisu (1986) argue that the international fertiliser market is characterised by a limited number of buyers and sellers. Estimates show that about 60 percent of world capacity is operated by state-owned enterprises, and for many countries exports are treated as residuals. Export decisions are thus often not entirely driven by commercial profit motives, which makes it difficult to predict future supply positions. In addition, Segura, Shetty, and Nishimisu argue that suppliers have an oligopolistic position in the phosphate and potash industry. On the demand side, a small number of countries, including China and India, have a significant effect on the international market, and their imports are often influenced by noneconomic considerations. International demand is inherently volatile, because it is influenced by such diverse factors as weather and balance of payments positions.

8. Fertiliser plants exhibit increasing returns to scale over a substantial range of production. An ammonia-urea plant reaches its optimal size at about 500,000 tons a year of urea, which requires an investment of about $500 million. It takes three to four years to build a new fertiliser plant and another two years to bring it to full capacity utilisation.

The systems that governments have introduced to control and stabilize domestic prices in the face of such large fluctuations in world prices have emphasized guaranteed rates of return rather than allocative signals. On the producer side, a variant of "cost-based pricing" is generally used to establish ex-factory prices and stimulate domestic production. A taxonomy of the various pricing policies is presented in Table 5. Six stylized ex-factory pricing approaches are categorized according to the signals they provide on technical and allocative efficiency, financial health and potential for management evaluation, impact on the government budget, and ease of implementation. Only smoothed international border prices provide positive signals on all these dimensions, but no country in this sample used such a pricing approach in the late 1980s.

Most commonly, ex-factory prices are designed to compensate producers for their costs of production. Based on some estimate of current operating costs and past capital expenditures, the link between the established price is completely broken from the world price, and domestic investors are provided an absolute buffer from the volatility of international fertilizer prices.[9] This approach has the effect of separating investment decisions from considerations of allocative efficiency and comparative advantage and takes very little account of the resulting economic and financial costs of inefficient production.

These pricing systems fail to make a distinction among firms with different degrees of economic profitability. Firms with high costs, uneconomic scale, and expensive feedstock tend to receive the same rate of return as firms that are more efficient and competitive in the world market. Ex-factory prices thus vary across firms, and there is an element of cross-subsidization between plants. New investors receive the perverse incentive to build very expensive plants since the rate of return is determined by capacity utilization and input use, not investment expenditure. Private investors allegedly "gold plate" their plants by acquiring more expensive parts than they need. In India

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9. Firms are expected to achieve a certain output target or capacity utilisation and restrict their use of inputs to some specified norm. Egypt, for example, maintains an output target, whereas India specifies a capacity utilisation of 80 percent.

Table 5

SIGNALS GIVEN BY THE EX-FACTORY FERTILIZER PRICING SYSTEMS

Ex-Factory Pricing System / Objectives	Administered Pricing System					Free Market Pricing (Allowing for Free Imports to Reflect Current International Prices)
	Actual Cost Recovery System (Including Bonus for Achieving Quantity Targets)	Actual Cost Plus System (Based on Rate of Return on Assets, Sales or Net Worth)	Normative Cost Plus System (Based on Rate of Return on Net Worth)	Fixed Price Based on Internal Prices of Selected Countries	Smoothed (Weighted Average) International (Border) Prices	
I. X-(COST) EFFICIENCY (a) Induce maximum efficiency and rationalization of existing facilities (short-term minimum cost); and (b) discourage operation of plants whose long-term economic viability is questionable	No incentive for (a) and (b), except for capacity	No incentive for (a) and (b)	Positive incentive to minimize actual costs for those costs for which there are norms in in the formula (specific consumptions), fixed costs (through capacity utilization), investment costs. No incentive for (b) to stop operation of uneconomic plants	Positive incentive to maximize efficiency and rationalize plant; unclear incentive to discontinue uneconomic plants	Positive incentive to maximize x-efficiency	Positive incentive to maximize x-efficiency on both counts
II. ALLOCATIVE EFFICIENCY Induce best choice of new investments for the sector and the economy (long-term minimum costs), including optimum timing, location, size, technology, etc.	No incentive to select optimal economic investment	No incentive to select optimal economic investment	No incentive to select optimal economic investment	Incentive unclear	Positive inducement to select optimal economic investment	Positive inducement to select optimal economic investment
III. FINANCIAL HEALTH AND MANAGEMENT EVALUATION Secure the financial health of economically viable operations and facilitate measurement of corporate and management performance	Negative impact on financial health; does not facilitate measurement of performance	Positive impact on financial health; does not facilitate measurement of management performance	Positive impact on financial health; facilitates measurement of management performance	Impact unclear depending on level of fixed prices	Yes, if the firm is economically viable in the long term	- No in the short term, if spot prices are low - Yes in the long term, if the firm is economically viable
IV. FISCAL IMPACT Minimize need by Government to provide budgetary allocations and subsidies to the sector	Positive impact	Negative impact	- Positive impact as far as actual costs are concerned - Negative impact if uneconomic firms are supported	Impact unclear	Minimum impact over the long term	Fluctuating, with impact depending on level of spot prices
V. COMPLEXITY AND EASE/COST OF IMPLEMENTATION	- Requires internal data - Ease of application	- Requires internal data - Ease of application	- Requires more sophisticated internal data - Ease of application	- Does not require internal data - Ease of application	- Does not require internal data - Ease of application	- Does not require internal data - Ease of application

Source: Edilberto L. Segura, "Fertilizer Pricing Principles," in Edilberto L. Segura, Y. T. Shetty, and Mieko Nishimizu, eds., Fertilizer Producer Pricing in Developing Countries: Issues and Approaches (Washington, D.C. World Bank, 1986).

procurement and capital costs are estimated to exceed the international norm by $100 to $200 million per plant, or roughly 20 to 40 percent of competitive construction costs.

In addition to price protection on the output side, fertilizer industries are often given advantages in input pricing, particularly with respect to feedstock. Urea industries in Bangladesh, Indonesia, India, and Pakistan, for example, receive natural gas at rates below its opportunity cost and often below the financial cost of extracting the feedstock.[10] The availability of natural gas locally at highly subsidized prices may have, in many cases, provided the impetus for expansion of domestic fertilizer industries beyond their economic viability. Even in the case of imported feedstock such as phosphate rock, developing countries have often subsidized their domestic production. Bangladesh and Indonesia, for example, provide--at very high economic costs--differential taxation and credit advantages to triple-super phosphate (TSP) and ammonium-sulphate (AS) plants.

For countries that have the necessary natural resources and a growing internal demand for fertilizer, domestic production can be efficient if the economy's exposure to fertilizer price instability in the world market is reduced and its subsequent macro effects dampened. But such benefits can be negated by improper timing of investment in domestic plant capacity and inefficient producer pricing. Because of increasing returns to scale in fertilizer production, domestic plants that come on stream substantially before there is adequate growth in domestic demand results in production inefficiencies and capacity underutilization. If the government subsidizes the export of domestically produced fertilizer, improper timing of investment can lead to large budgetary outlays. Likewise, if the government's pricing policy is one of setting ex-factory prices that sustain inefficient production, the policy may succeed in buffering the economy from short-run fluctuations in the world market, but at significant economic cost. An efficient and effective fertilizer supply policy thus requires a delicate balance of policies for trade, investment, and producer pricing.

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10. In Indonesia and Bangladesh the domestic to border price ratio for natural gas faced by urea producers is about 0.35.

Marketing and Distribution

Governments intervene at all levels of the marketing system, from international trade to retail sales, and such measures range from complete ownership to partial control of transportation, storage, and distribution. Government intervention is motivated by three primary concerns. First, because of the importance of fertilizer in the production of various food crops, its distribution needs to be assured at stable and "fair prices." Second, there are equity considerations, primarily to ensure the delivery to regions not easily accessible or served by private firms. Third, governments sometimes presume that nongovernmental agencies are unable to perform adequately the tasks of marketing because of the investments required in transportation, storage, and other related infrastructure facilities.[11] Ultimately, government intervention in the marketing system is a direct offshoot of the underlying fertilizer pricing policy.

Level of Government Involvement.-- Designing an efficient structure for government intervention in marketing is not an easy task. The present structure of government intervention in various countries can be characterized in the following way. Government agencies procure fertilizer from foreign and domestic sources and resell at subsidized prices. Prices are kept uniform across regions, and transportation and storage activities are undertaken by the government directly or by government-appointed dealers (see Table 6). The costs of these activities are absorbed by the government through "dealer margins."[12]

Policy makers have often argued that government control of the marketing sector at a wholesale and retail level is necessary to reduce the effect of international price fluctuations. This argument presupposes that domestic marketing systems pass through fluctuations in the world price and that dampening these fluctuations is not feasible

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11. The importance of supplying the right quantity of fertiliser at the right time, its bulkiness, and highly seasonal demand necessitate a fully developed transportation and storage infrastructure for fertiliser.

12. See Mudahar and Kapusta (1987).

Table 6. Share of Fertilizer Handled at Wholesale and Retail Levels by Channel and Agents for Imports, 1981

Country	Fertilizer Distribution								Fertilizer Imports
	Wholesale				Retail				
	Government	Cooperatives	Private	International Agency	Government	Cooperatives	Private	International Agency	(agent)
	(percent)								
East Asia									
South Korea		100				100			Cooperatives
Southeast Asia									
Indonesia	91		9			46	54		Government
Malaysia	50		35		50[a]		35		Private
Philippines		10	90			10	90		Private
Thailand	7	13	80		7	13	80		Private
South Asia									
Bangladesh	100					10[b]	90		Government
India			50	50			50	50	Government
Sri Lanka	74		26		49	44	7		Government
Pakistan	60	10	30		60		40		Government

[a]For smallholder schemes only.

[b]Includes government-owned or assisted cooperatives.

Source: Mittendorf (1982).

without complete control of the marketing sector. Experience has shown that competitive marketing systems are reasonably neutral price transmitters of international prices in the absence of government price interventions and of policy-determined prices when supplies are readily available. In Thailand, for example, the externally-oriented agricultural marketing systems have been relatively neutral transmitters of world prices at all levels of the marketing chain. This was possible because of the competitive nature of marketing systems in Thailand.[13] In Bangladesh, it was a competitive wholesale and retail marketing sector that allowed the government to deregulate the retail price of fertilizer and stabilize farm-gate prices at a regional level. What was crucial in this set up was the willingness of the government to defend a subsidized price of fertilizer and guarantee any quantity demanded at that price. Price stability was effective without public ownership of the marketing sector.

Competitive Marketing Channels.-- Competitive marketing channels in wholesale and retail fertilizer trade ensure that policy-determined prices are reflected at the farm gate without direct intervention by the government. With USAID assistance, Bangladesh introduced a two-tier pricing system in 1983. The government sets prices at a primary distribution point and allows private wholesalers and retailers to set prices at the farm-gate level. Price deregulation in Bangladesh did not lead to sudden increases in prices or greater price variation.[14] A combination of a competitive marketing structure and government commitment to keep the fertilizer pipeline open at the regional level--a more manageable task for the government than fertilizer distribution at the retail level--was important in achieving successful price deregulation. With price deregulation at the retail level, governments no longer bear directly the costs of dealer margins that serve to compensate traders for transportation and storage costs. These costs are normally passed on to farmers in the price they pay retailers for fertilizer. The size of these distribution costs relative to the cost of fertilizer at regional distribution points dictates the extent to

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13. See Siamwalla (1978).

14. See Mudahar, (1984).

which a government subsidy is needed for the private distribution system to deliver the desired farm price.

In addition to providing transportation and storage, an efficient marketing system is also an important channel for diffusion of technology and information. Marketing systems in most countries, however, have not been effective in transferring technical and market information about fertilizer. In Bangladesh, a field study based on about 400 households from December 1981 to July 1983 indicated that 80 percent of farmers received no information about fertilizer. About 10 percent received information from dealers, and the rest learned from extension agents or "ideal farmers."[15] In parallel fashion to the private sector's role in transportation and storage activities, retail-level traders can disseminate information related to fertilizer use and, in the process, promote the adoption of fertilizer-seed technology. An appropriate price policy and a competitive marketing system can induce dealers in the private sector to invest time and resources in providing technical help to farmers, thereby generating sales and customer loyalty. In developing countries, it is the government, however, that has the primary role in providing technical information through extension agents, including farm demonstrations, farmers' meetings, field tests, communication programs, and general research. Public-sector commitment has to be continuing, however; even in industrialized countries such as the United States, government involvement in assisting private-sector marketing groups in research, development, and diffusion of new technology is important.[16]

Marketing Margins and Fertilizer Price Policy.-- Price policy intervention inevitably has consequences for price margins--a crucial determinant of private and public participation in marketing activities. Price controls, which affect both spatial and intertemporal price margins and are designed to subsidize and stabilize fertilizer prices, might not provide sufficient incentives for traders to undertake transportation or storage

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15. See Mudahar and Kapusta (1987).

16. This point is often forgotten by foreign-aid agencies in their efforts to promote private-sector participation in developing countries.

activities without substantial government assistance. If the "squeeze" on the price margins is large enough, the public sector has to perform all the functions of marketing. Government intervention has both a static and dynamic dimension, affecting short-run participation and longer-run investment in marketing. Such consequences of intervention in price policy are often not considered by policy makers.[17]

Government intervention has direct effects on the major functions performed by the marketing system--transportation, storage, and processing. Governments often impose a uniform fertilizer price over a wide geographical area, a policy meant to ensure the delivery of fertilizer at a "fair" price to all regions. With a uniform price, the areas close to the point of final demand that are serviced by the private sector are relatively favored compared to more distant areas, which must rely on fertilizer distribution handled by government agencies--at high cost. The government's direct participation requires a budgetary allocation to perform this task, but the costs tend to mount. Because the operating costs of government agencies engaged in fertilizer distribution are seldom lower than those of the private sector, subsidies are required. Policy makers then have to decide if maintaining a uniform fertilizer price regionally or throughout a country is worth the substantial cost that might be involved.

Price policies for fertilizer have analogous effects on storage activities. The uniform regional price, combined with the holding of that price stable over time, has the effect of undermining incentives for traders or farmers to store fertilizer. Storage is important for providing a supply of fertilizer to farmers for the peaks of each cropping season. It is only through storage that the farmers' need for fertilizer at particular times can be reconciled with the inflexible nature of most fertilizer production processes, which requires plants to be operating at a certain capacity every day. If price policies designed to stabilize fertilizer prices do not compensate traders or farmers for storage costs,

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17. See Timmer, Falcon, and Pearson (1983) for a discussion of price policy and its effect on marketing margins. See also Timmer (1986a, 1987) on the connection between price stabilization and marketing margins.

including the opportunity cost of capital and the losses from spoilage, a government agency has to supplant the role of the private sector and engage in storage activities itself.

The dynamic consequences for marketing margins are equally important. By reducing participation by the private sector, the government's price policy discourages investment by traders and farmers in transportation and storage infrastructure in rural areas. The private sector is unwilling to invest in trucks, water transportation, or warehouses, and the real costs of marketing are thus increased. Ironically, a price policy designed to reduce marketing margins thus has the opposite effect--the government is forced to provide greater subsidies to defend the given farm-gate price.

Farm Demand and Utilization

Policy makers intervene to make stable supplies of fertilizer available and create marketing systems to distribute it to rural areas in order for farmers to use fertilizer to raise crop yields. To do so, farmers must have access to the fertilizer at the time needed for the crops, must know the appropriate amount to use, must have the necessary financing to purchase it, and must be willing to take the risks involved.

Even after the fertilizer is physically available in convenient locations for farmers to purchase it, and this is the most frequent failure of government interventions in distribution and marketing, the private decision making of farmers can fail in at least three important ways: inadequate knowledge, insufficient credit, and aversion to risk. If farmers are to be encouraged to use socially optimal quantities of fertilizer, government efforts to affect their decision-making process may well be justified. The question is what kinds of interventions will improve on the outcomes that farmers would reach if left to their own volition. The answer depends on an empirical understanding of farmer behavior with respect to fertilizer demand. Why do farmers apply the quantities of fertilizer they now use (including zero) and what elements of their decision-making process can be affected by government interventions? The answers are likely to be quite

different over time, and government policies that stimulate fertilizer use in the short run might be counterproductive in the long run. Similarly, optimal long-run solutions may have little impact for a decade or more, not a satisfactory solution to a society seeking rapid economic growth.

Empirical analysis of demand for fertilizer has pursued two relatively independent research approaches.[18] The first is the *indirect* approach, in which farmers are assumed to optimize fertilizer applications relative to a set of constraints. These constraints include the physical response function between marginal applications of fertilizer and the incremental yield of the crop being grown, as well as fertilizer and crop prices. The simplest models assume pure profit maximization using only these variables; more complicated models attempt to incorporate variables that capture the impact of other prices, degree of knowledge, attitudes toward risk, access to liquid financial resources, and the like. Despite the appeal of this approach to economists, it has always been suspect to policy makers. They distrust the ability of "backward" farmers to utilize efficiently a modern input such as fertilizer. Equally important in policy debates, the fertilizer response functions at the microeconomic level used to calculate optimal levels of fertilizer applications vary wildly, with large changes from field to field, region to region, and season to season. Attempts to estimate aggregate fertilizer response functions over time face severe problems of specification bias because of omitted variables, especially labor, in the regression analysis.[19] Although the indirect approach offers considerable insight into the nature of variables influencing fertilizer use and its resulting productivity, the approach yields few insights into how farmers actually behave with respect to those variables.

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18. The following sections draw heavily on a review article on fertiliser demand prepared early in 1974 in the context of the world food crisis and the sharply higher prices for fertiliser then seen in world markets (Timmer, 1974). The emphasis in the article was on the role of prices in determining fertiliser demand because few models until that time incorporated price as an important variable. Considerable empirical work has been reported in the literature since that time, but the basic parameters and fundamental conclusions have changed relatively little.

19. See Griliches (1957) for the classic reference, one that draws on his effort to estimate derived fertilizer demand functions from aggregate agricultural production functions, and Timmer (1986b) for the problems faced by a similar effort using modern Indonesian data.

The *direct* approach attempts to answer these questions of farmer behavior empirically. In what is now known as estimation of the "reduced form" of the structural model outlined in the indirect approach, analysts have made the demand for fertilizer the dependent variable in a regression specification that permits many variables to influence fertilizer use. Both cross-section and time series data have been used in such analyses. With suitable concern for the mechanisms by which fertilizer prices are determined in local markets, estimates of direct demand functions can be very revealing of the forces that determine use by farmers.[20] Analyses at the micro level conducted in this manner invariably show a wide array of household-level variables to be significant factors in determining fertilizer use. Education levels, income, size of land holdings, years of experience, access to credit, type of seeds, control over water, distance from roads and markets, visits from extension agents or model farmers, and so on are frequently independently significant when large samples and substantial variance permit their inclusion. The price of fertilizer and the price of the crop on which it is used are also usually significant, but not to a larger degree than many other variables. Cross-input and output prices are seldom significant in direct estimations, although more sophisticated profit-function models force their inclusion through techniques of constrained least squares.

What can be said of both the diversity and the central tendencies with respect to fertilizer demand that will help policy makers know what to do? First, farmers almost never use enough fertilizer from the perspective of economic efficiency, where the marginal cost of an additional unit of fertilizer would just be returned, on average, by the value of the incremental output. Policies designed to stimulate greater fertilizer use will push farmers in the right direction.[21] Second, farmers nearly always are responsive

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20. Simultaneous determination of supply and demand in a market that clears through price movements creates significant biases when demand functions are estimated by ordinary least squares techniques. Cross-section data do not face this limitation, and it is insignificant in those settings where price is controlled by government policy and supplies are adjusted to meet demand at that price.

21. This statement does not hold for advanced countries where excessive nutrient run-off and leaching have negative environmental impact on quality of water supplies.

to the price of fertilizer in their local market. An increase in price will lower purchases, slow adoption, or reduce the rate of growth in fertilizer use in those environments where significant disequilibrium exists between what farmers ought to do and what they actually do. Higher crop prices have the opposite effect, but there is no necessary reason why the two responses should be symmetric in quantitative terms.[22] Third, the "other" variables in farm demand functions for fertilizer are important. Improving knowledge about appropriate use and levels of application will raise demand, as will improving access to credit (access rather than interest rate seems to be the crucial concern), making new seed technology more reliable, especially through improved water control, and lowering market risks by guaranteeing a price for output that is known at the time of planting and fertilizer application.

Governments have many instruments with which to influence the demand for fertilizer at the farm level. Which ones to use, if any, depends crucially on the actual situation in a given country at a given time. Perhaps more than any other important component of the rural economy, fertilizer use in developing countries is in a continuous state of disequilibrium. Models based on equilibrium conditions in household decision making can offer little guidance in specific situations about what interventions are appropriate, and advice based on empirical analysis of these specific situations will be relatively short-lived. Policy makers probably have no recourse except to maintain a basic strategic vision for the fertilizer sector in the context of fairly pragmatic year-to-year policy initiatives. The next section reviews the likely components of such a strategic vision and the role of interventions in the supply, marketing, and demand sectors.

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22. The issue is whether the fertiliser demand function is homogeneous of degree zero, as simple models of farm decision making suggest it should be. See Timmer (1974) for a more complete discussion of the issue.

Major Policy Issues in Perspective

Fertilizer policy is a key element of agricultural development policy, but it is only one element. Other important components of agricultural policy are commodity pricing, irrigation, technology, credit, and extension--all of which influence the role and use of fertilizer. These components are not addressed specifically in this paper, which focuses on short-run and long-run government interventions into the fertilizer sector directly and analyzes the widespread resort to fertilizer subsidies to speed adoption and increase the levels of use. Not all fertilizer subsidies reach farmers, of course, and the allocation of budgetary and economic subsidies at each level of the fertilizer sector is an important topic for analysis. Rough guidelines on the costs and benefits of fertilizer subsidies at the farm level are provided, but subsidies to the marketing and producing sectors must be analyzed within the broader context of the role of the private sector and pricing mechanisms that can be used to induce an efficient allocation of investment resources over the long run.

Price Subsidies for Fertilizer

Fertilizer is commonly subsidized in developing countries. As an important component of government expenditure it is often the target of criticism by foreign aid agencies and even finance ministries of national governments. Rough estimates of fertilizer subsidies in various countries can be made, but these estimates reveal neither the full extent of the subsidies nor their complexity (see Table 7). In particular, it is not clear who receives the subsidy--whether farmers, manufacturers, or distributors--nor is it clear whether the subsidy is transferred to foreign farmers or producers, to what extent it is a financial subsidy, as opposed to an economic one, or what part of the subsidy is comprised of counterpart funds generated through sales of aid-financed fertilizer.

Table 7. Fertilizer Subsidies in Selected Countries of Asia

Country	Fertilizer Subsidy (domestic currency)				Share of Fertilizer Subsidy in Current Expenditures (percent)			
	1981-82	1982-83	1983-84	1984-85	1981-82	1982-83	1983-84	1984-85
Bangladesh (million takas)	1,084	850	1,466	848	6.6	4.6	4.8	2.5
India (billion rupees)	2.75	5.50	9.00	12.00	1.4	2.3	3.1	3.5
Indonesia (billion rupiahs)	266	325	295	NA	3.8	3.9	3.1	NA
Nepal (million rupees)	64.0	38.2	63.8	163.5	4.2	2.0	3.0	6.0
Pakistan (million rupees)	NA	1,948	1,931	1,501	NA	3.5	3.5	2.1
Sri Lanka (million rupees)	1,000	1,000	1,000	1,000	5.2	4.0	3.1	2.9

Sources: M. G. Quibria, The Role of Fertilizer Subsidies in Agricultural Production: A Review of Selected Issues. ADB Staff Paper no. 38 (Manila: Asian Development Bank, October, 1987); and Food and Agriculture Organization of the United Nations (FAO), Fertilizer Yearbook, 1985 (Rome).

In many developing countries fertilizer is supplied to farmers at a uniform price well below that in the world market or the cost of procuring fertilizer domestically; the difference is absorbed by the government and thus represents the subsidy. Depending on the situation, only part of the subsidy is actually passed on to farmers. A portion may be used to subsidize inefficient production (see Figure 1).[23] In some cases, efficient producers are actually taxed under the pricing policy, introducing an element of cross-subsidization between production units (see Figure 2).[24]

Figure 2 also illustrates the difference between economic and financial subsidies. The financial subsidy is calculated with reference to domestic market prices, whereas the economic subsidy is based on the concept of border prices or opportunity cost and economic efficiency.[25] Economic subsidies provide a better picture of the resource costs of a specific policy, but finance ministries may worry more about financial subsidies. Depending on the type of pricing policies pursued, economic subsidies in a country may or may not exceed financial subsidies.[26]

The availability of fertilizer under foreign aid can complicate calculating the size and impact of the subsidy. The invoice price of aid-funded imports of fertilizer is often higher than the world price because of restrictions on source of supply and arrangements for shipping. If governments were actually to pay the higher invoice price with current dollars, the expenditure on fertilizer subsidies would increase substantially. But fertilizer procured through aid finance is usually provided as grants or long-term credits, which in present-value terms involve a substantial grant element. The resale of aid-financed fertilizer in domestic markets provides counterpart funds for the government budget (see

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23. In Indonesia in 1987-88, for example, producers received on average about 10 percent of the economic subsidy, distributors 7 percent, and farmers 83 percent. This varied across specific fertiliser nutrient. For ammonium sulphate, for example, producers received about 50 percent of the subsidy (see Barichello, Mason, and Flatters, 1987).

24. India, Pakistan, and Bangladesh are good examples. In the case of Pakistan, the ex-factory price plus transportation and distribution costs received by some of the older plants is well below the sales price. In such cases the government collects a surcharge that is equivalent to the difference.

25. The example in Figure 2 depicts an importer at the margin. The relevant economic price in this case is the c.i.f. price.

26. Bangladesh is an example in which the financial subsidies in 1983-84 exceeded the economic subsidy. This was a result of overpricing of fertiliser procured through aid financing. See below, and Rais uddin Ahmed (1987).

Figure 1

Subsidy to Farmers and Consumers

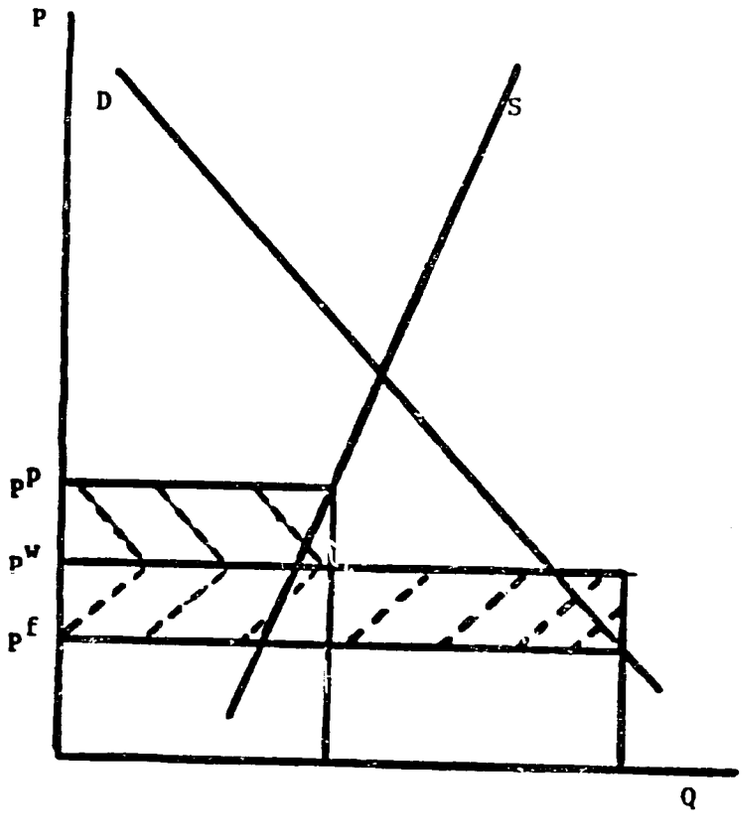
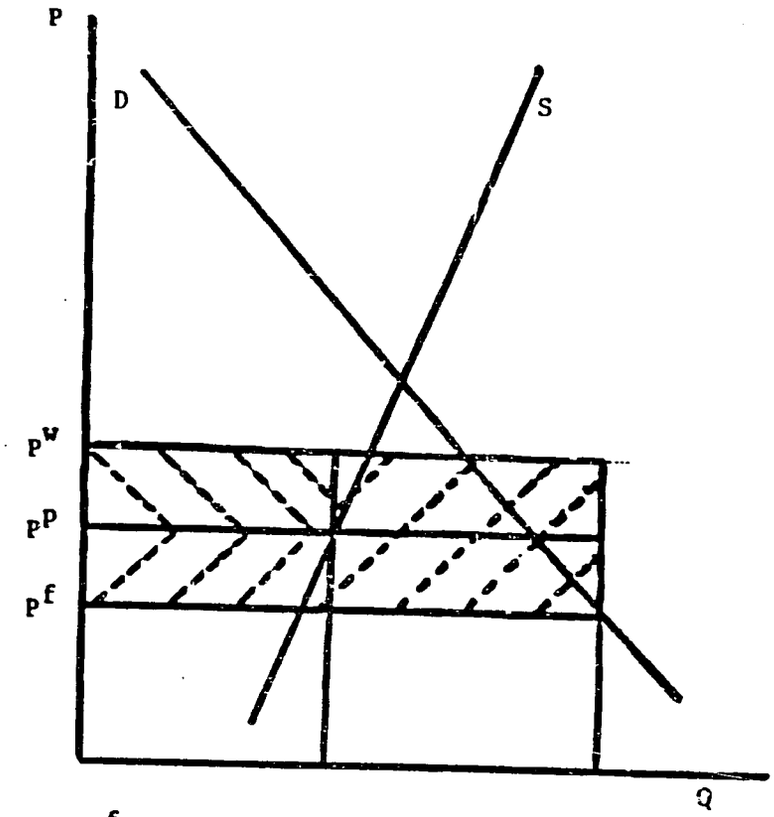


Figure 2

Financial versus Economic Subsidy



P^P = produ r price P^W = world price P^f = farm price

Subsidy to producers

Subsidy to farmers

Economic tax on producers

+

Economic subsidy to farmers

Financial subsidy tofarmers

Figure 3). In Bangladesh, for example, subsidies of aid-financed imports are calculated on the basis of the invoice price. In effect, this accounting procedure inflates the amount of the subsidy provided to farmers and does not take into account the availability of counterpart funds to the government.[27]

Two other components of fertilizer subsidies are often not incorporated in the calculation of subsidies. First, producers usually receive subsidies on their inputs, especially feedstock, foreign exchange, and credit. Similarly, distributors in the public and private sector often benefit from direct government assistance. Second, governments often subsidize exports and in effect end up subsidizing foreign farmers. Both Bangladesh and South Korea, for example, provide export compensation to domestic producers.[28] Calculations of economic subsidies, however, should be able to capture some of these "hidden" costs of government policy, and export subsidies often show up in the financial accounts as well.

Fertilizer subsidies are more complex than simply a transfer of resources to farmers. The linkages between production, consumption, and marketing imply that government intervention through a subsidy or a tax will have important spillover effects along the chain. The implications of government pricing policies on the entire fertilizer sector are explored below in more detail. Primary attention is focused on why governments subsidize fertilizer and what the potential failures are in market pricing.

General Analytical Arguments.-- The use of a fertilizer subsidy for farmers has been justified most often to increase agricultural production, particularly in countries in which food self-sufficiency is a major policy objective. Policy makers usually see the fertilizer subsidy as a tool for offsetting the effects of low agricultural prices and for improving income in the rural sector. At the same time, fertilizer subsidies are heavily criticized on

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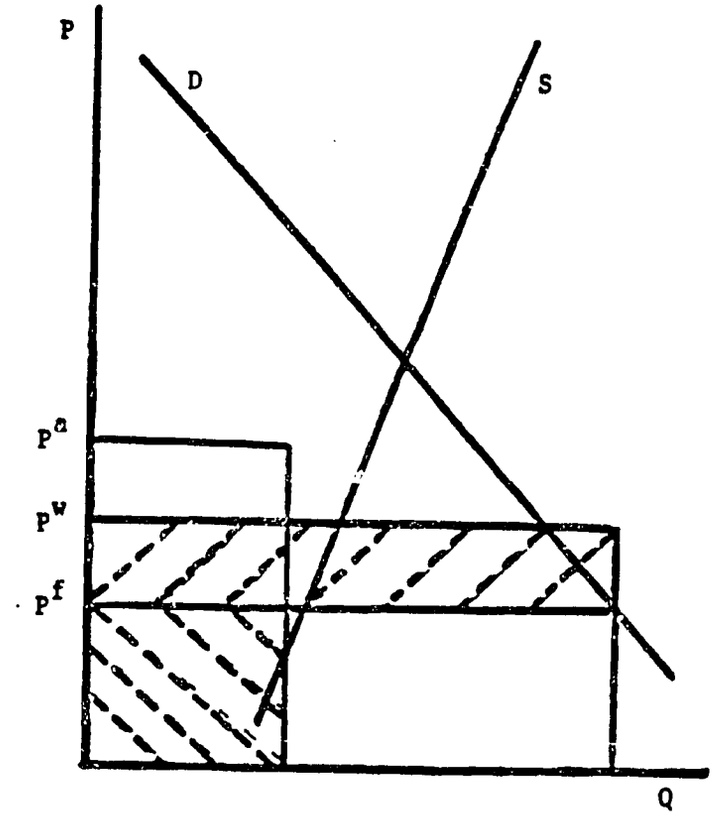
27. In 1983-84, the Bangladesh government received TK 218 million, or 15 percent of the reported subsidy, from fertiliser sales. See Ahmed (1987).

28. See Johnson (1988), a study done by the Asian Development Bank on rice market interventions in Asia.

Figure 3

Counterpart Funds from

Aid-Financed Fertilizer



P^a = aid price P^w = world price P^f = farm price

Subsidy to farmers

Counterpart funds

the basis of neoclassical models of economic efficiency for their distortions of incentives and adverse impact on income distribution.

In a textbook world of complete and perfect markets, there is no need for taxes or subsidies to promote economic efficiency. In the presence of certain types of market failures, however, a potential case for government intervention can be made. In fertilizer use, policy analysts point to three potential sources of market disequilibrium: risk-averse behavior on the part of farmers, inadequate knowledge about the productivity of fertilizer use, and imperfections in capital markets. As a result, it is argued that farmers will underinvest in fertilizer. On the basis of increasing social profitability, a case for a direct subsidy to stimulate fertilizer use can be advocated.

Agriculture is a highly risky business with uncertainty in both price and production. Farmers without recourse to hedging mechanisms are rarely able to circumvent the risks inherent in agricultural production and, not surprisingly, use lower levels of inputs than would be profit maximizing in a less risky world. In the case of fertilizer, the lower rate of investment is further exacerbated by a lack of farmer knowledge about optimal use of fertilizer, especially since the optimum is continually adjusting in a changing agricultural environment. Extension agents in developing countries have seldom been successful in providing farmers with appropriate technical information. Imperfections in rural credit markets restrict farmer access to credit to buy fertilizer and hence reduce investment in new seed-fertilizer technology, which usually requires greater cash outlays.

A fertilizer subsidy can be used to compensate, at least partially, for these various sources of disequilibrium. A subsidy serves to some extent as a substitute for crop insurance and a rural credit market. It also provides incentives for farmers to experiment with higher levels of fertilizer, thereby speeding the learning process about optimal applications. To the extent that risk aversion, inadequate information, and imperfections in capital markets lead to a departure in fertilizer use from the social optimum, a fertilizer subsidy should *improve* the efficiency of resource allocation.

These arguments in favor of a fertilizer subsidy need to be qualified. Studies have shown that risk aversion can account, at most, for a 15 percent deviation from profit-maximizing levels of fertilizer use.[29] Accordingly, risk aversion justifies only a small permanent subsidy. Second, with regard to inadequate information on fertilizer use, a temporary subsidy is advocated to lower the cost of technology diffusion. Once the farmers become familiar with the fertilizer technology, the subsidy could be withdrawn. Finally, if informational failures and imperfect capital markets are the actual constraints to fertilizer application, the long-term solution may be to improve the operation of credit markets and efficiency of extension services rather than subsidizing consumption of fertilizer. Indeed, investments in non-price interventions have long been advocated as a more efficient method for expanding agricultural production.

These qualifications are not an indictment of fertilizer subsidies *per se*. In fact, they strengthen the argument that in disequilibrium settings economic theory does not in principle dictate whether a subsidy is socially profitable or not--the issue is empirical. In Indonesia, for example, calculations showed that a fertilizer subsidy had the potential to be a socially profitable intervention to deal with risk aversion, imperfect information, and failures of credit markets.[30] Such an intervention, though profitable when Indonesia was a large importer, facing a high c.i.f. price for rice, was not profitable when rice surpluses presented Indonesia with low f.o.b. prices. The switch simply emphasizes further the empirical nature of policy intervention.

Similarly, the efficiency of non-price interventions, such as improvement of credit markets, extension services, or irrigation systems, cannot be resolved only at a theoretical level; certain practical realities must be included. At the farm level, problems of imperfect information, adverse selection, and moral hazard, which account for many of

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29. See Shalit and Binswanger (1985). These studies look only at productions risks and thus introduce a significant downward bias in the estimations. Price risks may be more important.

30. See Timmer (1986b). The social profitability calculations depend on the values of the demand elasticity of fertiliser, marginal productivity of fertiliser, and the shadow rate of foreign exchange. Srinivasan (1986), employing a similar methodology for India, also confirms the profitability of a fertiliser subsidy.

the limitations of rural credit markets, are not easily overcome. Furthermore, the institutional developments necessary for removing such constraints probably involve a time horizon considerably longer than that of the problem at hand. In any case, fertilizer subsidies and improvements in credit markets and extension services are not mutually exclusive investments in the public sector; each should be made on the basis of their social profitability.

Impact on Income Distribution.-- Fertilizer subsidy policy has direct and indirect effects on income distribution. In the presence of policies that adversely tax the agricultural sector in favor of the urban sector, fertilizer subsidies may offset some of the bias. In simple rural-urban terms, fertilizer subsidies improve income distribution directly. The impact on income distribution within the rural sector depends on who benefits from input subsidies. According to a World Bank study, the benefits of fertilizer subsidies in India went mostly to better-off farmers who had access to institutional credit and irrigation facilities.[31] In addition, since fertilizer applications are usually not uniform across regions, a fertilizer subsidy may in fact exacerbate disparities in regional income distribution.[32]

These arguments provide only a partial story. In a general-equilibrium setting, the indirect effects of the fertilizer subsidy on increased food production, greater farm employment, and lower real prices of cereals are likely to have positive effects on income distribution within both rural and urban sectors. An evaluation of the indirect effects of fertilizer subsidies on income distribution is thus an essential part of any attempt to analyze the consequences of fertilizer subsidies.

The Appropriate Use of Fertilizer Subsidies.-- Despite the widespread use of subsidies in developing countries to stimulate adoption and use of fertilizer, they have come under increasing attack as a burden to the government budget and an inefficient

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31. See Quison (1985).

32. See Mudahar and Kapusta (1987).

allocation of resources. This is likely to be true in several circumstances: when subsidies are used to keep high-cost distributors and producers in business; when inadequate fertilizer supplies must be rationed at the subsidized price; and when the value of additional output to the society is less than the full social costs, including budgetary costs of the subsidy, of producing it. Producer subsidies and the need to ration supplies are the result of ineffective policies in the distribution and producing sectors. The crucial task is to determine the environment in which a farm-level subsidy, appropriately financed and implemented, improves social welfare.

The general circumstances are clear enough. An empirical case almost certainly can be made for providing a subsidy for fertilizer at the farm level under the following conditions: when new seed technology has raised the physical response of a crop to fertilizer; when investment in irrigation has lowered the risks of crop failure, or price-guarantee schemes have reduced market risks, or both; and fertilizer use has remained relatively low. Such a subsidy stimulates greater use, if the type of fertilizer is appropriate to the crop and is available in local markets when farmers need it. In the early stages of such a policy, the social benefits will be substantially larger than the full social costs, including the distortions introduced into the economy by the need to raise government revenues to pay for the subsidy. Indeed, one of the most effective investments that aid-agencies can make in such circumstances is to fund the local-currency costs of the subsidy.

The high rates of return associated with a fertilizer subsidy in the initial stages of fertilizer adoption do not last forever. For many countries in Asia and the Near East the question is when to reduce or eliminate fertilizer subsidies whose budgetary cost has grown as farmers use more fertilizer. At what point do farmers have "enough" knowledge about the full profitability of fertilizer use to apply the "right" amounts? Which market failures can be corrected by improving the markets rather than by intervening directly? The guidelines here are less robust and depend crucially on circumstances in individual countries, especially on constraints imposed by the budget. Fundamentally, the optimal

size of a fertilizer subsidy to increase farm-level demand is an empirical question. The answer might be zero and it might be 10 percent of the country's budget, but only data and analysis can say.

Fertilizer Marketing

Government involvement in marketing and distribution has been highly costly, not only for the government budget but also in terms of its inability to provide the right amount of fertilizer at the right time to farmers. The dynamic consequences have included retarded growth in agricultural output and inadequate private-sector investment in storage and transportation, thus exacerbating further the need for subsidies from the government. A review of Asian experience with fertilizer marketing and distribution shows how often governments simply get this wrong, mostly because of a deep distrust of traders and middlemen who are universally seen as exploitative and manipulative at worst, and, at best, as merely incompetent to carry out such important tasks. The adverse effects of a failed fertilizer distribution system on agricultural development are profound. When an input that contributes up to half of total gains in output is physically unavailable when farmers need it, the virtual necessity to formulate a better policy is clear.

Marketing studies have consistently pointed out that storage and transportation costs for fertilizer are relatively high.[33] These studies have advocated a greater role for public-sector financing of basic infrastructure. The public goods nature of road and rail networks implies that investments in such basic infrastructure have to be undertaken by the government.[34] But the private sector can undertake complementary investment in storage capacity, trucks, or river transportation. Such investments lower the costs of

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33. Fertiliser marketing costs in Africa and Asia range from about US $20 per metric ton to as much as $230; $40 to $75 is typical. In many cases the true cost cannot be estimated because of the financial structure of the marketing organisations, different accounting procedures, subsidies, and special concessions (see Mudahar and Kapusta, 1987).

34. See Rais uddin Ahmed (1988).

storage and transportation and directly benefit farmers. A marketing structure that permits easy entry is necessary for promoting private investment in these activities and ensuring that their benefits are passed on to farmers. Potential private-sector investment in infrastructure should not be underestimated or discouraged. A pricing policy that distorts price margins and government legislation that limits participation in marketing to a few groups does precisely that. Government participation in the marketing sector should be restricted to investing in infrastructure and participation in distribution at a regional level if the private sector cannot handle the entire task effectively. The private sector and cooperatives are more efficient at wholesale and retail distribution, but the government must ensure that retail marketing is competitive and that neither pricing policy nor direct legislation fosters a public or private monopoly.

Domestic Production of Fertilizer

The decision to build a modern fertilizer factory should involve a careful project appraisal that examines the costs and benefits of local production using domestic or imported raw materials relative to the long-run opportunity costs of importing the fertilizer and employing the domestic resources in their next-best use. The benefits to local production, as argued above, should include the contribution to stability in supplies and the likelihood that more effective distribution channels will be developed for domestically produced fertilizer than for imports. Farmers can usually count on more regular supplies at stable prices when a substantial share of total fertilizer consumption is produced domestically. Whether these potential benefits actually reach farmers depends to a substantial extent on how the fertilizer plants are managed and how their supplies are integrated into an overall strategy of fertilizer procurement and distribution. The key managerial instrument governments use to control their fertilizer industry, whether in public or private hands, is ex-factory pricing policy. Fertilizer supply management involves stocks and imports (or exports) as well as domestic production. Integrating

pricing with the other dimensions of supply management is necessary to maintain an efficient industry and regular supplies at reasonable costs to farmers.

Subsidies that reach farmers effectively should not be confused with subsidies to inefficient fertilizer producers or marketing systems. For political reasons they are often linked in the budgetary process. Governments have sometimes provided blanket protection to fertilizer producers with little regard for economic costs or budgetary outlays. Excessive procurement costs and lenient policies of subsidizing consumption of locally available feedstocks have exacerbated the economic costs of sustaining domestic production. A wholesale rationalization of producer policies needs to be undertaken in many developing countries.

Advocating changes in producer pricing policy does not preclude government assistance to domestic production. Fertilizer prices in the world market are volatile, and for countries facing foreign-exchange constraints, the volatility can impose severe restrictions on the ability to import fertilizer. While government intervention can play an important role in stabilizing prices and encouraging domestic production, it should not sustain production that is significantly more costly than imported supplies in the long run. Of course, defining "significantly" is the crux of the problem, especially when stability is included as an element of efficient policy. Domestic production can provide a buffer for the agricultural sector in the face of a foreign-exchange crisis. When countries develop balance-of-payments problems, imports of fertilizer have often been reduced, an action that has serious implications for the agricultural sector. Governments may well want to pay some premium for domestic production to protect their agricultural sectors from such foreign exchange crises. Even with this added bonus for domestic production, however, only those countries that have some comparative advantage because of the availability of local feedstocks and a large internal market can make a case for providing incentives to domestic production to protect themselves from uncertain world prices, or try to achieve "fertilizer security." Producer prices that follow the long-term trend in world prices while

paying some premium for domestic production are likely to provide suitable incentives for a reasonably efficient and stable domestic fertilizer industry.

For fertilizer price stabilization to be successful, an ex-factory pricing system that is linked in the intermediate run to an average international price is essential. Various studies have proposed alternative methods for estimating long-term prices.[35] Such pricing systems not only reduce price fluctuations in the short-run but also ensure that investments are guided by their opportunity costs. Pricing policies have an important impact on the level of capacity utilization--a major determinant of the operational efficiency of fertilizer factories. As previously noted, fertilizer plants exhibit increasing returns to scale and decreasing average costs over a range of production. For an ammonia-urea complex on an international scale, plants would have to operate at a capacity of 1,500 tons a day or 500,000 tons a year to benefit from the low production costs of advanced technologies. A single plant of this kind would be able to supply the needs of most medium-sized countries.[36]

Trade as an Efficient Strategy at the Margin

Despite the importance of domestic production of fertilizer to guarantee reliable supplies, especially for the large countries in Asia, a strategy of complete autarky is likely to be extremely costly and inefficient. The arguments are parallel to those made for stabilizing prices of staple foodgrains.[37] For large countries in Asia, self-sufficiency on trend for these grains is one element in a set of policies to ensure reasonable price stability, but buffer stocks and international trade are also important tools. In fertilizer, the goal of a large country should be to strive for efficient production in the long run.

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35. See Segura (1986), Barichello, Mason, and Flatters (1987), and Pradhan (1988).

36. In 1984 the total consumption of fertiliser in Bangladesh, Thailand, Malaysia, and the Philippines was 602,000, 500,000, 609,000, and 262,000 metric tons, respectively. Total consumption of urea is less than the full production capacity of an internationally sized urea factory. In Bangladesh, fertiliser plants operate on average at 72 percent of capacity, with some plants at 50 percent and others at 80 percent.

37. See Timmer (1988) for a discussion of these arguments.

In this context, efficiency includes the benefits from stable supplies provided from domestic factories, but whether self-sufficiency makes economic sense will depend, even for large countries, on the nature of the natural resource base.

Whatever the appropriate degree of self-sufficiency, a country will also want to hold operational stocks to provide reliable supplies of fertilizer at regional distribution points. An additional "iron stock" may be desirable for insurance purposes for those countries with substantial and continuing import needs. But when domestic production, operational stocks, and the iron stock have all been exhausted and unmet demand remains at the domestic price, the efficient balance wheel is international trade. A sharp divergence between the international price and the domestic price raises serious questions about price policy, extent of overvaluation of the exchange rate, or other factors influencing demand, but resort to trade in the face of shortages (or surpluses) should not be hostage to an industrial policy of self sufficiency through import substitution at all costs. No agricultural sector can sustain its momentum in the face of such costs.

Fertilizer in Perspective

Governments influence the fertilizer sector in developing countries in a variety of ways, ranging from indirect price policy to direct ownership of production and marketing. While the results of such interventions vary, certain important lessons can provide useful guidelines for policy makers in designing more effective policies.

Fertilizer has played an important role in contributing to agricultural growth, and subsidies to farmers have often stimulated that role. Investment in agriculture is inherently risky, and farmers in developing countries lack access to crop insurance, futures markets, or fully functioning credit markets. Fertilizer subsidies have sometimes been an effective channel for partially ameliorating these various sources of disequilibrium and promoting both fertilizer use and agricultural production. The efficiency of a given fertilizer subsidy, the length of time a subsidy policy should be

pursued, and the level of the subsidy are empirical issues. Policy makers must make their own judgments in the specific context of their countries. Although the potential to use a subsidy to promote economic efficiency exists in many developing countries, the potential to misuse it is also significant. The strength and integrity of the budget process, the level of analytical capacity, and the degree of policy flexibility will determine which potential is most important.

Importance of Fertilizer to Agricultural Development

Fertilizer is a unique input. Its large contribution to agricultural production makes fertilizer crucial to any strategy designed to speed the modernization of the rural economy. Its volatile prices in the international market create linkages to the macro economy through the balance of payments and government budget, as well as through instability in food supplies if the international prices are routinely passed through to farmers. A country that chooses to produce its own fertilizer to circumvent instability in world markets faces a technology with increasing returns to scale, large capital costs, and requirements for guaranteed access to low-cost feedstocks. Whether fertilizer is imported or produced domestically, an efficient marketing infrastructure is needed to ensure widespread and timely dissemination and distribution. Farmers must know about the use of fertilizer and be able to afford to buy it in optimal amounts.

These issues must be resolved simultaneously, a daunting task for policy makers seeking to develop a coherent fertilizer policy. In the face of significant market imperfections, the unique features of fertilizer require governments to intervene and establish an efficient fertilizer strategy. This paper emphasizes the importance of pricing policy as the crucial link to the three primary levels of concern: domestic production or imports as a source of supply; the nature of government involvement in marketing and distribution; and the role of government policy in stimulating farm-level demand for fertilizer and a more dynamic agricultural economy. No government will leave all of

these concerns to the free market. The key question is which interventions will improve efficiency and set the domestic fertilizer economy on a sustainable path. Given the importance of the industry and the large sums of money involved, the answer must deal with both the economics and the politics of the question.

Lessons of Political Economy and Fertilizer Policy

Fertilizer policy in Asia and the Near East presents a major puzzle to economic analysts. Theoretical models and empirical applications demonstrate the necessity for government intervention if farmers are to use optimal amounts of fertilizer. Intervention is needed to stabilize supplies as well as to influence demand. Analytically, the potential for intervention into the fertilizer sector to improve economic welfare has been demonstrated in country after country.

No country has ignored this message. All the countries in Asia and the Near East intervene into their fertilizer sector in one way or another, and most intervene massively. State control of fertilizer imports and exports, state-owned or licensed fertilizer factories, monopoly distribution rights for a government firm or restricted set of semi-private firms, and controls over fertilizer use by farmers are the norm throughout the region. Interventions at the level of farm use are especially popular, with price subsidies, extension workers, model farmers, and village leaders all encouraging farmers to use more fertilizer.

Given the apparent match between analytical design and policy implementation, why is the record of the fertilizer sector in these countries strewn with the wreckage of repeated failures? In virtually every country and in virtually every arena of government intervention, the actual results have usually been dramatically worse than promised by the models. Often the signs on the balance sheet are negative instead of positive. Imports usually cost more than market conditions would warrant, are bought in panic at peak prices, and then deteriorate in warehouses for lack of distribution mechanisms. Fertilizer

factories cost hundreds of millions of dollars more than international standards and then operate so far below rated capacity that capital costs must be written off completely. Many plants cannot even cover their operating costs. Governments consistently try to monopolize or license the distribution of fertilizer from the point of supply all the way to the farm gate. When supplies are ample and the government distributors are unable to cope with the large volumes, the private sector may be offered opportunities to participate in distribution. When it does, government distributors are unable to compete and lose market share, reflecting the lower cost structure of the private distributors. But when supplies become tight and prices start to rise, the uniform reaction is to eliminate the private distributors and revert to monopoly controls. Farmers are no longer able to get fertilizer, or must buy it on the black market. Agricultural production falls, the crisis stimulates a review of policy, and the cycle starts again.

Unfortunately, this parody of experience with fertilizer policy contains too much truth to be dismissed. The question must be taken seriously: if government intervention is necessary to create a modern fertilizer sector in a developing country, why do governments in fact do it so badly? The answer must be found in models of political economy and public choice rather than narrower models of project costs and benefits. The two together, however, provide ample insights into why things go wrong so often.

The fertilizer sector is an irresistable source of funds for government officials, off-budget operations, and favored clientele in the private sector. No country can do without fertilizer. *Some* mechanism must be found to supply it to farmers if agricultural output is to grow. Even in relatively small countries where domestic production of fertilizer does not make economic sense, controlling imports provides lucrative opportunities for over-invoicing, side-payments for distribution licenses, and informal taxes throughout the marketing chain. When a factory is to be built, the stakes are much higher. An overcharge of 20 percent, split between the supplier and the government officials responsible for accepting bids, can easily net each party $50 million.

Control over the distribution of fertilizer can offer similar rewards. Every 100,000 tons of fertilizer distributed offers $5 million in rents if a way can be found to add $0.05 per kilogram to the costs of marketing. With licenses and permits required at every step of the system, it takes little imagination to figure out how this might be done.

This pernicious outcome of government control over the fertilizer sector is almost never by conscious design. Instead, the controls are usually set up because of a paradoxical idealism in the design of policy itself. Many policy makers in developing countries are convinced that government planning, control, and ownership of key elements of their economies are essential to speeding economic growth. These views are reinforced by a distrust, often deep and visceral, of private traders and middlemen. In this view, no truly important commodity can be left to the whims of the market and manipulative traders. At one level, modern economic analysis supports this view, because markets do not guarantee satisfactory outcomes for either efficiency or income distribution. But neither do governments. The task for fertilizer policy in the 1990s is to find a path through the minefield of market failures *and* government failures by limiting interventions to those areas where both analytics and potential to control corruption are promising. Experience of the last several decades provides some insights.

First, there are substantial benefits from domestic production of fertilizer if the basic natural resources are available to permit reasonable costs of production. Ownership of the plants is not the key element in determining the efficiency of operation; ex-factory pricing policy is. Aid donors have not always been as helpful in reaching the right decisions in this arena as they might be. Fertilizer factories make marvelous aid projects. They are discrete entities, absorb lots of money, can use Western machinery and technology, and require little donor monitoring. To guarantee a reasonable rate of return on the investment, however, donors often insist on guaranteed ex-factory prices. The negative effects such a pricing policy has on choice of technique and operating efficiency have repeatedly been stressed.

Second, once a country has the domestic capacity to produce fertilizer, beneficial pressures are generated to develop an effective distribution system to deliver it to farmers. One argument for domestic production is the reduced exposure to instability of fertilizer prices in world markets, but the enhanced regularity of supply to farmers because of domestic production is a separate factor. In political terms, the fertilizer producers are an additional weight in the balance between farmers' desires for regular and low-cost supplies as opposed to government officials' desires to control and extract rents. Tipping the balance in favor of farmers by fostering a more effective distribution system has helped avoid fertilizer shortages when foreign exchange crises occur. Farmers who are totally dependent on imports for their supplies do not have this added support for their interests.

Last, "pure" solutions are guaranteed not to work. Total government control of the fertilizer sector has proven very high cost and insufficiently effective in delivering supplies to farmers. The dynamic losses in efficiency are larger than either the allocative or X-efficiency losses, although the latter can be extremely large in some circumstances. A free-market approach solves some of these problems but creates others, including the likelihood that no fertilizer industry at all will emerge from domestic investors. The resulting instability may dampen the entire growth process as well as threaten the political survival of any government that attempts such a strategy. Some combination of market forces and government interventions is needed, with the market providing allocative signals, the government stabilizing them around a market trend, and a competitive private sector delivering the goods at low cost. The challenge is to see if any country can find and sustain this magical combination.

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