DISCUSSION PAPER

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AN ECONOMIC APPRAISAL OF WITHDRAWING FERTILIZER SUBSIDIES IN INDIA

by

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I. Introduction

Because of the importance of fertilizers in increasing agricultural output, government intervention in the fertilizer market to encourage its more widespread production and use has been a common phenomenon in many developing economies. However, whenever government decides to intervene in the fertilizer market, or in any market for that matter, what follows is not a simple task. It not only involves the delicate choice from among alternative forms of intervention, but it also demands that, from the social standpoint, comparisons of alternative uses of scarce public funds be made in order to justify the cost of the intervention itself.

In this paper, we are not concerned with what the optimal form of intervention in the fertilizer market ought to be. The economic literature already discusses this at length, offering clues as to the proper ranking of forms of intervention based on their social impact on given social objectives. Instead, this paper considers the economic costs and returns of alternative uses of public funds already earmarked for a fertilizer subsidy. In particular, it looks at the current fertilizer subsidies in India. It uses a general equilibrium model of India's agricultural sector to simulate the likely consequences of its removal on agricultural performance and the overall distribution of income. The model is also used

1/ Throughout this paper, we focus mainly on India's total financial subsidy on fertilizers.
to determine the net effects of reallocating fertilizer subsidies to finance other government sponsored agricultural programs instead, as for instance, for expanding irrigation and for increasing foodgrain imports.

Section II of this paper gives a brief history of Indian fertilizer pricing policy since the early 60s. This section highlights the nature and scope of India's current fertilizer subsidy. In Section III, we discuss the different ways the current fertilizer subsidy in India can be withdrawn. This section also illustrates what would likely happen to domestic fertilizer production, fertilizer consumption, fertilizer producer and retail prices and fertilizer imports if any of these alternative ways of withdrawing the fertilizer subsidy is pursued. In Section IV, we first give a verbal description of the structure of the general equilibrium model. We then report the model results from simulating the withdrawal of fertilizer subsidies in India. Scenario results from using these subsidies to finance other government programs are likewise reported.

II. The Nature and Scope of Fertilizer Subsidies in India

Unlike irrigation which has been practiced for many centuries, the promotion and use of chemical fertilizers in India has a more recent history.² Chemical fertilizers were first used in appreciable quantities on tea plantations in the 1920's. But it was only in 1943-44 when measures were first taken to promote their more widespread use.

Prior to 1965, the government followed a basic policy of pooling fertilizer supplies and regulating their distribution. Fertilizer production was an infant industry and imports were the main domestic supply

² Desai (1979, 1984) gives a comprehensive history of fertilizer consumption and pricing policy in India. He shows how and why the initial and relatively simple fertilizer controls set in the mid-1940s have grown in complexity in recent years.
source. A Central Fertilizer Pool (CFP) procured all domestic and imported fertilizers. Retention prices of domestically procured fertilizers were fixed by the Cost Accounting Division of the Ministry of Finance based on average actual costs of production but including a fair return on investments to manufacturers. The CFP disbursed fertilizers to the states who in turn distributed it to cultivators, plantations and industrial users. A uniform retail fertilizer price, set on a no-profit and no-loss basis, was established by pooling indigenous and imported fertilizer prices. There was very little use of a fertilizer subsidy then that the CFP even made a profit in 18 out of 20 years between 1944-45 and 1963-64.

After 1965, the government implemented new policies to increase domestic production and use of fertilizers. It gradually abolished domestic procurement by the CFP, allowing manufacturers to fully market their own products. Distribution margins were also revised upwards, although, except for complex fertilizers, fertilizer prices remained statutorily fixed. The period from 1964-65 to 1974-75 saw two large increases in fertilizer farmgate prices. The first came in 1967-68 because of the devaluation of the rupee in mid-1966. The second and larger increase happened in 1974-75 following the 1973-74 oil price hike. In both instances, the price of imported fertilizer and the domestic cost of fertilizer production also increased dramatically. In 1974-75 however, the increase in the fertilizer retail price was significantly larger than the increase in the domestic cost of fertilizer production but much lower than the increase in the fertilizer import prices. A Fertilizer Pool Equalization Charge (FPEC) was introduced in 1974 whereby domestic manufacturers were required to pay a charge per ton into the FPEC to help subsidize the high cost of imported
fertilizers. However, this charge was not sufficient to cover the government subsidy on imported fertilizers. This was the start of the fertilizer subsidies in Indian agriculture which, in 1973-74 to 1975-76, were basically import subsidies.

In 1977, a Fertilizer Retention Prices Scheme (FRPS) was introduced. In order to encourage domestic fertilizer production and to rely less on the widely fluctuating international fertilizer market, ex-factory retention prices were fixed for each fertilizer plant. This retention price guaranteed a 12% post tax return on net worth, subject to a capacity utilization of 80% and appropriate input consumption norms for each fertilizer plant. This new price policy was important, particularly for new investments in the industry, because the large increases in the cost of capital and raw materials after the 1973-74 oil price hike, made average costs of new production larger than average ex-factory prices for many domestic producers. Although the FRPS encouraged domestic production, it also gave rise to domestic fertilizer subsidies. By 1978-79, the relative share of domestic fertilizers in the total fertilizer subsidy was already larger than that of fertilizer imports. This share has since grown dramatically. It now stands at 86% of the total 1983-84 fertilizer subsidy.

In India, fertilizer subsidies since 1973-74 have been used to ensure that fertilizers are made available to farmers at stable and affordable prices while, at the same time, increasing domestic fertilizer production efficiently by assuring a fair return to domestic fertilizer producers. Although these subsidies have undoubtedly helped increase domestic fertilizer production and use, they have also been and continue to be a large budgetary burden. The total fertilizer subsidy has grown dramatically from 1970-71 to 1983-84. This is shown in Table 1 where from a gross tax of Rs. 12 million in 1970-71, a gross subsidy of Rs. 10,480 million was in place in 1983-84.
Many varied reasons have been given in favor of continuing existing fertilizer subsidies in India. As summarized in the Report of the Committee on Controls and Subsidies (1979), these arguments state that:

"... (a) the national objective of a rapid increase in agricultural output calls for the subsidization of fertilizer use;

(b) that the subsidization of inputs would be a far better method of subsidization of agriculture than the raising of the prices of agricultural products. The reason in that a higher price for agricultural products would help only the relatively larger farmer with marketable surplus;

(c) that even the more prosperous farmers cannot be stated to have a standard of life comparable with urban residents who enjoying many social amenities not available in rural areas, and that a shift in the terms of trade in favor of the agriculturist is desirable, both in order to stimulate agricultural production and in order to increase the demand for manufactured products in the rural areas;

(d) that the fertilizer subsidy as of today largely neutralizes the burden of diverse taxes on fertilizer, and that the net subsidy on fertilizers is rather small, and finally;

(e) that a fertilizer subsidy, to the extent it is promotional, must be retained."
The first three of these arguments are not convincing as they are not supported by solid empirical evidence. The question remains: does the existing fertilizer subsidy policy outrank all other identifiable alternative policies in achieving higher agricultural outputs, a more equitable rural income distribution, and more favorable rural against urban income outcome? This is the empirical question we seek to answer in a later part of this paper. The fourth of the above-mentioned arguments is presumptive as this has also never been empirically shown. Finally, the last argument for continuing existing subsidies, though perhaps the most theoretically appealing, is likewise questionable. Fertilizer subsidies can be justified, but only as a temporary measure, when used as a means to facilitate the adoption and learning of new technology.\(^3\) However, given that fertilizer subsidies in India have been in existence for over a decade, they are now an enduring long run expense rather than a temporary incentive for technology diffusion.

Overall, there appears to be no clear reason for continued fertilizer subsidies in India. As the Committee on Controls and Subsidies in fact recommends, the current subsidy should be gradually phased out and fertilizer should be marketed at an economic price.

III. Withdrawing Fertilizer Subsidies in India - A Partial Equilibrium Analysis

The current huge cost of the Indian fertilizer subsidy is brought about by the policy to meet growing requirements for fertilizers via domestic production (at a guaranteed producer retention price) while at the same time fixing fertilizer prices to farmers lower than their true production costs. Because domestic supplies still fall short of current demand, imports remain

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\(^3\) Shalit and Binswanger (1984) argue that the only valid reason for a permanent fertilizer subsidy is the existence of a non-optimal tax on fertilizer responsive crops for revenue purposes. The subsidy in this case would compensate for the loss of output caused by the tax. This, however, is not the case in India.
Figure 1

Fertilizer Price/nutrient tonne

Domestic fertilizer supply curve

Fertilizer demand curve

Fertilizer Quota (nutrient tonnes)
important and are still used to equate fertilizer supplies and domestic demands. But the total fertilizer import subsidy, though still large, is now much lower than the total domestic producer subsidy. This is clearly shown in Table 1.

In Table 1, we also report fertilizer consumption, retail prices and subsidies in India from 1970-71 to 1982-83. In order to understand what would have happened to agricultural performance and the overall distribution of income in India had fertilizer subsidies been withdrawn at anytime during the 70s to the early 80s, it is best to consider 1977-78 as the reference point. At this time, some subsidy was in place and the gross and the implicit rupee/ton subsidies were low. These best fit the analysis which is to follow.

In Figure 1, we illustrate what would likely happen to domestic fertilizer production, producer prices, total fertilizer consumption, retail prices and fertilizer imports if fertilizer subsidies are withdrawn in any of three different ways.

In Figure 1, let $P_w$ be the world price, $P^0_C$ the initial retail price of fertilizer and $P^0_S$ the initial guaranteed producer price of fertilizer. Here, we assume that government sets $P_S$ and $P_C$ but has no influence on $P_w$. We also assume that the government imports fertilizers to balance domestic fertilizer supply and demand. In Figure 1, $P_w$ is set lower than $P^0_C$ although this need not necessarily be the case for the analysis that follows. $P_w$ can also lie anywhere between $P^0_C$ and $P^0_S$ without largely affecting the main substance of the analysis. Insofar as $P_w$ is lower than $P^0_S$, Figure 1 is descriptive of what likely was the Indian fertilizer situation in the late 70s and early 80s. The case where $P_w$ is lower than $P^0_S$ is reviewed in Figure 2.

$^4$ We assume that fertilizers are a homogenous commodity.
Table 1
India: Fertilizer Consumption, Prices and Subsidies, 1970-71 to 1982-83 a/

<table>
<thead>
<tr>
<th>Fertilizer Consumption (Thousands of tons nutrient)</th>
<th>Weighted Average Retail Price (Rs/ton nutrient)</th>
<th>Total Subsidy (Tax) on Imported Fertilizer (Rs Crores)</th>
<th>Total Subsidy on Domestic Fertilizer (Rs Crores)</th>
<th>Total Fertilizer Subsidy (Tax) (Rs Crores)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/P/K</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970/71</td>
<td>2,256</td>
<td>2,155</td>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>1971/72</td>
<td>2,657</td>
<td>2,105</td>
<td>(20)</td>
<td>(20)</td>
</tr>
<tr>
<td>1972/73</td>
<td>2,768</td>
<td>2,160</td>
<td>(18)</td>
<td>(18)</td>
</tr>
<tr>
<td>1973/74</td>
<td>2,839</td>
<td>2,270</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>1974/75</td>
<td>2,573</td>
<td>4,375</td>
<td>371</td>
<td>371</td>
</tr>
<tr>
<td>1975/76</td>
<td>2,894</td>
<td>4,365</td>
<td>242</td>
<td>242</td>
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<tr>
<td>1976/77</td>
<td>3,411</td>
<td>3,730</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>1977/78</td>
<td>4,286</td>
<td>3,240</td>
<td>159</td>
<td>107</td>
</tr>
<tr>
<td>1978/79</td>
<td>5,117</td>
<td>3,190</td>
<td>169</td>
<td>173</td>
</tr>
<tr>
<td>1979/80</td>
<td>5,255</td>
<td>3,060</td>
<td>282</td>
<td>321</td>
</tr>
<tr>
<td>1980/81</td>
<td>5,516</td>
<td>4,275</td>
<td>335</td>
<td>170</td>
</tr>
<tr>
<td>1981/82</td>
<td>6,067</td>
<td>4,925</td>
<td>100</td>
<td>275</td>
</tr>
<tr>
<td>1982/83</td>
<td>6,418</td>
<td>4,895</td>
<td>98</td>
<td>550</td>
</tr>
</tbody>
</table>

a/ Fertilizer subsidy figures are from Desai (1984).
In Figure 1, at retail price $P_C^0$, farmers demand $QQ_C^0$ tons of fertilizer, of which $QQ_D^2$ is domestically produced (at $P_D^0$ prices to producers) and $QQ_D^2$ is imported (at $P_W$ prices to government). The government pays a subsidy to fertilizer producers equal to the area given by $P_C^0P_S^0AB$. At the same time, the government makes a profit on imports given by the BCED. Total net subsidy (or the total financial subsidy) therefore is the difference between the producer subsidy and the government's profits, i.e., $P_C^0P_S^0AB$-BCED, which in Figure 1 is greater than zero. To remove this net subsidy, government can pursue any one of three viable alternatives. First, the government can eliminate all subsidy by letting the world fertilizer price rule the market. Under this scheme, $P_C = P_S = P_W$, domestic production declines to $QQ_D^1$ while total consumption increases to $QQ_C^1$. Fertilizer imports also increase to $QQ_D^1$. Second, the government can set higher retail prices for fertilizer, say to $P_C^2$, such that the net subsidy is equal to zero, i.e., the total subsidy to producers now given by $P_C^2P_S^2AF$ and is equal to government profits given by FGID. In this scenario, fertilizer consumption decreases to $QQ_C^2$, indigenous production remains unchanged ($QQ_D^2$) but fertilizer imports decline to $QQ_D^2$. Finally, a third alternative is for government to reduce producer prices enough to equate the consequent lower producer subsidies and higher government profits. In this case, domestic fertilizer supply will decline, fertilizer imports will increase while domestic consumption will remain unchanged.

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5/ We do not show this in Figure 1 as this would only unduly complicate an already overextended illustration.
<table>
<thead>
<tr>
<th>Effects on:</th>
<th>1</th>
<th>Alternatives</th>
<th>2</th>
<th>Alternatives</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equating $P_C$</td>
<td>Increasing $P_C$</td>
<td>Decreasing $P_g$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Domestic fertilizer production</td>
<td>negative</td>
<td>constant</td>
<td>negative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Domestic producer's price</td>
<td>negative</td>
<td>constant</td>
<td>negative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Domestic retail price</td>
<td>negative</td>
<td>positive</td>
<td>constant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Fertilizer consumption</td>
<td>positive</td>
<td>negative</td>
<td>constant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Fertilizer imports</td>
<td>positive</td>
<td>negative</td>
<td>positive</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In Table 2, we summarize the expected effects on different fertilizer variables given any of three alternative ways government chooses to remove the net fertilizer subsidy. Of course, these alternatives do not exhaust all the possible ways of totally eliminating the fertilizer subsidy. Alternatives 2 and 3, for instance, can actually be used in combination such that their aggregate effects still result in having a zero net fertilizer subsidy. It is also possible to decrease (or increase) both the retail price and the producer retention price at the same time and still obtain a zero net fertilizer subsidy. The alternatives listed in Table 2 are only meant to highlight the widely different agricultural output and income distribution consequences of eliminating the fertilizer subsidy according to which of all possible alternatives is chosen. In general, an increase in the fertilizer retail price will cause agricultural outputs to decline since less fertilizers will then be used by farmers. Food prices will rise and net buyers of food, the rural poor and the urban classes, will suffer. On the other hand, any decrease in retention prices to fertilizer producers will not affect fertilizer use by farmers. Agricultural outputs will therefore remain unchanged. Indigenous fertilizer production will decrease but this is unlikely to significantly affect employment in the fertilizer industry since the industry is not labor-intensive. Except perhaps for a marginal decline in the incomes of the fertilizer producers or the urban rich, the overall income distribution will remain unaltered.

6/ In Figure 1, the point K describes the equilibrium fertilizer price and quantity that would prevail in the absence of any imports or fertilizer subsidy. Indeed this is an option open to government. However, the opportunity cost of having high domestic prices relative to world prices is extremely high. Only if world prices were greater than or equal to the equilibrium price, i.e., $P_w \geq P_e$, would this alternative be viable.
Finally, we note that the twin goals of increasing domestic fertilizer production and fertilizer consumption cannot be attained without having higher fertilizer subsidies and/or more efficient fertilizer plants that causes a rightward shift in the domestic fertilizer supply curve. Since the early 80s, India saw more of the former rather than the latter adjustments.

Figure 2 illustrates what will happen if the fertilizer subsidy were withdrawn given the same a priori conditions assumed in Figure 1 except that the world fertilizer price \( P_w \) is now set higher than the government's guaranteed price to domestic fertilizer producers \( P^o_s \). Figure 2 is reminiscent of the Indian fertilizer situation immediately after first oil price hike of 1973-74.

Our initial conditions in Figure 2 show that the amount \( Q^o_d \) of fertilizer is domestically produced (\( P^o_p \) producer prices) and the amount \( Q^o_c \) is consumed (at \( P^o_r \) retail prices). Total fertilizer subsidy is given by the area \( P^o_c P^o_D + A B D E \). Any decrease in \( P^o_s \) will decrease this total.

**Figure 2**
subsidy, and so would any increase in $P_C$. The total subsidy however can only be eliminated if retail fertilizer prices rise to the world price level, i.e., $P_C = P_w$. But then, local fertilizer producers will suffer an opportunity loss (equal to the area $P_gP_wAC$) because retail prices are set higher than producer prices. Only if $P_s$ were also set equal to $P_w$ would there then be no net losses to producers and zero subsidies. In this instance, world prices rule. Domestic fertilizer production will increase but fertilizer consumption will decline.

In Figure 2, only in the unlikely case where the world price $P_w$ is greater than the equilibrium domestic price $P_e$ will a setting of both $P_C$ and $P_s$ lower than $P_w$ result in no net losses to domestic fertilizer producers and in no net fertilizer subsidy by government. Both $P_C$ and $P_s$ will equal $P_e$ and there will also be no imports.

In 1973-74, what the government of India did in response to higher world fertilizer prices was to increase its retail and producer retention prices (although a fertilizer equalization charge was asked of producers). This was a judicious response though it invariably led to lower fertilizer consumption but slightly higher domestic fertilizer production. And because these domestic fertilizer price increases were not sufficient to offset the higher cost of fertilizer imports, a large subsidy on fertilizer imports first came into place in 1974-75. The government could not have avoided this subsidy. Only if it had allowed for even higher fertilizer retail and producer retention prices, or the high world fertilizer prices, to dominate the domestic market could the subsidy have been avoided. Fortunately, this subsidy came down in the following years primarily because of lower fertilizer import prices.
IV. Withdrawing Fertilizer Subsidies in India — A General Equilibrium Analysis

In this section, we depart from the partial equilibrium economics of the previous section and move to general equilibrium analysis. To determine the growth and distributional effects of withdrawing the Indian fertilizer subsidy, we use a computable general equilibrium model of India's agricultural sector with nonagricultural linkages.7

The model consists of a producer core, a system of output supply and factor demand equations that describe producer behavior. The producer core determines the aggregate supplies of rice, wheat, coarse cereals, and other agricultural commodities. It also determines aggregate demands for variable factors, including labor, draft power, and fertilizer.

A variety of shifter variables may shift each of these output supply and input demand curves. They are land, a fixed factor; rainfall; irrigation; high-yielding varieties (HYVs); roads; farm capital; regulated markets; and technological change.

The parameters of this system have been econometrically estimated, first for each agroclimatic region and then aggregated to obtain the parameters for India as a whole.8 A flexible functional form has been used and all cross-price terms, including those between inputs and outputs, have been

7/ Except for a few minor departures to be noted later, the model in this section is exactly the same as that described in Quizon and Binswanger (1984). The mathematical structure and all the econometrically estimated parameters of the model are given in this paper.

8/ Bapna, Binswanger and Quizon (1984) describes how these parameters were obtained for the semi-arid tropical regions of India.
estimated. No separability restrictions have been used. The agroclimatic regions are the northern wheat region, the eastern rice region, the coastal rice regions of south India, and the semi-arid tropics.

Income groups are defined as quartiles of the total rural and urban expenditure distributions, with R1 and U1 being the lowest rural and urban quartiles respectively and R4 and U4 the highest.

Input supplies to agriculture are determined as follows: land, which is exogenously given, is supplied only by the rural groups; labor is responsive to the real rural wage and supplied by each of the rural groups and by urban groups via migration; draft power is responsive to real draft animal rental rates and supplied by each of the rural groups; and fertilizer is responsive along the aggregate supply curve to the producers price of fertilizer relative to nonagricultural goods.

The consumer core is made up of output demands. Commodities are demanded by each of the eight groups according to the prices of the commodities and according to demand elasticities for the specific income group, that is, poorer groups have higher income elasticities than richer groups. The demand system have been estimated econometrically. A flexible functional form has been used so that all Slutsky substitution terms have been directly estimated. Aggregate demand is the sum of each group's demand.

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9/ As nonagricultural output is given, changes in migration will create excess demand or supply of labor in the urban sector, or unemployment.

10/ See Binswanger, Quizon and Swamy (1982).
The nominal income of each group is computed as the sum of their respective supplies of factors of production multiplied by the factor prices, plus an exogenously given component of nonagricultural income.

Real income is defined as nominal income, deflated by an endogenous consumer price index. The price index reflects all endogenous food price changes and is specific to each income group.

Prices and quantities are determined by equating aggregate demands with aggregate supplies for each of the four agricultural outputs and for each of the variable inputs except fertilizer.\textsuperscript{11} For fertilizer, its retail price (in the fertilizer demand equation) and its producer price (in the fertilizer supply equation) are assumed to be exogenously given. Fertilizer imports, purchased at a fixed price, are what equate domestic fertilizer demand and supply and are endogenous. The total fertilizer subsidy is the sum of a domestic fertilizer subsidy and a fertilizer import subsidy. These components of the total subsidy are computed as residual losses (or gains) from selling the available fertilizer at the given retail price.

The quantity of land is exogenous, but the "land rent" is determined endogenously as the residual farm profits after variable factors have been paid off. Nonagricultural prices are given exogenously, and the quantity consumed adjusts.\textsuperscript{12}

The model solves for all endogenous price and quantity changes and simultaneously determines for each income group the changes in their nominal income, price deflator, real income, labor and draft power supply, and consumption levels. The entire model is written in logarithmic-linear form.

\textsuperscript{11} This is the first departure from the general model described in Quizon and Binswanger (1984). Appendix I shows in mathematical terms how the fertilizer market and fertilizer subsidies are modeled.

\textsuperscript{12} As nonagricultural income is given exogenously, nonagricultural production is also exogenously given; that is, consumption must adjust via trade.
Finally, in the model we use estimated 1980-81 shares of domestic production and of imports in the total supply of each agricultural output and of fertilizer, even though all other model parameters, i.e., the elasticities and the remaining shares, assume 1973-74 prices and quantities.\textsuperscript{13} The size and the composition of the fertilizer subsidy are also 1980-81 estimates.

Table 3 shows what would likely have happened in 1980-81 had India then cut back its fertilizer subsidy by half. Each column in this table refers to a particular way the 1980-81 subsidy is assumed to be halved. The numbers under each column are estimates of the likely percentage difference in the endogenous variables (from their actual 1980-81 levels) caused by this particular intervention. They do not yet assume anything as to how government uses the saved funds from the cutback in the subsidy.

Alternative 1 assumes that the fertilizer retail price remains unchanged ($P'_C = 0$). Only the price of fertilizer to fertilizer producers is allowed to decrease to a level such that the total amount of the 1980-81 fertilizer subsidy declines by 50%. As we already noted in our earlier partial equilibrium analysis, this alternative has no real effects on agricultural production and output prices because fertilizer retail prices

\textsuperscript{13} This is a second departure from the general model in Quizon andBinswanger (1984).
and domestic fertilizer consumption remain unchanged. Fertilizer imports increase by 23.8%, enough to cover the decline in domestic fertilizer production by 15.5%. The main losers are likely to be fertilizer producers who presumably belong to the richest urban group (U4). Unfortunately, this is not shown in Table 3. Because the model does not treat the nonagricultural sector endogenously, the effect of reducing fertilizer producer prices on nonagricultural incomes is not taken into account. Nonetheless, we can expect the decline in the income of U4 to have no significant effects on agricultural output demands and on agricultural prices. The richest urban group not only consume a small proportion of total agricultural output but also have relatively smaller income elasticities of demand for agricultural commodities. Alternative 1 assumes that self-sufficiency in fertilizer is not a paramount government goal.

Alternative 2 allows the fertilizer retail price to increase but assumes that the government's fertilizer retention price to producers does not change (P_s' = 0). Fertilizer consumers bear the initial burden of the withdrawal of the fertilizer subsidy by 50%.

Fertilizer consumption declines (-6.6%), and so does aggregate agricultural production (-0.4%). Food prices increase and all urban classes lose. Real farm profits decline (-1.7%) and landowners lose mainly because higher fertilizer retail prices increase farm production costs. Finally, the poorest rural group who are net buyers of food lose from the food price increase. However, because labor is a substitute for fertilizer
Table 3: SIMULATED EFFECTS OF HALVING THE 1980-81 FERTILIZER SUBSIDY UNDER DIFFERENT ALTERNATIVE, ALL-INDIA a/

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) $P'_c = 0$</th>
<th>(2) $P'_s = 0$</th>
<th>(3) $P'_c = -P'_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>% changes from 1980-81 levels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Production (TOTQ)</td>
<td>-</td>
<td>-0.441</td>
<td>-0.276</td>
</tr>
<tr>
<td>Rice production</td>
<td>-</td>
<td>-0.106</td>
<td>-0.067</td>
</tr>
<tr>
<td>Wheat production</td>
<td>-</td>
<td>-0.385</td>
<td>-0.241</td>
</tr>
<tr>
<td>Coarse cereals production</td>
<td>-</td>
<td>0.652</td>
<td>0.408</td>
</tr>
<tr>
<td>Other crops production</td>
<td>-</td>
<td>-0.773</td>
<td>-0.484</td>
</tr>
<tr>
<td>GNP Deflator</td>
<td>-</td>
<td>0.367</td>
<td>0.230</td>
</tr>
<tr>
<td>Rice price</td>
<td>-</td>
<td>0.568</td>
<td>0.356</td>
</tr>
<tr>
<td>Wheat price</td>
<td>-</td>
<td>0.606</td>
<td>0.380</td>
</tr>
<tr>
<td>Coarse cereals price</td>
<td>-</td>
<td>-0.391</td>
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<td>Real Wage Bill</td>
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<td>Real Farm Profits</td>
<td>-</td>
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<tr>
<td>R1</td>
<td>-</td>
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</tr>
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<td>R2</td>
<td>-</td>
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<td>-0.148</td>
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<td>R3</td>
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<td>-0.301</td>
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<td>R4</td>
<td>-</td>
<td>-0.787</td>
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<tr>
<td>U1</td>
<td>-</td>
<td>-0.201</td>
<td>-0.126</td>
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<td>U2</td>
<td>-</td>
<td>-0.246</td>
<td>-0.154</td>
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<td>U3</td>
<td>-</td>
<td>-0.200</td>
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<td>U4</td>
<td>-</td>
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<td>Aggregate Real Per Capita Income (REALM)</td>
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<td>Fertilizer Production</td>
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<td>-</td>
<td>-5.773</td>
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<tr>
<td>Fertilizer Imports</td>
<td>23.814</td>
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<td>Fertilizer Retail Price</td>
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<td>Fertilizer Producer's Price</td>
<td>-15.451</td>
<td>-</td>
<td>-5.773</td>
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</table>

a/ Assumptions are that:
(a) domestic own price elasticity of fertilizer supply is equal to 1 ($e_f = 1$);
(b) world price of fertilizer remains unchanged ($f^w = 0$);
(c) total fertilizer subsidy is cut by 50% ($V' = -50$).
in production, \(^{14}\) agricultural wages and employment also increase and the rural poor, who are mainly landless laborers, end up with a slight overall gain in their real income (0.1\%).

Alternative 3 allows the fertilizer retail price to decrease and the fertilizer producer retention price to increase in the same proportion \((P'_r = -P'_c)\). The burden of halving the subsidy now initially falls on both producers and consumers of fertilizer. Because neither the indigenous production nor the domestic consumption of fertilizers are drastically reduced, this appears to be the most reasonable and perhaps the most politically feasible alternative for cutting back the fertilizer subsidy. Fertilizer production and consumption decline but only by 5.8\% and 4.1\% respectively. Fertilizer imports decline as well (−1.6\%). All other effects also lie between the extremes of alternatives 1 and 2.

In Table 4, we provide the growth and distributional effects from a few simulation exercise. We assume that the government cuts back its total fertilizer subsidy as in alternative 3 above and now has Rs 2,483 billion, on 50\% of its actual 1980–81 fertilizer subsidy, at its disposal. In these simulations, we do not assume any position as to the political feasibility or otherwise of any alternative government policy affecting agriculture.

\(^{14}\) The shift from fertilizer using (rice and wheat) to more labor using crops (coarse cereal) partly explains how in the overall, labor can be a substitute for fertilizers.
<table>
<thead>
<tr>
<th>Endogenous Variables</th>
<th>Food Subsidy Scenarios</th>
<th>Irrigation Scenarios</th>
<th>4.3</th>
<th>4.4</th>
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<tr>
<td></td>
<td>4.1</td>
<td>4.2</td>
<td></td>
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<tr>
<td>Total Agricultural Production</td>
<td>-0.209</td>
<td>-0.335</td>
<td>0.487</td>
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<td>Rice Production</td>
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<td>0.761</td>
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<td>Coarse Cereals Production</td>
<td>0.052</td>
<td>1.351</td>
<td>0.949</td>
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<td>Other Crops Production</td>
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<td>Rice Price</td>
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<td>Wheat Price</td>
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<tr>
<td>Coarse Cereals Price</td>
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<tr>
<td>Other Crops Price</td>
<td>1.639</td>
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<td>0.271</td>
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<td>Agricultural Employment</td>
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<td>Real Per Capita Income of:</td>
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<td>Rural 1</td>
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<td>Rural 2</td>
<td>-0.053</td>
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<td>-0.107</td>
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<td>Rural 3</td>
<td>0.019</td>
<td>-0.776</td>
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<tr>
<td>Rural 4</td>
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<td>-0.634</td>
<td>-0.523</td>
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<td>1.010</td>
<td>2.035</td>
<td>1.506</td>
<td>2.600</td>
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<td>1.433</td>
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<td>0.223</td>
<td>-0.255</td>
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<td>-6.063</td>
<td>-3.940</td>
<td>-5.102</td>
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<tr>
<td>Fertilizer Production</td>
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<td>-5.433</td>
<td>-5.800</td>
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<td>Fertilizer Imports</td>
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<td>-7.034</td>
<td>-1.101</td>
<td>-4.347</td>
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<td>Fertilizer Retail Price</td>
<td>5.942</td>
<td>5.433</td>
<td>5.800</td>
<td>5.631</td>
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<tr>
<td>Fertilizer &quot;Producer's Price&quot;</td>
<td>-5.942</td>
<td>-5.433</td>
<td>-5.800</td>
<td>-5.531</td>
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<tr>
<td>Per Capita Cereals Consumption</td>
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<td></td>
<td></td>
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<tr>
<td>Rural 1</td>
<td>-0.109</td>
<td>0.738</td>
<td>0.793</td>
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<td>Rural 3</td>
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<td>0.306</td>
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<td>Rural 4</td>
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<td>-0.083</td>
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<td>Urban 1</td>
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<td>2.101</td>
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<td>Urban 4</td>
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<tr>
<td>Aggregate Per Capita Cereals</td>
<td>0.348</td>
<td>0.569</td>
<td>0.577</td>
<td>0.516</td>
</tr>
</tbody>
</table>

a/ These scenarios assume instantaneous irrigation. Benefits from new irrigation are assumed to flow for 30 years discounted at 12%. Cost of irrigation is assumed = Rs.18,713/ha. Maintenance and operational cost of new irrigation is assumed = Rs.216/ha per year.
We also do not show how existing regional disparities in the size and composition of agricultural outputs, agricultural inputs and infrastructure, real per capita incomes, and so on are altered by government policy.

Scenario 4.1 shows what happens if government uses this Rs 2.483 billion for a food subsidy to urban residents which it disburses via urban food ration shops. Under this scheme, each urban resident is provided with the same amount of subsidized food irrespective of the person's income level. This subsidized food is procured domestically. When released in the ration shops, we further assume that the per capita urban food rations are either inframarginal, or if not, the excess of one's own demand can be resold by the urban recipient in the open market. This scheme then is tantamount to a nominal income transfer of Rs 2.483 billion to all urban residents in equal amounts.

Scenario 4.2 shows the effects a second option, that is, of importing Rs 2.483 billion worth of wheat or 1.38 million metric tons of wheat at 1980-81 world prices and subsequently releasing these in the open market.

Scenario 4.1 and 4.2 are basically alternative short-term poverty alleviation programs. They show that if the paramount goal of government is to improve the incomes of the poor in the short-run, targeted food subsidies or income transfers to them, and/or increased cereal imports are better ways of attaining this objective than fertilizer subsidies. However, fertilizer subsidies are better only if the government's main objective were to encourage domestic agricultural production instead. Both
scenarios 4.1 and 4.2 show net agricultural production losses if government withdrew fertilizer subsidies in favor of targeted food subsidies or direct food imports.

Comparing scenarios 4.1 and 4.2, we note that with imports of wheat (scenario 4.2), aggregate agricultural production declines by more than when urban food subsidies are financed (scenarios 4.1). However, urban residents gain more in the import scheme than in the urban ration shop scheme which already initially favors them. Dumping wheat imports also favors the rural poor though it harms the rural upper income group. Overall, increasing the per capita cereal consumption of both the urban and rural poor is best attained by importing foodgrains rather than by relying on other short-run remedies, such as a high food price policy or a fertilizer subsidy, that increase domestic food production.

The last two columns of Table 4 show the effects of using Rs 2.483 billion from the fertilizer subsidy for major/medium irrigation at the cost of Rs 3.5713 per hectare in 1980-81. Both scenarios assume that the benefits from newly irrigated land will extend for 50 years, the lifespan of the new irrigation infrastructure. Maintaining and operating a major/medium irrigation system costs Rs 6969 per hectare in 1970-71 prices for new major/medium irrigation. Assuming an inflation rate equal to that for non-agricultural commodities, this cost is equivalent to Rs 18713 per hectare in 1980-81. This figure is undoubtedly an upper limit. Independent simulations on the effects of irrigation investments in India currently being done by A. Parikh, T.N. Srinivasan and N.S.S. Narayana at IIASA assume a cost of Rs 1988.6 per hectare and Rs 6736.84 per hectare for minor and major irrigation respectively at 1970-71 prices. Moreover, at least two World Bank project studies on major irrigation in India assume a cost between Rs 12300 and Rs 14400 per hectare in 1982 prices.

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15/ The Sixth Five Year Plan of the Government of India assumes an average set-up cost of Rs 6969 per hectare in 1970-71 prices for new major/medium irrigation. Assuming an inflation rate equal to that for non-agricultural commodities, this cost is equivalent to Rs 18713 per hectare in 1980-81. This figure is undoubtedly an upper limit. Independent simulations on the effects of irrigation investments in India currently being done by A. Parikh, T.N. Srinivasan and N.S.S. Narayana at IIASA assume a cost of Rs 1988.6 per hectare and Rs 6736.84 per hectare for minor and major irrigation respectively at 1970-71 prices. Moreover, at least two World Bank project studies on major irrigation in India assume a cost between Rs 12300 and Rs 14400 per hectare in 1982 prices.
medium irrigation system will also cost Rs 216 per hectare per year.\textsuperscript{16}

Whereas scenario 4.3 assumes that the government will bear the full cost of maintaining and operating the new irrigation system, scenario 4.4 assumes that this expense will instead be fully shouldered by direct beneficiaries (users) of the new system. Scenario 4.1 then assumes a higher cost per irrigated hectare since the government has to initially set aside a certain amount to cover the maintenance and operating costs for the next 50 years. Scenario 4.4 assumes that a larger land area is actually irrigated (because of lower cost to government). However, landowners have slightly higher total production costs because they now bear the full expense of maintaining and operating the new irrigation system. Both scenarios assume that the extra agricultural output made possible by the new irrigation will be absorbed domestically.

The figures for scenarios 4.3 and 4.4 show the 50 year net effects of investing 50% of the fertilizer subsidy in new irrigation in 1980-81. These were obtained by first computing the year to year benefits from the new irrigation and subsequently discounting these benefits at 12% to 1980-81. The scenarios report the sum of these discounted benefits. As in the previous scenarios, these numbers are percentage differences in the endogenous variables (from their actual 1980-81 levels) caused by the policy intervention. They are therefore comparable to scenarios 4.1 and 4.2.

From a growth with equity perspective, irrigation investment appears to be better than either the imports cum market dumping of foodgrain or the domestic procurement cum urban ration shops schemes. With

\textsuperscript{16} This estimate is from dividing the 1980-81 aggregate maintenance and operating costs of government irrigation systems by the actual irrigated area under major/medium irrigation (see, for instance, Economic Survey, 1982-83). Two different World Bank project studies alternatively assume Rs 270 and Rs 220 per hectare in 1982 rupees.
irrigation, domestic production of food increases (0.48%), the aggregate price index declines (-1.4% and -2.7% respectively), and the net purchasers of food, the rural poor and urban residents, gain. Because irrigation has a labor using bias, the wage rate, agricultural employment and the wage bill all increase. Farm profits however, decline because the agricultural price drop is larger than the agricultural output gains due to irrigation. In scenario 4.4, the decline in farm profits is larger because of the operational/maintenance cost shouldered by agricultural landowners. In both scenarios however, the overall distribution of incomes improves.

We also note that the per capita cereal consumption of the poor improves dramatically under both irrigation scenarios. In scenario 4.4, the cereal consumption gains of the poor are even larger than what would have occurred if cereals were directly imported. These results, however, are not meant to diminish the importance of immediate poverty alleviation schemes (scenarios 4.1 and 4.2) in favor of long-run improvements of physical infrastructure (scenarios 4.3 and 4.4). Rather, it merely demonstrates the constraints to agricultural growth often imposed by poverty itself. The immediate and pressing need to raise the already extremely low nutrition levels of a large segment of the population can inhibit long-run improvements which alone ensure sustained economic development. This immediate demand to feed the poor, however, can best be attained by means other than a fertilizer subsidy.

The last two scenarios only illustrate how a simple reallocation of public funds already earmarked for subsidizing agricultural production can lead to higher agricultural output and an improved distribution of income. They show why fertilize. subsidies are meant only as a short-run
measure to help in the diffusion of new technology. Fertilizer subsidies are not supposed to be substitutes to investment in agricultural research and extension or in social and physical infrastructure which alone guarantee the viability of new technology itself.

Finally, we note that the scenarios listed in Table 4 assume a state trading economy where decisions to import or export any amount of food grains rest solely on the government. The importance of trade decisions in effecting the distribution of income is implicit in scenario 4.2. Another paper (Binswanger and Quizon (1984)) explicitly shows these crucial effects. A government decision to export the extra food grain made available from increased irrigation, for example, would reverse the progressive income distribution effects shown in scenarios 4.3 and 4.4. With exports, food grain outputs will increase but so will food grain prices. Net producers of food, or the rural upper income group, will gain while net consumers of food, or the rural poor and the urban class, will lose. Trade policy is a major determinant of the final distributional outcome of any government program in agriculture.
ODELING FERTILIZER SUBSIDIES IN A GENERAL EQUILIBRIUM
MODEL OF THE INDIAN AGRICULTURAL SECTOR

This note shows how fertilizer subsidies in India can be modeled
within the Quizon and Binswanger (Q-B) (1984) general equilibrium model
of the Indian agricultural sector. The nature of the existing fertilizer
subsidy in India is explained in Section II of this paper.

Let \( P_s \) be the retention price of fertilizer to fertilizer
producers, \( P_c \) the fertilizer retail price and \( P_w \) the world price of
fertilizer. Both \( P_s \) and \( P_c \) are set by government and \( P_w \) is fixed, i.e.,
the government cannot influence the world price of fertilizer. Also, let
\( Q_d \) be the total demand for fertilizer, \( Q_s \) the total supply of fertilizer,
\( Q_{sd} \) the total domestic production of fertilizer and \( Q_{sw} \) the total
fertilizer imports. We then have the following equations:

\[
\begin{align*}
Q_d' &= \alpha P_c' + Q_d \text{ (others)} \\
Q_{sd}' &= \varepsilon P_s' + Q_{sd} \text{ (others)} \\
Q_s' &= W_1 Q_{sd}' + W_2 Q_{sw}' \\
Q_d' &= Q_s'
\end{align*}
\]

These equations are exactly like what are used in the Q-B (1984)
model except that \( P_c' \neq P_s' \). The primes (') indicate the endogenous
variables as expressed in rates of growth, \( \alpha \) is the own price elasticity of
fertilizer demand, \( \varepsilon \) is the own price elasticity of fertilizer supply,
$w_1$ and $w_2$ are base year shares of $Q_{sd}$ and $Q_{sw}$ in total fertilizer supply, and the last two terms of equation (1) and (2) refer to all other terms that enter the fertilizer demand and domestic fertilizer supply equation respectively.

We define the total fertilizer subsidy ($V$) as:

$$V = (P_s - P_c) Q_{sd} + (P_w - P_c) Q_{sw}$$

i.e.,

the subsidy is the sum of a domestic subsidy to fertilizer producers and a subsidy on fertilizer imports. Expressing this equation in terms of rates of growth, we obtain:

$$V' = s_d (P'_s + Q'_{sd}) + s_w (P'_w + Q'_{sw}) - s_c (P'_c + Q'_s)$$

where $s_d = \frac{P_s Q_{sd}}{V}$, $s_w = \frac{P_w Q_{sw}}{V}$, $s_c = \frac{P_c Q_s}{V}$ and are base year values.

The equation system described by equations (1) to (5) has 7 unknowns, $Q'_d$, $Q'_s$, $Q'_w$, $P'_s$, $P'_w$, $P'_c$, and $V'$. The last three unknowns are policy variables. The government can set the rate of change in the total amount of the subsidy ($V'$). How any adjustment in the total subsidy is to be attained can likewise be set by government, e.g., $P'_s = 0$ or $P'_c = 0$ or $P'_c = -P'_s$, etc. The equation system given by (1) to (5) is solvable if any two of these three policy variables are defined a priori. In the scenarios described in Table 3, for instance, we set $V' = -50$ and either $P'_s = 0$, $P'_c = 0$ or $P'_c = -P'_s$.

Note that equation (1) is econometrically estimated. See Quizon and Binswanger (1984) and Bapna, Binswanger and Quizon (1984), for details. For equation (2), the own price elasticity of fertilizer supply is assumed to be 1.
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