ASIA/PNS

DISTRIBUTION AND USE OF FERTILIZER IN PAKISTAN

FOLLOW-ON STUDY

NFC

NFC-US AID MARKET RESEARCH PROJECT
NATIONAL FERTILIZER CORPORATION OF PAKISTAN LIMITED
1st FLOOR AL-FALAH SHAHRAH-E-QUAID-E-AZAM LAHORE

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FOREWORD

Pakistan enters the eighties with a firm conviction that any substantial national progress is possible only through rapid development of the agriculture sector. The potential of this sector can be fully utilized by wide-scale adoption of improved technology particularly, by the use of adequate and balanced doses of chemical fertilizers. World-wide research has established that fertilizer provides the greatest increase in yield at less cost per hectare than any other agricultural input.

For a better understanding of the phenomena and factors related to fertilizer use, the National Fertilizer Corporation of Pakistan and USAID in 1976 jointly undertook a research project on "Distribution and Use of Fertilizer in Pakistan" The purpose of this study was to examine the critical factors which influence farmers' decision regarding fertilizer use.

Three years later, at a seminar held at Islamabad in February 1979, experts, policy makers and researchers met and discussed in detail the findings of the study and formulated a number of recommendations for consideration by Government of Pakistan.

The "Follow-on Study" was undertaken to verify and explain the changes that had occurred in quantitative and qualitative terms since the inception of the origional project. This study examined additional physical, economic and social factors which have limited fertilizer use and which had not been considered by the earlier study.

NFC believes that the findings generated by the 'Follow-On Study' can provide a sound statistical basis to policy makers in their task of formulating policies for maximizing use of fertilizer and enhancing its benefits in Pakistan. It is hoped that the study will be a useful addition to the available literature on rural development in Pakistan.

I acknowledge with thanks the positive collaboration of the USAID Mission in carrying out the study. Special thanks are owed to Dr. R.W. Hooker whose contribution as the project coordinator and as a scholar has been of immense value in the successful completion of the project.

I am also grateful for the valuable contributions made by the panel of experts who were associated with the project staff.

Lahore
April 26, 1980

RIYAZ H. BOKHARI
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CHAPTER I

INTRODUCTION AND RESEARCH DESIGN

Introduction

Pakistan is predominantly an agricultural country. The agricultural sector contributes about 30% to the country's Gross National Product. It provides a livelihood to about 79% of the population and jobs to about 53% of the labour force. It accounts for over 39% of export earnings.[1] The development of agriculture is the fulcrum of national progress and commands priority accordingly.

Progress in agricultural development can be guaged by the sector's growth in productivity and the extent to which there is broad participation in the growth. Despite concerted national efforts, Pakistan's crop yields are still very low, only a fraction of their potential. Studies conducted in several countries suggest that fertilizer provides more rapid, quicker and greater increase in yield at less cost per hectare than any other agricultural input. The consumption of fertilizers has increased at a compound rate of 15.2% annually during the last six years, i.e., 1972—1978. However, the level of fertilizer use per hectare in Pakistan is still very low compared to advanced agricultural economies and to recommended rates. In order to ascertain the constraints to fertilizer use by Pakistani farmers the National Fertilizer Corporation of Pakistan (NFC) and US AID undertook a joint research study on"Distribution and Use of Fertilizer in Pakistan" in December, 1975. The original study was completed in four inter-related phases; General Farmers' Investigation Survey (G. F. I.). Fertilizer Dealers' Survey, Institutional Credit Survey and Intensive Farmers' Study. The four reports were published. All above reports especially the G. F. I. received wide circulation.

Post GFI Situation

A number of important policy changes were made in the fertilizer industry following the completion of the above mentioned four reports. These studies were instrumental in causing some of these changes while other were made independently of the studies. The changes include :

(a) The control prices of fertilizer were reduced in the country to make them more readily acceptable by the farming community,

(b) The fertilizer dealers' commission was raised from Rs. 38.00 to Rs. 40.00 per ton to increase the profitability of dealers' investment and to promote interest in this business,

(c) A major shift in the policy of licensing private dealership was implemented. This increased the density of fertilizer distribution outlets which improved fertilizer availability at the grass-roots level,

(d) The Government procurement prices of wheat, rice and cotton were significantly increased, and

(e) The policy of agricultural credit was reviewed, liberalised and extended to improve credit availability particularly to small farmers and landless tenants.

1. Source : Economic Survey of Pakistan, 1978-79 P. 21.

(f) NFC in collaboration with PARC, NFDC and US AID conducted a very successful two day seminar on "Fertilizer Distribution and Use in Pakistan" which was based on the reports. The seminar was held in Islamabad on February 28 and March 1, 1979. It was participated by 115 experts, scientists and planners representing 39 national and 9 international organizations. The seminar recommendations committee developed 17 recommendations for improving the nation's agriculture. The "Recommendations" were published as were the seminar "proceedings". Both received wide distribution.

Follow-on Study

In collaboration with US AID, NFC decided to conduct a Follow-on Survey (FOS) to ascertain the kinds and magnitudes of changes that had occurred in the fertilizer industry after the original four studies were made. The field work for the (FOS) was started in the spring of 1978. For comparative purposes, the FOS was designed so as to parallel the GFI.

G.F.I. Objectives

The following were the specific objectives of the GFI :

1. To gather base-line data for measuring future changes in fertilizer use in Pakistan,
2. To identify farmers socio-economic characteristics related to fertilizer use,
3. To identify factors acting as barriers to the improvement of fertilizer use level, and
4. To make policy recommendations aimed at suggesting improvements in fertilizer use.

While comparing with the GFI, the FOS was designed to obtain more information. For example, fertilizer was in tight supply in large parts of the country during the 1977—78 wheat fertilizing season. One of the purposes of the FOS was to test the hypothesis that this tight supply impacted more than proportionately on the smaller farmer.

FOS Objectives

The objectives of the FOS were :

1. To identify and explain changes occurring in farmers', especially smaller farmers' access to and use of fertilizer since GFI Study,
2. To examine additional physical and social factors limiting fertilizer use which were not considered in the GFI,
3. To establish empirical relationship between fertilizer use and crop productivity, and
4. To develop recommendations for measures which the Government of Pakistan may take to overcome constraints, to the increased fertilizer use and thereby increased agricultural productivity.

Information Gathered

Survey data were obtained in the following important areas :

a) Farming practices, cropping patterns and cropping intensities,
b) Size of farm,
c) Landlord/Tenant relationships,
d) Incidence of fertilizer use,[1]
e) Fertilizer use experience,

1. Fertilizer use refers to whether or not the farmer is using fertilizer including use rate of nitrogen and phosphate on major crops.

f) Reasons for not using fertilizer,
g) Changes in fertilizer use, 1972—1978,
h) Credit availability for fertilizer,
i) Sources of information about fertilizer use and recommended dozes,
j) Convenience and quality of fertilizer received at sale outlets,
k) Distance and type of road between the farm and sale outlets,
l) Fertilizer control price, price paid, transportation cost and total cost,
m) Fertilizer use and wheat productivity,
n) Farmers' perception of effects of nitrogen and phosphate on wheat and soil, and
o) Level of technology adoption and wheat production.

HYPOTHESES

The probability that a given farmer is using fertilizer is related to a number of factors. The relationship of these factors has been spelled out in the form of following specific hypotheses :

a. The older the farmer, the less likely he is to use fertilizer,
b. Literate farmers are more likely than illiterate farmers to use fertilizer,
c. Owners are more likely to use fertilizer than other farmers,
d. Farmers operating large farms are more likely to use fertilizer than those operating small farms,
e. Farmers having access to irrigation water are more likely to use fertilizer than those without such access,
f. The greater the distance between the farm and the nearest fertilizer sale outlet, and the poorer the quality of the road linking these two points, the less likely is the farmer to use fertilizer,
g. Farmers reporting having adequate financial resources for fertilizer purchase are more likely to use fertilizer than those who report a shortage of such resources,
h. Farmers using improved varieties, are more likely to use fertilizer than those using *'desi'* varieties,
i. The higher the control over irrigation the more likely to use fertilizer,
j. The higher the use of fertilizer, the higher the per acre yield, and
k. Tight fertilizer supply impacted more than proportionately on the smaller farmers.

SAMPLE DESIGN

Selection of Study Area (Tehsil/'Taluka')

The sampling frame designed for the G.F.I. was followed in the present survey. A multi-stage sampling technique was used to select study areas (tehsils in the North West Frontier Province and the Punjab, 'talukas' in Sind), villages within these areas and respondents within these villages.

Fifteen study areas (3 tehsils in NWFP, 7 tehsils in the Punjab and 5 'talukas' in Sind) corresponding to about a 10 percent sample of these administrative units in the three provinces were selected randomly after stratification for cropping pattern and availability of irrigation water.

These two stratification variables were used because of their strong theoretical association with fertilizer use. Data regarding cultivated areas, irrigated area and acreage under individual crops were obtained from the Agricultural Census of 1972. The fifteen study areas selected represent nine major cropping patterns while 11 irrigated and 4 rainfed (barani) tehsils/'talukas'. In Sind, Mirpur Sakro 'taluka' was substituted with Mirpur Bathero.[1]

The table 1.1 shows the characteristics of the sample tehsils/'talukas'.

Selection of Villages

The latest maps of the sample tehsils/ 'talukas' were collected from the office of the Survey of Pakistan and respective District Councils. Ninety degree angles were drawn from the tehsil headquarters to the tehsil boundary lines.[2] The total length from all directions was measured and summed up. An area within a radius of two and four miles was subtracted in case of tehsil and district headquarters respectively from the total distance, as it did not represent typical characteristics of the rural scene. The average distance was equally divided into three concentric zones of short, medium and long distances from the tehsil headquarters. A list of all the villages falling within the first concentric zone (short distance) was prepared. One village was selected by applying the purposive random sampling technique in such a way that the "village" distance from the tehsil headquarters fell 75 per cent or more on a 'pacca' road. The second village located 75 per cent or more on a 'katcha' road from the tehsil headquarters was selected from the opposite direction within the same concentric zone. The next sets were selected from the second and third concentric zones by applying the same technique. Ease of access was measured in terms of the percentage of total distance made up by metailed (pacca) road and unmetalled (katcha) road or track. Thus six villages per study area or 90 villages in all were selected.

The purpose of stratifying the sample villages in this manner was to attempt to facilitate testing of the hypothesis that access to a market center offering a variety of services and supplying agricultural inputs including credit and fertilizer, influences farmers' use of fertilizer.

The sample in four 'barani' tehsils was raised from 24 villages to 32 villages in the Follow-on Study, giving a total of 98 villages as against 90 villages in the original study (G.F.I.). The selection of additional villages in 'barani' tehsils was made on the pattern of the original study. The experience in the original GFI study showed that the number of fertilizer users in the 'barani', areas were limited relative to those in the irrigated areas. This created statistical inadequacies and analytical problems. Hence, to overcome this limitation, the size of the sample in the barani' area had to be increased.

Village Dhalla Azmat in Isa Khel tehsil was substituted with village Kaloo Wala, because the inhabitants of original village (Dhalla Azmat) had migrated to other parts of the tehsil as a result of artificial lake created by Chasma Barrage. The substituted village

1. This was done because of mass migration of rural population from Mirpur Sakro 'taluka' to various parts of the Sind as a result of constant floods and water logging. The substituted 'taluka' falls within the same District, primarily a rice growing tract with additional sugarcane crop but having more or less same percentages of farm size and tenancy.

2. In some cases, six lines from the tehsil headquarters were drawn to obtain a higher degree of representativeness of the tehsil villages.

was selected following the original sampling technique having more or less the same distance and approach from the tehsil headquarters with similar distribution of farm size and tenancy.

Selection of Farmers

Approximately, 10 farmers per village or 980 in all were selected as respondents. Based on tehsil-wise data from the Agricultural Census of 1972 showing the distribution of farms by size and tenurial class, the number of respondents in each category was determined. The distribution of the sample was roughly proportional to the distribution reported in the Census (Table 1.2). The interviewers were instructed to obtain names of the farmers in the village from a village leader or key informant. At least three times as many names were to be recorded for a given farm size-tenure class as required in a sample village and respondents were randomly selected from the lists. While it would have been desirable to draw a completely randomly stratified sample, this would have required a census of all households in the village, an approach which was not judged feasible due to time and financial constraints. Still, the procedure adopted should have eliminated some of the bias resulting from interviewing each of a small number of respondents named by the village headman.

Unit of Study The basic unit of study and analysis was a farmer actually cultivating a piece of land during the last three years.

Characteristics of the Sample

A total of 980 farmers (660 in irrigated and 320 in 'barani' areas) constituted sample for this study. The average age of sample farmer was 43 years. There were 35 per cent literates, out of which only 9 per cent respondents had 10 years and above schooling. Less than one per cent of the sample farmers had training (a few week's orientation) in agriculture and owned farm machinery.[1] Sixty six per cent of the respondents operated farms individually.

In terms of tenurial status, 47 per cent were owners, 19 per cent owner-cum-tenants, and 34 per cent tenants only. Seventy per cent of the sample farmers were cultivating up to 12 acres of land, 24 per cent 13—25 acres and remaining 6 per cent 26 acres or more.

With the exception of owners and large farmers,[2] distribution of farm size and tenancy categories of sample farmers were roughly close to the proportions of farmers selected under G.F.I. (1976) and Agricultural Census, 1972. According to the census of the total 3.76 million were private farms in Pakistan, 42 per cent were owner farms, 24 per cent and 34 per cent owner-cum-tenant and tenant farms respectively. Farms up to size of less than 12.5 acres were 68 per cent of the total farms, 21 per cent fell in the size category of 12.5—25 acres while 11% fell in the size category of above 25 acres.

Interviewing Schedule

Keeping in view the specific hypotheses and objectives of the study, a comprehensive interviewing schedule was prepared in English. Urdu version of the main questions was

1. It included tubewell, tractor, seed drill, thresher and spray machine.
2. There was five per cent increase among owners with similar decrease for owner-cum-tenants and same decrease for large farmers in the Follow-on Study (1978) from Agricultural Census 1972. This variation could be explained because of Land Reforms of 1972 and 1976, which resulted in shifts of owner-cum tenants to owners and large farmers to medium and small farmers.

also given to facilitate establishing rapport among interviewers and interviewees. The interviewing schedule contained structured questions.

Pretesting

In order to test the validity and reliability of the interviewing schedule, it was pretested in five tehsils/ 'talukas' of the Punjab, North Western Frontier Province and Sind before its final administration in the field. As a result of pretesting a number of questions were added, changed, deleted and rearranged in their logical sequence.

Field Operations

Four teams were formed for data collection. Pushto, Punjabi and Sindhi speaking interviewers were selected for field operations in the respective provinces. The interviewers were given a two weeks orientation course in techniques of data collection before sending them to the field. Two teams were deputed in the Punjab and one each in Sind and NWFP. The field operations commenced on June 28, 1978 simultaneously in all the three provinces, and completed during last week of August, 1978.

A 10 per cent reliability check was conducted by the supervisory staff to verify the authenticity of the information collected by the field interviewers. Comparison of the two sets of data showed a very low incidence of non-sampling error. As a result, it would appear that the data reliability is adequate. The filled-in questionnaires were thereafter edited and the data transferred to data sheets for subsequent computer processing.

TABLE 1.1

Characteristics of the Sample Tehsil/'Taluka' by Farm Size and Tenancy with Major Crops, 1972.

Tehsil/'Taluka'	Source of water	Major Crops	Distribution of Farms by Size Category (Percentages) in acres				Farms Operated by (Percentages)		
			0-4.9	5—12.5	12.6—24.9	25 and above	Owner	Owner-cum-Tenant	Tenant
Charsadda	Irrigated	Wheat, Maize, Sugarcane	59	32	7	2	34	18	48
Isa Khel	Irrigated	Wheat, Pulses	20	25	27	28	36	43	21
Hafizabad	Irrigated	Wheat, Rice, Fodder	16	41	27	16	37	24	39
Toba Tek Singh	Irrigated	Wheat, Cotton, Sugarcane	31	45	19	5	46	26	28
Dipalpur	Irrigated	Wheat, Cotton, Fodder	25	36	23	16	31	17	52
Rajanpur	Irrigated	Wheat, Cotton, Fodder	20	37	25	18	24	20	56
Tando Allah Yar	Irrigated	Wheat, Cotton, Fodder	9	54	26	11	21	8	71
Gambat	Irrigated	Wheat, Cotton, Fodder	35	45	14	6	48	22	30
Mirpur Bathero	Irrigated	Rice, Sugarcane, Pulses	22	52	18	8	28	12	60
Kambar	Irrigated	Rice, Pulses, Wheat	34	52	12	2	26	15	59
Matli	Irrigated	Wheat, Rice, Sugarcane, Cotton	9	50	31	10	28	7	65
Hangu	Rainfed[1]	Wheat, Maize	68	27	4	1	70	16	14
Abbottabad	Rainfed	Wheat, Maize	74	22	4	0	84	12	4
Gujar Khan	Rainfed	Wheat, Maize	35	45	15	5	60	36	4
Campbellpur (Attock)	Rainfed	Wheat, Coarse Grain	39	36	17	8	45	34	21

Source :—Agricultural Census, 1972.

TABLE 1.2

Comparative Distribution of Farm Size and Tenancy, 1972, 1976, 1978

—In Percentages

Year	Distribution of Farms by Size Category (in acres)			Farms Operated by		
	Upto 12	13—25	26 and Above	Owner	Owner-cum Tenant	Tenant
1972 (Agricultural Census*)	68	21	11	42	24	34
1976 (G.F.I. Study)	72	20	8	42	20	38
1978 (Follow-on Study)	70	24	6	47	19	34

*Census categories are under 12.5 acres, 12.5 to under 25 acres and onward.

CHAPTER II

ANALYSIS OF DATA

Cross sectional data were collected for a number of physical, social and economic characteristics related to farmers' access to fertilizer and its use. The major hypotheses on the subject have been detailed in the first chapter. The present chapter pertains to the statistical analysis of data aiming at testing of these hypotheses.

This chapter deals with land use, landlord-tenant relations, fertilizer, credit, and information usage of the farmers mainly restricted to descriptive statistics and individual hypothesis testing. The third chapter pertains to inductive statistics particularly multivariate analysis of fertilizer use.

Size of Holding

The following few pages present descriptive background information on sample farmers land use, cropping intensity, farming practices and landlord-tenant relations.

The average farm size (operational) was 11.53 acres for the total population distributed into 13.81 acres in irrigated and 7.56 acres in 'barani' areas. Five per cent of the total owned cultivated area was reported as 'salt affected'[1] (7% and 3%[2] in irrigated and 'barani' areas respectively).

Cropping Pattern

Table 2.1 shows the average cropping intensity[3] being 133% and 121% in irrigated and 'barani' areas respectively. Relatively low difference in cropping intensity of irrigated and 'barani' areas has been noticed. Farm size was inversely related to the cropping intensity in irrigated and barani' areas.

In irrigated areas 37% of the cultivated area was under wheat during crop year, 1978, while the corresponding figure for 'barani' areas was 45%. In irrigated areas, farm size appeared to be positively related with a higher percentage of area under wheat. Whereas, in 'barani' areas farmers operating 6—12 acres seemed to bring relatively a higher percentage of their cropped area under wheat as compared to other farm size categories. Tenants of both the areas, appeared to be growing on a higher percentage of their cropped area under wheat than any other tenurial arrangements.

For Kharif crops 20%, 13%, 6% and 3% were under rice, cotton, sugarcane and maize respectively in irrigated areas. Small farmers appeared to bring relatively a higher

1. It was entirely farmers' own perception whether or not his piece of land was salt affected. The concept of salinity had a wide range of variation ranging from white to black salt.
   These figures may appear on the lower side because these percentages refer to cultivated area and not total area which includes uncultivated area as well.
2. Salinity was reported in few villages in Gujar Khan and Campbellpur tehsils. These villages were mainly located by river/stream belt and were under 'Sailaba'.
3. The cropping intensity is on higher side both from 1972 Agricultural Census (89%) and our previous Intensive Farmers' Study, 1977 (119%, 91%) in irrigated and 'barani' areas. The formula of cropping intensity used was the same, in all the three cases. Regulated and increased supply of surface and ground water could be another reason for the enhanced cropping intensity. Furthermore, in case of sample area, the entire province of Baluchistan, Bahawalpur and D.I. Khan divisions of the Punjab and NWFP were not included which are primarily areas of low average cropping intensities.

percentage of sugarcane and maize than other farm size categories in irrigated areas. For rice farmers operating 6—12 acres appeared to cultivate relatively on a higher percentage area than other farm size categories, while no significant difference was observed in case of cotton on farm size axis. The owner-cum-tenants raised relatively a higher percentage of rice, cotton and sugarcane than other tenurial classes in irrigated areas and owners on maize 'barani'.

Maize the major Kharif crop occupied 22% of the cropped 'barani' areas, where farm size was inversely related to the percentage of area under maize.

Reasons for Leaving Land as Seasonal Fallow

Table 2.2 indicates that land replenishment and shortage/non-availability of water were the prominent reasons in rank order for leaving some land fallow during both the cropping seasons in irrigated and 'barani' areas, while salinity during Rabi and floods in Kharif were the third most common reason for leaving land short fallow in irrigated areas.

Landlord-tenant Relationship

Farming decisions such as which crops are to be sown and how much fertilizer is to be used are made as a result of consultation between tenant and landlord. Looking at all the farms, table 2.3 indicates that in case of 40% of the tenants and owner-cum-tenants, landlord was the decision maker regarding what crop varieties were to be grown while 39% reported that they themselves made such decisions.

As against 53% of the cultivators who were themselves the prime decision makers in case of owner-cum-tenants farms, 49% of the landlords turned out to be the chief decision makers for tenant farms. In 'barani' areas both owner-cum-tenants and tenants (81% and 58%) decided themselves about the crop varieties to be planted. The position of owner-cum-tenants was further strengthened both in irrigated and 'barani' areas where both cultivator and landlord were mainly responsible for decision making in this respect.

Decision About Fertilizer Application/Cost Sharing

As regards the decision making for fertilizer application and its cost sharing, the indication based upon the responses of the tenants and owner-cum-tenants have been given in table 2.4. Looking at all the tenant and owner-cum-tenant farms in the irrigated area, landlords were the sole decision makers (45%) for fertilizer application. Next were the cultivators themselves (32%), followed by the joint decision of both (21%). In case of tenant farms, the prominent decision maker (53%) was the landlord. On 39% of the owner-cum-tenant farms the decision regarding fertilizer application was jointly taken by the landlord and the cultivator. The percentage of joint decision makers was more than double the corresponding percentage in case of tenant farms. This implies that owner-cum-tenants were more independent in this respect.

Unlike the position in the irrigated areas, cultivator himself was the chief decision maker (51%) as regards the overall position of the two categories of the farms in the 'barani' areas. Next was the landlord alone (39%), while joint decisions were taken on the remaining 10% of the farms.

Looking at the separate proportions of tenant and owner-cum-tenant farms, cultivator himself likewise in the irrigated areas was better placed in case of owner-cum-tenant farms, where he was reported to have made decisions in 70% of the cases, as against only 22% by the landlord.

Landlord, however, commanded a better position in the combined universe of irrigated and 'barani' areas, where they were responsible for making decision on 44% of the farms as against 34% by the cultivators.

Table 2.4 indicates that 85% tenants and owner-cum-tenants of irrigated areas and 64% of 'barani' areas shared 50% of the fertilizer cost. Little above one-fourth of tenants and owner-cum-tenants in 'barani' areas paid the full cost of fertilizer, corresponding to only 9% in irrigated areas. This feature was more common in the case of owner-cum-tenants (35%) as compared to tenants (15%) in 'barani' areas. The findings in table 2.3 and 2.4 suggest that owner-cum-tenants enjoy relatively better position as regards decision making on which crops are to be planted and fertilizer application than tenants.

Incidence of Fertilizer Use

Table 2.5 shows the number and percentage of sample farmers using[1] and not using some fertilizer during crop year (CY) 1977-78. Application of the chi—square test on difference of sample proportions revealed the following facts.

Firstly, there was no significant difference[2] either among farm size categories[3] or tenurial classes in the proportion of farmers using some fertilizer both in the irrigated and 'barani' areas. However, if the farm size below 12 acres in irrigated areas was further divided into farmers operating upto 5 acres and 6—12 acres, the chi—square test showed statistically significant relationship in this respect. Thus there was a higher percentage of user farmers among 6—12 acres as compared to 1—5 acres. Secondly, there was a significant difference between irrigated and 'barani' areas in the percentage of farmers (83% vs. 47%) using some fertilizer. This difference was actually understated because some farmers not using fertilizer in irrigated areas operated under 'barani' conditions while some farmers using fertilizer in 'barani' areas had access to irrigation water for part of their farm. In 'barani' area, for example, almost all farmers using fertilizer irrigated at least some part of the land they fertilized.

These findings were in agreement with GFI[4] survey except that users percentage has increased by 3% in irrigated and 2% in 'barani' areas over the last two years. This increase was, however, not statistically significant.

The implication of such a finding that within areas stratified for the availability of irrigation water there was little difference in the percentages of fertilizer users who were operating under various tenurial arrangements and operating various size of farms is that small farmers as well as tenants were equally involved in the fertilizer adoption process.

1. Farmers using some chemical fertilizer N or P or both N+P on some part of his cropped land during CY 1977-78.
2. The term "significant difference" implies to a difference between two or more statistics (such as sample proportions or means) which has at least a 95% probability of not being due to chance.
3. Farm size classified into three categories i.e., below 12 acres, 13—25 acres, 26 acres and above.
4. Chapter II and III are essentially comparison of GFI with additional information collected in the current survey, Information on wheat productivity, and fertilizer application rates and multi-variate analysis have been given in Chapters IV and V.

The sharp differences in the incidence of fertilizer use among farmers of various size and tenurial classes between irrigated and 'barani' areas indicated that farmers' adoption of fertilizer was influenced by the availability of adequate and dependable supplies of irrigation water. This factor of irrigation water has been discussed in relation to fertilizer application rates and crop yield in the following section of this report.

However, while evaluating the farmers' real access to fertilizer, it is not sufficient to make crude comparisons of 'use' and 'non-use'. Presentation of the valid picture of the situation requires sophisticated statistical analysis of incidence of fertilizer use by quantity and nutrient balance of its application on various crops.

The application of Z—test revealed presence of no significant differences among the fertilizer users of 1975-76 and 1977-78 in either of the category of farms and tenancy as well as areas.

Farmers Applying N and P to Major Crops

Table 2.6 gives the percentage of farmers applying nitrogen and phosphate to wheat, cotton, rice, sugarcane and maize by farm size and tenancy in irrigated and 'barani' areas.

The chi-square[1] test was applied to test the hypotheses that the difference in the proportions of sample farmers applying nitrogen and phosphate between crops, farm size, tenurial classes and areas could be attributed to chance.

The results of the statistical analysis indicated that there was no significant difference among farm size and tenurial groups with respect to percentage of farmers applying nitrogenous fertilizers to rice and irrigated wheat.

Similarly, the farmers' tenurial status did not significantly influence the percentage of users applying nitrogenous fertilizers to 'barani' wheat, cotton and sugarcane and farm size to maize 'barani'. These findings were consistent with the results reported earlier that farm size and tenurial status of the farmers were not associated with the fertilizer use during the CY 1977-78 as well as our previous General Farmers Study (G.F.I.) in which both farm size and tenancy did not have any significant influence on the use of nitrogen on cotton, rice and wheat.

However, significant differences among farm size and tenurial arrangements with respect to the percentage of farmers applying nitrogenous fertilizers to each of the five major crops were found in the following cases :

a) Farm size and tenancy to irrigated maize and tenancy to 'barani' maize, and

b) Farm size to wheat 'barani', cotton and sugarcane.

The chi-square test further revealed that percentage of farmers applying phosphatic fertilizers was independent of farm size categories, tenurial classes, areas and crops with the exception of;

Owners and small farmers on irrigated maize and large farmers to 'barani' wheat.

1. Correction factor was applied in case for cells having less than 5 cells while calculating the chi-square test.

The finding in case of wheat 'barani' was in agreement with GFI Survey.[1] The departure was however observed in :

i) Farm size and application of phosphates on cotton in GFI and irrigated maize in the current survey, and

ii) As against G.F.I. findings tenancy did not influence significantly the percentages of owner-operators applying phosphates to irrigated wheat and cotton in the present survey.

Because of the absence of any significant differences among the users of phosphate on irrigated wheat in various farm size categories, no definite conclusion could be drawn. On the other hand, significant difference observed in case of 'barani' wheat suggested the comparative lesser willingness of small farmers in taking the risk of experimenting with relatively newly-introduced fertilizer type i.e., phosphate.

In case of disappearance of relationship between tenancy and percentage of farmers applying phosphate to wheat irrigated and cotton in the present survey it could be explained that farmers of all tenurial classes were, more or less, equally involved in the adoption process of phosphatic fertilizers on irrigated wheat and cotton.

Furthermore, alternate hypothesis could be described that low percentage of phosphate use on 'barani' wheat might be due to financial constraints in case of small tenants who normally bore one-half to full cost of inputs but shared the produce ranging from one-third to two-thirds with the landlord.

The percentage of farmers applying phosphate remained low as compared to percentage of farmers applying nitrogenous fertilizers to all major crops in irrigated and 'barani' areas. However, table 2.6 indicated several fold increase in irrigated and 'barani' areas during the CY 1975-76 to 1977-78. This is consistent with the previous trend on the incidence of phosphate use from 1969-70 to 1975-76 period.

In case of the percentage use of nitrogenous fertilizers, there has been substantial increase for rice and cotton (13 % and 8 %) and 'barani' wheat (15 %) from the CY 1975-76 to 1977-78.

The percentage of farmers applying both nitrogenous and phosphatic fertilizers to wheat and maize under 'barani' conditions was significantly lower than the corresponding percentages of those growing under irrigated conditions. This finding is quite consistent with the GFI Survey.

The recent trend in the percentage use of nitrogenous and phosphatic fertilizers is a healthy sign and could the attributed to the Government of Pakistan's efforts in promoting balanced fertilizer use on various crops of irrigated and 'barani' areas.

Fertilizer Application Rates for Major Crops

Table 2.7 shows crop-wise comparison of application rates of nitrogen and phosphate by user farmers on wheat, rice, cotton, sugarcane and maize by farm size and tenurial status. Difference-of-Means test was applied to test the hypotheses that there was no

1. This table on percentage of users of N and P to major crops by farm size and tenancy in GFI has been given as Annexure—D.

difference in the average application rates of N and P between crops, areas, farm size categories and tenurial classes. The results of the statistical analysis (for the farmers, applying the stated fertilizer to the specified crop) are as below :

1. Significantly higher dozes of nitrogen per acre were applied to sugarcane than wheat, maize, cotton and rice,
2. Growers of irrigated areas used significantly more phosphate per acre on wheat than maize and rice,
3. Growers of irrigated areas applied significantly more nitrogen and phosphate per acre on wheat and maize than in 'barani' areas,

   The findings at No. "1", "2" and "3" are in agreement with GFI results.[1]
4. Farmers operating 1—5 acre holdings applied significantly more nitrogen per acre than those operating 13—25 acres on irrigated wheat. This group of farmers also showed significantly higher application rate of nitrogen on cotton and sugarcane. Similarly, farmers belonging to the smallest size group applied significantly higher dozes of nitrogen to wheat in the 'barani' areas than any of the size groups,
5. The rates of nitrogen application on rice for farmers operating 26 acres and above were significantly higher than any other size group,

   The findings at No. "4" and "5" pertaining to wheat irrigated and cotton are in agreement with GFI results.
6. Tenants applied significantly more nitrogen per acre than owners on 'barani' wheat and maize but in case of rice the application rate of owner-cum-tenants was significantly higher than owners and tenants,
7. Farmers operating 13—25 acres applied comparatively higher dozes of phosphate per acre than any other size group on 'barani' wheat,
8. Cultivators farming 6—12 acres applied significantly more phosphate per acre on irrigated wheat than the 13—25 acres category; whereas farmers belonging to the smallest size group applied significantly more on rice than other farm size categories except 26 and above acres group,
9. No significant differences were observed either among farm size categories or tenurial classes in the average application rates of phosphate for cotton, sugarcane and maize[2], and
10. Again there was no significant difference among various tenurial classes in the mean application rates of phosphate even for wheat and rice.

    The findings at No. "9" and "10" were consistent with GFI results except farmers operating 6—12 acres than 13—25 acres for wheat irrigated; 1—5 acres than 13—25 acres for rice.

1. In GFI information was available for wheat, cotton and rice only. Table giving statistical information has been given in Annexure—D.
2. In case where differences in the mean application rates, particularly, phosphate appeared to be significant, the null hypotheses could not be rejected because of small number of observations and high variation in the sample application rates.

Several comments could be made on these findings :

Firstly, despite substantial increases in the average application rates of nitrogen on rice (13 Nt. lbs.), wheat irrigated (12 Nt. Lbs.), wheat 'barani' (9 Nt. Lbs.) and cotton (6 Nt. lbs.) during the last two years, these rates were still considerably lower than the recommended dozes[1] both in the irrigated and 'barani' areas. Actual application by the sample farmers as a proportion of the recommended dozes were encouraging for rice 'basmati' and sugarcane, followed by wheat, and rice IRRI.

These findings were quite consistent with GFI results. This implies that no major shift took place in the allocation pattern of fertilizer to various crops during the last two years. The difference was however, more pronounced in 'barani' areas as compared to irrigated ones particularly in case of phosphatic fertilizers where a rise of 22 nt. lbs. for maize and 24 nt. lbs. for wheat was observed,

Secondly, the average application rates of fertilizer among users were significantly higher for wheat and maize in irrigated than 'barani' areas. This finding was consistent with GFI results for wheat,

Thirdly, the observations raised at "4" and "5" above coupled with the information contained in table 2.6 and 2.20 (regarding the short supply during the year under study) suggested that the difficulty in obtaining fertilizer was faced equally by the small and large farmers as well as owners and tenants,

Fourthly, the finding that owner operators in the sample generally applied more nitrogen per acre than tenants, could be attributed to uncertain and insecure conditions for tenants under the Tenancy Laws prevailing in the country, and

Lastly, while it is true that small farmers and owner-operators who used fertilizer tended to apply significantly more fertilizer than other farmer groups in absolute terms, the difference in the average use rates was usually not much, as it seldom exceeded 10 nt. lbs. or one-fifth of a bag of urea.

Fertilizer Application Rates for Growers

Annexure-I contains sample data on per acre nitrogen and phosphate application rates for wheat, rice, cotton, sugarcane and maize in irrigated and 'barani' areas. These rates have been calculated on the basis of growers which also include cropped acreage of non-

1. Recommended Dozes

(per acre nt. lbs)

Crops	N	P	K
Wheat (barani)	90	60	—
Wheat (Irrigated)	125	75	—
Rice (IRRI)	125	50	—
Rice (Basmati)	75	50	—
Cotton	75	50	—
Sugarcane	150	100	50
Maize (Grain)	100	50	—

Source :- Directorate of Soil Fertility Survey and Soil Testing Institute, Lahore (Punjab—Pakistan).

users of fertilizer for the major crops. Per acre application rates of nitrogen and phosphate in this case are lower for all crops both in irrigated and 'barani' areas than those calculated on the basis of cropped acreage of fertilizer users as given in table 2.7.

Fertilizer Application Ranges

The proportions of farmers falling within various ranges of fertilizer application rates (N and P) were calculated to have an idea as to how many were applying recommended dozes on different crops. The modal class values for use of N and P on improved wheat varieties in irrigated areas were 51—75 nt. lbs. and 26—50 nt. lbs. respectively. It was observed that only 5 % and 7 % of user farmers applied recommended dozes of N and P. This is a clear indicator of not only low level of fertilizer application rates but also an index of imbalanced use (Annexure C). Findings are quite consistent with information contained in Tables 2.6 and 2.7 on the incidence of fertilizer use and use-rate.

In 'barani' areas the most frequently occurring application rate was 1—25 nt. lbs. for both N and P. There were only 4% (N) and 6% (P) of the user farmers whose level of application was close to recommended dozes on wheat 'barani' (Annexure-C)

It is interesting to note that in case of irrigated and 'barani' wheat, more user farmers applied phosphatic fertilizers close to recommended dozes than nitrogen. A possible explanation for this could be that at the time of rabi sowing of 1977-78 there were short supplies of fertilizer, particularly of nitrogen. Therefore, farmers might have used DAP, NP and SSP as basal application. Table 2.20 of the present report supports this hypothesis where 60% of the farmers reported the shortage of nitrogen as against 40% for phosphate.

For cotton, the most frequently occurring ranges for N and P application were 51—75 and 26—50 nt. lbs. respectively, while recommended dozes of N and P were applied only by 14% and 12% respectively. However, it is worth noting that percentage of users, close to recommended dozes both of N and P were higher for cotton than for wheat (Annexure-C-b).

For IRRI varieties of rice, modal values of both N and P applications were 26—50 nt. lbs. and the percentage of farmers using the dozes close to the recommended ones here, were 11% and 13% respectively (Annexure-C-c).

The modal value of both N and P applications on rice 'basmati' were 26—50 nt. lbs. The proportions of farmers applying the dozes of N and P close to the recommended ones on rice 'basmati', turned out to be 20% and 18% respectively, which were by far the highest of all the other crops (Annexure-C-d).

Modal values of N and P applications on sugarcane were 101—125 and 26—50 nt. lbs. respectively. Fifteen percent and 13% farmers applied close to recommended dozes of N and P in this case (Annexure-C-e).

The most frequently occurred phenomena on irrigated maize for N and P applications were 51—75 and 26—50 nt. lbs. respectively. In 'barani' areas most of the farmers fell in the categories of 26—50 and 1—25 nt. lbs. of N and P respectively. The number of farmers applying recommended dozes of N and P to maize was negligible (Annexure-C-f).

To sum up the above analysis, although an overwhelming majority of the user farmers were lagging far behind the recommended dozes of fertilizer on various crops, yet it would be noted that the proportion of farmers applying close to the recommended dozes were higher in case of cash crops as compared to non-cash crops. More remunerative as the former crops were, this was an indication of farmers' consciousness of profitability.

Looking at various size/tenancy groups, a higher percentage of small farmers (1—5 acres) and owner operators were in general applying close to the recommended dozes of fertilizer, but the difference in the percentages seldom exceeded 13. These findings are quite consistent with those given in table 2.7 on "average application rates of N and P on major crops".

Analysing the above statistics while keeping in view the findings from the incidence of fertilizer use (Table 2.5 and 2.6) and application rates on various crops (Table 2.7), it would appear that the real problem was of balanced and appropriate use rate on various crops. This in turn brings the balanced fertilizer use rate into correct perspective by taking it as one of the vital components of modern input-package used. The future research, therefore, should take into consideration not only the use and effects of fertilizer but also the input-package as a whole.

Fertilizer Use Experience

Table 2.8 indicates that nitrogenous fertilizers were, more or less, introduced simultaneously both in irrigated and 'barani' areas. However, the experience in phosphate use was longer (4.25 years) in irrigated areas as compared to 'barani' areas (2.91 years).

Application of chi-square test revealed that average length of experience in the use of N and P was independent of farm size categories, tenurial classes and area. Nevertheless, owner-cum-tenants appeared to be the innovators in the use of N and P in both the areas, who happened to be the large operators as well.

Large farmers took the lead in introducing phosphate in both irrigated and 'barani' areas. In case of nitrogen large farmers in irrigated areas and farmers operating 6—12 acres in 'barani' areas were the early adopters.

Changes in Fertilizer Use

Data from the 1972 Pakistan Agricultural Census, GFI and FOS provided a basis for measuring changes in the proportion of farmers using fertilizer between the years 1972, 1976 and 1978. As shown in table 2.9 there was a substantial increase in the percentage of farmers using fertilizers under each tenancy and farm size category between 1972 to 1976. Statistically speaking, these increases were highly significant in all cases. The highest increases, however, took place in case of farmers operating 26 acres and above and owner operator class.

The change from 1976 to 1978 in the proportion of farmers using fertilizer was much smaller than 1972 to 1976. For the former period, the percentage of fertilizer users gone up absolutely by 4% on overall population. The largest change (from 72% to 81%) was for farmers operating 6—12 acres.

So far our discussion was limited to the incidence of fertilizer use or its non-use. The drop out rate among user farmers could be another indicator of the stability of fertilizer use.

Discontinuation of Fertilizer Use

The drop out rate among the user farmers which otherwise is the measure of the degree of farmers' dissatisfaction with fertilizer use, could be an important indicator of the prospective use. Table 2.10 shows that overall drop out[1] rate was 13% distributed into 7% and 36% in irrigated and 'barani' areas respectively. Application of chi-square test examining the difference in the proportions of farmers discontinuing fertilizer use during the last three years among various farm categories, tenurial classes and areas suggested that they were all insignificant.

The relative high drop out rate in 'barani' areas is likely to be the effect of a set of factors enumerated and discussed in the following sections

Reasons for Discontinuation

Farmers reporting discontinuation of fertilizer use during one or two of the intermediate years, gave several reasons for doing so. In descending order of importance these reasons were "no funds"/"shortage of funds", "short supply of fertilizer", "insufficient irrigation water", "preference for farmyard manure"[2] and "fertilizer being too expensive"/"not profitable"[3] for farmers in both the irrigated and 'barani' areas.

The prominent reasons for the discontinuation of fertilizer use, in irrigated areas, remained the same in 1978 as they were in 1976, with the exception of :

(i) ' Fertilizer not timely available" was the second most frequently stated reason in 1978 but fourth in 1976. As stated earlier in this report that fertilizer particularly nitrogen was in tight supply in 1977-78.

(ii) "Fertilizer too expensive"/"not profitable", ranked fifth in 1978 but second in 1976. This could be attributed to the decrease in the fertilizer prices during the period under study.

(iii) The "farmyard manure" application emerged as one of the reasons for discontinuation.

(iv) Additionally, "water logging"/"salinity" was reported (1% of all reasons) as a reason for the discontinuation of fertilizer use in 1978.

In 'barani' areas the first and the second reason remained the same. However, "insufficient water", "preference for farmyard manure" and "fertilizer too expensive"/"not profitable" were relatively more important as compared to irrigated areas. "No funds"/"shortage of funds" was the principal reason for the discontinuation of fertilizer use both in irrigated and 'barani' areas which was confirmed under the topic of credit in the present study as well as from the GFI findings.

1. This drop out was temporary. The farmer may or may not use fertilizer in the coming years.

2. This reason appears to be more valid in case of nitrogen than phosphate. The farm yard manure needs phosphate complement which was also confirmed from the findings of table 2.10 (b), where only 3% of the responses were reported to be using farm yard manure as a substitute of phosphate due to their lack of knowledge.

3. We interpret this to mean that while farmers think the fertilizer would increase yield, the value of additional yield would not exceed the cost of the additional input.

"Non-availability of fertilizer" was the second most commonly stated reason in both irrigated and 'barani' areas. This underscores the significance of maintaining abundant supplies "availability thesis".

The above findings suggest that if the credit and fertilizer supply situation are improvd, these alone could check 58% of the drop outs in fertilizer use provided other conditions remain the same.

Table 2.10(a) further shows that the problem of "shortage of funds" was the major reason for discontinuation of fertilizer use by the tenants of irrigated and 'barani' areas. This reason appeared to be more prominent for the farm sizes of 1—5 acres in irrigated and 6—12[1] acres in 'barani' areas respectively.

Reasons for not Using Phosphate

Farmers who never used phosphatic fertilizers were asked the reason for this. Their responses are given in table 2.10(b). From the table, it can be seen that "no experience" (29%) followed by "no funds" (25%), "fertilizer not available" (22%), "not profitable" (6%) and "preference for farmyard manure" and "barani land" (3% each) were the reasons given on overall basis. As regards the non-users of phosphate in irrigated areas, their important reasons were "no funds" (39%), "no experience" (24%), "non-availability" (9%) and "not profitable"/"farmyard manure preference" (4% each). In 'barani' areas the reasons were largely the same, but with some difference in order of importance viz. "not available" (40%), "no experience" (36%), "not profitable" (10%), "barani areas" and "no funds" (5% each).

"Non-availability" of phosphates was reported as the principal reason for non using phosphate in 'barani' areas and the third most common reason in irrigated areas. It would thus seem that the "availability thesis" does carry some weight in the introduction of phosphate particularly in 'barani' areas.

"No experience" was the second most common reason in both irrigated and 'barani' areas. This points out the importance of and need for agricultural extension in educating the farmers in the use of phosphatic fertilizers.

Credit Availability

Farmers using fertilizer were asked if they had enough money (own plus borrowed)[2] to apply as much fertilizer as they intended on their wheat crop. Table 2.11 shows that seven percent (mainly tenants and owner-cum-tenants) of the total users obtained fertilizer from their landlords. The same table shows that 39% on over all basis stated that they had "not enough money to buy desired quantity of fertilizer".

The chi-square test was applied to ascertain whether the proportion of farmers having "enough money" was independent of farm size, tenancy and area.

The test revealed that for farmers in irrigated areas, the adequacy of funds to purchase all fertilizer desired was statistically independent of farm size at the 5% level of significance but not at the 10%. There is thus some evidence that the adequacy of funds is a function of farm size. It was the smallest farm size category that observed and expected frequencies

1. It is considered that 1—5 acres category in irrigated areas is likely to be having similar position as 6—12 acres in 'barani' areas.
2. It included both institutional and non-institutional credit.

deviated the most. Surprisingly, the expected frequency of "yes" (adequate funds) was substantially smaller than the observed frequency. For the 'barani' areas, however, where the hypothesis of independence was clearly rejected, it was the larger farmer who was the least affected by inadequate funds to purchase desired fertilizer, we cannot see a straight forward interpretation of these findings. However, with respect to tenancy in irrigated areas, the X^2 test shows that the owner was clearly in a better position than either the tenant or owner-cum-tenant and that the latter was in the worst position.

One of the findings of table 2.11 is that an almost equal percentage of farmers reported having or not having enough money for fertilizer purchase in irrigated and 'barani' areas. The phenomenon could be explained that farmers in 'barani' areas usually apply smaller and straight nitrogenous fertilizers of low nutrient contents as against the farmers of irrigated areas who strive for both straight and compound fertilizers having high nutrient contents. In the former case, the price of nitrogenous fertilizers (AS, AN) is lower than urea, the fertilizer most commonly applied in irrigated areas. Thus farmers, conception of "having enough money to buy desired quantity of fertilizer" would be different in 'barani' and irrigated areas.

The small operational holding, lower level of fertilizer use and low cropping intensity in 'barani' areas may be a partial explanation for this finding.

Desired Fertilizer Application Rates

Farmers were asked, if they had "enough money", how much fertilizer they would have applied on their wheat crop. The responses are given in table 2.12. The table shows that 87% and 13% of farmers in irrigated areas reported a range of 101—125 nt. lbs. of nitrogen and phosphate application for wheat; as against 88% and 13% of the farmers reporting this range for improved wheat, 33% and 20% expressed it for 'desi' wheat. The corresponding percentages of farmers desirous of using nitrogen and phosphate in the 'barani' areas were 19% and 38% respectively, distributed as 14% and 29% for improved while 23% and 50% for 'desi' varieties of wheat crop.

Fertilizer Information Source

Farmers who reported on desired application rates of N and P on wheat varieties in table 2.12 were asked about the source of information for such rates. Table 2.13 shows that fellow farmers[1] (62% and 59%) was the most commonly cited source of information on desired fertilizer application rates on wheat varieties in irrigated and 'barani' areas. The farm radio programme, agriculture extension and published literature were the next most important sources (21%, 11%, 3%) of information in irrigated areas. Agriculture extension, radio and published literature assumed the second, third and fourth position (31%, 8%, 2%) in 'barani' areas on the other hand. It is pertinent to note that according to farmers, fertilizer dealers as a source of information was negligible both in the irrigated and 'barani' areas.

The findings of the present study agree with GFI Survey to the extent that fellow farmers and farm radio programme were the chief sources of information on fertilizer use with a variation that agricultural extension assumed as the second common most source of information instead of radio in 'barani' areas in the present study. It may be that agricultural extension source became important because of 'barani' projects initiated jointly by US AID—IRDP for the introduction of fertilizer.

1. Fellow farmers also include demonstration plots laid down in own or nearby villages.

Reasons For Not Applying Recommended Dozes[1]

Farmers who had enough money for fertilizer purchase and did not face any difficulty in obtaining fertilizer during Rabi 1977-78, but did not apply the recommended dozes of N and P on wheat crop were asked why they did not do so. Table 2.14 shows that "lack of knowledge"/"experience" was the most frequently reported reason (44%), followed by "fertilizer too expensive" (28%) and then "shortage of irrigation water" (16%). It is interesting to note that 3% of the responses (fifth major reason in rank order) indicated "preference for farmyard manure".

In irrigated areas "lack of knowledge"/"no experience" was relatively more pronounced among farmers operating less than 5 acres and owner-cum-tenants, while "fertilizer too expensive"/"not profitable" was more important among farmers operating 13—25 acres and owner-cum-tenants. "Shortage of water" as one of the reasons for not applying recommended dozes of fertilizer on wheat was mainly reported by large farmers (26 acres and above) and owners, while, "preference for farmyard manure" was mainly confined to farmers operating below 5 acres and owners.

In 'barani' areas "shortage of irrigation water"/"less rains" was the single most important reason (61%) for not applying recommended dozes of fertilizers, followed by "lack of knowledge"/"No experience" (23%) and "fertilizer too expensive"/"not profitable" (12%). A "preference for farmyard manure" constituted 2% of the reasons, ranking fourth in 'barani' areas.

"Barani land"/"shortage of water" was relatively more pronounced reason among large farmers and owners while "lack of knowledge"/"no experience" was the peculiar feature of owner-cum-tenants in the 'barani' areas. Fertilizer "too expensive"/"not profitable" was restricted to owners alone.

Soil Testing

Table 2.15 shows that about 1% of the sample farmers got their soil tested. Of those who did not get their soil tested, only 16 percent knew something about soil testing, of which 71 percent were willing to get their soil tested mainly "to know soil characteristics/deficiencies" and "appropriate fertilizer".

Fertilizer Outlets; Convenience and Quality of Service

If fertilizer was really difficult to obtain either because of inaccessibility to the outlet or because of the timely supplies at the outlet being undependable, it could be expected that this situation might result in :

a) greater number of trips to the sale outlet,
b) more transport cost,
c) larger distance travelled
d) getting impure, adulterated, caked/lumpy fertilizer even at a higher price,
e) lower proportion of farmers using the input in a given locality,
f) smaller application rates among user farmers, and
g) imbalance use of fertilizers.

1. Recommended Dosage level is given on Page 15

Farmers' attitude towards the convenience and access to sources of fertilizer and quality of the services they received from fertilizer dealers were elicited through several questions. Table 2.16 shows that one-half and one-third of the user farmers in 'barani' areas purchased fertilizer from village shopkeepers[1] and government depots respectively. Only 15% of the farmers in 'barani' areas purchased fertilizer from private dealers[2].

Source of Fertilizer Purchase

In irrigated areas private dealers were the major source of supply (52%), followed by government depots (23%) and village shopkeepers (18%). It is interesting to note that of all those farmers who reported private dealers as the principal source of fertilizer purchase in irrigated areas, 14% could not identify the dealership which shows poor contact level between users and the dealers in irrigated areas. The above findings were in agreement with GFI results on the source of fertilizer purchase.

Distance Travelled for Fertilizer Purchase

Table 2.17 indicates that average distance of 6.22 and 5.39 miles were travelled by the farmers from irrigated and 'barani' areas respectively for fertilizer purchase during 1977-78. The corresponding figures were 4.33 and 4.00 miles in the G.F.I. study. The findings of Follow-on and G.F.I. studies agree to the extent that farmers in irrigated areas travelled slightly more than their counterparts in 'barani' areas[3]. The point of departure was that farmers had to travel on an average 1.96 miles more distance during 1978 as compared to 1976. The reasons for travelling longer distance during rabi, 1978 could be attributed to : (a) rabi of 1978 was a short supply season, and (b) use rate of phosphate during 1978 was higher than 1976 and phosphate availability was limited at the village level as compared to 'mandi' town. This points out the facts that farmers had to travel longer distance to the sale outlet (pay more transport cost resulting in greater difficulty in obtaining fertilizer, more chances of receiving defective fertilizers and smaller application rates of fertilizer than intended).

Trips Made for Fertilizer Purchase

Table 2.18 indicates that on the whole farmers made about the same number of trips during rabi 1978 and 1977 (an average of 2.93 and 2.92 respectively) to purchase fertilizer. In both the years farmers of irrigated areas made the same average trips (3.18). The corresponding figures for 'barani' areas were 2.10 and 1.98, a difference of 0.12 trips during rabi 1977-78. However, farmers in irrigated areas on an average made more trips (1.08) than 'barani' areas for fertilizer purchase. These statistics suggest that shortage of fertilizer was more acute during rabi 1978 in irrigated areas than 'barani' areas.

1. Village shopkeeper is not an authorized fertilizer dealer.
2. National Fertilizer Corporation of Pakistan,
   EXXON (ESSO) Fertilizers Limited, and
   Dawood Corporation Limited.
3. As mentioned earlier the farmers in 'barani' areas usually acquire straight nitrogenous fertilizer (mainly A S.) from the village shopkeeper. So they do not travel that far as compared to the farmers of irrigated areas.

Reasons for Travelling More/Less Distance

Table 2.18(a) shows that "fertilizer not available" was the prominent most reason (75%), followed by "farmer happened to visit for other purpose and purchased fertilizer" (11%) for travelling more during rabi 1977 and 1978. The reason for travelling less distance was the opening of sale outlet in the vicinity.

Per Bag Price and Transport Cost

In order to understand the cost born by the users, per bag average price and transport charges were calculated for rabi 1977 and 1978. Table 2.19 revealed the following findings:

(a) With the exception of NP in 'barani' areas, none of the fertilizers were purchased at control prices,

(b) Average excess per bag prices paid for a bag of urea, AN, AS, DAP, NP and SSP were Rs. 1.61, 2.00, 4.14, 0.63, 2.00 and 2.80 respectively in irrigated areas during rabi, 1978,

(c) Excluding NP and SSP the corresponding figures for 'barani' areas were Rs. 2.71, 3.32, 6.69 and 0.77, respectively,

(d) The highest excess charges paid per bag (Rs. 4.14) was for AS in irrigated areas and Rs. 6.69 in 'barani' areas,

(e) SSP was purchased by an average of Rs. 2.80 per bag higher than the control price in irrigated areas whereas in 'barani' areas no excess price was paid for the product. These excess charges give some clue to the brandwise scarcity and degree of over charging which was mainly prevailing in the areas of high demand, far flung localities and the resale of fertilizer,

(f) Comparing the urea price of rabi 1976-77 with rabi 1977-78 in irrigated areas there was negligible difference in the actual price paid by the farmers. The price in 'barani' areas, however, went down by Rs. 0.39 per bag,

(g) Average price for AN was lesser by Rs. 1.38 and Rs. 0.15 in irrigated and 'barani' areas respectively, and

(h) Average prices of AS, DAP, NP and SSP were higher by Rs. 2.52, 0.28, 1.03 and 0.45 in irrigated areas and Rs. 1.90, 0.48, 0 and (−) 0.50 in 'barani' areas respectively.

Transport Cost Per Bag

Table 2.19 indicates that the average per bag transport cost of fertilizer for irrigated and 'barani' areas was Rs. 1.82 and 3.02 respectively during 1976-77 which went up by Rs. 0.05 in irrigated areas and decreased by Rs. 0.31 in 'barani' areas during 1977-78. Reasons for lower average transport cost in 'barani' areas were consistent with our findings in Table 2.17 (a) and 2.18 that farmers in 'barani' areas not only travelled lesser distance but also made lesser number of trips during 1977-78 as compared to 1976-77.

While comparing the results with GFI findings, on the whole, the farmer paid Rs. 0.87 more transportation cost per bag during Follow-on Study (an increase of Rs. 0.87 and Rs. 0.90 per bag in irrigated and 'barani' areas respectively). Such an increase can be attributed to the rise in the general level of prices in the country.

Fertilizer Availability

Table 2.20 shows that 55% of all user farmers (59% in irrigated and 41% in 'barani' areas) reported that they had "difficulty in obtaining fertilizer" during rabi, 1978. This is quite a high and alarming percentage. The farmers reporting such a difficulty were asked to mention the specific brand names. The farmers of irrigated areas registered urea (56%) and DAP (37%) as the major products difficult to obtain, while in 'barani' areas AS, urea (31% each) and DAP (25%) were reported in this respect.

Impacts of Short Supply of Fertilizer

The farmers reporting "difficulty in obtaining fertilizer" were asked whether or not they applied less fertilizer because of this constraint, Table 2.20 (a) shows that 46% of the total respondents (42% and 64% in irrigated and 'barani' areas) applied less fertilizer than intended because of this difficulty. It shows farmers' willingness to increase the fertilizer application rates which might enhance the productivity if the fertilizer availability situation is eased.

Table 2.20 (b) shows that an overwhelming majority of farmers in irrigated and 'barani' areas reported that they applied one to two bags less of urea, DAP, AS and AN per acre due to short supply during rabi 1977-78. This clearly depicts the possibility for greater use of fertilizer in the country.

In irrigated areas 94% and 98% farmers reported applying "one bag less" per acre than desired of urea and DAP, whereas, in 'barani' areas 42% and 43% farmers reported applying 2 bags of AS and AN less per acre than desired. This necessitates enhancing the supply of fertilizer and thereby increasing its consumption in 'barani' areas.

The availability of SSP in irrigated and NP in 'barani' areas was reported to be according to farmers' demand, indicating the satisfactory supply situation of these brands in respective areas.

Quality of Fertilizer

"Caked", "sub-standard" and "adulterated" fertilizers emerged as the three major problems (31%, 27% and 13% respectively) for the sample farmers. Bags of "sub-standard weight" (32%) "caked" (27%) and "adulterated fertilizer" (17%) were the three most common problems in order of rank, reported by the farmers in irrigated areas, whereas, "caked" (45%) and bags of "sub-standard weight" (7%) were the two major problems reported by the farmers in 'barani' areas. The problem of "adulterated" fertilizer was negligible in 'barani' areas. This might be due to the fact that AS is the commonly used fertilizer which has lesser chances of mixing and adulteration with other fertilizers, because it is the cheapest nitrogenous fertilizer available in the market.

Farmers reported applying "caked" fertilizer were asked whether they paid less price for the defective fertilizer. An overwhelming majority (96%) of irrigated and 'barani' areas said that they did pay equal to market[1] price for the defective fertilizers (Table 2.20-c).

Table 2.20 (d) shows that in irrigated areas urea and DAP were mainly "caked" and their bags were reported of "sub-standard weight". Whereas AS, urea and DAP were reported as defective fertilizers in rank order in 'barani' areas.

Farmers' Perception of Effects of N and P on Wheat Crop and Soil

Table 2.21 shows farmers' perception of the major effects of nitrogenous fertilizers on wheat crop, which emerged in order of frequency as :

a) it increases wheat yield,
b) turns crop green, and
c) strengthens/lengthens the wheat plant.

In case of phosphatic fertilizers the responses in order of rank were; it "increases yield" (41%), "turns crop green" (14%), "early and high seed germination rate" (13%), "strengthens plant roots" (12%) and "promotes rapid growth" (10%) in irrigated areas.

Phosphatic fertilizers "increase yield", "strengthen and lengthen the plant", "strengthen the plant roots" were the three major effects (58%, 20% and 11%) reported in 'barani' areas.

Table 2.21 (a) shows that farmers in irrigated areas reported that nitrogenous fertilizers "soften the soil" (33%), "improve the soil" (19%), "decrease soil fertility in the long run" (12%) and "hardens the soil" (8%). Sixty percent of responses from 'barani' areas indicated that nitrogenous fertilizers "soften the soil". In irrigated areas 39% and 30% responses pertained to the fact that phosphatic fertilizers "soften the soil" and "improve the soil" respectively. The corresponding figures for the 'barani' areas were 65% and 3%.

It is interesting to note that 13% of the responses from irrigated areas referred to nitrogenous fertilizers as having "no effect on the soil", while, eight percent of the total responses were categorized under "no response", distributed into 20% in 'barani' areas and 4% in irrigated areas. Totalling the "no effects" and "no response" (NR) the percentage on the whole comes to 18% which is a substantial portion of the total response. It could be inferred that about one-fifth of the response particularly in 'barani' areas referred to the fact that farmers were not aware of effects of nitrogenous fertilizers on soil. Similarly, about one-fifth of the farmers of irrigated and 'barani' areas reported that phosphatic fertilizers either have "no effects on soil" or there was "no response".

These findings were quite consistent with our earlier discussion on the topic of "reasons for not using phosphatic fertilizers" and "reasons for not applying recommended dozes of fertilizers" despite the fact that farmers did not face any supply and credit problems.

General Problems of Fertilizer Use

Farmers were asked to spell out general problems regarding fertilizer use in the village. As shown in table 2.22 "fertilizer not timely available," "no sale outlet in village," "non-

1. It is not essential that the market price is equivalent to the Government fixed (control) price. As discussed in the report it was on the high side for all fertilizers except NP during 1977, 1978.

availability of credit," "high fertilizer prices," "fertilizer not available on control price," "shortage of irrigation water" (23%, 20%, 16%, 14%, 11% and 5%) were the major problems on fertilizer use in irrigated areas. In 'barani' areas "no sale outlet in the village" was the most commonly cited problem (35%), followed by "high fertilizer prices" (23%), "fertilizer not timely available" (14%) and "fertilizer not available on control price" (11%).

These findings were very close to the analysis given for non-use, discontinuation and not applying recommended dozes of fertilizer in the present report as well as in the GFI.

TABLE 2.1

Average Cropping Intensity and Pattern by Area, Farm size and Tenancy, 1978

—In Percentages—

Farm Size/Tenancy	No. of Farmers	Cropping Intensity	CROP ACREAGE									
			Wheat	Oil Seed	Fodder Rabi	Other Rabi Crops	Sugar-cane	Rice	Cotton	Maize (Grain)	Maize (Fodder)	Other Kharif crops
Irrigated (All)	660	133	37	1	6	6	6	20	13	2	1	8
Farm Size (Acres)												
1—5	171	166	28	1	5	7	8	20	11	6	1	13
6—12	236	134	33	1	5	6	7	26	14	2	1	5
13—25	199	114	39	1	6	6	6	19	13	2	1	7
26 and above	54	108	40	1	6	6	4	14	15	1	1	12
Tenancy												
Owner	228	130	36	1	6	7	6	18	13	3	1	9
Owner-cum-Tenant	121	145	35	1	5	6	7	22	15	1	2	6
Tenant	311	133	40	*	6	5	5	19	11	2	1	11
Barani (All)	320	121	45	2	1	5	—	*	1	22	*	24
Farm Size (Areas)												
1—5	174	152	41	3	1	3	—	*	—	39	—	13
6—12	103	114	48	2	*	5	—	*	—	18	1	26
13—25	38	105	46	2	*	7	—	—	5	12	—	28
26 and above	5	92	39	3	1	2	—	—	—	11	—	44
Tenancy												
Owner	230	139	44	2	1	4	—	*	2	25	*	22
Owner-cum-Tenant	63	119	47	3	1	5	—	1	—	24	1	19
Tenant	27	127	48	2	*	5	—	*	—	13	*	32

* less than 0.5
— Nil.

TABLE 2.2

Reasons for Fallow Land by Area During Rabi and Kharif, 1977-78

Area	RABI																KHARIF															
	Land Replenishment		Shortage of Water		Non-availability of Water		Salinity		Floods		Others		No Response		Total		Land Replenishment		Shortage of Water		Non-availability of Water		Salinity		Floods		Others		No Response		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated	208	44	175	37	11	2	21	4	11	2	47	10	6	1	479	100	193	47	165	40	2	*	12	3	23	6	15	4	1	*	411	100
Barani	163	79	8	4	1	*	4	2	1	*	28	14	2	1	207	100	168	85	1	1	7	3	5	2	2	1	14	7	1	1	198	100
Total	371	54	183	26	12	2	25	4	12	2	75	11	8	1	686	100	361	59	166	27	9	2	17	3	25	4	29	5	2	*	609	100

* Less than 0.5

TABLE 2.3

Decision Making About Crop Varieties by Tenancy

Area/Tenancy	Landlord		Cultivator Himself		Farmer and Landlord		Landlords' Manager		Farmer and Landlords' Manager		No Response		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated (All)	152	40	147	39	72	19	4	1	2	1	—	—	377	100
Tenant	137	49	97	34	43	15	3	1	2	1	—	—	282	100
Owner-cum-Tenant	15	16	50	53	29	30	1	1	—	—	—	—	95	100
Barani (All)	14	17	63	74	7	8	—	—	—	—	1	1	85	100
Tenant	9	34	15	58	1	4	—	—	—	—	1	4	26	100
Owner-cum-Tenant	5	9	48	81	6	10	—	—	—	—	—	—	59	100
Total	166	36	210	46	79	17	4	1	2	*	1	*	462	100

* Less than 0.5

— Nil

TABLE 2.4

Fertilizer Application/Cost Sharing Decision by Area and Tenancy

Area/Tenancy	Fertilizer Application Decision												Cost Sharing Decision											
	Landlord		Farmer Himself		Farmer and Landlord		Farmer and Landlords' Manager		Landlords' Manager		Total		Full		2/5		1/3		1/2		2/3		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated (All)	136	45	99	32	65	21	3	1	3	1	306	100	28	9	1	—	4	1	258	85	15	5	306	100
Tenant	125	53	67	29	37	16	3	1	3	1	235	100	21	9	1	—	2	1	202	86	9	4	235	100
Owner-cum-Tenant	11	16	32	45	28	39	—	—	—	—	71	100	7	10	—	—	2	3	56	79	6	8	71	100
Barani (All)	16	39	21	51	4	10	—	—	—	—	41	100	10	28	1	3	—	—	23	64	2	5	36	100
Tenant	10	72	2	14	2	14	—	—	—	—	14	100	2	15	1	8	—	—	10	77	—	—	13	100
Owner-cum-Tenant	6	22	19	70	2	8	—	—	—	—	27	100	8	35	—	—	—	—	13	57	2	8	23	100
Total	152	44	120	34	69	20	3	1	3	1	347	100	38	11	2	1	4	1	281	82	17	5	342	100

—NIL

TABLE 2.5

Comparative Number and Percentage of Users and Non-Users by Area, Farm Size and Tenancy, 1975-76, 1977-78

Farm Size/Tenancy	1977 - 78				1975-76 (G.F.I.)[1]			
	Users		Non-Users		Users		Non-Users	
	No.	%	No.	%	No.	%	No.	%
Irrigated (All)	551	83	109	17	519	80	131	20
Farm Size (Acres)								
1 — 5	137	80	34	20	138	79	36	21
6 — 12	212	90	24	10	203	79	55	21
13 — 25	158	79	41	21	123	79	31	21
26 and above	44	82	10	18	55	86	9	14
Tenancy								
Owner	196	86	32	14	171	81	41	19
Owner-cum-Tenant	96	79	25	21	97	79	26	21
Tenant	259	83	52	17	251	80	64	20
Barani (All)	150	47	170	53	103	45	129	55
Farm Size (Acres)								
1 — 5	82	47	92	53	62	45	75	55
6 — 12	46	45	57	55	28	44	36	56
13 — 25	19	50	19	50	9	43	12	57
26 and above	3	60	2	40	4	40	6	60
Tenancy								
Owner	113	49	117	51	74	48	80	52
Owner-cum-Tenant	26	41	37	59	21	39	33	61
Tenant	11	41	16	59	8	33	16	67

1. General Farmers' Investigation Survey.

TABLE 2.6

Percentage of Users[1] Applying Nitrogen and Phosphate to Major Crops by Area, Farm Size and Tenancy

—In Percentages

Farm Size/Tenancy	CROPS									
	Wheat		Cotton		Rice		Sugarcane		Maize	
	N	P	N	P	N	P	N	P	N	P
Irrigated (All)	78	54	86	55	76	38	88	43	53	28
Farm Size (Acres)										
1 — 5	74	48	87	57	70	43	95	39	86	43
6 — 12	83	62	94	62	80	43	91	47	54	26
13 — 25	74	48	78	49	74	27	86	41	44	24
26 and above	79	56	82	47	75	42	75	42	22	17
Tenancy										
Owner	81	55	87	58	83	42	90	45	62	35
Owner-cum-Tenant	73	53	94	55	78	48	89	43	61	25
Tenant	77	52	83	52	71	32	87	41	40	21
Barani (All)	44	12	—	—	—	—	—	—	45	4
Farm Size (Acres)										
1 — 5	43	6	—	—	—	—	—	—	49	3
6 — 12	43	15	—	—	—	—	—	—	38	5
13 — 25	46	27	—	—	—	—	—	—	36	8
26 and above	60	20	—	—	—	—	—	—	100	50
Tenancy										
Owner	46	13	—	—	—	—	—	—	43	4
Owner-cum-Tenant	36	8	—	—	—	—	—	—	45	3
Tenant	41	9	—	—	—	—	—	—	65	6

1. Farmers who applied compound fertilizers such as DAP and NP are credited with having applied both N and P to crop. Confidence intervals for the proportions are shown in Annexure "A".

—Not applicable

TABLE 2.7

Average Per Acre Application Rates of Nitrogen and Phosphate on Major Crops by Area, Farm Size and Tenancy

— Nutrient Lbs.

Farm Size, Tenancy	Wheat				Rice				Cotton				Sugarcane				Maize			
	No. of Users	%[1]	N	P	No. of Users	%[1]	N	P	No. of Users	%[1]	N	P	No. of Users	%[1]	N	P	No. of Users	%[1]	N	P
Irrigated (All)	431	92	67	30	224	98	60	20	246	97	64	27	195	100	100	27	84	100	67	26
Farm Size (Acres)																				
1—5	92	99	75	30	47	100	62	25	40	100	74	28	39	100	119	28	30	100	70	32
6—12	158	97	68	34	92	99	56	19	98	99	62	29	71	100	100	15	25	100	61	17
13—25	140	93	61	26	67	98	59	14	80	100	60	26	67	100	90	23	24	100	69	26
26 and above	41	86	66	30	18	94	75	27	28	90	63	22	18	100	95	27	5	100	63	35
Tenancy																				
Owner	163	88	70	31	76	99	62	21	88	93	66	28	77	100	101	27	42	100	64	27
Owner-cum-Tenant	80	93	69	31	39	93	69	23	44	100	58	26	33	100	100	28	17	100	82	22
Tenant	188	97	64	29	109	100	55	18	114	100	63	27	85	100	99	26	25	100	61	26
Barani (All)	128	74	36	6	—	—	—	—	—	—	—	—	—	—	—	—	106	97	43	4
Farm Size (Acres)																				
1—5	64	92	45	5	—	—	—	—	—	—	—	—	—	—	—	—	71	99	40	2
6—12	44	70	29	7	—	—	—	—	—	—	—	—	—	—	—	—	24	97	49	3
13—25	17	71	21	10	—	—	—	—	—	—	—	—	—	—	—	—	9	88	48	16
26 and above	3	52	18	1	—	—	—	—	—	—	—	—	—	—	—	—	2	100	47	24
Tenancy																				
Owner	97	74	33	6	—	—	—	—	—	—	—	—	—	—	—	—	78	98	37	5
Owner-cum-Tenant	22	69	40	4	—	—	—	—	—	—	—	—	—	—	—	—	17	94	57	3
Tenant	9	100	58	8	—	—	—	—	—	—	—	—	—	—	—	—	11	100	62	2

— Not Applicable

1. Percentage of fertilized area.

TABLE 2.8

Fertilizer Use Experience by Area, Farm Size and Tenancy

Farm Size/Tenancy	Average Length of Experience in Years	
	Nitrogen Use	Phosphate Use
Irrigated (All)	7.68	4.25
Farm Size (Acres)		
1 — 5	7.56	4.49
6 — 12	7.41	4.01
13 — 25	7.83	4.17
26 and above	8.80	5.03
Tenancy		
Owner	8.17	4.49
Owner-cum-Tenant	8.42	4.96
Tenant	7.00	3.76
Barani (All)	7.41	2.91
Farm Size (Acres)		
1 — 5	7.05	2.31
6 — 12	8.80	3.00
13 — 25	6.59	3.45
26 and above	6.00	4.00
Tenancy		
Owner	7.47	2.96
Owner-cum-Tenant	8.00	3.25
Tenant	5.44	2.00
Total	7.63	4.15

TABLE 2.9

Comparative Percentages of Fertilizer Users by Farm Size and Tenancy During 1972, 1976 and 1978, Population Estimates@.

—In Percentages

Farm Size/Tenancy	YEAR		
	1972*	1976**	1978
Farm Size (All) (Acres)	52	70	74
1 — 5	44	64	66
6 — 12	54	72	81
13 — 25	58	75	76
26 and above	51	80	79
Tenancy			
Owner	45	66	70
Owner-cum-Tenant	52	67	68
Tenant	59	77	80

@ This gives some weight to irrigated and 'barani' areas (GFI—1976 P. 23).

*Pakistan Agriculture Census, 1972.

**General Farmers' Investigation Survey, 1976.

TABLE 2.10

Percentage of Sample Farmers Discontinuing Fertilizer Use by Area, Farm Size and Tenancy, 1976–78

Farm Size/Tenancy	Farmers Discontinuing Fertilizer Use	No. of Users	Percentage of Discontinuation
Irrigated (All)	39	551	7.1
Farm Size (Acres)			
1—5	13	137	9.5
6—12	12	212	5.7
13—25	9	158	5.7
26 and above	5	44	11.4
Tenancy			
Owner	15	196	7.7
Owner-cum-Tenant	6	96	6.3
Tenant	18	259	6.9
Barani (All)	54	150	36.0
Farm Size (Acres)			
1—5	23	82	28.0
6—12	26	46	56.5
13—25	5	19	26.3
26 and above	—	3	—
Tenancy			
Owner	38	113	33.6
Owner-cum-Tenant	10	26	38.5
Tenant	6	11	54.5
Total	93	701	13.3

—NIL

TABLE 2.10 (a)

Reasons* for Discontinuing Fertilizer Use by Area, Farm Size and Tenancy, 1976—78

Farm Size/Tenancy	No Funds/ shortage of Funds		Short supply of Fertilizer		Insufficient Water Barani Areas		Farm Yard Manure Applied		Too Expensive/Not Profitable		Saline/Water Logged Land		Others		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated (All)	17	40	9	21	8	19	2	5	2	5	1	3	3	7	42	100
Farm Size (Acres)																
1—5	7	59	2	17	—	—	1	8	—	—	1	8	1	8	12	100
6—12	3	25	3	25	2	17	1	8	1	8	—	—	2	17	12	100
13—25	5	42	2	17	4	33	—	—	1	8	—	—	—	—	12	100
26 and above	2	34	2	33	2	33	—	—	—	—	—	—	—	—	6	100
Tenancy																
Owner	8	44	5	28	4	22	—	—	—	—	—	—	1	6	18	100
Owner-cum-Tenant	—	—	—	—	1	20	1	20	2	40	1	20	—	—	5	100
Tenant	9	47	4	21	3	16	1	5	—	—	—	—	2	11	19	100
Barani (All)	23	37	11	18	9	14	9	14	9	14	—	—	2	3	63	100
Farm Size (Acres)																
1—5	6	20	5	17	7	23	7	23	3	10	—	—	2	7	30	100
6—12	15	54	6	21	1	4	2	7	4	14	—	—	—	—	28	100
13—25	2	40	—	—	1	20	—	—	2	40	—	—	—	—	5	100
26 and above	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tenancy																
Owner	12	27	10	23	6	14	8	18	7	16	—	—	1	2	44	100
Owner-cum-Tenant	7	53	1	8	3	23	1	8	1	8	—	—	—	—	13	100
Tenant	4	66	—	—	—	—	—	—	1	17	—	—	1	17	6	100
Total	40	39	20	19	17	16	11	10	11	10	1	1	5	5	105	100

*There were multiple response in some cases.

—NIL

TABLE 2.10 (b)

Reasons* for Non-Adoption of Phosphate by Area, Farm Size and Tenancy

Farm Size/Tenancy	REASONS																	
	No Funds		No Experience		Not Available		Not Profitable		Barani Areas		Farmyard Manure Applied		Others		No Response		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	44	39	28	24	10	9	4	4	1	1	4	4	19	17	2	2	112	100
Farm Size (Acres)																		
1—5	14	45	7	23	1	3	2	6	—	—	2	7	3	10	2	6	31	100
6—12	14	36	9	23	5	13	1	3	—	—	2	5	8	20	—	—	39	100
13—25	14	40	11	32	3	8	1	3	—	—	—	—	6	17	—	—	35	100
26 and above	2	29	1	14	1	14	—	—	1	14	—	—	2	29	—	—	7	100
Tenancy																		
Owner	20	51	8	20	2	5	1	3	1	3	1	3	4	10	2	5	39	100
Owner-cum-Tenant	6	40	4	27	2	13	2	13	—	—	1	7	—	—	—	—	15	100
Tenant	18	31	16	28	6	10	1	2	—	—	2	3	15	26	—	—	58	100
Barani (All)	4	5	29	36	32	40	8	10	4	5	1	1	2	3	—	—	80	100
Farm Size (Acres)																		
1—5	2	4	19	37	21	40	6	11	2	4	1	2	1	2	—	—	52	100
6—12	1	5	6	30	9	45	2	10	1	5	—	—	1	5	—	—	20	100
13—25	1	17	3	50	1	17	—	—	1	16	—	—	—	—	—	—	6	100
26 and above	—	—	1	50	1	50	—	—	—	—	—	—	—	—	—	—	2	100
Tenancy																		
Owner	2	3	21	36	22	38	8	14	4	7	1	2	—	—	—	—	58	100
Owner-cum-Tenant	2	12	5	29	8	47	—	—	—	—	—	—	2	12	—	—	17	100
Tenant	—	—	3	60	2	40	—	—	—	—	—	—	—	—	—	—	5	100
Total	48	25	57	29	42	22	12	6	5	3	5	3	21	11	2	1	192	100

* There were multiple responses in some cases.

— NIL

TABLE 2.11

Fertilizer Users• Having Enough Money to Buy Desired Quantity of Fertilizer by Area, Farm Size and Tenancy, Wheat 1978

Farm Size/Tenancy	Landlord Provides Fertilizer		ENOUGH MONEY					
			Yes		No		Total	
	No.	%	No.	%	No.	%	No.	%
Irrigated (All)	**37**	**9**	**242**	**61**	**156**	**39**	**398**	**100**
Farm Size (Acres)								
1 5	7	7	63	72	24	28	87	100
6 12	24	15	79	56	61	44	140	100
13 25	6	5	72	57	54	43	126	100
26 and above	—	—	28	62	17	38	45	100
Tenancy								
Owner	—	—	115	71	46	29	161	100
Owner-cum-Tenant	2	2	38	48	42	52	80	100
Tenant	35	18	89	57	68	43	157	100
Barani (All)	**1**	**1**	**80**	**63**	**48**	**37**	**128**	**100**
Farm Size (Acres)								
1 5	—	—	35	53	31	47	66	100
6 12	1	2	28	67	14	33	42	100
13—25	—	—	13	87	2	13	15	100
26 and above	—	—	4	80	1	20	5	100
Tenancy								
Owner	—	—	56	57	42	43	98	100
Owner-cum-Tenant	1	4	17	74	6	26	23	100
Tenant	—	—	7	100	—	—	7	100
Total	38	7	322	61	204	39	526	100

•Percentages calculated on users of wheat.

—NIL

TABLE 2.12

Desired Application Rates of Nitrogen and Phosphate of Farmers Not Having Enough Money by Area, Wheat 1978

— Per Acre Nt. Lbs.

Area/Variety	Desired Application Rates																			
	N										P									
	Less than 50		51 75		76—100		101—125		Total		Less than 50		51 75		76—100		101—125		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated (All)	**2**	**1**	**10**	**6**	**9**	**6**	**136**	**87**	**157**	**100**	**13**	**10**	**79**	**64**	**16**	**13**	**16**	**13**	**124**	**100**
Improved	1	1	9	6	7	5	134	88	151	100	11	9	77	65	16	13	15	13	119	100
Desi	1	17	1	17	2	33	2	33	6	100	2	40	2	40	—	—	1	20	5	100
Barani (All)	**16**	**33**	**16**	**33**	**7**	**15**	**9**	**19**	**48**	**100**	**1**	**8**	**5**	**38**	**2**	**16**	**5**	**38**	**13**	**100**
Improved	8	36	8	36	3	14	3	14	22	100	—	—	5	71	—	—	2	29	7	100
Desi	8	31	8	31	4	15	6	23	26	100	1	17	—	—	2	33	3	50	6	100

—Nil

TABLE 2.13

Source of Information on Desired Application Rates of User Farmers Not Having Enough Money by Area, Farm Size and Tenancy, Wheat 1978

Farm Size/ Tenancy	Fellow* Farmer		Radio		Agriculture Extension		Published Literature		Fertilizer Dealers		Others		Total	
	No.		No.		No.		No.		No.		No.		No	
Irrigated (All)	98	62	33	21	17	11	5	3	—	—	4	3	157	100
Farm Size (Acres)														
1—5	18	69	3	11	3	12	1	4	—	—	1	4	26	100
6—12	34	60	13	23	7	12	1	2	—	—	2	3	57	100
13—25	29	57	13	25	6	12	2	4	—	—	1	2	51	100
26 and above	17	74	4	18	1	4	1	4	—	—	—	—	23	100
Tenancy														
Owner	29	60	9	19	7	15	3	6	—	—	—	—	48	100
Owner-cum-Tenant	27	64	9	22	5	12	1	2	—	—	—	—	42	100
Tenant	42	63	15	22	5	8	1	1	—	—	4	6	67	100
Barani (All)	31	59	4	8	16	31	1	2	1	2	—	—	53	100
Farm Size (Acres)														
1—5	22	73	2	7	5	17	1	3	—	—	—	—	30	100
6—12	7	41	1	6	8	47	—	—	1	6	—	—	17	100
13—25	2	33	1	17	3	50	—	—	—	—	—	—	6	100
26 and above	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tenancy														
Owner	28	64	3	7	12	27	1	2	—	—	—	—	44	100
Owner-cum-Tenant	3	43	1	14	3	43	—	—	—	—	—	—	7	100
Tenant	—	—	—	—	1	50	—	—	1	50	—	—	2	100
Total	129	61	37	18	33	16	6	3	1	—	4	2	210	100

*Includes demonstration plots at farmers fields as well as friends/relatives.

Nil

TABLE 2.14

Reasons* for Not Applying Recommended Dozes of Fertilizer by Area, Farm Size and Tenancy, Wheat 1978

Farm Size/ Tenancy	REASONS															
	Lack of Knowledge/ Experience		Fertilizer Too Expensive/Not Profitable		Shortage of Irrigation		Barani Land/ Less Rain		Farm Yard Manure Applied		Salt Affected Land		Others		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated (All)	51	44	33	28	18	16	5	4	4	3	2	2	4	3	117	100
Farm Size (Acres)																
1 — 5	16	53	6	20	4	14	1	3	3	10	—	—	—	—	30	100
6 — 12	19	48	12	30	5	13	1	3	1	2	1	2	1	2	40	100
13 — 25	12	34	12	34	5	14	2	6	—	—	1	3	3	9	35	100
26 and above	4	33	3	25	4	33	1	9	—	—	—	—	—	—	12	100
Tenancy																
Owner	19	41	11	24	9	19	2	4	3	6	2	4	1	2	47	100
Owner-cum-Tenant	8	50	6	37	2	13	—	—	—	—	—	—	—	—	16	100
Tenant	24	44	16	29	7	13	3	6	1	2	—	—	3	6	54	100
Barani (All)	12	23	6	12	2	4	29	57	1	2	—	—	1	2	51	100
Farm Size (Acres)																
1 — 5	6	25	3	13	2	8	11	46	1	4	—	—	1	4	24	100
6 — 12	3	22	2	14	—	—	9	64	—	—	—	—	—	—	14	100
13 — 25	3	27	1	9	—	—	7	64	—	—	—	—	—	—	11	100
26 and above	—	—	—	—	—	—	2	100	—	—	—	—	—	—	2	100
Tenancy																
Owner	6	15	6	15	1	2	26	64	1	2	—	—	1	2	41	100
Owner-cum-Tenant	4	67	—	—	—	—	2	33	—	—	—	—	—	—	6	100
Tenant	2	50	—		1	25	1	25	—		—	—	—	—	4	100
TOTAL	63	38	39	23	20	12	34	20	5	3	2	1	5	3	168	100

*Reason of farmers having enough money for fertilizer purchase and did not face any difficulty in obtaining fertilizer during Rabi 1977-78.

—Nil

TABLE 2.15

Farmers Having Their Soil Tested, its Knowledge, Willingness and Reasons Thereof by Area

Area	Ever Tested				Knowledge				Willingness				REASONS					
	Yes		No		Yes		No		Yes		No		To know soil Characteristics Deficiencies		To know suitable fertilizer		To reclaim land	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated	10	2	650	98	90	14	570	86	70	78	20	22	45	64	21	30	4	6
Barani	—	—	320	100	70	22	250	78	44	63	26	37	36	82	8	18	—	—
TOTAL	10	1	970	99	160	16	820	84	114	71	46	29	81	71	29	25	4	4

—NIL

TABLE 2.16

Sources of Fertilizer Purchase by Area

Area	Landlord		Govt. Depot		Village Shop-keeper		Co-op. Society		DEALERS*																			
									NFC		EXXON		DCL		NFC and EXXON		NFC and DCL		Do Not Know		(Total)		Others		N.R.		TOTAL	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated	21	5	98	23	76	18	5	1	9	2	43	10	83	19	18	4	9	2	62	14	224	52	2	1	5	1	431	77
Barani	1	1	43	33	62	48	1	1	8	6	—	—	8	6	1	1	—	—	2	2	19	15	2	2	—	—	128	23
TOTAL	22	4	141	25	138	25	6	1	17	3	43	8	91	16	19	3	9	2	64	11	243	43	4	1	5	1	559	100

*Joint dealers have not been counted under individual head.

—Nil

TABLE 2.17

Average* Distance Travelled for Fertilizer Purchase by Area, 1976-78

Area	1976 - 77						1977 - 78					
	1-4	5-8	9-12	13-16	Total	Average	1-4	5-8	9-12	13-16	Total	Average
Irrigated	191	109	78	45	423	6.28	191	102	78	42	413	6.22
Barani	69	15	10	17	111	5.60	72	19	8	16	115	5.39
TOTAL	260	124	88	62	534	6.14	263	121	86	58	528	6.04

*Village shopkeeper cases were not included.

TABLE 2.18

Average Trips Made for Fertilizer Purchase by Area, Rabi 1976—78

Area	TRIPS									
	1976 - 77					1977 - 78				
	1 - 2	3 - 4	5 - 6	Total	$\bar{X}$	1 - 2	3 - 4	5 - 6	Total	$\bar{X}$
Irrigated	172	155	103	430	3.18	169	154	101	424	3.18
Barani	95	23	3	121	1.98	94	26	6	126	2.10
TOTAL	267	178	106	551	2.92	263	180	107	550	2.93

$\bar{X}$ Average calculated on grouped data formula.

TABLE 2.18 (a)

Reasons for Travelling* More/Less for Fertilizer Purchase by Area, Rabi 1976—78

Area	Travelled more/less during 1976-77 and 1977-78	REASONS									
		Fertilizer Not Available		Happened to visit Market for other purposes but purchased Fertilizer		Sale Outlet Opened Nearby		Others		Total	
	Percentage	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated	5	14	67	3	14	1	5	3	14	21	100
Barani	13	13	86	1	7	—	—	1	7	15	100
TOTAL	7	27	75	4	11	1	3	4	11	36	100

*Includes only those cases who travelled more/less distance as compared to the last year.

—Nil

TABLE 2.19

Per Bag Control Price of Fertilizer, Average Price Paid, Transport Cost/Total Cost by Area, Rabi 1976—78

Average Price Per Bag in Rs.

Area/ Fertilizer Types	Control price	1976 - 77					1977 - 78				
		Price paid	Additional Price paid		Transport Cost.	Total Cost	Price paid	Additional price paid		Transport Cost	Total Cost
	Rs.	Rs.	Rs.	%	Rs.	Rs.	Rs.	Rs.	%	Rs.	Rs.
Irrigated (All)					1.82*					1.87*	
Urea	68	69.62	1.62	2.4	1.81	71.43	69.61	1.61	2.4	1.92	71.53
A. N.	39	42.38	3.38	8.7	1.33	43.71	41.00	2.00	5.1	1.59	42.59
A. S.	31	32.62	1.62	5.2	1.41	34.03	35.14	4.14	13.4	1.12	36.26
D. A. P.	72	72.35	.35	.5	1.94	74.29	72.63	.63	.9	1.90	74.53
N. P.	50	50.97	.97	1.9	1.62	52.59	52.00	2.00	4.0	1.49	53.49
S.S.P.	18	20.35	2.35	13.1	1.52	21.87	20.80	2.80	15.6	1.52	22.32
Barani (All)					3.02*					2.71*	
Urea	68	71.10	3.10	4.6	2.92	74.02	70.71	2.71	4.0	2.82	73.53
A. N.	39	42.47	3.47	8.9	3.92	46.39	42.32	3.32	8.5	2.24	44.56
A. S.	31	35.79	4.79	15.5	3.20	38.99	37.69	6.69	21.6	2.98	40.67
D. A. P.	72	72.29	.29	.4	2.45	74.74	72.77	.77	1.1	2.19	74.96
N. P.	50	50.00	—	—	3.00	53.00	50.00	—	—	3.33	53.33
S. S. P.	18	18.50	.50	2.8	1.00	19.50	18.00	—	—	1.00	19.00
TOTAL					2.04*					2.01*	

*Weighted average of transport cost per bag.

—Nil

TABLE 2.20

Users Facing Difficulty in Obtaining Fertilizer/Specific Brand by Area, Wheat, 1978

Area	Difficulty in getting any Fertilizer				Specific Fertilizer Types*													
	Yes		No		Urea		AS		AN		DAP		NP		SSP		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated	253	59	178	41	220	56	2	1	1	**	142	37	19	5	5	1	389	100
Barani	55	41	78	59	22	31	22	31	8	12	13	25	—	—	1	1	71	100
TOTAL	308	55	256	45	242	53	24	5	9	2	160	35	19	4	6	1	460	100

*There was multiple response.

**Less than 0.5%

—Nil

TABLE 2.20 (a)

Users Applying Less Quantity Due to Short Supply of Fertilizer by Area
Wheat 1978

Area	Less Application							
	Yes		No		N. R.		Total	
	#	%	#	%	#	%	#	%
Irrigated	107	42	143	57	3	1	253	100
Barani	35	64	18	33	2	3	55	100
Total	142	46	161	52	5	2	308	100

TABLE 2.20 (b)

Users Applying Less Quantity by Types*Due to Short Supply of Fertilizer by Area, Wheat 1978

Type of Fertilizer	AREA											
	IRRIGATED						BARANI					
	Applying 1 Bag Less		Applying 2 Bags Less		Total Applying Less		Applying 1 Bag Less		Applying 2 Bags Less		Total Applying Less	
	#	%	#	%	#	%	#	%	#	%	#	%
Urea	93	94	6	6	99	100	11	100	—	—	11	100
A.S.	1	100	—	—	1	100	7	58	5	42	12	100
A.N.	—	—	1	100	1	100	4	57	3	43	7	100
D.A.P.	56	98	1	2	57	100	10	100	—	—	10	100
N.P.	9	100	—	—	9	100	—	—	—	—	—	—
S.S.P.	—	—	—	—	—	—	1	100	—	—	1	100
Total	159	95	8	5	167	100	33	80	8	20	41	100

*Multiple Response

—Nil

TABLE 2.20 (c)

Farmers Response Regarding Weight/Quality/Price of Fertilizer by Area, Wheat 1978

Area	Sub-Standard Weight				Adulterated				Caked				Price paid for Caked Fertilizer			
	Yes		No		Yes		No		Yes		No		Full		Reduced	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated	140	32	291	68	72	17	359	83	116	27	315	73	110	95	6	5
Barani	9	7	119	93	3	2	125	98	57	45	71	55	56	98	1	2
Total	149	27	410	73	75	13	484	87	173	31	386	69	166	96	7	4

TABLE 2.20 (d)

Farmers Response Regarding Weight and Quality of Various Fertilizers by Area, Wheat 1978

Area	Sub — Standard Weight													
	Urea		AS		AN		DAP		NP		SSP		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated	66	47	1	1	1	1	63	45	7	5	2	1	140	100
Barani	3	33	3	33	—	—	2	22	1	12	—	—	9	100
Total	69	46	4	3	1	1	65	44	8	5	2	1	149	100

Area	Caked													
	Urea		AS		AN		DAP		NP		SSP		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated	82	70	9	8	—	—	22	19	2	2	1	1	116	100
Barani	20	35	32	56	—	—	4	7	1	2	—	—	57	100
Total	102	59	41	23	—	—	26	15	3	2	1	1	173	100

—Nil

TABLE 2.21

Users Perception Regarding Effects of Nitrogen and Phosphate Use on Crop by Area, Wheat 1978

Area/Fertilizer Type	EFFECTS ON CROP																			
	Increase Yield		Turn Green		Streng-then Plant Roots		Lengthen/ Strengthen Plant		Promote Rapid Growth		Burn Crop if no water Rain		Early and High Ger-mination Rate		No Response		Others		Total*	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Effects of "N"																				
Irrigated	278	42	219	33	10	3	69	11	46	7	3	1	22	3	1	—	1	—	658	100
Barani	94	52	37	20	9	5	24	13	5	3	4	2	1	1	2	1	6	3	182	100
Total	372	44	256	31	28	3	93	11	51	6	7	1	23	3	3	—	7	1	840	100
Fffects of "P"																				
Irrigated	162	41	54	14	48	12	33	9	40	10	—	—	50	13	1	—	3	1	391	100
Barani	26	58	—	—	5	11	9	20	2	5	1	2	1	2	1	2	—	—	45	100
Total	188	43	54	12	53	12	42	10	42	10	1	—	51	12	2	—	3	1	436	100

*Multiple Response

—Nil

TABLE 2.21 (a)

Users Perception of Nitrogen and Phosphate Use on Soil by Area

Area/Fertilizer	EFFECTS OF FERTILIZER ON SOIL																					
	Harden Soil		Dry up the Soil		Decrease Soil Fertility in Long Run		Soften Soil		Improve the Soil		Make Soil Saline		Remove Salinity		No Effects		No Response		Others		Total*	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Effects of "N"																						
Irrigated	38	8	13	3	54	12	157	33	89	19	15	3	10	2	63	13	21	5	11	2	471	100
Barani	4	3	3	2	6	4	88	60	8	6	—	—	2	1	—	—	30	20	6	4	147	100
Total	42	7	16	2	60	10	245	40	97	16	15	2	12	2	63	10	51	8	17	3	618	100
Effects of "P"																						
Irrigated	5	2	3	1	12	4	124	39	96	30	1	—	1	—	61	19	12	4	3	1	318	100
Barani	—	—	1	3	1	3	23	65	1	3	1	3	—	—	—	—	7	20	1	3	35	100
Total	5	1	4	1	13	4	147	42	97	28	2	1	1	—	61	17	19	5	4	1	353	100

*Multiple Response

—Nil

TABLE 2.22

General Problems Regarding Fertilizer Use by Area

Area	P R O B L E M S *																			
	Fertilizer Not Timely Available		No Sale Outlet in Village		Non-availability of Credit		High Fertilizer Price		Not Available on Control Price		Shortage of Water		Sub-standard Bags		Adulterated Fertilizer		No Response		Total	
	#	%	#	%	#	%	#	%	#	#	#	%	#	%	#	%	#	%	#	%
Irrigated	259	23	227	20	179	16	157	14	129	11	62	5	40	4	25	2	56	5	1134	100
Barani	68	14	165	35	55	12	111	23	51	11	—	—	4	1	1	**	21	4	476	100
Total	327	20	392	24	234	14	268	17	180	11	62	4	44	3	26	2	77	5	1610	100

* There was multiple response.

** Less than 0.5 percent.

—Nil

CHAPTER III

MULTIVARIATE ANALYSIS OF FERTILIZER USE

One of the major objectives of Follow-on Study was to identify and assess the relative importance of factors affecting farmers' use of fertilizer and compare the findings with the GFI Survey. Multiple regression analysis was used to test the null hypothesis that the following factors do not significantly influence the probability that a given farmer uses fertilizer :

1. Farmers' use of irrigation water,
2. Distance to fertilizer source,
3. Farmers' education,
4. Farm size,
5. Quality of road linking the farm with fertilizer sale outlet
6. Farmers' age, and
7. Tenurial status.

The regression model used was of the following form :

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + e$$

Where:

Y = 1 if farmer used nitrogenous fertilizer; 0 if not,

X_1 = 1 if farmer used irrigation; 0 if not,

X_2 = Distance to fertilizer source in miles[1],

X_3 = 1 if farmer received 1—10 years of schooling; 0 if no schooling,[2] intercept if 11 and above years of schooling,

X_4 = Farm size in acres,

X_5 = Ratio of 'pacca' road from farm gate to fertilizer sale outlet; 1 if primarily 'pacca', 0 if primarily 'katcha'[3],

X_6 = Farmers' age in years, and

X_7 = 1 if farmer owner; 0 if not.

a = Intercept.

e = Residual.

The model was applied to the portion of sample farmers who grew wheat irrespective whether they applied nitrogenous fertilizers to crop or not. This gave 701 observations[4].

1. For farmer who used fertilizer x_2, is the number of miles the farmer reported travelling for fertilizer purchase for farmer not using fertilizer in villages where at least one sample farmer used fertilizer, x_2 is the medium distance sample farmer travelled to obtain fertilizer.
2. This variable was classified as 1, 2, and 0. In the first pass code 1 was controlled masking 2 and 0 and in the second 2 was controlled masking 0 and 1.
3. If 51% or more of total distance was 'pacca' it was considered primarily 'pacca' road and vice versa.
4. In GFI the number of observations were 724 for the similar analysis. One of the reason might be that lesser percentage of farmers in irrigated and 'barani' areas grew wheat because of low market price for the crop during the study year.

Table 3.1 shows regression coefficients, R^2, and F-value. The value of F for the regression as a whole, was 102.54, a value which was highly significant. The probability of such a large F-value being due to chance alone is one in a thousand.

The R^2 value for the equation as a whole was .508. This meant that 50% of the variation in the dependent variable was accounted for by the seven independent variables acting together. The remaining 50 % of the variation in dependent variable (Y) remained unexplained which could be attributed to the factors either not included in the Study, or different levels of the factors being considered in the analysis.

The table further shows that the independent variables of "use of irrigation," "distance to fertilizer source," "quality of road," and "tenurial status" were highly significant at .001 level. While "farmers' education" was significant at .05 level whereas "farmers' age" and "farm size" were insignificant. The signs of the regression coefficients seemed logically consistent. The independent variables "use of irrigation", "tenurial status" "education" and "ratio to 'pacca' road" were positively correlated with fertilizer use. Also as expected, negative relationships existed between "distance to fertilizer source" and "farm size" to the adoption of fertilizer use.

Comparing the findings with GFI, there was agreement on the degree and signs of the regression coefficients of "use of irrigation," "farmers' education", "quality of road," and "distance to fertilizer source". "Farmers' age" was not related to nitrogen use in either study. However, there was a point of departure in the case of "farm size" which was positively related in GFI while, it was negative but insignificant in the FOS. Similarly, farmers' "tenurial status" was insignificantly correlated in GFI while it emerged as positively and significantly related in the present study.

The negative insignificant relationship between "farm size" and "fertilizer use" in the present study as against GFI is consistent with our previous findings (Table 2.5) where the percentage of users belonging to large farm category (26 acres and above) decreased by four percent (from 86 % to 82 %) during 1978 as compared to 1976. The two smaller size categories showed increased fertilizer use, while the third largest "farm size" showed no change.

The farmers' "tenurial status" was positively related with fertilizer use and this finding was in harmony with our results of the present study on fertilizer application rates and percentage of farmers applying recommended dozes of fertilizer.

The regression coefficients like significance level of the independent variables varied widely and ranged from .001 to .392. These coefficients are useful in interpreting data when incorporating them into the above regression model to calculate the probability that a given farmer uses fertilizer. This was done by summing up the intercept coefficient and the products of the coefficients of the individual independent variables and any given values of these variables. For example, the model predicts that a farmer using irrigation, living on a 'pacca' road 5 miles from a fertilizer sale outlet, having three years of education and operating 10 acres of land has the probability of using fertilizer of .427 (intercept coefficient) $+ (.392 \times 1) + (-.028 \times 5) + (.195 \times 1) + (.048 \times 3) + (-.001 \times 10) = .98$ or about 98 percent. If a farmer does not use irrigation, other conditions remaining the same, the

probability of his using fertilizer decreases from .98 to .59 (= .98 – .39) a fall of 39 percent. In contrast, changing farm size from 10 to 2 acres, other factors remaining the same, results in an increase in the probability of farmer using fertilizer from .98 to .99 a rise of one percent.

A comparative study of the findings of both the surveys, considering the same regression model, independent variables and dependent variable reveal that :

a) There has been an increase of about .09 (27%) in the value of intercept co-efficient in the present study (.42) against the GFI Survey (.33). This means that the interaction effect of independent variables on the dependent variable (incidence of fertilizer use) has become more important in the present study as compared to GFI. This further implies that the individual factors (variables) in isolation might not provide "sufficient conditions," for the probability of fertilizer use. It is the "interaction effect" of these variables (factors) which is more relevant now than it was in the GFI.

b) There has been an increase of 14% in the probability of using fertilizer for farmers having similar social, economic and physical conditions in the FOS as compared to GFI.

c) Although irrigation variable bears the highest value of coefficient of all the independent variables under test in both the studies yet the relative importance of this variable decreased during FOS.

d) There has been a rise of about 1% in our present study when the farm size is reduced from 10 acres to 2 acres, whereas in GFI there was a decrease of about 2 percent.

To summarise, the null hypotheses that "use of irrigation water", "distance to fertilizer source", "ratio of pacca road", "farmers' education" and "tenurial status" are not correlated with the "incidence of fertilizer use" are rejected. As measured by their relative significance, "use of irrigation" was the most important explanatory variable, used in regression followed by "quality of road", farmers' "tenurial status", "education" and "distence to fertilizer source". The null hypotheses that the "farmer's age" and "farm size" had no effect on the "incidence of fertilizer use" cannot be rejected.

Both in G.F.I. and F.O.S. "farmers' age" was not statistically significant, while his tenurial status was not related to his incidence of fertilizer use in G.F.I., whereas farm size in F.O.S.

TABLE 3.1

Regression Coefficients, R^2, F-Values and Level of Significance of Factors Related to the Probability of Farmers' Use of Nitrogen, Wheat 1978*

Independent Variables	Regression Coefficient	F-Value	Level of Significance
Use of Irrigation	.392	259.74	.001
Distance** to Fertilizer Source	(—) .028	130.98	.001
Education	.048	4.25	.05
Farm Size	(—) .001	3.04	N.S.
Ratio to Pacca Road ***	.195	61.07	.001
Farmers' Age	.001	1.60	N.S.
Farmers' Tenurial Status	.145	37.49	.001

F = 102.539 R^2=.508 Intercept Coefficient = .427

*The table for G.F.I. has been given in Annexure D (b).

**The distance variable was fed to the computer in the reverse order, i.e., zero is greater than one, one is greater than two and so on.

***Similarly, the variable "ratio to pacca road", was fed to the computer in the reverse order.

N.S. = Not significant.

TABLE 3.2

Correlation Matrix of Factors Related to the Probability of Farmers' Incidence of Nitrogen Use, Wheat 1978

Independent Variables	N-Use	Use of Irrigation	Farmers' Age	Education	Distance to Fertilizer Source	Ratio to Pacca Road	Farm Size	Farmers' Tenurial Status
N-Use	1.000	0.566	−0.025	0.102	0.483	−0.294	0.114	0.124
Use of Irrigation	0.566	1.000	−0.107	−0.010	0.350	−0.088	0.178	−0.151
Farmer's Age	−0.025	−0.107	1.000	−0.239	−0.067	0.014	0.006	0.162
Education	0.102	−0.010	−0.239	1.000	0.031	−0.076	0.131	0.206
Distance to Fertilizer Source	0.483	0.350	−0.067	0.031	1.000	−0.045	0.163	−0.060
Ratio to Pacca Road	−0.294	−0.088	0.014	−0.076	−0.045	1.000	0.010	−0.128
Farm Size	0.114	0.178	0.006	0.131	0.163	0.010	1.000	0.109
Farmers' Tenurial Status	0.124	−0.151	0.162	0.206	−0.060	−0.128	0.109	1.000

CHAPTER IV

FACTORS ASSOCIATED WITH WHEAT PRODUCTION

The present chapter deals with farmers' practices associated with wheat production including the level of technology adoption. It discusses the area under wheat, growing of wheat on different types of soil, land preparation methods, methods of cultivation, use of high yielding varieties, number of irrigations, fertilizer application rate, farmers' perception of fertilizer application on various soils under wheat, wheat production, production level for different types of soil and wheat selling.

Area Under Wheat

Table 4.1 shows that 76% (74% in irrigated and 86% in barani areas) of the total cultivated area in the sample was under wheat during rabi 1977-78. The tenant operators both in irrigated and 'barani' areas had higher percentages of their cultivated area under wheat as compared to other tenurial classes. These percentages were invariably high for all types of farms irrespective of their farm size and tenure and mostly not significantly different among themselves and between areas.

Method of Sowing

Table 4.2 indicates that a substantial percentage 74% in irrigated areas followed the "broadcasting" method for wheat sowing as compared to 45% in 'barani' areas. This finding is quite consistent with the farmers' practice of sowing deeper in 'barani' areas in order to reach the moisture required for the germination of wheat.

Adopted Level of Technology

The determination of level of technology adopted for wheat in Pakistan and elsewhere has become quite technical and complicated exercise. It requires comprehensive data about different factors. The contents of table 4.2(a) do provide some insight in this respect. The data pertain to irrigated areas only because modernization efforts are mainly concentrated in these areas. Survey findings on some of the important related factors are discussed below :

(i) *Land Preparation.* The table 4.2(a) indicates that 10% of wheat growers had access to tractor while preparing land for cultivation and 14% used tractor plus draught animals for the same purpose. This implies that there is still much room for improvement in this regard.

(ii) *High Yielding Varieties.* Eighty six percent of wheat growers planted high yielding varieties of seed whereas, 50% used the following four early varieties; a) Chenab-70, b) Mexi-Pak, c) Khushhal and d) Pak-70. These were sown within 5 weeks time (October 15-November 21); an appropriate time for their sowing.

(iii) *Irrigation Facility.* The table further indicates that 33% of wheat growers had access to both canal and tubewell water which enhances sufficient timely supplies. Only 18% of the farmers applied four irrigations (excluding 'roni') to wheat, which is the minimum recommendation for the crop.

(iv) *Fertilizer Use, Application Rate.* The use and application rate of fertilizer on a particular crop are of major importance especially in case of high yielding

varieties. The table indicates that 24% of the wheat growers applied nitrogen only while 54% applied both nitrogen and phosphate. Although the incidence of fertilizer use was encouraging, it was far behind the balanced fertilizer use. The table also revealed that 100 or more nt. lbs. of nitrogen and 50 or more nt. lbs. of phosphate were used by only 8% of wheat growers, while 11% used 50 to less than 100 nt. lbs. of nitrogen and 25 to less than 50 nt. lbs. of phosphate per acre. These statistics indicate a low level of fertilizer use much below the recommended level.

Wheat Selling

Table 4.3 indicated that in irrigated areas, 84% of the sample farmers grew wheat, of those, 35% sold part of their grain. For those who sold wheat, the average quantity sold was 73 maunds. The corresponding figures for 'barani' areas were 91,3 and 12 respectively. Table 4.3 indicates that although there was a higher percentage of wheat growers during rabi of 1978 as compared to 1977, yet the percentage of farmers selling wheat was smaller, as was the average quantity sold, in both irrigated and 'barani' areas. There was 22.2% market surplus in the over all sample distributed into 25.2% and 1.2% in irrigated and 'barani' areas respectively.[1]

The same table also shows that as regards the percentage of wheat growers and sellers and the average quantity of wheat sold, owners and large farm operators were the most important classes in the irrigated areas. This was, however, not true in case of 'barani' areas.

Reasons for Not Selling Wheat

Wheat growers, who did not sell any produce, were asked to enumerate the reasons for not doing so. Table 4.4 indicates that an overwhelming majority (98%) of farmers of irrigated and 'barani' areas said that they kept the produce for home consumption because of low wheat yield and thus question of selling did not arise. This reason appeared to be almost equally prevalent among all farm size categories and tenurial classes.

Salinity and Fertilizer Use

It was generally believed that farmers might not grow wheat on saline land and if they did, they might apply smaller dozes of fertilizer than on a "good" land. Tables 4.5 and 4.6 present statistics on the subject.

Table 4.5 shows that slightly more than 3% of the total area under wheat, (3.3% in irrigated and 2.4% in barani areas) was salt affected during 1977-78.

Table 4.6 shows that 79% of the wheat growers (86% in irrigated and 53% in barani areas) applied some fertilizer on salt affected land[2]. Of those who applied fertilizer on salt affected land under wheat, an overwhelming majority 85% (87% in irrigated and 67% in barani areas) applied the same quantity of fertilizer as that applied to "good" land. Of those who applied a smaller quantity, 71% applied 50% less fertilizer while, in 'barani' areas 67% applied 75% less fertilizer than the usual doze on "good" soil.

1. See further details in Annexure-j.
2. Degree of salinity varied from white to black, it was farmers' own perception whether his land was saline or not. If so; was it slight, moderate or high?

Incidence of Rust and Fertilizer Application

Table 4.7 shows that 47% of the total wheat growers (51% in irrigated and 39% in barani areas) reported the incidence of rust on wheat 1977-78.

Table 4.7(a) indicates that there were no significant differences in the per acre average application rates of nitrogen and phosphate for farmers reporting "no-rust", rust and various degrees of rust on irrigated wheat 1977-78. On the other hand, farmers reporting rust in 'barani' areas applied significantly less nitrogen than those reporting "no-rust". Anyhow, no clear trend emerged within the rust reporting farmers on 'barani' wheat viz-a-viz degree of rust reported.

Area Fertilized

The percentage of fertilized[1] area under wheat could be a possible indicator of fertilizer use. Table 4.8 shows the percentage of area fertilized by the growers of wheat in irrigated and 'barani' areas. The table indicates that small farmers and tenants were more likely to have a higher percentage of fertilized acreage as compared to other farm size categories and tenurial classes both in irrigated and 'barani' areas. The finding is quite consistent with the conventional wisdom that small operators and tenant farmers were more likely to use fertilizer because of the farmers' interest to get maximum produce by intensive cultivation and the latter's sharing one-third to two-thirds of the produce with landlord.

Farmers Applying N and P on Wheat

Table 4.9 gives the number and percentages of farmers not using fertilizer, users of nitrogen only and users of both nitrogen and phosphate on wheat by farm size and tenancy in irrigated and 'barani' areas.

The chi-square test revealed that with one exception, farm size and tenurial status were not related to the percentages of sample farmers: (a) not using fertilizer, (b) using nitrogen only, and (c) using nitrogen plus phosphate on wheat in irrigated and 'barani' areas. The exception was farm size in 'barani' area which was inversely related with fertilizer use.

Average Application Rates of N and P on Wheat

Table 4.10 indicates the average per acre application rates of nitrogen and phosphate by farm size and tenancy in irrigated and 'barani' areas. The difference-of-means test revealed the following :

1. Growers of irrigated wheat applied significantly more nitrogen and phosphate per acre than growers of wheat 'barani'. Farmers operating 1—5 acres category applied significantly more nitrogen per acre than those operating 13—25 on irrigated wheat. Similarly, farmers belonging to the smallest size group applied significantly higher dozes of nitrogen on wheat in the 'barani' areas than any other size group.
2. Tenants applied significantly more N per acre than owners in wheat 'barani'. On the other hand, there was no significant difference in the average application rates of N among various tenurial classes in case of wheat irrigated.

1. Farmers who applied some fertilizer irrespective of nitrogen or phosphate on wheat.

3. Farmers in the 13—25 acres category applied comparatively higher dozes of phosphate per acre than any other size category on wheat 'barani'. Whereas, farmers in the 6—12 acres category applied significantly more phosphate per acre than 13—25 acres category on wheat irrigated.
4. There were no significant differences among various tenurial classes in the mean application rates of phosphate for both irrigated and 'barani' wheat.

Nitrogen and Phosphate Ratio

Table 4.11 shows fertilizer application ranges of nitrogen and phosphate and their ratios on wheat. The table shows that the N:P ratios were 2.3:1, 2:1 and 6:1 for total population, irrigated and 'barani' areas respectively. The table clearly demonstrates that dream of 1:1 ratio is yet to go a long way before its realisation even in irrigated areas. The 'barani' areas were lagging far behind the irrigated areas, which calls for special extension efforts and improved fertilizer distribution system.

Type of Fertilizer Applied

Farmers when asked what types of fertilizer they applied on wheat 1977-78, indicated that more than one type of fertilizer was applied on the crop. Table 4.12 shows that for the total sample, urea (51%), DAP (30%), AS (7%) and NP (5%) attained the first, second, third and fourth positions as regards the frequency of use on wheat. Table 4.12 also shows that urea (54%), DAP (33%) and NP (6%) in irrigated areas while urea (39%), AS (31%), DAP (17%) and AN (11%) in 'barani' areas were reported in ranked order.

The ex-post facto use of various fertilizers on wheat could be considered as an index of popular fertilizers for the crop. The most popular fertilizers for wheat crop, seemed to be urea and DAP in irrigated areas and urea and AS in 'barani' areas.

Response to Fertilizer Price Increase

Farmers were asked to indicate their probable reaction to a price increase of Rs. 5 per bag for urea DAP and NP, table 4.13, 4.14 and 4.15 show farmers stated reaction.

Urea. Table 4.13 shows that a majority (70%) of farmers in irrigated and 'barani' (63%) areas reported that they would apply the same doze even if the price of a bag of urea was Rs. 5 higher than the prevailing control price.

In such a hypothetical situation the percentage of farmers that would stop using fertilizer was significantly higher in 'barani' areas (14%) as compared to irrigated areas (5%). The owners and small operators (1—5 acres) appeared to be significantly higher in this category as compared to other farm size categories and tenurial classes in irrigated areas, whereas tenants and farmers operating 13—25 acres were having significantly higher percentage in 'barani' areas.

DAP. In case of DAP (Table 4.14) a majority of farmers (71%) in irrigated areas reported that they would apply the same doze of DAP under higher price of DAP, while 8% of the farmers said that they would stop using. A relatively higher percentage of tenants and farmers operating 13—25 acres were likely to stop use as compared to any other farm size and tenurial class. In case of 'barani' areas, the number of responses were very few therefore, no firm conclusion could be drawn.

NP. Table 4.15 shows that 58% of the respondents in irrigated areas would apply the same doze of NP under higher prices, while, 28% would apply half a bag less. Owner-cum-tenants and operators of 13—25 acres were more likely to reduce dozes by half a bag, than any other farm size category and tenurial classes.

The price elasticity of demand for urea was greater than DAP and NP, and DAP more than NP on wheat irrigated and 'barani'.

Multivariate Analysis for Fertilizer Use Rate

The primary objective of the multivariate analysis was to identify and evaluate the relative importance of factors influencing farmers' application rate of fertilizer on wheat 1977—78. Multiple regression analysis was applied to test the null hypotheses that the following factors did not significantly influence farmers' per acre application rate of nitrogen on wheat :

1. Farmers' use of phosphate,
2. Farmers' use of irrigation water,
3. Farmers' control over irrigation water,
4. Farmers' education,
5. Farm size,
6. Tenancy,
7. Availability of credit,
8. Availability of fertilizer,
9. Quality of road linking the farm with fertilizer sale outlet,
10. Distance from sale outlet, and
11. Farmers' age.

The regression model used was of the linear form :

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + e$$

Where :

Y = Average per acre nitrogen application rate in nutrient lbs,
X_1 = 1 if farmer applied phosphate ; 0 if not,
X_2 = 1 if farmer used irrigation ; 0 if not,
X_3 = 1 if canal irrigation ; 2 if canal + tubewell irrigation ; 0 if no irrigation,
X_4 = Number of years of schooling,
X_5 = Farm size in acres,
X_6 = 1 if owner ; 0 if not,
X_7 = 1 if sufficient credit; 0 if not,
X_8 = 1 if fertilizer available ; 0 if not,
X_9 = 1 if primarily 'pacca'; 0 if not,
X_{10} = Distance to fertilizer sale outlet in miles, and
X_{11} = Farmers' age in years.
a = Intercept.
e = Residual.

The above model was applied to the portion of sample farmers who applied some nitrogon to the crop. The total number of observations were 556 which appeared to be sufficient for the proposed statistical analysis. Relation of the variables, like "cash crop income", "improved seed varieties", "number of irrigations", "farmers' technical education", "size of mogha" "location of farm on the mogha" "farmers' level of technological adoption", "type of land", "urban orientation" and "access to mass media" with the probability of farmers' fertilizer application rate could not be studied because of the data on quality and distribution of these variables were unreliable and abnormal.

Table 4.16 shows regression co-efficients, R^2 and F-values. The value of F for the table as a whole was 21.247, a value which was highly significant. This implied that probability of regression results occurred by sampling fluctuations and independent variables were not really related with the probability that farmers nitrogen application rate on wheat was one-in-a-thousand.

The R^2 value for the equation as a whole was .301. This implied that about 30 percent of the variation in dependent variable was being explained by the eleven independent variables taken together. The remaining 70 percent of the variation in dependent variable (N use rate) remained unexplained which could be attributed to the factors either not included in the study or different levels of factors being considered in the analysis.

The table further reveals that the independent variables of "use of phosphate," "control over irrigation," "credit availability", and "farmers' age" were highly significant at .001 level; while farmers' "tenurial status", was significant at .05 level, "water source" and "type of road" at .10 level whereas "farmers' education", "farm size", "fertilizer availability" and "distance from sale outlet" were not significant. The "credit availability", "use of phosphate" and "control over irrigation" were the most important variables effecting farmers' per acre nitrogen application rate on wheat.

The signs of the regression coefficients seem logical. The independent variables of "use of phosphate," "water source," "control over irrigation," "farmers tenurial status," "credit availability" and "ratio of 'pacca' road" were positively correlated with fertilizer application rate. As expected negative relationships of "distance from fertilizer sale outlet," "farmers' age," "farm size," "farmers education" and "fertilizer availability" emerged with the nitrogen application rate. It may be noted once again that "farmers education", "farm size," "fertilizer availability" and "distance from sale outlet" were not significantly related to fertilizer application rate. However, "farmers' education," and "fertilizer availability" may not be as important variables at the later stages of diffusion process i.e., fertilizer application rate as in the early stages of innovation, e.g., incidence of fertilizer use. This was substantiated by the fact that in table 3.1 "farmers education" was significantly related in the positive way. Similarly, "fertilizer availability" might be significant variable in the early stages of diffusion of fertilizer use but might become insignificant in case of fertilizer application rate.

The signs of the regression co-efficients, like, the significance levels, of the independent variables varied widely and ranged from .002 to .253. These coefficients are helpful in interpreting data when incorporated into the above regression model to estimate that a

given farmer applies some amount of nitrogen per acre. This was done by summing up the intercept co-efficient and the products of the co-efficients of the individual independent variables and any given values of these variables. For example, the model predicts that an owner farmer of 30 years operating 10 acres, having three years of education, living on 'pacca' road at a distance of 5 miles from fertilizer sale outlet, having access to irrigation water and control over irrigation, using phosphate, having sufficient credit and not facing fertilizer availability problem would apply 72 nutrient lbs. of nitrogen per acre, i.e., 35.154 (intercept coefficient) + $(16.495 \times 1) + (6.340 \times 1) + (10.105 \times 1) + (-3.386 \times 3) + (-0.062 \times 10) + (7.001 \times 1) + (17.064 \times 1) + (-2.958 \times 1) + (4.280 \times 1) + (-0.015 \times 5) + (-0.349 \times 30) = 72.158$. If a given farmer did not have "control over irrigation", other conditions remaining same, the estimated application of nitrogen on wheat would decrease from 72 nt. lbs. to 62 nt. lbs. per acre (72.158—62.053) a fall of about 10 nt. lbs. per acre. In contrast, changing farm size from 10 to 5 acres, other factors remaining the same, would result in a rise of about .3 or one-third of a nt. lb. per acre (72.158 to 72.468 nutrient lbs. per acre). Similarly, a farmer not having sufficient credit to purchase fertilizer, other conditions remaining constant, his estimated application rate would fall to 55.094 nt. lbs. per acre = (72.158—55.094), a fall of about 17 nutrient lbs. per acre.[1]

To summarise, the null hypotheses that farmers "use of phosphate", "source of irrigation", "control over irrigation", "tenurial status", "credit availability", "ratio of 'pacca' road linking fertilizer sale outlet" and "farmers' age" were not correlated with per acre application rate of nitrogen on wheat, were rejected. The null hypotheses that "farmers' education", "farm size", "fertilizer availability" and "distance from fertilizer sale outlet" had no influence on per acre application rate of nitrogen on wheat could not be rejected.

1. The correlation between "irrigation source" and "control over irrigation" was quite high (due in large part to the fact that both took on a value of zero if no irrigation was used and one if only canal irrigation was used). Both variables were also correlated (weakly, but higher than desirable when trying to isolate and interpret the effects of individual explanatory variables) with "use of P" (see Table 4.17). "Water source" was also correlated with "tenancy". Despite the frequency, the partial regression coefficients for "use of P", "irrigation source' and "control over irrigation" were all statistically significant. There was no correlation between farm size and tenancy (with owner-cum-tenants and tenants combined into one category). A surprise is the following: The signs of the correlation coefficients between "tenancy" and "irrigation source" and between "tenancy" and "control over irrigation" were negative. That is, owners were less likely to have used irrigation than tenants (including owner-cum-tenants) and also less likely to have used canal irrigation and/or canal plus tubewell irrigation. The coefficients are not statistically significant, however, in retrospect, it is obvious that there is a better way (coding method) to handle the question that the inclusion of variables X_2 and X_3 was attempting to address.

TABLE 4.1

Wheat Acreage by Area, Farm Size and Tenancy, 1978

—In Acres

Area	Farm Size				Tenancy			
	1—5	6—12	13—25	26 and above	Owner	Owner-cum-Tenant	Tenant	Total
Irrigated								
Total Area Rabi (1977-78)	418	1310	2078	1641	2284	1899	1264	5447
Area under Wheat	284	950	1566	1223	1633	1406	984	4023
Wheat area in Percentages	68	72	75	75	71	74	78	74
Barani								
Total Area Rabi (1977-78)	328	536	347	82	880	92	321	1293
Area under Wheat	285	467	290	71	753	78	282	1113
Wheat Area in Percentages	87	87	84	87	86	85	88	86
Total								
Total Area Rabi (1977-78)	746	1846	2425	1723	3164	1991	1585	6740
Area under Wheat	569	1417	1856	1294	2386	1484	1266	5136
Wheat Area in Percentages	76	77	77	75	75	75	80	76

TABLE 4.2

Method of Sowing by Area, Wheat 1978

Area	Pora		Broadcast/ Chatta		Drill		Kera		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Irrigated	67	12	409	74	46	8	33	6	555	100
Barani	143	49	133	45	8	3	8	3	292	100
Total	210	25	542	64	54	6	41	5	847	100

TABLE 4.2 (a)

Adopted Level of Technology of Irrigated Wheat Growers*, 1978

Level of Technology adoption	No.	%
Using tractor alone for land preparation	54	10
Using both draught animals and tractor for land preparation	75	14
Planting high yielding varieties	478	86
Planting Chenab—70, Maxi Pak, Khushal, Pak—70 (15th October — 21st November)	276	50
Canal + Tubewell Water Access	182	33
Applying at least 4 irrigations	102	18
Users of N only	132	24
Applying both N and P	297	54
Applying 100 nt. lbs. of N and 50 nt. lbs. of P or above per cropped acre	44	8
Applying 50 nt. lbs. of N + 25 nt. lbs. of P but less than 100 nt. lbs. of N and 50 nt. lbs. of P per cropped acre	59	11

* No. of Wheat Growers = 555

TABLE 4.3

Farmers Growing, Selling, Average Quantity Sold and Market Surplus by Area, Farm Size and Tenancy, Wheat 1976—78

Farm Size/ Tenancy	YEAR 1976—77 Growing No.	Growing %	Selling No.	Selling %	Average Quantity Sold (Mds.)	1977—78 Growing No.	Growing %	Selling No.	Selling %	Average Quantity Sold (Mds.)	Wheat sold as Percentage of produce
Irrigated (All)	537	81	221	41	76	555	84	195	35	73	25.2
Farm Size (Acres)											
1 — 5	122	71	33	27	21	124	73	27	22	27	
6 — 12	183	78	78	43	34	191	81	73	38	35	
13 — 25	180	90	79	44	62	188	94	69	37	55	
26 and above	52	96	31	60	278	52	96	26	50	276	
Tenancy											
Owner	196	86	88	45	117	202	89	77	38	111	
Owner-cum-Tenant	108	89	46	43	76	109	90	33	30	40	
Tenant	233	75	87	37	36	244	79	85	35	69	
Barani (All)	283	88	15	5	29	292	91	8	3	12	1.2
Farm Size (Acres)											
1 — 5	145	83	4	3	12	148	85	3	2	13	
6 — 12	96	93	5	5	17	102	99	3	3	11	
13 — 25	37	97	5	14	42	37	97	2	5	16	
26 and above	5	100	1	20	100	5	100	—	—	—	
Tenancy											
Owner	202	88	13	6	30	209	90	6	3	12	
Owner-cum-Tenant	59	94	1	2	30	61	96	1	2	12	
Tenant	22	81	1	5	15	22	81	1	5	20	
Total											22.2

—Nil

TABLE 4.4

Reasons for Not Selling Wheat by Area, Farm Size and Tenancy, 1978

—In Percentages

Farm Size/ Tenancy	R E A S O N S							
	Kept for Home Consumption*		Selling when Rates are Higher		No Response		Total	
	No.	%	No.	%	No.	%	No.	%
Irrigated (All)	351	98	4	1	5	1	360	100
Farm Size (Acres)								
1 — 5	95	98	1	1	1	1	97	100
6 — 12	114	97	3	2	1	1	118	100
13 — 25	118	99	—	—	1	1	119	100
26 and above	24	92	—	—	2	8	26	100
Tenancy								
Owner	122	97	2	2	1	1	125	100
Owner-cum-Tenant	73	96	2	3	1	1	76	100
Tenant	156	98	—	—	3	2	159	100
Barani (All)	280	98	2	1	2	1	284	100
Farm Size (Acres)								
1 — 5	144	99	—	—	1	1	145	100
6 — 12	96	97	2	2	1	1	99	100
13 — 25	35	100	—	—	—	—	35	100
26 and above	5	100	—	—	—	—	5	100
Tenancy								
Owner	199	98	2	1	2	1	203	100
Owner-cum-Tenant	60	100	—	—	—	—	60	100
Tenant	21	100	—	—	—	—	21	100
Total	631	98	6	1	7	1	644	100

* It includes next year seed requirements Also

— Nil

TABLE 4.5

Percentage of Salt Affected Land by Area, Wheat 1978

—In Acres

Area	Total Area	Salt Affected Land	
		#	%
Irrigated	4023	133	3.3
Barani	1113	27	2.4
Total	5136	160	3.1

TABLE 4.6

Salt Affected Land Cultivators Using Different Dozes of Fertilizer by Area, Wheat 1978

Area	Salt Affected Land*			Applying Same		Applying Less		Applying Less Dozes					
	Growers	Users	User Percentage					Applying 25%		Applying 50%		Applying 75%	
				#	%	#	%	#	%	#	%	#	%
Irrigated	65	56	86	49	87	7	13	2	29	5	71	—	—
Barani	17	9	53	6	67	3	33	—	—	1	33	2	67
Total	82	65	79	55	85	10	15	2	20	6	60	2	20

* Degree of salinity varied from white to black, it was farmers' own perception whether his land was saline or not. If so, was it slight, moderate or high.

—Nil

TABLE 4.7

Number and Percentage of Farmers Reporting Rust by Area, Wheat 1978

Area	REPORTING RUST			
	Yes		No	
	#	%	#	%
Irrigated	285	51	270	49
Barani	110	38	182	62
Total	395	47	452	53

TABLE 4.7 (a)

Application Rates of Nitrogen and Phosphate Under Rust/No-Rust Conditions by Area, Wheat 1978

—Nutrient Lbs.

Area	No-Rust		R U S T							
			Total		Slight		Moderate		Heavy	
	N	P	N	P	N	P	N	P	N	P
Irrigated	66.29	30.56	68.36	29.59	67.42	29.61	71.80	33.03	65.98	25.92
Barani	40.71	5.36	28.21	6.28	34.14	4.12	25.30	9.03	22.21	5.43
Total	58.59	22.97	61.86	25.81	61.87	25.36	62.90	28.44	60.64	23.42

TABLE 4.8

Percentage of Fertilized Acreage* by Area, Farm Size and Tenancy, Wheat 1978

—In Acres

Farm Size/Tenancy	Cropped Area	Fertilized Area	
		No.	%
Irrigated (All)	3290	3031	92
Farm Size (Acres)			
1 — 5	204	201	99
6 — 12	833	805	97
13 — 25	1154	1077	93
26 and above	1099	948	86
Tenancy			
Owner	1425	1253	88
Owner-cum-Tenant	718	671	93
Tenant	1147	1107	97
Barani (All)	490	362	74
Farm Size (Acres)			
1 — 5	128	118	92
6 — 12	182	128	70
13 — 25	120	85	71
26 and above	60	31	52
Tenancy			
Owner	383	284	74
Owner-cum-Tenant	93	64	69
Tenant	14	14	100

* Farmers who applied some fertilizer irrespective of nitrogen or phosphate on wheat.

TABLE 4.9

Number and Percentage of Users of (N, N+P) and Non-Users, by Area, Farm Size and Tenancy, Wheat 1978

Farm Size/ Tenancy	Fertilizer Use							
	Non-Users		N Users		N+P Users		Total	
	#	%	#	%	#	%	#	%
Irrigated (All)	126	22	132	24	297	54	555	100
Farm Size (Acres)								
1 — 5	33	26	32	26	59	48	124	100
6 — 12	33	17	40	21	118	62	191	100
13 — 25	49	26	48	26	91	48	188	100
26 and above	11	21	12	23	29	56	52	100
Tenancy								
Owner	40	20	51	25	111	55	202	100
Owner-cum-Tenant	30	28	21	19	58	53	109	100
Tenant	56	23	60	25	128	52	244	100
Barani (All)	165	56	93	32	34	12	292	100
Farm Size (Acres)								
1 — 5	84	57	55	37	9	6	148	100
6 — 12	59	58	29	28	14	14	102	100
13 — 25	20	54	7	19	10	27	37	100
26 and above	2	40	2	40	1	20	5	100
Tenancy								
Owner	113	54	69	33	27	13	209	100
Owner-cum-Tenant	39	64	17	28	5	8	61	100
Tenant	13	59	7	32	2	9	22	100
TOTAL	291	34	255	27	331	39	847	100

TABLE 4.10

Average per Acre Application Rates of Nitrogen and Phosphate by Area, Farm Size and Tenancy, Wheat 1978.

—Nutrient Lbs.

Farm Size/Tenancy	Wheat Irrigated			Wheat Barani		
	# of Users	N	P	# of Users	N	P
Farm Size (All)	431	67	30	128	36	6
1 — 5	92	75	30	64	45	5
6 — 12	158	68	34	44	29	7
13 — 25	140	61	26	17	21	10
26 and above	41	66	30	3	18	1
Tenancy						
Owner	163	70	31	97	33	6
Owner-cum-Tenant	80	69	31	22	40	4
Tenant	188	64	29	9	58	8

TABLE 4.11

Average Application Ranges and Ratios of Nitrogen and Phosphate by Area, Wheat 1978

—Nt. lbs.

Area	RANGES															
	N								P							
	1—25	26—50	51—75	76—100	101—125	126—150	151—175	Total	1—25	26—50	51—75	76—100	101—125	126—150	151—175	Total
Irrigated	42	48	234	46	37	19	5	431	77	63	138	12	7	—	—	297
Barani	63	34	21	5	6	—	—	129	29	4	2	—	1	—	—	36
Total	105	82	255	51	43	19	5	560	106	67	140	12	8	—	—	333

— Nil

RATIOS

			N	P	Ratio
Irrigated	$\bar{X}$	=	66	32	2 : 1
Barani	$\bar{X}$	=	35	6	6 : 1
Total	$\bar{X}$	=	59	26	2.3 : 1

TABLE 4.12

Fertilizer Users by Type of Fertilizer Area-wise, Wheat 1978

Area	Fertilizer* Type													
	Urea		AN		AS		DAP		NP		SSP		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated	407	54	16	2	16	2	248	33	46	6	24	3	757	100
Barani	66	39	18	11	53	31	30	17	2	1	2	1	171	100
Total	473	51	34	4	69	7	278	30	48	5	26	3	928	100

* Multiple Response.

TABLE 4.13

Users Reaction if Urea Price Increases by Rs. Five by Area, Farm Size and Tenancy

Farm Size/Tenancy	Urea*									
	Apply Nil		Apply Same		Apply One Bag Less		Apply 1/2 Bag Less		Total	
	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	19	5	285	70	18	4	85	21	407	100
Farm Size (Acres)										
1 — 5	6	7	57	69	5	6	15	18	83	100
6 — 12	1	1	105	69	9	6	36	24	151	100
13 — 25	11	8	91	69	3	2	27	21	132	100
26 and above	1	2	32	78	1	3	7	17	41	100
Tenancy										
Owner	13	8	113	72	7	5	24	15	157	100
Owner-cum-Tenant	2	3	48	62	4	5	23	30	77	100
Tenant	4	2	124	72	7	4	38	22	173	100
Barani (All)	11	14	49	63	7	9	11	14	78	100
Farm Size (Acres)										
1 — 5	3	9	21	62	6	17	4	12	34	100
6 — 12	5	17	19	66	1	3	4	14	29	100
13 — 25	3	25	7	58	—	—	2	17	12	100
26 and above	—	—	2	67	—	—	1	33	3	100
Tenancy										
Owner	8	14	37	65	4	7	8	14	57	100
Owner-cum-Tenant	1	7	8	57	2	14	3	22	14	100
Tenant	2	29	4	57	1	14	—	—	7	100
TOTAL	30	6	334	69	25	5	96	20	485	100

* Only users of urea were considered for tabulation.

— Nil

TABLE 4.14

Users Reaction if DAP Price Increases by Rs. Five by Area, Farm Size and Tenancy

Farm size / Tenancy	DAP*									
	Apply Nil		Apply Same		Apply One Bag Less		Apply 1/2 Bag Less		Total	
	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	17	8	180	71	6	2	49	19	252	100
Farm Size (Acres)										
1 — 5	3	7	31	72	1	2	8	19	43	100
6 — 12	4	4	74	72	4	4	21	20	103	100
13 — 25	8	10	54	69	1	1	16	20	79	100
26 and Above	2	7	21	78	—	—	4	15	27	100
Tenancy										
Owner	3	3	73	78	2	2	16	17	94	100
Owner-cum-Tenant	3	7	25	54	2	4	16	35	46	100
Tenant	11	10	82	73	2	2	17	15	112	100
Barani (All)	5	16	20	62	—	—	7	22	32	100
Farm Size (Acres)										
1 — 5	1	14	5	72	—	—	1	14	7	100
6 — 12	2	17	7	58	—	—	3	25	12	100
13 — 25	2	17	8	67	—	—	2	16	12	100
26 and above	—	—	—	—	—	—	1	100	1	100
Tenancy										
Owner	3	12	17	65	—	—	6	23	26	100
Owner-cum-Tenant	1	25	2	50	—	—	1	25	4	100
Tenant	1	50	1	50	—	—	—	—	2	100
Total	22	8	200	70	6	2	56	20	284	100

* Only users of DAP were considered for tabulation.

— Nil

TABLE 4.15

Users Reaction if Nitrophos* Price Increases by Rs. Five by Area, Farm size and Tenancy

Farm Size/Tenancy	N. P.									
	Apply Nil		Apply Same		Apply One Bag Less		Apply 1/2 Bag Less		Total	
	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	1	2	25	58	5	12	12	28	43	100
Farm Size (Acres)										
1 — 5	—	—	5	56	1	11	3	33	9	100
6 — 12	—	—	8	62	3	23	2	15	13	100
13 — 25	1	6	10	59	—	—	6	35	17	100
26 and above	—	—	2	50	1	25	1	25	4	100
Tenancy										
Owner	1	5	10	53	2	11	6	31	19	100
Owner-cum-Tenant	—	—	5	45	1	9	5	46	11	100
Tenant	—	—	10	77	2	15	1	8	13	100
Barani (All)	1	25	—	—	2	50	1	25	4	100
Farm Size (Acres)										
1 — 5	—	—	—	—	2	100	—	—	2	100
6 — 12	1	50	—	—	—	—	1	50	2	100
13 — 25	—	—	—	—	—	—	—	—	—	—
26 and above	—	—	—	—	—	—	—	—	—	—
Tenancy										
Owner	1	100	—	—	—	—	—	—	1	100
Owner-cum-Tenant	—	—	—	—	1	50	1	50	2	100
Tenant	—	—	—	—	1	100	—	—	1	100
Total	2	4	25	53	7	15	13	28	47	100

* Only Users of Nitrophos were considered for tabulation.

— Nil

TABLE 4.16

Regression Co-efficients, Beta Values, F-Values and Level of Significance of Factors Related to Farmers' Use Rate of Nitrogen, Wheat 1978

Independent Variable	Regression Co-efficient	Beta Value	F—Value	Level of Significance
Use of P	16.495	.248	37.93	(.001)
Water Source	6.340	.081	2.01	(. 10)
Control over Water	10.105	.245	20.31	(.001)
Education	– 3.386	– .051	1.68	N.S.*
Farm Size	– 0.062	– .033	0.78	N.S.*
Farmers' Tenurial Status	7.001	.102	6.39	(. 05)
Credit Availability	17.064	.253	46.90	(.001)
Fertilizer Availability	– 2.958	– .045	1.41	N.S.*
Pacca/Katcha Ratio[1]	4.280	.061	2.77	(. 10)
Distance from Fertilizer Outlet[2]	– 0.015	– .002	0.003	N.S.*
Farmers' Age	– 0.349	– .146	14.27	(.001)

F = 21.247 Constant = 35.154 DF = 11, Infinity R^2 = .301

* Not Significant.

1. The distance variable was fed to computer in the reverse order, i.e zero is greater than one, one is greater than two and so on.
2. Similarly, the variable of "ratio to pacca road," was fed to the computer in the reverse order.

TABLE 4.17

Correlation Matrix of Factors Related to Farmers' Use Rate of Nitrogen, Wheat 1978

Independent Variable	N Use Rate	Use of P	Irrigation Source	Control Over Irrigation	Schooling	Farm Size	Tenancy	Credit Availability	Fertilizer Availability	Katcha/Pacca Ratio	Distance from Outlet	Age
N Use Rate	1.000	0.370	0.349	0.357	0.001	0.053	0.052	0.293	0 072	0.068	0.005	-0.171
Use of P	0.370	1.000	0.363	0.251	0.084	0.112	-0.097	0.200	0.203	0.014	0.049	-0.048
Irrigation Source	0.349	0.363	1.000	0.736	-0.120	0.190	-0.322	0.038	0.139	0.152	0.112	-0.119
Control Over Irrigation	0.357	0.251	0.736	1.000	-0.118	0.153	-0.192	-0.016	0.182	0.039	0.035	-0.130
Schooling	0.001	0.083	-0.120	-0.118	1.000	0.108	0.195	0.072	0.007	-0.056	-0.028	-0.264
Farm Size	0.053	0.112	0.190	0.153	0.108	1.000	0.093	0.011	0.083	0.047	0.131	0.002
Tenancy	-0.052	-0.097	-0.322	-0.192	0.195	0.093	1.000	-0.039	0.056	-0.105	-0.167	0.171
Credit Availability	0.293	0.200	0.038	-0.016	0.072	0.011	-0.093	1.000	0.014	-0.040	-0.067	-0.019
Fertilizer Availability	0.072	0.203	0.139	0.182	0.008	0.083	0.056	0.014	1.000	-0.041	0.167	-0.046
Katcha/Pacca Ratio	0.068	0.014	0.152	0.039	-0.056	0.047	-0.105	-0.040	0.041	1.000	0.126	0.007
Distance from Outlet	0.005	0.049	0.112	0.035	-0.028	0.131	-0.167	-0.067	0.167	0.126	1.000	-0.069
Age	-0.171	-0.048	-0.119	-0.130	-0.264	0.002	0.171	-0.019	-0.046	0.007	-0.069	1.000

CHAPTER V

FERTILIZER USE AND WHEAT PRODUCTIVITY

The present chapter deals with comparative production levels of wheat during the study year and year prior to it, per acre average wheat yield of non-users, users of nitrogen only, users of nitrogen plus phosphate, affect of rust, salinity and multivariate analysis of factors effecting wheat yield.

Wheat Production

Table 5.1 shows that 46% of the total wheat growers reported that they had less production during the study year as compared to last rabi. A higher percentage (49) of growers in irrigated areas, than 'barani' areas (40 percent), reported lower wheat production. The present chapter shall later on deal with the reasons for and on the extent of lower wheat yield during the study year.

Wheat Productivity

A comparative study of tables 5.2 and 5.2(a) shows that average wheat production was lower in 1978 than 1977 by 0.65 maunds (4.6%) per acre for the total sample and 1.31 maunds (7.5%) in irrigated areas. Wheat productivity in 'barani' areas however was higher by 0.61 maunds (7.8%). This increase was true for 'barani' wheat non-users, users of nitrogen alone and users of nitrogen plus phosphate. Such an increase in productivity in 'barani' areas during rabi 1978 could be explained by relative absence of rust and favourable rain fall.

Table 5.2(a) suggests that the average per acre wheat yield during rabi 1978 was 14.08 maunds (16.11 and 8.41 in irrigated and barani areas) for total population[1]. The difference-of-means test indicated that there were significant differences in the wheat productivity of non-users, users of nitrogen alone and users of nitrogen plus phosphate in irrigated and 'barani' areas and the population as a whole with the exception that the differences between users of nitrogen alone and farmers applying nitrogen plus phosphate in 'barani' areas, were not statistically significant. Possibly the reason for such insignificant differences among users of nitrogen alone and nitrogen plus phosphate could be explained by the size of sample of nitrogen plus phosphate users being very small and, therefore, sampling error of the average substantially large.

Table 5.2 (a) also shows that there was nominal difference (0.60 maunds) in the per acre average wheat yield between non-users of irrigated and 'barani' areas. Further investigation into the phenomenon revealed that :

(a) One percent of the cropped acreage in 'barani' areas was being operated under irrigated conditions and 16 percent acreage of irrigated areas under 'barani' conditions (Annexure-G),

(b) Forty-eight percent of the 'barani' farms applied some farm yard manure. The corresponding figure for irrigated farms was 7% (Annexure-H),

(c) Fifty-one percent of the irrigated farmers and 39 percent of the 'barani' farmers reported rust attack on wheat during the study year (Table 4.7), and

1. For wheat production the 'barani' area comprised of 12.46% and consumed 6% nitrogen.

(d) There was lesser percentage (2) of 'barani' farms reporting growing wheat on saline land as compared to the irrigated farms (3%). (table 4.5).

Nutrient : Grain/Cost : Benefit Ratios

It is generally believed that a user farmer may not be highly concerned with optimum level of yield per acre for the quantity of fertilizer applied but he may be interested to know that with what level of fertilizer use-rate he will get the highest economic return. The cost : benefit ratios for wheat crop were calculated to understand this phenomenon. Table 5.3 suggests that on the average there was an extra yield of 9.83, 1.16 and 8.95 maunds per acre with the application of fertilizer in irrigated, 'barani' areas, and overall universe respectively. In terms of nutrient: grain ratio there were 1:8.5, 1:3.1 and 1:8.5 ratios in irrigated, 'barani' and overall universe respectively. This implies that average nutrient : grain ratio was quite encouraging in irrigated areas as compared to 'barani' areas. This might be due to the fact that the nutrient : grain ratio in 'barani' areas mainly depends on the amount and appropriate time of rainfall, which could range from 1:1 to 1:6 or more with the improved situation.

In terms of cost : benefit ratio, there was an overall ratio of 1:3.07, distributed into 1:3.08 and 1:1.12 in irrigated and 'barani' areas respectively. The above statistics suggest that cost: benefit ratio was quite favourable to the farmers of irrigated areas as compared to 'barani' ones.

The present marked disparity of cost: benefit ratio between irrigated and 'barani' areas demonstrates the fact that all possible measures be adopted by the concerned agencies to improve the situation so that better benefits be gained by the 'barani' farmers as well.

Reasons for Low Wheat Yield

Farmers who had lesser wheat yield during current year as compared to last year were asked to report reasons for the same. Table 5.4 shows the principal reasons for low wheat yield. Rust (50% of all responses), "inadequate rain"/"less number of irrigation" (23 percent), "heavy rain"/"hail storm" (10 percent), and "less fertilizer use" (7 percent) were the principal reasons given. The same order of reasons were observed in irrigated and 'barani' areas with an exception of the second reason "inadequate rainfall" being more pronounced in 'barani' areas. It is worth noting that "defective/poor seed germination" was the fifth important reason (4 percent) for the low wheat yield in irrigated and 'barani' areas.

Rust and Wheat Productivity

Table 5.5 provides a comparison between the average wheat yield of farmers reporting "rust" versus "no-rust" during rabi 1978. The table shows that there were substantial differences (1.84 maunds or 13%) in per acre yield of farmers reporting "rust" and "no-rust" (12.29 versus 14.13 maunds). Similarly, in irrigated and 'barani' areas the average per acre wheat yield was lower for farmers reporting rust (14.74 versus 17.00 and 5.97 versus 9.71 maunds) than the corresponding average of those who reported "no-rust"

The table also reveals that the degree of rust seemed to be inversely related to wheat productivity in irrigated, 'barani', and total population.

Saline Land and Wheat Yield

The farmers growing wheat were asked to give their idea about the difference and variation of wheat yield between saline and salt free (good) land.

Table 5.6 shows farmers response on the average wheat yield on saline and "good" soils. The difference-of-means test revealed that there were significant differences in the per acre average wheat yield of saline and "good" land both in irrigated and 'barani' areas.

Fertilizer Use and Wheat Yield

Farmers were asked to report their perceptions of per acre wheat yield with and without a bag of urea on 'good'[1] and 'bad'[2] soils. Table 5.7 summarises farmers' responses on the issue.

The "difference-of-means" test suggested that there were statistically significant differences in farmers' perception of per acre wheat yield on "good" and "bad" soils with and without a bag of urea both in irrigated and 'barani' areas.

Multivariate Analysis for Wheat Production

The purpose of multivariate analysis was to identify and verify the relative importance of factors effecting per acre wheat yield during the year under study. This technique was applied to test the null hypotheses that the following factors did not significantly influence the wheat production :

1. Farmers' use of nitrogen,
2. Farmers' use of nitrogen plus phosphate,
3. Sowing high yielding varieties,
4. Water source,
5. Control over irrigation,
6. Farmers' education,
7. Farm size,
8. Tenancy,
9. Line sowing,
10. Seed rate,
11. Salinity,
12. Land preparation methods, and
13. Rust attack.

The regression model used was of the following form :

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + b_{12}X_{12} + b_{13}X_{13} + e.$$

Where :

Y = Average per acre wheat yield,

X_1 = 1 if farmer applied nitrogen; 0 if not,

X_2 = 1 if farmer applied nitrogen + phosphate; 0 if not,

X_3 = 1 if farmer used high yielding varieties; 0 if not,

1. A piece of land apparently salt free and essentially clay loam soil.
2. A piece of land having some degree of salinity and falling primarily under sandy and stony type of soil.

X_4 = 1 if farmer used irrigation; 0 if not,
X_5 = 1 if canal irrigation, 2 if canal+tubewell irrigation; 0 if no irrigation,
X_6 = Number of years of schooling,
X_7 = Farm size in acres,
X_8 = 1 if owner ; 0 if not,
X_9 = 1 if farmer uses line sowing ; 0 if not,
X_{10} = Actual seed rate in seers,
X_{11} = 1 if salt free ; 0 if not,
X_{12} = 1 if non mechanical land preparation methods ; 0 if not, and
X_{13} = 1 if rust attack ; 0 if not.
a = Intercept.
e = Residual.

The model was applied to the portion of sample farmers who grew wheat irrespective of the fact whether they were located in irrigated or 'barani' areas, or they applied fertilizer or not on wheat. This was done on the assumption that we would be having sufficient number (834) of observations. The effect of variables, "farmers' age", "quality of road linking farm with fertilizer sale outlet", "distance from sale outlet", "cash crop income", "number of irrigation", "farmers' technical education", "farmers' urban orientation", "farmers' exposure to mass media", "size of mogha", "location of farm on the mogha", and "effect of access to credit" on the probability of farmers wheat productivity could not be determined because of infrequent occurrence resulting in abnormal distribution of these variables in the population.

Table 5.8 gives regression coefficient, R^2 and F-value. The value of F for the table, as a whole, was 52.842, a value which was highly significant.

The R^2 value of the equation as a whole was .456. This means that about 46 percent of the variation in dependent variable was being explained by thirteen independent variables taken together. The remaining 54 percent of the variation in dependent variable (Y) remained unexplained which could be attributed to the factors either not included in the study, or different levels of factors being treated in the analysis, or natural factors operating on the crop not considered in the study.

The table further shows that independent variables of "nitrogen use", "nitrogen plus phosphate use", "control over irrigation", "line sowing", "seed rate," and "rust attack" were highly significant at .001 level. Whereas, "use of irrigation", and "tenancy", were significant at .01 level and "salt free soil" at .05 level. "High yielding varieties", "farmers' education", "farm size" and "land preparation methods" were not significant.

The signs of regression coefficients were logically consistent. The independent variables of "nitrogen use," "nitrogen plus phosphate use," "use of high yielding varieties," "irrigation source," "control over irrigation," "education," "tenurial status," "line sowing," "seed rate" and "salt free soil," were positively correlated with wheat productivity. Also as expected negative relationship emerged for "farm size," "rust attack," and "traditional land preparation methods" with wheat productivity.

The standardized regression coefficients like significance levels of the independent variables varied widely and ranged from .0004 to .2360. These coefficients are useful in interpreting data when incorporating them into the above regression model to estimate per acre wheat yields. This was done by summing up the intercept coefficients (-5.396) and adding the products of the coefficients of the individual independent variables, and any given values of these variables. For example, the model predicted that an owner farmer of 10 acres, having 3 years of schooling, irrigating his land and having control over irrigation, applying nitrogen and phosphate, using high yielding wheat varieties on a salt free land with mechanical land preparation methods, applying 40 seers of seed per acre, following line sowing method and having rust attack on wheat crop was likely to obtain an average wheat productivity of -5.396 (intercept) + (3.886 × 1) + (4.262 × 1) + (.939 × 1) + (1.956 × 1) + (2.124 × 1) + (.772 × 3) + (-.028 × 10) + (1.531 × 1) + (2.489 × 1) + (.229 × 40) + (1.671 × 1) + (-.010 × 1) + (-2.744 × 1) = 21.904 maunds per acre. If there was no rust attack on the crop, other conditions remaining the same, the farmer was likely to get an average per acre wheat production of 24.65 maunds (21.904 + 2.744) an increase of 2.744 maunds per acre.

In contrast when the farmer was not applying nitrogen plus phosphate, other conditions remaining the same, the average per acre wheat yield would decrease from 21.904 to 17.64 (21.904—4.262) a fall of 4.262 maunds per acre. Similarly, when a farmer was not applying nitrogen only, other conditions remaining the same, his average per acre wheat yield would decrease from 21.904 to 18.02 (21.904 – 3.886) a fall of 3.886 maunds per acre.

The above regression model provides a means to predict the affects on per acre wheat production when one independent variable is changed and other variables are controlled for.

To summarise, the null hypotheses that "nitrogen use," "nitrogen plus phosphate use", "use of irrigation water", "control over irrigation", "tenurial status", "line sowing", "seed rate", "salt free soil" and "rust attack" were not correlated with wheat productivity were rejected. The null hypotheses that "land preparation methods", "high yielding varieties", "Farm size", and "farmers' education" had no effect on wheat productivity could not be rejected.

TABLE 5.1

Comparative Level of Wheat Production 1976, 1978

Area	Less		Same		More		Total	
	#	%	#	%	#	%	#	%
Irrigated	257	49	50	9	220	42	527	100
Barani	108	40	38	14	125	46	271	100
Total	365	46	88	11	345	43	798	100

TABLE 5.2

Fertilizer Application/yield Variation Among Non-Users, Users of Nitrogen, Nitrogen plus Phosphate by Area, Wheat 1977

Area	Non—User			User of Nitrogen Alone				User of both Nitrogen and Phosphate					Total		Average Wheat yield in Maunds
	Non-User		Average Wheat yield in Maunds	N User		Average Application Rate	Average Wheat yield in Maunds	N+P User		Average Application Rate		Average Wheat yield in Maunds			
	#	%		#	%			#	%	N	P		#	%	
Irrigated	104	19	8.26	153	29	48	15.62	280	52	76	30	21.81	537	100	17.42
Barani	160	56	6.55	96	34	40	9.24	27	10	26	6	10.15	283	100	7.80
Total	264	32	7.22	249	30	44	13.16	307	38	71	25	20.78	820	100	14.89

TABLE 5.2(a)

Fertilizer Application/yield Variation Among Non-Users, Users of Nitrogen, Nitrogen plus Phosphate by Area, Wheat 1978

Area	Non—User			User of Nitrogen Alone				User of both Nitrogen and Phosphate							
	Non-User		Average Wheat yield in Maunds	N User		Application per Acre	Average Wheat yield in Maunds	N+P User		Use Rate Per Acre		Average Wheat yield in Maunds	Total		Average Wheat yield in Maunds
	#	%		#	%			#	%	#	%		#	%	
Irrigated	124	22	7.50	133	24	48	14.72	298	54	76	44	20.37	555	100	16.11
Barani	164	56	6.90	94	32	40	10.34	34	12	26	22	10.49	292	100	8.41
Total	288	34	7.16	227	27	44	12.91	332	39	71	41	19.36	847	100	14.08

TABLE 5.3

Nutrient : Grain/Cost : Benefit Ratios of Fertilizer* Use by Area Wheat 1978

Area	Per Acre Yield		Per Acre Additional** yield in maunds.	Nutrient grain ratio (in lbs.)	Cost benefit ratio (in Rs.)
	Users	Non-users			
Irrigated	17.33	7.50	9.83	1 : 8.5	1 : 3.08
Barani	8.06	6.90	1.16	1 : 3.1	1 : 1.12
Total	16.11	7.16	8.95	1 : 8.5	1 : 3.07

* It includes both nitrogen and phosphate nutrients.

** Additional per acre wheet yield was calculated on the basis of per acre yield difference between user and non-user farmers. Per acre fertilizer (nitrogen + phosphate) was calculated on users' cropped acreage. Thus Nutrient : Grain ratio, was worked out. While calculating the Cost : Benefit ratio, proportions of nitrogen and phosphate were worked out in irrigated and barani areas on which the control price of nutrient pound of fertilizer was calculated. Similarly, rupee value of per acre grain against one nutrient pound of fertilizer was converted at the control price.

TABLE 5.4

Reasons for Low Yield by Area and Farm Size, Wheat 1978

Area/Farm Size	REASONS*													
	Rust		Inadequate Rain/Less No. of Irrigation		Heavy Rain/Hail Strom/ Floods		Less Fertilizer Use		Defective/ Poor Seed Germination		Others		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	133	51	46	18	30	12	18	7	10	4	20	8	257	100
Farm Size (Acres)														
1 — 5	29	53	6	11	9	16	2	4	4	7	5	9	55	100
6 — 12	38	48	17	22	8	10	5	6	3	4	8	10	79	100
13 — 25	47	51	17	18	10	11	8	9	3	3	7	8	92	100
26 and above	19	61	6	19	3	10	3	10	—	—	—	—	31	100
Barani (All)	48	45	37	34	8	7	8	7	4	4	3	3	108	100
Farm Size (Acres)														
1 — 5	19	44	15	35	4	9	5	12	—	—	—	—	43	100
6 — 12	14	33	18	43	4	10	—	—	4	10	2	4	42	100
13 — 25	13	62	4	19	—	—	3	14	—	—	1	5	21	100
26 and above	2	100	—	—	—	—	—	—	—	—	—	—	2	100
Total	181	50	83	23	38	10	26	7	14	4	23	6	365	100

* Only principal reason was considered for tabulation. — Nil

TABLE 5.5

Per Acre Yield for No-Rust and Various Degrees of Rust by Area, Wheat 1978

Area	Average Yield				
	No-Rust	Rust			
		Total	Slight	Moderate	Heavy
Irrigated	17.00	14.74	16.97	14.23	12.49
Barani	9.71	5.97	7.72	5.74	3.28
Total	14.13	12.29	14.07	12.09	10.09

TABLE 5.6

Users Perception* of Wheat Yield on Salt Affected/Good Land by Area

--In Maunds

Area	Average per Acre Wheat Yield	
	Salt Affected	Good Land
Irrigated	8.60	16.80
Barani	6.00	12.00
Total	8.17	16.00

* These data are based on farmers who grew wheat on salt affected land and are applying unequal dozes of fertilizer on good and salt affected lands.

TABLE 5.7

Farmers Perception of Wheat Yield on Good/Bad Soil with/without a Bag of Urea

—Per Acre Yield in Maunds

Area	With One Bag of Urea		Without One Bag of Urea	
	Good	Bad	Good	Bad
Irrigated	20.29	10.86	13.29	6.47
Barani	13.83	7.29	8.51	3.75
Total	19.05	10.18	12.37	5.96

TABLE 5.8

Regression Coefficients, Beta Values, F-Values, and Level of Significance of Factors Related to Wheat Yield, 1978

Independent Variable	Regression Co-efficient	Beta Value	F-Value	Level of Significance
N use	3.886	.209	33.97	(.001)
N+P Use	4.262	.236	48.78	(.001)
Sowing High Yield Varieties	0.939	.048	1.97	N.S.*
Irrigation Source	1.956	.105	6.61	(.01)
Control over Irrigation	2.124	.202	25.00	(.001)
Education	0.772	.042	2.47	N.S.*
Farm Size	−0.028	−.047	2.98	N.S.*
Farmers' Tenurial Status	1.531	.081	7.82	(.01)
Line Sowing	2.489	.136	21.34	(.001)
Seed Rate	0.229	.193	36.58	(.001)
Salt Free Soil	1.671	.057	4.77	(.05)
Land Preparation Method	−0.010	−.0004	0.000	N.S.*
Rust Attack	−2.744	−.155	32.59	(.001)

* Not significant.

F = 52.842
R^2 = .456
Constant = −5.396
DF = 13, Infinity

TABLE 5.9

Correlation Matrix of Factors Related to Farmers' Wheat Production, 1978

	Wheat Yield	N Use	N + P Use	High Yield-ing Varieties	Irriga-tion Source	Control Over Irriga-tion	School-ing	Farm Size	Tenancy	Line Sowing	Seed Rate	Salt Affec-tedness	Land Prepa-ration Method	Rust
Wheat Yield	1.000	0.517	0.532	0.363	0.398	0.484	0.120	0.098	−0.083	−0.097	0.424	0.013	−0.010	−0.004
N Use	0.517	1.000	0.579	0.493	0.337	0.518	0.143	0.118	−0.119	−0.206	0.394	−0.039	−0.072	0.193
N + P Use	0.532	0.579	1.000	0.355	0.404	0.453	0.146	0.154	−0.133	−0.112	0.406	−0.057	−0.021	0.166
High Yield-ing Varieties	0.363	0.493	0.355	1.000	0.464	0.514	−0.005	0.114	−0.176	−0.370	0.419	−0.010	−0.107	0.234
Irrigation Source	0.398	0.337	0.404	0.464	1.000	0.695	−0.066	0.244	−0.367	−0.294	0.399	−0.096	0.170	0.153
Control over Irrigation	0.484	0.518	0.453	0.514	0.695	1.000	0.010	0.193	−0.211	−0.305	0.390	−0.108	0.041	0.210
Schooling	0.120	0.143	0.146	−0.005	−0.066	−0.010	1.000	0.096	0.160	0.047	0.045	−0.035	−0.079	−0.006
Farm Size	0.098	0.118	0.154	0.114	0.244	0.193	0.096	1.000	0.054	−0.024	0.154	−0.097	−0.090	0.098
Tenancy	−0.083	−0.119	−0.133	−0.176	−0.367	−0.211	0.160	0.054	1.000	0.217	−0.276	−0.005	−0.095	−0.016
Line Sowing	−0.097	−0.206	−0.112	−0.370	−0.294	−0.305	0.047	−0.024	0.217	1.000	−0.366	0.014	0.065	0.026
Seed Rate	0.424	0.394	0.406	0.419	0.399	0.390	0.045	0.154	0.276	−0.366	1.000	−0.061	−0.028	0.052
Salt Affec-tedness	0.013	−0.039	−0.057	−0.010	−0.096	−0.108	−0.035	−0.097	−0.005	0.014	−0.061	1.000	−0.042	0.108
Land Prepa. ration Method	−0.010	−0.072	−0.021	−0.107	0.170	0.041	−0.079	−0.090	−0.095	0.065	−0.028	−0.042	1.000	0.028
Rust	−0.004	0.193	0.166	0.234	0.153	0.210	−0.006	0.098	−0.016	0.026	0.052	−0.108	0.028	1.000

CHAPTER VI

SUMMARY OF FINDINGS AND POLICY IMPLICATIONS

Summary of Main Findings

SAMPLE

A multi-stage sampling technique was used to select 15 study areas (3 tehsils in NWFP, 7 in Punjab while 5 talukas in Sind), corresponding to about 10% sample of these administrative units. These areas represent 9 major cropping patterns and past use of chemical fertilizer, dividing the sample into 11 irrigated and 4 'barani' tehsils. Six villages per irrigated and 8 per 'barani' area (98 villages in all) were selected randomly after stratification of villages on distance from and ease of access to tehsil headquarters. Approximately, 10 farmers per village (980 in all) were selected as respondents representing tehsil percentages of farm size and tenancy.

1. *LAND USE*

- The average operational holding was 11.5 acres for the total universe distributed into 13.8 acres in irrigated and 7.6 acres in 'barani' areas.
- Five percent of the total owner cultivated area (7% in irrigated and 3% in 'barani' area) was reported to be saline with varying degrees of salinity.
- The cropping intensity was 133% and 121% in irrigated and 'barani' areas respectively.
- Farm size was inversely related with cropping intensity.
- Thirty seven percent and 45% of the cultivated area in irrigated and 'barani' area was under wheat during the study year.
- In irrigated area 20%, 13%, 6% and 3% of the cultivated area was under rice, cotton, sugarcane and maize-grain respectively during kharif season of the study year.
- Maize was the principal kharif crop in 'barani' areas.
- "Land replenishment" and "shortage/non-availability of water" were the prominent reasons for leaving the land short fallow.
- Landlord in case of tenant and cultivator himself in case of owner-cum-tenant were the prime decision makers regarding crop varieties to be sown and the application of fertilizer.
- In general, one-half of the fertilizer cost was shared by the tenant with landlord, while about one-fourth of the tenants and owner-cum-tenants in 'barani' areas and one-tenth in irrigated area paid the full cost of fertilizer.

2. *ADOPTION OF FERTILIZER*

- Statistically significant increase has occurred between 1971-72 and 1975-76 in the proportion of farmers who used some fertilizer (52% Vs. 70%). The increase from 1975-76 to 1977-78 *(72% Vs. 74%) in the proportion of sample farmers using some fertilizer was, however, not statistically significant.

*Refer to Page 35

— Like GFI, there was no significant difference either among farm-size categories or tenurial classes in the proportion of sample farmers applying some fertilizer within each category of irrigated and 'barani' areas during the period under study.

— Similarly, about the same proportion of large and small farmers, tenants and owners applied some nitrogen to major crops during crop year 1977-78 ; however, exceptions to the above were :

  — Farm-size and tenancy to irrigated maize and tenancy to maize 'barani'.

  — Farm-size to wheat, cotton and sugarcane in irrigated area.

3. *FERTILIZER APPLICATION RATES*

Nitrogen

— As in GFI, farmers operating 1—5 acres applied significantly more nitrogen per acre on wheat (irrigated/barani), cotton and sugarcane than other size categories.

— As against GFI findings, large farmers applied significantly more nitrogen per acre on rice than others.

— Contrary to GFI, tenants on the average applied significantly more nitrogen per acre than owners on wheat and maize 'barani' whereas owner-cum-tenants used more than owners and tenants on rice.

Phosphate

— Growers of irrigated wheat applied significantly more phosphate per acre than those of cotton, sugarcane, maize and rice which was in accordance with GFI findings.

— Some categories of farmers applied significantly more phosphate to wheat and maize than others. The groups for which this holds true were :

  a) As in GFI survey, large farmers for wheat 'barani'.

  b) Owner operators for irrigated wheat and large farmers and owners for cotton in GFI, whereas, these were insignificant in the follow-on study.

  c) Owners than owner-cum-tenants and farmers operating 1—5 acres on maize irrigated in the follow-on study (maize was not included in GFI).

— As in GFI, percentage of farmers applying phosphate (54%, 55%, 38%, 43% and 28%) to wheat, cotton, rice, sugarcane and maize irrigated and (12% and 4%) on wheat and maize 'barani' remained low as compared to the percentage of farmers applying nitrogen to major crops in irrigated and 'barani' areas.

— Increase in the phosphate use during the crop year 1975-76 to 1977-78 was several-fold which is consistent with previous trend of phosphate use in Pakistan since 1970.

— As in GFI, there was no significant difference either among farm size categories or tenurial classes in the average application rates of phosphate for cotton, maize and sugarcane.

— Contrary to GFI, farmers operating 6—12 acres applied significantly more phosphate per acre than 13—25 acres category for wheat irrigated and small farmers (1-5 acres) applied more phosphate than other farm size categories except large farmers (26 acres and above) on rice crop.

4. *PERCENTAGE OF FERTILIZED AREA*
(Follow-on Findings)

Irrigated

— In irrigated tracts 92% of wheat, 98% of rice and 97% of cotton area was fertilized by user farmers. Sugarcane and maize area, on the other hand, was fertilized 100%.

— Among the farm sizes and tenurial classes, there were no significant differences in the percentage of fertilized acreage among user farmers of cotton, sugarcane and maize.

— Farm size was inversely related to the percentage of fertilized acreage on wheat and rice.

— Tenants fertilized higher percentage of wheat and rice acreage than other tenurial classes.

Barani

— Seventy four percent of the wheat acreage and 97% of maize acreage of user farmers were fertilized. Farm size was inversely related with the percentage of fertilized acreage of wheat and maize. Tenants had higher percentage of fertilized acreage of these crops than other tenurial classes.

5. *FERTILIZER APPLICATION DOZES*
(Follow-on Findings)

Irrigated

— Among the user farmers, 5%, 14% and 15% were applying close to the recommended dozes of nitrogen on wheat, cotton and sugarcane. The corresponding percentages for phosphate turned out to be 7%, 12% and 13%. In case of rice-irri and basmati, 11% and 20% of the user farmers applied close to the recommended dozes of nitrogen while 13% and 18% used prescribed rate of phosphate.

Barani

— There were only 4% and 6% user farmers who applied nitrogen and phosphate nearer the recommended rates to wheat 'barani'.

6. *CHANGES IN FERTILIZER USE*

As in G.F.I, large farmers assumed the role of leaders in introducing nitrogen in irrigated areas and phosphate in both irrigated and 'barani' areas. On the other hand, the farmers operating 6—12 acres were the first to use nitrogen in 'barani' areas.

An overall drop out (temporary discontinuation of fertilizer use) rate of 13.3% (7% in irrigated and 36% in barani areas) was found during the last three years (1976-78).

7. *REASONS FOR DISCONTINUATION / NON-USE OF FERTILIZER*

— On an overall basis, "no funds/shortage of funds", "short supply of fertilizer", "insufficient irrigation water", "preference for farm yard manure" and "fertilizer too expensive/not profitable" were the reasons in rank order for the farmers' discontinuation of fertilizer use during the last three years.

— "No experience", "no funds", "short supply" and "not profitable" were the principal reasons of farmers not using phosphate in both irrigated and 'barani' areas.

8. *FACTORS RELATED TO FERTILIZER USE*

a) Irrigation

— As in G.F.I, regression analysis indicated that use of irrigation water was the most important variable related with the probability that a given farmer used some fertilizer.

— Farmers' "control over irrigation" was the third most common factor related with the probability of a given farmers' fertilizer application rate.

— "Insufficient water" was the third most common reason for the discontinuation of fertilizer use.

— Eighty three percent of the sample farmers used some fertilizer in irrigated areas as compared to 47% in 'barani'.

— "Shortage of irrigation water/less rain" was the third important reason (20%) in irrigated areas and the most prominent reason (61%) in 'barani' areas for not applying recommended dozes of fertilizer among the user farmers.

b) Credit

— Regression analysis indicated that credit availability accounted for a larger proportion of the variation in farmers' fertilizer use rate than any other factor.

— "Shortage of funds" was the most important reason (40% of the response) for the discontinuation of fertilizer use and for not using phosphate (39%) in irrigated areas.

— Similarly, "shortage of funds" was the principal reason (37% of responses) for the discontinuation of fertilizer use in 'barani' areas.

— Thirty nine percent of the user farmers reported not having enough money (own plus borrowed[1]) for buying desired quantity of fertilizer during rabi 1978.

— Nine percent of the sample farmers (owner-cum-tenants and tenants) in irrigated areas and one percent in 'barani' obtained fertilizer from the landlord.

1. The GFI revealed that borrowed money includes mainly non-institutional (96%) and institutional credit (4%) in cash and in kind, i.e., fertilizer.

c) *Physical Access*

— As in GFI, the regression analysis showed that distance to fertilizer source and ratio of 'pacca' road linking the farm with fertilizer sale outlet were significantly related to farmers' incidence of fertilizer use. Access to 'pacca' roads was significantly related with farmers' fertilizer application rate as well.

— Short supply of fertilizer was the second most common reason for the temporary discontinuation of fertilizer use in irrigated and 'barani' areas. This was the principal reason for not using phosphate in remote 'barani' areas.

— Fifty five percent of the user farmers (59% in irrigated and 41% in barani areas) reported difficulty in getting fertilizer during rabi, 1978 while 46% of the total respondents (42% and 64% in irrigated and barani areas) applied less fertilizer than intended because of short supply.

— Contrary to GFI, a typical user farmer on the average travelled longer distance during FOS (6 Vs. 4 miles) during rabi period under study and made 2.93 trips for fertilizer purchase.

— None of the fertilizers, except Nitrophos in 'barani' areas was available at control price.

— The average excess price paid for a bag of urea, AN, AS, DAP, NP and SSP was Rs. 1.61, 2.00, 4.14, 0.63, 2.00 and 2.80 respectively in irrigated areas during rabi, 1978. The corresponding figures, excluding NP and SSP were Rs. 2.71, 3.32, 6.69 0.77 for 'barani' areas. The over-charging was mainly found in remote areas, spots of high demand/short supply of popular brands and the resale of fertilizer by village shopkeeper due to imperfection in the fertilizer marketing system.

— Average transport cost per bag from sale outlet to farm gate was Rs. 2.01.

d) *Quality of Fertilizer*

— On an overall basis, caked, under-weight and adulterated fertilizer emerged as the three major quality problems (31%, 27% and 13%).

— User farmers (31%) buying caked fertilizer paid the prevailing market price even for defective product.

— DAP in irrigated area, AS, Urea and DAP in 'barani area were reported as defective (caked, under-weight and adulterated brands) in rank order.

e) *Tenurial Status*

— The Multivariate analysis indicated that farmers' tenurial status was positively but not strongly related to the probability of farmers' incidence of fertilizer use and its application rate.

f) *Information*

— As in GFI, the most commonly cited sources of information were fellow farmers (61%), farm radio programme (18%) and agriculture extension (16%). Relatively a lower proportion of farmers (3%) reported having received information from published literature and less than 1% from fertilizer dealers.

— A substantial proportion of farmers (38%) reported "lack of knowledge" as a reason for not applying recommended dozes of fertilizer.

g) *Effects of Fertilizer Use*

— Nitrogenous fertilizers "increase yield" (44%), "turn the crop green" (31%) and "strengthen/lengthen the plant" (11%) and phosphates "increase yield" (43%), "turn the crop green" (12%), "strengthen plant roots" (12%), "lengthen and strengthen the plant" (10%) and "promote rapid growth" (10%) were the farmers' perception regarding effects of fertilizer on wheat crop.

— Application of nitrogen "softens the soil" (40%), "improves the soil" (16%), "decreases soil fertility" (10%) and "hardens the soil" (7%) were the farmers' perception regarding its effects on soil. Phosphate "softens the soil" (42%) and "improves the soil" (20%) were its two major reported effects on soil by the user farmers The effects turning the crop green/lengthening the plant appears to be misconception due to the use of phosphate alone without nitrogen.

— Eighteen percent and 22% of the user farmers reported "no effect"/"no response" regarding the effects of nitrogen and phosphate on soil respectively.

— No response was prominent in 'barani' areas than irrigated which is an indicator of farmers' lack of knowledge about effects of fertilizers in the former case.

h) *Soil Testing*

— As in GFI, only one percent of fertilizer users in irrigated areas got their soil tested against none in 'barani' area.

— Sixteen percent of the remaining 99% of user farmers were aware of soil testing, of which 71% were willing to get their soil tested to know the soil characteristics/deficiencies while 25% wanted to know the appropriate fertilizers for their soils.

i) *Fertilizer Sale Outlets*

— Fifty two percent of the sample farmers reported private dealers as the principal source of fertilizer purchase in irrigated areas, of these 14% could not identify the specific dealership.

9. *PROFITABILITY*

— "Fertilizer too expensive"/"not profitable" was the second most important reason, reported by 23% of the farmers in the sample and 28% in irrigated areas, for not applying recommended doses of fertilizer. In 'barani' areas, however, it turned out to be the third most common reason (12% of responses).

— "Fertilizer too expensive"/ "not profitable" was 10% of the total response, (5% in irrigated and 14% in barani areas) for the discontinuation of fertilizer use.

10. *WHEAT PRODUCTIVITY*
(Follow-on Study)

a) *Wheat Area*

— Thirty eight percent (37% in irrigated and 45% in barani areas) of the total cultivated area was under wheat during rabi 1977-78.

Salinity

— About 3% of the total area of sample farmers under wheat (3.3% in irrigated and 2.4% in barani areas) was salt affected.

— Seventy nine percent of fertilizer users on wheat (86% in irrigated and 53% in barani areas) applied some fertilizer on salt affected land, of which 85% (87% in irrigated and 67% in barani areas) applied the same quantity of fertilizer as on "good land".

b) Farming Practice

— Seventy four percent of wheat growers in irrigated and 45% in barani areas followed broadcasting method for wheat cultivation.

Irrigated Area

— Ten percent of wheat growers had access to tractor for land preparation while, 14% used both tractor and draught animals.

— One-third of the wheat growers had access to canal plus tubewell water.

— Eighteen percent of the growers applied at least four irrigations excluding "roni".

— Eighty-six percent of wheat growers planted high yielding varieties, of these one-half planted early varieties i.e., Chenab—70, Mexipak, Khushhal and Pak—70.

— Twenty-four percent of the fertilizer users on wheat applied nitrogen alone, while 54% used nitrogen plus phosphate on the crop.

c) Wheat Production

— A sizeable number (46% of all response) of wheat growers, 49% in irrigated and 40% in barani areas, reported lower wheat yields during the study year as compared to last rabi.

— The overall average wheat yield was lower by 0.65 maunds (4.6%) per acre in 1978 than 1977. In irrigated areas the negative effect was 1.31 maund per acre (7.5%) as against positive effect of 0.61 maund per acre (7.8%) in the barani area.

— The difference-of-means test revealed that there were significant differences in wheat yield among non-users and users of fertilizer in irrigated and barani areas.

d) Fertilizer Application

— The average per acre application rates of nitrogen on wheat irrigated and barani were 67 'N' lbs. and 36 'N' lbs. respectively. The corresponding figures for phosphate were 30 P_2O_5 lbs. and 6 P_2O_5 lbs. The N:P ratio in the overall fertilizer use was 2.3:1. These ratios in case of irrigated and barani wheat were 2:1 and 6:1 respectively.

— Urea and DAP on wheat irrigated while urea and ammonium sulphate on wheat barani were the most popular fertilizer brands.

— Price elasticity of demand for urea was greater than that for DAP and NP; and DAP more so than NP on wheat irrigated and barani.

10 *FACTORS RELATED TO WHEAT PRODUCTION*

a) Fertilizer

— Beta coefficients indicated that in terms of relative significance, use of nitrogen plus phosphate and "nitrogen alone" were the first and second important variables related with the probability of enhancing average wheat yield.

b) Irrigation

— Farmers "control over irrigation" was the third most important factor; while, "water source" was the seventh important factor related with enhancing average wheat yield.

c) Seed Rate

— Seed rate was the fourth important variable in increasing wheat yield per acre.

d) Rust Attack

— Beta coefficients showed that rust attack on wheat was inversely related to wheat yield. This was the fifth important factor in this respect.

— Per acre wheat yield was significantly lower by 1.84 maunds (13%) for farmers reporting rust than no-rust.

e) Line Sowing

— Beta coefficient indicated that line sowing was the sixth important variable effecting wheat yield.

f) Tenancy

— Beta coefficient showed that farmers tenurial status was the eighth important factor related to wheat production.

g) Salinity

— Beta coefficient showed that affect of salinity was the ninth important factor related to wheat yield.

— The difference-of-means test suggested that there was a significant difference in farmers' perception of average wheat yield on "good" and "bad" soils with and without a bag of urea in irrigated and barani areas.

h) Wheat Selling

— Among wheat growers of irrigated areas, 35% sold a part of their produce averaging 73 maunds per seller. The corresponding figures for barani areas were 3% and 12 maunds.

— Farmers' marketable surplus of wheat amounted to 22% of production, distributed into 25.2% and 1.2% in irrigated and barani areas.

— Although the percentage of wheat growers was higher during rabi 1978, as compared to 1977, yet the percentage of farmers selling wheat and average quantity sold were lower in irrigated as well as in barani areas during 1978.

— Keeping the produce for home consumption because of low wheat yield during rabi 1978, was the principal reason for not selling the produce.

i) Reasons for Low Wheat Yield

— "Rust attack" (50% of all responses), "inadequate rain"/"less number of irrigation" (23%), "heavy rain"/"hail storm" (10%) and "less fertilizer use" (7%) were the main reasons reported for the low wheat yield during rabi 1978.

— Rust attack in irrigated areas, while "rust attack" and "inadequate rainfall" in barani areas appeared to be the prominent reasons for low wheat yield during rabi under study.

j) Nutrient : Grain/Cost : Benefit Ratios

— There was an extra yield of 8.95 maunds per acre (9.83 in irrigated and 1.16 in barani areas) with the application of fertilizer for the wheat growers.

— Nutrient : grain ratio for the overall universe was 1:8.5. These ratios for irrigated and barani areas were 1:8.5 and 1:3.1 respectively.

— The cost : benefit ratio, measured in rupees, was 1:3.07 for the overall sample; distributed as 1 : 3.08 and 1 : 1.12 in irrigated and barani areas.

POLICY IMPLICATIONS

The survey findings generated an empirical basis for a very large number of policy measures, needed to improve upon the fertilizer use situation in Pakistan. However, we will restrict our recommendations to a few which we believe to be the most imperative.

Adequate Fertilizer Supplies : The survey underlines the importance of an adequate supply of fertilizer in the country. Inadequate supplies are extremely costly in terms of crop production foregone and the emergency measures that are typically taken once a shortage occurs. In a seller's market, there is little or no incentive for the distributor and retailer to provide quality services and product since they can sell all even defective fertilizer (viz, bags of sub-standard weight, caked and adulterated) at the market price.

As demonstrated once again by the rabi 1978 fertilizer shortage, the GOP clearly needs to replace its current ad hoc, yet feeling based arrangement for importing fertilizer with a rational and systematic up dated import arrangement.

We recommend that the GOP explicitly assign to the National Fertilizer Development Centre (NFDC) the responsibility for developing import requirements and the scheduling in order to ensure adequate fertilizer supplies so as to avoid costly emergency import measures. The NFDC should produce a monthly "Fertilizer Supplies Situation" report. These reports should be reviewed at all meeting of the Fertilizer Review Committee.

Extension : The amount of fertilizer now consumed in Pakistan is large enough so that poor application practices (viz, inappropriate nutrient balance, time and method of application) are very costly to the nation as well as to the individual farmers. It is reasonable to believe that the efficiency of fertilizer use level be increased by at least 25%. The saving potential is now thus very large. An effective public information programme would cost only a portion of the costs arising from poor application practices. We recommend that the GOP charge the NFDC with the responsibility of developing a detailed public information system including training of fertilizer dealers by way of evaluating the present information pattern and then developing a detailed report on "fertilizer information system programme" for the farmers of irrigated and barani areas. A small surcharge on each bag of fertilizer sold should be considered as the source of financing the programme when implemented.

Small Farms : We had hypothesized that the tight fertilizer supply conditions of rabi 1978 impacted more than proportionately on the smaller farmers. The survey data did not support this hypothesis. In fact for irrigated areas, the proportion of farmers operating less than 13 acres using fertilizer increased from 68% in 1976 to 69% in 1978; while this percentage decreased by about one percent i.e., from 77% to 76% for farmers operating 13 acres and more acres for the same period. Furthermore, the average application rate was relatively higher for the smaller farmers than for the larger. Thus the goal of equity in farmers' fertilizer participation is being achieved.

We highly recommend that the Government of Pakistan policy of promoting a broadly participatory agriculture be continued. Many of the worlds' foremost experts on the rural development process are now convinced that a broadly participatory agriculture is "a necessary condition" for the meaningful development, i.e., growth with equity.

Credit : The credit (institutional and non-institutional) availability to the farmer was the most important factor related to his fertilizer application rate, and lack of credit with discontinuation of fertilizer use and not using phosphate. Furthermore, a substantial proportion of user farmers reporting "not having enough money" particularly tenants and small farmers of barani areas for buying desired quantity of fertilizer, indicates if additional credit facility is injected, it might increase the fertilizer use to a large extent.

The GOP present policy towards agricultural production credit has substantially improved the lot of small farmers in irrigated areas. We recommend that GOP should direct the State Bank of Pakistan to implement its directive in its real spirit of equity on farm size and tenancy axis and ask the commercial banks including the specialized ones like Agricultural Development Bank of Pakistan and Supervised Rural Credit Programme (SRCP) of the National Bank of Pakistan to extend their SRCP to both irrigated and barani areas.

Irrigation : The survey findings underline the critical importance of water availability and its control in the incidence of fertilizer use, its application rate and per acre wheat production. We endorse the present efforts of GOP for on-farm water management, improved design and maintenance of water courses in irrigated areas which would reduce water losses thus making additional water available to lands now receiving little or no irrigation.

In barani areas alternate actions are suggested for water conserving techniques to redress the water constraints including, well digging, rain water/water-fall reservoirs channelising, the GOP should provide sufficient funds to Agency for Barani Areas Development (ABAD) to assist farmers organize on "self help basis" to store water and make its efficient use for irrigation.

Further Research : Research is a systematic continuous process of verification and reverification of known facts and the exploration of the unknown. We strongly recommend that the direction of future research on fertilizer use be focussed on the economics of fertilizer use including production response, input : output/cost : benefit ratios for major crops in irrigated and barani areas. Furthermore, indepth studies are urgently required to estimate production credit requirements, water efficiency, farmers' information level on production inputs and a minimum package of appropriate technology acceptable particularly to tenants and small operators of irrigated and barani areas.

GLOSSARY

Acre	—	A unit of land measurement equivalent to 0.405 hectare of land.
A. S.	—	Ammonium Sulphate.
Barani	—	Rainfed area.
Bubersher/Engro	—	Local brand names of urea.
Chak	—	Colonized village.
Desi variety	—	A local variety of native or indigenous origin.
D.A.P.	—	Diammonium Phosphate.
Katcha road	—	An un-metalled road usually used by village bullock-carts etc.
Kharif	—	A crop season in Pakistan from April to September in which cotton, sugarcane, maize and rice are the major crops.
Mandi	—	A grain or livestock market.
Maund	—	A unit of weight in Pakistan about 1/28 of a ton = 37.32 Kilos.
Numberdar	—	Village headman responsible for collection of land revenue and other taxes from farmers on behalf of Government.
Pacca road	—	Metalled (surfaced) road.
Private dealer/ Sale outlet	—	A person trading in fertilizer on commercial basis whether a licensed fertilizer dealer of a Producer or Distribution Agency or unlicensed town/village shopkeeper.
Public dealer/ Sale outlet	—	Public fertilizer sale depot operated by full time salaried employees of provincial public sector fertilizer distribution agencies i.e., Punjab Agricultural Development & Supplies Corporation in Punjab, Sind Agricultural Supplies Organization in Sind and Agricultural Development Authority in NWFP.
Rabi	—	A crop season in Pakistan from October to March in which wheat, gram, oilseeds and lentil are the major crops.
Saim	—	Water logging.
S.S.P.	—	Single Super Phosphate
Taluka	—	Administrative unit in Sind Province consisting part of administrative district corresponding to tehsil in Punjab.
Tehsil	—	An administrative unit of a district in Punjab and NWFP Provinces.
Thur	—	Salinity (salinization).
Town shopkeeper	—	Dealer located in mandi or sub-mandi town.
Village shopkeeper	—	Dealer located in a village who trades in other consumers goods in addition to fertilizer.

Annexure - A

Control Limits* for Percentage of Farmers Applying Nitrogen and phosphate to Major Crops by Area, Farm Size and Tenancy, 1978**

Farm Size, Tenancy	CROPS									
	Wheat		Cotton		Rice		Sugarcane		Maize	
	N	P	N	P	N	P	N	P	N	P
Irrigated (All)	78 (75--81)	54 (50—58)	86 (82—90)	55 (49—61)	76 (69--83)	38 (30—46)	38 (84 92)	43 (36--50)	53 (45—61)	28 (21—35)
Farm Size (Acres)										
1 — 5	74 (66--82)	48 (39-57)	87 (77--97)	57 (43 71)	70 (55--85)	43 (26—60)	95 (88 102)	39 (24 50)	86 (74 98)	43 (26 60)
6 — 12	83 (78--88)	62 (55—69)	90 (89—99)	62 (52 72)	80 (74-90)	43 (31—55)	91 (85--97)	47 (36—58)	54 (39 69)	26 (13 39)
13 --- 25	74 (68 80)	48 (40 56)	78 (70—86)	49 (39--59)	74 (62-86)	27 (14-40)	86 (78 94)	41 (30—52)	44 (30 58)	24 (12--36)
26 and above	79 (68--90)	56 (42 70)	82 (69 95)	47 (30-64)	75 (54--96)	42 (19-65)	75 (57—93)	42 (22 62)	22 (5--39)	17 (1 33)
Tenancy										
Owner	81 (75—87)	55 (50—62)	87 (80--94)	58 (48 68)	83 (74-92)	42 (30 54)	90 (84 96)	45 (34—56)	62 (50 74)	35 (23 47)
Owner-cum-Tenant	73 (64--82)	53 (43--63)	94 (87-101)	55 (40—70)	78 (64 92)	48 (31—65)	89 (79—99)	43 (27—59)	61 (43—79)	25 (9—41)
Tenant	77 (72--82)	52 (46--58)	83 (77--89)	52 (43--61)	71 (60--82)	32 (21 43)	87 (80--94)	41 (31 51)	40 (28--52)	21 (11 31)
Barani (All)	44 (38-50)	12 (8 -16)							45 (39 51)	4 (1 7)
Farm Size (Acres)										
1 — 5	43 (35—51)	6 (2--10)							49 (41 57)	3 (*— 6)
6 — 12	43 (33—53)	15 (8-22)							38 (26--50)	5 (* 10)
13 — 25	46 (32—62)	27 (12—42)							36 (17 -55)	8 (*—19)
26 and above	60 (16—104)	20 (*-56)							100 (**)	50 (* 121)
Tenancy										
Owner	46 (39--53)	13 (8--18)							43 (36—50)	4 (1— 7)
Owner-cum-Tenant	36 (24--48)	8 (1--15)							45 (29--61)	3 (*— 9)
Tenant	41 (20-62)	9 (*-21)							65 (42--88)	6 (* 17)

* Negative Value ** Not Applicable *** At 95% level of significance given in parentheses.

Formula for Control Limits. $= P \pm 2\sqrt{\frac{P(1-P)}{N}}$

P = Percentage of farmers applying (N) and (P).

N = Sample Size (Total No. of growers in a particular group)

Annexure – B

Confidence Intervals for Average Application Rates of Nitrogen and Phosphate to Wheat, Maize, Cotton, Sugarcane and Rice for User Farmers by Area, Farm Size and Tenancy, 1978**

Farm Size/Tenancy	CROPS													
	Wheat Irrigated		Wheat Barani		Maize Irrigated		Maize Barani		Cotton		Sugarcane		Rice	
	N	P	N	P	N	P	N	P	N	P	N	P	N	P
Farm Size (All)	67 (64.28–70.16)	30 (27.74–32.26)	36 (31.42–40.48)	6 (3.94–8.06)	67 (60.44–72.76)	26 (20.06–31.94)	48 (37.80–47.30)	4 (1.30–6.70)	64 (60.78–66.22)	27 (24.53–29.47)	100 (93.07–106.79)	27 (23.20–30.80)	60 (56.09–63.29)	20 (17.12–22.88)
1 — 5	75 (68.36–82.14)	30 (24.93–35.07)	45 (38.52–52.35)	5 (1.65–8.35)	70 (57.13–82.27)	32 (19.99–44.01)	40 (34.07–45.43)	2 (*–4.7)	74 (65.78–81.48)	28 (21.70–34.30)	119 (97.66–140.64)	28 (17.04–38.96)	62 (55.07–69.29)	25 (19.07–30.93)
6 — 12	68 (63.88–72.88)	34 (30.32–37.68)	29 (22.86–35.24)	7 (4.17–9.83)	61 (51.35–70.39)	17 (8.86–25.14)	49 (37.98–59.24)	3 (*-6.59)	62 (58.75–66.09)	29 (25.30–32.70)	100 (89.88–110.70)	15 (8.28–21.72)	56 (50.45–61.05)	19 (14.79–23.21)
13 — 25	61 (56.16–66.08)	26 (22.16–29.84)	21 (12.79–29.73)	10 (5.64–14.36)	69 (58.45–80.29)	26 (15.29–36.71)	48 (31.48–63.61)	16 (*-35.35)	60 (55.00–64.91)	26 (21.58–30.42)	90 (80.42–99.04)	23 (18.20–27.80)	59 (52.72–66.04)	14 (8.98–19.02)
26 and above	66 (55.11–76.06)	30 (22.67–37.33)	18 (5.76–29.90)	1 (*-2.52)	63 (54.95–71.81)	35 (15.56–54.44)	47 (5.39–87.75)	24 (*-70.72	63 (54.57–71.27)	22 (14.36–29.64)	95 (77.79–111.81)	27 (16.45–37.55)	75 (57.49–91.59)	27 (12.77–41.23)
Tenancy														
Owner	70 (64.69–75.10)	31 (27.03–34.97)	33 (28.68–37.32)	6 (3.51–8.49)	64 (57.02–71.16)	27 (18.84–35.16)	37 (32.15–41.09)	5 (1.53–8.46)	66 (61.73–71.29)	28 (24.12–31.88)	101 (90.67–110.69)	27 (21.17–32.83)	62 (55.63–68.65)	21 (15.60–26.40)
Owner-cum-Tenant	69 (61.17–76.11)	31 (25.81–36.19)	40 (25.09–55.17)	4 (1.05–6.95)	82 (73.55–89.71)	22 (8.36–35.65)	57 (42.34–70.46)	3 (*-8.34)	58 (52.69–63.61)	26 (20.27–31.73)	100 (75.65–123.99)	28 (16.24–39.76)	69 (59.58–77.76)	23 (16.09–29.91)
Tenant	64 (62.24–68.34)	29 (25.80–32.20)	58 (35.73–79.39)	8 (*-16.82)	61 (49.63–71.55)	26 (14.37–37.63)	62 (43.94–80.81)	2 (*-6.06)	63 (59.47–67.23)	27 (23.19–30.81)	99 (90.31–108.27)	26 (20.69–31.31)	55 (50.02–59.52)	18 (14.15–21.85)

* Negative Value

** Confidence interval at 95% level of significance given in parentheses below the mean

Formula for Confidence interval = $\bar{X} \pm 1.96$ S.E.

Annexure—C

Nitrogen and Phosphate Application Ranges for Wheat (Improved) by Area, Farm Size and Tenancy 1978

Application Ranges —Nutrient lbs.

Farm Size Tenancy	N																		P											
	1—25		26—50		51—75		76—100		101—125		126—150		151—175		176—200		Total		1—25		26—50		51—75		76—100		101—125		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	35	9	91	22	187	46	39	10	34	8	17	4	5	1	1	—	409	100	72	25	182	64	12	4	11	4	7	3	284	100
Farm Size (Acres)																														
1 — 5	3	3	15	18	35	41	9	11	16	19	4	5	2	2	1	1	85	100	14	26	29	55	4	7	3	6	3	6	53	100
6 — 12	8	5	36	23	81	53	11	7	8	5	10	7	—	—	—	—	154	100	24	21	81	69	5	4	4	3	3	3	117	100
13 — 25	20	15	30	23	54	41	15	11	8	6	2	2	2	2	—	—	131	100	30	35	51	59	2	2	3	2	1	1	87	100
26 and above	4	10	10	26	17	43	4	10	2	5	1	3	1	2	—	—	39	100	4	15	21	77	1	4	1	4	—	—	27	100
Tenancy																														
Owner	12	8	36	23	63	41	17	11	14	9	8	5	3	2	1	1	154	100	28	27	60	57	6	6	5	5	5	5	104	100
Owner-cum-Tenant	7	9	11	14	37	48	11	14	7	9	3	4	1	1	—	—	77	100	12	22	38	68	3	5	3	5	—	—	56	100
Tenant	16	9	44	25	87	49	11	6	13	1	6	3	1	1	—	—	178	100	32	26	84	68	3	2	3	2	2	2	124	100
Barani (All)	32	43	21	28	13	17	6	8	3	4	—	—	—	—	—	—	75	100	11	69	3	19	1	6	—	—	1	6	16	100
Farm Size (Acres)																														
1 — 5	16	36	13	30	8	18	4	9	3	7	—	—	—	—	—	—	44	100	4	57	2	29	—	—	—	—	1	14	7	100
6 — 12	12	55	4	18	4	18	2	9	—	—	—	—	—	—	—	—	22	100	4	80	—	—	1	20	—	—	—	—	5	100
13 — 25	2	29	4	57	1	14	—	—	—	—	—	—	—	—	—	—	7	100	2	67	1	33	—	—	—	—	—	—	3	100
26 and above	2	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	100	1	100	—	—	—	—	—	—	—	—	1	100
Tenancy																														
Owner	25	46	19	35	6	11	4	8	—	—	—	—	—	—	—	—	54	100	9	69	2	15	1	8	—	—	1	8	13	100
Owner-cum-Tenant	5	38	1	8	5	38	1	8	1	8	—	—	—	—	—	—	13	100	1	100	—	—	—	—	—	—	—	—	1	100
Tenant	2	25	1	13	2	25	1	12	2	25	—	—	—	—	—	—	8	100	1	50	1	50	—	—	—	—	—	—	2	100
Total (All)	67	14	112	23	200	41	45	9	37	8	17	4	5	1	1	—	484	100	83	28	185	62	13	4	11	4	8	2	300	100

— Nil

Annexure—C (a)

Nitrogen and Phosphate Application Ranges for Wheat (Desi) by Area, Farm Size and Tenancy, 1978

—Nutrient lbs.

Farm Size/Tenancy	Application Ranges N														Application Ranges P											
	1—25		26—50		51—75		76—100		101—125		126—150		Total		1—25		26—50		51—75		76—100		101—125		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	9	41	7	32	1	5	4	18	—	—	1	4	22	100	6	46	5	38	1	8	—	—	1	8	13	100
Farm Size (Acres)																										
1 — 5	2	29	2	29	1	14	2	28	—	—	—	—	7	100	1	17	3	50	1	17	—	—	1	16	6	100
6 — 12	2	50	2	50	—	—	—	—	—	—	—	—	4	100	1	100	—	—	—	—	—	—	—	—	1	100
13 — 25	4	45	3	33	—	—	2	22	—	—	—	—	9	100	3	75	1	25	—	—	—	—	—	—	4	100
26 and above	1	50	—	—	—	—	—	—	—	—	1	50	2	100	1	50	1	50	—	—	—	—	—	—	2	100
Tenancy																										
Owner	3	34	2	22	1	11	2	22	—	—	1	11	9	100	3	43	3	43	—	—	—	—	1	14	7	100
Owner-cum-Tenant	3	100	—	—	—	—	—	—	—	—	—	—	3	100	2	100	—	—	—	—	—	—	—	—	2	100
Tenant	3	30	5	50	—	—	2	20	—	—	—	—	10	100	1	25	2	50	1	25	—	—	—	—	4	100
Barani (All)	24	45	20	38	6	11	1	2	2	4	—	—	53	100	18	95	1	5	—	—	—	—	—	—	19	100
Farm Size (Acres)																										
1 — 5	4	20	7	35	6	30	1	5	2	10	—	—	20	100	1	50	1	50	—	—	—	—	—	—	2	100
6 — 12	11	50	11	50	—	—	—	—	—	—	—	—	22	100	10	100	—	—	—	—	—	—	—	—	10	100
13 — 25	8	80	2	20	—	—	—	—	—	—	—	—	10	100	7	100	—	—	—	—	—	—	—	—	7	100
26 and above	1	100	—	—	—	—	—	—	—	—	—	—	1	100	—	—	—	—	—	—	—	—	—	—	—	—
Tenancy																										
Owner	18	42	17	40	6	14	1	2	1	2	—	—	43	100	14	93	1	7	—	—	—	—	—	—	15	100
Owner-cum-Tenant	6	67	2	22	—	—	—	—	1	11	—	—	9	100	4	100	—	—	—	—	—	—	—	—	4	100
Tenant	—	—	1	100	—	—	—	—	—	—	—	—	1	100	—	—	—	—	—	—	—	—	—	—	—	—
Total (All)	33	44	27	36	7	9	5	7	2	3	1	1	75	100	24	75	6	19	1	3	—	—	1	3	32	100

— Nil

Annexure—C (b)

Nitrogen and Phosphate Application Ranges for Cotton in Irrigated Area, by Farm Size and Tenancy, 1977-78

—Nutrient lbs.

Farm Size/Tenancy	Application Ranges																									
	N														P											
	1—25		26—50		51—75		76—100		101—125		126—150		Total		1—25		26—50		51—75		76—100		101—125		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	14	6	63	25	135	55	19	8	13	5	2	1	246	100	40	25	99	63	17	11	—	—	1	1	157	100
Farm Size (Acres)																										
1 — 5	—	—	7	17	20	50	6	15	6	15	1	3	40	100	7	27	15	58	3	11	—	—	1	4	26	100
6 — 12	5	5	23	24	61	62	6	6	3	3	—	—	98	100	14	22	43	66	8	12	—	—	—	—	65	100
13 — 25	8	10	23	29	42	53	4	5	2	2	1	1	80	100	15	30	30	60	5	10	—	—	—	—	50	100
26 and above	1	3	10	36	12	43	3	11	2	7	—	—	28	100	4	25	11	69	1	6	—	—	—	—	16	100
Tenancy																										
Owner	3	4	23	26	47	53	6	7	8	9	1	1	88	100	14	24	36	61	3	15	—	—	—	—	59	100
Owner-cum-Tenant	4	9	11	25	27	62	1	2	1	2	—	—	44	100	7	27	17	65	2	8	—	—	—	—	26	100
Tenant	7	6	29	25	61	53	12	11	4	4	1	1	114	100	19	27	46	64	6	8	—	—	1	1	72	100

— Nil

Annexure—C (c)

Nitrogen and Phosphate Application Ranges for Rice (IRRI) in Irrigated Area by Farm Size and Tenancy, 1977-78

—Nutrient Lbs.

Farm Size/Tenancy	Application Ranges																											
	N																P											
	1—25		26—50		51—75		76—100		101—125		126—150		151—175		Total		1—25		26—50		51—75		76—100		101—125		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	22	11	81	40	69	34	9	4	15	7	6	3	1	1	203	100	41	39	50	48	10	9	1	1	3	3	105	100
Farm Size (Acres)																												
1 — 5	3	7	14	34	18	44	1	3	5	12	—	—	—	—	41	100	9	32	13	46	5	18	1	4	—	—	28	100
6 — 12	10	12	40	47	26	31	5	6	2	2	2	2	—	—	85	100	21	47	19	42	4	9	—	—	1	2	45	100
13 — 25	8	13	22	36	21	34	2	3	6	10	1	2	1	2	61	100	10	42	13	54	—	—	—	—	1	4	24	100
26 and above	1	6	5	31	4	25	1	6	2	13	3	19	—	—	16	100	1	13	5	63	1	12	—	—	1	12	8	100
Tenancy																												
Owner	7	11	24	36	22	33	2	3	7	11	4	6	—	—	66	100	12	35	15	44	5	15	1	3	1	3	34	100
Owner-cum-Tenant	1	3	12	32	15	40	4	11	3	8	1	3	1	3	37	100	11	46	12	50	—	—	—	—	1	4	24	100
Tenant	14	14	45	45	32	32	3	3	5	5	1	1	—	—	100	100	18	38	23	49	5	11	—	—	1	2	47	100

— Nil

Annexure - C (d)

Nitrogen and Phosphate Application Ranges for Rice (Basmati) in Irrigated Area, by Farm Size and Tenancy, 1977-78

—Nt. Lbs.

Farm Size/Tenancy	Nitrogen																Phosphate											
	1–25		26–50		51–75		76–100		101 125		126–150		151–175		Total		1–25		26–50		51–75		76–100		101–125		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	2	4	28	52	13	24	3	5	5	9	2	4	1	2	54	100	7	41	7	41	1	6	1	6	1	6	17	100
Farm Size (Acres)																												
1 — 5	—	—	3	43	1	14	1	14	1	14	1	15	—	—	7	100	3	75	—	—	—	—	—	—	1	25	4	100
6 — 12	1	6	5	31	7	44	—	—	2	13	1	6	—	—	16	100	3	43	2	29	1	14	1	14	—	—	7	100
13 — 25	1	4	17	71	4	17	1	4	1	4	—	—	—	—	24	100	1	33	2	67	—	—	—	—	—	—	3	100
26 and above	—	—	3	43	1	14	1	14	1	14	—	—	1	15	7	100	—	—	3	100	—	—	—	—	—	—	3	100
Tenancy																												
Owner	1	4	17	63	3	11	2	7	3	11	—	—	1	4	27	100	3	43	3	43	—	—	—	—	1	14	7	100
Owner-cum-Tenant	1	11	8	22	5	56	—	—	1	11	—	—	—	—	9	100	4	80	1	20	—	—	—	—	—	—	5	100
Tenant	—	—	9	50	5	27	1	6	1	6	2	11	—	—	18	100	—	—	3	60	1	20	1	20	—	—	5	100

— Nil

Annexure—C (e)

Nitrogen and Phosphate Application Ranges for Sugarcane in Irrigated Area by Farm Size and Tenancy, 1977-78

- Nt. Lbs.

Farm Size Tenancy	Nitrogen																		Phosphate															
	26—50		51—75		76—100		101—125		126—150		151—175		176-200		201 & above		Total		1—25		26-50		51 75		76—100		101—125		126—150		151—175		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	26	13	55	28	14	7	57	29	15	8	16	8	5	3	7	4	195	100	15	16	46	48	18	19	4	4	11	12	—	—	1	1	95	100
Farm Size (Acres)																																		
1 — 5	4	10	10	26	2	5	8	20	5	13	3	8	1	3	6	15	39	100	3	19	2	13	5	31	2	12	3	19	—	—	1	6	16	100
6 — 12	10	14	17	24	3	4	24	34	8	11	5	7	3	4	1	2	71	100	6	16	14	38	8	22	2	5	7	19	—	—	—	—	37	100
13 — 25	9	13	24	36	7	10	18	27	2	3	6	9	1	2	—		67	100	5	16	22	69	4	12	—	—	1	3	—	—	—	—	32	100
26 and above	3	17	4	22	2	11	7	39	—	—	2	11	—	—	—	—	18	100	1	10	8	80	1	10	—	—	—	—	—	—	—	—	10	100
Tenancy																																		
Owner	10	13	17	22	9	12	22	29	10	13	5	6	1	1	3	4	77	100	9	23	16	41	8	20	1	3	5	13	—	—	—	—	39	100
Owner-cum-Tenant	7	21	12	37	1	3	5	15	2	6	2	6	1	3	3	9	33	100	4	25	6	37	2	13	1	6	2	13	—	—	1	6	16	100
Tenant	9	11	26	31	4	5	30	35	3	3	9	11	3	3	1	1	85	100	2	5	24	60	8	20	2	5	4	10	—	—	—	—	40	100

— Nil

Annexure C (f)

Nitrogen and Phosphate Application Ranges for Maize by Area, Farm Size and Tenancy, 1977-78

–Nt. Lbs.

Farm Size/Tenancy	N Application Ranges 1–25		26–50		51–75		76–100		101–125		126–150		Total		P Application Ranges 1–25		26–50		51–75		76–100		101–125		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Irrigated (All)	16	13	31	25	54	44	8	7	11	9	2	2	122	100	11	25	15	35	9	21	3	7	5	12	43	100
Farm Size (Acres)																										
1 – 5	6	19	6	19	9	28	6	19	3	9	2	6	32	100	2	12	3	19	6	38	2	12	3	19	16	100
6 – 12	3	9	8	24	18	53	2	6	3	8	—	—	34	100	5	38	4	31	3	23	–	–	1	8	13	100
13 – 25	6	15	9	23	20	52	–	–	4	10	—	—	39	100	3	30	5	50	—	—	1	10	1	10	10	100
26 and above	1	6	8	47	7	41	–	–	1	6	—	—	17	100	1	25	3	75	—	—	–	–	–	–	4	100
Tenancy																										
Owner	8	15	14	26	22	41	6	11	4	7	—	—	54	100	8	33	8	33	3	13	2	8	3	13	24	100
Owner-cum-Tenant	1	4	5	20	13	52	–	–	5	20	1	4	25	100	1	14	3	43	2	29	1	14	–	–	7	100
Tenant	7	16	12	28	19	44	2	5	2	5	1	2	43	100	2	17	4	33	4	33	–	–	2	17	12	100
Barani (All)	33	31	41	39	20	19	10	2	2	2	—	—	106	100	5	50	2	20	1	10	1	10	1	10	10	100
Farm Size (Acres)																										
1 – 5	25	35	30	43	6	8	8	11	2	3	—	—	71	100	3	75	—	—	—	—	—	—	1	25	4	100
6 – 12	5	21	8	33	11	46	–	–	—	–	—	—	24	100	2	67	1	33	–	–	–	–	–	–	3	100
13 – 25	2	22	3	34	2	22	2	22	–	—	—	—	9	100	—	—	—	—	1	50	1	50	—	—	2	100
26 and above	1	50	–	–	1	50	–	–	—	—	—	—	2	100	—	–	1	100	–	–	–	–	–	–	1	100
Tenancy																										
Owner	30	38	30	39	14	18	4	5	—	—	—	—	78	100	4	50	2	25	—	–	1	13	1	12	8	100
Owner-cum-Tenant	2	12	6	35	6	35	3	18	—	—	—	—	17	100	—	—	—	—	1	100	–	–	–	–	1	100
Tenant	1	9	5	46	–	–	3	27	2	18	—	—	11	100	1	100	–	—	–	–	–	–	–	–	1	100
Total (All)	49	22	72	31	74	32	18	8	13	6	2	1	228	100	16	30	17	32	10	19	4	8	6	11	53	100

– Nil

Annexure—D

Percentage of Farmers Applying Nitrogen and Phosphate to Wheat, Rice and Cotton[1] by Area, Farm Size and Tenancy, 1976

(Percentages)

Farm Size/ Tenurial Status	CROP					
	Wheat		Rice		Cotton	
	N	P	N	P	N	P
Irrigated Areas (All)	78	30	63	17	78	21
Farm Size (Acres)						
1 – 5	76	27	65	17	72	20
6 – 12	75	30	60	19	81	22
13 – 25	81	28	64	12	73	14
26 and above	92	43	71	17	91	39
Tenurial Class						
Owner	81	38	63	16	78	34
Owner-cum-Tenant	80	28	65	14	79	18
Tenant	76	26	62	18	78	15
Barani Areas (All)	29	3				
Farm Size (Acres)						
1 – 5	29	0				
6 – 12	28	0				
13 – 25	23	12				
26 and above	37	11				
Tenurial Class						
Owner	33	3				
Owner-cum-Tenant	21	1				
Tenant	26	4				

1 Farmers who applied compound fertilizers such as DAP and Nitrophos are credited with having applied both N and P to the crops. Confidence intervals for the proportions are shown in Annexure D (a).

Annexure D (a)

Confidence Intervals for Proportions of Farmers Using Nitrogen and Phosphate on Wheat, Rice and Cotton[1] by Area, Farm Size and Tenancy, 1976

Farm Size/ Tenurial Class	Wheat Irrigated		Wheat Barani		Rice		Cotton	
	N	P	N	P	N	P	N	P
Farm Size (All)	78	30	29	3	63	17	78	21
	(81 75)	(33 27)	(34 24)	(5 1)	(68 58)	(21 13)	(82 74)	(25 17)
1 – 5	76	27	29	–	65	17	72	20
	(82 70)	(33 21)	(37 21)	– –	(75 55)	(25 9)	(82 62)	(29 11)
6 – 12	75	30	28	–	60	19	81	22
	(80 70)	(35 25)	(38 18)	– –	(68 52)	(25 13)	(87 75)	(28 16)
13 – 25	81	28	23	12	64	12	73	14
	(87 75)	(35 21)	(37 9)	(23 1)	(74 54)	(19 5)	(81 65)	(20 8)
26 and above	92	43	37	11	71	17	91	39
	(99 85)	(55 31)	(56 18)	(24 *)	(87 55)	(30 4)	(99 83)	(53 25)
Owner	81	38	33	3	63	16	78	34
	(86 76)	(44 32)	(40 26)	(6 0)	(71 54)	(23 9)	(85 71)	(42 26)
Tenant	76	26	26	4	62	18	78	15
	(81 72)	(31 21)	(42 10)	(11 *)	(69 55)	(23 13)	(84 72)	(20 10)
Owner-cum-Tenant	80	28	21	1	65	14	79	18
	(86 74)	(35 21)	(30 12)	(3 *)	(76 54)	(22 6)	(88 70)	(27 9)

1 Confidence intervals at 90 percent given in parentheses below the sample proportion.
* Negative number.

— Nil

Annexure—D (b)

Regression Coefficients, F-Values and Levels of Significance of Factors Related to the Probability of Farmers' Use of Nitrogen, Wheat, 1976

Independent Variable	Regression Coefficient	F - Value	Level of Significance
Use of Irrigation	0.449	135.54	.001
Distance to fertilizer source	(−) 0.018	24.72	.001
Farmer's education	0.020	16.38	.001
Farm size	0.002	4.51	.05
Ratio of pacca to total miles	0.075	3.63	.10
Farmer's age	(−) 0.001	0.26	N.S.
Farmer's tenurial status	(−) 0.003	0.01	N.S.

N.S. = Not Significant.

Annexure—E

Average Application Rates of Nitrogen and Phosphate on Wheat, Cotton and Rice of Farmers Using Some Fertilizer[1] by Area, Farm size and Tenancy, 1976

—Nutrient Pounds Per Acre

Farm Size/Tenurial Status	CROP					
	Wheat		Rice		Cotton	
	N	P	N	P	N	P
Irrigated (All)	55.1	16.8	47.0	7.4	58.5	12.5
Farm Size (Acres)						
1 — 5	58.8	17.9	53.0	8.8	69.9	12.5
6 — 12	54.6	17.3	46.7	9.2	58.7	13.4
13 — 25	50.0	12.2	43.5	5.2	50.0	6.0
26 and above	60.4	22.9	42.4	1.5	60.3	23.1
Tenurial Class						
Owner	59.6	20.6	47.2	6.9	65.0	19.4
Owner-cum-Tenant	50.2	16.3	42.9	4.6	52.1	8.3
Tenant	54.0	14.2	48.4	8.7	56.9	9.8
Barani (All)	27.2	2.3				
Farm Size (Acres)						
1 — 5	36.0	Nil				
6 — 12	15.9	Nil				
13 — 25	22.1	7.7				
26 and above	21.1	10.3				
Tenurial Class						
Owner	31.9	2.0				
Owner-cum-Tenant	19.6	3.9				
Tenant	15.1	0.3				

1. Confidence intervals for the means are shown in Annexure E (a).

Annexure – E (a)

Confidence Intervals for Average Application Rates of Nitrogen and Phosphate on Wheat, Rice and Cotton of Farmers Using Some Fertilizer[1] by Area, Farm Size and Tenancy, 1976

Farm Size/ Tenurial Class	Wheat Irrigated		Wheat Barani		Rice		Cotton	
	N	P	N	P	N	P	N	P
All	55.1	16.8	27.2	2.3	47.0	7.4	58.5	12.5
	(57.5 52.7)	(18.7 14.9)	(29.6 24.8)	(3.4 1.2)	(49.6 44.4)	(8.9 5.9)	(61.4 55.6)	(14.7 10.3)
1 – 5	58.8	17.9	36.0	--	53.0	8.8	69.9	12.5
	(63.5 54.1)	(22.4 13.4)	(39.3 32.7)	--	(57.6 48.4)	(12.6 5.0)	(77.2 62.6)	17.2 7.8
6 – 12	54.6	17.3	15.9	—	46.7	9.2	58.7	13.4
	(58.0 51.2)	(20.2 14.4)	(17.8 14.0)	—	(50.8 42.6)	(11.6 6.8)	(63.1 54.3)	(17.0 9.8)
13 – 25	50.0	12.2	22.1	7.7	43.5	5.2	50.0	6.0
	(55.1 44.9)	(15.0 9.4	(29.8 14.4)	(12.0 3.4)	(48.9 38.1)	(7.9 2.5)	(54.4 45.6)	(8.5 3.5)
26 and above	60.4	22.9	21.1	10.3	42.4	1.5	60.3	23.1
	(69.7 51.1)	(28.9 16.9)	(30.0 12.2)	(18.5 2.1)	(50.6 34.2)	(3.7 *)	(71.2 49.4)	(31.5 14.7)
Owner All	59.6	20.6	31.9	2.0	47.2	6.9	65.0	19.4
	(64.1 55.1)	(23.9 17.3)	(34.8 29.0)	(3.4 0.6)	(51.8 42.6)	(9.7 4.1)	(70.6 59.4)	(23.7 15.1)
1 – 5	65.8	20.8	37.2	--	53.3	7.8	68.1	14.1
	(74.5 57.1)	(27.2 14.4)	(40.9 33.5)	--	(61.1 45.5)	(14.1 1.5)	(77.7 58.5)	(21.6 6.6)
6 – 12	55.7	23.5	19.1	--	44.0	9.3	62.9	21.6
	(62.8 48.6)	(29.9 17.1)	(21.4 16.8)	—	(49.9 38.1)	(15.3 3.3)	(46.6 61 2)	(23.0 20.2)
13 – 25	54.1	15.6	20.7	10.2	44.2	5.9	55.3	10.7
	(61.7 46.5)	(21.1 10.2)	(31.5 9.9)	(19.4 1.0)	(56.4 32.0)	(10.9 0.9)	(63.9 46.7)	(16.4 5.0)
26 and above	63.3	20.8	30.7	16.8	47.4	2.9	75.1	31.6
	(77.8 48.8)	(28.9 12.7)	(44.2 17.2)	(35.7 *)	(62.1 32.7)	(7.4 *)	(96.3 53.9)	(45.9 17.3)

Contd.

Farm Size/ Tenurial Class	Wheat Irrigated		Wheat Barani		Rice		Cotton	
	N	P	N	P	N	P	N	P
Tenant All	54.0	14.2	15.1	0.3	48.4	8.7	56.9	9.8
	(57.5 50.5)	(16.6 11.8)	(20.1 10.1)	(0.6 0.0)	(52.1 44.7)	(11.0 6.4)	(61.1 52.7)	(12.8 6.8)
1 – 5	54.7	15.1	33.7	—	50.3	9.1	72.2	13.1
	(60.5 48.9)	(19.6 10.6)	(46.1 21.3)	—	(56.5 44.1)	(14.3 3.9)	(85.4 59.0)	(20.6 5.6)
6 – 12	55.7	15.3	16.4	—	48.7	10.0	59.1	11.2
	(60.1 51.3)	(19.1 11.5)	(24.7 8.1)	—	(54.5 42.9)	(13.2 6.8)	(65.0 53.2)	(16.0 6.4)
13 – 25	50.5	9.7	3.2	1.2	46.7	5.7	45.8	5.3
	(60.2 40.8)	(13.7 5.7)	(7.9 *)	(3.7 *)	(54.1 39.3)	(10.4 1.0)	(51.1 40.5)	(9.1 1.5)
26 and above	54.7	36.0	1.2	—	36.5	—	46.6	10.1
	(66.2 43.2)	(68.4 3.6)	(3.7 *)	—	(125.5 *)	—	(67.2 26.0)	(31.6 *)
Owner-cum-Tenant All	50.2	16	19.6	3.9	42.9	4.6	52.1	8.3
	(54.9 45.5)	(21.3 11.3)	(24.2 15.0)	(6.6 1.2)	(48.1 37.7)	(7.4 1.8)	(57.6 46.6)	(12.2 4.4)
1 – 5	53.0	19.5	25.4	—	63.8	10.1	67.4	—
	(64.3 41.7)	(42.9 *)	(35.1 15.7)	—	(85.6 42.0)	(31.6 *)	(92.9 41.9)	—
6 – 12	49.1	13.1	10.5	—	42.2	5.7	51.0	8.4
	(57.4 40.8)	(19.1 7.1)	(12.0 9.0)	—	(51.6 32.8)	(9.9 1.5)	(59.4 42.6)	(15.5 1.3)
13 – 25	44.2	13.1	24.0	4.4	36.8	3.3	53.2	3.0
	(49.8 38.6)	(18.6 7.6)	(37.6 10.5)	(6.0 2.8)	(45.0 28.6)	(8.1 *)	(65.6 40.8)	(5.8 0.2)
26 and above	58.2	22.6	22.5	10.1	36.9	—	47.8	18.4
	(73.8 42.6)	(33.1 12.1)	(38.6 6.4)	(23.4 *)	(46.2 27.6)	—	(57.4 38.2)	(30.9 5.9)

1. Confidence intervals at 90 percent given in parentheses below the mean. — Nil
* Negative number.

Percentage Share of Nitrogen and Phosphate Consumption on Major Crops by Area, 1978

Area	CROPS					
	Wheat	Rice	Cotton	Sugarcane	Maize	Total
N. Application						
Irrigated	45	19	20	13	3	100
Barani	54	—	—	—	46	100
TOTAL	45	18	19	13	5	100
P. Application						
Irrigated	50	16	22	9	3	100
Barani	76	—	—	—	24	100
TOTAL	51	16	22	8	3	100

--- Nil

Annexure—G

Cropped Acreage and Per Acre Wheat Production of Farmers in Irrigated Area, Growing under Barani Conditions and in Barani Area Growing Under Irrigated Conditions, 1978

Area	Barani Conditions			Irrigated Conditions		
	Cropped Area (Acres)	Average Production (Maunds)	Saline Area (Percentage)	Cropped Area (Acres)	Average Production (Maunds)	Saline Area (Percentage)
Irrigated	524	5.03	1	270	9.51	13.3
Barani	670	6.60	3.4	7	5.71	—
Total	1194	5.91	2.4	277	9.41	13

— Nil

Annexure—H

Cropped Acreage and Percentage of Cropped Acreage of Non—Users of Chemical Fertilizer Applying Farm Yard Manure on Wheat, 1978

Area	With Farm Yard Manure		Without Farm Yard Manure	
	Cropped Area (Acres)	Percentage of total cropped Acreage	Cropped Area (Acres)	Percentage of total cropped Acreage
Irrigated	272	7	522	13
Barani	534	48	157	14
Total	806	16	679	13

Annexure – I

Per Acre Application Rates of Nitrogen and Phosphate for Growers* of Major Crops by Area

Fertilizer in Nt. Lbs. per Acre

Grops	Area		
	Irrigated	Barani	Total
Wheet			
Cropped Acreage	4023	1113	5136
Nitrogen	53	11	44
Phosphate	24	3	20
Rice			
Cropped Acreage	2103	—	2103
Nirogen	43	—	43
Phosphate	15	—	15
Cotton			
Cropped Acreage	1583	—	1583
Nitrogen	60	—	60
Phosphate	27	—	27
Sugarcane			
Cropped Acreage	668	—	568
Nitrogen	97	—	97
Phosphate	26	—	26
Maize			
Cropped Acreage	227	542	769
Nitrogen	54	19	29
Phosphate	23	2	8

* It in cludes cropped acreage of both users and non--users of fertilizer. '–Nil'

Annexure—J

Wheat Production, Market Surplus and Percentage sold by Area, 1978

Area	Total Production non—users+users (Mds.)		Market Surplus (Mds.)		Percentage of total produce sold
	#	%	#	%	
Irrigated	56489	87.5	14235	99.0	25.2
Barani	8042	12.5	96	1.0	1.2
Total	64531	100.0	14331	100.0	22.2

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