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FERTILIZER POLICY IN KOREA

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Abstract

Farmers in Korea are often thought to be assisted by current fertilizer policy, since the government sells fertilizer to them at roughly 20 per cent below cost. However, this farm price is about 20 to 30 per cent above the international price. That is, fertilizer manufacturers are enjoying a nominal rate of protection of more than 50 per cent. The fertilizer "subsidy" is really a mechanism by which taxpayers help farmers bear the direct cost of that protection. It involves large government outlays though, which the government would like to phase out. One option is to remove the "subsidy" which would force farmers to carry the full direct cost of that protection. Another option is to lower the rate of protection to fertilizer manufacturers. This paper provides estimates of the price changes required to eliminate government outlays under these alternative circumstances. It also quantifies the effects of such changes on fertilizer production and use and discusses the appropriateness of each option in terms of efficiency of resource allocation, food security and farm incomes.

I. Introduction

Virtually all chemical fertilizer used in Korea is manufactured domestically. The government, through the National Agricultural Cooperatives Federation (NACF), purchases domestic requirements from manufacturers and sells them below cost to farmers. The differences between the purchase price received by manufacturers and the selling price paid by farmers, less marketing costs, has been financed by loans from the Bank of Korea and NACF to a Fertilizer Fund Account operated by NACF. Since 1980 the deficit in this account has been rising at roughly 140 billion won per year (almost US$200 million), which is equivalent to about 2 per cent of all government expenditure. The government has become increasingly concerned by the size of this deficit, and would like to see it reduced to zero by 1986. Understandably, farmers in turn are concerned that any policy change will mean higher farm prices for this crucial input. One of the purposes of this paper is to show that this need not be the case.

Typically, the present policy is interpreted as providing a subsidy to farmers (on the assumption that the government will eventually write

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off the deficit and thereby convert past loans into grants). However, that interpretation ignores the fact that fertilizer prices internationally are considerably lower than prices paid by Korean farmers. The policy is thus more appropriately interpreted as providing protection to fertilizer manufacturers, with some of the direct cost of protection being paid by farmers ans the rest by future taxpayers. The extent of protection and its effects on fertilizer production and trade are examined in the next section. Section III then analyses alternative policy changes aimed at eliminating the annual deficit in the Fertilizer Fund Account. After a summary of the results, the paper concludes with a discussion of the effects of alternative policies on the efficiency of resource use, food security and farm incomes.

II. Effects of Current Fertilizer Policy

Until the mid 1960s, Korea was less than 20 per cent self sufficient in chemical fertilizer (Table 1). The government decided to encourage domestic fertilizer production by guaranteeing a number of firms profits of at least 20 per cent per year for up to two decades. As a result, production

TABLE 1 FERTILIZER PRODUCTION, CONSUMPTION AND SELF SUFFICIENCY ('000 tonnes by element)

	Production	Consumption	Self sufficiency (%)[a]	Use per hectare of cropped land (kg)
1963	45	307	15	97
1964	65	364	18	105
1965	75	393	19	110
1966	83	423	19	131
1967	186	486	39	148
1968	485	478	103	145
1969	561	535	107	160
1970	590	563	105	172
1971	599	605	99	195
1972	635	648	98	211
1973	672	793	85	260
1974	750	837	90	270
1975	860	886	97	282
1976	833	643	129	203
1977	1,089	736	148	243
1978	1,330	866	154	289
1979	1,438	863	167	297
1980	1,345	828	162	300
1981	1,168	832	140	301
1982[p]	1,261	616	205	220

[a]Production divided by consumption, expressed as a percentage.
[p]Preliminary.
Source: National Agricultural Cooperatives Federation, *Agricultural Cooperatives Yearbook*, various issues.

expanded rapidly and by 1968 had slightly exceeded consumption. Then in the early and mid 1970s, domestic demand for fertilizer accelerated as farmers switched to fertilizer-intensive Tongil rice and expanded their production of vegetables. This caused fertilizer self sufficiency to drop slightly below 100 per cent between 1971 and 1975. However, the share of production exported rose rapidly from 1976, following a sharp increase in fertilizer prices faced by farmers. Over the period 1976 to 1982, 37 per cent of fertilizer production was exported.

To ensure that the promised level of profits for fertilizer manufacturers is reached, the government has prohibited imports of almost all types of fertilizer and, when export surpluses have been produced, has compensated firms in some cases for losses on export sales. On the other hand, the government has chosen to supply farmers at less than the cost of purchasing and marketing domestic fertilizer. The deficits that have resulted from selling at below cost are shown in column 7 of Table 2. The interest on the accumulating deficit in the Fertilizer Fund Account has increasingly dominated the annual addition to that deficit, however. If it is assumed that this loan will eventually be written off so that it can be treated like a grant, then the value of that annual grant would be the annual deficit less the interest payment (column 8). This is still a substantial figure, being equivalent in recent years to more than 1 per cent and in the mid 1970s to as much as 4 per cent of government expenditure.

An indication of the extent to which domestic prices have differed from international fertilizer prices is given in Table 3, which shows the average prices for all fertilizer distributed by the government. Between 1976 and 1982 the government purchase price averaged 60 per cent above the export price while the sale price (net of marketing costs) averaged 32 per cent above the export price.[1] This suggests farmers have paid about half the direct cost of protecting fertilizer firms in recent years. During the five years prior to 1976, by contrast, domestic fertilizer prices were close to or below export prices.

Thus the main effects of current fertilizer policy have been to stimulate an export surplus of fertilizer (37 per cent of production during 1976–82) which has to be disposed of at much less than domestic prices; to keep the prices paid to fertilizer manufacturers well above international levels (60 per cent above during 1976–82); to keep fertilizer prices paid by farmers below prices received by manufacturers but above international levels (32 per cent above during 1976–82); and to create a large and growing deficit in the Fertilizer Fund Account due to the difference between pur-

[1] To check that Korean fertilizer export prices are representative of international prices generally, the urea export price for Korea was compared with that for Japan and Western Europe. During the 1976–82 period, the Korean price average was within 4 per cent of the export prices received by Japan and Western Europe.

TABLE 2 DETAILS OF THE FERTILIZER FUND ACCOUNT
(current billion Won)

	Purchases	Intermediate expenses				Sales	Annual deficit[b]	Implicit grant	
		Maketing costs	Export compensation	Interest[a]	Other			Value[c]	As a % of Govt. expend.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1966	20	3		0	0	23	0	0	0.3
1967	20	3		0	0	23	1	1	0.4
1968	22	4		0	0	24	2	2	0.6
1969	26	4		0	0	26	3	3	0.9
1970	29	4		0	−1	29	4	4	0.9
1971	32	5		1	−1	30	7	6	1.2
1972	37	5		1	0	32	11	10	1.4
1973	52	5		2	0	44	15	13	2.1
1974	79	7		3	−43[d]	56	−10	30	3.0
1975	152	16		2	−1	99	70	68	4.4
1976	106	13		6	0	127	−2	−8	−0.4
1977	131	13	0	6	−3	145	3	−3	−0.1
1978	169	19	2	5	−5	170	20	15	0.4
1979	186	22	4	8	−7	167	60	51	1.0
1980	235	26	30	36	−4	207	114	78	1.2
1981	360	32	14	54	−6	291	162	109	1.4
1982	388	37	0	67	−10	344	138	70	0.9

[a]Between 1966 and 1976, interest is assumed to be 6 per cent of the previous year's cumulated deficit.

[b]Purchases plus intermediate expenses minus sales.

[c]Annual deficit less interest plus (in 1974) direct subsidy. Numbers do not always add up because of rounding.

[d]Direct subsidy.

Sources: KDI (1982, Table 3-9); Braverman, Ahn and Hammer (1983, Table 20); Economic Planning Board, *Major Statistics of Korean Economy*, 1982. Table 8-4.

TABLE 3 AVERAGE FERTILIZER PRICES
(Won per tonne)

	Government purchase price	Marketing costs	Government selling price	Export price	Implicit subsidy for fertilizer manufactures (%)[a]	Implicit tax on fertilizer use by farmers (%)[b]
	(1)	(2)	(3)	(4)	(5)	(6)
1970	22,160	2,890	24,101	16,047	38	32
1971	26,655	3,582	23,463	21,398	25	−7
1972	28,182	4,023	23,036	25,000	13	−24
1973	31,079	3,466	24,064	34,488	−10	−40
1974	49,257	4,096	32,524	—	—	—
1975	78,239	4,953	53,538	—	—	—
1976	86,021	5,374	98,662	48,626	77	92
1977	93,185	7,164	92,367	55,411	68	54
1978	107,019	9,274	95,091	66,518	61	29
1979	128,855	14,001	103,324	87,615	47	2
1980	189,263	17,999	139,180	145,094	30	−17
1981	235,643	21,824	189,450	150,416	57	11
1982[c]	226,218	23,402	215,973	(128,126)	(77)	(50)

[a]The difference between the purchase price and the export price, expressed as a percentage of the latter.
[b]The difference between the selling price minus marketing costs and the export price, expressed as a percentage of the latter.
[c]The export price for 1982 refers to January only.
Source: Ministry of Agriculture and Fisheries (unpublished data).

chase and sale prices and to some compensation for export losses (600 billion won by 1982). The government would like to eliminate annual additions to this deficit. The next section examines ways it might do that, assuming the existing deficit is written off so that there are no futher interest payments on past deficits.

III. Effects of Alternative Policies

In considering alternative price and trade policies for fertilizer, it is helpful to make use of the illustration of the fertilizer market in Figure 1. The supply curve includes provision for a 20 per cent profit margin. The demand curve refers to quantities demanded by farmers at factory or port prices (to which marketing costs have to be added). P_p is the average price paid by the government to fertilizer manufacturers.[2] P_f is the farmers' price as set by the government. P_x is the price received for exports, and P_m is the price that would have to be paid for imports. In recent years, as shown above, P_p has exceeded p_f which in turn has been above P_x. The difference between P_m and P_x is due to ocean transport, etc., costs.

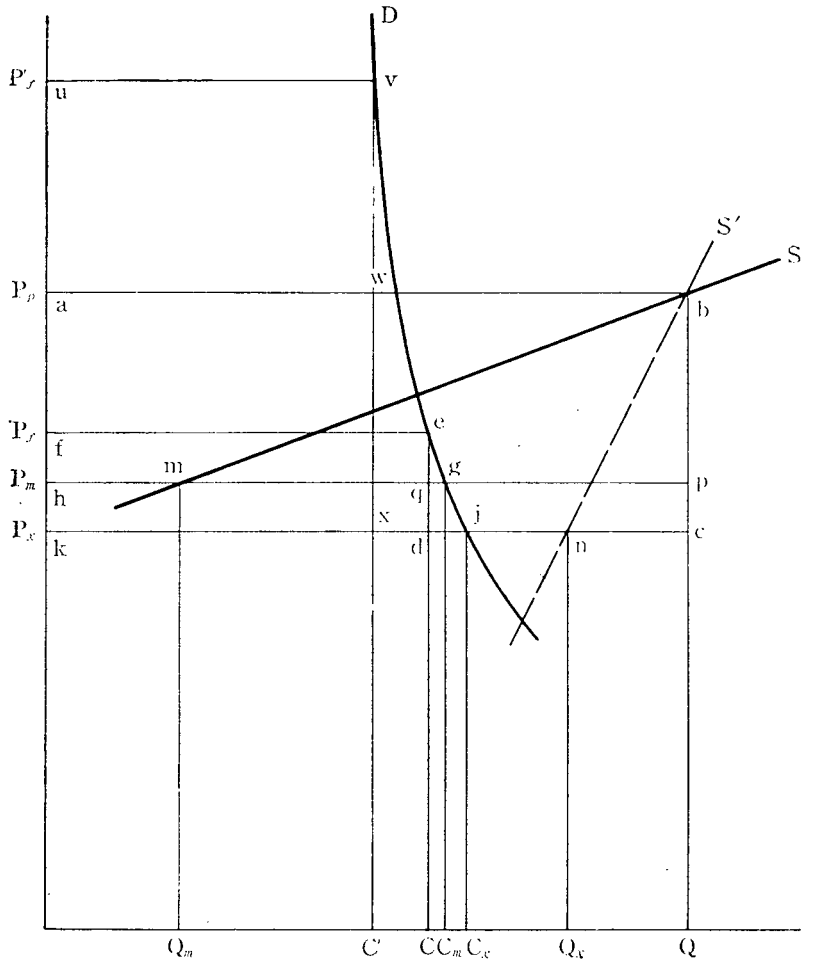
At the policy-distorted prices, Q units of fertilizer are produced, C units are consumed domestically, and the difference (Q-C) is exported. If there were no intervention, on the other hand, both producers and farmers would face a price of P_m in the case where S is the supply curve, with imports of (C_m-Q_m) supplementing domestic production of Q_m to meet the demand by farmers of C_m. [Should the domestic supply curve be sufficiently inelastic, as is S′ in Figure 1, Korea may still produce an export suplus at free market prices, in which case P_x would be the domestic price, C_x would be consumed, Q_x produced and (Q_x-C_x) exported.]

The present policy requires the government to pay a subsidy to fertilizer manufacturers equal to area abcdef in Figure 1. As compared with no intervention, farmers' welfare is reduced by area fegh [or fejk if S' rather than S is the supply curve] and fertilizer manufacturers enjoy rents represented by area abmh [or area abnk if S′ is the supply curve]. If there were no other distortions (see the final section below), the net loss to the economy is area bpm plus area egq plus area cdqp [or area bnc plus area ejd if S′ is the supply curve]. That is, the more elastic the supply curve, the larger the net gain to the economy and the smaller the loss to fertilizer manufacturers from a reduction in their price support. Note that the closer P_f is to P_m and P_x, the smaller are areas egq and ejd and hence the smaller are the deadweight losses to farmers and the economy generally (again, assuming no other distortions), but the larger is the government's outlay of taxpayers' money.[3]

[2] The actual price paid differs between firms according to their cost of production.

[3] In practice, the government has restricted its obligations to subsidize exports,

FIGURE 1



To what extent is it necessary to raise the government's selling price to farmers and/or lower the purchase price paid by the government in order to eliminate the annual Fertilizer Fund deficit (assuming the current deficit is written off by the government so that no interest or principal on past loans has to be repaid)?

1. Raising the Farm Price

Consider first the prospects for eliminating the deficit through raising the

so that in effect the government's policy restricts production to OF. Without such a limit on the government's obligation, there would be nothing to prevent firms from expanding indefinitely if they were to be guaranteed a 20 per cent profit margin regardless of marginal production costs.

price paid by farmers, P_f, while leaving the purchase price, p_p, unchanged. In terms of Figure 1, this requires raising P_f to P_f' such that the profit on domestic sales, area uvwa, is just sufficient to cover the losses on export sales, area wbcx, where $Q-C'$ is now the quantity exported and C' the amount used domestically. That is, set

$$(P_f - P_p)\,C' = (P_p - P_x)\,(Q - C'). \qquad (1)$$

By defining

$$t = (P_f' - P_f)/P_f,$$
$$q = (P_p - P_x)/P_p,$$
$$s = (P_p - P_f)/P_p,$$
$$y = (Q - C)/Q \text{ and}$$
$$f = (C' - C)P_f/(P_f' - P_f)C,$$

where f is the price elasticity of demand over the range e to v in Figure 1, equation (1) reduces to the following quadratic in t:

$$(t - s - st + q)\,(1 - y + tf - tfy) - q = 0$$

The smaller of the two solutions is:

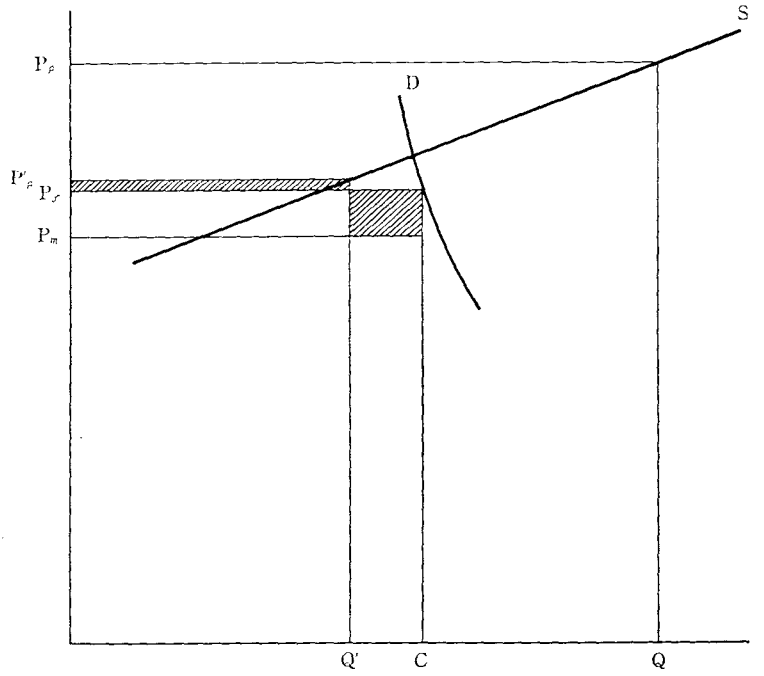
$$t = [s - 1 + fs - fq + ((s - 1 + fs - fq)^2 - 4f(s - 1)(s + qy/(1 - y))^{0.5}]/2f(1 - s).$$

To obtain parameter values, it seems sensible to use the averages of values in recent years, say 1976 to 1982. During that period, as shown above, the proportion by which export prices were below purchase prices (q) averaged ((1.60−1)/1.60 =).375; the proportion by which sale prices net of marketing costs were below purchase prices (s) averaged ((1.60-1.32) /1.60 =).175; and the proportion of fertilizer production exported (y) averaged .37. A recent estimate of the price elasticity of demand for fertilizer is -.2 (KDI 1982, 60). Using these parameter values, the estimated value of t is .57. That is, if the purchase price paid by the government to fertilizer firms remains unchanged and the government continues to cover export losses, the sale price facing farmers would have to rise 57 per cent, which would make it double the international price level. Fertilizer use would fall by (.57 × −.2 =) 11 per cent which would raise the share of production exported to 44 per cent.

2. Lowering the Purchase Price

Consider now the prospects for eliminating the deficit in the Fertilizer Fund though lowering the purchase price received by fertilizer manufacturers, P_p, while leaving the price paid by farmers, P_f unchanged. If the price elasticity of domestic supply is sufficiently elastic, it is possible that the new purchase price could be above P_f. The country would become an importer of fertilizer and would be able to tax imports so as to keep the

FIGURE 2



farmer's price at P_f, with the tariff proceeds being used to support the purchase price at a level above P_f. On the other hand, if the domestic supply curve is quite inelastic, P_p would have to be below P_f. This is to ensure some profits on domestic sales in order to subsidize export losses.

The first of these two cases is illustrated in Figure 2, in which P_p' is that purchase price which just equates the two shaded areas in Figure 2. That is,

$$(P_p' - P_f)Q' = (P_f - P_m)(C - Q'). \tag{2}$$

By defining the additional symbols

$$z = (P_p - P_p')/P_p,$$
$$r = (P_p - P_m)/P_p,$$

and e as the price elasticity of supply over the relevant range, equation (2) reduces to the following quadratic in z:

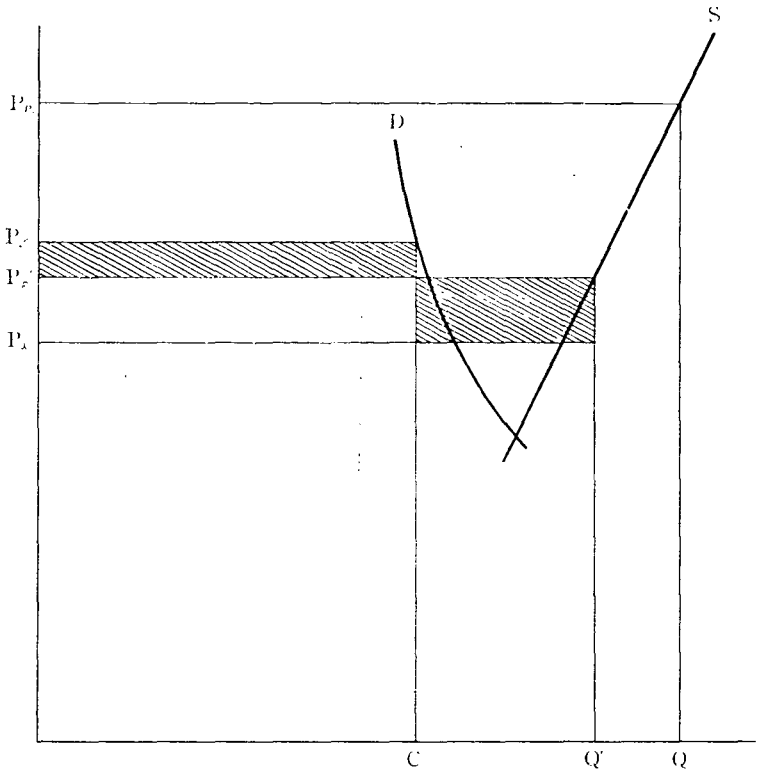
$$(s - z)(1 - ex) = (r - s)(ez - y).$$

The smaller of the two solutions is:

$$z = [1 + er - ((1 + er)^2 + 4e(sy - ry - s))^{0.5}]/2e.$$

The inelastic supply case, illustrated in Figure 3, requires P_p' to be below P_f so that profits on domestic sales can be used to subsidize export

FIGURE 3



losses. In this case the minimum drop in the purchase price which equates the two shaded areas is found by setting:

$$(P_f - P_p')C = (P_p' - P_x)(Q' - C). \tag{3}$$

Using the above symbols, equation (3) reduces to

$$(z - s)(1 - y) = (q - z)(y - ez),$$

and the smaller of the two solutions is:

$$z = [1 + eq - ((1 + eq)^2 + 4e(sy - qy - s))^{0.5}]/2e.$$

If it can be assumed that the transport cost wedge between the f.o.b. export price and the c.i.f. import price is 10 percentage points, then the proportion by which the import price was below the purchase price (r) would be (1.60—1.10/1.60 =) .31. In the absence of any relevant historical experience it is impossible to estimate econometrically the elasticity of supply of fertilizer in Korea to a *decline* in its price, so different values for e are experimented with. Using these parameter values, the following results are obtained:

Assuming	Proportional Change in: P_p	P_f	Q	C	New self sufficiency ratio (%)
e = 2.5	−. 16	0	−.41	0	94
e = 2.1	−.175	0	−.37	0	100
e = 0.5	−. 21	0	−.11	0	142

The first row shows that if the domestic supply elasticity is as high as 2.5, a 16 per cent fall in the purchase price would be sufficient to ensure no deficit, assuming the sale price is unaltered. Such a change would cause domestic production to fall 41 per cent and self sufficiency would drop to 94 per cent. If the supply elasticity were as low as 0.5, on the other hand, the purchase price would have to fall 21 per cent to induce an 11 per cent production cut. About 30 per cent of production would still be exported (self sufficiency of 142 per cent), and the loss from those exports would be financed by the governments' profit on domestic sales. If the supply elasticity were 2.1, the fall in the purchase price of 17.5 per cent would induce a drop in production equal to the amount previously being exported, so that the country would be exactly self sufficient and the purchase and sale prices would be equated at P_f (with this supply curve passing through points b and e in Figure 1).

3. Raising the Farm Price and Lowering the Purchase Price

A strategy that is perhaps more likely than either of the above approaches involves some increase in P_f combined with some decrease in P_p. Suppose, for example, that P_f were to be raised 10 per cent. Using equation (3) but replacing P_f with $1.1P_f$, and C with .98C, the results become:

Assuming	Proportional Change in: P_p	P_f	Q	C	New self sufficiency ratio (%)
e = 2.5	−.12	.10	−.30	−.02	113
e = 0.5	−.17	.10	−.08	−.02	148

By comparing this and the previous set of results, it is clear that the decline in the purchase price needed to ensure no deficit is about 4 percentage points less if the sale price is raised 10 per cent rather than being left unchanged. Fertilizer production and self sufficiency are also greater if the sale price is raised 10 per cent, and fertilizer use drops 2 per cent.

4. Lowering the Sale Price to the International Price

These three sets of changes can be compared with what would happen if government intervention in the fertilizer market were completely removed. The changes that would occur with a move to free trade, assuming different price elasticities for domestic fertilizer supply (e), are as follows:

Assuming	Proportional Change in: P_p	P_f	Q	C	New self sufficiency ratio (%)
e = 2.5	−. 31	−.17	−.78	.03	37
e = 1.21	−. 31	−.17	−.40	.03	100
e = 0.96	−.375	−.24	−.39	.05	100
e = 0.5	−.375	−.24	−.19	.05	135

If the fertilizer supply elasticity is less than .96, the country would continue to export fertilizer even under free trade conditions. If that elasticity exceeds 1.21 the country would be a net importer under free trade. Between those two values the country would be autarchic, the range being dependent on the difference between the f.o.b. export price and the c.i.f. import price for fertilizer (which in the above calculations has been assumed to be 10 per cent of the f.o.b. export price). Clearly, the free trade levels of fertilizer production and self sufficiency are smaller relative to those in the previous scenarios, the greater the fertilizer supply elasticity. The level of fertilizer use, on the other hand, is likely to be little different if the price elasticity of demand for fertilizer is only −0.2.

V. Summary and Conclusion

The present fertilizer policy in Korea seeks to protect local fertilizer manufacturing firms from import competition but at the same time relieve farmers from the full burden of the direct cost of that protection. The latter is achieved by selling fertilizer to farmers at less than the prices received by manufacturers. The difference between the purchase and sale prices of fertilizer, plus marketing costs and compensation for losses on export sales, has been financed by government loans to a Fertilizer Fund Account, the deficit in which has been rising at more than 100 billion won per year. The government would like to see no further additions to the Fertilizer Fund deficit. Four alternative pricing policies to achieve this objective are analysed: (1) raising the sale price sufficiently above the purchase price to generate enough profit on domestic sales to compensate export losses; (2) lowering the purchase without changing the sale price; (3) lowering the purchase price and raising the sale price; and (4) lowering both the purchase and the sale prices to the free trade price level. The first alternative would involve raising the sale price almost 60 per cent, to twice the

export price. This presumably would be a politically unacceptable option. Alternative 2 requires the purchase price to fall roughly 15 to 20 per cent, depending on the domestic supply elasticity for fertilizer. If the sale price were to be raised 10 per cent, the required fall in the purchase price would be about 4 percentage points less (alternative 3). The fourth alternative, namely free trade, would involve a fall of more than 30 per cent in the purchase price received by manufacturers and a fall of roughly 20 per cent in the sale price paid by farmers. If the domestic supply elasticity is below unity, Korea would continue to be an export supplier under free trade, but if it is above 1.2 some imports of fertilizer would be required.

Which of these options in the most appropriate from an economic efficiency viewpoint depends in part on the extent of other distortions in the economy. Within the manufacturing sector, the effective rate of protection to fertilizer relative to other industires is extremely high: in 1982 it was about 300 per cent for urea and compound fertilizers compared with 30 per cent for manufacturing as a whole (Young et al. 1982, 201). Thus a reduction in fertilizer *purchase* prices would undoubtedly improve the efficiency of resource use within the manufacturing sector, as resources would move to industries that are more internationally competitive.

Within the agricultural sector, fertilizer policy probably has had little effect on the dispersion of effective rates of assistance between rural industries. While fertilizer is perhaps the most important cash expense in crop farming in Korea, in 1980 it accounted for only 4 per cent of all farm production costs (KDI 1982, Section 3.4). Thus while high fertilizer prices would be discouraging crop production (especially fertilizer-intensive crops such as vegetables) relative to grain-fed livestock production, the extent of the effect of this distortion on output mix is likely to be very small. Its effect on the mix of farm inputs used may be more significant, however, as farmers would substitute other imputs for fertilizer.

Whether a drop in the *sale* price of fertilizer is desirable on efficiency grounds depends more on the intersectoral difference in effective rates of assistance. It happens that the agricultural sector is assisted by government policies much more than manufacturing on average (Young et al. 1982; Anderson 1982). If this present structure of assistance were to continue, then removing a tax on fertilizer use would tend to worsen intersectoral resource allocation by encouraging agriculture even more. However, this effect is likely to be insignificant given the small contribution of fertilizer to farm costs, and in any case the first-best policy intervention is to reduce farm product price distortions.[4] Moreover, there are some non-economic policy objectives to consider, namely the government's desire to boost food security and farm incomes.

[4] For a similar but opposite argument against using fertilizer subsidies to offset the effect of protecting manufacturing more than agriculture, see Warr (1977).

Food security is harmed rather than helped by present fertilizer policy. Being self sufficient in fertilizer production can hardly contribute to food security since its raw material inputs have to be imported. And even if food security is *perceived* to be greater in the absence of fertilizer imports, it is presumably no greater with fertilizer self sufficiency of 160 per cent (the 1976–82 average) than with 100 per cent. On the other hand, food production is discouraged somewhat by high fertilizer prices,[5] which is likely to have reduced perceived food security more than fertilizer self sufficiency has raised it. Farm income is also lowered by higher fertilizer prices, which is counter to the government's general aim of trying to support farm incomes. While free trade in fertilizer would probably raise farm household incomes by little more than 1 per cent, the political importance of a policy change in that direction may be somewhat greater because fertilizer is considered a crucial cash input.

In conclusion, it would appear that reducing fertilizer prices in Korea would be desirable. Certainly the efficiency of resource use within the manufacturing sector would improve if fertilizer purchase prices were lowered. And if the government wishes to protect agriculture relative to manufacturing, as is apparent from its farm product price policies, then lowering the sale price of fertilizer would help meet that non-economic objective and at the same time reduce the inefficiency associated with socially sub-optimal input mixes on farms. With the recent drop in world prices for petroleum and hence for inputs into fertilizer production, and with the government's profit-guaranteeing agreements with fertilizer firms gradually expiring over the next four years, now is probably a politically suitable time to begin such reductions.

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[5] Available production function studies suggest that the elasticity of rice production with respect to fertilizer input is less than .13 (KDI 1982, 60). Barley and vegetable production is somewhat more dependent on fertilizer but it is unlikely that the elasticity of total crop production to fertilizer input exceeds .2. This, together with the earlier-mentioned price elasticity of domestic demand for fertilizer of −.2, suggests that the elasticity of crop production to the price of fertilizer is less than(.2 × −.2 =) −.04. Therefore, the effect of farmers paying up to one-third more than they would if fertilizer were freely traded has been to reduce crop production by less than (33 × .04=) 1.3 per cent. That is, food self sufficiency (currently around 90 per cent) has probably been only about 1 percentage point lower as a result of the effective tax on fertilizer use.

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