Research Study No 2007/4

FACTORS AFFECTING FERTILIZER CONSUMPTION IN HARYANA

R.P.S.MALIK
C.S.C.SEKHAR

AGRICULTURAL ECONOMICS RESEARCH CENTRE
UNIVERSITY OF DELHI
DELHI 110007

JULY 2007

ACKNOWLEDGMENTS

The need to intensify agricultural production in the wake of the slow pace of growth in agricultural output realized in the recent past coupled with the rising demand for agricultural commodities, declining per capita availability of arable land, deteriorating position of availability of natural resources such as water, and the desire to maintain a high growth rate of aggregate GDP for the Indian economy has put the agricultural sector back at the center stage of India' planning process. In the absence of any significant breakthrough in agricultural production technology having been achieved in the last several years, achieving the desired levels of agricultural production in the short to medium run would require making more concerted efforts towards bridging the crop productivity gaps attainable with existing technology. The demonstrated capability of chemical fertilizers, an important component of the available agricultural production technology, in increasing the crop productivity and raising the farm profitability provides some ray of hope.

The present study on Factors Affecting Fertilizer Consumption, suggested by the Department of Fertilizers, Ministry of Chemicals and Fertilizers, Government of India, has been undertaken by Agro-Economic Research Centres (AERCs) located in Delhi, Chennai, Jorhat, Ludhiana and Vishva Bharati.at the instance of Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. The study has been coordinated by AERC, Ludhiana who has also has provided the study design and the methodology for the study. The present report is part of this coordinated study and pertains to the state of Haryana.

We are grateful to AERC, Ludhiana, in particular to Professor R.S.Sidhu for preparing the study design and coordinating the study. A number of our colleagues provided inputs in various forms towards completion of this study. We would like to thank P.K.Bhattacharya, Mool Chand, K.K.Shingari, Balbir Singh, Santosh Mann, Parveen Taneja, Prem Bhasin and Narinder Singh. Linu Philip Mathew was associated with the study in its early stages.

July 31, 2007 **R.P.S.Malik and C.S.C Sekhar**

CONTENTS

LIST OF TABLES

Executive Summary

FACTORS AFFECTING FERTILIZER CONSUMPTION IN HARYANA

Rationale for the Study and Study Objectives

The need to intensify agricultural production in the wake of the slow pace of growth in agricultural output realized in the recent past coupled with the rising demand for agricultural commodities, declining per capita availability of arable land, deteriorating position of availability of natural resources such as water, and the desire to maintain a high growth rate of aggregate GDP for the Indian economy has put the agricultural sector back at the center stage of India' planning process. In the absence of any significant breakthrough in agricultural production technology having been achieved in the last several years, achieving the desired levels of agricultural production in the short to medium run would require making more concerted efforts towards bridging the crop productivity gaps attainable with existing technology. The demonstrated capability of chemical fertilizers, an important component of the available agricultural production technology, in increasing the crop productivity and raising the farm profitability provides some ray of hope. While the fertilizer consumption, both in absolute terms as well as on per hectare basis, has increased manifold over the years, however in the last few years the growth has not been satisfactory. Apart from wide inter-regional disparities in consumption of fertilizer, there are severe imbalances in usage of different nutrients. The current fertilizer usage pattern thus offers more scope for not only increasing the consumption of fertilizers but their more efficient usage and the scope intensive and balanced use of fertilizers holds for increased agricultural production, productivity, farm profitability and a more sustainable resource base.

The present study, suggested by the Department of Fertilizers, Ministry of Chemicals and Fertilizers, Government of India has been undertaken by Agro-Economic Research Centres (AERCs) located in Delhi, Chennai, Jorhat, Ludhiana and Vishva Bharati at the instance of the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. The study has been co-ordinated by AERC, Ludhiana who has also

provided the study design and the methodology for the study. The larger study attempts to analyze the trends in fertilizer consumption and identify factors affecting growth/ stagnation in fertilizer consumption over time and in different regions of the country. The study also attempts to assess the impact of fertilizer use on productivity of selected crops and the economic efficiency of fertilizer use for important crops in different states Based on this analysis the study attempts to suggest some remedial measures to boost fertilizer use in the country to achieve the targets set for agricultural production. The present report relates to the state of Haryana. The specific objectives of the present study are:

- Analyze the trends in fertilizer use over time and across different farm size categories.
- Identify the determinants of fertilizer consumption
- Assess the impact of fertilizer use on productivity of select crops and also the economic efficiency of fertilizer use.

Data Base

The study utilizes both secondary as well as primary data. Time series data at the State level on fertilizer consumption and the various determining factors of fertilizer use has been collected for the period 1970-71 to 2003-04. The two sub-periods are – Period I (stable fertilizer consumption) from 1970-71 to 1988-89 and period II (stagnant fertilizer consumption) from 1989-90 to 2003-04.

To analyse the pattern of fertilizer use across various size-groups, the impact of fertilizer use on crop production, and to analyse the economic efficiency of use of fertilizers, primary data was collected from 150 sampled households covering marginal (< 1 ha), small (1-2 ha), medium (2-4 ha) and large (>4 ha) categories of farms. Multistage random sampling technique was adopted with districts, blocks and villages forming the different stages of sample selection. The districts of the state were divided into three groups – high, medium and low based on their share of fertilizer consumption and one district was selected from each group. The districts thus selected for the study were Karnal, Gurgaon

and Fatheabad. The final sample size from different districts and different size groups of farms is presented in Table 1.

Table 1 : Distribution of Sampled Households

District	Category	Size of Operated Land (hectare)	Number of Sampled Households
Gurgaon	**Marginal**	<1	28
	Small	1-2	10
	Medium	2-4	8
	Large	>4	4
	All		50
Karnal	**Marginal**	<1	24
	Small	1-2	9
	Medium	2-4	9
	Large	>4	8
	All		50
Fatehabad	**Marginal**	<1	15
	Small	1-2	10
	Medium	2-4	12
	Large	>4	12
	All		49
Over All	**Marginal**	<1	67
	Small	1-2	29
	Medium	2-4	29
	Large	>4	24
	All		149

Findings

Growth in Fertilizer Consumption

During the period 1970-71 to 2003-04, the total consumption of N in Haryana grew by more than 8% per annum, that of P by 11.5 percent while the consumption of K grew by 6.0 %. The growth rates in consumption of total fertilizer use as well as for the three nutrients individually were however much higher in the first sub period (1970-71 to 1988-89) as compared to the second sub period (1989-90 to 2003-04. For wheat, the

fertilizer use per hectare over the entire period of analysis from 1970-71 to 2003-04 increased on an average by 6.10 percent per annum while for rice the fertilizer consumption increased by about 5 percent per annum. As in the case of total fertilizer consumption, the growth rates of fertilizer consumption per hectare for both wheat and rice were much higher in the first sub period as compared to the second sub period. During this period the rates of growth in crop yields of wheat and rice differed. While the crop yield in the case of wheat increased by an average of 2.9 percent per annum, the growth in yield of rice was much smaller at 1.19 percent per annum

Determinants of Fertilizer Consumption – State Level

An econometric analysis of the major determinants of fertilizer consumption at the state level indicates that the relative prices and percentage of irrigated area are the two most important factors influencing fertilizer consumption. Lagged dependent variable is also a determinant in case of wheat but not in the case of rice. Fertilizer consumption, in turn, appears to be a major causal factor of yield increases for both the crops. Lagged yield is another major determinant of the yield level (Tables 2 and 3).

Table 2: Factors Affecting Fertilizer Consumption in Haryana

Explanatory Variable	**Elasticity**	
	Wheat	**Rice**
Lagged Dependent Variable	0.73***	-
Relative Price (Price Ratio)	-0.19***	-0.72***
% of Irrigated Area	1.20***	4.87**
% of Area Under HYV	-	0.17
Credit	-	-
R Bar Square	0.97	0.85

Table 3: Factors Influencing Crop Yields in Haryana

Explanatory Variable	**Elasticity**	
	Wheat	**Rice**
Lagged Dependent Variable	0.60***	0.21***
Fertilizer Consumption	0.19***	0.15**
% of Area Under HYV	-	-
R Bar Square	0.95	0.57

Pattern of Fertilizer Consumption – Farm Level

An analysis of the primary data collected from sampled farmers from the three selected districts of Haryana show that for the pooled sample, wheat and paddy combined together accounted for about 63 percent of the gross cropped area (GCA) while cotton accounted for 12 percent and bajra for another about 7 percent. Fodder crops (kharif plus rabi) accounted for 10 percent of the gross cropped area. Across farm size groups, the proportion of area allocated to wheat as also that allocated to paddy increased somewhat as one moves from marginal to large size farms. However the proportion of area allocated to bajra declined from marginal to large farms.

The cropping pattern however showed marked differences across different districts. While wheat continues to be the most important crop in all the three districts during the rabi season, the pattern differs in kharif season. While paddy was the most predominant crop of the kharif season in Karnal district, bajra in Gurgaon and cotton in Fatehabad occupied the largest proportion of GCA during kharif season. Wheat and paddy occupied about 87 percent of GCA in Karnal; wheat, paddy and bajra accounted for about 63 percent GCA in Gurgaon; while wheat and cotton together accounted for about 73 percent of GCA in Fatehabad.

For the pooled sample the average fertilizer nutrient use per hectare for wheat work out to 150 kgs of N and 67 kgs of P, while nutrient use per hectare for paddy work out to 167 kgs of N and 50 kgs of P. The average quantity of P use on both the focused crops within the selected districts as also for both the crops across different districts did not differ significantly. In the case of use of N, while the quantum of N use did not differ across crops within a given district, the level of N use for both the crops differed significantly across districts. However in general there was no apparent systematic trend in quantum of fertilizer usage with the size of holding. From amongst the three districts surveyed, the fertilizer use on wheat and paddy in Karnal was higher by 20 to 30 percent than the other two districts. The wheat yield in Karnal was also higher in Karnal by about 30 percent as compared to the other two districts.

Amongst the factors that could help promote fertilizer usage and/ or its more efficient use adequate and timely availability irrigation is the most important. While the entire cropped area of the sampled farmers in all the three districts was fully irrigated, however a large proportion of farmers had problems with the quantum and timeliness in availability of irrigation water. The most important reason attributed to such a situation was inadequacy and unreliability of electricity supply for pumping irrigation water. However more than 84 percent of the sampled farmers were unwilling to increase their fertilizer usage even if the supply of electricity were to be made more regular and reliable.

Along with irrigation, availability of adequate credit for purchase of fertilizers and its availability at the required time is another important that governs the fertilizer usage by farmers. About 76 percent of the sampled farmers reported problems in getting adequate credit. Similarly about 56 percent farmers complained about the timings in availability of the required credit. However almost 92 percent of the sampled farmers responded that they were unlikely to increase their fertilizer usage by any significant amount even if more credit were to be made available for purchase of fertilizers. The unwillingness of a large majority of sampled farmers to apply larger than current doses of fertilizers in response to increased availability of credit for the purpose could be due to the fact that either (i) the farmers are already using the required doses of fertilizers and/or (ii) the availability of credit for buying fertilizers is adequate and/or (iii) the marginal returns form use of additional fertilizers are less than the cost of credit.

To ascertain the price responsiveness of fertilizer consumption with respect to its price we enquired from the sampled farmers if they would contemplate reducing their fertilizer consumption if a small increase in the prices of fertilizers were to be effected. About 75 percent of the sampled farmers were forthwith that such an increase in fertilizer prices will not result in their using less than the current doses of fertilizers

Determination of appropriate doses of fertilizers to be applied require occasional testing of soil for nutrient content. The extent to which farmers actually resort to such a practice

however depends upon several factors including on the awareness about the utility of undertaking soil testing and the availability of testing facilities. Almost 85 percent of the sampled farmers responded that they have never got their soil/water samples tested. One of the reasons for such a low percent of sampled farmers responding about non testing of their soils for nutrient content could be the non availability of adequate soil testing facilities. More than 80 percent of the sampled cultivators reported inadequacy of fertilizer testing facilities in Haryana. To ascertain if the farmers who get their soil tested actually follow the recommendations on the use of fertilizers we asked the sampled farmers if they were applying fertilizers on the basis of the recommendations given by the soil testing laboratories. Of the total sampled farmers, about 15 percent had got their soil tested for determining the appropriate fertilizer doses that need to be applied. Of those who got their soil tested however only 50 percent actually followed the recommendation on the dosage of fertilizer that actually need to be applied (Table 4.17). The remaining 50 percent however did not actually follow the advise given by the soil testing laboratories.

Green manuring practices have not been very popular with farmers in the study region though green manuring can help save on use of chemical fertilizers. Of the 149 surveyed farmers in the present study 95 percent farmers did not practice green manuring

Most of the farmers in the study region have been cultivating the same crops over a number of years and have to a large extent perfected the art of cultivation practices and doses of various inputs that need to be applied to these crops. However with changing soil - climatic conditions over the years, the farmers need to make necessary adjustments in use and application of various inputs. To ascertain who guides the farmers in taking appropriate decisions with regard to quantity and timing of application of fertilizers, we asked the farmers to list major sources of their information on use of fertilizers. While in general farmers do discuss these issues with a number of possible sources however they are generally influenced relatively more by one of these sources. The results obtained suggest that the major source of information for the farmers is fellow farmers/ friend and relatives. More than 47 percent of the sampled farmers reported this as their major source of their information. Another important source of information on this aspect is the

extension personnel/ agricultural university which was reported by about 32 percent of the sampled farmers. Fertilizer dealer is another source to whom farmers turn for advise. About 14 percent of the sampled farmers quoted fertilizer dealer as their major source of information.

Determinants of Crop Yield: Farm Level Analysis

An analysis of the determinants of yields of wheat and paddy based on the primary data collected from the sampled farmers suggest that in the case of wheat, consumption of N and P appear to be significant determinants of yield in two of the three districts and also for the pooled sample. The value of the marginal product of fertilizer use (VMP) is also much higher than the marginal factor cost of fertilizer (MFC) in these two districts – Karnal and Gurgaon (Table 4). No other variable appears to affect wheat yield significantly.

In the case of paddy, N and P do not show significant effect on crop yield. The major determinants of paddy yield appear to be irrigated area (IA) and machine labor use in operations (MLO). However, human labor use in operations (HLO) and seed input (SEED) show significant negative effects. The VMP of P much is higher than the corresponding MFC as compared to N (Table 5).

Table 4: Value of Marginal Product and Marginal Factor Cost of Fertilizer of Wheat Farming in Haryana

Fertilizer Nutrient	**VMP/MFC**	**Karnal**	**Gurgaon**	**Fatehabad**	**Overall**
N	VMP	47.09	62.68	-6.60	41.16
	MFC	10.50	10.50	10.50	10.50
P	VMP	50.36	37.45	-5.32	88.99
	MFC	16.22	16.22	16.22	16.22

Table 5: Value of Marginal Product and Marginal Factor Cost of Fertilizer of Rice Farming in Haryana

Fertilizer Nutrient	**VMP/MFC**	**Karnal**	**Fatehabad**	**Overall**
N	VMP	19.91	-10.14	11.05
	MFC	10.50	10.50	10.50
P	VMP	57.82	28.16	37.38
	MFC	16.22	16.22	16.22

Conclusions and Policy Implications

The data presented and results obtained clearly indicate that although there are inter-regional differences in fertilizer consumption and the fertilizer consumption also differs between the analyzed important crops, yet the fertilizer consumption is quite high in Haryana both with respect to most of the other regions of the country as also in comparison to the recommended fertilizer dosages by the scientists. This however does not imply that Haryana has exhausted all the avenues for increasing fertilizer consumption and/ or using the fertilizers more efficiently. The results obtained have shown that the value of marginal product of fertilizer usage at current level of usage is still higher than marginal factor cost of fertilizers.

As the analysis presented has shown that there is a tendency on the part of the farmers to use higher doses of N as compared to other nutrients leading to imbalances in the use of different nutrients resulting in nutrient deficiency which affects soil health leading to soil fatigue with resultant impact on crop yields. While the imbalanced use of fertilizers by the farmers could partly be attributed to the lack of his awareness on the aspect of soil health and its nutrition balance, the distorting role of fertilizer pricing policy, availability and management of fertilizers are also to blame. Though not analyzed in the present study, besides these nutrients, other widespread mineral deficiencies such as gypsum and carbon content in the soil, also affect the fertilizer use efficiency. Appropriately devised nutritional management programs comprising of soil testing, distribution of soil health cards to all the farmers and creating awareness on farm nutrition management would

need to be taken up on a priority basis. Adequate soil testing facilities within easy reach of the farmers would need to be provided to enable them get their soil tested for efficient fertilizer usage. This would need to be supplemented by appropriate extension facilities to make farmers understand the necessity of following these recommendations of the soil testing and basing their fertilizer usage on these recommendations.

One of the major determinants of fertilizer consumption is the percentage of area irrigated. The macro level data analysis suggests that fertilizer consumption is elastic with respect to this variable with a significant elasticity of 1.2 for wheat. For rice, irrigated area has a very high elasticity of 4.87 and is statistically significant. Along with percentage of irrigated area an equally important factor that could facilitate higher fertilizer usage and/or its more efficient usage is the quality and quantity of irrigation available to irrigate this area. Availability of reliable and adequate supply of electricity for irrigation pumping could go a long way in improving the available irrigation facilities and could trigger higher and efficient fertilizer usage. Efforts thus need to be directed towards improving the supply of electricity for irrigation pumping.

Given that the relative (crop-fertilizer) prices have been a major determinant of fertilizer consumption at the state level efforts should be made to keep this price relative favorable so as to encourage higher fertilizer consumption. Given further that fertilizer consumption is a major causal factor of yield increases for both the studied crops such a measure would help increase foodgrain production.

CHAPTER I

INTRODUCTION

The slow pace of growth in agricultural output, the rising demand for agricultural commodities coupled with decreasing per capita availability of arable land has put the agricultural sector back at the center stage of India' planning process. The need to intensify agricultural production in a sustainable manner from the finite natural resources has assumed much greater significance. Meeting this challenge require agricultural production technology to play an ever increasingly important role. In the absence of any significant breakthrough in agricultural production technology having been achieved in the last more than three decades and with no signs of any technological breakthrough likely to be achieved in the near future, achieving the desired levels of agricultural production would require making more concerted efforts towards bridging the crop productivity gaps attainable with existing technology. This would not only require extending application of the available technology in areas where the adoption rates still lag behind but also more intensive and judicious use of the available technology- based on careful use of available HYV seeds together with chemical fertilizers and irrigation water - even in those areas where the technology adoption rates have been satisfactory.

While all the three principal components of the available technology – HYV seeds, fertilizers and irrigation water - are equally important for achieving the growth in agricultural productivity and production, fertilizers have an important role for two specific reasons. First, fertilizers facilitate the adoption of yield- increasing technologies and thereby promote sustainable growth of food production on limited cultivable land. Second, they help to replenish nutrients removed by crops and therefore prevent soil degradation and preserve the resource base.

The demonstrated capability of chemical fertilizers in increasing the crop productivity and increasing the farm profitability, coupled with intensive extension efforts, increased investment in irrigation, provision of credit, pricing and subsidy policies and intensive

marketing efforts combined together has led to massive growth in fertilizer consumption in Indian agriculture. From less than 2 million tonnes of fertilizer consumption in 1969-70, the consumption increased more than two and a half times in just one decade. The estimated fertilizer consumption during 2005-06 was 20.34 million tonnes (Table 1.1, Figure 1). The fertilizer consumption after reaching its peak level of 18.1 million tonnes in 1999-2000, stagnated and/or declined in subsequent years before recovering in 2004-05 to the level of consumption realized in 1999-2000. The fertilizer consumption however increased to a still higher level of 20.34 million tones in 2005-06.

Table 1.1: Growth of fertilizer consumption in India (000 tonnes Nutrients)

Year	Consumption			
	N	P2O5	K2O	Total
1959-1960	229	53.9	21.3	305
1969-1970	1,360	416	210	1,980
1979-1980	3,500	1,110	592	5,120
1989-1990	7,250	2,720	1,070	11,000
1999-2000	11,600	4,800	1,700	18,100
2000-2001	10920	4215	1568	16113
2001-2002	11310	4382	1667	17359
2002-2003	10474	4019	1601	16094
2003-2004	11077	4124	1598	16799
2004-2005	11714	4624	2061	18398
2005-2006	12723	5204	2413	20340

The growth in fertilizer consumption per hectare also followed a somewhat similar trend. The fertilizer consumption per hectare after reaching a peak of about 95 kg/ha in 1999-2000 declined somewhat in subsequent years before recovering back to the level of level of 96.5 kg/ha in 2004-05 and rising to 107 kg/ha in 2005-06 (Table 1.2, Figure 2).

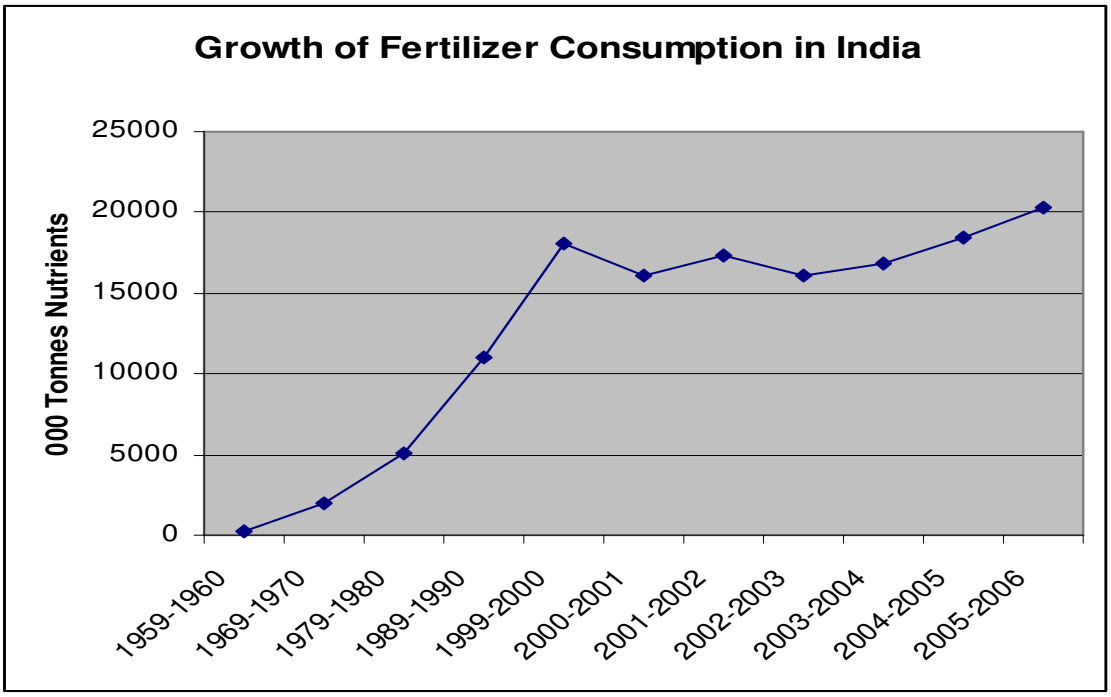
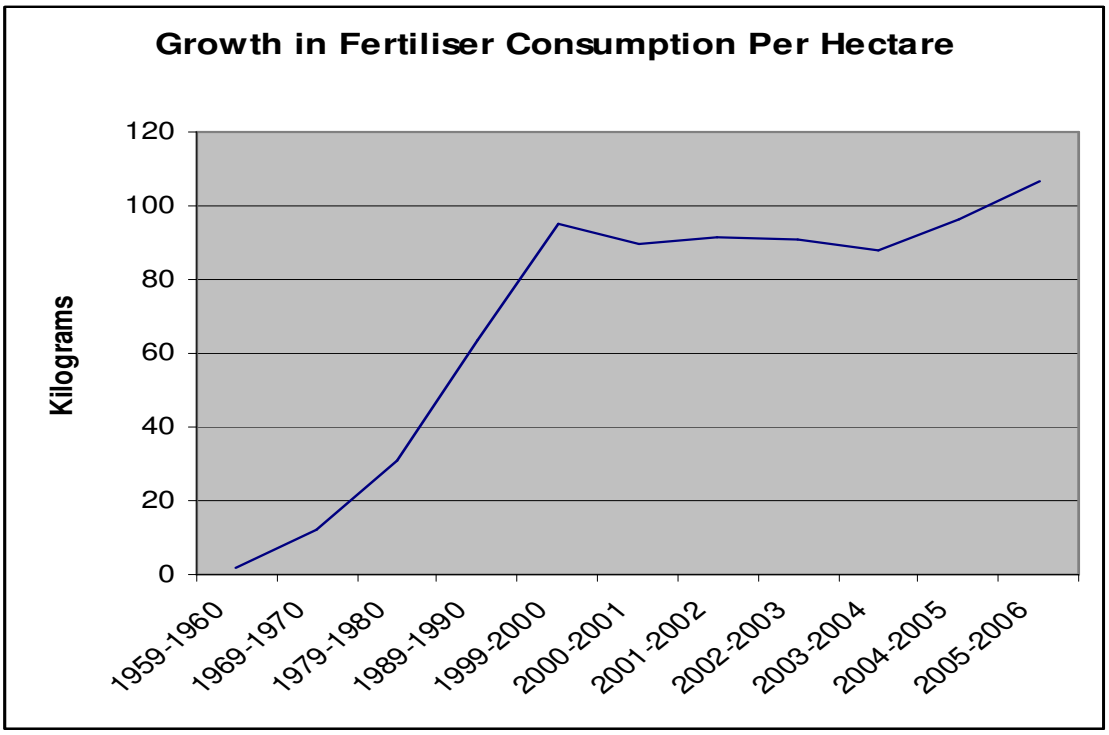


Table 1.2: Trend in intensity of fertilizer consumption in India (kg/ha).

Year	Consumption, kg/ha			
	N	P2O5	K2O	Total
1959-1960	1.50	0.35	0.14	1.99
1969-1970	8.36	2.56	1.29	12.21
1979-1980	20.63	6.79	3.58	31.00
1989-1990	40.52	16.54	6.41	63.47
1999-2000	61.19	25.33	8.86	95.38
2000-2001	58.80	22.70	8.44	89.94
2001-2002	59.45	23.04	8.76	91.25
2002-2003	59.27	22.74	9.06	91.07
2003-2004	58.10	21.63	8.38	88.12
2004-2005	61.44	24.25	10.81	96.51
2005-2006	66.74	27.30	12.66	106.69



The aggregate per hectare fertilizer consumption however conceals wide variation in fertilizer consumption between and within different regions of the country and thereby the potential increased fertilizer consumption and its more efficient use holds for increasing agricultural production. As against the all-India average fertilizer consumption of 104.5 kg/ha in 2005-06, the fertilizer consumption in some states such as Kerala, Madhya Pradesh, Maharashtra, Rajasthan etc was much lower (Table 1.3). On the other hands fertilizer consumption per hectare in states such as Andhra Pradesh, Tamilnadu, Punjab, Haryana, Uttar Pradesh and West Bengal was much higher than the all-India average. The per hectare fertilizer consumption in Haryana at 166.72 kg was almost 60 percent higher than the all-India average of 104.50 kg in 2005-06.

Table 1.3 : Per Hectare Fertiliser Consumption of N,P,K fertilizers during 2004-05 and 2005-06 (in Kg) (Based on 2004-05 provisional GCA)

S. No	State/UT	2005-06	2004-05
1	Andhra Pradesh	203.61	158.57
2	Karnataka	117.34	99.51
3	Kerala	57.00	56.74
4	Tamilnadu	183.67	159.07
5	Pondicherry	1100.26	1086.30
6	A& N Island	12.63	10.92
7	Gujarat	111.07	99.49
8	Madhya Pradesh	47.13	53.42
9	Chattisgarh	67.36	65.19
10	Maharashtra	84.52	74.68
11	Rajasthan	36.29	31.33
12	Goa	32.66	34.08
13	Dadra and Nagar Haveli	43.97	41.25
14	**Haryana**	**166.72**	**155.10**
15	Himachal Pradesh	48.75	47.00
16	Jammu and Kashmir	81.31	66.30
17	Punjab	210.06	194.56
18	Uttar Pradesh	140.37	134.13
19	Delhi	10.51	13.08
20	Uttranchal	94.24	88.93
21	Bihar	152.32	99.78
22	Jharkhand	67.61	62.10
23	Orissa	57.33	51.59
24	West Bengal	127.50	129.73
25	Arunachal Pradesh	20.94	2.98
26	Assam	49.26	41.25
27	Tripura	39.21	34.74
28	Manipur	59.84	85.97
29	Meghalaya	17.98	18.05
30	Nagaland	1.50	1.46
31	Mizoram	25.45	5.85
32	Sikkim	2.83	5.01
	All India	**104.50**	**94.52**

Source Economic Survey 2006-07

The high doses of fertilizers in certain regions/ States however do not necessarily imply their efficient and optimal use and the potential their more balanced[1] and efficient use holds for realizing increased agricultural production. Prescription of a uniformally specific fertilizer dose or the balance between different nutrient ingredients for an entire region is neither possible nor desirable. The level and composition of fertilizer use depends upon several factors such as the soil health and extent of imbalance in different nutrient ingredients specific to cultivation conditions prevailing at the micro level. In the absence of adequate scientific facilities available for determining the level and composition of fertilizer use at the micro level, farmers often tend to decide on fertilizer usage based on their prices, availability and expected returns from use of fertilizers. Thus the imbalance use of fertilizers by the farmers is often not on account of his awareness on the aspect of soil health and its nutrition balance but due to distorting role of policy (such as subsidy on Nitrogenous fertilizers) and availability of fertilizers (such as deficit in the production capability of Phosphatic and Potash fertilizers).

During 2005-06 the all –India average N,P,K ratio was 5.2:.1:1. The average N,P,K ratios have not followed a consistent trend and as mentioned above have in large part been the result of varying underlying conditions prevailing during different time periods. Although in more recent years the average nutrient consumption ratios have tended to move in somewhat desired direction, as usual the averages mask the huge differences that may be prevailing at the more disaggregated levels. Wide variations can be seen in this ratio in different states ranging from 48:15:1 in Haryana to 1.3 : 0.6 : 1 in Kerala. Imbalanced use of fertilizers along with other agronomical factors also leads to inefficient use of fertilizers which threatens crop productivity, soil fertility and sustainability of agriculture and resulting in adversely affecting the economics of fertilizer use.

[1] It not only relates to appropriate N : P: K ratio but also use of other secondary and micro nutrients required by the plants

Table 1.4 : N,P,K Ratio During Select Years

Year	N: P:K
1991-92	5.9:2.4:1
1992-93	9.5:3.2:1
2001-02	6.8:2.6:1
2003-04	6.9:2.6:1
2004-05	5.7:2.2:1
2005-06	5.2:2.1:1

Given the important role the fertilizers play in increasing crop productivity and crop production, a number of studies have been carried out by the researchers to analyze various aspects of fertilizer usage in Indian agriculture viz the pattern of fertilizer consumption, the factors governing the use of fertilizers by the farmers, the economics of fertilizer use, the reasons for imbalanced use of fertilizers etc. These studies have been carried out at different points of time in different regions of the country using different level of geographical aggregation using wide variety of data sets and using alternative analytical techniques. These studies have come up with their findings with respect to the relative importance of different factors in determining the pattern of fertilizer usage under different underlying conditions at different points of time and have identified a number of pricing and non pricing factors which explains the level and composition of fertilizer usage.

The present study, suggested by the Department of Fertilizers, Ministry of Chemicals and Fertilizers, Government of India has been undertaken by Agro-Economic Research Centres (AERCs) located in Delhi, Chennai, Jorhat, Ludhiana and Vishva Bharati.at the instance of Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. The study has been coordinated by AERC, Ludhiana who has also has provided the study design and the methodology for the study. The study attempts to analyze the trends in fertilizer consumption and identify factors affecting growth/ stagnation in fertilizer consumption over time and in different regions of the country. The study also attempts to assess the impact of fertilizer use on productivity of selected crops and the economic efficiency of fertilizer use for important crops in different states Based on this

analysis the study suggest remedial measures to boost fertilizer use in the country to achieve the targets set for agricultural production. The present report relates to the state of Haryana. The specific objectives of the present study are:

- Analyze the trends in fertilizer use over time and across different farm size categories.

- Identify the determinants of fertilizer consumption

- Assess the impact of fertilizer use on productivity of select crops and also the economic efficiency of fertilizer use.

CHAPTER II

DATA AND METHODOLOGY

As already discussed, the present study is an attempt to analyze the trends in the use of fertilizers and the determinants of fertilizer consumption in the state of Haryana. The study also examines the effect of fertilizer use on the productivity of selected crops.

The study utilizes both secondary as well as primary data. Time series data at the State level on fertilizer consumption and the various determining factors of fertilizer use has been collected for the period 1970-71 to 2003-04. This period has been further divided into two sub-periods based on the strong changes witnessed in the fertilizer consumption in the late 1980s. The two sub-periods are – Period I (stable fertilizer consumption) from 1970-71 to 1988-89 and period II (stagnant fertilizer consumption) from 1989-90 to 2003-04. The compound growth rates (CAGR) are calculated for each sub-period and also for the entire period, by fitting a semi-log trend.

To analyse the pattern of fertilizer use across various size-groups, the impact of fertilizer use on crop production, and to analyse the economic efficiency of use of fertilizers, primary data has been collected from 150 sampled households covering marginal (< 1 ha), small (1-2 ha), medium (2-4 ha) and large (>4 ha) categories of farms. Multistage random sampling has been adopted with districts, blocks and villages forming the different stages of sample selection. The districts of the state were divided into three groups – high, medium and low based on their share of fertilizer consumption and one district has been selected from each group. The districts selected for the study are Karnal, Gurgaon and Fatehabad. The details of the sample size selected from different districts and different size groups of farms are presented in Table 2.1

Table 2.1 : Distribution of Sampled Households

District	Category	Size of Operated Land (hectare)	Number of Sampled Households
Gurgaon	**Marginal**	<1	28
	Small	1-2	10
	Medium	2-4	8
	Large	>4	4
	All		50
Karnal	**Marginal**	<1	24
	Small	1-2	9
	Medium	2-4	9
	Large	>4	8
	All		50
Fatehabad	**Marginal**	<1	15
	Small	1-2	10
	Medium	2-4	12
	Large	>4	12
	All		49
Over All	**Marginal**	<1	67
	Small	1-2	29
	Medium	2-4	29
	Large	>4	24
	All		149

Analytical Tools

The following econometric methodology has been used in the empirical estimation at the state level using the secondary data. A simultaneous equation model with two equations has been formulated for identifying the determinants of fertilizer consumption and the impact of fertilizer consumption on crop productivity. The model is as follows.

$FCH_t = f(P_t, AHYV_t, IA_t, CR_t, e_{1t})$.....(1)

$Y_t = g(Y_t(-1), FCH_t, IA_t, AHYV_t, e_{2t})$.....(2)

where

FCH_t = Fertilizer consumption per hectare

P_t = Relative price of fertilizer (ratio of fertilizer price and the MSP of the crop)

$AHYV_t$ = Percentage of area under HYV under the crop

IA_t = Percentage of irrigated area under the crop

CR_t = Credit disbursal per hectare of the crop

Y_t = Yield per hectare of the crop

e_{it} = Error term of the I th equation; i=1,2

Application OLS gives inconsistent estimates in the present case because of the presence of a current endogenous variable (FCH_t) among the explanatory variables of eqn (2). Therefore, method of two-stage least squares has been used for estimation.

Marginal productivity at the micro level (farm level) using the primary data is calculated by estimating the following Cobb-Douglas production function.

$Y = f(IA, SEED, HLO, MLO, LI, N, P)$

Y - yield in kg per hectare

IA - percentage of irrigated area

SEED - seed input per hectare

HLO - human labour use in operations (other than irrigation)

MLO - machine labour use in operations (other than irrigation)

LI - labour use in irrigation (human + machine)

N - consumption of N

P - consumption of P

Economic efficiency of fertilizer use has been assessed by comparing the value of the marginal product of fertilizer nutrient with the marginal factor cost (price) of fertilizer. Access to various inputs/services like fertilizers, credit, soil testing etc are analyzed on the basis of the farmers' response.

CHAPTER III

DETERMINANTS AND IMPACT OF FERTILIZER USE ON PRODUCTIVITY – A STATE LEVEL ANALYSIS

During the year 2003-04, Haryana with about 3.3 percent of the gross cropped area of the country accounted for about 6 percent of the total fertilizer consumption in India. In terms of intensity of fertilizer use also, Haryana is one of the leading states. As compared to the all-India average fertilizer consumption of 90 kg, per hectare, the fertilizer use intensity per hectare of gross cropped area in Haryana during 2003-04 was 167 Kg.

An examination of the trend in fertilizer consumption in Haryana suggests that in terms of nutrients, the total fertilizer consumption in Haryana during the TE 1972-73 was of the order of 85 thousand tonnes which in just a decade increased three times to reach the level of 249 thousand tonnes (Table 3.1). The fertilizer consumption in the state has increased consistently over time and in the TE 2003-04 the fertilizer consumption in Haryana reached nearly one million tonnes. While the increase in total fertilizer use was accompanied by increase in consumption of all the three nutrients, the pace of increase in consumption differed between the three nutrients. During the period of analysis while the consumption of N increased from 72 thousand tonnes to 734 thousand tonnes, that of P increased from 10 to 231 and of K from 2 to 12 thousand tonnes.

Table 3.1: Fertilizer Consumption in Haryana – Select Years

('000 TONNES)

TE	N	P	K	N+P+K
	000 tonnes	000 tonnes	000 tonnes	000 tonnes
1972-73	72	10	2	85
1977-78	117	18	6	141
1982-83	204	34	11	249
1987-88	308	80	6	394
1992-93	459	147	4	611
1997-98	619	152	3	774
2003-04	734	231	12	976

Percentage annual compound growth rates (CAGR) of total nutrient consumption (N, P, K) have been calculated for the period from 1970-71 to 2003-04. CAGRs have also been calculated for fertilizer consumption (N+P+K) per hectare of wheat and rice and its correlates like percentage of irrigated area, percentage area under HYVs and yield. The growth rates have been calculated by fitting a semi-log trend to the data. The period of analysis has been divided into two sub-periods – Period I from 1970-71 to 1988-89 and Period II from 1989-90 to 2003-04. CAGRs are presented for the two sub-periods and the entire period in Tables 3.2 and 3.3.

Table 3.2: Growth Rate of Fertilizer Consumption in Haryana (ACGR in %)

Period	N	P	K	N+P+K
1972-73 to 1988-89	10.93***	15.73***	6.94***	11.56***
1989-90 to 2003-94	5.03***	4.82***	6.54***	4.99***
1972-73 to 2003-94	8.20***	11.46***	6.00***	8.60***

Note: *** indicates significance at 1% level.

It will be seen from Table 3.2 that over the entire period of analysis the total consumption of fertilizers in Haryana increased at the rate of 8.6 percent per annum. While the consumption of N grew by more than 8% per annum, that of P and K increased by 11.5 % and 6.0% respectively. The growth rates in consumption of total fertilizer use as well as

for the three nutrients individually were much higher in the first sub period as compared to the second sub period.

Looking at the per-hectare consumption of fertilizer and its correlates (Table 3.3), it will be seen that the fertilizer consumption for wheat and rice has grown impressively over the entire period. For wheat, the fertilizer use per hectare over the entire period of analysis from 1970-71 to 2003-04 increased on an average by 6.10 percent per annum while for rice the fertilizer consumption increased by about 5 percent per annum. As in the case of total fertilizer consumption, the growth rates of fertilizer consumption per hectare for both wheat and rice were much higher in the first sub period as compared to the second sub period. The rates of growth in crop yields of wheat and rice differed. While the crop yield in the case of wheat increased by an average of 2.9 percent per annum, the growth in yield of rice was much smaller at 1.19 percent per annum. An examination of the pattern of growth in crop yields during the two sub periods indicate that while wheat yields increased in both the sub periods, albeit at different rates, the yields of rice increased in the first sub period while in the second sub period there was a deceleration in yield. Percent of irrigated area under both the crops as also the proportion of area under HYVs over the entire period of analysis increased, though there were marked differences in the pattern of growth between the two sub periods. The low growth in proportion of area irrigated under the two crops in the second sub period is possibly on account of the fact that almost the entire area under the two crops had been brought under irrigation by the end of the first sub period (Table 3.4). Similarly the proportion of area under HYV of wheat had also risen to its maximum level by the end of the first sub period, though in the case of rice there has been some decline in proportion of crop area cultivated with HYVs. This is on account of the fact that a sizeable proportion of the area under rice in Haryana is sown with high value Basmati variety of rice.

Table 3.3: Growth Rate of Fertilizer Consumption per Hectare and its Correlates (ACGR in %)

	Fert Cons per Ha		Yield		% of Irrigated Area		% of Area Under HYV	
	Wheat	Rice	Wheat	Rice	Wheat	Rice	Wheat	Rice
1970-71 to 1988-89	8.64***	7.04***	3.28***	2.48***	1.44***	0.71***	2.31***	7.61***
1989-90 to 2003-94	2.73***	1.48***	1.46***	-0.42	0.10***	0.05***	-0.07	-0.17
1970-71 to 2003-94	6.10***	4.97***	2.89***	1.19***	0.70***	0.39***	0.95***	1.62***

Note: *** indicates significance at 1% level.

Table 3.4: Irrigated Area and Area Under HYV in Haryana – Select Years

Triennium Ending	WHEAT		RICE	
	% of irrigated area	% of HYV area	% of irrigated area	% of HYV area
1972-73	73	60	88	23
1977-78	89	89	92	61
1982-83	93	92	97	87
1987-88	97	95	99	81
1992-93	98	98	99	67
1997-98	98	96	100	62
2003-04	99	97	100	66

Factors Affecting Fertiliser Consumption and Crop Yields : Regression Results

A simultaneous equation model has been formulated on the lines described in Chapter II. Two functions – fertilizer consumption function and yield function have been estimated for wheat and rice separately. The results are presented in Tables 3.5 and 3.6 and discussed below.

Wheat

The dependent variable in fertilizer demand function is the fertilizer consumption (N+P+K) per hectare. The explanatory variables are the proportion of irrigated area under wheat, price of urea deflated by MSP of wheat, credit disbursed per hectare and the lagged dependent variable. We have not included HYV area because of the proven multicollinearity of the variable with irrigated area in case of wheat crop in Haryana. In case of yield function, the dependent variable is the yield per hectare of wheat. The explanatory variables are the lagged dependent variable and fertilizer consumption per hectare. A double log functional form has been fitted. The equations are estimated using two stage least squares (2SLS) method of estimation because of the presence of a current endogenous variable (fertilizer consumption) among the explanatory variables of the yield equation. The two equations are then solved together to yield the equilibrium values of the endogenous variables.

The results show a good fit for the fertilizer demand equation with a $\bar{R}^2$ of 0.97. Fertilizer consumption is a stable function and therefore the lagged dependent variable showed a significant coefficient with an elasticity of 0.73. The price elasticity of fertilizer demand is about –0.19 and is significant. The other major determinant of fertilizer consumption is the percentage of area irrigated. Fertilizer consumption is elastic with respect to this variable with a significant elasticity of 1.2. Credit did not show a statistically significant coefficient and was therefore dropped from the equation. The yield function shows a good fit too with a $\bar{R}^2$ of 0.95. Lagged yield is statistically significant with a coefficient value of 0.60. Fertilizer consumption is also statistically significant with an elasticity of 0.19.

Rice

The dependent variable in the fertilizer demand function is the fertilizer consumption per hectare. The explanatory variables are the price of urea deflated by the MSP of rice, irrigated area as percentage of cropped area under rice, area under HYV as percentage of cropped area under rice and credit disbursed per hectare of rice area. In the yield function, the dependent variable is the rice yield per hectare and the explanatory variables are the fertilizer consumption per hectare and proportion of HYV area. As in the case of wheat, the equations are estimated using 2SLS and solved to yield the equilibrium values of the endogenous variables.

The results show a good fit for the fertilizer demand equation with a $\bar{R}^2$ of 0.85. The major determinants in this equation are the irrigated area and the price. Irrigated area has a very high elasticity of 4.87 and is statistically significant. The price elasticity of demand is –0.72, much higher than that of wheat, and is also significant. The HYV area shows the expected sign but is not significant. The credit variable does not show either the right sign or the magnitude and is therefore dropped from the final equation.

The fit for the yield function is moderate with a $\bar{R}^2$ of 0.57. The fertilizer consumption shows a statistically significant elasticity of 0.21. The elasticity of HYV area is 0.15 and is statistically significant too.

Table 3.5: Factors Affecting Fertilizer Consumption in Haryana

Explanatory Variable	**Elasticity**	
	Wheat	**Rice**
Lagged Dependent Variable	0.73***	-
Relative Price (Price Ratio)	-0.19***	-0.72***
% of Irrigated Area	1.20***	4.87**
% of Area Under HYV	-	0.17
Credit	-	-
R Bar Square	0.97	0.85

Table 3.6: Factors Influencing Crop Yields in Haryana

Explanatory Variable	**Elasticity**	
	Wheat	**Rice**
Lagged Dependent Variable	0.60***	0.21***
Fertilizer Consumption	0.19***	0.15**
% of Area Under HYV	-	-
R Bar Square	0.95	0.57

Note: ** and *** indicate significance at 5% and 1% level respectively.

Thus the major determinants of fertilizer consumption at the state level have been the relative prices and percentage of irrigated area. Lagged dependent variable is also a determinant in case of wheat but not in the case of rice. Fertilizer consumption, in turn, appears to be a major causal factor of yield increases for both the crops. Lagged yield is another major determinant of the yield level.

CHAPTER IV

PATTERN OF FERTILISER USE ON SAMPLED FARMS

In this Chapter we present results on the pattern of fertilizer use and practices at the micro level based on the information collected from a sample of farming households selected from three districts of Haryana – Gurgaon, Karnal and Fatehabad.

Size of Holding

The average size of operational holding of sampled household was 2.264 hectares, of which 1.984 hectares was ownership holding, 0.324 hectares was leased-in and 0.044 hectares was leased out (Table 4.1). The average size of ownership holding constituted about 87 percent of the size of operational holding. The average size of operational holdings of sampled marginal households was 0.672 hectares, that of small farmers was 1.556 hectares, of medium farmers was 2.848 hectares while that of large farmers was 6.864 hectares. The ownership holding constituted 98, 90, 84 and 85 percent of respective operational holding in the four size groups of farms. Although leasing –in and leasing – out of land was prevalent in all the size groups of farm size groups, it was relatively less in marginal and small farms as compared to the medium and large farms.

Table 4.1 : Average Size of Ownership and Operated Holding of Sampled Farmers (Pooled Sample) (Hectares)

Size Group	Owned	Leased-in	Leased-out	Operated
Marginal	0.664	0.012	0.004	0.672
Small	1.404	0.16	0.008	1.556
Medium	2.4	0.504	0.056	2.848
Large	5.864	1.184	0.184	6.864
Total	1.984	0.324	0.044	2.264

Across districts the average size of operational holding at 1.744 hectares in Gurgaon was smaller than that of Karnal (2.108 hectares) and of Fatehabad (2.96 hectares) (Table 4.2).

The size of ownership holding constituted about 95 percent, 80 percent and 89 percent respectively of the size of operational holding in the three districts. While leasing-in of land was reported by the sampled households in all the three districts, leasing out was absent in the sampled households of Karnal.

Table 4.2 :Average Size of Ownership and Operational Holding of Sampled Farmers in the Three Districts

(Hectares)

Size Group	Owned	Leased-in	Leased-out	Operated
		District Gurgaon		
Marginal	0.72	0.00	0.00	0.72
Small	1.3	0.24	0.02	1.52
Medium	2.624	0.252	0.00	2.876
Large	7.2	1.1	1.1	7.2
Total	1.66	0.176	0.092	1.744
		District Karnal		
Marginal	0.632	0	0	0.632
Small	1.5	0	0	1.5
Medium	1.888	0.888	0	2.776
Large	4.776	1.7	0	6.476
Total	1.676	0.432	0	2.108
		District Fatehabad		
Marginal	0.0616	0.06	0.012	0.664
Small	1.42	0.22	0	1.64
Medium	2.632	0.384	0.132	2.884
Large	6.14	0.868	0	7.008
Total	2.628	0.368	0.036	2.96

Extent of Irrigation

Irrigation is quite widespread in the study area. The entire operated of all the sampled farmers in all the three districts was irrigated (Table 4.3).

Table 4.3 : Percent of Operated Area Irrigated

	Gurgaon	Karnal	Fatheabad	Combined
Marginal	100	100	100	100
Small	100	100	100	100
Medium	100	100	100	100
Large	100	100	100	100
Total	100	100	100	100

Cropping Pattern

Table 4.4 gives information on cropping pattern practiced by the sampled farmers according to farm size group for each of the three surveyed districts as well as for the three districts combined. For the pooled sample wheat and paddy combined together accounted for about 63 percent of the gross cropped area (GCA) while cotton accounted for 12 percent and bajra for another about 7 percent. Fodder crops (kharif plus rabi) accounted for 10 percent of the gross cropped area. Across farm size groups, the proportion of area allocated to wheat as also that allocated to paddy increased somewhat as one moves from marginal to large size farms. However the proportion of area allocated to bajra declined from marginal to large farms.

The cropping pattern however shows marked differences across different districts. While wheat continues to be the most important crop in all the three districts during the rabi season, the pattern differs in kharif season. While paddy was the most predominant crop of the kharif season in Karnal district, bajra in Gurgaon and cotton in Fatehabad occupied the largest proportion of GCA during kharif season. Wheat and paddy occupied about 87 percent of GCA in Karnal, wheat, paddy and bajra accounted for about 63 percent GCA in Gurgaon, wheat and cotton together accounted for about 73 percent of GCA in Fatehabad.

Table 4.4 Cropping Pattern of Sampled Farmers (Percent of GCA Allocated to Different Crops)

District	Category	Paddy	Cotton	Bajra	Wheat	Pulses	Fodder (Kharif)	Fodder (Rabi)	S.Cane	Vegetables	Others
Gurgaon	Marginal	0.77	4.88	33.18	30.66	0.00	9.14	1.75	0.00	0.77	18.85
	Small	1.58	0.00	28.46	32.02	0.00	7.11	2.37	0.00	0.00	28.46
	Medium	5.73	0.00	28.16	29.96	0.00	7.40	2.02	0.00	0.00	26.73
	Large	9.56	0.00	22.79	29.41	0.37	5.15	1.84	0.00	1.47	29.41
	All	5.17	1.18	27.61	30.27	0.12	7.01	1.95	0.00	0.69	26.00
Karnal	Marginal	42.22	0.00	0.00	41.30	0.00	7.78	8.70	0.00	0.00	0.00
	Small	44.81	0.00	0.00	42.96	0.00	5.19	6.30	0.00	0.00	0.74
	Medium	41.47	0.00	0.00	39.68	0.79	7.34	6.35	1.19	2.38	0.79
	Large	45.44	0.00	0.00	44.44	0.20	3.57	2.58	2.38	1.19	0.20
	All	43.93	0.00	0.00	42.64	0.29	5.30	4.86	1.44	1.15	0.38
Fatehabad	Marginal	3.97	33.40	0.00	47.86	0.00	7.38	7.38	0.00	0.00	0.00
	Small	3.76	39.81	0.00	43.57	0.00	8.78	4.08	0.00	0.00	0.00
	Medium	13.81	30.33	0.00	43.09	0.00	7.81	4.95	0.00	0.00	0.00
	Large	20.62	23.00	0.00	46.48	0.00	6.73	2.32	0.00	0.00	0.83
	All	16.07	27.27	0.00	45.45	0.00	7.26	3.46	0.00	0.00	0.49
Over All	Marginal	15.82	9.10	14.79	37.92	0.00	8.31	5.33	0.00	0.34	8.40
	Small	16.27	15.08	8.55	39.90	0.00	7.13	4.28	0.00	0.00	8.79
	Medium	20.45	12.71	7.43	38.55	0.25	7.55	4.62	0.38	0.76	7.30
	Large	26.50	11.95	3.84	42.97	0.12	5.48	2.32	0.74	0.62	5.45
	All	22.28	12.16	6.78	40.83	0.12	6.57	3.54	0.46	0.54	6.72

Crop Yields

We present in Table 4.5 the data on crop yields realized on the farms of the sampled farmers in respect of two of the most important crops viz wheat and paddy. The pooled average yield of wheat on sampled farm was estimated to be 36.95 quintals per hectare while the average yield of paddy was estimated at 38.88 quintals per hectare. Across different farm size groups there were no marked differences in wheat yield per acre though in the case of paddy there were some observable, though not large, differences in crop yields per acre. Across districts wheat yield was highest in Karnal followed by Fatehabad and Gurgaon. Paddy yields were highest in Fatehabad and lowest in Gurgaon.

Table 4.5: Yields of Wheat and Paddy (Qtls/ Hectare)

		Wheat	Paddy
District	**Category**		
Gurgaon	**Marginal**	33.48	33.33
	Small	31.60	33.33
	Medium	31.18	25.83
	Large	34.58	34.74
	All	32.94	32.05
Karnal	**Marginal**	36.42	36.41
	Small	39.31	35.37
	Medium	36.73	35.47
	Large	49.61	40.82
	All	43.51	38.26
Fatehabad	**Marginal**	39.27	35.19
	Small	35.88	53.33
	Medium	39.40	34.49
	Large	30.99	42.90
	All	33.94	41.36
Over All	**Marginal**	36.11	36.28
	Small	36.03	36.89
	Medium	36.84	34.48
	Large	37.42	41.29
	All	36.95	38.88

Fertiliser Use on Important Crops

We present in Table 4.6, fertilizer material use by sampled farmers on the two most important crops viz Wheat and Paddy while Table 4.7 gives similar information on fertilizer use in terms of nutrients. Urea and DAP are the two most important fertilizer material used by the farmers. While Urea contains 46 percent Nitrogen, DAP contains 18 percent Nitrogen and 46 percent Phosphorus.

For the pooled sample the average fertilizer material use per hectare for wheat work out to 125 kgs of DAP and 277 kgs of Urea. For paddy the average fertilizer material use per hectare work out to 110 kgs of DAP and 322 kgs of Urea. Converted in to nutrient use per hectare the fertilizer use per hectare for wheat work out to 150 kgs of N and 67 kgs of P, while nutrient use per hectare for paddy work out to 167 kgs of N and 50 kgs of P. The average quantity of P use on both the focused crops within the selected districts as also for both the crops across different districts did not differ significantly. In the case of use of N, while the quantum of N use did not differ across crops within a given district, the level of N use for both the crops differed significantly across districts. However in general there was no apparent systematic trend in quantum of fertilizer usage with the size of holding.

Table 4.6 : Fertilizer Material Use on Different Crops (Kgs/Hectare)

District	Category	D A P		U R E A	
		Wheat	Paddy	Wheat	Paddy
Gurgaon	Marginal	110	125	197.5	250
	Small	120	100	210	300
	Medium	120	125	180	177.5
	Large	117.5	110	270	220
	All	117.5	115	220	212.5
Karnal	Marginal	122.5	110	362.5	337.5
	Small	135	120	372.5	370
	Medium	125	115	327.5	402.5
	Large	135	110	320	352.5
	All	130	112.5	335	365
Fatehabad	Marginal	120	125	295	305
	Small	125	125	295	375
	Medium	122.5	90	307.5	305
	Large	125	112.5	237.5	240
	All	125	107.5	262.5	257.5
Over All	Marginal	117.5	112.5	285	332.5
	Small	127.5	120	302.5	367.5
	Medium	122.5	107.5	287.5	357.5
	Large	127.5	110	267.5	300
	All	125	110	277.5	322.5

Table 4.7: Fertilizer Nutrient use on different crops (Kg/Hectare)

District	Category	Wheat		Paddy	
		N	P	N	P
Gurgaon	Marginal	110	50	137.5	57.5
	Small	117.5	55	155	45
	Medium	105	55	105	57.5
	Large	145	55	120	50
	All	122.5	52.5	117.5	52.5
Karnal	Marginal	187.5	55	175	50
	Small	195	62.5	190	55
	Medium	172.5	57.5	205	52.5
	Large	170	62.5	182.5	50
	All	177.5	60	187.5	52.5
Fatehabad	Marginal	157.5	55	162.5	57.5
	Small	157.5	57.5	195	57.5
	Medium	162.5	57.5	157.5	42.5
	Large	127.5	57.5	130	52.5
	All	140	57.5	137.5	50
Over All	Marginal	152.5	55	172.5	52.5
	Small	162.5	57.5	190	55
	Medium	155	57.5	185	50
	Large	145	57.5	157.5	50
	All	150	57.5	167.5	50

Factors That Could Help Promote Larger and Efficient Usage of Fertilizers : Status and Farmer's Perception

A number of factors could help promote use of fertilizers and facilitate their optimal allocation and more efficient utilization. Some of the factors which could help encourage larger use of fertilizers include : availability of assured and timely irrigation, access to adequate and timely credit for purchase of fertilizers, availability of fertilizers at the required time, reduction in prices of fertilizer etc; while some of the factors that could enhance fertilizer use efficiency and help promote more efficient usage of fertilizers include their application on the basis of soil testing, practicing of green manuring, use of FYM, information about right doses of fertilizers to be used etc. We attempted to

ascertain from the sampled farmers the current status of some of these underlying factors and the perceptions of farmers on some of these issues.

Adequacy of Irrigation Availability

While irrigation availability in the study area has been widespread, and as reported in Table 4.3 above the entire operated area of the sampled farmers have had access to irrigation, still a number of farmers face lots of problems in getting the required quantity of water at the desired time. These problems are not only restricted to areas irrigated predominantly by canals, these problems also exist in areas where tube well is the major source of irrigation. Of the 149 sampled farmers 92 farmers (62 percent of the sampled farmers) reported problems of either inadequacy and/or timeliness in availability of irrigation water (Table 4.8). And these problems are not restricted to resource poor marginal and small farmers only, farmers belonging to medium and large size groups also face these problems. Across districts however there was some variation in the intensity of problems relating to irrigation. As against 76 percent of the sampled farmers complaining about inadequacy of irrigation water availability in Guragon, the proportion of such farmers in Karnal was 68 percent while in Fatheabad this percentage was the lowest- 41 percent.

Of the farmers reporting problems with irrigation, 83 percent attributed this to the inadequacy and unreliability of electricity supply for irrigation pumping. About 15 percent attributed this to the other tube well related irrigation problems – low and declining water table, non availability of purchased water in required quantity and/or required time, higher cost of purchased water etc. While problems related with supply of electricity for pumping was quoted as the most important problem by sampled farmers belonging to all the size groups of farms, a substantially large proportion (more than 20 percent) of farmers belonging to marginal and small farm size group attributed this inadequacy to other factors discussed above. A comparison across districts also broadly follow a similar pattern.

Table 4.8 : Adequacy of Irrigation and Problems Associated with Availability of Irrigation

District	Category	Total Number of Sample Farmers	Number of Sample Farmers facing problems with adequacy of irrigation	Nature of Problem with Irrigation Percent of farmers reporting Poor Supply Of Elect	Inadequate Canal Water Availability	Others*
Gurgaon	**Marginal**	28	17 (61)	71	0	29
	Small	10	10 (100)	70	0	30
	Medium	8	8 (100)	100	0	0
	Large	4	3 (75)	67	0	33
	All	50	38 (76)	76	0	24
Karnal	**Marginal**	24	16 (67)	81	0	19
	Small	9	4 (44)	100	0	0
	Medium	9	6 (67)	100	0	0
	Large	8	8 (100)	100	0	0
	All	50	34 (68)	91	0	9
Fatehabad	**Marginal**	15	6 (40)	100	0	0
	Small	10	5 (50)	60	20	20
	Medium	12	6 (50)	67	17	17
	Large	12	3 (25)	100	0	0
	All	49	20 (41)	80	10	10
Over All	**Marginal**	67	39 (58)	80	0	21
	Small	29	19 (66)	74	5	21
	Medium	29	20 (69)	90	5	5
	Large	24	14 (58)	93	0	7
	All	149	92 (62)	83	2	15

* Others include such problems as non availability of purchased water in required quantity and/or at required time, high cost of purchased water, low water table etc.

Will Improved Availability of Irrigation Water Promote Fertilizer Usage ?

Is the constraint on availability of adequate irrigation water affecting the level of fertilizer use and if adequate and timely availability of irrigation water were to be made available, are farmers willing to apply larger doses of fertilizers? Only 16 percent of the sampled farmers opined that they would consider increasing fertilizer use if irrigation water availability conditions were to improve (Table 4.9). A large majority - 84 percent of the sampled farmers were unwilling to increase their fertilizer usage even after water availability conditions were to improve. A similar response pattern is observed across all the size groups of farms. A somewhat similar pattern is observed across all the selected districts as well except Gurgaon where almost one fourth of sampled farmers responded that they were willing to increase their fertilizer usage in response to better availability of irrigation water.

Availability of Adequate Credit

Adequacy of credit a-priori is an important consideration in deciding about the use and dosage of fertilizers by the farmers. However of all the sampled farmers, less than 11 percent reported that availability of credit was adequate (Table 4.10). About 76 percent of the sampled farmers reported inadequate availability of credit while the remaining about 13 percent of the sampled farmers did not require credit. A somewhat similar scenario prevails across all the size groups of sampled farmers. Across districts however the situation somewhat differs. While almost all the sampled farmers in Fatehabad reported about inadequacy of the required credit, the proportion of such sampled farmers in Karnal was 78 percent and in Gurgaon this was 52 percent. About 22 percent of the sampled farmers in Gurgaon, 16 percent in Karnal and 2 percent in Fatehabad district did not require the credit facilities.

Table 4.9: Percent of Farmers who would increase fertilizer consumption if irrigation water availability were to improve

District	Category	Total Number of Sample Farmers	Percent of Farmers who would increase fertilizer consumption if irrigation water availability were to improve	
			Yes	No
Gurgaon	**Marginal**	28	28.6	71.4
	Small	10	20.0	80.0
	Medium	8	12.5	87.5
	Large	4	50.0	50.0
	All	50	26.0	74.0
Karnal	**Marginal**	24	12.5	87.5
	Small	9	11.0	89.0
	Medium	9	0	100.0
	Large	8	12.5	87.5
	All	50	10.0	90.0
Fatehabad	**Marginal**	15	6.7	93.3
	Small	10	30.0	70.0
	Medium	12	8.3	91.7
	Large	12	8.3	91.7
	All	49	12.2	87.8
Over All	**Marginal**	67	17.9	82.1
	Small	29	20.7	79.3
	Medium	29	6.9	93.1
	Large	24	16.7	83.3
	All	149	16.1	83.9

Table 4.10: Adequacy of Credit

District	Category	Total Number of Sample Farmers	Adequacy of Loan Amount Yes	No	Not Appl.
Gurgaon	**Marginal**	28	25.0	50.0	25.0
	Small	10	20.0	50.0	30.0
	Medium	8	12.5	87.5	0
	Large	4	75.0	0	25.0
	All	50	26.0	52.0	22.0
Karnal	**Marginal**	24	4.2	75.0	20.8
	Small	9	11.1	77.8	11.1
	Medium	9	11.1	88.9	0
	Large	8	0	75.0	25.0
	All	50	6.0	78.0	16.0
Fatehabad	**Marginal**	15	0	93.3	6.7
	Small	10	0	100.0	0
	Medium	12	0	100.0	0
	Large	12	0	100.0	0
	All	49	0	98.0	2.0
Over All	**Marginal**	67	11.9	68.7	19.4
	Small	29	10.3	75.9	13.8
	Medium	29	6.9	93.1	0
	Large	24	12.5	75.0	12.5
	All	149	10.7	75.8	13.4

Timeliness in Availability of Credit

Apart from the quantum and adequacy of loan availability, another important related factor influencing the decision making process is the timeliness in the availability of credit for the purpose. The performance on this aspect however was also not satisfactory. Of the 149 sampled farmers, less than 34 percent reported that that the credit availability was on time while another 56 percent were not satisfied with the timings of the availability of credit (Table 4.11). In comparison with marginal and small farmers, a much larger proportion of medium and large sampled farmers were not satisfied with the timing of availability of loan. The situation also differed between different districts. As against only 32 percent of the sampled farmers in Gurgaon who were not satisfied with

the timings of availability of loan, the proportion of such sampled farmers in Karnal and Fatehabad was 56 percent and 71 percent respectively.

Table 4.11 : Timeliness in Availability of Credit

District	Category	Total Number of Sample Farmers	Timeliness of Credit Availability Yes	No	Not Appl.
Gurgaon	**Marginal**	28	35.7	39.3	25.0
	Small	10	60.0	10.0	30.0
	Medium	8	50.0	50.0	0
	Large	4	75.0	0	25.0
	All	50	46.0	32.0	22.0
Karnal	**Marginal**	24	29.2	50.0	20.8
	Small	9	33.3	55.6	11.1
	Medium	9	33.3	66.7	0
	Large	8	8.3	62.5	25.0
	All	50	26.5	56.0	16.0
Fatehabad	**Marginal**	15	33.3	60.0	6.7
	Small	10	30.0	70.0	0
	Medium	12	33.3	66.7	0
	Large	12	8.3	91.7	0
	All	49	26.5	71.4	2.1
Over All	**Marginal**	67	32.8	47.8	19.4
	Small	29	41.4	44.8	13.8
	Medium	29	37.9	62.1	0
	Large	24	20.8	66.7	12.5
	All	149	33.6	53.0	13.4

Will Increased and Timely Availability of Credit Promote Larger Fertiliser Use?

The quantum of fertilizer use by farmers is influenced by a large number of factors of which availability of adequate credit to buy fertilizers is an important determining factor. In the present case however almost 92 percent of the sampled farmers reported that they were unlikely to increase their fertilizer usage even if more credit for purchase of fertilizers was made available (Table 4.12). Almost a similar response scenario is observed amongst all size group of farmers. This broad pattern also holds across all the

three surveyed districts with some exception in the case of Gurgaon district. In Gurgaon however 18 percent of the sampled farmers reported that they would consider increasing the quantum of fertilizer usage if more credit for the purpose were to be made available. A similar response was observed across all size group of farmers in Gurgaon.

The unwillingness of a large majority of sampled farmers to apply larger than current doses of fertilizers in response to increased availability of credit for the purpose could be due to the fact that either (i) the farmers are already using the required doses of fertilizers and/or (ii) the availability of credit for buying fertilizers is adequate and/or (iii) the marginal returns form use of additional fertilizers are less than the cost of credit.

Table 4.12 : More Credit More Fertilizer?

District	Category	Total Number of Sample Farmers	Percent of Farmers who reported increased use of fertilizers due to increased availability of credit	
			Yes	No
Gurgaon	**Marginal**	28	17.9	82.1
	Small	10	20.0	80.0
	Medium	8	12.5	87.5
	Large	4	25.0	75.0
	All	50	18.0	82.0
Karnal	**Marginal**	24	8.3	91.7
	Small	9	0	100.0
	Medium	9	0	100.0
	Large	8	0	100.0
	All	50	4.0	96.0
Fatehabad	**Marginal**	15	0	100.0
	Small	10	0	100.0
	Medium	12	0	100.0
	Large	12	8.3	91.7
	All	49	2.0	98.0
Over All	**Marginal**	67	10.4	89.6
	Small	29	6.9	93.1
	Medium	29	3.4	96.6
	Large	24	8.3	91.7
	All	149	8.1	91.9

Likely Impact of Increase in Fertilizer Prices on Fertilizer Consumption

To ascertain the price responsiveness of fertilizer consumption with respect to its price we enquired from the sampled farmers if they would contemplate reducing their fertilizer consumption if a small increase in the prices of fertilizers were to be effected. About 75 percent of the sampled farmers were forthwith that such an increase in fertilizer prices will not result in their using less than the current doses of fertilizers (Table 4.13). About 24 percent of the sampled farmers however responded that they might reduce their fertilizer consumption while about 1 percent of the sampled farmers were not sure about the impact small increases in fertilizer prices would have on their fertilizer usage. Across farm size groups almost a similar pattern of response emerged though there were some differences across different size groups. While more than 86 percent of the sampled farmers belonging to the small farmer category opined that an increase in fertilizer prices over a small range would not lead to a decrease in fertilizer consumption, about 66 percent of the sampled farmers belonging to medium size group shared such a perception.

Across sampled districts there were however some significant differences. As against 84 percent of the sampled farmers of Karnal and 80 percent of Fatehabad who were of the view that small increases in fertilizer prices would not affect their level of use of fertilizers, only 60 percent of the sampled farmers of Gurgaon agreed with this perception. The inter-district differences in response could possibly be on account of differences in cropping patterns.

Ability to Identify Soil Nutrient Deficiency

The sampled farmers were asked if they could on their own identify soil nutrient deficiency. About 23 percent of the sampled farmers responded in the affirmative while the remaining 77 percent farmers responded that they could not (Table 4.14). Proportionately a relatively larger proportion of medium and large sampled farmers could identify the soil nutrient deficiency as compared to marginal and small farmers. A comparison across districts suggest that as against 30 percent of the sampled farmers in

Karnal who could identify soil nutrient deficiency, the proportion of such farmers was 25 percent in Fatehabad and 14 percent in Gurgaon.

Table 4.13 : Impact of Increase in Fertilizer Price on Consumption of Fertilizers

District	Category	Total Number of Sample Farmers	Will Increase in Fertilizer Price Reduce Fertilizer Consumption? Percent of Farmers Responding		
			Yes	No	Uncertain
Gurgaon	**Marginal**	28	32.1	67.9	0
	Small	10	20.0	80.0	0
	Medium	8	87.5	12.5	0
	Large	4	50.0	50.0	0
	All	50	40.0	60.0	0
Karnal	**Marginal**	24	20.8	79.2	0
	Small	9	0	100.0	0
	Medium	9	11.1	88.9	0
	Large	8	25.0	75.0	0
	All	50	16.0	84.0	0
Fatehabad	**Marginal**	15	20.0	73.3	6.7
	Small	10	20.0	80.0	0
	Medium	12	16.7	83.3	0
	Large	12	8.3	83.3	8.3
	All	49	16.3	79.6	4.1
Over All	**Marginal**	67	25.4	73.1	1.5
	Small	29	13.8	86.2	0
	Medium	29	34.5	65.5	0
	Large	24	20.8	75.0	4.2
	All	149	24.2	74.5	1.3

Table 4.14: Ability to Identify Nutrient Deficiency in Soil

District	Category	Total Number of Sample Farmers	Percent of Farmers Who Could Identify Yes	No
Gurgaon	**Marginal**	28	14.3	85.7
	Small	10	10.0	90.0
	Medium	8	0	100.0
	Large	4	50.0	50.0
	All	50	14.0	86.0
Karnal	**Marginal**	24	16.7	83.3
	Small	9	22.2	77.8
	Medium	9	33.3	66.7
	Large	8	75.0	25.0
	All	50	30.0	70.0
Fatehabad	**Marginal**	15	13.3	86.7
	Small	10	20.0	80.0
	Medium	12	33.3	66.7
	Large	12	33.3	66.7
	All	49	24.5	75.5
Over All	**Marginal**	67	14.9	85.1
	Small	29	17.2	82.8
	Medium	29	24.1	75.9
	Large	24	50.0	50.0
	All	149	22.8	77.2

Testing of Soil

Determination of appropriate doses of fertilizers to be applied require occasional testing of soil for nutrient content. The extent to which farmers actually resort to such a practice would depend upon several factors including on the awareness about the utility of undertaking soil testing and the availability of testing facilities. During the course of our survey we tried to ascertain from the sampled farmers if they have ever got their soil/ water samples tested. Almost 85 percent of the sampled farmers responded that they have never got their soil/water samples tested (Table 4.15). Across farm size groups however there are some noticeable differences. While about 96 percent of the sampled farmers belonging to marginal and small farmer categories had not got their soil/ water samples

tested, the percentage of such farmers belonging to medium and large size categories was 69 and 58 percent respectively.

A comparison across districts suggest that farmers in Karnal were relatively better placed than those in Fatheabad and Gurgaon districts. As against 74 percent of the sampled farmers who have not had got their samples tested in Karnal, the proportion of such farmers in Gurgaon and Fatheabad was 88 and 92 percent respectively.

Table 4.15: Soil Testing

District	Category	Total Number of Sample Farmers	Percent of Farmers who got tested soil/water	
			Yes	No
Gurgaon	**Marginal**	28	3.6	96.4
	Small	10	0	100
	Medium	8	12.5	87.5
	Large	4	100	0
	All	50	12	88.0
Karnal	**Marginal**	24	4.2	95.8
	Small	9	11.1	88.9
	Medium	9	66.7	33.3
	Large	8	62.5	37.5
	All	50	26.0	74.0
Fatehabad	**Marginal**	15	6.7	93.3
	Small	10	0	100
	Medium	12	16.7	83.3
	Large	12	8.3	91.7
	All	49	8.2	91.8
Over All	**Marginal**	67	4.5	95.5
	Small	29	3.4	96.6
	Medium	29	31.0	69.0
	Large	24	41.7	58.3
	All	149	15.4	84.6

Adequacy of Soil Testing facilities

One of the reasons for such a low percent of sampled farmers responding about non testing of their soils for nutrient content could be the non availability of adequate soil testing facilities. More than 80 percent of the sampled cultivators reported inadequacy of fertilizer testing facilities in Haryana (Table 4.16). The adequacy in availability of these facilities however differs across different study zones. While about 34 percent of the sampled farmers in Karnal reported adequate availability of fertilizer facilities, only 8 percent of sampled farmers in Fatheabad and 16 percent in Gurgaon reported adequacy of fertilizer testing facilities. Across farm size groups relatively larger proportion of medium and large sampled farmers reported adequate availability of fertilizer testing facilities as compared to marginal and small farmers. This holds true, by and large, for all the districts.

Use of Fertilizers on the Basis of Soil Test

To ascertain if the farmers who get their soil tested actually follow the recommendations on the use of fertilizers we asked the sampled farmers if they were applying fertilizers on the basis of the recommendations given by the soil testing laboratories. Of the total sampled farmers, about 15 percent had got their soil tested for determining the appropriate fertilizer doses that need to be applied. Of those who got their soil tested however only 50 percent actually followed the recommendation on the dosage of fertilizer that actually need to be applied (Table 4.17). The remaining 50 percent however did not actually follow the advise given by the soil testing laboratories. The proportion of farmers who got their soil tested was much higher in medium and large size categories of farms as compared to marginal and small farms. The proportion of farmers actually following the recommendations on the use of fertilizer was much higher in large farm size group category as compared to the other size groups of farms. Across districts, the proportion of sampled farmers who got their soil tested was much higher in Karnal (26 percent) as compared to Gurgaon (12 percent) and Fatehabad (8 percent)

Table 4.16 : Adequacy of Soil Testing Facilities

District	Category	Total Number of Sample Farmers	Percent of Farmers who reported facilities are adequate	
			Yes	No
Gurgaon	**Marginal**	28	10.7	89.3
	Small	10	10.0	90.0
	Medium	8	12.5	87.5
	Large	4	75.0	25.0
	All	50	16.0	84.0
Karnal	**Marginal**	24	20.8	79.2
	Small	9	22.2	77.8
	Medium	9	66.7	33.3
	Large	8	50.0	50.0
	All	50	34.0	66.0
Fatehabad	**Marginal**	15	13.3	86.7
	Small	10	0	100.0
	Medium	12	8.3	91.7
	Large	12	8.3	91.7
	All	49	8.2	91.8
Over All	**Marginal**	67	14.9	85.1
	Small	29	10.3	89.7
	Medium	29	27.6	72.4
	Large	24	33.3	66.7
	All	149	19.5	80.5

Table 4.17 : Number of Farmers Following the Recommendations on Fertilizer Application

District	Category	Total Number of Sample Farmers	Number of Farmers who got tested	Number of Farmers Who followed the tested recommendations with respect to fertilizer use	
				Yes	No
Gurgaon	**Marginal**	28	1	0	1
	Small	10	0	0	0
	Medium	8	1	0	1
	Large	4	4	3	1
	All	50	6	3	3
Karnal	**Marginal**	24	1	0	1
	Small	9	1	1	0
	Medium	9	6	2	4
	Large	8	5	3	2
	All	50	13	6	7
Fatehabad	**Marginal**	15	1	1	0
	Small	10	0	0	0
	Medium	12	2	1	1
	Large	12	1	1	0
	All	49	4	3	1
Over All	**Marginal**	67	3	1	2
	Small	29	1	1	0
	Medium	29	9	3	6
	Large	24	10	7	3
	All	149	23	12	11

Adoption of Practices of Green Manuring

Green manuring practices have not been very popular with farmers in the study region though green manuring can help save on use of chemical fertilizers. Of the 149 surveyed farmers in the present study 95 percent farmers did not practice green manuring (Table 4.18). Most of the farmers who practiced green manuring belonged to large size group of farms. In fact 21 percent of the farmers in the large size group practiced green manuring. Across districts green manuring was highest in Karnal while in Fatehabad none of the sampled farmers reported having practiced green manuring.

Table 4.18 : Extent of Adoption of Green Manuring

District	Category	Total Number of Sample Farmers	Percent of Farmers Practicing Green Manuring Yes	No
Gurgaon	**Marginal**	28	0	100
	Small	10	0	100
	Medium	8	0	100
	Large	4	50	50
	All	50	4	96
Karnal	**Marginal**	24	0	100
	Small	9	11.1	88.9
	Medium	9	11.1	88.9
	Large	8	37.5	62.5
	All	50	10.0	90.0
Fatehabad	**Marginal**	15	0	100
	Small	10	0	100
	Medium	12	0	100
	Large	12	0	100
	All	49	0	100
Over All	**Marginal**	67	0	100
	Small	29	3.4	96.6
	Medium	29	3.4	96.6
	Large	24	20.8	79.2
	All	149	4.7	95.3

Policy Preference : Low Fertiliser Prices vs Higher Minimum Support Prices (MSP) for Crop Output

Should there be a policy option for the Government in either lowering the fertilizer prices or increasing the MSP of the crop output what would be the preferred choice of farmers? While without specifying the quantum of either reduction in fertilizer prices or increase in MSP it is difficult to specify which option would be more beneficial for the farmer, we nevertheless attempted to ascertain from the sampled farmers their preference for such a policy choice if these prices were to change on the margin. As expected, the results presented in Table 4.19 suggest that a majority of the farmers would like both policies to be effected – a reduction in fertilizer prices and an increase in MSP. Thus while 55 percent of the sampled farmers wanted both the policy options to be

implemented if there was a choice, about 22 percent sampled farmers preferred reduction in fertilizer prices alone and almost the same proportion preferred increase in MSP. Across size groups also a larger proportion of sampled farmers in all the size groups also preferred both the policy options. However of those giving their preference between the two policy options, while relatively larger proportion of sampled marginal and small farmers preferred lower fertiliser prices as a preferaeble choice, a relatively larger proportion of medium and large farmers preferred higher MSP of crop output as a preferred choice. Such a response is however expected due to relatively larger marketable surplus available with medium and large size groups of farmers as compared to marginal and small farmers. Across sampled districts also the preference pattern of sampled farmers does not differ substantially.

Table 4.19 : Pricing Policy Preference : Low Fertiliser Prices vs Higher MSP

District	Category	Total Number of Sample Farmers	**Pricing Policy Preference** Low Fert Prices	High MSP	Low Fert Prices and High MSP
Gurgaon	**Marginal**	28	35.7	21.4	42.9
	Small	10	20.0	10.0	70.0
	Medium	8	12.5	0	87.5
	Large	4	25.0	25.0	50.0
	All	50	28.0	16.0	56.0
Karnal	**Marginal**	24	20.8	20.8	58.3
	Small	9	33.3	22.2	44.4
	Medium	9	0	33.3	66.7
	Large	8	12.5	37.5	50.0
	All	50	18.0	26.0	56.0
Fatehabad	**Marginal**	15	26.7	13.3	60.0
	Small	10	30.0	40.0	30.0
	Medium	12	25.0	16.7	58.3
	Large	12	0	41.7	58.3
	All	49	20.4	26.5	53.1
Over All	**Marginal**	67	28.4	19.4	52.2
	Small	29	27.6	24.1	48.3
	Medium	29	13.8	17.2	69.0
	Large	24	8.3	37.5	54.2
	All	149	22.1	22.8	55.0

Major Source of Information For Determining the Doses of Fertilisers/ Micro Nutrients to Different Crops

Most of the farmers in the study region have been cultivating the same crops over a number of years and have to a large extent perfected the art of cultivation practices and doses of various inputs that need to be applied to these crops. However with changing soil - climatic conditions over the years, the farmers need to make necessary adjustments in use and application of various inputs. To ascertain who guides the farmers in taking appropriate decisions with regard to quantity and timing of application of fertilizers, we asked the farmers to list major sources of their information on use of fertilisers. While in general farmers do discuss these issues with a number of possible sources however they are generally influenced relatively more by one of these sources. The results obtained suggest that the major source of information for the farmers is fellow farmers/ friend and relatives (Table 4.20). More than 47 percent of the sampled farmers reported this as their major source of their information. Another important source of information on this aspect is the extension personnel/ agricultural university which was reported by about 32 percent of the sampled farmers. Fertilizer dealer is another source to whom farmers turn for advise. About 14 percent of the sampled farmers quoted fertilizer dealer as their major source of information. Across districts also the major source of information for the sampled farmers was similar.

Table 4.20: Major Source of Information For Determining the Doses of Fertilisers/ Micro Nutrients to Different Crops

District	Category	Total Number of Sample Farmers	Percent of Sampled Farmers Reporting the Following as Major Information Source					
			Relatives/ Friends	Extn Agencies/ University	Media	Fertilizer Dealer	Others	
Gurgaon	**Marginal**	28	46.4	17.9	17.9	10.7	7.1	
	Small	10	70.0	20.0	10.0	0	0	
	Medium	8	50.0	37.5	0.0	12.5	0	
	Large	4	0	100.0	0.0	0	0	
	All	50	48.0	28.0	12.0	8.0	4.0	
Karnal	**Marginal**	24	50.0	33.3	0	16.7	0	
	Small	9	55.6	44.4	0	0	0	
	Medium	9	44.4	22.2	0	33.3	0	
	Large	8	37.5	62.5	0	0	0	
	All	50	48.0	38.0	0	14.0	0	
Fatehabad	**Marginal**	15	53.3	26.7	0	13.3	6.7	
	Small	10	60.0	30.0	0	10.0	0	
	Medium	12	41.7	25.0	0	25.0	8.3	
	Large	12	25.0	41.7	0	33.3	0	
	All	49	44.9	30.6	0	20.4	4.1	
Over All	**Marginal**	67	49.3	25.4	7.5	13.4	4.5	
	Small	29	62.1	31.0	3.4	3.4	0	
	Medium	29	44.8	27.6	0	24.1	3.4	
	Large	24	25.0	58.3	0	16.7	0	
	All	149	47.0	32.2	4.0	14.1	2.7	

CHAPTER V

IMPACT OF FERTILIZERS ON CROP PRODUCTIVITY – MICRO LEVEL ANALYSIS

In this chapter we have analysed the marginal product of fertilizer for two major crops – wheat and rice. The analysis is carried out separately for each of the three districts from where the sample of households was drawn for the present study, and all the districts combined. Basic data on wheat and paddy yield is presented in Table 5.1. Wheat yield on sampled farms was highest in Karnal district – about 44 qtls/ha followed by Fatehabad (34 qtls/ha) and Gurgaon (33 qtls/ha). Overall, the wheat yield of sampled farms was 37 qtls/ha. In the case of paddy, the highest yield was reported in Fatehabad (41 qtls/ha) followed by Karnal (38 qtls/ha) and Gurgaon (32 qtls/ha). The average yield of the pooled sample was 39 qtls/ha.

Table 5.1: Output of Wheat and Paddy (Qtl./ha)

		Wheat	Paddy
District	**Category**		
Gurgaon	**Marginal**	33.48	33.33
	Small	31.60	33.33
	Medium	31.18	25.83
	Large	34.58	34.74
	All	32.94	32.05
Karnal	**Marginal**	36.42	36.41
	Small	39.31	35.37
	Medium	36.73	35.47
	Large	49.61	40.82
	All	43.51	38.26
Fatehabad	**Marginal**	39.27	35.19
	Small	35.88	53.33
	Medium	39.40	34.49
	Large	30.99	42.90
	All	33.94	41.36
Over All	**Marginal**	36.11	36.28
	Small	36.03	36.89
	Medium	36.84	34.48
	Large	37.42	41.29
	All	36.95	38.88

A production function of the following form was fitted to the data collected from sampled households to estimate marginal productivity and economic efficiency of fertilizer use.

$Y = f$ [IA, SEED, HLO, MLO, LI, N, P]

where

Y- yield in kg per hectare

IA - percentage of irrigated area

SEED - seed input per hectare

HLO - human labour use in operations (other than irrigation)

MLO - machine labour use in operations (other than irrigation)

LI - labour use in irrigation (human + machine)

N - consumption of N

P - consumption of P

The above equation was fitted to the sample household data of each of the districts and for the pooled sample. The OLS regression errors showed presence of heteroscedasticity. Therefore, method of weighted least squares (WLS) with cropped area as the weighing variable, has been used for estimation.

Wheat: The above model was fitted to the sample data of all the three districts and the pooled data to derive state level estimates. For the pooled sample (Table 5.2), the results show a good fit with the seed input, human labour use in operations, consumption of N and P showing significant positive effect on yield with elasticities of 0.43, 0.28, 0.18 and 0.15 respectively. The machine labour use in operations and labour use in irrigation show negative effect.

In Karnal district (Table 5.3), the major determinants of wheat yield appear to be consumption of N and P with positive and significant elasticities of 0.21 and 0.08 respectively. All the other variables show non-significant effect.

Table 5.2: Estimates of Wheat Production Function – Pooled Sample

Explanatory Variable	Elasticity	Marginal Product (qtls)	Output Price (Rs/kg)	Marginal Value Product Rs)
Nitrogen	0.18*	0.07	6.18	41.16
Phosphorous	0.15*	0.14		88.99
Irrigated Area	-			
Seed	0.43*			
Human Labor (operations other than irrgn)	0.28*			
Machine Labor (operations other than irrgn)	-0.20**			
Labor Use in Irrigation	-0.03			
R Bar Sq	0.99			

Table 5.3: Estimates of Wheat Production Function – Karnal District

Explanatory Variable	Elasticity	Marginal Product (qtls)	Output Price (Rs/kg)	Marginal Value Product Rs)	Fertilizer Price (Rs/kg)
Nitrogen	0.21**	0.08	6.06	47.09	10.5
Phosphorous	0.08	0.09		52.36	16.22
Irrigated Area	-0.30				
Seed	-0.12				
Human Labor (operations other than irrgn)	-0.11				
Machine Labor (operations other than irrgn)	0.19				
Labor Use in Irrigation	-0.04				
R Bar Sq	0.98				

In Gurgaon district (Table 5.4), the results are slightly encouraging. Seed input, consumption of N and P and labour use in irrigation show positive effect on yield with elasticities of 0.89, 0.24, 0.06 and 0.05 respectively. All variables with the exception of irrigation are statistically significant. The human labour use in operations show

significant negative effect on yield, probably indicating the high level of mechanization in Haryana.

In Fatehabad district (Table 5.5), only one variable – human labour use in operations show significant positive effect on yield. Seed input, machine labour in operations and labour use in irrigation show either significant negative effect or are non-significant. The consumption of N and P appear to have a negative but non-significant effect on yield.

Table 5.4: Estimates of Wheat Production Function – Gurgaon District

Explanatory Variable	Elasticity	Marginal Product (qtls)	Output Price (Rs/kg)	Marginal Value Product Rs)	Fertilizer Price (Rs/kg)
Nitrogen	0.24*	-0.10	6.37	62.68	10.5
Phosphorous	0.06*	0.06		37.46	16.22
Irrigated Area	-				
Seed	0.88***				
Human Labor (operations other than irrgn)	-0.76*				
Machine Labor (operations other than irrgn)	0.14				
Labor Use in Irrigation	0.05				
R Bar Sq	0.97				

Table 5.5: Estimates of Wheat Production Function – Fatehabad District

Explanatory Variable	Elasticity	Marginal Product (qtls)	Output Price (Rs/kg)	Marginal Value Product Rs)	Fertilizer Price (Rs/kg)
Nitrogen	-0.03	-0.01	6.11	-6.60	10.5
Phosphorous	-0.01	-0.08		-5.32	16.22
Irrigated Area	-				
Seed	-1.85**				
Human Labor (operations other than irrgn)	0.52**				
Machine Labor (operations other than irrgn)	-0.75***				
Labor Use in Irrigation	0.05				
R Bar Sq	0.94				

The value of the marginal product (VMP) of N and P is much higher than the marginal factor cost (MFC) of the respective nutrients in Karnal and Gurgaon (Table 5.6). However in Fatehabad, fertilizer shows negative return, probably due to poor quality of irrigation.

Table 5.6: Value of Marginal Product and Marginal Factor Cost of Fertilizer of Wheat Farming in Haryana

Fertilizer Nutrient	**VMP/MFC**	**Karnal**	**Gurgaon**	**Fatehabad**	**Overall**
N	VMP	47.09	62.68	-6.60	41.16
	MFC	10.50	10.50	10.50	10.50
P	VMP	50.36	37.45	-5.32	88.99
	MFC	16.22	16.22	16.22	16.22

Rice: The above model was also fitted to sample household data in each of the three districts and the pooled data to derive state level estimates. Very few sampled households in the district of Gurgaon were cultivating paddy. Therefore, this district has been excluded from this analysis. The results show good fit at the state level (Table 5.7). The major determinants of rice yield are irrigated area (IA) and machine labour use in operations (MLO), with statistically significant elasticities of 0.07 and 0.14 respectively. The human labour use in operations (HLO) and labour use in irrigation (LI), which is predominantly human labour, show significant negative coefficients, possibly reflecting the extent of mechanization in Haryana. Similarly expenditure on seeds is also negative. This could be due to the fact that the seed use in rice is mainly through transplantation. The fertilizer consumption of N and P show the expected positive signs but are statistically non significant. This could be due to the fact that fertilizer use is already very high in Haryana and the marginal supply response is therefore very low.

Table 5.7: Estimates of Rice Production Function – All Districts

Explanatory Variable	Elasticity	Marginal Product (qtls)	Output Price (Rs/kg)	Marginal Value Product Rs)	Fertilizer Price (Rs/kg)
Nitrogen	0.05	0.02	6.5	11.05	10.5
Phosphorous	0.05	0.06		37.38	16.22
Irrigated Area	0.07***				
Seed	-0.42***				
Human Labor (operations other than irrgn)	-0.46**				
Machine Labor (operations other than irrgn)	0.14***				
Labor Use in Irrigation	-0.10***				
R Bar Sq	0.98				

The results for Karnal district are very similar to those at the state level (Table 5.8). Fertilizer consumption (of N and P) has no significant effect on yield while seed input has a significant negative effect. Surprising result in this district is the positive and significant elasticity of 0.3 for human labour use in operations.

Table 5.8: Estimates of Rice Production Function – Karnal District

Explanatory Variable	Elasticity	Marginal Product (qtls)	Output Price (Rs/kg)	Marginal Value Product Rs)	Fertilizer Price (Rs/kg)
Nitrogen	0.11	0.03	5.84	19.91	10.5
Phosphorous	0.09	0.10		57.82	16.22
Irrigated Area	-				
Seed	-0.74***				
Human Labor (operations other than irrgn)	0.29*				
Machine Labor (operations other than irrgn)	-				
Labor Use in Irrigation	-				
R Bar Sq	0.97				

The results for Fatehabad district are also similar to those at the state level (Table 5.9). Irrigation and machine labour use in operations show significant positive coefficient while human labour and seed input show significant negative coefficients. Consumption of N shows a negative effect on yield but is non-significant. However, consumption of P appears to have a significant positive effect on yield with an elasticity of 0.03.

The VMP of P is much higher than the MFC of P (Table 5.10). However in case of N, VMP is higher then MFC only in Karnal and is negative in Fatehabad. Overall, VMP is much higher than MFC in case of P as compared to N.

Table 5.9: Estimates of Rice Production Function – Fatehabad District

Explanatory Variable	Elasticity	Marginal Product (qtls)	Output Price (Rs/kg)	Marginal Value Product Rs)	Fertilizer Price (Rs/kg)
Nitrogen	-0.03	-0.01	7.51	-10.14	10.5
Phosphorous	0.03*	0.04		28.16	16.22
Irrigated Area	0.11*				
Seed	-0.77**				
Human Labor (operations other than irrgn)	-1.91***				
Machine Labor (operations other than irrgn)	0.40**				
Labor Use in Irrigation	-				
R Bar Sq	0.98				

Table 5.10: Value of Marginal Product and Marginal Factor Cost of Fertilizer of Rice Farming in Haryana

Fertilizer Nutrient	**VMP/MFC**	**Karnal**	**Fatehabad**	**Overall**
N	VMP	19.91	-10.14	11.05
	MFC	10.50	10.50	10.50
P	VMP	57.82	28.16	37.38
	MFC	16.22	16.22	16.22

The analysis presented in this Chapter thus show that in the case of wheat, consumption of N and P appear to be significant determinants of yield in two of the three districts and also for the pooled sample. The value of the marginal product of fertilizer use (VMP) is also much higher than the marginal factor cost of fertilizer (MFC) in these two districts – Karnal and Gurgaon. No other variable appears to affect wheat yield significantly.

In the case of rice, N and P do not show significant effect on crop yield. The major determinants of rice yield appear to be irrigated area (IA) and machine labour use in operations (MLO). However, human labour use in operations (HLO) and seed input

(SEED) show significant negative effects. The VMP of P much is higher than the corresponding MFC as compared to N.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Rationale for the Study and Study Objectives

The need to intensify agricultural production in the wake of the slow pace of growth in agricultural output realized in the recent past coupled with the rising demand for agricultural commodities, declining per capita availability of arable land, deteriorating position of availability of natural resources such as water, and the desire to maintain a high growth rate of aggregate GDP for the Indian economy has put the agricultural sector back at the center stage of India' planning process. In the absence of any significant breakthrough in agricultural production technology having been achieved in the last several years, achieving the desired levels of agricultural production in the short to medium run would require making more concerted efforts towards bridging the crop productivity gaps attainable with existing technology. The demonstrated capability of chemical fertilizers, an important component of the available agricultural production technology, in increasing the crop productivity and raising the farm profitability provides some ray of hope. While the fertilizer consumption, both in absolute terms as well as on per hectare basis, has increased manifold over the years, however in the last few years the growth has not been satisfactory. Apart from wide inter-regional disparities in consumption of fertilizer, there are severe imbalances in usage of different nutrients. The current fertilizer usage pattern thus offers more scope for not only increasing the consumption of fertilizers but their more efficient usage and the scope intensive and balanced use of fertilizers holds for increased agricultural production, productivity, farm profitability and a more sustainable resource base.

The present study, suggested by the Department of Fertilizers, Ministry of Chemicals and Fertilizers, Government of India has been undertaken by Agro-Economic Research

Centres (AERCs) located in Delhi, Chennai, Jorhat, Ludhiana and Vishva Bharati at the instance of the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. The study has been co-ordinated by AERC, Ludhiana who has also provided the study design and the methodology for the study. The larger study attempts to analyze the trends in fertilizer consumption and identify factors affecting growth/ stagnation in fertilizer consumption over time and in different regions of the country. The study also attempts to assess the impact of fertilizer use on productivity of selected crops and the economic efficiency of fertilizer use for important crops in different states Based on this analysis the study attempts to suggest some remedial measures to boost fertilizer use in the country to achieve the targets set for agricultural production. The present report relates to the state of Haryana. The specific objectives of the present study are:

- Analyze the trends in fertilizer use over time and across different farm size categories.
- Identify the determinants of fertilizer consumption
- Assess the impact of fertilizer use on productivity of select crops and also the economic efficiency of fertilizer use.

Data Base

The study utilizes both secondary as well as primary data. Time series data at the State level on fertilizer consumption and the various determining factors of fertilizer use has been collected for the period 1970-71 to 2003-04. The two sub-periods are – Period I (stable fertilizer consumption) from 1970-71 to 1988-89 and period II (stagnant fertilizer consumption) from 1989-90 to 2003-04.

To analyse the pattern of fertilizer use across various size-groups, the impact of fertilizer use on crop production, and to analyse the economic efficiency of use of fertilizers, primary data was collected from 150 sampled households covering marginal (< 1 ha), small (1-2 ha), medium (2-4 ha) and large (>4 ha) categories of farms. Multistage random sampling technique was adopted with districts, blocks and villages forming the different

stages of sample selection. The districts of the state were divided into three groups – high, medium and low based on their share of fertilizer consumption and one district was selected from each group. The districts thus selected for the study were Karnal, Gurgaon and Fatheabad.

Growth in Fertilizer Consumption

During the period 1970-71 to 2003-04, the total consumption of N in Haryana grew by more than 8% per annum, that of P by 11.5 percent while the consumption of K grew by 6.0%. The growth rates in consumption of total fertilizer use as well as for the three nutrients individually were however much higher in the first sub period (1970-71 to 1988-89) as compared to the second sub period (1989-90 to 2003-04. For wheat, the fertilizer use per hectare over the entire period of analysis from 1970-71 to 2003-04 increased on an average by 6.10 percent per annum while for rice the fertilizer consumption increased by about 5 percent per annum. As in the case of total fertilizer consumption, the growth rates of fertilizer consumption per hectare for both wheat and rice were much higher in the first sub period as compared to the second sub period. During this period the rates of growth in crop yields of wheat and rice differed. While the crop yield in the case of wheat increased by an average of 2.9 percent per annum, the growth in yield of rice was much smaller at 1.19 percent per annum

Determinants of Fertilizer Consumption – State Level

An econometric analysis of the major determinants of fertilizer consumption at the state level indicates that the relative prices and percentage of irrigated area are the two most important factors influencing fertilizer consumption. Lagged dependent variable is also a determinant in case of wheat but not in the case of rice. Fertilizer consumption, in turn, appears to be a major causal factor of yield increases for both the crops. Lagged yield is another major determinant of the yield level.

Pattern of Fertilizer Consumption – Farm Level

An analysis of the primary data collected from sampled farmers from the three selected districts of Haryana show that for the pooled sample, wheat and paddy combined together accounted for about 63 percent of the gross cropped area (GCA) while cotton accounted for 12 percent and bajra for another about 7 percent. Fodder crops (kharif plus rabi) accounted for 10 percent of the gross cropped area. Across farm size groups, the proportion of area allocated to wheat as also that allocated to paddy increased somewhat as one moves from marginal to large size farms. However the proportion of area allocated to bajra declined from marginal to large farms.

The cropping pattern however showed marked differences across different districts. While wheat continues to be the most important crop in all the three districts during the rabi season, the pattern differs in kharif season. While paddy was the most predominant crop of the kharif season in Karnal district, bajra in Gurgaon and cotton in Fatehabad occupied the largest proportion of GCA during kharif season. Wheat and paddy occupied about 87 percent of GCA in Karnal; wheat, paddy and bajra accounted for about 63 percent GCA in Gurgaon; while wheat and cotton together accounted for about 73 percent of GCA in Fatehabad.

For the pooled sample the average fertilizer nutrient use per hectare for wheat work out to 150 kgs of N and 67 kgs of P, while nutrient use per hectare for paddy work out to 167 kgs of N and 50 kgs of P. The average quantity of P use on both the focused crops within the selected districts as also for both the crops across different districts did not differ significantly. In the case of use of N, while the quantum of N use did not differ across crops within a given district, the level of N use for both the crops differed significantly across districts. However in general there was no apparent systematic trend in quantum of fertilizer usage with the size of holding. From amongst the three districts surveyed, the fertilizer use on wheat and paddy in Karnal was higher by 20 to 30 percent than the other two districts. The wheat yield in Karnal was also higher in Karnal by about 30 percent as compared to the other two districts.

Amongst the factors that could help promote fertilizer usage and/ or its more efficient use adequate and timely availability irrigation is the most important. While the entire cropped area of the sampled farmers in all the three districts was fully irrigated, however a large proportion of farmers had problems with the quantum and timeliness in availability of irrigation water. The most important reason attributed to such a situation was inadequacy and unreliability of electricity supply for pumping irrigation water. However more than 84 percent of the sampled farmers were unwilling to increase their fertilizer usage even if the supply of electricity were to be made more regular and reliable.

Along with irrigation, availability of adequate credit for purchase of fertilizers and its availability at the required time is another important that governs the fertilizer usage by farmers. About 76 percent of the sampled farmers reported problems in getting adequate credit. Similarly about 56 percent farmers complained about the timings in availability of the required credit. However almost 92 percent of the sampled farmers responded that they were unlikely to increase their fertilizer usage by any significant amount even if more credit were to be made available for purchase of fertilizers. The unwillingness of a large majority of sampled farmers to apply larger than current doses of fertilizers in response to increased availability of credit for the purpose could be due to the fact that either (i) the farmers are already using the required doses of fertilizers and/or (ii) the availability of credit for buying fertilizers is adequate and/or (iii) the marginal returns form use of additional fertilizers are less than the cost of credit.

To ascertain the price responsiveness of fertilizer consumption with respect to its price we enquired from the sampled farmers if they would contemplate reducing their fertilizer consumption if a small increase in the prices of fertilizers were to be effected. About 75 percent of the sampled farmers were forthwith that such an increase in fertilizer prices will not result in their using less than the current doses of fertilizers

Determination of appropriate doses of fertilizers to be applied require occasional testing of soil for nutrient content. The extent to which farmers actually resort to such a practice however depends upon several factors including on the awareness about the utility of

undertaking soil testing and the availability of testing facilities. Almost 85 percent of the sampled farmers responded that they have never got their soil/water samples tested. One of the reasons for such a low percent of sampled farmers responding about non testing of their soils for nutrient content could be the non availability of adequate soil testing facilities. More than 80 percent of the sampled cultivators reported inadequacy of fertilizer testing facilities in Haryana. To ascertain if the farmers who get their soil tested actually follow the recommendations on the use of fertilizers we asked the sampled farmers if they were applying fertilizers on the basis of the recommendations given by the soil testing laboratories. Of the total sampled farmers, about 15 percent had got their soil tested for determining the appropriate fertilizer doses that need to be applied. Of those who got their soil tested however only 50 percent actually followed the recommendation on the dosage of fertilizer that actually need to be applied (Table 4.17). The remaining 50 percent however did not actually follow the advise given by the soil testing laboratories.

Green manuring practices have not been very popular with farmers in the study region though green manuring can help save on use of chemical fertilizers. Of the 149 surveyed farmers in the present study 95 percent farmers did not practice green manuring

Most of the farmers in the study region have been cultivating the same crops over a number of years and have to a large extent perfected the art of cultivation practices and doses of various inputs that need to be applied to these crops. However with changing soil - climatic conditions over the years, the farmers need to make necessary adjustments in use and application of various inputs. To ascertain who guides the farmers in taking appropriate decisions with regard to quantity and timing of application of fertilizers, we asked the farmers to list major sources of their information on use of fertilizers. While in general farmers do discuss these issues with a number of possible sources however they are generally influenced relatively more by one of these sources. The results obtained suggest that the major source of information for the farmers is fellow farmers/ friend and relatives. More than 47 percent of the sampled farmers reported this as their major source of their information. Another important source of information on this aspect is the extension personnel/ agricultural university which was reported by about 32 percent of

the sampled farmers. Fertilizer dealer is another source to whom farmers turn for advise. About 14 percent of the sampled farmers quoted fertilizer dealer as their major source of information.

Determinants of Crop Yield: Farm Level Analysis

An analysis of the determinants of yields of wheat and paddy based on the primary data collected from the sampled farmers suggest that in the case of wheat, consumption of N and P appear to be significant determinants of yield in two of the three districts and also for the pooled sample. The value of the marginal product of fertilizer use (VMP) is also much higher than the marginal factor cost of fertilizer (MFC) in these two districts – Karnal and Gurgaon. No other variable appears to affect wheat yield significantly.

In the case of paddy, N and P do not show significant effect on crop yield. The major determinants of paddy yield appear to be irrigated area (IA) and machine labor use in operations (MLO). However, human labor use in operations (HLO) and seed input (SEED) show significant negative effects. The VMP of P much is higher than the corresponding MFC as compared to N.

Conclusions

The data presented and results obtained clearly indicate that although there are inter-regional differences in fertilizer consumption and the fertilizer consumption also differs between the analyzed important crops, yet the fertilizer consumption is quite high in Haryana both with respect to most of the other regions of the country as also in comparison to the recommended fertilizer dosages by the scientists. This however does not imply that Haryana has exhausted all the avenues for increasing fertilizer consumption and/ or using the fertilizers more efficiently. The results obtained have shown that the value of marginal product of fertilizer usage at current level of usage is still higher than marginal factor cost of fertilizers.

As the analysis presented has shown that there is a tendency on the part of the farmers to use higher doses of N as compared to other nutrients leading to imbalances in the use of

different nutrients resulting in nutrient deficiency which affects soil health leading to soil fatigue with resultant impact on crop yields. While the imbalanced use of fertilizers by the farmers could partly be attributed to the lack of his awareness on the aspect of soil health and its nutrition balance, the distorting role of fertilizer pricing policy, availability and management of fertilizers are also to blame. Though not analyzed in the present study, besides these nutrients, other widespread mineral deficiencies such as gypsum and carbon content in the soil, also affect the fertilizer use efficiency. Appropriately devised nutritional management programs comprising of soil testing, distribution of soil health cards to all the farmers and creating awareness on farm nutrition management would need to be taken up on a priority basis. Adequate soil testing facilities within easy reach of the farmers would need to be provided to enable them get their soil tested for efficient fertilizer usage. This would need to be supplemented by appropriate extension facilities to make farmers understand the necessity of following these recommendations of the soil testing and basing their fertilizer usage on these recommendations.

One of the major determinants of fertilizer consumption is the percentage of area irrigated. The macro level data analysis suggests that fertilizer consumption is elastic with respect to this variable with a significant elasticity of 1.2 for wheat. For rice, irrigated area has a very high elasticity of 4.87 and is statistically significant. Along with percentage of irrigated area an equally important factor that could facilitate higher fertilizer usage and/or its more efficient usage is the quality and quantity of irrigation available to irrigate this area. Availability of reliable and adequate supply of electricity for irrigation pumping could go a long way in improving the available irrigation facilities and could trigger higher and efficient fertilizer usage. Efforts thus need to be directed towards improving the supply of electricity for irrigation pumping.

Given that the relative (crop-fertilizer) prices have been a major determinant of fertilizer consumption at the state level efforts should be made to keep this price relative favorable so as to encourage higher fertilizer consumption. Given further that fertilizer consumption is a major causal factor of yield increases for both the studied crops such a measure would help increase foodgrain production.

Comments of the Study Coordinator- AERC, Ludhiana and the response thereon by AERC, Delhi

The report submitted by AERC, Delhi is largely as per the format provided by AERC, Ludhiana. However there are a few suggestions which may be incorporated while finalizing the report.

1. In the first chapter (Introduction), it is better if the authors give a line graph instead of bar graph to depict the growth in fertiliser consumption (total as well as per ha)

This has been done.

2. In the third chapter, the compound growth rate of the K-fertilisers from 1972-73 to 1988-89 is given as 6.94 percent and that during 1989-2003-04 has been given as 6.54 percent (Table 3.2). However the overall growth rate is given to be -0.06 which seems to be incorrect. The figure needs to be rechecked.

There was a typographical error. This has been corrected.

3. The inclusion of FYM, as an explanatory variable in the rice and wheat production functions, could have added more to the analysis. The authors may include the variable, if feasible.

The authors agree with the importance of using FYM as an explanatory variable, however the same was not used due to measurement problem with this variable. Due to shortfall in the availability of FYM the farmers generally do not apply FYM to all plots of land in the same year and they do not apply FYM to the same plot of land every year.

In all, the report is well written and may be finalized after incorporating the minor suggestions.