PN-AAW-536

RESEARCH AND PLANNING PAPER SERIES

Number 6

November 1986

FERTILIZER PRICE POLICY IN NEPAL

Michael B. Wallace

HMG-USAID-GTZ-IDRC-WINROCK PROJECT

STRENGTHENING INSTITUTIONAL CAPACITY IN THE

FOOD AND AGRICULTURAL SECTOR IN NEPAL

FOREWORD

This Research and Planning Paper Series is funded through the project, "Strengthening Institutional Capacity in the Food and Agricultural Sector in Nepal," a cooperative effort by the Ministry of Agriculture (MOA) of His Majesty's Government of Nepal and the Winrock International Institute for Agricultural Development. This project has been made possible by substantial financial support from the U.S. Agency for International Development (USAID), the German Agency for Technical Cooperation (GTZ), and the Canadian International Development Research Centre (IDRC).

One of the most important activities of this project is funding for problem-oriented research by young professional staff of agricultural agencies of the MOA and related institutions. In particular, funding is provided by the IDRC to support the activities of the Research and Planning Unit (RPU) of the Agricultural Projects Services Centre (APROSC). This research is carried out with the active professional assistance of the Winrock staff.

The purpose of this Research and Planning Paper Series is to make the results of the research activities of APROSC's Research and Planning Unit available to a larger audience, and to acquaint younger staff and students with advanced methods of research and statistical analysis. It is also hoped that publication of the Series will stimulate discussion among policymakers and thereby assist in the formulation of policies which are suitable to the development of Nepal's agriculture.

The views expressed in this Research and Planning Paper Series are those of the authors, and do not necessarily reflect the views of their parent institution.

Michael B. Wallace
Series Editor

RESEARCH AND PLANNING PAPER SERIES

Number 6

November 1986

FERTILIZER PRICE POLICY IN NEPAL

Michael B. Wallace

HMG-USAID-GTZ-IDRC-WINROCK PROJECT

STRENGTHENING INSTITUTIONAL CAPACITY IN THE

FOOD AND AGRICULTURAL SECTOR IN NEPAL

TABLE OF CONTENTS

	Page
ABSTRACT	1
THE PROBLEM	2
HISTORY OF FERTILIZER USE	4
HISTORY OF FERTILIZER PRICE POLICY	8
POLICY ALTERNATIVES	10
CONCEPTUAL ANALYSIS	12
Assumption (1)	13
Assumption (2)	15
The Open Border	16
EMPIRICAL ANALYSIS	17
Economic Calculations	18
The Open Border	19
POLICY IMPLICATIONS	22
Summing Up	23
APPENDIX A: Economic Theory	24
APPENDIX B: Survey Results	24
REFERENCES	28

LIST OF TABLES AND FIGURES

Table 1. Sources of Fertilizer	5
Table 2. Sales of Fertilizer	5
Table 3. Seasonal Fertilizer Sales	6
Table 4a. Fertilizer Sales by Region	6
Table 4b. Per-Hectare Fertilizer Sales by Region	6
Table 5. Fertilizer Prices	9
Table 6. Agricultural Inputs Corporation Finances	9
Table 7. Nepal-India Urea and Complex Fertilizer Price Ratios	21
Table 8. Fertilizer Use	21
Table B-1. Survey Results--Fertilizer Users	26
Table B-2. Survey Results--Fertilizer Use	26
Table B-3. Survey Results--Problems in Fertilizer Use	27
Table B-4. Price Elasticity of Fertilizer Demand	27
Figure 1. Crop Response to Fertilizer Application	12
Figure 2. Fertilizer Demand	12
Figure 3. Crop Response to Fertilizer Application by Region	14
Figure 4. Fertilizer Demand by Region	14
Figure 5. Fertilizer Demand by Region	15
Figure 6. Fertilizer Demand and Supply	16

FERTILIZER PRICE POLICY

IN NEPAL

Michael B. Wallace*

ABSTRACT

This paper reviews the history of fertilizer use and price policy in Nepal, with particular emphasis on the fertilizer price subsidy. Although fertilizer use has dramatically increased since fertilizer use was officially introduced 20 years ago, the price subsidy has not led to significant overall increases in crop production. The economics of this price subsidy are conceptually and empirically analyzed, and policy alternatives are suggested. The most important factor constraining Nepal's price policies is the long open border with India, which effectively prevents Nepal from implementing an independent price policy.

---

*Michael B. Wallace is Specialist, Human Resources Development Division, Winrock International Institute for International Development, Kathmandu, Nepal. This paper is a revised version of a paper originally published in April 1985, under the same title. The author expresses his thanks to Mr. Narayan Dhakal, Research Assistant, APROSC, who collected most of the field data and prepared it for analysis; to Anita Regmi, for help in collecting and analyzing secondary data; to Dr. John Cool, Dr. Gerald Nelson, and Dr. David Nygaard, Agricultural Development Council, for substantive comments on an earlier draft of the paper; and to Simin Litkouhi and Pirooz Wallace, for their endless patience.

THE PROBLEM

Nepal is a country of subsistence farmers whose hungry population is growing by nearly 2.7 percent per year. Per capita annual income is less than US$200. Although there are no published statistics covering both formal and informal food exports, Nepal may have produced a food surplus in the past. However, recent estimates indicate that most hill and some Tarai districts now have food deficits.

In Nepal, food production means cereal grain crop production. Animal and fish products account for only a small fraction of the average villager's diet, and this situation cannot be expected to change in the forseeable future. In view of Nepal's inability to import foodgrains on a large scale, domestic foodgrain production must be increased. Crop production can be increased in three ways: by expanding the cultivated area, by increasing the number of crops grown each year, or by raising the yield of each crop.

In the past, crop production has generally been increased by expanding the cultivated area, but this expansion has had dire environmental consequences. As farmers cultivate higher and steeper hillsides and previously forested areas, increased erosion washes away new and old farmland, decreasing the moisture retention capacity of watersheds. Yields on steep hillside fields are lower than yields on flatter land, so increase in production requires a more than proportional increase in cultivated land. From 1961/62 to 1981/82, cultivated area for major foodgrains (paddy, maize, wheat, barley, and millet) increased by over 33 percent, but crop production increased by less than 25 percent. Thus, the scope for increasing food production by expanding the cultivated area is limited, because the environmental costs of such expansion are high and benefits are minimal.

Unavailability of water is the main constraint to increasing the number of crops grown each year. Cropping intensities have increased in the Tarai with the introduction of winter irrigation and use of high-yielding wheat varieties. In the hills, increasing winter irrigation would require a cheap source of energy for either diverting or lifting water from perennial stream sources to farmers' fields. While falling water itself can provide energy, harnessing this energy for irrigation is a long-term effort--Nepal's terrain is such that transmission costs are high for large hydroelectric projects, and constructing hundreds of small projects is difficult. Although many irrigation projects are both planned and underway, the possibilities for quickly increasing cropping intensities by improving the availability of water are limited.

Lack of chemical fertilizer, in combination with fertilizer-responsive seeds, is the main constraint to increased crop yields. Modern high-yielding varieties of seed--particularly rice, wheat, and maize which are Nepal's most important foodgrains--are generally dependent upon chemical fertilizer for maximum productivity. Nepal produces no chemical fertilizer, so raising crop yields by increasing the use of imported fertilizer may be expensive, especially in view of Nepal's high internal transport costs.

Environmentally, however, increased fertilizer use may be a better way to raise crop production than expanding cultivated area. The ecological costs of greater fertilizer use are probably much less than the costs of further deforestation, and the gains from more irrigation--which can only be achieved gradually--would be increased by greater fertilizer use. Thus, increased fertilizer use may be a necessary expense to raise food production. Whose expense this should be is an important policy question.

In Nepal, the fertilizer price is a major food policy issue which attracts public attention whenever it is changed. Fertilizer is the most important purchased input for most farmers, requiring them either to spend precious cash or to obtain loans from time-consuming formal or expensive informal sources. Although fertilizer may represent only about ten percent of the total cost of production, it is often most or all of the cash cost. While the average farmer uses less than 50 kg of fertilizer per year, and this costs less than Rs.200 (US$10), farmers know that the government fixes fertilizer prices, and direct their complaints accordingly when the price rises. Large farmers spend considerably more than the average, and complain more loudly. A rise or fall in the price of chemical fertilizer thus has a politically visible effect on the welfare of farmers--a large, vocal, and sometimes politically powerful group of people.

The low use of fertilizer in the hills as compared with the Kathmandu Valley and the Tarai is also cause for policy concern. Fertilizer transport costs are lower for the Tarai and the Kathmandu Valley, so it is easier to increase fertilizer use there. However, the poorer half of Nepal's population lives in the hills where food deficits have become chronic, so there are equity reasons for subsidizing their fertilizer use. Transporting food into the hills is also more expensive than transporting the fertilizer to grow food.

Fertilizer sales have been subsidized by the Nepalese government and by foreign donor agencies to encourage increased use by farmers and thereby increase crop production. Fertilizer use has increased dramatically since it was introduced in Nepal in 1965/66, and some of the increase in crop production during that time can be attributed to fertilizer. However, fertilizer subsidies lead to inefficient use because real costs are not taken into consideration by recipients. Also, the financial burden of the subsidy for both the Nepalese government and foreign donor agencies has risen substantially along with fertilizer use, and this rising burden cannot be borne indefinitely. Thus, for both economic efficiency and fiscal budgetary reasons, the eventual elimination of this subsidy must be considered.

This research addresses problems related to the efficiency and equity objectives of fertilizer price policy. The efficiency objective is to increase crop production by encouraging farmers to use fertilizer wisely without placing an extreme financial burden on the government or foreign donors. The equity problem is to ensure that fertilizer price policy does not disadvantage poor farmers, especially those living in the hills. The main hypotheses of this research are that (1) changes in the fertilizer price affect hill, Tarai, and Kathmandu Valley farmers differently; and (2) these differences are relevant to policy decisions.

HISTORY OF FERTILIZER USE

Fertilizer use officially began in Nepal in 1965/66 when 3169 mt were received as aid from India (2169 mt) and the U.S.S.R. (1000 mt). Most of this (2500 mt) was ammonium sulfate (N:P:K = 21:0:0). Fertilizer sales were 2096 mt, all in the Central Development Region (AIC).

Both foreign aid and imports have increased steadily since 1965/66, with the proportion of foreign aid varying from zero (1966/67-1968/69) to 100 percent (1975/76) (Table 1). Since 1975/76, fertilizer received as aid has varied from one-fifth to nine-tenths of the annual supply. Since 1981/82, Nepal has also received fertilizer through loans from the World Bank and the Asian Development Bank, and in 1984/85, loans accounted for over half of the fertilizer supply.

Fertilizer is imported and received as aid from several countries, with one notable exception: no fertilizer is officially imported from India. India--which is both a fertilizer producer and importer--has prohibited the export of this commodity since 1965/66 (APROSC, 1978).

Annual fertilizer sales are now over 100,000 mt, increasing at more than 15 percent per year, with urea (N:P:K = 46:0:0) and complex (N:P:K = 20:20:0) each accounting for about half the total. Fertilizer is used in over 60 of Nepal's 75 districts. Average fertilizer use, as measured by sales, is now about 18 nutrient-kg/ha, among the lowest in the world.

Based on sales, more chemical fertilizer is used on summer crops (mostly rice and maize) than on winter crops (mostly wheat) (Table 3). However, more fertilizer is used per hectare on the winter wheat crop than on summer rice and maize. This is probably because most of the wheat strains cultivated in Nepal are high-yielding fertilizer-responsive varieties which have been recently introduced, while most of the rice and maize strains are traditional varieties which have long been cultivated without chemical fertilizer. Almost all the wheat area cultivated in Nepal is planted with high-yielding varieties, but this is the case for only one-third of the rice and maize.

Much more fertilizer is sold in the Kathmandu Valley and the Tarai than in the hills and mountains (Table 4). The Kathmandu Valley contains about two percent of Nepal's cultivated area, but farmers there purchase over one-fifth of all fertilizer sold in the country. The Tarai has about half the cultivated land, and farmers there buy nearly three-fifths of all fertilizer. Hill farmers, who cultivate nearly half of Nepal's farmland, buy less than one-fifth of the fertilizer. If all fertilizer is used where it is sold, on a per-hectare basis Kathmandu farmers use over 140 nutrient-kg of fertilizer, while Tarai farmers use 16 kg, and those in the hills use less than 9 kg.

Fertilizer use is increasing throughout Nepal. The rate of increase is most rapid in the hills (over 20 percent per year from 1975/76 to 1983/84), followed by the Tarai (over 17 percent) and the Kathmandu Valley (nearly 8 percent). However, the high rates of increase in the hills are partly the result of the low base from which these rates are measured. Per hectare, the absolute increase in fertilizer use from 1975/76 to 1983/84 was highest in Kathmandu (from 70 to 142 kg), followed by the Tarai (from 5 to 16 kg) and the hills (from 3 to 9 kg).

Table 1. Sources of Fertilizer, 1965/66-1985/86 (mt)

Year	Foreign Aid	Loan	Import	Total
1965/66	3169		0	3169
1966/67	0		6670	6670
1967/68	0		15011	15011
1968/69	0		12232	12232
1969/70	1000		18109	19109
1970/71	8100		10300	18400
1971/72	13064		11000	24064
1972/73	20174		44000	64174
1973/74	11950		25500	37450
1974/75	28500		31800	60300
1975/76	5000		0	5000
1976/77	20069		17000	37069
1977/78	37316		9000	46316
1978/79	42218		5000	47218
1979/80	25176		13325	38501
1980/81	31359		22825	54184
1981/82	25945	12075	41276	79296
1982/83	31300	20100	48400	99800
1983/84	17500	5000	55730	78230
1984/85	25600	59700	30000	115300
1985/86 (to 12/85)	33007	10870	20000	63877

Source: AIC.

Table 2. Sales of Fertilizer, 1965/66-1984/85 (mt)

Year	21:0:0	46:0:0	20:20:0	Other	Total
1965/66	1629			467	2096
1966/67	4000		1150	361	5511
1967/68	5664		3042	1253	9959
1968/69	7510	461	2668	5562	11611
1969/70	10133	547	4572	646	15898
1970/71	9929	2125	4558	1116	17728
1971/72	12295	2346	9203	1590	25434
1972/73	17005	5080	9024	1466	32575
1973/74	16857	6541	12127	1254	36779
1974/75	13440	7165	14056	1700	36361
1975/76	6507	10060	8332	6232	31131
1976/77	7755	13661	9423	6996	37835
1977/78	10410	16290	14253	4329	45282
1978/79	7376	19789	10649	7777	45591
1979/80	5060	22324	14718	8066	50168
1980/81	4079	23555	23710	2656	54000
1981/82	5217	26693	19892	4643	56444
1982/83	3559	32200	33748	4208	73715
1983/84	4887	43655	33480	4894	86916
1984/85	1637	46475	49611	2397	100120

Source: AIC.

Table 3. Seasonal Fertilizer Sales

Year	Summer	Winter	Total	Summer	Winter	Total
	(total nutrient-mt)			(nutrient-kg/ha)*		
1975/76	4994	7273	12267	2.9	22.1	6.0
1976/77	10274	4621	14895	6.0	13.3	7.2
1977/78	11723	5744	17467	6.9	15.7	8.4
1978/79	10884	7660	18544	6.3	21.5	8.9
1979/80	12645	8320	20964	7.5	22.7	10.2
1980/81	11202	11256	22458	6.5	28.7	10.6
1981/82	12943	10880	23823	7.3	27.2	11.0
1982/83	16033	15246	31279	9.1	31.6	13.9
1983/84	20967	16330	37297	12.1	34.6	16.9
1984/85	18675	24157	42832	9.6	53.5	17.8

Source: AIC.

Table 4a. Fertilizer Sales by Region (total nutrient-mt)

Year	Mountain	Hills	Kathmandu	Tarai	Total
1975/76	107	1380	4575	6205	12267
1976/77	179	1823	5165	7727	14895
1977/78	455	2529	5379	9105	17467
1978/79	434	2588	6096	9427	18544
1979/80	652	3353	6498	10462	20964
1980/81	878	3150	7261	11170	22458
1981/82	913	3557	6780	12573	23823
1982/83	1232	4531	7498	18017	31279
1983/84	1305	5324	8431	22237	37297
1984/85	1284	8280	6555	26711	42832

Table 4b. Per-Hectare Fertilizer Sales by Region (nutrient-kg/ha)*

Year	Mountain	Hills	Kathmandu	Tarai	Total
1975/76	1.3	2.8	70.1	4.5	6.0
1976/77	2.2	3.6	81.7	5.5	7.2
1977/78	5.5	4.8	84.8	6.5	8.4
1978/79	5.3	4.8	93.7	6.8	8.9
1979/80	8.0	6.3	109.8	7.6	10.2
1980/81	10.6	5.6	121.5	7.9	10.6
1981/82	11.0	5.8	117.1	8.9	11.0
1982/83	15.5	6.8	125.5	12.5	13.9
1983/84	15.6	8.9	142.2	15.7	16.9
1984/85	12.7	10.3	111.9	18.5	17.8

Source: AIC.

*Per-hectare information on fertilizer use is based on the assumption that all fertilizer sold is used on paddy, wheat, and maize, which cover 85 percent of Nepal's cropped area. Fertilizer is also used on vegetables and cash crops, so these statistics may slightly overestimate per-hectare fertilizer use, but relative magnitudes should not be affected.

Fertilizer use and fertilizer demand may be quite different quantities. Nearly all of the fertilizer used in Nepal is officially imported and sold through the Agricultural Inputs Corporation (AIC), and the remainder is unofficially hand-carried into the Tarai from India. Farmers' demand has little direct impact on the kinds or quantities of fertilizer that are available each crop season--the availability of loans and foreign aid grants, and AIC's management capacity, are much more influential factors. As a result, total fertilizer demand is probably considerably greater than sales and actual use.

Fertilizer demand is based on the expected impact of fertilizer use on crop production, and on the expected value of crop output. The impact of fertilizer use on crop output depends on seed variety, soil type, temperature, kind of fertilizer, and time of application. This impact also depends on the amount of fertilizer used: as more fertilizer is applied, the resulting increase in crop production declines. Seed variety is perhaps the most important factor in changing farmers' practices with respect to fertilizer use. The introduction of high-yielding varieties of wheat in the early 1960s is probably the single factor most responsible for increased fertilizer in Nepal. Even now, relatively (and absolutely) little fertilizer is used on the rice and maize crops, which have a much smaller proportion of their area planted with high-yielding, fertilizer-responsive varieties.

Fertilizer demand is also related to the expected value of crop output, and thus it is directly related to farmers' expectations about the prices they will receive for their crops at harvest time. Since 1971/72 fertilizer prices have generally not risen faster than crop prices, and in many periods crop prices have risen considerably more than fertilizer prices. Thus, the relative economic benefit of using fertilizer has generally increased in the last 15 years. However, crop prices have been considerably more variable than fertilizer prices, which have remained constant for years at a time.

Aside from food crops, farmers also use fertilizer on vegetables and cash crops such as jute, sugarcane, and tobacco for which there is an assured market. Although this use is significant in some areas such as the Kathmandu Valley with well developed produce markets, in total it probably constitutes less than one-fifth of all fertilizer use. The ratio between foodgrain and fertilizer prices is the main economic factor influencing overall fertilizer use.

Fertilizer use is also related to farmers' expectations about the availability of water, which complements fertilizer and is necessary to achieve high yields from modern varieties of seed. The low use of fertilizer in Nepal is partly a reflection of the dependence on irregular monsoon rains and the lack of assured irrigation to supplement rainfall. However, given the low absolute levels of fertilizer use in Nepal, considerable production gains could be realized from increased fertilizer use even in the absence of more irrigation facilities.

HISTORY OF FERTILIZER PRICE POLICY

The price of fertilizer in Nepalese markets is currently determined by the Cabinet of Ministers of His Majesty's Government (HMG). The General Manager of the AIC can propose a price change to the AIC Board of Directors, and if the Board approves, the suggestion is forwarded to the Ministry of Agriculture. If the Ministry approves, the proposal goes to the full Cabinet for a final decision.

Before 1972, the selling price of fertilizer was based on AIC's import costs plus internal transportation costs. In 1972, the government established a uniform national price for fertilizer, and this uniform price policy is still in effect (Table 5). In general, this decision lowered fertilizer prices by not charging farmers the cost of transportation. Although fertilizer prices have been raised several times since 1972, the AIC continues to suffer losses averaging over Rs.100 million annually (Table 6). Sales prices do not cover the costs of importing fertilizer and transporting it to sales points, even though considerable fertilizer is received as aid grants.

The subsidy provided by AIC, HMG, and donor agencies varies from year to year and from one kind of fertilizer to another. While it is difficult to determine who contributes what to the overall subsidy, it is estimated that AIC and HMG have borne about half of the cost, and foreign donor agencies--including the World Bank and the Asian Development Bank--have borne the other half (Hill, 1982). HMG pays AIC to transport fertilizer to the hills, but this payment--now over Rs.18 million annually--does not even begin to cover transport costs. Other aspects of the subsidy are hidden because profits on grant-supplied fertilizer are used to offset losses on purchased fertilizer.

Current CIF (cost, insurance, and freight) Calcutta prices of urea and complex are Rs.2450 (US$115) and Rs.4150 (US$195) per mt, and transport to the Nepal border costs Rs.1030. Internal transport and marketing costs add Rs.1200, and interest on fertilizer loans costs Rs.450 per mt, so total real costs in Nepal are Rs.5130 and Rs.6830 per mt, or Rs.5.13 and Rs.6.83 per kg (AIC, FADINAP). Official selling prices in Nepal are now Rs.3.99 for both urea and complex, so current total subsidies are Rs.1.14 per kg for urea and Rs.2.84 per kg for complex. These are minimum estimates because Nepal also receives considerable fertilizer under tied-source arrangements at higher than world market prices.

The subsidy from the farmers' viewpoint is less: prices in India are now equal to Rs.3.78 per kg for urea and Rs.4.20 for complex (11). Thus, there is no effective subsidy for urea for a farmer whose alternative source is India, and only Rs.0.21 per kg subsidy for complex.

The actual subsidy on a bag of fertilizer sold in Nepal varies tremendously. Fertilizer sold in the Tarai is subsidized the least, and fertilizer sold in the hills, the most. Fertilizer which farmers buy from India and bring to Nepal on their backs or in bullock carts is not subsidized at all from Nepal's viewpoint, and fertilizer which Indians buy in Nepal is subsidized without any direct return to Nepal. The fertilizer subsidy has also often made it profitable to buy fertilizer in Nepal and smuggle it across the border for resale or use in India. Higher per kg subsidies are provided to farmers who live in the hills

where transport costs are higher, but the chief beneficiaries of the subsidy are farmers in the Kathmandu Valley who use the most fertilizer per household, and Indian traders who can profit from price differences.

Table 5. Fertilizer Prices (Rs/mt)

Year	21:0:0	46:0:0	20:20:0
1965/66	726		913
1966/67	693		913
1967/68	693	1313	913
1968/69	858	1400	913
1969/70	858	1400	1064
1970/71	850	1342	1057
1971/72	1000	1535	1557
1972/73	1000	1535	1557
1973/74	1658	2193	2214
1974/75	1658	2193	2214
1975/76	1870	2440	2270
1976/77	1870	2440	2270
1977/78	1870	2440	2270
1978/79	1870	2440	2270
1979/80	1870	2440	2270
1980/81	2400	3100	2800
1981/82	2400	3100	2800
1982/83	2400	3500	3250
1983/84	2400	3500	3250
1984/85	2400	3500	3250
1985/86	2400	3500	3250
1986/87	2850	3990	3990

Source: AIC.

Table 6. Agricultural Inputs Corporation Finances (Rs. million)

Fiscal Year	80/81	81/82	82/83	83/84	84/85	85/86 (target)
Sales	159.7	185.1	235.8	323.7	402.1	561.4
Cost of Sales	196.0	289.0	295.7	413.8	667.0	737.7
Profit	-36.3	-103.9	-59.9	-90.1	-264.9	-176.3
Net Fixed Assets	35.0	37.1	39.3	41.1	50.0	60.0
Current Assets	257.8	268.0	320.7	446.0	350.0	470.0
Current Liabilities	179.9	193.6	241.8	276.7	300.0	421.1
Transport Subsidy	9.5	11.2	15.2	15.2	18.5	20.0
Fertilizer Sales (000 mt)	54.0	56.4	73.7	86.9	100.1	129.0
Loss per mt (Rs)	-672	-1841	-813	-1037	-2646	-1367

Note: Although AIC sells seeds and pesticides as well as fertilizers, seeds and pesticides constitute a small fraction of sales, so the loss per mt calculation is only a slight overestimate.

Source: Ministry of Finance.

POLICY ALTERNATIVES

The issues with respect to the fertilizer price policy are simply stated, but resolving these issues involves difficult choices. Should fertilizer use be subsidized? If so, how much? Should the price be uniform throughout the country, or vary according to transport costs? Who should bear the subsidy costs--HMG, AIC, or foreign donor agencies? How should Nepal's fertilizer price policy be related to India's policy?

There are four general policy alternatives which the government may pursue with respect to the fertilizer price:

(a) import price and transport cost subsidy (current policy);
(b) import price subsidy only;
(c) transport cost subsidy only;
(d) no subsidy.

The current fertilizer price policy is designed to address both production efficiency and distribution equity goals. The low price, achieved through the import price subsidy, provides an incentive for farmers to use more fertilizer, thus increasing crop production. This policy is efficient if the total real cost of the additional fertilizer used is less than the value of the increased output. The uniform national price, achieved through the transport cost subsidy, is an attempt to provide benefits to hill farmers who are relatively disadvantaged and, perhaps more importantly, a recognition of the political power of Kathmandu farmers. This policy is equitable if hill farmers actually receive benefits comparable to farmers in other areas.

Any change from the current policy has both efficiency and equity implications. Removing the transport cost subsidy would force hill farmers to take real transport costs into their decisions about fertilizer use. This might reduce fertilizer use in the hills where transport costs are high, thus further disadvantaging poor farmers there. However, there may be better ways to achieve equity goals with respect to hill farmers--for example, increased crop production research focusing on rainfed areas could lead to improved technology choices for hill farmers, and improved transportation networks could both reduce the cost of fertilizer and increase access to markets generally.

Removing the import price subsidy would force all farmers to take the real cost of imported fertilizer into account in making fertilizer use decisions. Those farmers who are using fertilizer profitably would continue to do so, and farmers whose additional output is less than the cost of the fertilizer would reduce their use.

Reducing the import price or transport cost subsidy would save money for AIC and HMG, and AIC could import more fertilizer. Currently the more fertilizer AIC sells, the more money it loses, so there is little incentive to increase imports. Lack of timely availability is much more often a reason for not using fertilizer than high price, so reducing the subsidy may not decrease fertilizer use, especially if this is accompanied by increased fertilizer availability when farmers need it. Chemical fertilizer is still new for most Nepalese farmers, and as more farmers learn about the economic advantages of using fertilizer even at non-subsidized prices, demand will continue to increase.

Any fertilizer price policy which Nepal pursues must take into account current fertilizer prices in India. The long, open border means that significant price differences will result in fertilizer moving one way or the other across the border. This may be to Nepal's advantage if prices are higher in Nepal, but it may also lead to unsold stocks if the price difference is large. Lower prices in Nepal are a disadvantage, because fertilizer will move south across the border, and Nepal will effectively be subsidizing Indian agriculture. While there are no official statistics, informal estimates indicate that as much as 85 percent of some shipments of fertilizer intended for the Tarai have gone to India when fertilizer prices were higher there. A policy which keeps Indian prices as lower bounds on fertilizer prices in Nepal, and which responds quickly to changes in Indian prices, is probably necessary to insure that the benefits of Nepal's fertilizer policies are reaped by farmers in Nepal.

Politically, such a change in policy may be difficult to implement. The fertilizer price is currently a Cabinet-level decision made only after a recommendation by the General Manager of the Agricultural Inputs Corporation, approval by the AIC's Board of Directors, and subsequent approval by the Ministry of Agriculture. This is a long, slow process, which in the past has led to temporary suspension of operations by fertilizer sales points in the Tarai following significant price changes in India. An improvement of this decision process is needed, but the revision suggested above would be an explicit acknowledgment of India's economic dominance, and this may be politically impossible to implement.

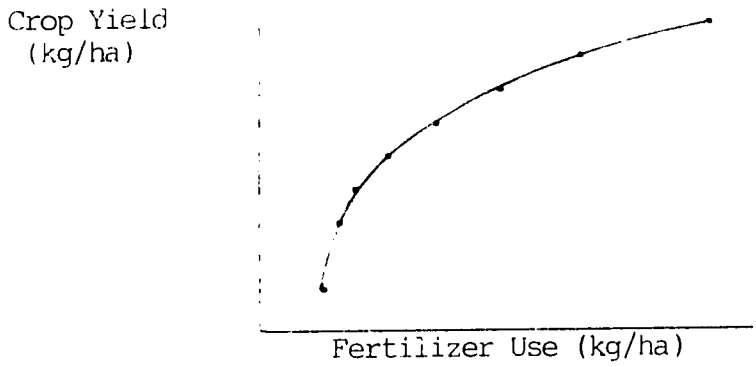
The above policy alternatives presume that the government of Nepal, through the Agricultural Inputs Corporation, will continue to be the main source of fertilizer supply for Nepalese farmers. There are other possible sources of fertilizer: for example, the private sector could be encouraged to import and distribute fertilizer, and the government's role could be reduced or even eliminated, as in Bangladesh. If the fertilizer subsidy were eliminated, the private sector should be eager to sell fertilizer in those areas where a profit can be made--that is, in the Tarai (where transport costs are low) and the Kathmandu Valley (where demand is high). The private sector might not be willing to supply fertilizer to the hills where demand is still low and transport costs are high. For equity reasons, the government could either continue to supply fertilizer to the hills, or pay the private sector to transport fertilizer to specified points in the hills.

The arguments for a significantly decreased government role in fertilizer procurement and distribution are conceptually powerful, but political considerations indicate that the private sector's formal role will remain limited in the near future. Until the price and transport subsidies are eliminated, the private sector will not be interested in fertilizer distribution, unless the government directly subsidizes private sector distributors. The government is unlikely to subsidize the private sector or to dismantle the existing Agricultural Inputs Corporation. Thus, it is likely that the government, through the Agricultural Inputs Corporation, will continue to be the main source of fertilizer supply for most of Nepal's farmers for the near future.

CONCEPTUAL ANALYSIS

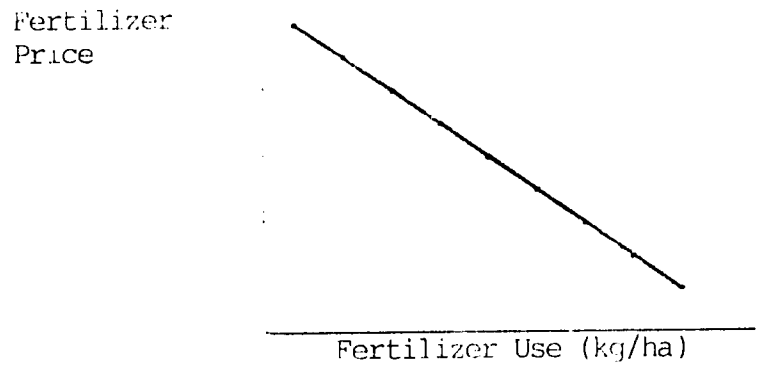
Farmers use fertilizer because it increases crop yields. The demand for fertilizer is thus a derived demand based on the relationship between the cost of fertilizer and the value of increased crop output. The economic term for the relation between inputs and outputs--in this case fertilizer and crops--is a production function. For fertilizer and crops, this is called the fertilizer-response ratio. This ratio is not constant--as more fertilizer is applied, the resulting increase in crop production declines. This is an example of the economic concept of decreasing returns to scale, graphically illustrated in Figure 1.

Figure 1. Crop Response to Fertilizer Application



The exact shape of the fertilizer-response curve depends on factors such as seed variety, soil type, rainfall, temperature, kind of fertilizer, and time of application. A farmer who wishes to maximize profits will, perhaps implicitly, use this information to decide how much fertilizer to use. Such a farmer will use fertilizer until the cost of the last kg of fertilizer is just equal to the benefit of the additional crop production which results. This farmer will adjust fertilizer use to the fertilizer price, as shown in Figure 2. As the price increases, the demand for fertilizer decreases. (See Appendix A.)

Figure 2. Fertilizer Demand



For each point on the production function (fertilizer-response curve), there is a corresponding point on the demand curve. That is, the fertilizer response curve shows how much additional output a farmer obtains from each additional unit of fertilizer used. The fertilizer demand curve shows how much the farmer would be willing to pay for each additional unit of fertilizer, or conversely, how much fertilizer a

farmer will buy at any given price. This description takes crop prices as given: as crop prices change, fertilizer demand also changes. An increase in crop prices will lead to an increase in fertilizer demand, and vice versa. The main point is: the fertilizer demand curve for profit-maximizing farmers who value their output at market prices can be directly and uniquely determined from the fertilizer response curve.

Just as additional output declines as more fertilizer is used, the response of fertilizer demand to changes in the fertilizer price also varies. This response--the price elasticity of fertilizer demand--can also be directly determined from the fertilizer-response curve. As more fertilizer is used, the additional crop output decreases, and changes in the fertilizer price have more effect on demand. That is, as fertilizer use increases, the price elasticity of demand also increases.

If all farmers had exactly the same production function, the same access to information about fertilizer use, and faced the same input and output prices, all farmers would use the same amounts of fertilizer per hectare for a given crop. However, this is not the case--some farmers have better soil and seeds than others, some know more about using fertilizer, and some face higher input or output prices.

This analysis assumes that all farmers in Nepal have the same production function. Actual variations will not affect the main points of this analysis of fertilizer price policy. (Equity issues arising from differences in production functions are best addressed by means other than fertilizer price policy.)

Two alternative assumptions will be used in this analysis: (1) differences in fertilizer use are explained by different access to information about fertilizer use; (2) differences in fertilizer use are explained by different fertilizer/crop price ratios.

Assumption (1). Differences in fertilizer use are explained by different access to information about fertilizer use: Kathmandu farmers have more experience with fertilizer use than Tarai and hill farmers. People living in Kathmandu are more educated and have greater access to information than people living elsewhere in Nepal. Most government and foreign aid project offices are in Kathmandu, and as a result Kathmandu is the main channel for obtaining and disseminating information. As the availability of commodities and use of new technology follow the dissemination of information, the use of fertilizer use has spread faster in Kathmandu than in the Tarai and hills.

The relative positions of Kathmandu, Tarai, and hill farmers are indicated in Figure 3. Because they are low on the fertilizer-response curve, hill farmers get a higher crop production response per unit of fertilizer applied than Tarai or Kathmandu farmers, but their yields are lowest because they use such little fertilizer. As their experience with fertilizer increases, hill farmers' demand will increase.

These positions on the fertilizer-response curve can be related to a fertilizer demand curve, as shown in Figure 4. Fertilizer use in the Tarai and the hills is relatively new, and almost certainly less than profit-maximizing optimal demand at the current price, so fertilizer use by hill and Tarai farmers probably lies well below the demand curve.

Figure 3. Crop Response to Fertilizer Application by Region

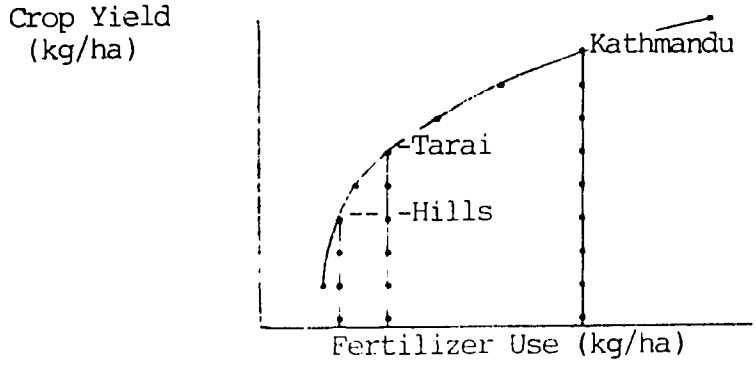
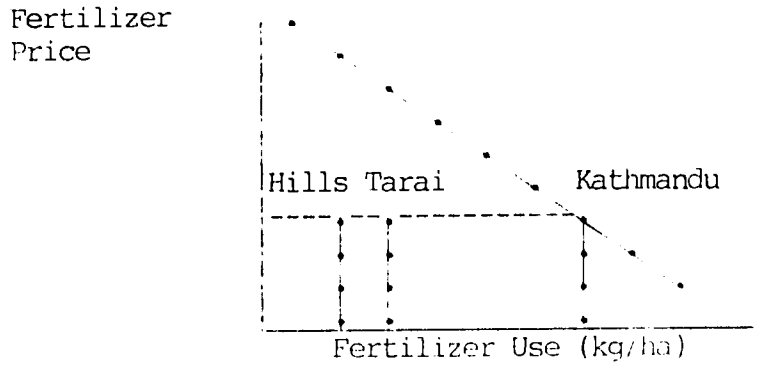


Figure 4. Fertilizer Demand by Region



The demand curve is derived by determining the amounts of fertilizer that a profit-maximizing farmer would use, based on the fertilizer-response curve and the price of fertilizer. Most hill and Tarai farmers are not using optimal amounts of fertilizer in the profit-maximizing sense, so they are shown below the demand curve. Their use will increase as they learn about the benefits of fertilizer use--as they acquire more information about the fertilizer-response curve.

A fertilizer price increase may thus not decrease fertilizer use in the hills and Tarai at all--it may only slow the growth of use in these areas. Tarai and hill farmers are increasing fertilizer use faster than Kathmandu farmers, and they may be simply catching up on the learning curve. However, a price increase may reduce use (or considerably slow the growth of use) by Kathmandu farmers who are already using optimal (or more nearly optimal) amounts of fertilizer. In economic terms, Kathmandu farmers' fertilizer demand is likely to be more price-elastic (more price-responsive) than demand by hill and Tarai farmers.

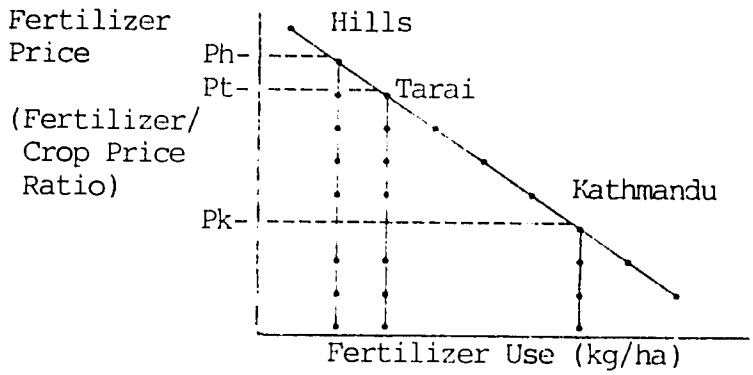
If this analysis is correct, an increase in the national fertilizer price will affect fertilizer use by Kathmandu farmers more than use by Tarai and hill farmers. The rate of growth of fertilizer use will slow more in the Kathmandu Valley than in the Tarai and the hills, though in all three areas fertilizer use is likely to continue to increase.

Assumption (2). Differences in fertilizer use are explained by different fertilizer/crop price ratios: Kathmandu farmers receive higher prices for their crops than Tarai farmers, while hill farmers often do not produce enough to sell. Also, despite the uniform national fertilizer price, hill farmers face higher fertilizer prices--in terms of greater transport and waiting costs, or higher costs of obtaining credit from institutional or informal sources--than other farmers.

Thus, Kathmandu farmers receive more benefits from fertilizer use than Tarai farmers because crop prices are higher, and they receive more benefits than hill farmers because fertilizer prices are lower. The net effect is that Kathmandu farmers face lower fertilizer/crop price ratios than hill and Tarai farmers, they thus receive greater benefits from fertilizer use, and as a result use more fertilizer.

The relative positions of Kathmandu, Tarai, and hill farmers on the fertilizer demand curve are indicated in Figure 5.

Figure 5. Fertilizer Demand by Region



Ph, Pt, Pk = hill, Tarai, and Kathmandu price ratios.

The effect of an increase in the national fertilizer price in this situation is best described with an example. For illustrative purposes let the price elasticity of fertilizer demand* be -0.5 for all of Nepal. If the national fertilizer price is doubled, Kathmandu farmers will cut their fertilizer use by half, because their fertilizer/crop price ratio has been doubled. Tarai farmers will cut their use by less than half unless the price in India is also doubled, because they can buy fertilizer from India by paying the extra transport cost, so a doubling of the Nepal fertilizer price will not double the fertilizer/crop price ratio for farmers who are willing to cross the border. Hill farmers will cut their fertilizer use by less than half because their fertilizer price is the sum of the national price plus the extra transport costs of obtaining fertilizer, and thus their fertilizer/crop price ratio is less than doubled when the national price is doubled.

---

*The price elasticity of demand is a measure of the response of demand to changes in price. Specifically, it is the percentage change in demand divided by the percentage change in price. If the price elasticity of demand is -0.5, a doubling of the fertilizer price (a 100 percent increase) will lead to a reduction of fertilizer demand by half (a 50 percent decrease).

The relative positions on the demand curve reinforce this conclusion: the price elasticity of demand for Kathmandu farmers is probably greater (in absolute value) than the price elasticity for Tarai or hill farmers. That is, Kathmandu farmers will respond more to price increases than will Tarai or hill farmers.

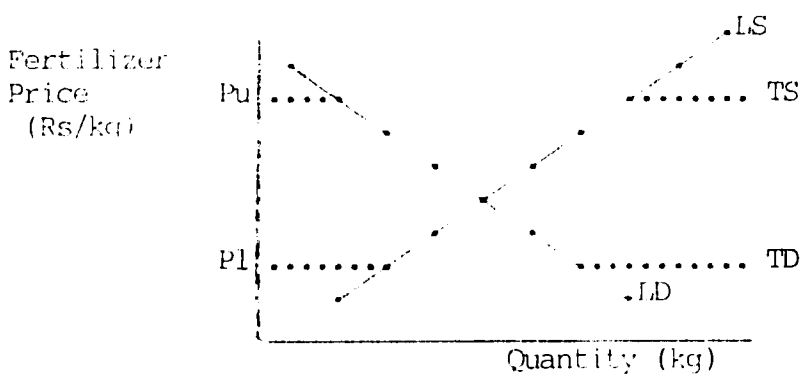
Thus, if the price is raised farmers in Kathmandu will reduce fertilizer use by more than farmers in the Tarai and the hills. This is the same result as obtained under Assumption (1).

Assumptions (1) and (2) are not mutually exclusive explanations of fertilizer use. In fact, the effects of different access to information and different fertilizer/crop price ratios reinforce each other: both lead to higher fertilizer consumption and greater response to fertilizer price changes (at current consumption levels) in Kathmandu than in the Tarai and the hills. While it is difficult to determine the relative importance of these two effects, both contribute to significant differences in fertilizer use.

<u>The Open Border.</u> Nepal's long, open border with India and the relative sizes of these countries' markets have implications for Nepal's fertilizer price policy. Nepal is like the flea on an elephant's back--no matter which way the flea turns, it will travel in the elephant's direction. Nepal cannot maintain a fertilizer price policy completely independent of India.

In the Indian states bordering Nepal--West Bengal, Bihar, and Uttar Pradesh--3.8 million mt of fertilizers were sold in 1983/84, compared to less than 0.1 million mt in Nepal (MAO GOI, 1984; FAI, 1985). Nepal can buy from or sell to the Indian market without affecting Indian prices. This usually insures that the Nepalese price of fertilizer is equal to the Indian border price plus or minus transportation and transaction costs, including taxes and trade regulations and bribes to border customs and inspection officials. As a result, Nepalese prices can be controlled with price policy instruments only within upper and lower bounds defined by transport and transaction costs (see Figure 6).

Figure 6. Fertilizer Demand and Supply



Pu = Indian price plus transport/transaction costs; import price
Pl = Indian price minus transport/transaction costs; export price
LS = Local supply (Nepal only); TS = Total supply (Nepal plus India)
LD = Local demand (Nepal only); TD = Total demand (Nepal plus India)

Above price Pu, fertilizer supply is elastic because villagers can bring as much as they want across the border from India at price Pu. Below price Pl, demand is elastic because Indian farmers and traders will buy all of Nepal's fertilizer. (Pu and Pl are not the same in all regions. Pu is highest in the hills and mountains, lowest in the Tarai, and in between these two in the Kathmandu Valley, while the opposite holds for Pl.)

Thus, there are both upper (Pu) and lower (Pl) bounds on Nepal's fertilizer prices. Below Pl demand from India swamps the market, and above Pu supply from India swamps the market. It is only for prices between Pl and Pu, where fertilizer is untraded and will not move north or south across the Indian border, that Nepalese price policy can be effective. The larger the size of the range between Pl and Pu, the greater the scope for price policy in Nepal. This range varies for different regions. It is virtually zero for the Tarai, moderate for the Kathmandu Valley, higher for the hills, and highest for the mountains.

Any attempt to use price policy instruments to move Nepalese fertilizer prices outside the range defined by Pl and Pu will lead to income transfers from the policy implementing agencies to the individuals who receive fertilizer. Individuals who receive sudsidized fertilizer can sell it at the Indian price and capture the difference as income. Even if beneficiaries of government policy do not actually resell goods at Indian prices, their real income will increase.

EMPIRICAL ANALYSIS

The main objective of a fertilizer subsidy is to increase crop production by reducing the cost of an important input. This should encourage farmers to use more fertilizer, thus increasing overall crop output. A subsidy is economically efficient if farmers are using less than optimal amounts of fertilizer and the subsidy provides an incentive for them to move them closer to the optimum. More specifically, a fertilizer subsidy is efficient if the total real cost of the additional fertilizer used is less than the value of the increased output.

Total fertilizer sales are now over 100,000 mt per year, with urea and complex each accounting for about half the total. Current official prices for urea and complex are both Rs.3.99 per kg, but actual costs are Rs.5.13 and Rs.6.83. Thus, the subsidy per kg is about one-third of actual cost, and total subsidy costs are more than Rs.185 million per year--over US$8 million at the official exchange rate. Although it is not in the national budget, this subsidy is more than one-fifth of the expenditure devoted to agriculture. Before the price increase in May 1986, the subsidy was estimated to cost Rs.330 million per year (Rising Nepal, July 31, 1986).

From a practical policy viewpoint, a subsidy is more effective the more elastic the demand for fertilizer, because a small subsidy will lead to a significant increase in fertilizer use and crop output. (In theory, a more general tax-and-subsidy policy might include efficient subsidies for goods whose demand was inelastic, but as a practical matter Nepal and most developing countries are not in a position to use tax policy to fine-tune and balance subsidy policy.) However, the price elasticity of demand for fertilizer in Nepal is probably low--at least

as calculated from changes in the announced official price. This low elasticity is one result of the currently low use rate and the limited supplies available at the official price.

Estimating the price elasticity of fertilizer demand from secondary data is not easy. Fertilizer prices and official import quantities are fixed by the government, so there is little or no variation in prices, and observed sold quantities probably lie below the true demand curve at the official price. The effects of year-to-year price variations on sales are difficult to distinguish from the effects of increased knowledge about and experience with fertilizer use.

An informal survey of 264 farmers using fertilizer on the 1983/84 wheat crop provided several useful results (see Appendix B). Demand for fertilizer does not change dramatically with changes in price--demand is relatively inelastic. Demand is more elastic in Kathmandu than in the Tarai and the hills, but the differences are not significant. Smaller farmers are more responsive to price changes than larger farmers.

Farmers reported a variety of problems with obtaining and using fertilizer, but one stood out: fertilizer is not available on time. Over a third of the farmers were unable to get fertilizer when they needed it. One tenth reported that lack of water was a problem, and one tenth reported both availability and water problems. One fourth had no difficulties obtaining or using fertilizer. The price of fertilizer is generally not perceived as a constraint to increased use: fewer than one sixteenth of the farmers interviewed indicated that cost was a problem.

These responses clearly show that availability is a much greater problem than cost. This indicates that farmers would be willing to pay more for fertilizer if it were available on time. The price elasticity estimates presented in Appendix B are thus probably overestimates--demand is probably less elastic than these estimates indicate.

Economic Calculations

At the farm level, the economics of fertilizer use are relatively simple. Fertilizer costs Rs.4.00 per kg. The most commonly used fertilizers, urea and complex, have 46 and 40 percent nutrient content, respectively. Yield-response ratios for paddy and wheat probably lie between 10 and 15. The value of these crops is Rs.2.00 or more per kg. Thus, a farmer who spends Rs.4.00 on one kg of fertilizer can expect a return of at least (.40)x(10)x(Rs.2) = Rs.8.00, and often a return of as much as (.46)x(15)x(Rs.3) = Rs.20.70, with an average return of about Rs.14.00, a 3.5:1 benefit-cost ratio.

This simple calculation, which has been verified many times on farmers' fields, indicates that even if the fertilizer price subsidy were completely eliminated and fertilizer sold for as much as Rs.7.00 per kg, farmers would still double their money on fertilizer investments. The fertilizer subsidy is not needed to make fertilizer use profitable. Indeed, subsidizing fertilizer may encourage unwise use, because farmers may use it when the return is more than the subsidized price but less than the real cost. The main point is worth repeating: a subsidy is not needed to make fertilizer use profitable.

If the subsidy were eliminated, revenues and costs would be equal, and there would be a total annual savings of over Rs.185 million. This money could be used to ensure that sufficient fertilizer is available on time where farmers need it or to make other improvements in the agricultural sector, such as supporting a substantially improved agricultural research program, or improving irrigation facilities.

The economic gains of eliminating the fertilizer subsidy depend on the price elasticity of demand for fertilizer, the yield-response ratio, and crop values. The above conceptual and empirical analyses indicate that price elasticity is probably low, so eliminating the subsidy will not lead to a substantial reduction in fertilizer use. Fertilizer yield-response ratios and crop values are high enough to make it profitable for farmers to use fertilizer even if the subsidy is eliminated, so the overall gains of eliminating this subsidy should be significant.

The Open Border

Another practical reason for eliminating the fertilizer subsidy is the open border. The possibility of moving agricultural commodities both ways across the Indian border in response to price differences has been discussed above. An examination of relative prices in Nepal and India gives an indication of how frequently moving fertilizer one way or the other has been profitable (Table 7). For urea, Nepalese prices have sometimes been higher and sometimes lower than in India. For complex, prices have usually been higher in India.

The quantity of fertilizer which can move south across the Indian border when prices are higher in India is illustrated by a comparison of AIC fertilizer sales statistics and fertilizer use statistics from the Central Bureau of Statistics (CBS). The fertilizer use statistics (Table 8) should be compared to sales statistics (Table 3) for 1980/81 (winter crops) and 1981/82 (summer crops). The comparison is striking: AIC's records indicate that at least 54,000 mt of fertilizer were sold, but CBS's records indicate that less than 15,000 mt of fertilizer were used on the five crops which dominate fertilizer use.

An examination of district-level data from CBS reveals that in all areas of the country reported use was less than reported sales. The largest discrepancies are for the Kathmandu Valley, which indicates that considerable fertilizer is purchased there for use elsewhere.

There are several possible explanations for this large discrepancy between fertilizer sales and use: the CBS sample of households may have been unrepresentative; CBS respondents may have under-estimated fertilizer use; farmers may purchase fertilizer and store it for later use; fertilizer may be used on crops not included in the CBS statistics; or fertilizer may have been purchased in Nepal and used in India.

The first three possible explanations are unlikely. First, CBS used a two-stage stratified random sampling procedure to select a sample of 33,000 households from a population of 2.6 million households. With such a large sample randomly selected, substantial sampling bias in the results is extremely unlikely. Second, there is no reason for respondents to consistently underestimate fertilizer use by nearly three-fourths--there is no potential benefit for doing so. Other studies of

non sampling bias in survey statistics in Nepal have shown large discrepancies between survey data and reality. However, as fertilizer is a purchased input--either for cash or credit--farmers should have better memories of fertilizer use than of other farm production statistics. Even if considerable memory bias is assumed (farmers were asked about fertilizer use during the preceding year), substantial differences remain between the CBS and AIC data.

Third, farmers are unlikely to buy more fertilizer than they need for the current crop season. Purchasing fertilizer diverts either cash or credit from other current consumption needs; and stored fertilizer can easily lose its nutrient value, particularly if it becomes wet.

Fertilizer is certainly used on other crops besides paddy, maize, wheat, sugarcane, and potato. However, these five crops cover over 85 percent of the total cropped area in Nepal, and total fertilizer use on vegetables, fruits, and cash crops such as jute and tobacco is unlikely to add substantially to the CBS statistics. (AIC estimates that over 80 percent of all fertilizer sold is used on paddy, wheat, and maize.)

This leaves the fifth explanation: fertilizer was purchased in Nepal and used in India. In the two fiscal years partially covered by the CBS survey, about half the fertilizer sold in Nepal was sold in the Tarai and half in the mountains, hills, and Kathmandu Valley (Table 4). However, even if fertilizer used on crops not included in the CBS survey and non sampling errors triple total fertilizer use (which is extremely unlikely), half the fertilizer sold in the Tarai would have to have been used in India to reconcile the AIC and CBS statistics.

The reason for moving fertilizer from Nepal to India is evident from an examination of fertilizer prices (Table 7). In early 1981, the urea price in India was IC Rs.2000 = NC Rs.2900/mt, while the price in Nepal was NC Rs.3100. On July 11, 1981 the price of urea in India was raised to IC Rs.2350 = NC Rs.3408/mt, while the price in Nepal remained at NC Rs.3100 until April 18, 1983. Similarly, in the beginning of 1981, the complex price in India was IC Rs.2050 = NC Rs.2973, while the price in Nepal was NC Rs.2800. In July the Indian price was raised to IC Rs.2400 = NC Rs.3380, while the Nepalese price remained at NC Rs.2800. Thus, for almost two years nearly ten percent profit could be made simply by moving urea fertilizer across the border, and over twenty percent could be made on complex. This situation changed in April 1983 when fertilizer prices in Nepal were raised.

Nepal faced the same problem in late 1985 and early 1986. As a result of the devaluation of the Nepalese Rupee on November 30, 1985 from IC Rs.100 = NC Rs.14[illegible] to IC Rs.[illegible] = NC Rs.170, the price of urea in India (IC Rs.2250) increased from NC Rs.3263 to NC Rs.3825, while the price in Nepal was NC Rs.3500. Similarly, the price of complex fertilizer in India increased from NC Rs.3625 to NC Rs.4250, while the price in Nepal was NC Rs.3250. This situation was remedied in May 1986 when both urea and complex prices in Nepal were raised to NC Rs.4200 (reduced in July 1986 to Rs.3990). In the meantime, however, fertilizer dealers and traders reaped profits by buying in Nepal and selling in India.

Table 7. Nepal-India Urea and Complex Fertilizer Price Ratios*

Year	Exchange IC/NC	NC Urea Price	IC Urea Price	Urea Ratio	NC Comp Price	IC Comp Price	Comp Ratio
1967/68	1.35	1313	840	1.16	913	NA	NA
1968/69	1.35	1400	860	1.21	913	NA	NA
1969/70	1.35	1400	943	1.10	1064	NA	NA
1970/71	1.35	1342	943	1.05	1057	938	0.83
1971/72	1.35	1535	923	1.23	1557	1035	1.11
1972/73	1.39	1535	997	1.11	1557	1187	0.94
1973/74	1.39	2193	1842	0.86	2214	1400	1.14
1974/75	1.39	2193	1888	0.84	2214	2283	0.70
1975/76	1.39	2440	1750	1.00	2270	2571	0.64
1976/77	1.39	2440	1600	1.10	2270	2013	0.81
1977/78	1.39	2440	1550	1.13	2270	NA	NA
1978/79	1.45	2440	1450	1.16	2270	NA	NA
1979/80	1.45	2440	1908	0.88	2270	1500	1.04
1980/81	1.45	3100	2263	0.94	2800	1958	0.99
1981/82	1.45	3100	2350	0.91	2800	2313	0.83
1982/83	1.45	3500	2350	1.03	3250	2400	0.93
1983/84	1.45	3500	2350	1.03	3250	2250	1.00
1984/85	1.45	3500	2183	1.11	3250	2200	1.02
1985/86	1.70	3500	2250	0.92	3250	2500	0.76
1986/87	1.68	3990	2250	1.06	3990	2500	0.95

*(Nepal price/India price)/(IC/NC); a ratio greater than one means fertilizer is more expensive in Nepal than in India.

Source: AIC for Nepal prices; Fertilizer Association of India for Indian prices. Annual averages for Indian data are used for comparison with Nepalese data.

Table 8. Fertilizer Use 1981/82 (kg)

Crop	Holdings		Chemical Fertilizer Use		
	Number	Area (ha)	Number	Area	Quantity
Paddy	1021730	1394123	163604	106696	6340482
Maize	838596	522469	43154	14330	1379428
Wheat	649510	389172	174445	64781	5377063
Sugarcane	60157	32512	8585	3899	945975
Potato	193185	67403	14787	2211	196658
Total	2763178	2405679	404575	191917	14239606

Note: Fertilizer sales statistics (Table 2) are compiled by AIC for Nepal's fiscal year (July 16 to July 15), while fertilizer use statistics (Table 8) were recorded by CBS for the reference period of the National Sample Census of Agriculture 1981/82 (January 14, 1981 to January 13, 1982). Both statistics report gross fertilizer weight, not net nutrient content.

Source: CBS, Sample Census of Agriculture 1981/82.

POLICY IMPLICATIONS

The conceptual and empirical analyses both indicate that farmers in the Tarai, hills, and Kathmandu Valley will respond differently to an increase in the fertilizer price. Tarai farmers--who use little fertilizer, obtain a high crop-response ratio, have some experience and relatively easy access to information about fertilizer, and have an alternative source of fertilizer in India--will decrease their use little if any if the price increases. Hill farmers--who use little fertilizer, obtain a high crop-response ratio, have little experience and difficult access to information, and have transport costs on top of the official price--may decrease their use if the price is increased. Kathmandu farmers--who use much fertilizer, obtain a lower crop-response ratio, have both experience and access to information--will respond more like profit-maximizers and decrease their use if the price is raised.

An increase in the fertilizer price will least affect the Tarai, where the most productive cropland is; it will have some effect in the hills, where the poorest people live; and it will have most effect in Kathmandu, where the most political power is. To improve the decision-making process with respect to agricultural policy, these effects should be explicitly recognized.

For financial and economic efficiency reasons, the fertilizer subsidy should be reduced and eventually be eliminated--otherwise farmers may use fertilizer unwisely, and subsidy costs may become unmanageable. This reduction can be achieved by decreasing the import price subsidy, the transport cost subsidy, or both.

For political reasons, it may be difficult to eliminate the transport subsidy. If this subsidy is retained, it should be recognized as an investment in transport services like building a road, and should be phased out as better transport becomes available. If this transport subsidy is maintained for the purpose of benefitting farmers in the hills and mountains, the government should allocate funds for transport consistent with fertilizer demand in those areas.

The import price subsidy should gradually be reduced. The price of fertilizer in Nepal should be kept a little above the price in India. A policy which maintains the Nepal price at least ten percent above the Indian price should discourage the informal export of fertilizer from the Tarai to the bordering states of India. A policy which allows for quick responses to changes in Indian prices is needed.

One useful role for the Nepalese government would be to negotiate with the Indian government to eliminate the ban on fertilizer exports from India to Nepal. Nepal could then take advantage of relative fluctuations in Indian and world fertilizer prices, importing from India when prices are lower there. Many problems now associated with obtaining fertilizer from overseas sources and shipping it through Calcutta would also be eliminated if fertilizer were purchased directly from India.

A reduction in the fertilizer subsidy will benefit HMG and AIC because their costs will be less. Farmers--for whom the value of increased output exceeds the cost of increased fertilizer use--will benefit if AIC's decreased losses lead to an improvement in timely fertil-

izer availability. Equity goals with respect to farmers in the mountains and hills can be achieved by maintaining the transport subsidy (that is, selling fertilizer at a uniform national price), and by using the gains from eliminating the fertilizer subsidy for other purposes--for example, increased crop production research focusing on rainfed areas could lead to improved technology choices for hill farmers, and improved transportation networks could both reduce the cost of fertilizer and increase access to markets generally.

Summing Up

Nepal's fertilizer price policy fertilizer has not achieved its officially stated objective. Subsidized fertilizer, intended to increase crop output, has been provided in such small quantities that there has been little overall impact on food production.

The scope for increasing the impact of this policy is limited. Financial constraints limit the ability of the government to transport substantial quantities of fertilizer into the hills and mountains, and political considerations insure that Kathmandu Valley residents receive preference. Even if financial constraints did not limit the government's ability to subsidize fertilizer prices, the long open border with India effectively prevents Nepal from implementing an independent price policy for fertilizer.

The main issue facing the Nepalese government is thus to recognize the constraints on fertilizer price policies, and to avoid policies which cannot be implemented in the face of these constraints. Fertilizer subsidies can be maintained only within the range determined by market prices and transport costs from India. Political considerations may tempt government officials to ignore these constraints for short-term gains, but economic factors are almost certain to dominate in the long run.

APPENDIX A: Economic Theory

A profit-maximizing farmer will use fertilizer on a crop until the cost of the last unit of fertilizer used is equal to the value of the crop produced by that fertilizer. As fertilizer and other inputs are subject to diminishing returns, there is a point beyond which more fertilizer will not increase production on a given plot of land. This yield-response relationship is easily illustrated with a quadratic production function:

$$Y = a + bX - X^2$$

where Y is crop output, X is the amount of fertilizer used, and a and b define the yield-response relationship.

Substituting this production relation into the farmer's profit function gives:

$$R = PyY - PxX,$$

where R is profit, Py is the crop price, and Px is the fertilizer price. Differentiating with respect to X gives the demand function for fertilizer in terms of fertilizer and crop prices:

$$X = (b - (Px/Py))/2.$$

This equation shows that the ratio of the fertilizer and crop prices (Px/Py) is important, not their absolute levels.

Most importantly, this analysis shows that the derived demand for fertilizer can be directly determined from the production function (that is, from the fertilizer-response relationship) and from crop and fertilizer prices. It also shows the nature of the relationships between fertilizer demand and crop and fertilizer prices. Fertilizer demand is postively related to crop prices and negatively related to fertilizer prices: the demand for fertilizer increases as either crop prices increase or fertilizer prices decrease.

APPENDIX B: Survey Results

Primary data were obtained from 264 farmers using fertilizer on the 1983/84 wheat crop. Data were collected during this wheat season, and do not reflect total use of fertilizer on wheat for all farmers interviewed. Some farmers had not applied a top dressing to wheat when the survey was conducted. Farmers were interviewed as available when researchers were in the field, so care must be taken in generalizing the results. Cultivated areas and fertilizer use rates should be examined to insure comparability of the survey sample and other populations.

Farmers were asked how much land was devoted to wheat cultivation, how much of this was fertilized, and where they obtained fertilizer. Quantities used and prices paid for fertilizer were recorded. To elicit information about the price elasticity of fertilizer demand, farmers were asked how much they would buy if prices were raised or lowered. Farmers were also asked about problems in obtaining or using fertilizer.

Farmers were using four kinds of fertilizer on wheat--urea (46:0:0), complex (20:20:0), DAP (18:46:0), and potash (0:0:60). Urea was used by over four-fifths of the farmers, complex and DAP by fewer than one-third, and potash by fewer than one-fifth (see Tables B-1 and B-2). This Appendix presents the analysis of data for urea and complex, for which sufficient data is available for comparative purposes.

Farmers reported a variety of problems with obtaining and using fertilizer, but one stood out: fertilizer was not available on time (see Table B-3). Over one-third (93) of the farmers indicated that they were unable to get fertilizer when they needed it. Just over one-tenth (28) reported that lack of water was a problem connected with fertilizer use, and just under one-tenth (25) reported both availability and water problems. Over one-fourth (70) indicated that they had no difficulties obtaining or using fertilizer. A surprisingly small number--fewer than one-sixteenth (16)--indicated that fertilizer cost was a problem, and only eight farmers said that cost was their only fertilizer problem.

Price elasticities of demand for urea and complex fertilizer were calculated for price increases of approximately twenty-five percent, with round number (whole or half-rupee) prices used to simplify questions (see Table B-4). In interpreting these results, it must be noted that fertilizer quantities related to hypothetical price changes are farmers' predictions, not farmers' observed behavior: what farmers say they will do if the fertilizer prices rise may or may not be what actually occur if these prices actually increase.

Several results stand out among the calculations. Total demand for fertilizer generally does not change dramatically with changes in price--demand is relatively inelastic. Demand is most elastic in the Kathmandu Valley and least elastic in the Tarai, but differences among areas are not statistically significant. Smaller farmers are usually more responsive to price changes than larger farmers--the quantity-weighted calculations indicate less elastic demand than unweighted calculations.

The standard deviations of these price elasticity estimates indicate that these estimates are not very precise. However, the quantity-weighted calculations show that overall demand for fertilizer is generally inelastic (the estimated elasticities are between -1.00 and 0.00). Thus, these data indicate that a 25 percent rise in the fertilizer price would result in less than a 25 percent fall in fertilizer demand. Nearly half of the farmers indicated that their fertilizer purchases would not decrease at all if prices rose, and fewer than five percent indicated that they would not buy fertilizer at all.

Table B-1. Survey Results--Fertilizer Users

	Tarai				Hills	Kathmandu Valley			
District	MORA	DHAN	CHIT	RUPA	SALL	BHAK	LALI	KATH	Total
Urea	31	31	34	31	23	31	22	37	240
Complex	27	30	0	1	22	11	6	2	99
DAP	0	0	38	35	0	4	0	3	80
Potash	11	23	13	2	0	0	0	0	49
Total	31	33	39	40	30	31	23	37	264

MORA=Morang; DHAN=Dhanusha; CHIT=Chitwan; RUPA=Rupandehi;
SALL=Sallyan; BHAK=Bhaktapur; LALI=Lalitpur; KATH=Kathmandu.

Table B-2. Survey Results--Fertilizer Use

	Tarai				Hills	Kathmandu Valley		
District	MORA	DHAN	CHIT	RUPA	SALL	BHAK	LALI	KATH
WAFU	29.9	20.9	8.1	24.7	10.1	4.0	4.7	3.6
	(44.9)	(17.7)	(7.4)	(34.7)	(8.7)	(2.2)	(2.4)	(2.2)
UREQ	92.4	38.9	36.6	90.1	36.7	55.1	46.2	41.8
	(200.8)	(32.8)	(37.9)	(197.8)	(36.6)	(29.5)	(31.1)	(28.4)
UREP	3.5	3.6	3.6	3.5	3.5	3.6	3.5	3.5
	(0.0)	(0.0)	(0.0)	(0.1)	(0.0)	(0.0)	(0.0)	(0.0)
WAFC	31.9	21.4	--	120.0	11.9	5.7	5.3	2.5
	(47.5)	(17.7)	--	(0.0)	(8.2)	(2.4)	(2.6)	(0.0)
COMQ	156.4	97.7	--	900.0	70.2	33.5	30.0	17.5
	(256.9)	(91.8)	--	(0.0)	(70.9)	(20.5)	(19.7)	(3.5)
COMP	3.3	3.5	--	3.3	3.2	3.3	3.3	3.4
	(0.1)	(0.1)	--	(0.0)	(0.1)	(0.0)	(0.0)	(0.1)

WAFU, WAFC = wheat area fertilized with urea or complex (kattas in Tarai, ropanis in Kathmandu Valley and hills);
UREQ, COMQ = quantity of urea or complex used (kg);
UREP, COMP = price of urea or complex (Rs./kg).
Unweighted means; standard deviations in parentheses.

Table B-3. Survey Results--Farmers with Problems in Fertilizer Use

	Tarai				Hills	Kathmandu Valley			Total
	MORA	DHAN	CHIT	RUPA	SALL	BHAK	LALI	KATH	
None	3	9	21	7	6	12	3	9	70
Time (T)	7	9	14	16	12	12	8	15	93
Water (W)	2	5	1	1	0	6	3	10	28
T & W	13	8	0	1	1	0	0	1	25
Cost (C)	0	1	1	0	2	1	2	1	8
T & C	0	0	0	6	1	0	0	0	7
T & W & C	0	0	0	1	0	0	0	0	1
Other	6	1	2	8	8	0	7	1	32
Total	31	33	39	40	30	31	23	37	264

None = no problems obtaining or using fertilizer; Time = fertilizer not available on time; Cost = fertilizer too expensive; Other = other problems.

Table B-4. Price Elasticity of Fertilizer Demand

	Tarai				Hills	Kathmandu Valley		
	MORA	DHAN	CHIT	RUPA	SALL	BHAK	LALI	KATH
Urea N	31	31	34	31	23	31	22	37
UPRE	-1.4	-1.9	-0.6	-1.3	-1.5	-2.0	-1.6	-1.4
	(1.6)	(2.7)	(1.6)	(1.9)	(1.3)	(1.9)	(1.6)	(1.5)
UPREW	-0.4	-1.0	-0.4	-0.5	-1.2	-1.7	-1.1	-1.3
UPRE0	12	14	26	17	7	12	10	18
UPRQ0	1	2	1	2	0	0	0	0
Complex N	27	30	0	1	22	11	6	2
CPRE	-0.5	-0.7	--	0.0	-0.9	-0.3	-0.8	-0.8
	(0.6)	(1.0)	--	(0.0)	(0.7)	(0.4)	(1.1)	(0.1)
CPREW	-0.3	-0.6	--	0.0	-0.6	-0.6	-0.9	-1.5
CPRE0	10	16	--	1	4	6	3	0
CPRQ0	1	2	--	0	0	0	1	0

Urea N, Complex N = number of farmers using urea or complex;
UPRE, CPRE = price rise elasticity of demand for urea (unweighted average across farmers);
UPREW, CPREW = weighted price rise elasticity of demand for urea (weighted by fertilizer quantities);
UPRE0, CPRE0 = number of farmers for whom UPRE or CPRE = 0--whose fertilizer use will not change if the price rises;
UPRQ0, CPRQ0 = number of farmers who will not buy any urea or complex if the price rises.
Means; standard deviations in parentheses.

REFERENCES

Agriculture Inputs Corporation (AIC) (1983), Basic Statistics of Agricultural Inputs in Nepal, Kathmandu, Nepal.

AIC, unpublished statistics.

Agricultural Projects Services Centre (APROSC) (1978), Evaluation Study of Agricultural Inputs and Credit Services in Nepal, June. Kathmandu, Nepal.

Central Bureau of Statistics (CBS) (1985), National Sample Census of Agriculture 1981/82, Kathmandu, Nepal.

Department of Food and Agricultural Marketing Services (DFAMS) (1983), Agricultural Statistics of Nepal, Kathmandu, Nepal.

Fertilizer Advisory, Development and Information Network for Asia and the Pacific (FADINAP), "Fertilizer Trade Information," various issues, Bangkok Thailand.

FADINAP (1984), "Agro-Chemical News in Brief," September, Bangkok, Thailand.

Fertiliser Association of India (FAI) (1985), Fertiliser Statistics 1984-85, November, New Delhi, India.

John M. Hill (1982), "A Fertilizer Strategy for Nepal," manuscript.

Owen M. Kupferschmid (1983), "Fertilizer Use in Nepal: Problems and Policy Responses," manuscript.

"Govt. Decides to Reduce Fertilizer Price by 5%," Rising Nepal, July 31, 1986.

Ministry of Agriculture, Government of India (MOA GOI) (1984), Bulletin on Food Statistics, 1982-84, Directorate of Economics and Statistics, New Delhi, India.

Thakur N. Pant (1984), "Fertilizer Price, Subsidy and Promotion Policies in Nepal," paper presented at the National Workshop on Fertilizer Use and Marketing in Nepal, 1-3 March, Kathmandu, Nepal.

Papers in this Series:

1. Krishna B. Hamal and Mukti Upadhyay, "Rural Savings Mobilization in Nepal," November 1986.

2. Ramrajya L. Shrestha, "Socioeconomic Factors Leading to Deforestation in Nepal," November 1986.

3. Manohar Sharma, "Factors Affecting the Tarai Paddy Market: Pricing Policy Implications," November 1986.

4. Prakash Raj Sapkota, "Crop Productivity in Nepal: Spatial and Temporal Dimensions," November 1986.

5. Tilak Rawal, "Transport Cost Minimization for Nepal's Subsidized Foodgrain Program: A Proposed Model," November 1986.

6. Michael B. Wallace, "Fertilizer Price Policy in Nepal," November 1986.

Winrock International Institute for Agricultural Development was established in 1985 through the merging of the Agricultural Development Council (A/D/C), the International Agricultural Development Service (IADS), and the Winrock International Livestock Research and Training Center. Winrock International's mission is to improve agriculture for the benefit of people--to help increase the productivity, improve the nutrition, and advance the well-being of men, women, and children throughout the world. Winrock International's main areas of emphasis are human resources, renewable resources, food policy, animal agriculture and farming systems, and agricultural research and extension.

Winrock International Institute
for Agricultural Development

Route 3, Petit Jean Mtn.
Morrilton, AR 72110-9537
U.S.A.

P.O. Box 1312
Kathmandu
Nepal