FACTORS AFFECTING THE USE OF CHEMICAL FERTILISERS IN AGRICULTURE

A case study of Ferozepur, Muzaffar Nagar and Deoria Districts - 1967-69.

BY

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I cerfify that the dessertation entitled " Factors Affecting the Use of Chemical Fertilisers in Agriculture - A case study of Deoria, Muzaffar Nagar and Ferozepur Districts" submitted by Mr. S.M. Arif in fulfilment of six credits out of the total requirements of twenty four credits for the degree of Master of Philosophy (M. Phil) of the University, is a bonafide work and may be placed before the examiners for their consideration.

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PREFACE AND ACKNOWLEDGEMENT :

Improved agricultural practices are the products of modern science and every country has its own set of bright and enterprising scientists to produce techniques suited to local conditions. The problem starts, however, in disseminating these techniques among farmers who are the potential beneficiaries of the inventions.

Present work is an attempt in the direction that whether there are more easy practicable ways by which the use of chemical fertilisers for the farmers can be made rapidly adaptable, widely prevelant that is, whether there are easily controllable factors which make the farmers to use chemical fertiliser by which a farmer can be made to use chemical fertiliser more rapidly.

This dissertation is an attempt towards the partial fulfillment of M.Phil requirement. I express my gratitude to Prof. G.S. Bhalla, Chairman, C.S.R.D., JNU, who supervised this study. Without his advice this work was impossible to be completed.

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CHAPTER 1

INTRODUCTION

Introduction of changes in existing pattern of agricultural practices, techniques and methods adopted by the producers to raise the level of production, is the base of all agricultural development programme. Research programme in agriculture has to be the source from where information about improvements to be advocated for being adopted by the producers should flow out continuously. Improved agricultural practices are the products of modern science and every country has its own set of bright and enterprising scientists to produce techniques suited to local conditions. The problem starts, however, in disseminating these techniques among farmers who are the potential beneficiaries of the inventions. It is an acknowledged fact that Indian agriculture does not suffer as much from technological handicaps as it does from lack of extent of adoption of new techniques. The Planning Commission of India in their Notes on Perspective of Development (April 1964) refer to this situation and observes, "on the basis of available evidence, there is good reason to believe that the level of farm output envisaged in the perspective Plan targets for the Fourth and the Fifth Five Year Plans of India, is technically feasible attainment". What is wanting under our situation is the acceptance and adoption of improved methods and techniques of scientific farming by the vast body of farm population. Unless conditions are created in which a major section of the agricultural population is not completely involved to raise the level of production substantially per acre of land and per unit of factors of production applied, by encouraging, motivating and assisting the people to adopt scientific methods of farming, our problems will remain unsolved.

The introduction of new high yielding varieties of cereals has definitely raised the hopes for a "green revolution" in the country. But we appear to be still far away from achieving our goals as is clearly evident from the situation created by droughts in a large part of the country during 1972-73. We have still to reach a stage when agriculture will start playing a significant role in developing the overall economy. This state of affairs is mainly because the so-called green revolution is confined to small and limited pockets of the country. Unless we make concerted efforts to spread it over a larger area, the problem of balanced regional economic development may remain unsolved.

A central feature of a programme of improvement of the standard of living of poorer sections of India's rural areas or of generation of employment opportunities at the required level of productivity will have to be in the expansion of irrigation and the spread of the new technology, thus also increasing the intensity of land use. As economists, we know little of the processes by which the new technologies are accepted and spread in a relatively quick period nor of ways of building up an infrastructure which will be of equal use to the rich and poor alike. Present work is an attempt in this direction, to identify some of the major economic factors influencing the adoption of the new technology by the farmers.

<u>Scope of the Study</u> :

The high yielding varieties and fertiliser are land substituting, labour using innovations, they are also neutral to scale and therefore, usable by all farmers regardless of farmsize. Consequently, they should raise income and employment of small farmers and farm labourers; they could break the chain of rural poverty. In effect, therefore, the high yielding varieties appeared to be "engine of change" that would modernise and radically transform traditional agriculture. Misgivings related mainly to the social consequences of this "seed-fertilizer revolution or the green revolution" : whether or not it would lead to massive problem of equity and welfare. Firstly, how would the benefit from the green revolution be distributed between regions? On the whole the distribution of benefits among regions would likely parallel existing resource endowment. Benefits occured from the adoption of new technology in one period, so the adoption pattern would differ in different regions. The region with more developed infrastructure would be more prone to new technology compared to the region with less developed infrastructure. For this reason, in the present paper, two states, Punjab and U.P. with their distinct infrastructures have been selected for study. Punjab is the State with more developed infrastructure in comparison to the less developed infrastructure of U.P. Also, any single district in U.P. can not give the composite picture of whole of the Uttar Pradesh. Socio-economic, cultural and even political conditions are not evenly distributed all over the Uttar Pradesh. Its Western districts are much ahead in all fields than its eastern districts. I chose two completely different districts : in the west, Muzaffarnagar which is primarily devoted to the cultivation of wheat, and in the east, Deoria where wheat and rice are cultivated.

Second issue of the "seed-fertiliser revolution" is of intra-regional nature. That is, how the farmers of different categories of holdings would respond to the adoption of the revolution. To deal with it, the study would be conducted in accordance with the farm size. Farmers would be divided into three categories i.e. small, medium and large, and then the adoption pattern would be studied.

Farmers in Japan and Mixico have also been strong during recent decades in their demand for new agricultural factors. The notion that all farmers are handcuffed by tradition, making it impossible for them to modernise agriculture, belongs to the realm of myth.

What determines whether farmers will accept a new agricultural factor, given the knowledge about it? One approach is to explain differences in the rate of adoption in terms of cultural variables. Another approach is to explain the observed differences in the rate of adoption in terms of profitability. According to Zvi Griliches "One of the major factors accounting for the difference in the rate of acceptance of hybrid corn in different areas was the difference in absolute profitability of the shift over from open pollinated to hybrid varieties". Despite the views that the farmers in poor communities are subject to all manner of cultural restraints that make them unresponsive to morel economic incentives in accepting a new agricultural factor, studies of the observed lags in the acceptance of particular new agricultural factors show that these lags are explained satisfactorily by profitability. A pioneering study by Raj Krishna of the Supply Response of Cotton growers in Punjab, including acceptance of a new and better variety of cotton, strongly supports this proposition. The level of living indeces actually provéd unsuccessful in explaining the difference among State in the rate of acceptanse of hybrid corn.

Economic Factors towards the adoption of Bio-Chemical inputs:

As usual the rate of modernisation in agriculture is determined by its demand and supply. Assuming the supply of agricultural inputs to be given, the rate of modernisation becomes mainly a demand variable, which is a matter of the "willingness" and "ability" of the farmers to use modern inputs. The willingness to accept is related mainly to personal factors like education, age, etc. whereas the ability to modernise the farming depends upon economic factors, like creation of necessary infrastructure, capacity to invest, risk bearing capacity, etc. Thus, the factors, which affect the propensity to adopt are, irrigation facilities, size of holding profitability, increased income etc. For the sake of clear exposition the relationship between these economic factors and adoption has been examined separately in the following pages.

According to urban folk base, agriculture is the Gilvalter of traditionalism; hence to think of farmers forsaking custom and demanding new factors of production is absurd. But modern agriculture is obviously a consequence of farmers having acquired and having learned how to use new, superior factors of production. Nor is this underlying demand for new factors of production unique. This varies from country to country and from region to region with in a country. Danish farmers achieved such a transformation even before the turn of the century.

The concept of profitability is not restricted to market transactions. Increases in the yield of subsistence crops or in the crops of subsistence farmers can be profitable even if none of the crop is sold. It is likely to be true, however, that the profit possibilities associated with the acceptance of new agricultural factors are in general more restricted for essentially self-sufficient than for commercial farmers.

The same agricultural factor can not be profitable to same extent for the farmers of all regions and with different farm sizes. Also farm tenure arrangements can obviously affect the profitability of new factors to the actual farmer. If a tenant has to (as is the normal practice) get half of the yield of the crop, that is, he gets half of the profitability; then he may or may not adopt the new factors because he has to bear the risk involved in their adoption against the well established results of traditional varieties from decades.

The profitability depends upon the price and the yield. It would not suffice to examine only the relative increase in yield. The absolute increases in yield are what pay the costs and allow a profit.

<u>Farm Size and the use of B.C. Inputs</u> :

Although High Yielding Varieties and Fertilisers are size-neutral in the sense that they are divisible and can be used irrespective of the size of the farm, they are not resource neutral. Since the large farms have a better command over resources - own as well as borrowed - and since their risk bearing capacity would be greater than that of small farmers, the adoption of B.C. techniques is expected to be more extensive among large farms. Since the expansion of output through multiple cropping requires more labour input per unit of output than through the increase in yield per cropped acre from H.Y.V. or extensive use of fertiliser, it appears that the labour saving charactor of B.C. inputs provides a major incentive for their adoption among the large farms.

Irrigation :

Investment in modern inputs like fertilisers and H.Y.V. can be expected to be greater under conditions of high profitability and relative certainty of yields. Although there can be trade-off between the level of profit and the degree of yield-certainty, the profitability of modern inputs is generally higher when irrigation is assured and controlled so that the certainty of yield would be greater in such a situation.

Fixed Capital :

Effect of fixed capital on the adoption of Bio-Chemical inputs would also be examined. There has been a long established hypothesis that the limitations of capital had come in the way of adeption of high yielding varieties by farmers with 5 to 15 acres of land; that where the later had been able to secure credit for investment in irrigation and machinery, that small farmers with less than 5 acres of land had been wholly unable to take advantage of the high yielding varieties because they had been unable to invest in the indivisible inputs like water and machinery.

Total Value of Farm Products raised :

This is another important factor which is related to the adoption of improved farm practices. A reciprocal cause and effect relationship is likely to exist between this amount of the 'total value of products' and the acceptance of improved farm practices. The greater and quicker adoption of such farm practices leads to higher value of products raised, which in turn, makes more capital available and generates a psychological motivation to use these practices.

Cropping Intensity :

This variable has practical importance in the adoption of high yielding varieties of seeds and fertilisers. High yielding varieties are short duration varieties and can be either successively cultivated two times a year, as in case of rice and maise etc., or can provide more time after harvesting one crop for the preparation of land for second crop. So if the cropping intensity is more than 100% (gross cultivated area is more than net cultivated area) then this will raise the profitability of land and maximise farmers' income (and also will minimise risks involved inherent in 100% cropping intensity case). In this way, extent of cropping intensity prevailing or wish of a farmer to increase his cropping intensity makes farmers to adopt H.Y.V. of seeds and fertilisers.

<u>Tenancy</u> :

Unfair rents and no security of tenure have many unfortunate ramifications with regard to land improvement and higher productivity. So long as the tenant cultivator is to part with the bulk of his produce on account of rent, he is left with too little for his day-to-day needs, and still less for investment in the costly inputs like fertiliser and H.Y.V. of seeds. Cooperatives consider pure tenant to be a bad risk. The maximum loan limit for the tenant farmer is much less than that for the owner farmers.

Adoption of Bio-Chemical inputs depends upon two aspects - mode of rent payment and the pattern of tenancy. Usually mode of rent payment is either share-cropping or fixed rent system. From tenant's point of view, share-cropping makes sense only where there is the danger of recurring crop failure. Where this situation does not prevail (as in the case of rich rainfed region of east U.P. and good soil conditions of Ferozepur) crop sharing has a disincentive effect upon the cultivator working somebody else's land. Putting more into the land and solely at his expense, never results in a proportionate gain to the tenant.

As far as pattern of tenancy is concerned adoption depends upon the conditions that who leases-in. If the lesser-in happens to be a rich tenant, then he may have access to B.C. inputs. But mostly leaser-in is a poor tenant so it is unlikely that he will use costly new inputs on account of his being poor.

Objectives of the Study :

Main objectives of the study are as follow:

To assess the relative importance of economic factors towards the use of chemical fertilisers in agricultural practices.

To study the influence of economic factors towards the use of fertilisers over time in a given region, and also in different types of regions in a given period.

Hypothesis :

In the light of above discussions following hypothesis are proposed to be tested in this study :

Economic factors such as size of Farm, Irrigation, Fixed Capital, Total Value of Products raised, Ownership of land holding and Cropping Intensity are positively related to the (play a predominant role in the) fertiliser use in agricultural practices.

REVIEW OF LITERATURE

Summary of the Findings to Predict Adoption of Improved Farm Practices by a Group of Factors

Name of the Investigator	Main Independent Variables used	Percent variation explained in adoption of improved farm practices
Junghare, Y.N. (1962)	Extension contacts Formal social participation Socio economic status Formal education Age	23.81
Singh S.N. & Reddy, S.K.	Farm Size Economic Status Social participation	61.70
Shetty, N.S. (1966)	Size of Farm Extent of tenancy Value of fixed capital excluding land Liquidity Age Education Rate of Return of innovation	52.33*
Misra, V.N. (1968)	Size of farm Value of marketed produce Value of non-land fixed investment Percent of irrigated area Adjusted intensity of cropping	69.14*

* Only fertiliser use has been studied.

RESEARCH METHODS

Data Base :

The study is based on the secondary data collected through three "Studies in the Economics of Farm Management" sponsored by Directorate of Economics and Statistics' Ministry of Food and Agriculture, for Deoria in East U.P., Muzaffarnagar in West U.P. and Ferozepur in Punjab.

Period of Study :

Period of information collected through above studies relates to 1966-67, 1967-68, 1968-69 for Deoria and Muzaffarnagar and 1967-68, 1968-69 and 1969-70 for Ferozepur. The study in each district extends successively over three agricultural years beginning from 1st June of the previous year to 31st May of the next year.

Out of these three years, our study is based on two years, 1967-68 and 1968-69 for which the data for all the three districts is available.

METHOD OF DATA COLLECTION :

Method of Data Collection by the Farm Management Studies for Deoria, Muzaffarnagar and Ferozepur has been as follows:

The cost accounting method of investigations has been used for the collection of field data in all the three districts. In each district, a sample of 150 farms was selected from 15 villages of the respective district at the rate of 10 farms per village.

The sampling design is a multistage stratified random sampling with the village as the primary unit and the farm (operational holding) as the ultimate unit of study in each of the three districts.

Sampling :

1. District: As far as U.P. is concerned the eastern districts of Uttar Pradesh form one of the most agricultural backward regions of the state and also of the country. The farms are of Tiny size and Poverty limits application of credit in various forms to agriculture. Thus, Deoria district has been purposively selected for study.

On the other hand the Muzzaffarnagar district, exhibiting most of the characteristics of Western Uttar Pradesh agro-climatic condition, has been selected for the study.

Ferozepur district from Punjab district was selected for the study considering its agro-climatic conditions which resemble very much from Muzzaffarnagar.

2. <u>Villages</u> : Fifteen villages have been selected randomly from each district. Districts of Deoria and Muzzaffarnagar were divided into two zones while Ferozepur was divided into three zones, based on soil types, cropping pattern and irrigation facilities etc. The number of villages selected in each zone of each district had been determined in proportion to cultivated area of each zone to total cultivated area of the district. Thus 15 sample villages each in Deoria, Muzzaffarnagar and Ferozepur were selected for the study.

3. <u>Farm</u> : For the selection of the ultimate unit viz farm, a preliminary enumeration of all the farms (operational holdings) in selected villages was done alongwith the farms adopting improved farm practices, having Deoria where there were not such farms.

All the operational holdings of the selected villages were arranged in ascending order of their magnitude of area and were grouped in five size-strata on the basis of equal proportionate area cultivated under holdings falling in each village were, then, selected randomly. In each district 15 farms were selected from each village (from different size stratum as explained above), thereby constituting 10 x 15 = 150 households in each district or 450 households in total.

Details of Data Collected :

The Farm Management data collected as above covered the following diamensions of information :

1. Data relating to villages; identification, location, population, occupational distribution Land Utilisation, Irrigation, Crop Statement, and live-stock availability of the villages were studied.

2. Data relating to individual farms: Various objects covered about individual farms were : Identification, Description of family, source of income, type of tenure, farm size, irrigation, Age & Literacy of farmers, human labour, bullock labour, capital, implements, yields, seed, fertilisers, etc.

Type of Enquiry :

The data for Kharif season have been obtained by survey method and for Rabi season by cost accounting method.

ANALYTICAL METHODS :

For assessing the quantitative significance of the relative influence of selected factors on use of fertilisers per farm as well as per hectare, for all crops, the regression analysis has been used.

A tool in econometric research, regression equation model, postulates a casual relationship between a dependent variable and one or more independent variables. The regression model attempts to explain observed changes in a dependent variable as being causal relation expressed by the model.

The causal relation between the dependent variable (Y) and the independent variables, ($X_1, X_2, - - - X_N$) may be of any implicit functional form. Consider the relation,

$$Y = f (X_1 , X_2 , - - - - - - X_N)$$

where f (   ) is an implicit functional form.

But the available techniques of estimation require that the function , f (   ) be an explicit function. Also, not all explicit functional forms are estimable. When the explicit functional form is known but not estimable, we approximate the functional form f (   ) by a familiar estimable one.

An explicit functional form widely used to express the causal relation between a dependent variable and independent variables is the linear form. Even if the relation is not linear, when the relevant range of operation is small the linear form may adequately represent the true functional form.

Linear regression in two variables is as follows:

$$Y_t = B_1X_{1t} + B_2X_{2t} + Z_t + \eta_t + \quad t$$

Where Z stands for the combined influence of all the non-measurable variables. It is the error due to the linear approximation of some other implicit functional form. η is pure noise term inherent in the system and represent unaccounted for 'variation in the dependent variable'.

Standard linear regression equation in two variables is written as ,

$$Y_t = B_o + B_1X_{1t} + B_{2t} + \quad t$$

where $B_o = \bar{Z} +$ and $\quad_t = Z_t + \zeta_t + \eta_t$

$$Z_t = (Z_t - Z)$$

$$\quad_t = (\quad_t - \quad_t)$$

The B's are regression parameters and the ϵ's are the so-called error terms.

THE MODEL

Use of dummy variables in regression equations :

Dummy variables are usually associated with qualitative variables such as region, topography, occupation, caste, class, position etc. It is a simple and useful method of introducing such variables into the regression analysis, which would otherwise be difficult to measure on a numerical scale. Introduction of dummy varioblea into the regression analysis permits the separation of information on certain variables into discrete catagories by assuming dummy values (0 or 1) for each of the categories.

If Y is the dependent variable, amount of fertilisers used, and the explanatory variables are X_3, X_4-----X_8. It is proposed to study not only the influence of X_1, X_2, ------ X_6 on Y but to see the effect of 'farm size group' as well. Size group has been classified in three categories viz. small (farms between 2 to 6 hectares) and large (farms above 6 hectares). As such three dummy variables have to be defined with the property that $D_i = 1$ if the farm belongs to the i the size category, otherwise $D_i = 0$ if the farm belongs to the i th category otherwise $D_i = 1$. After introducing dummy variables, the model takes the following form

$$Y_1 \text{ or } Y_2 = a + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8 + D_1 X_9 + D_2 X_{10} + D_3 X_{11}$$

where, the coefficients D_1, D_2 and D_3 are the estimated intercepts of small, medium and large farms respectively.

Y_1 = Value of fertilisers per farm

Y_2 = Value of fertilisers per hectare

X_3 = Size of the farm

x_4 = Percentage of gross irrigated area to gross cropped area

x_5 = Ownership of land holding (percentage of owned area to total area under cultivation).

x_6 = Total value of output raised.

x_7 = Value of capital

x_8 = Intensity of cropping

In order to use the conventional computing program, one of the dummy variables (in this case large farms) has to be dropped. The effect of small and medium farms over the large farms is given by the regression coefficients of the included dummy variables in the model.

Above model was used to analyse the factors affecting use of chemical fertilisers in Deoria, Muzaffarnagar and Ferozepur. Different combination of the variables were tried, fitting different regression equations in each region. A comparative study of these equations on the basis of summary statistics of the equations would reveal the final (best fit) regression equation to be used for the region, to draw conclusions.

CHAPTER - 2

GENERAL ECONOMIC CONDITIONS OF THE DISTRICT FEROZEPUR (PUNJAB)

Ferozepur district was purposively selected for the study, because it had comparatively large sized holdings, which would permit adoption of new technology. It had a total area of 10028square kilometres, of which 88 percent was under cultivation.

Climate :

With its tropical climate Ferozepur district exhibits two main crop seasons, summer or kharif season extending from April to September and winter or rabi season from October to March. The climate presents extreme heat and cold. Wheat occupies the premier position.

Population :

The total populatinn of Ferozepur district increased from 1619 thousands in 1961 to 1900 thousands in 1971.

Literacy :

Functionally literate pppulation in Ferozepur district form 27.62 percent in 1971 against 22.55 percent in 1961.

Place of Agriculture in the Economy of the district :

Farming constitutes the major occupation of the district. Nearly 80 percent of its population is directly or indirectly dependent upon agriculture. The 1971 census revealed that 73 percent of the workers in the district were cultivators and agricultural labourers.

Average size of the Cultivated Holding :

The average size of cultivated holding in Ferozepur district was 6.3 hectares as compared to 5 hectares in the Punjab.

Land Utilisation :

It deals with the distribution of land according to various uses as well as rate of change of growth, indicating shifts in the land use patterns in the district.

Table

Classification of Area, Ferozepur district
1967-68, 1968-69

Particulars of the area	Percentage of total area	
	1967-68	1968-69
1. Area under forests	-	-
2. Land not available for cultivation	7.33	8.70
3. Other uncultivated land excluding fallow land	4.06	3.56
4. Current fallow	5.05	9.88
5. Net area sown	83.65	77.87
6. Area sown more than once	25.96	21.84
7. Total cropped area	1106 hect.	1009 hect.
8. Total area according to village paper	1009 "	1012 "

Source: Consolidated Report : Studies in the Economics of Farm Management, Ferozepur, 1967-70.

Intensity of Cropping in the district :

Intensity of cropping was 123.61 in 1967-68 but it dropped to 113.60 in 1968-69. This decline was mostly due to the dry spell during the sowing season of Rabi crops in the year.

Irrigation in the district :

The canal irrigation is very well developed in the district. One important feature is this that whereas in 1967-68 not a single thousand hectare was tubewell irrigated it shot up to 80 thousand hectares in 1968-69.

Table

Gross irrigated area and percentage of gross area irrigated to total cropped area

Year	Gross irrigated area (thousand hectares)	Gross area of crops irrigated as percentage of total cropped area
1967-68	784.9	81.0
1968-69	805.3	80.9

Source : Farm Management Studies : Ferozepur 1967-70

Economy of the selected villages :

The same 15 villages which were taken up for study during the first year of inquiry, were continued during the succeeding two years. The villages are uniformly disposed in the district and very well represent the different aspects of agro-socio-economic life of the district.

Land Utilisation forthe selected villages :

The proportion of area not available for cultivation was 10.76 percent of the total geographical area. Net sown area decreased from 15,916 hectares in 1966-67 to 15,321 in 1968-69 because of the dry weather.

Area sown more than once registered an increase from 5,135 hectares in 1966-67 to 6,980 hectares in 1969-70. However, cultivated area in the sample villages did not show any increase.

Cropping Pattern :

Wheat was the chief crop and it occupied 36.8 percent of the total cropped area in 1969-70 against 18 percent in 1953-54 for all the villages taken together. The area under gram and wheat-gram consistently declined.

Intensity of Cropping :

Intensity dropped from 126 in 1967-68 to 123 in 1968-69, which was due to dry weather prevailing during the sowing periods. It again went up to 135 in 1969-70.

Wages of Agricultural Labour :

The average wages which were Rs. 5.55 in 1967-68 increased upto Rs. 6.39 in 1968-69.

Prices of Agricultural Commodities :

Average wholesale prices of important commodities did not show a marked increment from 1967-68 to 1968-69. Though they fluctuated much with in the year. Highest and lowest of the year were recorded in October and August respectively.

Technological Developments :

Improved farm machinery and equipment: Mechanisation of agriculture in the sample villages had been going along for the last few years. Total number of tractors in sample villages increased from 125 in 1967-68 to 239 in 1969-70. Likewise, the number of tubewells and other improved implements registered an increase during the same period.

Table

Distribution of improved farm machinery and equipments in the sample villages, Ferozepur District

Name of Farm Machinery	1967-68	1968-69
Tractors	125	180
Electric Pumps	129	323
Oil Engines	145	433
Cane Crushers	20	38
Wheat Threshers	145	162
Maize Shellers(Power Driven)	35	36
Improved Harrows & Cultivators	267	185
Fertilisers & seed drills	16	48

Source: Studies in the Economics of Farm Management, Ferozepur, 1967-70.

Fertilisers :

The use of nitrogen, phosphorus and potash nutrients per hectare of cultivated area of the sample villages in 1967-68 and 1968-69 is shown in the following table.

Table

Zone	Name of villages	1967-68	1968-69	1967-68	1968-69	1967-68	1968-69
		N		P		K	
I	Bilaspur	17.29	51	3.23	19	.42	5
	Daroli	21.89	33	8.83	13	.50	4
	Gill	24.06	20	1.45	7	.17	1
II	Kahnewala	14.52	21	3.50	6	1.94	2
	Ghubaya	11.52	15	1.02	2	.47	-
	Malwal	15.80	42	.86	3	.33	-
	Bhinder	25.80	37	4.62	10	1.49	3
	Nurpur	16.81	21	1.76	3	-	-
III	Muliawali	19.87	19	8.11	9	.52	1
	Bodiwala	14.51	16	.82	-	.34	-
	Muradwala	23.47	3	-	-	-	-
	Balauna	21.05	27	1.75	2	4.38	2
	Jhalalwali	18.99	7	20.47	2	.79	1
	Channu	75.02	28	1.28	4	.36	2
	Faquarsar	23.58	41	1.48	3	3.32	5
Average for the region		21.49	23.39	3.93	5.60	.99	1.53

Source: Studies in the Economics of Farm Management, Ferozepur 1967-70

The average dose of nitrogen, P_2O_5 and Potash per hectare rose from 21.49 kgs, 3.93 kgs, .99 kgs, in 1967-68 to 28 kgs, 9.89 kgs and 2.20 kgs in 1969-70 respectively. The average consumption of fertilisers (in terms of N, P) was the highest in villages of Zone I compared to those of Zone II and III. The average dose of nitrogen varied from 3.71 kgs in Muradwala to 45.34 kgs in Faquarsar village.

Structure of Holdings :

The use of various factors such as land, labour, capital and other resources accounted for the structure of farms, of which we will give here some relevant information.

The total area of 150 farms was 1865.67 hectares, comprising 11.19 percent of the total cultivated area of the fifteen selected villages. These holdings, for the analysis, were divided into three size groups viz. below 2 hectares, 4-6 and more than 6 hectares numbering there by 0, 33 and 117 holdingsin each size group. (This division was consistant with the size group catagorisation of Deoria's and Muzaffar Nagar's farms).

GENERAL ECONOMIC CONDITIONS OF THE DISTRICT MUZAFFARNAGAR (WEST U.P.)

Location :

The district of Muzaffarnagar lies in the upper Ganga-Yamuna Doab in Western U.P. between the parallels 20°11' and 29°45' north latitudes and 77°4' and 78°7' east longitudes. It measures 98 kms from east to west and 58 kms from north to south, and covers an area of 4340.3 square kilometres.

Physical Features :

The district can be divided into three district natural tracts vertically, namely, the western upland, the eastern upland and the central depression with a small area under 'khadar' lands adjoining the uplands along the banks of the Yamuna in the west and the Ganga in the east.

The River System and Drainage :

The west tract (covering 45% area of the district) has Khakhovi, Katha and Krishna rivers while the east (covering 35% area of the district) has Nagan, Saloni and Budhi Ganga. All these rivers flow north to north indicating a gradual slope of the district from north to south. Some artificial 'nullahs' have been constructed in the central

Table

Percentage area of land utilisation in sampled villages during 1967-68 and 1968-69

	Land Use	1967-68	1968-69
	Total	100.00	100.00
1.	Forest Land	.58	.58
2.	Land put to non-agr. uses	6.86	6.86
3.	Barren and uncultivated uses	2.82	2.82
4.	Permanent pastures and groves	1.27	1.27
5.	Misc. trees and other lands	2.96	2.96
6.	Cultivable waste and old fallow	3.91	3.91
7.	Total cultivated land including current fallow	81.60	81.60
	Total Geo. Area (hectares)	12266.02	12266.02

Source: Studies in Economics of Farm Management, Muzaffarnagar, 1966-69 depression tract (which cover 20% of the district area) of the district connecting the rivers of Kali and Hindon to provide for drainage of the tract.

Climate :

The average temperature varies from a maximum of 91°F in May and June to a maximum of 55°F in January. The normal mean temperature of the district is about 75°F. Climate consists of 'hot tropical monsoon climate' with three seasons in the year.

Rainfall :

The normal average rainfall of the district is 79 cms. Out of which, nearly 85 percent is received during June to September, the rainy season.

Economic Conditions of Selected Villages :

The description of the physico-socio-economic background of the villages in which farms are operated is important, as it constitutes the environment which largely determines the farm production decisions.

Land Utilisation :

The following table gives land utilisation statistics for sampled villages.

Literacy :

Out of total population, 43820, 6970 people in all villages combined are literate that constitutes the literacy rate of the sampled villages to 15.9 percent.

Size of Holding in Selected Villages :

Total cultivated area of the villages is 9856.76 hectares which is 81.377 percent of total geographical area. Total number of holdings is 2,596 which constitutes the average size of holding equal to 3.80 hectares.

Cropping pattern :

Table

Distribution of percentage area under different crops in sampled villages

	Crops	Area	
		1967-68	1968-69
1.	Paddy	10.20	10.20
2.	Maize	4.25	4.32
3.	Fodder	13.23	13.42
4.	Sugarcane	30.08	30.63
5.	Wheat	29.57	30.62
6.	Gochani	2.10	2.03
7.	Gram	4.53	4.70
8.	Vegt.	.17	.18
9.	Others	3.45	1.61
10.	Pea	2.42	2.29
	Total	100.00	100.00

Source: Studies in Economics of Farm Management Muzaffarnagar 1966-69.

Table shows that wheat and sugarcane are two most important crops in the sampled villages each accounting to 30% of total cropped area.

Irrigation:

The irrigated area of the sampled villages is about 60% of the total cropped area.

Table

Irrigated area and percentage of cropped area irrigated in sampled villages during 1966-69

Sources	Area in hectares	
	1967-68	1968-69
Canal	4681.52 (61.23)	4664.87 (59.93)
Tube-wells	2154.58 (28.18)	2395.77 (30.77)
Wells	767.65 (10.04)	683.84 (8.78)
Others	42.05 (.55)	39.18 (.52)
	7645.80 (100.00)	7783.66 (100.00)

Source : ibid.

Table shows that percentage of area irrigated by canal has decreased from 61 to 59 in 1 year from 1967-68 to 1968-69. Also, tubewell irrigation is becoming more popular, it has gone up from 28% in 1967-68 to approx. 31 percent in 1968-69.

Use of Fertiliser :

The quantities of various fertilisers used in the sampled villages alongwith their percentages is given in the following tables :-

Table

Fertilisers used in sampled villages during 1966-69

	Fertilisers	Quantity(Quintals)	
		1967-68	1968-69
1.	Ammonium Sulphate	524.30	549.52
2.	Urea	41.36	203.15
3.	C.A.N.	352.67	36.60
4.	Super Phosphate	160.23	264.17
5.	Diammonium Sul.	-	15.22
6.	Ammonium Chloride	-	17.18
7.	Bone meal	-	52.70
	Total	1078.56	1138.04

Source : Ibid.

Ammonium sulphate accounts for about 60% of the total fertilisers used in the sampled villages followed by C.A.N. and Urea. Use of total fertilisers increased from 1078 quintals in 1967-68 to 1138 quintals in 1968-69.

Table

Per village and per cultivated hectare use of improved seed and fertilisers from 1966 to 1969

(In quintals)

Items	1967-68	1968-69
Per village		
(i) Improved seeds	53.34	70.40
(ii) Fertilisers	71.90	75.86
Per cultivated hectare		
(i) Improved seed	.08	.10
(ii) Fertilisers	. 10	.11

Prices :

Table

Harvest prices of different commodities in Muzaffarnagar District.

	Commodities	Price per quintal (Rs.)	
		1967-68	1968-69
1.	Wheat	84.90	89.00
2.	Gram	98.42	90.79
3.	Pea	91.25	67.42
4.	Gochani	85.00	90.00
5.	Maize	95.22	70.95
6.	Paddy	74.84	65.00
7.	Sugar Cane	15.84	9.00

Source: Ibid.

GENERAL ECONOMIC CONDITIONS OF THE DISTRICT DEORIA (EAST U.P.)

Location :

The district of Deoria lies in the extreme north-east corner of the State of Uttar Pradesh. The district occupies an area of 5424.3 sq. kilometres. In general, the district is a level alluvial plain interspread by river valleys and sandy ridges.

Soil :

The district can be divided into four soil zones namely, Tarai Bhat Domar Kachhar comprising 17.91, 38.22, 39.53, 4.34 percent respectively of the district area.

Climate:

The district enjoys monsoon climate. There are three district seasons corresponding to three agricultural seasons.

Summer season -- Zaid - from April 1 to mid June.
Rainy season -- Kharif - from 3rd week of June to 1st week of October.
Winter season -- from the 2nd week of October to the end of March.

Temperature ranges between 21.11°C to 43.33°C.

Rain Fall :

The average total rainfall for the district is 118.97 cms per annum. June, July, August and half of September receive 80% of rainfall. The winter months growing Rabi crops are more or less dry receiving a few light showers. This seasonal and uneven character of rainfall makes agriculture very much dependent on rains.

Irrigation :

There are certain areas in the district known as 'Bhat' where crops are grown without irrigation due to presence of moisture in the sub-soil throughout the year. Still a major portion of Deoria needs irrigation facilities in one form or the other. As an average 37.47% of net area sown is irrigated in Deoria and irrigation cover 28.28% of gross area sown.

Economy of Selected Villages :

Fifteen villages, eight from Zone I and seven from zone II, have been selected for sampling of farms and farm families. A perusal of agro-economic conditions of these selected villages is necessary as villages envionments and practices, to a large extent, influence decisions on individual farms.

The selected villages are scattered throughout the district.

Land Utilisation :

The net area sown as average for three years forms 84.31 percent of total area for the selected villages. There is no specific trend from year to year. Area sown more than once measures to 41% in 1966-67 and are reduced to 34% in 1967-68 with a further decline to 27% in 1968-69.

Current fallow extend over 2 percent of total area of all the villages during three years of field enquiry.

Area under forest is practically nil. Culturable waste also occupies insignificant area to prohibit any extension of area under cultivation.

Cropping Pattern :

Paddy is the most important crop in respect of area in each year of field enquiry, the average area being estimated as 22.16 percent of gross area sown. Wheat comes next and is followed by sugarcane. Maize, Arhar, Peas are other important crops. Intensity of cropping for villages varies between 126 to 128 from 1966-67 to 1968-69.

Irrigation:

Table

Details of irrigation in sample villages during 1966-69

(Area in hect.)

Villages	Sources of irrigation				Net irrig. area	Net irrig. area as % to net area sown	Gross irrig. area	Gross irrig. area as % to gross area sown
	Tube wells	Wells	Tanks	Others				
Sample	588	791	106	169	1655	38	1913	34

Source: Combined Report : Farm Management Study, Deoria 1966-69.

The wells dominate all sources of irrigation and tube-wells come next. Irrigation by tube-wells has increased considerably in 1968-69. Nearly 34% of gross area sown is the gross irrigated area.

Tenancy :

The following table explains ownership of cultivated land in view of tenancy i.e. self cultivated or not.

Table

Tenancy during 1966-69
(self cultivated and otherwise)

(In hectares)

	Self cultivated	Fixed kind rent	Crop sharing	Others	Total
Sample total	4058	76	281	223	4640
percentage	(87.46)	(1.65)	(6.06)	(4.83)	(100.00)

Source : Combined Report : Farm Management Study, Deoria 1966-69.

Crop sharing and kind renting are the common practices when land is not self cultivated. Fixed kind rents are also settled by a few farmers. The practice is either to supply seeds, manures and fertilizers and settle a portion of produce after adding proportionate cost of supplies or to lease out land and settled one third to one half of the total produce without providing any input.

Size of Holdings :

There are 2765 holdings in sampled villages. Average holding size is 1.57 hectares. Average cultivated area per capital comes to 0.16 hectares.

Use of manures and Fertilisers :

The following table gives estimate of manures and fertilisers used per hectare.

Table

Average use of manures and fertilisers per hect. of gross area sown during 1966-69

(Kg.)

Particulars	Quantity per hectare in selected villages		
	Zone I	Zone II	Sample
F.Y.M.	441	1268	795
Compost	288	66	197
Sanai(gram manuring)	1.8	-	1
Khali	5	1	3

Amn. Sulphate	4	9	6
Calcium Amm. Nitrate	5	2	4
Urea	6	5	6
Amm. Chloride	.2	.03	1
Amn. Sulphate Nitrate	3	.06	1
Mixture No. 2	.9	1	1
Mixture No. 3	.03	.6	.5
Mixture No. 4	1.8	2	2
Super Phosphate	.8	.3	.5
Amm. Phosphate	.07	-	.04
Di-Amm. Phosphate	.6	.3	.5
Rock Sulphate	1003	-	.0016
Bone meal	3	-	1.6
Nitro Phosphate	.3	-	.1
Muriate of Potash	.3	-	.2
N.P.K. Combse	.3	.03	.1
Potassium Chloride	.006	-	.003

Wages:

Average agricultural wages for male labourer were Rs. 2.14 in 1967-68. They were almost constant in the next year, 1968-69 i.e. Rs. 2.16.

Prices : During 3 years 1966-69

Average wholesale prices of important crops did not show a marked improvement from 1967-68 to 1968-69.

Prices varied from year to year and from month to month. These variations for a commodity may be to the extent of 40 percent in the same year in different months.

CHAPTER - 3

MULTIPLE LINEAR REGRESSION ANALYSIS FEROZEPUR DISTRICT, 1967-68

Explanation of Correlation Matrix :

Correlation matrix highlights the simple correlation between independent variables as also between dependent and the independent variables.

The presence of any fixed relation between independent variables presents a problem called multicollinearity. A standard rule for the detection of the presence of multicollinearity in the data, that some investigators have been using calls for inspection of the simple correlations among the independent variables. One should realise that simple correlations are only elements of the entire correlation matrix and hence may or may not contribute to the problems of multicollinearity. One should not a priori, rule out estimation of any regression equation because of high simple correlation between any two independent variables.

Another rule for detecting the multicollinearity is that if the R of the regression equation is greater than partial r^2 of the variables in the regression equation then multicollinearity is not a serious problem.

From the present correlation matrix, (page), we see that correlation coefficients are high between dependent variable(s) and (individual) independent variables which strengthens reliability of regression coefficients. For example, correlation between 'Size' and dependent variable Fertiliser (absolute value) is .68, between absolute Value of output and Absolute Value of Fertiliser it is .80 and between Absolute Value of fixed Capital and Absolute Value of Fertiliser it is .51. These high correlation show that there is high degree of association between the dependent variable and respective independent variables. Since correlation coefficients are only scaler quantities and not vectors so we cannot establish any cause and effect relationship between the variables based upon these correlation coefficients. For this point we will wait for the regression coefficients.

Correlation between percentage of H.Y.V. of seeds and all independent variables (individually) are very low, which indicates that in this district H.Y.V. seeds are not necessarily accompanied by high use of other modern inputs. This is the reason that adoption of H.Y.V. seeds could not been explained satisfactorily with this model.

Now, coming to the correlations between the independent variables, the higher correlation exists between Size and V, Output (absolute) viz., .84, to explit the joint effect of the two variables, Size was dropped as an explanatory variable from one of the regression equations, all the same Absolute Value of

Output was dropped as an explanatory variable from second equation then both were included in the third equation. A comparison of the three equations on the basis of summary statistics of the equations will help in deciding the matter that which of the variables should be kept in.

When X_1 and X_3 are collinear, X_3 will turn out to be superfluous when X_1 is already in the regression, and vice-versa. $\bar{R}^2$ invariably goes down when the second variable is added to the equation.

Correlation between Absolute Value of Output and Absolute Value of fixed Capital is .53; between Capital per hectare and total value of Capital it is .79. The later is obvious. To deal with the high correlation between Absolute Value of Output and Absolute Value of Capital, both the variables were deleted from the regression equation one by one and both were kept in simultaneously in the third regression equation, an analysis of the above type would give the unbiased estimates of the regression coefficients.

No other correlation coefficient between any two independent variables appeared to be high enough. However to deal with these problems arising out of high correlations, different regression equations were fitted taking appropriate explanatory variables and dropping the others.

Correlation Matrix   Fitting of Multiple Linear Regression Equations, Ferozepur 1967-68

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Fertiliser	1.00												
2. H.Y.V.	.13	1.00											
3. Size	.68	-.02	1.00										
4. Irrigation	.12	.12	-.12	1.00									
5. Tenancy	-.01	.02	.00	.02	1.00								
6. Value of Output	.80	.06	.84	.13	.02	1.00							
7. Capital (fixed)	.51	.14	.44	.13	-.02	.53	1.00						
8. Intensity	.06	.13	-.26	.06	.15	.07	.04	1.00					
9. S. Dummy	.00	.00	.00	.00	.00	.00	.00	.00	1.00				
10. M. Dummy	-.32	.06	-.50	.19	.10	-.40	-.19	.12	.00	1.00			
11. Fertiliser/hectare	.71	.19	-.19	.31	-.02	.37	.30	.36	.00	-.01	1.00		
12. Output/hectare	.37	.15	-.04	.47	.02	.41	.24	.36	.00	.14	.67	1.00	
13. Capital/hectare	.26	.20	.00	.22	.14	.14	.79	.29	.00	.11	.30	.31	1.00

Interpretation of Regression Equations :

Various multiple linear regression equations were fitted to analyse the effect of the economic variables on the use of Fertilisers. In some regression equations total value of Fertilisers used by an household was taken as the dependent variable while in other equations per hectare fertiliser used was taken as the dependent variable. The results of various regression equations are given in Tables/-8 . Regression equations in different independent variables bear serial numbers.

In regression equation F.1, only one variable, i.e. total value of Output (it bears very high correlation with the dependent variable) is regressed with use of Fertiliser (Absolute Value). R^2 = .64, $\bar{R}^2$ = .64 of this equation. Regression coefficient of Output is .04 and its t-ratio is 16.3. So the regression coefficient of Output is significant at 99 percent level of confidence. Which means that if there is an increase in Output value by one rupee, farmers would adopt more Fertiliser worth Re. .04 or fertiliser of the value of 4 paise (since unit of both Output and Fertiliser is in Rs.).

Another variable 'intensity of cropping' was added in the regression equation as shown in the regression equation F.2, R^2 and $\bar{R}^2$ both went up to .65, thereby increasing the explanation power and precision of the equation. However the regression coefficient of Output did not change neither did its t-ratio. Regression coefficient of intensity of cropping pattern turns out to be 6.7 which is significant at 99% level of confidence. This means that if there is 1 percent increase in cropping intensity then adoption of fertiliser will go up by 6.70 percent.

It becomes rather necessary to use more fertiliser if farmer has to cultivate the land more than once in a year. This seems to be the reason of a higher adoption of Fertiliser (worth Rs. 6.70) in response to unit increase in cropping intensity.

Also a comparison of equation number F.2 with F.1 shows that intensity of cropping does not play the role of dominant variable because the regression coefficient of Output does not change after the inclusion of intensity of cropping and also it is reasonable one, neither the $\bar{R}^2$ differs much in the two regression equations. If there is one-to-one correspondence between the one independent variable and the dependent variable then we should drop that independent variable to get unbiased estimates of other independent variables. But here this is not the case i.e. theoretically, there is no one-to-one correspondence between the intensity of cropping and use of Fertiliser. So the regression equation F.2 is better than equation F.1.

Output (Absolute Value) seems to play the role of dominant variable, because its exclusion from the regression equation F.4, and by taking all other variables in, brings down R^2 to .59 from .65(equation F.2),

$\bar{R}^2$ = .58, regression coefficients of almost all the variables (except tenancy) become significant. Simple correlation between Output and intensity of cropping is as low as .07 still with the exclusion of Output the regression coefficient of intensity of cropping swells up to 11.83 from 6.3 (equation F.2). Regression coefficient of Size of the form dictates that increase of 1 hectare in the Size of farm will lead to increase
Fertilizer use worth Rs. 81.70. One %
in gross irrigated area ensures increase in the adoption of Fertiliser worth Rs. 9.97. Regression coefficient of Capital is .02 and significant 95% confidence interval.

In regression equation No. F.4, all the explanatory variables were taken in. But the only significant variables were Output (Absolute Value) and intensity of cropping. R^2 went upto .67 but could not increase $\bar{R}^2$ (compared to previous equations). This provides a hint that among the included variables one or more variables could be superfluous (or inclusion of dominant variable Output has made them to be superfluous) and should be dropped. Regression coefficient of Output is .04 and regression coefficient of intensity of cropping is 6.30, both being significant at 95 confidence interval. These resemble with the results of regression equation No. F.2 (where only these two variables were included in the regression equation).

In regression equation F.5 "Size" was included from the explanatory variable list (in view of high correlation between Size and Output, .84). Again the Output and the Intensity of Cropping turned out to be significant with almost the same R^2 and $\bar{R}^2$. Regression coefficient of Output and Intensity of Cropping were .04 and 6.30 respectively, both significant at 95% level of confidence.

In regression equation F.6, Size was not included as the independent variable but Size dummy (intercept dummy, as mentioned before) was added. Here also Output and Intensity of Cropping turned out to be significant with almost same R^2 = .66 and same $\bar{R}^2$= .65 as before (equation 5, 4). Regression coefficient of Output and Intensity of Cropping were also unchanged (as in equation 5,4) i.e. .04 and 6.30 respectively, both significant at 5 percent probability level.

Regression equation F.7, included all the variables as well as Size dummy. Output and Intensity of Cropping turned out to be significant (as before), with same B coefficients, .04 and 6.30 respectively, both significant at 5 percent probability level. Also the coefficient of determination, R^2 and $\bar{R}^2$ were almost same as in equations F. 6, 5, 4, 2 and 1 before.

To take into account the problem of hetroscedasticity some regression equations specifying all the explanatory variables in per hectare terms were also fitted.

Regression equation F.8, was fitted by taking "per hectare Output" as the only explanatory variable to explain variations in the use of per hectare Fertiliser. Coefficient of determination turned out to be .44 and value of $\bar{R}^2$ was .44. Regression coefficient of per hectare Output is .05 and is significant at 1 percent probability level. Unit increase in per hectare Output value (worth Rs. 1) would increase per hectare use of Fertiliser of the value of Rs. .05 or 5 paise. This result is approximately same as it was in the Absolute Value of Output and Fertiliser case in regression equations F.1 to F.7. Reasons for not being a high value of R^2 (as compared to the cases of Absolute analysis i.e. equations 1 to 7) could be theorectical. That is, decisions regarding the Fertiliser use do not depend as much upon the per hectare calculations as they depend upon the total farm business as a whole. Being psychologically motivated towards the adoption of Fertiliser farmer will not be induced by the per hectare Output value rather by total value of the farm as a whole.

In equation F.9, Intensity of Cropping was also included, both the R^2 and $\bar{R}^2$ went up though not substantially. Regression coefficient of Output came down to .04 from .05 as in equation F.8, standard error increased substantially bringing down t-ratio to 2.1 from 10.9 as in equation F.8. Correlation between Output/H and Intensity of Cropping was .41. Due to this high correlation

Output/H perhaps had captured some of the effect of Intensity of Cropping, when Output per hectare was used alone as the explanatory variable in equation F.8. That could be the reason of reduced regression coefficient of Output/H and its increased standard error in regression equation F.9. Sise R^2 and $\bar{R}^2$ both have increased in equation 9 and theory also justifies inclusion of both the variables, we should retain Intensity of Cropping with Output becaus-e its inclusion reduces residual variance. However, regression coefficient of Intensity of Cropping is .36 and significant at 1% probability level, meaning thereby that unit change (1 percent increase) in Intensity of Cropping will increase Fertiliser consumption by the farmer of the value of 36 paise.

In regression equation F.10, all the variables were taken in except the variable " Value of Output per hectare". Coefficient of determination of this equation, $\bar{R}^2$ went down considerably (compared to equations F.8, 9). Going the value of R^2 and $\bar{R}^2$ considerably down when Output is excluded from the equation, gives the impression that Output is playing the role of dominant variable. That is, movement in Fertiliser use are explained more satisfactorily by the regression equations which include Output and not by the regression equation which does not include Output. Farmers seem to be using Fertiliser in expectation with higher value of Output.

higher value of Output.[1]

R^2 = .28 of the equation is significant at 1 percent probability level. In the absence of Output we see that Intensity of Cropping has captured some share of Output and its B coefficient has swelled to .99 (as compared to .36 in equation F.9) but its standard error has widened much thereby decreasing precision of the estimate of regression coefficient of Intensity of Cropping.

When a variable from true relation is left out, a part of its influence in explaining the movements of the dependent variable is captured by the other independent variables. If one independent variable has a larger partial relation to the left out variable than another, then the extent of bias in its coefficient will be larger. Output has a larger partial relation with Intensity of Cropping and Size in comparison to other variables in the regression equation. That seems to be the reason that why the regression coefficient of Intensity of Cropping has shot up to .99 from .36 (equation F.9). This is significant at 1 percent level of confidence. Similarly regression coefficient of Size is 1.30 which is significant at 1 percent probability level. Regression coefficients of irrigation .86 and Capital .01, per hectare are also significant at 1 percent and 10 percent probability levels respectively.

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1. If we exclude Output then the coefficient of determination, R^2, goes down to a great extent but the B coefficient of Output is as low as .04 when it is included. Had it been a true dominant variable (having one-to-one response with dependent variable) then its B coefficient should have been sufficiently high. It strengthens our hunch that farmers are not considering the changes in Output while making decisions to use Fertilizer rather they are being psychologically motivated by the total value of Output whether per hectare or per farm).

.01 value of regression coefficient of Capital shows that with every additional rupee incurred on Capital per hectare would increase Fertiliser use worth Re. .01 or 1 paisa. This seems to be below expectation. Here it is quite expected that at least a reasonable portion of regression coefficient of "Capital" must have been captured by the regression coefficient of "irrigation". This stems directly from the specification of this variable "Capital". Capital here also includes expenses incurred on pumpsets, which increase irrigation facilities. Correlation between Capital and irrigation is .22.

The only insignificant (not different from zero statistically) regression coefficient is of Tenancy (defined as the percentage of ownership of land holding).

In regression equation F.11, two variables, Size and Output per hectare were deleted from the regression equation. Remaining 4 variables were studied. $R^2 = .23$, $\bar{R}^2 = 2.1$. $R^2 = .23$ is significant at one percent probability level. Regression coefficient of 'Tenancy' was .05 but was not significantly different from zero statistically. B coefficient of Capital per hectare was .01 and was significant at 1 percent probability level. Every additional rupee of Capital per hectare raises use of Fertiliser per hectare worth rupee .01 or 1 paisa. Regression coefficient of irrigation was .77

and significant 1 percent probability level. Regression coefficient of Intensity of Cropping was .82 which was significant at 1 percent probability level. So the effects of irrigation and Intensity of Cropping were quite high and impressive. The equation was fitted on trial basis. R^2 is very low, also the equation does not include two very important theoretically required variables i.e. Size and Output. So it is not of much use.

In equation F.12, 5 variables were included deleting only one variable, that is Size. R^2 shot up to .46 (from .23 as in equation F.11) and $\bar{R}^2$ to .44. ($\bar{R}^2$ = .21 in Equation F.11). Inclusion of Output has raised R^2 to .46 from .23 as in previous equation. It has reduced values of /B coefficient of Intensity of Cropping from .82 to .31 (equation F.11). /B coefficient of Capital remains no longer significant (not different from zero statistically). /B coefficient of intensity of Cropping is significant at 10 percent probability level. Regression coefficient of tenancy is -.04 and not different from zero statistically (insignificant). Tenancy here is defined as percentage of ownership of land. Meaning thereby that 1 percent increase in ownership of land will cause reduction of use of Fertiliser per hectare worth Rs. .04 or 4 paise. This is not likely because an owner farmer is supposed to be more prone to Fertiliser than a tenant. /B coefficient of tenancy seems to be bearing a wrong sign.

If specification and interpretation of coefficients are correct a coefficient can still attain a wrong sign because of the sampling distribution of the estimates. If this is the case we generally observe the coefficients to be not significantly different from zero statistically. Deletion of the variable because of its wrong sign may still lead to mis-specification.

Regression equation F.13 includes all the six specified variables. Coefficient of determination, R^2 = .49 and $\bar{R}^2$ = .47; those values of R^2 and $\bar{R}^2$ are the highest among all the equations (regression equations run on the variables taken in per hectare terms). Also theoretecally all the explanatory variables are relevant in explaining the movements of the dependent variables, use of Fertiliser. So this is the most sound regression equation among all.

Regression coefficient of Output is .04 and significant at 1 percent probability level. Regression coefficient of irrigation is .12 but not significantly different from zero statistically. All the same regression coefficient of tenancy is -.03 but not significantly different from zero statistically. Regression coefficient of Size is 1.05 and significant at 2 percent probability level. If Size expands by 1 hectare farmers will use more Fertiliser per hectare worth Rs. 1.05. Regression coefficient of Capital is .007 but not significantly different from zero statistically. Regression coefficient of Intensity of Cropping is .46 and significant at 2 percent probability level.

In regression equation F.15, Output is deleted and all other variables are taken in. Regression coefficient of Output turns out to be .87 and significant at 1 percent probability level. Here we see one interesting relation. That, whenever Output is deleted from the regression equation 'irrigation' turns out to be a significant variable and when Output is included in the regression equation, β coefficient of Irrigation in explaining movements in Fertiliser use is always, not significantly different from zero statistically. Correlation between Output per hectare and irrigation is .47. When Output is a left out variable from the true regression equation, obviously its effect would be captured by the other included variables, and more by the variable with which it has more partial correlation i.e. irrigation.

When Output is left out,

$$E(\beta \text{ irrig.}) = \beta_{irrig} + B\, b_{output}$$

Where b is regression coefficient of Output when irrigation is dependent variable and Output independent variable.

Elasticity of output / H.w.r.t. fertiliser/H comes to be as $.04 \times \frac{1824.67502}{70.57621} = 1.03$. That is one percent increase in value of output per hectare would lead to more use of fertiliser per hectare by 1.03 percent.

Elasticity of Size w.r.t. fertiliser per hectare comes to be as $1.05 \times \frac{12.65366}{70.57621} = .19$ that is 100 percent increase in size of the farm would lead to more use of fertiliser/H by 19 percent.

<u>Elasticity</u> of intensity of cropping comes to be as .46 x $\frac{135.84000}{70.57621}$ = .88. That is one percent increase in intensity of cropping will lead to .88 percent increase in use of fertiliser per hectare.

Assessing all the aspects of the summary statistics provided by the various multiplelinear regression equations and the theoretical specification and justification of variables we conclude that the Fertiliser use in Ferozepur district is positively affected by Value of Output, Intensity of Cropping and Size of the farm. Regression coefficients of the Output per hectare, Intensity of Cropping and Size are .04, .46 and 1.05 respectively (see regression equation F.13).

Correlation Matrix Fitting of Multiple Linear Regression Equation, Ferozepur, 1968-69

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Fertiliser	1.00												
2. H.Y.V.	.47	1.00											
3. Size	.57	.02	1.00										
4. Irrigation	.08	.12	.03	1.00									
5. Tenancy	.02	-.09	.01	-.09	1.00								
6. A. Value of Output	.84	.34	.81	.02	.07	1.00							
7. A. Value of F. Capital	.60	.38	.43	.10	.09	.64	1.00						
8. Intensity	.05	.30	-.21	.15	-.28	-.03	.07	1.00					
9. Dummy Small	-.05	.12	-.09	.04	-.10	-.07	-.04	.09	1.00				
10. Dummy Medium	-.30	-.07	-.48	.05	.19	-.38	-.24	.11	-.04	1.00			
11. Fertiliser/hectare	.77	.67	.09	.07	-.02	.45	.41	.25	-.004	-.13	1.00		
12. Output/hectare	.53	.67	-.01	-.006	.04	.47	.36	.34	.06	.04	.73	1.00	
13. Capital/hectare	.42	.45	.13	.10	.09	.34	.85	.21	.01	-.15	.49	.41	1.00

MULTIPLE LINEAR REGRESSION ANALYSIS. FEROZEPUR DISTRICT 1968-69

Explanation of Correlation Matrix :

Regression Equations in two forms i.e. linear as well as log linear were fitted, but the results of M. Linear equations were found out to be better than log linear regression equations.

Present correlation matrix provides high correlations between dependent variable fertiliser and almost all other independent variables except the variables, irrigation and 'tenancy'. Correlation between Fertiliser (absolute value) and irrigation is .08 and it is as low as .02 between the fertiliser and tenancy.

When fertiliser was specified in per hectare terms and taken again as dependent variable then it bore high correlation with output and capital only. Correlation between fertiliser per hectare and tenancy (ownership of land holding) was -.02, which means that use of fertiliser per hectare and ownership of land holding vary in reverse directions. No cause and effect relationship can be established with the help of simple correlations only.

Checking for the correlations between independent variables, we see that high correlation exists between Size and Absolute Value of Output viz. .84. A high and positive correlation between these two variables is obvious. Other things (factors of production) remaining same, output will increase as size increases. In two regression equations absolute value of output and Size were taken as mutually exclusive variables and in the third equation both were included. A comparison of these three equations would help us in selecting the equation which would give us better estimates of regression coefficients of these variables.

Correlation between output per hectare and Size is -.01, which indicates that as Size increases its yield per hectare decreases.

Correlation between irrigation and output per hectare is -.006 though it is positive, .02, between output (absolute value) and irrigation.

Correlation between output (absolute value) and capital is .64. Output is having high correlation with almost all variables. So Output was treated as a lone variable in a separate regression equation.

However, there are no other high correlations between independent variables.

<u>Interpretation of Regression Equations</u> :

As output (absolute value) had very high correlation, .86, with dependent variable fertiliser, so in the regression equation F'.1, output alone was taken in as the explanatory variable. This variable alone explained as much as 71 percent variations in the use of fertiliser (absolute value). Degree of precision of the regression equation was also high, $\bar{R}^2$ = .71. Regression coefficient of output turned out to be .08 which was significant at 1 percent probability level, which shows that with every additional rupee of output raised, farmers will use more fertiliser worth rupee 0.08 or 8 paise.

In equation F'.2, the variable, intensity of cropping was also included. Both R^2 and $\bar{R}^2$ went up a little, which shows that this equation is a better fit than F'.1. Regression coefficient of intensity of cropping was, 3.21, and significant at 5 percent probability level. One percent increase in intensity of cropping makes the farmers to use more fertiliser worth Rs. 3.21. Output does not seem to be playing the role of dominant variable in this year, as against the case of previous year.

In regression equation F'.3 other five variables along with size dummy were included excluding the variable output. There is high correlation between Size and Output, .81, so output was not taken in with size. Exclusion of output pulled down degree of determination and precision of the regression equation to .49 and .47 respectively as against .72 and .72 respectively as in regression equation F'.2. Output is having overriding influence over the use of fertiliser. However, in this regression equation, regression coefficients of Size, Capital (absolute value) and intensity of cropping are .64, .08 and 4.41 respectively, all are significant at 1 percent, 1 percent and 5 percent probability levels respectively.

To have a clear idea about the relative influence of output over fertiliser use, all the 6 variables were included in the regression equation F'.4. Now, comparing the regression equations F'.3 and F'.4. We see that inclusion of output in the regression equation F'.4, (a) has raised the coefficient of determination to .76 from .49 and also $\bar{R}^2$ has shot up to .75 from .47 (as in F'.3), (b) sign of regression coefficient of Size has changed to negative viz. -63.29 but is significant at 1 percent probability level (c) sign of regression coefficient of intensity of cropping has also changed to negative, value of estimate is -.46 but is not different from zero statistically. In this regression equation, regression coefficients of Size and Output are significant.

In another regression equation F'.6, when Size was dropped from the regression equation, regression coefficient of intensity of cropping again have the positive sign, but was not different from zero statistically.

Remembering that there is a high correlation between output and Size, .81, when we exclude Output retaining size, coefficient of determination goes down to .49 from .76 (when all variables are included) and three variables intensity of cropping, capital (absolute value) and Size turn up to be significant and positively affecting use of fertiliser. But when we exclude size retaining Output in the equation, R^2 and $\bar{R}^2$ go up to .73 and .72 respectively as against .49 and .47 respectively (when output was excluded). Also exclusion of Output makes regression coefficient of intensity of cropping and capital insignificant. Regression coefficient of Output alone turns out to be significant. Finally when we take both size and output in the regression equation along with other variables, both R^2 and $\bar{R}^2$ go up to .76 and .75 respectively. But sign of regression coefficients of intensity of cropping and that of size get changed to negative from positive as before. Now the significant variables are size and output. Regression coefficient of size is -63.29, significant at 1 percent probability level. One hectare increase in size decreases fertiliser use worth Rs. 63.29. Regression co-efficient of output is .1 which is significant at 1 percent probability level. No other variable is significant.

Output seems to be capturing some effect of intensity of cropping and Capital on fertiliser use, thereby making the regression coefficient of intensity of cropping and Capital to be insignificant. Equation which includes all the variables seems to be most suitable, theoretically as well as technically.

Anyway, from the above analysis we see that only two variables, i.e., Output and Size are influencing the use of fertiliser. Output is influencing it positively though Size is influencing it negatively.

Some more regression equations by changing the specification of variables i.e. in per hectare terms, were fitted to overcome the problem of hetroscedasticity. Equation F'.8, was fitted by taking only one variable, Output per hectare, this regression equation could explain 54 percent variations in the use of fertiliser. Value of $\bar{R}^2$ was .54. Regression coefficient of output per hectare turned out to be .1 which was significant at 1 percent probability level.

In regression equation F'.9, 'intensity of cropping' was also included with Output. R^2 did not increase at all, $\bar{R}^2$ went down a little. Regression coefficient of Intensity of cropping was .01 but not different from zero statistically. Regression coefficient of Output did not change neither its standard error has changed substantially with the inclusion of intensity. So the summary statistics points out that either the intensity of cropping is a superfluous variable or the output is playing the role of dominant variable, thereby making intensity to be superfluous.

Statistically, as our guide line, when X_2 is a superfluous variable and its inclusion does not increase R^2 sufficiently to increase $\bar{R}^2$, then the variable is deleted from the regression. But when the theory unambiguously states that a variable is a specified explanatory variable then, of course, it should not be omitted even though it might appear superfluous. So we will better retain intensity of cropping as the explanatory variable in next equations. In next equation, F'.10, output was excluded from the regression equation to see the true effect of intensity of cropping and also of other variables. Deletion of output lowered the explanation power of the regression equation to .27 as against .54 when output was retained. But with the deletion of output regression coefficient of intensity of cropping has turned up to be significant. Value of the parameter of intensity is .40 and is significant at 5 percent probability level. Regression coefficient of capital has also turned up to be significant at 1 percent probability level with the value of parameter as .09. Every additional rupee incurred on capital premises to increase use of fertiliser worth rupee .09 or 9 paise. Regression coefficients of all other variables (Size, Irrigation, Tenancy) are not different from zero statistically.

In regression equation F'.13, all the, 6, theoretically specified variables were taken in. Values of R^2 and $\bar{R}^2$ of this equation are highest among all the equations, .59 and .58 respectively. Regression coefficients of Output and Capital, .09 and .04 respectively turned out to be significant both at 1 percent probability level. Regression coefficients of Size, Irrigation, Tenancy and Intensity were not different from zero statistically. Results of this equation would be used as this appears to be the most suitable equation, statistically as well as theoretically.

Summary :

Factors affecting use of chemical fertilisers in Ferozepur district in 1967-68 were Size of the Farm, Value of Output per hectare and Intensity of Cropping with linear regression coefficients as 1.05, .04 and .16 respectively or elasticities as .19, 1.03 and .88 respectively.

However the factors affecting the use of fertilisers for the same district in the next year, 1968-69, were Value of Output per hectare and value of non-land fixed capital per hectare with linear regression coefficients as .09 and .04 respectively or the elasticities as 1.53 and .12 respectively.

We see that the value of output retained its influence over the use of fertilizer in both the years though relative influence of 'Intensity of cropping' and 'Size of the Farm' vanished in 1968-69. In 1968-69, the factor, 'Value of non-land fixed capital' emerged as the influencial factor towards the use of fertilisers by the farmers.

Expected value of output consistantly influences use of fertiliser in Ferozepur in both the years. Though value of output per hectare in Ferozepur declined from Rs. 1,824 to Rs. 1,611 yet it still plays a predominant role in the use of fertilisers in Ferozepur in 1968-69.

Size of the farm played a significant role towards the use of fertilisers in 1967-68 but it lost its importance in 1968-69. Generally size of the farm becomes a determining factor for the use of fertilisers in the case of very small sized farms. In the sense that though fertilisers use is size neutral but not resource neutral, and hence small farmers having generally less resources and access cannot use fertilisers adequately. But this does not seem to be the reason of becoming the size of the farm an influencial factor in the use of fertilisers in Ferozepur in 1967-68. There is no small farmer (farmers having land below 2 hectares) in the sample data of Ferozepur. 33 farmers have land more than 6 hectares and 117 farmers have land between 2 to 6 hectares.

Use of chemical fertilisers in the country and also in Ferozepur is not very old. Fertiliser use got a major break through mostly after 1964-65. Obviously in the early stages big farmers would have adopted it as they have better command over resources as well as greater risk bearing capacity. That is why that size of the farm significantly affects use of fertiliser in 1967-68. But as farmers gradually increased the use of fertilisers, from worth Rs. 70 as an average, in 1967-68 to worth Rs. 95 as an average, in 1968-69 they must have been convinced with the profitability of fertiliser use and so size of the farm remained no longer an important factor towards fertiliser use in 1968-69. Once the profatibility of fertilisers got established all the farmers started using fertilisers irrespective of the farm size. So fluctuations in the fertiliser use corresponding to farm size have reduced, making the relative influence of farm size towards fertiliser use to be insignificant in 1968-69. Now other factors have become more important. This motivation of getting more profits by the use of chemical fertilisers made the farmers to use more capital per hectare (Rs. 400 in 1968-69 as against Rs. 283 in 1967-68) and so capital emerged as an important factor affecting the use of chemical fertilisers. Capital includes expenses on pumpsets for irrigation which stabilises the profitability of fertiliser.

CHAPTER - 4

MULTIPLE LINEAR REGRESSION ANALYSIS, MUZAFFAR NAGAR DISTRICT (WEST U.P.) 1967-68

Use of Fertiliser in Muzaffar Nagar

Correlation Matrix :

Higher the degree of association between dependent and an independent variable, higher is the confidence that may be placed in regression coefficients. High correlation between independent variables not necessarily points out to the problem of multi-collinearity, and hence deletion of the variable. All the same, low correlation between independent variables is no guarantee of not being the problem of multicollinearity. Sometimes, a set of low correlations between independent variables added together may pose a problem of multicollinearity.

However, in practice, the guiding rule is that the smaller the correlation between the independent variables, the higher the precision of the regression estimates.

Correlation between "Size of the farm" and "Intensity of Cropping" was -.09, which shows as the farm Size increases intensity of cropping decreases.

Correlation between Output per hectare and Size of the farm is also negative viz. -.06. This is the result of the above relation. Smaller the farm more is the Intensity of Cropping so per hectare Output would be more in relatively small farms.

Correlation Matrix Fitting of Multiple Linear Regression Equations, Muzaffarnagar, 1967-68

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Fertiliser	1.00												
2. H.Y.V.	.17	1.00											
3. Size	.37	.15	1.00										
4. Irrigation	.14	.12	.10	1.00									
5. Tenancy	.10	.00	.13	.23	1.00								
6. A. Value of Output	.44	.17	.87	.12	.18	1.00							
7. Value of F. Capital	.12	.32	.33	.09	.08	.33	1.00						
8. Intensity	-.07	.12	-.09	.08	-.03	-.66	-.07	1.00					
9. S Dummy	-.26	-.13	-.47	-.10	-.34	-.46	-.17	.09	1.00				
10. M Dummy	-.14	-.08	-.46	.05	.06	-.40	-.19	-.05	-.27	1.00			
11. Fertiliser/hectare	.73	.11	-.06	.10	.01	.00	-.01	-.03	-.14	.17	1.00		
12. Output/hectare	-.03	-.05	-.34	.13	-.03	.00	-.06	.05	.25	.14	.09	1.00	
13. Capital/hectare	.01	.19	-.01	.09	.09	.04	.77	-.02	.01	-.04	-.01	.07	1.00

Correlation between "non-land fixed Capital (Absolute Value)" and "Size" is positive but it is negative, -.01, between same variables when they are taken into per hectare terms i.e. Size and Capital per hectare. Big farmers are having less Capital in proportion to small farms.

There is very high correlation, .87, between Output (a.v.) and Size of the farm.

Correlation between "Output"(absolute value) and "Intensity of Cropping" is -.66. This is because of large scale cultivation of sugarcane in this region. Productivity of sugarcane is much higher compared to that of rice or wheat (worth Rs. 3000 against worth Rs. 1000). So large scale cultivation of sugarcane increases value of output per farm or per hectare, it reduces doubly cropped area (intensity of cropping). To isolate the combined effect of above related variables equations in different combinations of variables were fitted and examined to get the appropriate equation.

No other correlation coefficient between independent variables was high enough or alarmingly negative.

<u>Interpretation of Regression Coefficients</u> :

Different multiple linear regression equations were fitted under two different specifications of the variables. In some of the regression equations both the dependent and independent variables were taken in absolute form (for the farm as a whole) while in other regression equations all the variables were taken in per hectare form to overcome the problem of hetroscedasticity. Y_1 represents dependent variable in the first form while Y_2 represents dependent variable of the other form i.e. Fertiliser use per hectare.

In regression equation M.1 'Output' was taken as the only explanatory variable, its coefficient was .007. Which was significant at 1 percent probability level. But the regression equation did not represent a good fit. Its coefficient of determination was as low as .19 which was insignificant, $\bar{R}^2$= .18. Coefficient of determination for exactly the same type of regression equation in the same variable was as high as .64 for Ferozepur. Regression coefficient of Output shows that one unit increase in Output value (worth rupee one) will lead to increase in Fertiliser use worth Rupee .007).

Since there was high and negative correlation, -.66 between Output and Intensity of Cropping. That is why we did not keep Intensity with Output in first equation but coefficient of determination and $\bar{R}^2$ turned out to be very low for this equation. So we consider it to be appropriate to keep both Output and Intensity in next equation, M.2. Still the coefficient of determination R^2 and $\bar{R}^2$ did not increase rather they remained the same, Output again turned out to be significant with same regression coefficient and same standard error giving the impression that 'Intensity of Cropping' is a superfluous variable. However, coefficient of regression of Intensity of Cropping was -.20 which was not different from zero statistically.

Correlation between Size and Output was very high i.e. .87. So in the next equation M.3, Size was kept as the explanatory variable but Output was deleted. Coefficient of determination of the fit went down to, .16 and $\bar{R}^2$ to .16. Regression coefficient of Size was 13.12 which was significant at 80% confidence level. Which means that every additional hectare of land was making the farmers to use more Fertiliser of the value of Rs. 13.12. Regression coefficients of other variables, irrigation, tenancy, Capital and Intensity, were not significantly different from zero statistically.

In regression equation M.4, all the six variables were kept as explanatory variables. R^2 shot up to .52 as against .16 in equation, M.3, with the inclusion of Output. The only significant regression coefficients were of Size, .27 and Output .007 at 5 percent probability level. Dropping the insignificant variables and running the equation again by taking Output and Size as the explanatory variables, we found that R^2 did not go down much and $\bar{R}^2$ increased a little i.e. R^2 = .51 and $\bar{R}^2$ = .50, thereby showing more precision of the equation. The equation shows that the movements in the use of Fertiliser are more satisfactorily explained by Output and Size only and not by any other variable.

If we drop Size from the equation and take all the variables (equation M.5, M.6), regression coefficient of ownership of land holding comes out to be -16.02 which is significant at 95 percent confidence level. However both the coefficient of determination and the measure of precision of regression equation, R^2, $\bar{R}^2$, came down considerably as compared to the regression equation when Size was included. As the R^2 and $\bar{R}^2$ decrease with the deletion of the Size and also because its inclusion is dictated by the theory, so the Size was included in the regression equation, M.7 along with intercept dummy for three size groups. However the regression coefficients of Size and Output remained the same i.e. .26 and .007 respectively (as in equation M.5), which were significant at 95 percent confidence interval. Regression coefficients of all other variables were not significantly different from zero statistically. Intercepts within the Size groups are not significant.

None of the regression equations fitted by specifying the variables in per hectare terms gave R^2 and $\bar{R}^2$ more than .06 which is not significant at corresponding degrees of freedom (Testing with the value of F.)

Viewing the elasticities of significant variables, in "Output" (a.v.) and "Size" with respect to fertiliser (a.v.) we see that elasticity of output w.r.t. fertiliser is $.007 \times \frac{25934.00800}{214.53600} = .85$. That is one percent increase in output (absolute value) leads to .85 percent increase in value of fertiliser use per farm.

Elasticity of size w.r.t. fertiliser comes to be $.26 \times \frac{6.99568}{214.53600} = .01$.

So by analysing different regression equations we come to the conclusion that the use of Fertiliser in Muzaffar Nagar district is positively influenced by the two variables only, that is, absolute value of Output raised and Size of the farm (see equation M.4).

Correlation Matrix Fitting of Multiple Linear Regression Equations Muzaffar Nagar, 1968-69

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Fertiliser	1.00												
2. H.Y.V.	.16	1.00											
3. Size	.44	-.07	1.00										
4. Irrigation	.09	-.19	.05	1.00									
5. Tenancy	.09	-.001	.08	.26	1.00								
6. A. Value of Output	.55	.02	.89	.05	.10	1.00							
7. A. Value of F.Capital	.38	-.06	.48	.11	.02	.50	1.00						
8. Intensity	.07	.09	-.32	.14	.09	-.20	-.007	1.00					
9. Dummy Small	-.21	.20	-.42	-.15	-.16	-.40	-.19	.15	1.00				
10. Dummy Medium	-.24	-.06	-.50	.12	.08	-.43	-.26	.19	-.31	1.00			
11. Fertiliser/hectare	.74	.35	-.04	.01	.07	.10	.12	.22	-.01	.04	1.00		
12. Output/hectare	.25	.24	.01	-.03	.10	.34	.21	.18	-.20	.16	.34	1.00	
13. Capital/hectare	.05	-.01	-.01	.09	.03	-.004	.62	.15	.11	.006	.06	.33	1.00

MULTIPLE LINEAR REGRESSION ANALYSIS, MUZAFFAR NAGAR DISTRICT, 1968-69

Explanation of Correlation Matrix :

As far as correlation between dependent and independent variables for this region are concerned, only three independent variables, Size, Output (absolute value) and Capital (absolute value) are having reasonably high correlations with dependent variable, fertiliser viz., .44, .55, .38 respectively. In the previous year, 1967-68, capital (absolute value) was having as low as .12, correlation with fertiliser but this time in 1968-69, influence of capital towards the use of fertiliser seems to have gained the momentum, however, this remains to be viewed through the value of its regression coefficient.

Checking for the magnitude of correlation among independent variables we see that correlation between 'Size' and ' absolute value of Output' is as high as .89. For the fear of some sort of fixed relation between these two variables, both the variables were treated as mutually exclusive variables in the two regression equations and also in another, third equation, both were included, simultaneously. A thorough probe into the summary statistics would provide us some insite that which one or both of the variables should be included in the regression analysis.

Correlation between Size and Intensity of cropping is though small but negative, indicating that small farmers are more promptly cultivating their lands than large farmers. Size bears negative but low correlation with fertiliser per hectare also. As Size increases use of fertiliser per hectare decreases.

Correlation between absolute value of Output and intensity of cropping is -.20. Reason of negative correlation between these two variables is large scale cultivation of sugarcane in Muzaffarnagar which is explained in detail in the case of previous year, 1967-68.

Correlation betwеen out (absolute value) and Capital is .50 but between output (absolute value) and Capital per hectare it is negative, -.004. With additions in the expected output farmers are reducing expenditure on per hectare capital.

There are no other high correlations between any of the two independent variables, neither there are more objectionable negative correlations.

Interpretation of Regression Coefficients :

As output was having high correlation with the use of fertiliser and also for the fear of output being a dominant variable; output (absolute value) alone was used as the explanatory variable in regression equation M'.1. This regression equation could explain 31 percent variations in the use of fertilisers. Parameter of output was .02 and it was significant at 1 percent probability level. Every additional rupee of output increases fertiliwer consumption worth Re. .02 or 2 paise.

However, for the regression equation in the same variable (output alone), fitted in double log form regression coefficient of output was 1.17 which was significant at 1 percent probability level. Coefficient of determination of this equation was same as it is in linear form i.e. .31. $\bar{R}^2$ was slightly lesser than that of linear one. One percent increase in value of ~~of~~ output tends to increase fertiliser use of the order of 1.17 percent.

In regression equation M'.2, intensity of cropping was also included. This was done in order to check that whether, the variable output is having overriding influence on the use of fertiliser and makes other variables superfluous or it does let the other variables to exert significant effect on the use of fertiliser. Coefficient of determination of this equation went up to .34, same was the value of $\bar{R}^2$. Both intensity of cropping and output turned out to be significant at 1 percent probability levels, with values of regression coefficients as .02 and 4.59 respectively. One percent increase in intensity of cropping increases the use of fertiliser of the value of Rs. 4.59.

In regression equation M'.3, all the 5 variables including size dummies (intercept dummy) were taken in while the variable output was taken off. In the absence of Output coefficient of determination came down to .23 as against .31 where output alone was the explanatory variable (M'.1). This establishes the overriding influence of output in fertiliser use. However, the significant variables were Size, Capital (absolute value) and Intensity with values of regression coefficients as 32.04, .01 and 5.07 respectively.

In regression equation M'.4, all the six variables were taken in, R^2 and $\bar{R}^2$ again went up to .36 and .33 respectively. Regression coefficient of Size has born negative sign this time, -20.20 but not different from zero statistically. There was very high correlation beween output and size, .89. Output seems to have introduced bias in the regression coeffie cient of size. Both size and output are theoretically justified variables (towards the use of fertialise) so we cannot treat them as mutually exclusive varie ables to get the true regression equation.

Only significant coefficients were of Output, .02 and intensity of cropping, 3.46. Output has also undone the significance of capital as compared to the equation M'.3., when output was deleted.

Some other regression equations were also fitted by changing the specification of variables i.e. in per hectare terms for the reasons specified earlier, as they were fitted in case of each region for both the years.

V Viewing from these equations (from M'.8 to M'.15) we see that whenever we include output in the regression equation, regression coefficients of both 'Size' and 'Capital' bear negative signs, and when we exclude output from the regression equation, regression coefficients of both of these variables take positive signs, however they are not different from zero statistically in either case.

Regression equation M'.4 is best among all these equations. Values of R^2 and $\bar{R}^2$ are highest of all. All the 6 included variables are theoretically wanted variables.

Finally, two variables output and intensity of cropping are significant variables (see equation M'.4). Regression coefficient of output (a.v.) is .02 (this has always been .02 with minor fluctuations in its standard error in all the 15 regression equations fitted in various combinations of variables) which is significant at 1 percent probability level. Regression coefficient of intensity of cropping is 3.46 which is significant at 5 percent probability level.

Calculating elasticities of these variables with respect to use of fertiliser we get elasticity of output per hectare with respect to fertiliser as -

$.02 \times \frac{14598.146}{333.520} = .865$ and elasticity of intensity of cropping with respect to fertiliser as

$$3.46 \times \frac{141.290}{333.520} = 1.38$$

One percent increase in value of output increases use of fertiliser per hectare by .86 percent and one percent increase in intensity increases use of fertiliser per hectare by 1.3 percent.

One significant factor this time is that tenancy is having positive effect on fertiliser use though not statistically significant whereas it was having negative impact on fertiliser use in previous year (not significant statistically).

Summary :

In Muzaffar Nagar, factors affecting the use of fertilisers in 1967-68 were Size of the farm and Value of output per farm with linear regression coefficients as .27 and .007 respectively or with elasticities as .01 and .85 respectively.

Relative influence of factors towards the fertiliser use changed in 1968-69, and now the factors influencing fertiliser use were 'Value of output per farm' and 'Intensity of cropping' with linear regression coefficients as .02 and 3.46 respectively or respective elasticities as .88 and 1.45.

Size, which was significant factor in the adoption of fertilisers in 1967-68, loses its importance in 1968-69 and a new factor Intensity of cropping emerges as an important factor affecting the use of chemical fertilisers.

The same reasoning as it was in case of Ferozepur seems to hold true here also, that in early stages of adoption of fertilisers size plays an important role, because big farmers have better command over resources and have greater risk bearing capacity as compared to small farmers. Since fertilisers

is a size neutral input, small farmers also start using more fertiliser as its profitability gets confirmed. To make fertiliser more profitable, assured irrigation facilities are a pre-requisite and hence at this stage capital becomes an important factor in the fertiliser use (capital covers expenses on pumping sets and tubewells).

This is the reason that as fertiliser use in Muzaffar Nagar increases from Rs. 214 per farm in 1967-68 to Rs. 333 in 1968-69 per farm capital starts playing an influencial role in the use of fertiliser. In fact there was more use of capital, Rs. 4,639 per farm in 1968-69 as against Rs. 3,203 per farm in 1967-68 which facilitates increased use of fertiliser.

CHAPTER - 5

MULTIPLE LINEAR REGRESSION ANALYSIS, DEORIA DISTRICT, (EAST U.P.) 1967-68

Explanation of Correlation Matrix :

Correlation between value of Fertiliser per farm (dependent variable) and Size is .75, it is again .75 between value of Fertiliser per farm and value of Output per farm. Correlation between Intensity of cropping and Fertiliser value per farm is -.26. As Intensity of cropping increases value of Fertiliser per farm decreases Correlation between these two variables in Ferozepur was positive. In Ferozepur Fertiliser was used both in Rabi and Kharif (American cotton etc.) crops. Here, the farmers of Deoria seem to be not using Fertiliser in Kharif crops and are using in wheat (Rabi) only, that is why that value of Fertiliser decreases with Intensity of cropping. Same is true with correlation coefficient, -.19 between intensity of cropping and Fertiliser per hectare.

Correlation between Size and Intensity of cropping is -.29. As Size of the farm increases farmers reduce Intensity of cropping. Sign and magnitude of this correlation is approximately the same as they were in Ferozepur district though it is as low as -.09 in Muzaffarnagar.

Correlation between Size and Output per hectare is -.11 which means as Size increases Output per hectare decreases. Correlation between Irrigation and Intensity

Correlation Matrix **Fitting of Multiple Linear Regression Equations Deoria 1967-68**

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Fertiliser	1.00												
2. H.Y.V.	0.00	0.00											
3. Size	.75	0.00	1.00										
4. Irrigation	.27	0.00	.26	1.00									
5. Tenancy	-.04	0.00	-.02	.13	1.00								
6. A.V. Output	.75	0.00	.88	.28	-.04	1.00							
7. A.V. Capital	.17	0.00	.21	.10	-.12	.18	1.00						
8. Intensity	-.26	0.00	-.29	-.12	.00	-.21	-.17	1.00					
9. S. Dummy	-.39	0.00	-.69	-.17	.02	-.63	-.16	.27	1.00				
10. M. Dummy	.06	0.00	.23	.15	-.05	.24	.11	-.12	-.82	1.00			
11. Fertiliser/hectare	.69	0.00	.29	.19	-.05	.37	.14	-.19	-.22	.09	1.00		
12. Output/hectare	-.01	0.00	-.11	.09	.01	.16	-.06	.27	.12	-.09	.04	1.00	
13. Capital/hectare	.01	0.00	.00	.04	-.13	-.01	.95	-.09	.02	.00	.06	-.03	1.00

of cropping is -.12. This might be due to the fact that in Deoria District, a large proportion of area is Tarai region in which crop can be grown up without irrigation.

Correlation between Intensity and a.V. Output is negative but low, between a.v. Output and Size is .88, interpretation and remedial measures are same as they were in case of Muzaffarnagar district.

Interpretation of Regression Equations :

As in cases of Muzaffarnagar and Ferozepur in Deoria too multiple linear regression equations as well as log linear regression equations, under two different specifications of the variables were fitted for the year 1967-68 and 1968-69. However, the results of multiple linear regression equations turned out to be better than log linear regression equations. Results of multiple linear equations for the year 1967-68 are presented here.

In the regression equation D.1, only one variable that is absolute value of Output was taken as explanatory variable (Because Output was having very high correlation .75, with Fertiliser use (A) and this was highest among all the variables). The equation explained 55 percent variations in the Fertiliser use. Regression coefficient of Output was .01 and significant at 1 per cent probability level meaning thereby that one rupee increase in output value will cause more use of Fertiliser worth rupee .01 or 1 paisa (unit of both the variables is in rupees).

Equation D.2, turned out to be a better fit with more precision of the regression equation (both the R^2 and $\bar{R}^2$ increased) when another variable, Intensity of cropping was included in the regression along with Output. Regression coefficient of Output was the same with almost same standard error as in previous equation and regression coefficient of Intensity of cropping was -.58 which was significant at 95 percent probability level. One percent increase in Intensity of cropping tends to decrease Fertiliser use worth rupee .58. This negative effect of Intensity of cropping on Fertiliser use seems to be attributable to the small holdings of the farmers in this region of Deoria. Average holding size is 2.84 hectares. Small farmers do not have much resources to use high doses of Fertiliser. This could be seen from the per hectare use of Fertiliser which is worth rupee 15 in this region as against rupees 70 in Ferozepur. To have a slight view of resources in hand of the farmers we look into the capital per farm which is worth rupees 949 in Deoria as against rupees 5017 in Ferozepur. We should recall at this juncture that in Ferozepur Intensity was positively affecting use of Fertiliser as there were large farms (Average size was 12.65) with large resources in hand (value of output per farm and value of capital per farm were rupees 22,782 and rupees 5,017 respectively). So, we see that small farmer of this region see it more worthwhile to increase Intensity of cropping in order to get more Output by reducing use of Fertiliser which is so dictated by the negative regression coefficient of Intensity of cropping.

From the third regression equation, D.3, Output was deleted but all the other variables were retained including Size dummy. This was done in expectation of overriding influence of Output towards Fertiliser use as compared to other variables (Output alone could explain 55 percent variations in Fertiliser use in equation D.1). Coefficient of determination went up to .59 and also the degree of precision of the regression equation improved a little. Though R^2 of the equation increased but it could not raise $\bar{R}^2$ sufficiently, this gives the impression that not all but one or more of the variables is superfluous. Tenancy could be leveled as superflous, technically, from our previous experiense (in case of Muzaffarnagar and Ferozepur) and also, theoretically, due to the fact that leased-in area in this region is as low as 3 percent only. As the percentage of ownership of land holding (as we have defined the variable, tenancy) is almost same with all the farmers (there are not wide flustuations in this variable) so this variable is becoming incapable of explaining much of the movements in the Fertiliser use.

Unlike, the cases of Muzaffarnagar and Ferozepur, delition of Output has affected regression coefficient of Intensity of cropping. Correlation between the two variables is -.0.21. Regression coefficient of Intensity of cropping is no more significant now. Both Size and Irrigation have turned up to be significant at 1 percent and 5 percent probability levels respectively.

Seeing the above relation, we included Output in the regression equation D.4 along with all other variables. Explanation power and precision of the equation increased. The only significant estimates were of Size and Output. This fails the above reasoning of equation D.3.

In the next equation, D.5, Size was deleted from the regression equation, remaining five variables were tried out. Intensity of cropping again turned up to be significant and almost same as it was in equation D.2 when Size was not taken in. Absence of Size seems to have made Intensity of cropping significant. Correlation between the two variables is -.29. Fertiliser use seems to be the function of some sort of combination of Size and Intensity of cropping and with the deletion of Size Intensity seems to have captured some effect of Size. So, the estimate of regression coefficient of Intensity of cropping seems to be a biased one. Also, deletion of the variable Size is theoretically unjustified, so we will not depend upon this equation.

In another equation D.6, when we put Size dummy variable, deleting the variable Size, Output turned out to be significant at 95 percent level of confidence with the value of regression coefficient as .007. Intercept dummies for small and medium sizes were also significant meaning thereby that there are differences with in the different Sizes towards the pattern of Fertiliser use. Coefficients of Intensity, Irrigation, Tenancy and Capital were not significantly different from zero statistically.

In equation, D.7, we took all the variables including dummy variables. Value of the coefficient of determination was .66 and degree of precision of the regression equation was .64 both the values were the same as they were in equation D.6 when Size was not taken in. Again the absolute value of Output turned out to be significant at 5 percent probability level with the same regression coefficient. Intercept dummies for the variable Size again turned out to be significant with the same magnitudes.

As a conclusion with the analysis of these equationns we can say that the factors influencing the Fertiliser use in Deoria District are Size and absolute value of Output.

Few more equations were fitted by changing the specification of the variables e.g. in per hectare terms instead of per farm or in absolute form as in above equations, to overcome the problem of hetroscedasticity.

In first equation of this form i.e. equation D.8, Output per hectare alone was tried for per hectare use of Fertiliser. But unlike the cases of Muzaffarnagar and Ferozepur Output alone could not explain much of the movements in Fertiliser use, R^2 was as low as .004 which was not significantly different from zero statistically, testing by the value of F.

When Output was excluded from the regression equation and all other variables were taken in, explanation power of the equation increased, explaining 44 percent movements, which was significant at 1 percent probability level [significant at 145 degrees of freedom imposing 5 restrictions i.e. $F(5, 145)$]. Size turned out to be significant at 1 percent probability level. Regression coefficients of irrigation and Intensity of cropping were .09 and -.09 respectively, both significant at 10 percent and 15 percent probability level but not much validity can be placed in the regression coefficients of as low confidence levels.

In the regression equation, D.13, all the variables were included. Both the coefficient of determination and $\bar{R}^2$ were the highest among these types of regression equations, e.g. in per hectare terms. Values of R^2 and $\bar{R}^2$ were .12 and .09. R^2 was significant at 1 percent probability level. Variables positively affecting Fertiliser use were Size, irrigation and Output with regression coefficients 1.52, .08 and .001 respectively all significant at 99%, 90% and 85% confidence levels respectively. Intensity of cropping was negatively affecting Fertiliser use per hectare, value of regression coefficient was -.11 which was significant at 90% confidence level.

So depending upon the most appropriate regression equation D.13, technically as well as theoretically, we see that Fertiliser use in Deoria is favourably influenced by Size of the farm irrigation and value of Output and negatively affected by Intensity of cropping.

Checking for the elasticities of irrigation, output per hectare, intensity of cropping and size with respect to fertiliser use per hectare we find them to be .15, .16, -.91 and .27 respectively.

Effect of Intensity of cropping on Fertiliser use is positive in Ferozepur, it is not affecting Fertiliser use in Muzaffarnagar significantly and in Deoria its effect on Fertiliser use is negative.

Irrigation is the factor which is influencing Fertiliser use in Deoria only, but not influencing the same in Muzaffarnagar or Ferozepur districts.

The factors positively affecting the Fertiliser use in all the districts are Size of the farm and the value of Output. Factors like Ownership of land holding and Capital are not affecting Fertiliser use in any of the regions in 1967-69.

Coefficient of the variable, 'Ownership of land holding' though always not different from zero statistically but was negative towards Fertiliser use, which should not have been the case atleast theoretically. This remains to be examined in future by some other scholar in the field.

<u>Correlation Matrix</u> Fitting of Multiple Linear Regression Equations Deoria, East U.P. 1968-69

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Fertiliser	1.00												
2. H.Y.V.	.00	0											
3. Size	.75	0	1.00										
4. Irrigation	.01	0	.04	1.00									
5. Tenancy	-.02	0	.02	.01	1.00								
6. A. Value of Output	.70	0	.91	-.006	-.01	1.00							
7. A. Value of F. Capital	.62	0	.74	.13	.04	.71	1.00						
8. Intensity	.14	0	.31	-.05	.08	.26	.07	1.00					
9. Dummy Small	-.39	0	-.63	-.14	.02	-.64	-.44	-.15	1.00				
10. Dummy Medium	.12	0	.20	.14	-.07	.24	.15	.01	-.80	1.00			
11. Fertiliser/hectare	.46	0	.07	.05	-.05	.15	.12	-.03	-.02	.01	1.00		
12. Output Per Hectare	-.10	0	-.25	-.05	.03	-.09	-.12	-.10	.26	-.19	.38	1.00	
13. Capital Per Hectare	.12	0	.09	.12	.07	.13	.44	-.06	-.09	.07	.47	.29	1.00

MULTIPLE LINEAR REGRESSION ANALYSIS, DEORIA DISTRICT, 1968-69

Explanation of Correlation Matrix :

There are high and positive correlations between dependent variable fertiliser (absolute value) and the independent variables, 'Size', 'Output' (absolute value) and 'Capital (absolute value) viz. .85, .70 and .62 respectively. This is an encouraging factor, higher the correlation between dependent and independent variables, higher is the degree of reliability that can be placed in the regression coefficients of the independent variables. There is negative but very low correlation between fertiliser (absolute value) and 'Tenancy' (ownership of land holding), viz. .02. The dependent variable in another form (per hectare terms) had negative but low correlations with; tenancy, -.05; and intensity of cropping, -.02. (Fertiliser per hectare and fertiliser in absolute value terms had negative correlations with size dummy representing small farms (below 2 hectares) viz. -.02 and -.39 respectively. The case with farms below 2 hectares is such that use of fertiliser decreases as farm size increases. However this is not true with farms above 2 hectares where correlation between the two variables, size and fertiliser is positive).

Turning to the correlation between independent variables, first of all we see that variable 'Size' has very high correlation with Output (absolute value) also have high correlation, .71. For the fear of multicollinearity we treated all these three variables as mutually exclusive variables and also as taking all of them simultaneously thereby making several combination of regression equations.

However, there are no other higher correlations between independent variables. Problems remains of negative correlations which all are incidentally low enough and cannot make regression coefficients to be biased.

Interpretation of Regression Coefficients:

Like Muzaffarnagar and Ferozepur, for Deoria too regression equations, in both, multiple linear and log linear forms were fitted for the data of the year 1968-69. However, the multiple linear regression equations had definite superiority over log linear regression equations as judged by the summary statistics. Also, the use of fertiliser by the farmers can more satisfactorily explained in terms of linear regression equations as against log linear regression equations where linearity is imposed exogeneously. So study is based on interpretation of results of linear regression equations.

First seven equations are fitted by specifying all the variables in absolute form while other eight equations are fitted by defining the variables in per hectare terms.

In regression equation D.1, output alone was tried as an explanatory variable because there was high correlation between output and fertiliser viz. 70 and also because output was having high correlations with the independents variables, 'size' and 'capital' viz .91 and .71 respectively.

Output alone could explain 50 percent variations in the use of fertiliser and turned out to be significant at 1 percent probability level with the value of regression coefficient as .01. Every additional rupee of output raised seems to incite the farmer to use more fertiliser of the value of Rs. .01. Elasticity of output with respect to fertiliser use comes out to be $.01 \times \frac{6442.57333}{77.72667} = .83$.

In regression equation D.3, all the 5 variables including size dummy were included excluding output. Coefficient of determination of this equation went up to .54. However, Size and Capital turned out to be significant variables with values of regression coefficient as, 37.20 and .01 respectively.

In regression equation D.4, all the six variables were taken in, coefficient of determination remained same as .54. Values of regression coefficients of output, capital and size were .006, .01 and 17.35 respectively, of which output and size were significant at 5 percent probability level where as capital was significant at 10 percent probability level.

We see that in regression equation D.6, when size is deleted from the equation, standard error of regression coefficient of output has redused considerably. Values of R^2 and $\bar{R}^2$ have remained almost same. Size, Output and Capital are the only significant variables.

After a thorough probe into all the regression equations from D.8 to D.15, fitted by defining the variables in per hectare terms we see that output and capital are the significant variables with the values of regression coefficients as .004 and .03 respectively, regression equation (D.13). Regression coefficients of both output and capital are significant at 1 percent probability level.

So we see that, ceterisperibus, output and capital are positively significantly affecting use of fertiliser in Deoria in 1968-69 (using equation D.13).

Regression coefficients of irrigation, tenancy and intensity of cropping, all bear negative signs. Values of regression coefficients of irrigation, tenancy and capital are -.02, -.04 and -.03 respectively but all are not different from zero statistically.

Viewing the elasticities of the significant variables; elasticity of output with respect to fertiliser is,

$.004 \times \frac{2910.49357}{24.89217} = .47$ and that of capital respect to fertiliser is ,

$$.03 \times \frac{274.4424}{24.89217} = .33$$

That is, one percent increase in value of Output leads .47 percent more use of fertiliser per hectare and one percent increase in value of capital leads .33 percent more use of fertiliser per hectare.

Summary :

Factors affecting use of chemical fertilizers in Deoria for the year 1967-68 were size of the farm, Irrigation, Output and Intensity of cropping with linear regression coefficients as 1.52, .08, .001 and -.11 respectively. And also with elasticities as .27, .15, .16 and -.91 respectively. All the variables are taken in per hectare terms.

For the farmers, factors affecting the use of fertilisers in the next year, 1968-69, turned out to be output and Capital with linear regression coefficients as .004 and .03 respectively or with elasticities as .47 and .33 respectively.

So we see that over time the relative influence of the factors over the use of fertilisers has changed to the considerable extent in this region.

Output alone has retained its influence otherwise all the variables i.e. Size, Irrigation and Intensity of cropping which were affecting fertilizer use considerably in 1967-68 have lost their influence over the use of fertilisers in the next year, 1968-69, and their place is taken up by the value of non land fixed capital. Some line of reasoning is to be probed for this change over of the relative influence of the factors.

Although fertilizers are size-neutral in the sense that they are divisible and can be used irrespective of the size of the farm yet they are not resource neutral. Average farm size in Deoria is small, hence resources - owned as well as borrowed - with the farmers are obviously small. As farm size increases farmers get a better command over resources, and that is why the variable, Farm Size, seems to be positively influencing the Fertiliser use.

Having less resources they prefer to increase their income through multiple cropping rather by increased use of fertilizers, even they seem to cut down expenses of fertilizers hoping for increased output through multiple cropping. That is why that intensity of cropping is affecting use of fertilisers negatively.

Use of fertilizer without assured irrigation is a bad risk. (Crop can be burnt down in the absence of irrigation after fertilising). Irrigation in Deoria was only 29% in 1967-68. More than one third of the soil in Deoria is Tarai (at least for the present sample), on which crop can be grown without irrigation, but moisture may not be high enough to cope with the needs of use of fertilizers. So in that case farmers see it more worthwhile to increase cropping intensity and reduce use of fertilisers. Because increased use of fertilisers in the absence of assured irrigation is a bad risk.

Profitability of fertilisers becomes high as irrigation increases, that is why the farmers in the case of use of fertilisers are responding favourably as irrigation increases. Value of output also played a positive role in the use of fertilisers in 1967-68. Output was taken for the same year. Farmers seem to be psychologically motivated to use more fertilisers if the expected value of output increases.

Benefits occured from the adoption of new technology in one period lures the farmers to adopt them faster in the next period. Value of output per hectare in Deoria was Rs. 2,452 in 1967-68 where as it went up to Rs. 2,910 in 1968-69. That is why farmers used more fertiliser per hectare, worth Rs. 24 in 1968-69 than, worth Rs. 15, in 1967-68 and were consistently influenced by the value of output in the use of fertilisers in both the years.

As expected value of output increases, bit of commercialism emerges and now the farmers were more influenced by the value of capital in 1968-69 than by irrigation or negatively influenced by intensity as was the case in 1967-68.

CHAPTER - 6

CONCLUSION

Results in case of Deoria and Ferozepur are based upon the regression equations of exactly same form, whereas results for Muzaffarnagar district are based upon a different type of regression equation.

Size and value of output positively affected use of fertilisers both in Deoria and Ferozepur in 1967-68.

Value of output remained an influencial variable towards fertiliser use, the next year too i.e. in 1968-69, in both Deoria and Ferozepur.

But in the next year, 1968-69, 'Size of the Farm' remained no longer an influencial variable towards fertiliser use in either of the districts.

Irrigation was positively affecting use of fertilisers in Deoria in 1967-68 though it was not influencing fertiliser use in Ferozepur in 1967-68. Reason of this variable seems to be the lack of fluctuations in this variable (97% of the holdings are irrigated in Ferozepur).

Intra-regional effect of Intensity of Cropping is discriminatory. In Ferozepur intensity of cropping affected use of fertilisers positively but in Deoria, this variable negatively affected use of chemical fertilisers. Farmers of Deoria are poorer than those of Ferozepur (sample average holding size is 1.57 hectares in the former where as it is 12.57 hectares in the later). The poor farmers of Deoria see it more worthwhile to raise output through increasing multiple cropping and by reducing fertiliser use. They are being affected by real factors. As against this, farmers in Ferozepur are being affected by monetary factors. In order to maximise the output they increase fertiliser use side by side the increased intensity of cropping.

Value of capital which was not an influencial factor in either of the districts in 1967-68 emerged dn important decision making factor in fertiliser use in 1968-69 in both the districts, Deoria and Ferozepur. Use of chemical fertilisers, both in Deoria and Ferozepur increases considerably in these two years. This shows that fertiliser use has confirmed its profitability in both the regions, over time. Now in the next year, 1968-69 as compared to 1967-68, decision making by the farmers is being influenced by the variables as capital and value of output to be xxx raised and not by the so-called traditional factors, as, Size, irrigation and intensity of cropping as in the first year, in both the regions. The only variable, expected "Value of Output" (per hectare as well as per farm) affects use of chemical fertilisers favourably in all the three regions, in both the years 1967-68 and 1968-69.

Unlike output, no other variable affects fertiliser use consistently, in all the three regions over time.

Both, in Ferozepur and Muzaffarnagar use of H.Y.V. seeds did not affect use of fertiliser in 1967-68.

But it became an influencial factor (exerting positive influence) towards fertiliser use simultaneously in both the regions, in 1968-69.[1]

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1. In 1967-68 and 1968-69 use of H.Y.V. seeds was negligible in Deoria district. But use of H.Y.V. seeds was widely prevalent in Ferozepur and Muzaffarnagar in 1967-68 and onwards. For the sake of uniformity we did not include the variable "Use of H.Y.V. seeds" in the list of explanatory variables while fitting regression equations in any of the three regions.

   But in other few regression fitted in case of Ferozepur and Muzaffarnagar equations, fitted in case of Ferozepur and Muzaffarnagar for both the years, we included this variable, "percent use of H.Y.V. seeds". Four best fit regression equations (one for each region and each year) out of several fitted under different specifications and combinations of the variables, are presented on page 134 .

Finally, I conclude by saying that the use of fertilisers by the farmers is predominatly affected by the expected value of output to be raised. This "impetus" is generated within the system and cannot be controlled exogeneously. So the farmers cannot be persuaded to use more fertilisers unless they themselves are convincedof higher produce.

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Regression analysis of factors influencing the use of chemical fertilisers, Ferozepur, 1967-68
(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Const. a	Size x_3	Irrig. x_4	Tenan. x_5	Output x_6	Cap x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
F.1	$Y_1 = a + b_6x_6$	.64	.64	-99.0 (79.62)				.04@ (.002)				
F.2	$Y_1 = a + b_6x_6 + b_8x_8$	.65	.65	-975.42@ (346.09)				.04@ (.002)		6.3@ (2.4)		
F.3	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_2x_{10}$	.59	.58	-2753@ (577)	81.7@ (8.33)	9.92@ (3.09)	.82 (2.45)		.02@@ (.008)	11.83@ (2.87)		-8.87 (151)
F.4	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.67	.65	-1408.8	21.0	2.6	-.29	.03	.01	7.5		
Dropping insignificant variables												
	$Y_1 = a + b_6x_6 + b_8x_8$	.65	.65	-975.4				.04		6.3		

Figures in parenthesis indicate the standard errors of the regression coefficients.

@ Significant at 1 percent level.

@@ Significant at 5 percent level.

@@@ Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Ferozepur, 1967-68

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Const. a	Size x_3	Irrig. x_4	Tenan. x_5	Output x_6	Cap x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
F.5	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.66	.65	-869.0		.30	-.63	.04	.01	5.8		
Dropping insignificant variables.												
F.5(a)	$Y_1 = a + b_6x_6 + b_8x_8$	.65	.65	-975.4				.04		6.3		
F.6	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.66	.65	-946.8		1.4	-.12	.04	.01	6.4	-174.6	-174.6
Dropping insignificant variables.												
F.6a	$Y_1 = a + b_6x_6 + b_8x_8$	.65	.65	-975.4				.04		6.3		
F.7	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.67	.65	-1355.0	17.05	2.8	-.03	-.03	.01	7.6	-111.8	-120.8
Dropping insignificant variables												
F.7(a)	$Y_1 = a + b_6x_6 + b_8x_8$	.65	.65	-975.0				.04		6.3		

Figures in parenthesis indicate the standard errors of the regression coefficients.

@Significant at 1 percent level.

@@ Significant at 5 percent level.

@@@ Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Ferozepur 1967-68
(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
F.8	$Y_2 = a + b_6x_6$	.44	.44	-22.32@ (9.10)				.05@ (.004)				
F.9	$Y_2 = a + b_6x_6 + b_8x_8$	.46	.45	-65.49@				.04@@ (.004)		.36@ (.17)		
F.10	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.28	.25	-170@ (40)	1.39@ (.46)	.86@ (.21)	.07 (.17)		.01@@ (.008)	.99@ (.20)		
F.11	$Y_2 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.23	.21	-120.02@ (38.40)		.77@ (.22)	.05 (.17)		.01@@ (.008)	.82@ (.20)		

Figures in parentheses indicate the standard errors of the regression coefficients

@ Significant at 1 percent level.

@@ Significant at 5 percent level.

@@@ Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Ferozepur 1967-68

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
F.12	$Y_2 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.46	.44	-56.8 (1101.4)		.02 (.20)	-.04 (.14)	.04@ (.005)	.008 (.007)	.31@@ (.18)		
F.13	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.49	.47	-96.92@ (35.82)	1.05@ (.39)	.12 (.20)	-.03 (.14)	.04@ (.005)	.007 (.006)	.46@ (.18)		
F.14	$Y_2 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_8x_8 + D_2x_{10}$	.25	.22	-131.65@ (38.63)		.84@ (.22)	.09 (.17)	.01@ (.008)		.85@ (.20)		-17.44@ (9.57)
F.15	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_2x_{10}$	.28	.25	-170.09@ (40.92)	1.28@@ (.53)	.87 (.21)	.08 (.17)		.01@ (.008)	.99@ (.21)		-4.59 (10.84)

Figures in parentheses indicate the standard errors of regression coefficients.

@ Significant at 1 percent level.

@@ Significant at 5 percent level.

@@@ Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilizers, Ferozepore, 1968-69
(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
F.1	$Y_1 = a + b_6x_6$	.71	.71	-339@ (107)				.08@ (.004)				
F.2	$Y_1 = a + b_6x_6 + b_{12}x_{12}$	.72	.72	-805@ (266)				.08@ (.004)		3.21@@ (1.6)		
F.3	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.49	.47	-934 (984)	75.64@ (14.03)	2.04 (7.5)	1.03 (5.3)		.08@ (.01)	4.41@@ (2.5)	-189 (1184)	-85 (273)
F.4	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.76	.75	-300 (668)	-63.29@ (14.01)	7.50@@@ (5.1)	-4.60 (3.5)	.10@ (.008)	.01 (.01)	-.46 (1.7)		

Figures in parentheses indicate the standard errors of regression coefficients.

@ Significant at 1 percent level.

@@ Significant at 5 percent level.

@@@ Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Ferozepore, 1968-69

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
F.5	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$											
F.6	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.73	.72	-942 (706)		5.34 (5.4)	-2.5 (3.9)	.07* (.005)	.01*** (.01)	2.16 (1.8)	2.41 (859)	97.2 (191)
F.7	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.76	.75	-344 (675)	-66.6* (14.7)	8.00*** (5.1)	-3.98 (3.6)	.10* (.008)	.009 (.01)	-.33 (1.8)	-273 (808)	-143 (186)

Figures in parentheses indicate the standard errors of regression coefficients.

* Significant at 1 percent level.

** Significant at 5 percent level.

*** Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Ferozepore, 1968-69

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
F.8	$Y_2 = a + b_6x_6$	.54	.54	-67● (13)				.10● (.007)				
F.9	$Y_2 = a + b_6x_6 + b_8x_8$	.54	.53	-68 (19)				.10● (.008)		.01 (.013)		
F.10	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.27	.24	10 (67)	.81 (.79)	-.03 (.52)	-.05 (.36)		.09● (.01)	.40●● (.18)		
F.11	$Y_2 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.26	.24	26 (66)		-.003 (.52)	-.09 (.36)		.09● (.01)	.35●● (.17)		

Figures in parentheses indicate the standard errors of regression coefficients.

● Significant at 1 percent level.

●● Significant at 5 percent level.

●●● Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Ferozepore, 1968-69

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_1 x_{10}
F.12	$Y_2 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.59	.58	-51 (49)		.38 (.39)	-.37 (.27)	.09@ (.008)	.04@ (.01)	-.11 (.13)		
F.13	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.59	.59	-67 (51)	.79 (.59)	.36 (.38)	-.34 (.27)	-.09@ (.008)	.04@ (.01)	-.06 (.14)		
F.14	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.27	.23	4.90 (68.7)	.50 (.90)	.01 (.52)	.004 (.37)		.08@ (.01)	.41@@ (.18)	-17.1 (82.8)	-13.9 (19.3)
F.15	$Y_2 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.27	.24	10 (67)		.04 (.52)	.01 (.37)		.09@ (.01)	.39@@ (.18)	-22.5 (82.1)	-18.9 (17.1)

Figures in parentheses indicate the standard errors of regression coefficients.

@ Significant at 1 percent level.

@@ Significant at 5 percent level.

@@@ Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Muzaffarnagar 1967-68

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
M.1	$Y_1 = a + b_6x_6$	.19	.18	27.54 (41.32)				.007● (.001)				
M.2	$Y_1 = a + b_6x_6 + b_8x_8$	.19	.19	59.49 (70.34)				.007● (.001)		-.20 (.35)		
M.3	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.16	.11	143.62 (417.50)	13.12 (8.23)	2.12 (1.69)	-1.42 (4.04)		-.008 (.004)	-.24 (.378)	-155.7 (108.17)	-65.11 (75.81)
M.4	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.52	.49	-51.9 (365.2)	.27● (.05)	1.7 (1.5)	-.42 (3.7)	.007● (.001)	-.001 (.003)	-.24 (.36)		
Dropping insignificant variables												
M.4(a)	$Y_1 = a + b_3x_3 + b_6x_6$	.51	.50	29.8 (41.5)	.26● (.02)			.007● (.001)				

Figures in parentheses indicate the standard errors of regression coefficients.

● Significant at 1 percent level.
●● Significant at 5 percent level.
●●● Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Muzaffarnagar 1967-68

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan. x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
M.5	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.41	.39	1622.1@		.52	-15.8@	.007@	-.001	-.51		
				(178.8)		(1.7)	(2.4)	(.001)	(.004)	(.39)		
Dropping insignificant variables												
M.5(a)	$Y_1 = a + b_5x_5 + b_6x_6$	.40	.39	1607.7@			-16.02@	.007@				
				(176.8)			(1.8)	(.001)				
M.6	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.41	.38	1624.5@		.73	-16.2@	.007@	-.001	-.65	22.6	64.1
				(179.7)		(1.7)	(2.4)	(.002)	(.004)	(.79)	(94.5)	(79.2)
Dropping insignificant variables												
M.6(a)	$Y_1 = a + b_5x_5 + b_6x_6$	.40	.39	1607.7@			-16.02@	.007@				
				(176.8)			(1.8)	(.001)				
M.7	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.52	.49	-42.3	.27@	1.9	-.82	.007@	-.001	-.32	13.4	53.1
				(367)	(.05)	(1.61)	(3.76)	(.002)	(.003)	(.72)	(85.9)	(72.0)
Dropping insignificant variables												
M.7(a)	$Y_1 = a + b_3x_3 + b_6x_6$	.51	.50	29.8	.26@			.007@				
				(41.5)	(.02)			(.001)				

Figures in parentheses indicate the standard errors of regression coefficient

● Significant at 1 percent level.

●● Significant at 5 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Muzaffarnagar 1967-68

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
M.8	$Y_2 = a + b_6x_6$	.008	.00001	20.41 (12.67)				.003 (.003)				
M.9	$Y_2 = a + b_6x_6 + b_8x_8$	.01	-.005	24.7 (15.10)				.003 (.003)		-.03 (.05)		
M.10	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.02	-.01	13.59 (59.59)	-.72 (.79)	.32 (.25)	.001 (.60)		.001 (.005)	-.03 (.05)		
M.11	$Y_3 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.01	-.01	17.99 (59.36)		.30 (.25)	-.08 (.59)		-.001 (.005)	-.03 (.05)		

Figures in parentheses indicate the standard errors of regression coefficients.

@Significant at 1 percent level.

@@Significant at 5 percent level.

@@@Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Muzaffarnagar 1967-68

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
M.12	$Y_2 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.02	-.02	6.44 (60.81)		.27 (.25)	-.14 (.60)	.002 (.003)	-.002 (.005)	-.03 (.05)		
M.13	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.02	-.02	6.36 (60.96)	-.54 (.84)	.29 (.26)	.008 (.60)	.001 (.003	-.002 (.005)	-.04 (.05)		
M.14	$Y_2 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.05	.006	48.25 (63.14)		.27 (.25)	-.40 (.62)		-.001 (.004)	-.02 (.05)	-14.84 (11.90)	11.66 (8.08)
M.15	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.06	.01	66.97 (64.78)	-1.57 (1.26)	.31 (.25)	-.44 (.62)		.001 (.004)	-.03 (.05)	●●● -29.4 (16.72)	1.10 (11.71)

Figures in parentheses indicate the standard errors of regression coefficients.

● Significant at 1 percent level.

●● Significant at 5 percent level.

●●● Significant at 10 percent level.

Regression analysis of factors influencing the use of Chemical fertilisers, Muzaffarnagar, 1968-69
(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
M.1	$Y_1 = a + b_6x_6$	.32	.30	-.76 (50.9)				.02* (.002)				
M.2	$Y_1 = a + b_6x_6 + b_8x_8$	.34	.34	-674* (235)				.02* (.002)		4.59* (1.5)		
M.3	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.23	.24	-855*** (575)	32.04* (12.5)	.16 (1.9)	2.51 (5.6)		.01** (.005)	6.07* (1.8)	-155 (150)	-100 (101)
M.4	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.35	.33	-.660 (531)	-20.20 (16.05)	.70 (1.7)	1.09 (5.2)	.02* (.006)	.008*** (.005)	3.40** (1.7)		

Figures in parentheses indicate the standard errors of the regression coefficients.

* Significant at 1 percent level.

** Significant at 5 percent level.

*** Significant at 10 percent level.

Regression analysis of factors influencing the use of Chemical fertilisers, Muzaffarnagar, 1968-69

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
M.5	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$											
M.6	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.35	.32	770 (533)		.55 (1.8)	1.13 (5.3)	.02● (.004)	.007 (.005)	4.38● (1.6)	-39 (131)	-36 (85)
M.7	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.37	.33	-571 (543)	-29.79 (18.1)	.84 (1.79)	1.16 (5.78)	.02● (.006)	.007 (.005)	3.57●● (1.73)	-127 (141)	-107 (95.5)

Figures in parentheses indicate the standard errors of the regression coefficients.

● Significant at 1 percent level.

●● Significant at 5 percent level.

●●● Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Muzaffarnagar, 1968-69

(**Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2**)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
M.8	$Y_2 = a + b_6x_6$	.11	.11	.43 (12.2)				.02@ (.005)				
M.9	$Y_2 = a + b_6x_6 + b_8x_8$	.14	.13	-59@@ (30)				.02@ (.005)		.45@@ (.21)		
M.10	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.05	.02	-79 (76)	.37 (1.0)	-.11 (.25)	.50 (.75)		.002 (.004)	.63@ (.24)		
M.11	$Y_2 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.05	.02	-75 (75)		.11 (.25)	.53 (.24)		.001 (.004)	.60@ (.22)		

Figures in parentheses indicate the standard errors of regression coefficients.

@ Significant at 1 percent level.

@@ Significant at 5 percent level.

@@@ Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Muzaffarnagar, 1968-69

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan. x_5	Output x_6	Cap. x_7	Intsn. x_8	D_1 x_9	D_2 x_{10}
M.12	$Y_2 = a+b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.15	.12	-82 (71)		.002 (24)	.21 (.71)	.02* (.005)	-.003 (.004)	.46** (.21)		
M.13	$Y_2 = a+b_3x_3+b_4x_4 + b_5x_5+b_6x_6 + b_7x_7 + b_8x_8$	.15	.11	-81 (72)	-.06 (.92)	.004 (.24)	.21 (.72)	.02* (.005)	-.003 (.004)	.46** (.23)		
M.14	$Y_2 = B_3x_3+b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.05	.01	-68 (78)	-.21 (1.6)	-.13 (.26)	.45 (.76)		.002 (.004)	.64** (.24)	-13 (20.5)	-3.9 (13.8)
M.15	$Y_2 = a + b_4x_4+b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.05	.01	-78 (76)		-.13 (.25)	.45 (.75)		.002 (.004)	.64** (.23)	-11 (15)	-2.6 (9.4)

Figures in parentheses indicate the standard errors of regression coefficients.

* Significant at 1 percent level.

** Significant at 5 percent level.

*** Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Deoria 1967-68
(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
D.1	$Y_1 = a + b_6x_6$	.55	.55	-34.97● (9.5)				.01● (.001)				
D.2	$Y_1 = a + b_6x_6 + b_8x_8$	.57	.56	44.97 (40)				.01● (.001)		-.58●● (.29)		
D.3	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.59	.57	116.20 (102)	28.28● (4.005)	.57●● (.27)	-.79 (.83)		.0003 (.002)	-.26 (.297)	-31.58 (38)	-57.06 (31)
D.4	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.60	.59	41.3 (90.4)	16.5● (4.6)	.29 (.26)	-.4 (.81)	.007● (.002)	.0002 (.002)	-.33 (.29)		
Dropping insignificant variables												
D.4(a)	$Y_1 = a + b_6x_6 + b_8x_8$	.57	.56	17.9● (4.5)				.007● (.002)				

Figures in parentheses indicate the standard errors of regression coefficients.

● Significant at 1 percent level.
●● Significant at 5 percent level.
●●● Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilizers, Deoria 1967-68
(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
D.5	$Y_1 = a+b_4x_4+b_5x_5+b_6x_6+b_7x_7+b_8x_8$	.57	.56	61.7* (23.8)		.29 (.27)	-.29 (.85)	.01* (.002)	.001 (.002)	-.56** (.29)		
Dropping insignificant variables												
D.5(a)	$Y_1 = a+b_6x_6+b_8x_8$	.57	.56	44.5 (40.6)				.04* (.001)		-.58** (.29)		
D.6	$Y_1 = a+b_4x_4+b_5x_5+b_6x_6+b_7x_7+b_8x_8+D_1x_9+D_2x_{10}$	.66	.64	454.7* (105.1)		.38 (.25)	-.56 (.76)	.006* (.001)	.005 (.002)	-.42 (.26)	-356.9 (57.8)	-275.5 (50.5)
Dropping insignificant variables												
D.6(a)	$Y_1 = a+b_6x_6+D_1x_9+D_2x_{10}$	.65	.64	352.9 (63)				.007 (.001)			-359.9 (57.9)	-280.7 (50.7)
D.7	$Y_1 = a+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7+b_8x_8+D_1x_9+D_2x_{10}$	.66	.64	234.3 (116.5)	2.1 (5.2)	.37 (.25)	-.56 (.76)	.006* (.002)	.0005 (.002)	.40 (.27)	-340.9* (59.8)	-263.0* (53.6)
Dropping significant variables												
D7(a)	$Y_1 = a+b_6x_6+D_1x_9+D_2x_{10}$	.65	.64	352.9 (63)				.007 (.001)			-359.9 (57.9)	-280.7 (50.7)

Figures in parentheses indicate the standard errors of regression coefficients.

* Significant at 1 percent level.

** Significant at 5 percent level.

*** Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Deoria 1967-68

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
D.8	$Y_2 = a + b_6x_6$	.001	.005	14.52● (2.86)				.0004 (.0009)				
D.9	$Y_2 = a + b_6x_6 + b_8x_8$	.05	.03	37.77● (8.9)				.001●●● (.0009)		-.19● (.06)		
D.10	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.11	.08	36.11●● (21.6)	1.47● (.56)	.09●●● (.06)	-.17 (.19)		.0005 (.001)	-.09●●● (.06)		
D.11	$Y_2 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.07	.05	51.24●● (21.4)		.13●● (.06)	-.20 (.19)		.0003 (.001)	-.14●● (.06)		
D.12	$Y_2 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.08	.05	51.44● (21.4)		.13●● (.06)	-.20 (.19)	.0009 (.0001)	.0003 (.001)	-.167● (.07)		

Figures in parentheses indicate the standard errors of regression coefficients.

● Significant at 1 percent level.

●● Significant at 5 percent level.

●●● Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Deoria 1967-68
(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
D.13	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.12	.09	@@ 37.90 (21.5)	@ 1.52 (.56)	@@@ .08 (.06)	-.17 (.19)	@@ .001 (.0005)	.005 (.001)	@@ -.11 (.07)		
D.14	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.12	.08	@@ 50.80 (24)	.54 (.93)	@@@ .11 (.06)	-.20 (119)		.0006 (.001)	-.08 (.06)	-11.37 (9.1)	-8.40 (7.1)
D.15	$Y_2 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.12	.09	@ 57.09 (21)		@@ .12 (.06)	-.21 (.19)		.0006 (.001)	-.08 (.06)	@ -15.09 (5.5)	@@ -11.34 (5.4)

Figures in parentheses indicate the standard errors of regression coefficients.

@ Significant at 1 percent level.

@@ Significant at 5 percent level.

@@@ Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Deoria, 1968-69

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan. x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
D.1	$Y_1 = a + b_6x_6$	.50	.49	-30* (11)				.01* (.001)				
D.2	$Y_1 = a + b_6x_6 + b_8x_8$	.50	.49	103 (148)				.07* (.001)		-1.33 (1.47)		
D.3	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.54	.52	135 (175)	37.20* (6.2)	-.10 (.28)	-.60 (.91)		.01** (.008)	-1.72 (1.5)	86** (45)	56*** (36)
D.4	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.54	.52	176 (169)	17.35** (7.2)	-.09 (.27)	-.48 (.91)	.006** (.003)	.01** (.008)	-1.47 (1.5)		

Figures in parentheses indicate the standard errors of regression coefficients.

* Significant at 1 percent level.

** Significant at 5 percent level.

*** Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Deoria, 1968-69

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan. x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
D.5	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$											
D.6	$Y_1 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.53	.51	23 (178)		.02 (.28)	-.33 (.93)	.01● (.002)	.02● (.007)	-.59 (1.4)	46 42	18 34
D.7	$Y_1 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.56	.54	81 (173)	24.91● (7.8)	.01 (.28)	-.38 (.90)	.008● (.003)	.01●●● (.008)	-1.75 (1.49)	107●● 45	63●● 36

Figures in parentheses indicate the standard errors of the regression coefficients.

● Significant at 1 percent level.

●● Significant at 2 percent level.

●●● Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Deoria, 1968-69

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No.	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Cons. a	Size x_3	Irrig. x_4	Tenan. x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
D.8	$Y_2 = a + b_6x_6$	.14	.14	(7.69) (4.37)				.005● (.001)				
D.9	$Y_2 = a + b_6x_6 + b_8x_8$	.14	.13	3.04 (50)				.005● (.001)		.04 (.49)		
D.10	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.23	.20	53.7 (56)	.41 (.97)	-.006 (.09)	-.38 (.31)		-.04● (.006)	-.03 (.49)		
D.11	$Y_2 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8$	.23	.20	47.7 (54)		-.004 (.09)	-.38 (.30)		.04● (.006)	.03 (.47)		

Figures in parentheses indicate the standard errors of regression coefficients.

● Significant at 1 percent level.

●● Significant at 5 percent level.

●●● Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers, Deoria, 1968-69

(Regression Coefficients, Standard Errors, $\bar{R}^2$ and R^2)

Model No	Form of Reg. Eqn.	R^2	$\bar{R}^2$	Const. a	Size x_3	Irrig. x_4	Tenan. x_5	Output x_6	Cap x_7	Int. x_8	D_1 x_9	D_2 x_{10}
D.12	$Y_2 = a + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.29	.27	21 (52)		.02 (.08)	-.40 (.29)	.004● (.001)	.03● (.006)	.19 (.45)		
D.13	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8$	.30	.28	40 (53)	1.51 (1.28)	-.02 (.08)	-.40 (.29)	.004● (.001)	.03● (.006)	-.03 (.47)		
D.14	$Y_2 = a + b_3x_3 + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.23	.19	43 (59)	1.58 (1.64)	.003 (.09)	-.38 (.31)		.04● (.006)	-.05 (.50)	12.7 (15.3)	6.8 (12.4)
D.15	$Y_2 = a + b_4x_4 + b_5x_5 + b_7x_7 + b_8x_8 + D_1x_9 + D_2x_{10}$	.23	.19	46 (59)		.0003 (.09)	-.39 (.31)		.04● (.006)	.05 (.48)	.95 (8.3)	-.10 (8.4)

Figures in parentheses indicate the standard errors of the regression coefficients.

● Significant at 1 percent level.

●● Significant at 5 percent level.

●●● Significant at 10 percent level.

Regression analysis of factors influencing the use of chemical fertilisers.

(**Regression Coefficients, t-ratios, $\bar{R}^2$, R^2**)

Multiple Linear Regression Equations	Const. a	R^2	$\bar{R}^2$	H.Y.V. x_2	Size x_3	Irrig x_4	Tenan x_5	Cutput x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
Ferozepore 1967-68												
$Y_1 = a + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10}$	-1325 (-2.2)	.67	.65	3.04 (1.26)	18.36 (1.35)	2.65 (.85)	-.14 -.06	.03 (5.5)	.01 (1.3)	7.3 (2.7)	-42 (-.57)	-119 (.87)
Ferozepore 1968-69												
$Y_1 = a + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10}$	-504 (-.75)	.77	.76	8.73 (2.33)	51.89 (-3.2)	6.89 (1.34)	-3.02 (-.82)	.09 (10.6)	.005 (.42)	-.90 (-.50)	-490 (.511)	-116 (-.63)

Figures in brackets represent t-ratios.

Regression analysis of factors influencing the use of chemical fertilizers.

(**Regression Coefficients, t-ratios, $\bar{R}^2$, R^2**)

Multiple Linear Regression Equations	Const. a	R^2	$\bar{R}^2$	H.Y.V. x_2	Size x_3	Irrig. x_4	Tenan. x_5	Output x_6	Cap. x_7	Inten. x_8	D_1 x_9	D_2 x_{10}
Muzaffar Nagar 1967-68												
$Y_1 = a + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 \times b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10}$	-76 (-.20)	.52	.58	-.06 (-.69)	.66 (1.18)	1.95 (1.20)	-.52 (-.13)	.007 (3.38)	-.001 (-.45)	-.32 (-.44)	14 (.17)	.58 (.74)
Muzaffar Nagar 1968-69												
$Y_1 = a + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10}$	-578 (-1.07)	.39	.35	5.56 (2.25)	-24.08 (-1.33)	1.58 (.87)	.50 (.09)	.02 (3.91)	0.008 (1.59)	3.37 (1.97)	-179 (-1.2)	-112 (-1.1)

Figures in brackets represent t-ratios.