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THE DEMAND FOR NITROGEN, PHOSPHORUS AND POTASH FERTILIZER NUTRIENTS IN PAKISTAN

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Abstract. This study has been conducted to find out the factors which have been affecting demand for fertilizer as specified equations for nitrogen, phosphorus and potash, are estimated by using both the static as well as the dynamic models. The results are acceptable from both an economic and statistical point of view. The estimated price elasticity of demand demonstrates variations between the nutrients. The Cobb-Douglas production function has been applied to the analysis and Ordinary Least Square in double log form was used for estimation. The results suggest that the demand for nitrogen and phosphorous are price inelastic both in the short run as well as in the long run while for potash fertilizer, the elasticity of demand is price elastic both in the short run and in the long run. Future shift in fertilizer demand will be dependent on the reduction in the relative price of fertilizer. It indicates either increase in agricultural commodity price or decrease in fertilizer price.

I. INTRODUCTION

Fertilizers constitute a key component of the modern farm technology for achieving increased production through improving soil fertility. The introduction of the high yielding cereal varieties in 1966-67, having higher nutrient requirements, ushered in the 'fertilizer era' in Pakistan and set the stage for 'green revolution'. Prior to this, the use of fertilizer was nominal

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(NFDC, 1996). Application of commercial fertilizers in Pakistan began in 1952-53, and the off-take was only 1,000 nutrient tonnes of nitrogen. Phosphorus was introduced to farmers in 1959-60 with an initial usage of 100 nutrient tonnes. Potash fertilizer off-take started in 1966-67 with a volume of 120 nutrient tonnes. These trends in fertilizer usage emphasized the importance and role of fertilizer in the economy of Pakistan. There has been a continuous rise in the consumption of fertilizers. During the year 2000-01 total fertilizer sales were 2966,000 nutrients tonnes, augmented by 851 percent from 312,000 nutrient tonnes sold in 1969-70 (Table 1). The major increase was for nitrogen, which increased by 822 percent, *i.e.* from 274,000 nutrients tonnes to 2526 (000) nutrient tonnes. Nitrogenous fertilizers now account for 78 percent of commercial fertilizer off-take in Pakistan with phosphorous and potash accounting for 21 and about 0.7 percent, respectively.

TABLE 1

Fertilizer Nutrients Off-take in the Selected Years in Pakistan

Year	Nitrogen (N)	Phosphorous (P_2O_5)	Potash (K_2O)	Total
1952-53	1.00	0.0	0.00	1.00
1959-60	19.30	0.1	0.00	19.40
1966-67	112.76	3.9	0.12	116.80
1969-70	273.95	36.64	1.34	311.93
1979-80	805.99	228.46	9.60	1044.05
1990-91	1471.64	388.50	32.76	1892.90
2000-01	2265.58	677.58	22.87	2966.03
2003-04	2526.73	673.46	21.79	3221.98

Source: *Fertilizers and Their Use in Pakistan*, NFDC Publication, 3/96.
Economic Survey of Pakistan 2004-05.

Analysis of fertilizer demand on type basis may help to take proper decisions regarding their distribution. This paper is an attempt to alleviate this situation by presenting the empirical results of the aggregate demand for nitrogen (N), phosphorus (P), and potash (K), for macro plant nutrients as well as the combined demand for NPK.

FERTILIZER DEMAND

The demand for input is a derived demand and it is determined by the underlying demand for the final product being produced by the technical characteristics of the production function. Fertilizer is one of the inputs used in crop production. In the given study Cobb Douglas has been used as production function and demand for fertilizer has been derived via profit function. This study focuses on previous studies of the fertilizer demand and outlines the theoretical framework and models specification.

PREVIOUS STUDIES

This section presents a summary of previous studies of the demand for fertilizer and discusses the model used for the analysis. Griliches (1958) estimated aggregate demand functions for fertilizer used on all crops in the Unite States and verified for the period from 1911 to 1956 that most of the increase in fertilizer use could be explained by changes in fertilizer and crops prices and by the previous period's fertilizer use. During 1959 regional demand functions for total fertilizer consumption over the period from 1931 to 1956 was estimated. He estimated a large portion of the variation in regional fertilizer use and concluded that price elasticities of demand varied across regions. Gunjal, Roberts and Heady (1980) estimated fertilizer demand function for five major crops. It was observed that elasticities of demand with respect to prices and other explanatory variables were not similar for fertilizer applied to different crops. Carman (1979) disaggregated fertilizer use by major nutrients (NPK) and estimated nutrient demand function for 11 Western States. The estimated price elasticity of demand demonstrated considerable variation between states and nutrients.

The price elasticities of demand for phosphatic and nitrogenous fertilizer for Australia were estimated by Penm and Vicent (1987). They estimated that phosphoric fertilizer's price elasticity of demand is low both in the short run and long run, while the price elasticity of demand for nitrogenous fertilizers appeared higher, especially in case of application to wheat. Variations in fertilizer prices appeared to be relatively unimportant in explaining variations in application rate for both phosphatic and nitrogenous fertilizers.

Mahmood (1995) studied to estimate fertilizer demand function for Bangladesh typewise (Urea, TSP and MOP). He used Cobb-Douglas production function and, estimation was done using OLS in double log form. It was found that price of Urea does not play a significant role in determining its demand but prices of TSP and MOP are important for the determination of demand function and these demands are price elastic. Non-price factors are also important as demand factors, and fertilizer demand in all the three types has seasonal variation.

Subramaniyan and Nirmala (1991) made a macro analysis of fertilizer demand in India for the period between 1966-67 to 1985-86, the short-run price elasticity for fertilizer was –1.3 and the adjustment coefficient was 0.84. The long-run price elasticity for fertilizer demand worked out to be –1.54, indicating that the demand for fertilizer is price elastic. Timmer (1974) found considerable differences in the estimates of the elasticity in the short run and long run. Choudhry and Javed (1976) studied nitrogenous fertilizer demand in nutrient form for the period 1965-66 to 1973-74 and concluded that the demand for fertilizer is price responsive. Salam (1977) estimated fertilizer demand in the Punjab and used demand for fertilizer as a function of relative price, lagged output price, tube-wells number, acreage and trend etc., and found that relative price of fertilizer and increased acreage under major crops were important factors in fertilizer demand. Chemonics (1985) estimated nitrogen and phosphorous fertilizers demand for the period 1968-69 to 1983-84.

Dholakia and Jagdip (1995) derived the fertilizer demand function in India and they estimated short-run and long-run price elasticity. They found that fertilizer demand in India is price inelastic both in the short-run and in the long-run.

Hansen (2004) estimates nitrogen fertilizer demand elasticities for Danish crop farms using the dual profit function approach on micro panel data. The model includes several farm specific parameters, allowing to estimate the mean demand elasticity and test for homogeneity of elasticities across panel farms. The mean own price elasticity for nitrogen is –0.45, and there is a significant standard deviation from this mean for individual farms of 0.24.

THEORETICAL FRAMEWORK AND MODEL SPECIFICATION

The purpose of this paper is to estimate three nutrient demand functions from time series data and to find out policy implications from the estimated elasticities of demand. In this regard, separate major plant nutrients demand functions are estimated for nitrogen (N), phosphorus (P) and potash (K), using static and dynamic models. The analysis is based on time series data from 1970-71 to 2000-01. The sources of the data for this study are *Economic Survey* (various issues) and *Fifty Years of Pakistan in Statistics* as well as National Fertilizer Development Center (NFDC) reports. The data on all variables are given in Appendix I.

This paper is organized as fallows: Section II deals with model specification (Static and Dynamic) and estimation. Section III discusses empirical application and results and, finally, section IV presents concluding remarks.

II. MODEL SPECIFICATION AND ESTIMATION

STATIC MODEL

The demand for inputs such as fertilizer is usually a derived demand. Thus the demand for fertilizer can be derived from a given aggregate production function for the agricultural commodities. In economic theory, the utilization of any input like fertilizer, depends upon the profit maximization conditions and the production, *i.e.* technology adoption. Assuming Cobb-Douglus production function with two inputs, the following profit function has been considered.

$$Y = A F^{\alpha} L^{\beta} \mu_0 \qquad \text{Production function} \qquad (i)$$

$$\Pi = P_1 Y - P_2 F - P_3 L \qquad \text{Profit Identity} \qquad (ii)$$

Where Y = Output

F = Fertilizer

L = Labor

Π = Profit

P_1 = Output Price

P_2 = Fertilizer Price

P_3 = Labor Price or any other input price

By using profit maximization conditions $\frac{\partial \Pi}{\partial F}$ and $\frac{\partial \Pi}{\partial L}$

$$\frac{Y}{F} = \frac{P_2}{\alpha P_1 \cdot \mu_1} \qquad (iii)$$

$$\frac{Y}{L} = \frac{P_3}{\beta P_1 \cdot \mu_2} \qquad (iv)$$

In the above relation, μ_1 and μ_2 are random terms. Expressing (*i*), (*iii*) and (*iv*) in logarithmic form and solving for *F*, the narration obtained is:

$$\log F = \frac{\log A + \log\left(\frac{P_2}{\alpha P_1}\right)(\beta - 1) + \beta \log(\mu_1 - \mu_2) - \log \frac{P3}{P_1} + \log \mu_0 - \log \mu_1}{1 - \alpha - \beta} \qquad (v)$$

Relation (*v*) indicates that any demand function for fertilizer must incorporate product price, price of fertilizer and other input technological shift and random distribution term. Based on this, the demand function for fertilizer in the present study has been specified using double log form as:

$$\ln Qi = b_0 + b_1 \log (P_f/P_c) + b_2 \log HYV + b_3 \log W + b_4 \log Y_{t-1} + b_5 \log T + b_6 \ln A + \mu$$

Qi	=	Plant nutrient off-take (*i* = N is nitrogen, P is phosphorus and K is potash)
P_f/P_c	=	Ratio of fertilizer price index to 5 major crops price index
Y_{t-1}	=	Farm income in year t–1 from major and minor crops
HYV	=	Area under high yielding varieties in million hectare
W	=	Water available at farm-gate MAF
A	=	Area under principal crops in million hectare
T	=	Trend variable

THE DYNAMIC MODEL

The dynamic model considers that the process of adjustment in the independent variables is generally based on the relationship between the expected and the actual values of the variables, but in the dependent variables, it is generally the relationship between the desired versus realized quantities that provide the basis of the adjustment process. The Nerlovian Adjustment Model used by Griliches and many subsequent researchers seems to capture some of the dynamic elements in fertilizer demand better than simple static models without merely resorting to time trends. The model itself is straightforward. Thus we use the partial adjustment with adoptive expectations model for deriving the short-run and long-run elasticities of fertilizer demand. The model is specified as under:

$$C^*_{f\,t} = \beta_0 + \beta_1 P_{ft} + \mu_t \qquad (vi)$$

$$(C_{ft} - C_{ft-1}) = \delta (C^*_{f\,t} - C_{ft-1}) \qquad (vii)$$

Equations (*vi*) and (*vii*) yield the estimating equation.

$$C_{ft} = \beta_0 \delta + \beta_1 \delta P_{ft} + (1 - \delta) C_{ft-1} + \delta \mu_t \qquad (viii)$$

C_{ft} = Actual consumption of fertilizer,

$C^*_{f\,t}$ = Desired consumption of fertilizer in the long-run,

P_{ft} = Fertilizer price index relative to price index of five major crops,

δ = Adjustment coefficient ($0 \le \delta \le 1$), and

μ_t = Random disturbance term

Since the variables are in logarithms, the short-run elasticity of demand for fertilizer with respect to relative price is given by the estimate of $\beta_1 \delta$ and the long-run elasticity is given by $\beta_1 = \beta_1 \delta / 1 - (1 - \delta)$.

III. EMPIRICAL APPLICATION AND RESULTS

RESULTS OF THE STATIC MODEL

The results of the static model are presented in Table 2. All the explanatory variables used in the model are statistically significant as well as signs are as expected. The demands for Nitrogenous fertilizer (N), Phosphorus fertilizer (P_2O_5) and Potash fertilizer (K_2O) are estimated separately.

Nitrogen

The estimated coefficients for the nitrogen demand equations are shown in Table 2. The results are acceptable from both economic theory and statistical viewpoint. The signs on all of the coefficients are as hypothesized and the coefficients are significant at 99 percent level of confidence. The multiple correlation coefficient R^2 indicates the variables included and explains 94 percent of the variation in the off-take of nitrogen. The Durbin-Watson statistic indicate '*d*' as 1.50. From the Durbin-Watson tables it is found that at the 5% level the critical '*d*' values are $d_L = 1.297$ and $d_u = 1.570$. On the basis of the usual '*d*' test it is impertinent to say whether there is positive correlation or not because the estimated '*d*' value lies in the indecisive range. But on the basis of modified '*d*' test the hypothesis of no (first-order) positive correlation can be rejected as $d < d_u$.

The coefficient for the real price index of nitrogen is –0.42 and t-statistics is statistically significant at 99% confidence level. As the equation is estimated in linear logarithms, the coefficients can be interpreted as elasticities. The results indicate that the demand for nitrogen is price inelastic. The trend variable has the positive impact on nitrogen sales in the equation and the coefficient is significant at 99% level of significance.

TABLE 2

Regression Coefficients and Related Statistics for Nitrogen Fertilizer, Phosphorus Fertilizer and Potash Fertilizer Demand, 1970-2001[a]
Static Model

Variables	Fertilizers		
	Nitrogen (N)	Phosphorus (P_2O_5)	Potash (K_2O)
Coefficients			
Constant	4.98 (10.55)	1.40 (2.71)	1.03 (0.26)
ln (P_f/P_c)	–0.42 (–4.16)	–0.66 (–5.58)	–2.68 (–9.36)
ln Y_{t-1}		0.36 (3.79)	
ln T		0.51 (4.19)	
T	0.06 (20.25)		0.07 (3.94)
ln W			2.24 (2.82)
R^2	0.94	0.965	0.892
d^b	1.50	1.53	1.52

The dependent variable is ln Qi where Qi (i = N is Nitrogen, P is Phosphorus and K is Potash).

'*b*' is the Durbin-Watson statistic. The critical value at the five percent level of significance is: $d_L = 1.297$, $d_U = 1.570$ (For 31 observations and 2 explanatory variables at 5%), $d_L = 1.229$, $d_u = 1.650$ (31 observations and 3 explanatory variables).

Figures in parentheses are t-statistic.

Phosphorus

The estimated regression coefficients for the phosphorus demand are shown in Table 2. The sign of the estimated coefficients are in accordance with prior expectations. The equation has R^2 value of 0.965, which shows overall goodness of fit of the estimated regression model. Autocorrelation is not a problem as estimated '*d*' was 1.53. From the Durbin-Watson tables, it is found that at the 5 percent level the critical d values are: $d_L = 1.229$ and $d_u = 1.650$. On the basis of '*d*' test, the estimated '*d*' value lies in the indecisive range. But on the basis of the modified '*d*' test the hypothesis of no first order positive autocorrelation can be rejected since $d < d_u$. Fertilizer crop price index ratio coefficient has a negative sign and is statistically significant at 99% confidence level. The demand for phosphorus is price inelastic, as the coefficient is –0.66. The lagged farm income variable is positive as expected and statistically significant at 99% confidence level. The coefficient for the trend has the expected sign and is significant at 99% confidence level.

Potash

The results of estimating potash demand equation is shown in Table 2. Again the results are in line with expectations and the coefficients have the hypothesized signs. The R^2 value is 0.892 and the Durbin-Watson statistic is satisfactory. Price Index Ratio variable has the expected negative relationship to potash off-take. The estimated demand for potash is very elastic and the coefficient tends to be statistically highly significant at 99% confidence level. The coefficient for the trend variable is positive and highly significant. The coefficient for water available at farm-gate is positive and significant at 99% level of confidence. The response of potash off-take to change in water at farm-gate is very elastic with the coefficient –2.68.

RESULTS OF THE DYNAMIC MODEL

Since the variables are in logarithms, the short-run elasticity of demand for fertilizer (N, P and K) with respect to its relative price index is given by the estimate of $\beta_1\ \delta$, while the long-run elasticity is given by $\beta_1\ \delta / 1 - (1 - \delta)$.

Nitrogen

The estimated coefficients for the nitrogen demand equations are given in Table 3. The results are acceptable from both on economic theory and statistical viewpoint. The signs on all of the coefficients are as hypothesized and the coefficients are significant at 99 percent level of confidence. The multiple correlation coefficients R^2 indicate the variables included, explaining 98 percent of the variation in the off-take of nitrogen. The estimated Durbin-Watson '*d*' is 1.71, which is close to 2. In the Autoregressive models, it cannot be trusted to computed '*d*' to find out whether, there was serial correlation in our data. Using the estimated '*d*' value and the '*h*' statistic formula, the following is obtained:

TABLE 3

Regression Coefficients and Related Statistics for Nitrogen Fertilizer, Phosphorus Fertilizer and Potash Fertilizer Demand, 1970-2001[a]
Dynamic Model

Variables	Fertilizers		
	Nitrogen (N)	Phosphorus (P_2O_5)	Potash (K_2O)
Coefficients			
Constant	1.82 (3.25)	0.83 (2.06)	7.72 (5.48)
ln (P_f/P_c)	–0.14 (–1.92)	–0.35 (–3.11)	–1.85 (–5.65)
ln Q_{i-1}	0.64 (6.64)	0.48 (4.65)	0.43 (4.55)
ln T		0.21 (1.95)	
T	0.02 (3.17)		0.06 (4.88)
ln Y_{t-1}		0.20 (2.46)	
δ	0.3580	0.5160	0.5680
R^2	0.98	0.98	0.92
d^b	1.71	2.36	2.44
d^h	0.27	–1.20	–1.40

The dependent variable is ln *Qi* where *Qi* (*i* = N is Nitrogen, P is Phosphorus and K is Potash.

'*b*' is the Durbin-Watson statistic, '*h*' is the Durbin '*h*' test if '*h*' lies between –1.96 and 1.96 do not reject the null hypothesis that there is no first-order (positive or negative) autocorrelation.

Figures in parentheses are t-statistics.

'δ' Coefficient adjustment

$h = [1–1/2\ d)\ \sqrt{}\ n\ /\ 1–n\ [\text{var}\ (\alpha_2)]$

$h = 0.271$

The estimated '*h*' leads to the acceptance of the hypothesis that there is no serial correlation (of the first order).

By applying White's Heteroscedasticity-test to the residuals obtained from the regression:

$$n.R^2 \underset{\text{asy}}{\sim} \chi^2\ df$$

31(0.263) ~ 11.0705

8.53 ~ 11.0705

On the basis of White's Test, that there is no heteroscedasticity, it is, therefore, concluded that the above equation gives unbiased estimates of the regression coefficients. Since the variables are in logarithms, the short run elasticity of demand for nitrogenous fertilizer with respect to its relative price is given by the estimate of $\beta_1\ \delta$, while the long run elasticity is given by $\beta_1\ \delta/1 – (1 – \delta)$. For this period between 1970-71 and 2000-2001, the short run price elasticity for nitrogenous fertilizer demand was –0.14 and the adjustment co-efficient was 0.3580. The long run price elasticity for nitrogenous fertilizer demand worked out to be –0.40, indicating that the demand for nitrogenous fertilizer is inelastic. In the short run, nitrogenous fertilizer demand decreases by 1.4 percent and in the long run by 4 percent, in response to a 10 percent increase in its real price.

Phosphorus

The estimated coefficients for the phosphorus demand equations are given in Table 3. The results are acceptable from both on economic theory and statistical viewpoint. The signs on all of the coefficients are as hypothesized and most of the coefficients are significant at 99 percent level of confidence. The multiple correlation coefficients R^2 indicate the variables included, explaining 98 percent of the variation in the off-take of phosphorus fertilizer. The estimated Durbin-Watson 'd' is 2.36. Using the estimated 'd' value and the 'h' statistics formula, the following equation has been obtained:

$h = [1–1/2\ d)\ \sqrt{}\ n/1–n\ [\text{var}\ (\alpha_2)]$

$h = –1.23$

The estimated '*h*' leading to the acceptance of the hypothesis that there is no serial correlation (of the first order).

By applying White's Heteroscedasticity Test to the residuals obtained from the regression

$$n.R^2 \underset{\text{asy}}{\sim} \chi^2 \, df$$

$$31(0.193) \sim 11.0705$$

$$5.983 \sim 11.0705$$

On the basis of White's Test, that there is no heteroscedasticity, it is, therefore, concluded that the above equation gives unbiased estimates of the regression coefficients. For the period between 1970-71 and 2000-2001, the short run price elasticity for phosphorus fertilizer demand was –0.35 and the adjustment co-efficient was 0.5160. The long run price elasticity for nitrogenous fertilizer demand worked out to be –0.68, indicating that the demand for phosphorus fertilizer is inelastic. In the short run, phosphorus fertilizer demand decreases by 3.5 percent and in the long run by about 7 percent, in response to a 10 percent increase in its real price.

Potash

The short-run price elasticity for potash fertilizer demand was –1.85 and the adjustment coefficient was 0.5680. The long-run price elasticity for potash fertilizer demand worked out to be –3.26, indicating that the demand for potash fertilizer is price elastic. In the short-run, potash fertilizer demand decreased by about 19 percent and in the long-run by about 23 percent, in response to a 10 percent increase in its price index ratio.

IV. CONCLUDING REMARKS

In the study, attempts have been made to estimate fertilizer demand function by type. Estimation was completed for N, P, and K. The estimated demand equations are of general agreement as the signs of the estimated coefficients are in accordance with prior expectation. All the coefficients are statistically different from zero and the results are consistent with the theory. In this study, the macro plant nutrients (N, P, K) demand functions were derived and short run as well long run price elasticities were estimated. Our results indicate that the demand for nitrogen (N) and phosphorus (P) are price inelastic while the demand for potash fertilizer is price elastic. A 10 percent increase in the relative price of fertilizer may lead to a less than 2 to 3.5 percent decrease in the short run and about 4 to 7 percent decrease in the long run in the nitrogenous and phosphorus fertilizers per hectare. As for potash fertilizer, it was found that in the short run there was 18.5 percent decrease, while in the long-run there was 32.6 percent decrease in demand with an increase of 10 percent in the relative price of fertilizer. Thus, according to findings, demand for nitrogenous (N) and phosphorus (P) fertilizers are price inelastic both in the short-run and in the long-run, while for potash (K) fertilizer it was price elastic both in the short-run and in the long-run. Furthermore, the time variable used to measure shift in the production technology had a strong positive impact on off-take of fertilizer and its coefficients were highly significant.

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APPENDIX I

Year	N	P	K	Y	*Pc*	*Pf*	*Pf/Pct*–1	*W*
1970-71	15.13	1.83	0.07	823.25	31.21	64.04	–	69.95
1971-72	20.72	2.24	0.04	928.34	34.48	57.13	183.05	71.10
1972-73	22.82	2.88	0.08	976.83	40.51	46.56	135.05	81.17
1973-74	18.71	3.18	0.15	1365.05	51.42	62.38	153.97	80.06
1974-75	20.89	3.49	0.12	1731.22	66.94	87.80	170.76	88.02
1975-76	24.51	5.75	0.16	1915.19	69.50	92.59	138.32	85.95
1976-77	28.06	6.48	0.13	2047.92	75.48	81.94	117.90	84.57
1977-78	28.78	8.18	0.31	2389.82	84.71	80.24	106.30	89.44
1978-79	35.45	9.74	0.39	2610.05	92.45	76.50	90.31	87.39
1979-80	41.93	11.89	0.50	2932.14	92.35	85.99	93.01	81.14
1980-81	43.61	11.74	0.50	3431.41	100.00	100.00	108.28	97.79
1981-82	41.99	11.38	1.10	3840.95	114.26	87.31	87.31	96.45
1982-83	47.49	13.22	1.28	4057.03	118.85	99.86	87.40	101.4
1983-84	45.74	13.00	1.42	3928.74	132.06	123.12	103.60	103.69
1984-85	46.93	14.75	1.24	4595.29	132.09	123.12	93.23	102.81
1985-86	55.63	17.25	1.62	5086.25	134.58	123.12	93.21	104.73
1986-87	63.76	19.56	2.03	5056.09	137.63	133.40	99.12	109.72
1987-88	65.66	20.16	2.31	6013.15	144.32	137.12	99.63	112.22
1988-89	60.71	17.89	1.12	6726.18	157.01	151.81	105.19	114.66
1989-90	68.39	17.82	1.87	6842.59	171.74	170.57	108.64	117.14
1990-91	67.44	17.80	1.50	8138.82	193.75	215.32	125.38	119.62
1991-92	67.34	18.32	1.07	10231.81	181.04	233.89	120.72	122.05
1992-93	72.87	21.76	1.07	9669.76	194.12	243.92	134.73	125.12
1993-94	75.88	21.23	1.06	5984.25	214.43	330.69	170.35	128.01
1994-95	78.50	19.35	0.75	14325.31	266.39	385.10	179.59	129.65
1995-96	88.13	21.89	1.31	15432.64	279.23	428.04	160.68	130.85
1996-97	87.33	18.46	0.37	16947.17	330.92	532.91	190.85	132.05
1997-98	90.06	23.91	0.87	20126.58	376.27	551.20	166.57	122.15
1998-99	91.02	20.16	0.91	22147.10	390.46	595.97	158.39	133.78
1999-00	97.45	26.20	0.81	23013.22	384.58	680.40	174.26	133.28
2000-01	102.98	30.80	1.04	23141.43	401.15	651.82	169.49	134.77
2001-02	102.62	28.04	0.84					134.63
2002-03	101.72	29.41	0.93					134.48
2003-04	114.23	30.45	0.98					134.78

N = Nitrogenous fertilizer off take per hectare, P = Phosphatic fertilizer off take per hectare, K = Potash fertilizer of take per hectare, *Y* = Real Farm income from major and minors crops, *Pc* = Five major crops price index 1980-81=100, *Pf* = Fertilizer price index 1980-81=100, Pf/Pc_{t-1} = Fertilizer crops price index ratio, and W = Million Acres Feet