CHAPTER VII

............................................

Summary
It is an acceptable fact that in order to achieve the country’s aim of self-sufficiency in agricultural production and rural development, use of fertilizers must substantially be increased. The consumption of chemical fertilizers in India was very limited till the introduction of high yielding varieties of food crops during 1965-66. The total consumption of chemical fertilizers in the country was less than two lakh tonnes up to 1958-59. thereafter, it increased to 28 lakh tonnes during 1973-74 and 125.23 lakh tonnes during 1990-91. In Rajasthan too, the use for chemical fertilizers picked up speed only after the introduction of seed of high yielding varieties of food crops especially of wheat, rice, maize and bajra. The total consumption of chemical fertilizer in Rajasthan state was less than one lakh tonnes during 1970-71, which increased to 1.35 lakh tonnes during 1980-81 and 3.6632 lakh tonnes during 1990-91. The need has been felt to collect information regarding the distribution and consumption of pattern of fertilizers on various crops more specially on wheat and bajra, which are the most important food grain crops of Rajasthan state and of different categories of farmers. Keeping in view the fluctuating situation in the consumption and distribution of fertilizers, the present study entitled “Distribution, consumption and economic response of fertilizers on wheat and bajra crops in district Sawai-Madhopur, Rajasthan” was undertaken during 1992-93 with the following objectives:

1. To study the infrastructure of different system dealing with distribution of fertilizers.
2. To measure the differential consumption pattern of fertilizers by different categories of farmers under different cropping patterns and irrigation facilities available.
3. To review the fertilizers distribution policy of the Government, quasi Government and private agencies.

4. To study the economic response of fertilizer on wheat and bajra, major crops of the study area and

5. To analyse the productivity of fertilizer with other farm resources and to work out the optimization of fertilizer use for profit maximization.

For the purpose of present study as mentioned above, the sampling design used was multi stage stratified random sampling. The sampling technique consisted three main parts, viz., research design, data collecting procedure, statistical measures used and variables and their measurement. District Sawai-Madhopur was purposively selected in order to approach easily and timely. Among three sub-divisions of district, Sawai-Madhopur, only one sub-division namely Sawai-Madhopur was selected with probability proportion of area under wheat and bajra and consumption of fertilizers.

Ten villages from selected sub-division of the district were randomly selected with the probability proportion to the area under wheat and bajra and consumption of fertilizers, keeping in view to have at least 10 per cent area under wheat and bajra crops to total cropped area of each selected village. All the respondents of each selected village were categorized in four size groups and the respondents from each selected village were randomly selected under different categories of farm keeping in view that the number of selected respondents were in proportional to the number of farmers falling in each category of farm. The different categories of farmers and their number selected from selected villages are given below.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Category of Farmers</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Marginal Farmer (below 1 hectare)</td>
<td>20</td>
</tr>
<tr>
<td>2.</td>
<td>Small Farmers (1-2 hectares)</td>
<td>12</td>
</tr>
<tr>
<td>3.</td>
<td>Medium Farmers (2-4 hectares)</td>
<td>40</td>
</tr>
<tr>
<td>4.</td>
<td>Large Farmers (4 &amp; above 4 hectares)</td>
<td>28</td>
</tr>
</tbody>
</table>

Thus, the present study is based on 100 farmers who were randomly selected from 10 randomly selected villages from one randomly selected sub-division of purposely selected district. Wheat and bajra crops were selected in view of the facts that these crops occupied larger area to the total cropped area of the district under study as compared to other crops.

Officials and non-officials who were directly or indirectly engaged in fertilizer distribution and its promotional work in the study area were selected and interviewed with the help of well structured schedule and questionnaires in the selected district. Thus, the sampling unit represented the district, sub-division, villages, respondents and officials and non-officials. Survey method of sampling technique was used for the collection of desired data.

Various statistical techniques and tools used in the present study were

1. Tabular analysis
2. Average – weighted average
3. Test of significance
4. Correlation coefficient
5. Multiple regression equations.

The findings of the present study have been summarized chapter-wise.

1. Farm structure
   (i) Distribution of farms

   The study of distribution of farms among various selected farmers was found to be uneven as about 28 per cent farmers covered about 55 per cent of the total
cultivated area whereas the marginal and small farmers constituting together 32 per cent of total selected farms covered only 8.88 per cent to total cultivated area of all selected farms.

(ii) Irrigation

The percentage of irrigated area to total cultivated area was observed to be negatively and significantly correlated with the size of farm ($r = -0.8135$ significant at 5 per cent level) maximum being 84.6 per cent on marginal farms and minimum being 55.61 per cent on large farms and should complementary relationship with the consumption of fertilizers.

(iii) Source-wise irrigation

On an average of selected farms, the main sources of irrigation was observed to be pumping sets and tube-wells contributing 70.76 per cent to total irrigated area of the selected farms and found to be positively correlated with the size of farm ($r = +0.6725$ significant at 5% level) and the rest was under open well and canal being 6.77 and 22.45 per cent respectively.

(iv) Capital investment

Total investment per farm was observed to be positively correlated whereas per hectare, it was negatively correlated with the size of farm ($r = (+)0.812$ and $(-0.673$ respectively significant at 5 per cent level). On an average, the investment on land, building, milch and draught cattle, farm implement and machinery and irrigation structure came to 49.59, 17.39, 3.54, 9.08 and 28.38 per cent respectively to total investment including land value.

(v) Cropping intensity

On an average, the cultivated area, cropped area and area sown more than once came to 4.016, 6.320 and 2.310 hectare respectively and was found to be positively correlated with the size of farm ($r = +0.752 + 0.698$ and $+0.712$
significant at 5 per cent level). The cropping intensity was observed to be lowest being 154.52 per cent on large farms showed negative correlation with the size of farm \((r= -0.752\) significant at 5 per cent level). On an average, the cropping intensity on the farms as a whole came to 157.52 per cent.

**(vi) Cropping pattern**

The analysis of cropping pattern revealed higher percentage area under food grain crops on marginal and small farms as compared to medium and large farms. It was also observed that among the food grain crops, wheat and bajra were the main crops occupying on an average, 23.37 and 13.22 per cent area to total cropped area of all sample farms respectively. Area under other crops including cotton, fodder crops, barley etc. showed positive correlation with the size of farm \((r= +0.601\) significant at 5 per cent level) average being 35.49 per cent to total cropped area.

**(vii) Human Labour**

Total availability and utilization of family human labour on the farms under study clearly revealed that the availability and utilization of family labour was significantly higher on marginal and small farms being 750 and 850 working days and 500 and 450 days respectively as compared to medium and large farms being 600 days on each farm and 300 and 350 days respectively showing thereby 66.66 per cent on marginal farms and 41.00 per cent utilization on large farms of their respective total working days available of family labour.

**(viii) Hired human labour**

The findings in this respect clearly showed that per farm as well as per hectare utilization of hired human labour on the sample farms was observed to be positively correlated with the size of farm \((r = + 0.952\) and \(+ 0.853\) significant at 5% level), highest being 408.20 and 52 days on the large farms and lowest being 9.36 and 12.00 days respectively on the marginal farms. Further, the percentage
of utilization of family labour to total human labour utilization showed negative, 
correlation whereas hired human labour indicated positive correlation with the size 
of farm ($r = 0.852$ and $0.905$ respectively significant at 5 per cent level).

**(ix) Bullock and Tractor power utilization**

The findings reflected the facts that the utilization of bullock labour was 
found negatively correlated with the size of farms highest being 105 days on 
marginal farms and lowest being 40 days on large farms ($r = -0.592$ significant at 
5 per cent level) whereas tractor power utilization showed positive correlation 
with the size of farm, minimum being nil on marginal farms and maximum being 
190 hours on large farms with overall average of 65.80 days and 84.30 hours.

**Study the infrastructure of different systems dealing with distribution of fertilizer**

(i) **Socio-economic status**

The socio-economic status of the selected farms families was measured with 
the help of socio-economic status scale (rural) developed by Trivedi and Pareek 
(1964). The farmers were classified into three categories viz. upper class, middle 
class and lower class.

Highest number being 58 of the selected families belonged to upper class 
socio-economic status whereas equal number belonged to lower and middle class 
socio-economic status representing 21 per cent to each class to total selected farm 
families. The upper class socio-economic status constituted 26 large farmers, 30 
medium farmers and only one each from small and marginal group of farmers. The 
medium class socio-economic status constituted 7 marginal farmers, 4 from small 
group, 8 from medium and only 2 farmers from large farmers. Majority of 
marginal farmers were found to be of lower class socio-economic status whereas 
only 7 farmers from small and only 2 farmers from medium group belonged to 
lower class socio-economic status.
(ii)  Level of education
Fifteen per cent to total selected farmers were found as illiterate and the rest i.e., 85
Percent were literate farmers. Out of 100 selected farmers, 44 per cent
farmers were occupying the educational level above class, 27 per cent up to VIII
class and 14 per cent were educated only up to primary class. It was also observed
that educational level increased with the increase in the size of farm whereas
reverse trend was observed in the case of illiteracy indicating thereby negative
correlation with the size of farm.

Among the marginal farmers, only 5 per cent was found to be above VIII
class, 15 per cent were above VIII class and 30 per cent up to primary classes
showing negative correlation with the increase in educational level. Largest
percentage of marginal farmers being 50% was illiterate. About 75% to total large
farmers was educated above VIII class, 21.43 per cent up to VIII class and only
3.57 per cent farmers of this group were educated up to primary class. No farmer
of this category was illiterate. As regard to educational standard of medium
farmers, it was observed that 50%, 37.50% and 10% to total farmers of this group
were educated above VIII, up to VIII and up to primary class respectively. Only
one farmer of this group was found illiterate. Among small farmers, 66.66% was
literate and 33.33% was illiterate farmers. In literacy group of this category of
farmers, 16.66%, 25.00% and again 25.00% were educated above VIII standard, up
to VIII and up to primary class respectively.

(iii)  Age group
Maximum being 54 per cent to total farmers under study was found to be of
age group between 25-50 years of age whereas about 30 per cent and 16 percent
fall in the age group of above 50 years and below 25 years of age. In the age
group above 50 years of age, maximum percentage belong to marginal and small
farmers. The percentage of marginal and small farmers to their respective total
showed increasing trend with the increase in the age group of the farmers. The
percentage of farmers to total sample size in the age group below 25 years of age
showed negative correlation with the increase in the size of farms. Almost, similar trend was observed in the age group above 50 years of age whereas the farmers belonging to the age group between 25-50 years revealed positive and significant correlation with the size of farm, maximum being 71.43 per cent as big farmers and minimum being 30.00 per cent as marginal farmers.

(iv) Caste distribution

The caste analysis revealed that maximum farm families being 47 per cent to total farm families under study belonged to backward class followed by scheduled caste being 30 per cent and upper caste being 23 per cent. The main constituents of backward class belonged to medium and large farmers constituting about 55 and 57 per cent to their total respective selected farmers. On the contrary, the scheduled caste was mainly represented by marginal and small farmers being 60 and 50 per cent to their respective selected farmers. The high caste indicated positive correlation with the size of farm, maximum being about 38 per cent belonging to large farmers and minimum being 15 per cent to marginal farmers. Similarly, the backward caste also revealed positive association with the size of farm, maximum being 57 per cent of large farmers and minimum being 25 per cent to marginal group of farmers. On the contrary, negative correlation was observed between scheduled caste and size of farm maximum being 60 per cent of marginal farmers and minimum being 7.14 per cent of large farmers to their respective total selected farms under groups of farms in question.

(v) Type of family

The analysis of type of family clearly revealed that overall average of all selected farm families, 60 per cent were joint family and the rest 40 per cent were single family. The joint family system was mainly dominated by medium and large family whereas single family was mainly represented by marginal group of farm families.
(vi) Mechanization

Out of 100 selected farms, highest no. of farms belong to medium mechanized farm being 48 per cent followed by high mechanized farm representing 36 per cent, the rest being 16 per cent belonged to low mechanized farms. Among the different categories of farms, the study indicated that highest no. of large farms being 20 out of 28 farms were found to be high mechanized farms and only 8 large farms belonged to medium mechanized farm and nil to low mechanized farms. On the contrary, only 5 per cent of marginal farms was high mechanized and majority being 60 per cent was low mechanized followed by medium mechanized farms being 35 per cent. Almost similar trend was observed in the case of small farms among which, out of 12 selected farms only 2 belonged to high, 6 to medium and 4 farms to low mechanized farms. In the case of medium farms, it was observed that maximum percentage of medium farms being 67.50 per cent belonged to medium, 32.50 per cent to high and nil to low mechanized farm.

(vii) Scientific orientation

As regards training in scientific farming, it was observed that maximum number of farmers belonged to medium scientific orientation group being 53 per cent followed by high being 39 per cent and only 8 per cent of total selected farmers to low. Among the large farmers, maximum number being 78.57 per cent fall in high and the rest being 21.42 per cent to medium scientific orientation. No farmers of large farms was found in low scientific orientation. Similarly, out of selected medium farmers, maximum being 62.25% per cent belonged to medium, 30 per cent to high and only 7.5 per cent low scientific orientation. As regards to small and marginal farmers is concerned, it was observed that 16.66 per cent and 15 per cent came in high, 75 and 65 per cent in medium and only 8.33 per cent and 20 per cent to total respective selected farmers belonged to low scientific
orientation. Further, high scientific orientation revealed positive correlation whereas low scientific orientation indicated negative correlation with the size of farms indicating thereby that high scientific orientation largely belonged to large farmers whereas low scientific orientation represented by marginal and small farmers.

(viii) Risk orientation

Out of 100 selected farmers, maximum 49 percentage bore medium risk orientation followed by 31 per cent high and only 20 per cent farmers bore low risk orientation. High risk bearing capacity showed positive correlation with the size of farm, maximum being 5% to respective total selected farms represented by marginal farmers and almost nil belonged to large farms revealing thereby that majority of marginal farmers bore low risk bearing capacity. As regards to medium farms, the study showed that maximum number of farms bore medium risk orientation followed by high and low risk orientation.

(ix) Participation in social organization

It was observed that maximum number of selected farmers being 57 participated in 1 - 2 social organization followed by 39 in more than 2 organization and only 4 selected farmers did not participate in any social organization. The farmers participated in more than two social organization indicated positive correlation with the size of farms, maximum being 57.4 per cent belonged to large farmers and minimum being 15 per cent belonged to marginal farmers. As regards, small and marginal farmers is concerned, it was observed that maximum number of small and marginal farmers being 66.66 and 80 per cent of their respective group participated in 1-2 organization and 16.66 and 15 per cent participated in more than two organization respectively. Only 5 per cent of
marginal farmers and 16.66 per cent of small farmers did not participate in any organization.

(x) Preference of farmers

The study revealed that maximum number of selected farmers preferred cooperatives as distribution agency of fertilizer representing 54 per cent to total selected farmers followed by private agency being 33 per cent and least 13 per cent were in favour of agriculture department of the state. Similar trend among different categories of farms was visualized. The preference of cooperative society for distribution of fertilizer indicated positive correlation with the size of farm, maximum being 40.74 per cent of medium farmers and minimum being 11.11 per cent belong to small group of farmers. On the contrary the preference of private agency in the case of marginal farmer was 40 per cent and for large farmers, it was 28.57 per cent.

(xi) Infrastructure of fertilizer distribution agencies

The present study indicated that out of total fertilizers distributed by all distributing agencies, the maximum share being 55.75 per cent was in favour of cooperatives 34.75 per cent to private agencies and agricultural department minimum quantity being 9.50%. On the contrary, private agencies occupied maximum buffer godown being 46.88 per cent followed by cooperative being 31.25 per cent and minimum (21.87 per cent) occupied by agriculture department. As regards to sale point, it was observed that the private agencies had maximum sale points being 175 (59.33 per cent), cooperative 75 sale points (25.42%) and minimum being 45 (15.25%) were occupied by agricultural department. Inspite of maximum quantity of fertilizer distributed by cooperatives, have engaged minimum number of staff showing 21.95 per cent agriculture department 29.27 per cent and maximum being 48.78 per cent by private agencies.
Almost all the godowns of all the agencies were located on the main road or link road. At least one sale point of fertilizer was located at subdivision head quarter and the distance from the selected villages was not more than 4-5 km. In all cases, local transport of fertilizers was made either by bullock cart or by tonga or bicycles etc. in the rural area.

(xii) Distribution of total fertilizers by different agencies to selected farmers

The private agencies were found dominant in the distribution of fertilizers to the selected farmers contributing about 60 per cent whereas the cooperative contributed about 40 per cent of total fertilizer distributed to the selected farmers. The share of agricultural department in fertilizer distribution to the selected farmers was observed to be nil. It was also observed that the share of private agencies in the distribution of fertilizers to large and medium farmers was significantly higher being 64.48 and 66.83 per cent respectively as compared to cooperatives being 35.02 and 33.15 per cent to same categories of farmers. On the contrary, the contribution of cooperative in the distribution of fertilizers to small and marginal farmers was observed to be significantly higher being 61.31 and 75.09 per cent respectively as compared to private agencies being 37.69 and 24.91 per cent to respective category of farmers. The contribution of fertilizers by private agencies was observed to be positively correlated whereas in the case of cooperatives, it was negatively correlated with the size of farm.

(xiii) Reasons of preference of distribution agencies of fertilizer

It was observed that the department of agriculture was preferred due to being able to provide sale point on proper approachable location, fraudulent method not adopted, not making adulteration and other malpractices, suggest and provide proper technique and know how of crop technology, charge of fair price, conduct demonstration having the sure of 80%, 85%, 60%, 95%, 100% and 100 per cent respectively. The department of cooperative was preferred to provide credit, charge of fair price, required type of fertilizer and fulfill the demand of the farmers
store 100 per cent, 80 per cent and 50 per cent respectively whereas private agencies were preferred due to provision of easily and timely available of fertilizers, demand fulfilled, charge of fair price, system of fertilizer distribution efficient and procedure of distribution easy having the score of 70 per cent, 80 per cent, 90 per cent and 95 per cent respectively.

(xiv) Problems faced by the selected farmers

The problems of the selected farmers in obtaining fertilizers from various distributing agencies was reported by them were high rate of interest charged by private agencies, sale points were not easily approachable, procedure of distribution specially in the case of department of agriculture was time consuming and inconvenient, required demand was not fully fulfilled specially in the case of department of agriculture and cooperative, several visits to get the fertilizer and not available at proper time.

OBJECTIVE II

Policies of Government, Quasi Government and Private agencies

The fertilizer is distributed through Govt. Agencies, Semi- Govt. Agencies and Private Agencies. The prices of the fertilizers are fixed by the government and that of locally manufactured fertilizers are fixed by the State Government in consultation with Fertilizer Association of India.

The department of agriculture and private agencies distributed fertilizers only on cash, whereas cooperative distributed the fertilizers both on cash and on credit basis. Generally, the fixation of target of distribution at different levels is determined by the respective heads of the department in consultation with the District Agriculture Officer and the departmental heads either in the region or the State. D.A.O. is the licensing officer for fertilizer sale. Inspecting officers at district and sub division levels include district level heads and their nominees of
the department of agriculture, cooperative and sub divisional magistrate of their respective sub divisions. The B.D.O.s, Tehsildars constitute the inspecting staff at sub division level. The distribution of fertilizer at tehsil or subdivision level is controlled and supervised by A.D.G’s (Ag.) for agriculture department stores, by ADO (cooperatives) for cooperative stores and by B.D.O. and field representatives of different organization for private stores.

Fertilizer are transported to block stores on bill basis by the department of agriculture, cooperatives and in the case of private, it is transported on cash basis. As regards the fertilizer promotional work, the department of agriculture undertake several programmes to promote and educate the farmers about fertilizers use. The department of cooperative and private dealers do not take up fertilizers promotional work directly, but the organization of fertilizers manufacturers undertake promotional work in their collaboration.

**Marketing Policies**

The marketing cost includes the cost of transportation, taxes storage cost, handling charges and the margin of the state and wholesale dealers.

(i) **Transportation charges**

The charges of transportation of imported fertilizers are borne by the Government of India whereas the transport charges for indigenous fertilizers are paid by the manufacturers.

(ii) **Warehousing and storage of fertilizer**

Imported fertilizers are stored in the central and state warehouse whereas indigenous fertilizers are stored in the manufactured godowns. Prices and distribution policies of fertilizers are governed under Fertilizer’s Act 1935.

The main features of the Act are
I. Quality Control - The specific standards of fertilizers are fixed by the Government of India where in the purity of fertilizers is judged by central laboratory.

2. Price control - The issue price of fertilizer is fixed by the Government of India in consultation with FAI. The Government of India recommends the distribution margin of all the states.

3. Registration of sellers - The State Government provides license to the sellers through DAO in the Districts.

4. Subsidy - The subsidy on the purchase of fertilizers is provided on phosphatic and potassic fertilizers specially to marginal and small farmers on Govt. and Semi Govt. sale of fertilizers.

5. Marketing Channel - The imported fertilizers is allotted from central fertilizer pool to State Governments as per their requirements and then the State Governments distributed it to different department of states like Agriculture department, Cooperative Federations, Agro-industries corporations and also to the private dealers under the permission of the Government of India.

In the case of indigenous fertilizers, 40 per cent is distributed to private licensed dealers by the state government.

OBJECTIVE – III

To measure the differential consumption pattern of fertilizers by different categories of farmers under different cropping pattern and irrigation facilities available.
(i) Differential of fertilizer consumption during different years in district Sawai-Madhopur

The study revealed an increase of 5231 metric tonnes of nitrogen, 6496 metric tonnes in phosphoric and 99 metric tonnes in potassic fertilizers in 1992-93 over 1990-91. The respective increase over 1991-92 was observed to be 2508, 5174 and 19 metric tonnes. Total fertilizer (N+P+K) increase in 1992-93 over 1990-91 and 1991-92 came to 12276 and 7701 metric tonnes respectively. The percentage share of nitrogenous phosphatic and potassic fertilizers to their total fertilizers during 1992-93, 1991-92 and 1990-91 were observed to be 68.86 per cent, 66.65 per cent and 67.77 per cent (Nitrogenous), 30.63 per cent, 33.25 per cent and 32.02 per cent (Phosphatic) and 0.51 per cent, 0.54 per cent and 0.21 per cent (potassic) respectively. The study also showed that the average of three years consumption of nitrogenous, phosphatic and potassic fertilizers in the district under study was observed to be 16393, 9397 and 103 metric tonnes showing 63.31 per cent, 36.29 per cent and 0.34 per cent to their total.

(2) Consumption pattern of fertilizers under different category of farms.

(i) Consumption of Urea, DAP and SSP per farm and per hectare on selected farms on different crops:

The present study revealed that the consumption of Urea and DAP was found to be maximum on wheat on the marginal farms being 98 kg and 54 kg per farm and 206.75 kg and 113.92 kg per hectare respectively constituting 71.01 per cent and 58.06% to total respective quantity on all crops being 138 kg and 101.47 kg per farm and 93 kg and 68.38 kg per hectare. The share of Urea and DAP to their respective total on all crops on marginal farms was observed to 11.06 per cent and 9.68 per cent respectively.

In the case of small farms, the consumption of urea and DAP on wheat and bajra crops was 100 kg and 16.66 kg per farm and 123.00 kg and 53.49 kg per
hectare constituting 61.23 per cent and 10.20 per cent to their respective total on all crops. As regards to medium farmers, it was observed that the consumption of urea and DAP on wheat and bajra was found to be 112.50 kg and 82 kg per farm whereas respective figure per hectare were 86.54 kg and 76.92 kg sharing 24.46 per cent and 7.39 per cent to their respective total on all crops. The consumption of urea and DAP on large farms was found maximum being 205.30 kg and 131.00 kg per farm and 77.01 kg and 22.31 kg per hectare representing 58.49 per cent and 16.28 per cent to their respective total consumption on all crops.

As regards to average consumption of all farms under study is concerned, the study revealed that the consumption of urea and DAP was maximum on wheat being 154.08 kg per farm and 105.25 kg per hectare sharing 44.09 per cent to total consumption on all crops. The respective figures for bajra crop were 34.59 kg per farm and 41.37 kg per hectare and 9.90 per cent to total consumption of all crops.

The consumption of urea and DAP on Groundnut was almost nil on marginal and small farms whereas DAP and SSP was applied to the extent of 3.50 kg and 21.0 kg per farm and 21.60 kg and 21.00 kg per hectare constituting to 0.87 per cent and 80.78 per cent to their respective total on all crops on the medium farms.

Further, the consumption of DAP and SSP on groundnut crops on the large farms was observed to be 15 kg and 100 kg per farm and 14.42 kg and 96.15 kg per hectare representing to 4.91 per cent and 45.16 per cent to their respective total on all crops. The consumption of DAP and SSP on groundnut crop on an average of all farms under study was found to be 5.60 kg and 36.40 kg per farm and 24.78 kg and 161.06 kg per hectare sharing 1.99 per cent and 81.98 per cent to their respective total on all crops.

As regards to consumption of urea and DAP on mustard crop is concerned, the study revealed that the consumption of Urea was almost nil and DAP was 5.00 kg per farm and 27.82 kg per hectare only on the marginal farmers whereas the
consumption of urea and DAP on the small farms on the same crop was observed to be 16.66 kg and 16.66 per farm and 47.20 kg and 47.20 per hectare representing to 12.77 per cent and 10.63 per cent to their respective total on all crops. The consumption of urea and DAP on mustard crop on medium farm was recorded at 60.50 kg and 46.00 kg per farm and 61.30 kg and 46.60 kg per hectare sharing 16.99 per cent and 11.47 per cent to their respective total on all crops. Similarly, the respective consumption on the large farms came to 38.58 kg and 82.14 kg per farm and 17.70 kg and 37.68 kg per hectare constituting 10.99 per cent and 26.84 per cent to the total consumption of urea and DAP on all crops. The farmers of this group also used MoP to the extent of 28.57 kg per farm and 13.11 kg per hectare.

The consumption of urea and DAP on an average of all farms under study on mustard crop, it was observed that the consumption of above mentioned nutrients came to 37.00 kg and 44.39 kg per farm and 31.25 kg and 37.49 kg per hectare representing 10.59 per cent and 15.77 per cent to the total respective consumption of urea and DAP on all crops.

Turning the focus to the consumption of urea and DAP on other crops, the study perspicuous that the consumption of urea and DAP on other crops on marginal farms was observed to be 25 kg and 25 kg per farm and 61.88 kg each per hectare constituting to 18.47 per cent and 26.89 per cent to their respective total on all crops. The consumption of urea and DAP on other crops on small farms was found in equal quantity being 30.00 kg per farm and 24.73 kg per hectare sharing 18.37 per cent and 19.95 per cent to their respective total on all crops whereas the same nutrients on medium farms came to 253.00 kg and 250.00 kg per farm and 86.97 kg and 59.40 kg per hectare sharing 50.07 per cent and 62.34 per cent to the total respective consumption on all crops.

As regards to the consumption of urea and DAP on other crops on large farms is concerned, the study clearly revealed that almost equal quantity of urea
and DAP on other crops on large farms was used being 50.00 kg and 13.55 kg per farm and per hectare respectively constituting to 14.24 per cent and 16.34 per cent to their respective total on all crops.

The consumption of above mentioned nutrients on an average of all farms on other crops came to 123.80 kg and 120.60 kg per farm and 47.18 kg and 45.96 kg per hectare respectively constituting to 14.24 per cent and 16.34 per cent to their respective to their respective total on all crops.

The consumption on above mentioned nutrients on an average of all farms on other crops came to 123.80 kg and 120.60 kg per farm and 47.18 kg and 45.96 kg per hectare representing 35.42 per cent and 42.84 per cent to their respective total on all crops.

The share of different crops under study to total consumption of fertilizers in above mentioned farm as a whole was observed to be 5.95 per cent (groundnut), 7.54 per cent (bajra) 34.93 per cent (wheat), 11.54 per cent (mustard) and 40.04 per cent (other crops).

In order to compare and find out the differential between the actual consumption of fertilizers in the form of NPK and their technical recommendation, the actual consumption of NPK on various crops under different categories of farms was also studied.

Consumption of fertilizer in the farms of NPK under different cropping pattern on various categories farms

The present study clearly revealed that the consumption of nitrogenous and phosphate (N+P) fertilizers almost in all crops was significantly higher on marginal and small farms as compared to big farms except on the farms of medium farmers indicating there by that some of the constraints facing by the marginal and small farmers in the application of N and P nutrients have either
been removed or decreased. It is also possible that some special facilities like subsidy in the price of fertilizers and other inspiration have been provided to the farmers especially to marginal and small farmers. The study also clearly revealed that the consumption of N and P fertilizers in wheat showed negative significant correlation with the size of farm indicating thereby an increase in the use of N and P fertilizers with corresponding increase of farm size being 112.70 kg of N and 52.40 kg of P per hectare in the ratio of 2.15:1 on the marginal farms, 78.72 kg N and 56.58 P per hectare in the ratio of 1.39:1 on small farms, 51.16 kg N and 29.02 kg P per hectare in the ratio of 1.76:1 on medium farms was restricted to the extent of 44.24 kg and 22.60 kg per hectare respectively with the ratio of about 2:1.

In the case of bajra, the consumption of N and P fertilizer on marginal and small farmers was observed to be 37.87 kg and 17.20 kg per hectare for marginal farmers and 30.32 kg and 14.74 kg per hectare for small farmers in the ratios of 2.2:1 and 2.1:1 respectively whereas on the farms of medium farms the consumption of N and P fertilizers being 43.37 kg and 20.36 kg per hectare in the ratio of 2.13:1 was found to be significantly higher as compared to marginal, small and large farms.

It has also been noted that the consumption of N and P fertilizers on mustard crop was observed to be significantly positive correlation with the increase in the size of farm up to medium farms whereas in the case of other crops, the same was found to be negatively correlated with the size of farm except on the medium farms on which the consumption of N and P fertilizers was maximum being 55.48 kg and 39.53 kg per hectare. In absolute figure, the consumption of N and P fertilizers on marginal farms on mustard crop was 4.97 kg and 12.71 kg with the ratio of 1:2.6 respectively whereas on small farms respective consumption of N and P came to 21.70 kg and 21.70 in equal ratio. The consumption of both nutrients on mustard crop was observed to be maximum being 45.58 kg and 21.44 kg respectively in the ratio of 2.13:1 on medium farms whereas same was lowest.
on the large farms being 15.71 kg and 17.32 kg respectively in the ratio of 1:1.10. On the contrary, the consumption of N and P fertilizers on the marginal and small farmers on other crops came to 28.46 kg and 28.46 kg in equal ratio and 15.38 kg and 11.38 kg with the ratio of 1.38:1 respectively.

On an average for all selected farms as a whole, the consumption of N and P fertilizers was observed to be maximum on wheat being 53.19 kg and 30.58 kg per hectare in the ratio of 1.74:1 and lowest being 12.31 kg and 32.58 kg in the ratio of 1:2.65 for ground nut crop. The respective figures per hectare for bajra came to 22.12 kg and 10.20 kg in the ratio of 2.17:1, 21.11 kg and 17.31 kg in the ratio of 1.22:1 for mustard and 29.93 kg and 23.00 kg in the ratio of 1.30:1 for other crops. Average consumption of N and P fertilizer for all crops as a whole was observed to be maximum being 54.66 kg and 31.25 kg per hectare in the ratio of 1.75:1 on the marginal farms respectively followed by medium farmers being 50.36 kg and 31.75 kg in the ratio of 1.59:1, 36.16 kg and 25.98 kg in the ratio of 1.34:1 on small farms whereas the same was found to be lowest on large farms being 17.96 kg and 14.24 kg per hectare with the ratio of 1.26:1.

The consumption of nitrogenous and phosphate fertilizers for all crops and for all selected farms as a whole was calculated at 31.99 kg and 22.33 kg per hectare of cropped area with the ratio of 1.43:1.

The consumption of potassic fertilizers per hectare of cropped area was observed to be confined on the medium farms only on which it was used to the extent of 14.20 kg in groundnut, 1.8 kg in bajra and 0.34 kg in other crops.

**Consumption of fertilizer in relation to irrigation facilities**

The present study visualized that the consumption of N and P fertilizers per hectare of cropped are was found to be closely correlated with the irrigational facilities available on the different categories of farms. The consumption of
nitrogenous fertilizer was observed to be positively correlated with the percentage irrigated area occupied by different crops maximum being 54.66 kg per hectare on the marginal farms occupying highest irrigated area being 84.61 per cent whereas the lowest consumption of nitrogenous fertilizer per hectare being 17.96 kg was found on large farms occupying lowest percentage irrigated area being 55.56. Almost, similar trend was observed in the consumption of phosphatic fertilizers highest being 31.25 kg per hectare on the marginal farms and minimum being 14.24 kg per hectare on large farms with the exception on the medium farms on which the consumption of phosphatic and nitrogenous fertilizers was found to be 50.36 kg and 31.75 kg per hectare respectively with about 60 per cent irrigated area. Thus the consumption of fertilizers in the form of N and P was found to be complementary relationship with irrigated area on the farms under study.

**Suggestions of farmers to remove the present situation of fertilizer use**

The farmers of the study area suggested that the decrease in the price of fertilizer in order to increase the consumption of fertilizer was highly emphasized and got I rank order. II, III, IV and V ranking orders suggestion were observed in favour of increasing the price of products produced, timely availability of fertilizers, lower rate of interest on credit, availability of required type of fertilizers, simple credit obtaining procedure, more provision of irrigation facilities and checking in adulteration of fertilizers respectively. Other suggestion of the farmers viz. availability of fertilizer in the village, availability of information regarding efficient use of fertilizers and provision of soil testing facilities got VII, VIII and IX rank order respectively.

Suggestions of the officials engaged in the distribution of fertilizers were also invited. For this purpose, only 50 officers were chosen. The findings in this respect clearly revealed that all officials suggested in the reduction of price of the fertilizers along with the availability of irrigation facilities, 90 per cent and 88 per cent officers advised the supply of fertilizers in time and as required ban on unfair
price charged by the private dealers respectively. Reduction in the rate of interest on the loans, extension of fertilizers sale depots in the rural area, ban on the sale of fertilizers through unauthorized dealers, made available of readable and effective literature on the use of fertilizers were also advocated by 86, 84, 82 and 80 per cent officials. Similarly, 76, 72, 70, 66 and 64 per cent officials suggested the increase in the convenient transport facilities, conduction of free cost demonstration of the impact of fertilizers on crop production on the farmers fields, supply of subsidy for all NPK fertilizers made, available of long and medium term loans to purchase the fertilizer, checking of adulteration in the fertilizers. Further, few officials also suggested the fixation of same NPK ratio by all distributing agencies, increase in the soil testing facilities, uniformity in literature recommending doses of fertilizers by distributing agencies, fixation of one sale point for distribution of fertilizers at a particular area and simplification of procedure of distribution system of Government agencies etc. Besides the above, the officials also advocated the supply of fertilizers according to need of the consumers by the Govt. agencies, maintenance of packing and seal of fertilizers bags, provision to make available the subsidy to small and marginal farmers in the term of kind and the fixation of price of fertilizers on the basis of size of holdings of the farmers.

As regards the causes and reasons on non-application of recommended doses is concerned, a set of question was prepared and put in before the farmers for their suitable reply, which were recorded accordingly. The farmers advocated that high cost of fertilizers was the most important reason ranking I for non-application of recommended dose of fertilizers along with low price of the produce, lack of money with them and inadequate timely irrigation facilities ranking II, III and IV. The non-availability of required type of fertilizer at right time was also given as the reason for non adoption of recommended doses of fertilizers. Other reasons reported by the farmers like limited availability of credit on high rate of interest,
lacking of technical know-how about efficient use of fertilizers and lengthy procedure of credit advanced along with its complexity record V, VI and V rank respectively. The farmers also advocated the reasons like more use of F.Y.M and green manuring, non availability of fertilizers at consuming points or near by village, risk and uncertainty of profitability using fertilizers ranking VI rank each.

Besides above findings, an attempt was also made to find out the relationship between independent variables and extent of adoption by the farmers. Seven independent variables viz. knowledge, socio-economic status, size of holdings, education, social participation, farm mechanization and source of information were taken into account on the selected 100 farmers of the present study. For this purpose, multiple regression equation was fitted to find out the elasticity of each independent variable to visualize their independent influence on fertilizer use.

The findings of regression equation clearly revealed that the value of multiple determination (R2) was observed to be 0.771292 indicating thereby 77 per cent variation in adoption of recommended doses of fertilizers on wheat and bajra on the selected farmers of all size groups. It was also observed that (t) values of sources of information utilized (X1) and farm implements were found positively significant at 1% and 5% level of significance whereas (t) value of size of holdings was observed to be negatively and significantly associated at 5% level of significance. It was also observed that regression coefficient was found to be non significant for knowledge(x1), socio economic status (X2), education (X4) and social participation (X5) indicating no effect on adoption, thereby only sources information utilized and farm implements were found to be most important independent variables among all independent variables taken in the regression equation contributed maximum influence in the adoption of fertilizers recommended on wheat and bajra cultivation by the farmers. On the other hand, size of holdings had negative effect on the adoption of recommended technology on wheat and bajra cultivation revealing thereby that the adoption of
recommended technology decreased with the corresponding increase in the size of holdings. The independent variables which were found non significant indicated no association of the variables with the adoption of fertilizer technology on wheat and bajra cultivation on the selected farms.

**OBJECTIVE IV**

**Economic response of fertilizer on wheat and bajra**

Wheat crop provides support to the development of urban as well as rural sector. It is a dominant economic product making a substantial contribution to food its agro industries foreign exchange, labour and capital which are the pillar of economic growth of the country. It provides about 15 per cent and 30 per cent of gross agricultural income of the country as a whole and Rajasthan state respectively.

India stood fourth next to USSR, USA and China in order among all wheat producing countries of the world and occupied about 9.2 per cent of world’s wheat area and contributed about 8 per cent of world’s wheat production. The country produced 49.6 million tonnes of wheat on an area of 23456.9 thousand hectares with an average productivity of 2068 Kgs. per hectare during 1989-90. The growth rate of wheat production was about 6 per cent per annum in the last three decades, which has been the highest among all the cereals.

In Rajasthan, wheat occupied 7.88 per cent area and contributing 6.85 per cent of the total production of wheat in India. Rajasthan produced about 34.1 lakh metric tonnes of wheat in an area of 18.50 lakh hectares with a productivity of 20.00 Kgs. per hectare during 1989-90. Due to lack of low level of fertilizer use, lack of assured irrigation, credit facilities and comparatively lesser adoption of improved technology, the average yield per hectare is lower as compared to other developed states like Punjab and Haryana. Thus, it would not be wrong to say that
wheat occupies the most strategic position in respect of acreage as well as production in the Rajasthan state.

Sawai-Madhopur is one of important district of wheat producing districts of the state, occupying about 4.66 per cent and 5.23 per cent of the total area and production of wheat in Rajasthan state. The area under wheat and its production in selected district Sawai Madhopur was 86000 hectare and 178000 metric tonnes during 1989-90. Wheat was also observed the most important crop of the selected farms in the present study.

The analysis of break up of cost on input factors on wheat clearly revealed that total human labour cost was observed to be negatively correlated with the size of farm maximum being Rs. 1210.00 per hectare on the large farms. Similar trend was found in the case of family labour cost. On the contrary, the utilization of hired human labour showed positive correlation with increase in the size group, highest being Rs.1000.00 on large farms and minimum being Rs.400.00 on the marginal farms per hectare.

The analysis also indicated that lesser cost of bullock labour on the medium and large farms was due to major portion of farm operations were performed by heavy machinery and equipments. One interesting point was also observed that the marginal and small farmers, in spite of their weaker financial position, were using fertilizers more than double valuing Rs.11339.90 and Rs.1068.34 per hectare as compared to large farms being Rs.504.40. the cost of irrigation and over head cost revealed negative correlation with the size of farms whereas positive correlation with the size of farms was observed for the cost of plant protection and interest on working capital. On an average of all farms under study, the cost of human labour, bullock labour, manure and fertilizers, cost of irrigation, pant protection cost, interest on working capital and overhead cost were worked out at Rs.1308.61, Rs.507.27, Rs.607.50, Rs.297.43, Rs.191.58, Rs.190.66 andRs.529.25 per hectare respectively.
Further the analysis of contribution of various input factors to the total cost on wheat clearly indicated that the total contribution to total cost involved in the cultivation of wheat in almost all the size group was highest with the average of 22.02 per cent. The contribution of bullock labour cost to total cost was found to be maximum being 22.12 per cent on small farm followed by marginal farms being 15.31 per cent and minimum being 6.50 per cent on large farms. The contribution of manure and fertilizer cost showed negative correlation with the size of farm, maximum being 17.11 per cent to total cost on marginal farms and minimum being 8.74 per cent on large farms with overall average of 10.22 per cent. Similar tendency was observed as regards to the contribution of irrigation which was found to be maximum being 6.00 per cent total cost on marginal farms and minimum being 4.76 per cent on large farms.

The contribution of plant protection and interest on working capital was observed to be maximum being 3.91 per cent and 3.60 per cent on large farms and minimum being 1.50 per cent and 2.20 per cent on marginal farms showing positive correlation with the size of farms whereas the contribution of family labour cost to total human labour cost indicated negative correlation. The contribution of hired human labour cost to total human labour cost showed positive correlation with the size of farm.

Total cost per hectare was found to be negatively correlated with the size of farm, maximum being Rs.6663.03 on marginal farms and minimum being Rs.5770.32 on large farms with overall average of Rs.5941.97.

As regards, yield, value of output per hectare, cost of production per quintal, the present study clearly indicated that the yield and value of output per hectare showed negative significant correlation with the size of holdings maximum being 36.69 quintal and Rs.11067.80 on marginal farms and minimum being 28.65 quintals and Rs.9269.00 on large farms. Higher yield of wheat per hectare on marginal and small farms as compared to the medium and large farms was due to
higher consumption of fertilizers and irrigation on the farms than that of later showing complimentary relationship.

The cost of production per quintal of wheat grain was found to be positively correlated with the size of farm, minimum being Rs.157.39 per quintal on marginal farms and maximum being Rs.174.55 per quintal on large farms. Overall average of yield and value of output per hectare and cost of production per quintal came to 30.72 quintal, Rs.9711.20 and Rs.167.63, respectively.

The analysis of return to operating, fixed cost per hectare of wheat reflected the facts that return of value of output over operating and fixed cost per hectare of wheat was observed to be negatively correlated with the size of farm and showed complimentary relationship with the cost of manures and fertilizers under various size groups, maximum being Rs.6157.90 and Rs.9314.67 on the farms of marginal farmers and minimum being Rs.5217.86 and Rs.7550.09 respectively on large farms. The complimentary relationship of return to output over operating and fixed cost with the cost of manure and fertilizers was due to comparatively higher consumption of fertilizers responsible for increasing the yield per unit of land on the small farms as compared to large ones.

The study further revealed that input output ratio and cost price ratio in wheat grain showed decreasing trend with the increasing in the size of farm except on the farms of medium farmers, maximum being 1:1.66 and 1:1.65 on small farms and minimum being 1:1.61 and 1:1.49 on large farms. These two ratio were observed to be in consistence with the consumption of fertilizers under different size of farms. Overall average of all farms under study, the return of output over operating cost, over fixed cost per hectare, input – output ratio and cost price ratio came to Rs. 5489.14, Rs.7991.29, 1:1.63 and 1:1.58, respectively.

The analysis of net income, family labour income and farm business income per hectare of wheat revealed negative significant correlation with the size of
farms maximum being Rs. 4404.77, Rs. 5854.77 and Rs. 6203.40 on marginal farms and Rs. 3498.69, Rs. 3708.69 and Rs. 4086.97 respectively on large farms and showed complementary relationship with the consumption with the consumption of fertilizers on the farms of various size. Similar tendency was observed in the percentage share of net income, family labour income and farm business income per hectare and per farm and their respectively share in the value of output came to Rs.3769.23, Rs. 4298.55 and 4665.63 per hectare, 5493.28, Rs. 6022.60 and Rs. 6657.13 per farm and 38.81 per cent, 44.26 and 48.04 per cent respectively.

As regards return to capital investment and return per rupee investment on fertilizers on wheat, the study clearly revealed that the return per rupee investment on fertilizer per hectare was found to be positively correlated with the size of farm, maximum being 2.332 per cent and Rs. 2.86 on the farms of marginal farmers.

The return per rupee investment showed competitive relationship with the fertilizer investment on the farms in question. It indicates that the marginal and small farmers are applying the fertilizer near to recommend doses per hectare whereas as the large farms are far behind in applying the recommended doses on fertilizer on their farms. Overall average of all farms under study, the percentage return to capital investment and return per rupee investment of fertilizer were worked out at 4.09 per cent and Rs. 5.20 respectively.

The analysis of gross ratio, operating ratio and fixed ratio showed increasing tendency with the increase in the size of farms maximum being Rs. 0.62 and Rs. 0.18 on the large farms and minimum being Rs. 0.60 and Rs. 0.16 respectively on marginal farms indicating on the large farms as compared to marginal farms to get the same output. On the contrary, no clear relationship was observed in the case of operating ratio with the size of farm. Overall average of all farms under study, the gross ratio, operating ratio and fixed ratio came to Rs. 0.61, 0.44 and Rs. 0.17 respectively meaning there by that in order to get rupee one as the value of output
on wheat Rs.0.61, RS. 0.44 and Rs. 0.17 are required to invest as total cost, operating cost and fixed cost respectively.

Further, the percentage return to fertilizer investment and benefit cost ratio clearly indicated that percentage return on fertilizer consumption on wheat was observed to be maximum being 598 per cent on medium farms followed by large farms being 594 per cent significantly higher as compared to marginal and small farmers being 286 and 278 per cent respectively which was due to more proportional decrease in the consumption of fertilizer on large farms in comparison to smaller one on the hand and no significant decrease in the total cost and value of output on smaller farms as compared to larger farms on the other. Almost similar trend was observed in the cost of benefit cost ratio which was maximum on medium farms being 6.99:1 followed by large farms 6.94:1 significantly higher as compared to marginal and small farms being 3.86:1 and 3.98:1 respectively. Average of all farms as a whole, the percentage return to fertilizer investment and benefit cost ratio came to 520 per cent and 6.20:1 respectively, indicating there by that the farmers on an average were getting additional benefit of Rs. 5.20 by investing of rupee one on fertilizers.

**Economic response of fertilizer on Bajra crop**

Bajra is one of the most important food crop of the weaker section of Rajasthan state. The growth rate of bajra production in Rajasthan state was about 5 per cent per annum for the last three decades and produced 18.289 lakh tonnes from an area of 49.247 lakh hectares during 1989-90.

Sawai Madhopur is one of the most important district among bajra producing district of the state occupying 2.8 per cent and 6.24 per cent to total area and production in the state. The area and production of bajra in the district under study was observed to be 13854 hectare and 114300 tonnes with average productivity of 825 kg per hectare during 1989-90. On an average, bajra crop occupied second
place next to wheat contributing 13.22 per cent area to total cropped area of the sample farms as a whole.

The analysis of distribution of cost on input factors of bajra under various category of farms clearly indicated negative correlation of total human labour cost per hectare with the size of farms maximum being Rs. 650.35 on marginal farms and minimum being Rs. 250.31 on large farms. Almost similar trend was observed in the case of family human labour cost maximum being Rs. 450.21 on marginal farms and minimum being Rs. 75.31 on large farms per hectare contributing about 69.22 and 30.08 per cent to total human labour cost on the above farms respectively.

On the contrary, positive significant correlation was observed between hired human labour cost and size of farms mainly due to more use of tractor power on the big farms. The cost of bullock labour indicated negative trend whereas tractor power cost showed positive trend with the increase in the size of farms maximum being Rs. 450.00 on large farms and almost nil on marginal farms. The cost of seed, irrigation and rental value did not show any significant difference among various size of farms. The cost of fertilizer was found to be maximum being Rs. 440.81 on medium farms and minimum being Rs. 116.28 on large farms.

The cost of plant protection measures indicated positive correlation with the size pf farms maximum being Rs. 240.50 on large farms and minimum being Rs. 120.50 on marginal farms. The total cost incurred on bajra per hectare indicated decreasing tendency with an increase in the size of farm with an exception on medium farms on which it was maximum being Rs. 2873.19. The minimum total cost of bajra per hectare was observed on the large farms being Rs. 2403.97 which was in consistence with the cost of fertilizer on the above size of farm.

As regards the cost of various input factors per farm and their contribution to total is concerned, the present study clearly revealed that almost all cost of input
factors per farm showed positive correlation with the size of farm. The contribution of family human labour, hired human labour, bullock labour, tractor power, seed manure and fertilizer, irrigation, plant protection, interest on working capital, Rental value and overhead charges an average of all farms under study came to 4.00, 7.1, 6.20, 15.13, 1.51, 7.30, 3.75, 8.25, 2.80, 37.50 and 6.35 per cent to total cost respectively. The contribution of operating cost to total cost showed decreasing tendency whereas contribution of fixed cost to total cost indicated increasing trend with and increase in the size of farm with an exception on medium farms.

As regards, yield and value of output per hectare, cost of production per quintal of bajra and input, output ratio, it is persipicuous from the study that negative correlation between the yield of product of bajra grain and total value of output with the size of farm was observed having comparatively higher yield being 16.56 quintal and value of output as Rs. 4050.00 on marginal farms and 13.24 quintal and Rs.3366.00 on large farms with the exemption on medium farms being 17.25 quintals and input-output ratio was observed with the size of farm. On an average of all farms as a whole, the yield of bajra main product and by-product and input-output ratio came to 15.81 and 33.94 quintals, Rs. 2529, Rs.1357.60 and Rs. 3887.20, Rs.112.55 and Rs.28.19 per quintals and 1:1.42 ratio respectively.

The analysis of return of output over operating an fixed cost per hectare of bajra crop and its crop and its cost price ratio showed decreasing trend with the size of farm minimum being 2193.94, RS. 2134.06 and 1:1.400 on large farms and maximum being Rs. 2450.60, 2831.11 and 1:1.437 on the marginal farm with an exception of medium farms on which respective figure came to Rs.2650.14, Rs. 2926.47 and 1:1.469. The values of above said items per farm indicated positive correlation with the size of farm. Average value per hectare of all farms under study worked out at Rs.2336.00, 2629.00 and 1:1.421 respectively.
Turning to measure of farm profits viz. net income family labour income and farm business income, the present study showed decreasing trend of above mentioned items with the size of farms except of medium farms on which the net income, family labour and farm business income per hectare were observed to be maximum being Rs. 1349.21, RS. 1449.46 and Rs. 1611.19 respectively, whereas the respective values were observed to be Rs. 1231.71, Rs. 1681.92 and Rs. 1801.49 on marginal farms and Rs.962.03, Rs. 1037.34 and Rs. 1161.59 on large farms. On an average of all farms the same values were found to be Rs. 1077.10, RS. 1270.35 and Rs.1409.67 respectively. No clear trend with the size of farm was observed in the case of percentage of net income to total value of output whereas the percentage of family labour income and farm business income to total value of output of bajra was observed to be negatively correlated with the size of farm, maximum being 41.53 per cent and 44.48 per cent on marginal farms and minimum being 30.82 and 34.51 per cent on large farms with overall average of 32.68 and 36.26 per cent respectively.

As regards, return to capital investment and return per rupee investment on fertilizer, it was observed that the percentage return to capital investment and return per rupee to fertilizer investment showed positive correlation with the size of farm, maximum being 1.25 per cent and Rs. 9.28 on large farms and minimum being 0.69 per cent and Rs. 4.25 on marginal farms with the exception of medium farms on which the respective figures were 1.55 per cent and Rs. 4.06. Higher return per rupee investment on fertilizers on these farms as compared to the farms of other size groups. Overall average of all farms, the percentage return to capital investment and return per rupee investment on fertilizers came to 1.12 per cent and Rs.4.34 respectively.

The analysis of financial cost ratio did not indicate clear relationship with the size of farms. However, these ratio viz. gross, operating and fixed ratio were observed to be minimum being 0.695, 0.394 and 0.300 on marginal farms meaning
there by that in order to get Re.1.00 as the value of output, one has to invest Re. 0.694 as total cost, 0.394 as operating cost and Re. 0.300 as fixed cost whereas these ratios were observed to be maximum on small farms being 0.723, 0.398 and 0.324 respectively, revealing there by that higher total cost, operating cost and fixed cost was required on the small farms as compared to the farms of other size group in order to earn Re. one from bajra crop. Overall average of gross, operating and fixed ratio came to 0.74, 0.378 respectively.

Turning to the analysis of benefit cost ratio and percentage return on fertilizer consumption on bajra crop the study indicated increasing tendency of benefit cost ratio as well as percentage return to fertilizer investment with the increase in the size of farmer with the exception on medium farms on which there were lowest being 3.06:1 and 406.00 per cent and maximum being 8.27:1 and 928 per cent on large farms. The average of all farms, the benefit cost ratio and percentage return to fertilizer investment came to 3.34:1 and 434.00 per cent respectively.

**OBJECTIVE V**

**Regression Analysis**

(i) *Regression analysis of fertilizer consumption*

The important factors effecting the fertilizer consumption are considered to be gross cropped area, prices agricultural produce, gross irrigated area, area under HYV of crops, availability of credit and annual rainfall. In the present study, an attempt is being made to estimate the impact of gross irrigated area, area under HYV of cropped area of crops, annual rainfall and time element on the consumption of fertilizers in the district of Sawai Madhopur. The time series data of above selected variables from 1970-71 to 1990-91 were taken into account for the purpose. The Cobb-Douglas type of regression equation was fitted. Besides matrix of simpler correlation coefficient between each independed variable and
dependent variable (consumption of fertilizer) was undertaken. Critical examination of correlation coefficient matrix indicated that the correlation of consumption of fertilizer with independent variables was observed to be positive and ranged between 0.25 of \( x_4 \) (annual rainfall) to 0.96 (area under high yielding varieties). Extent of correlation of dependent variable “\( Y \)” (Total fertilizer consumption with gross irrigated area \( x_2 \), area under high yielding varieties of crops \( x_3 \) and the element \( x_5 \) being 0.96, 0.92 and 0.92 respectively was observed to be positive and significant. The above mentioned values of independent variables clearly revealed that the total fertilizer consumption in the district was increased with corresponding increase in gross irrigated area, area under high yielding varieties and with the passage of time. The value of coefficient of correlation of \( Y \) in relation to annual rainfall \( x_4 \) and cropped area \( x_1 \) came non-significant being 0.25 and 0.33.

\[
Y = 2.64 \times x_1^{0.566} \times x_2^{0.801} \times x_3^{0.944} \times x_4^{0.034} \times x_5^{0.005}
\]

\[ R^2 = 0.933 \]

** Indicates significant at 5% level of significance

*Figure below \( x_i \) shows standard error*

Critical examination of above regression equation of fertilizer consumption taken as \( Y \) dependent variable with independent variables of \( x_1, x_2, x_3, x_4 \) and \( x_5 \) (gross cropped area, irrigated area, area under HYV of crops, annual rainfall and time element respectively) clearly revealed that \( b_1 \) value of \( x_1 \) was observed to be negative being - 0.556 indicating there by that there was negative effect of gross cropped area on the consumption of fertilizer which was due to expression of area under rainfed crops along with limited availability of capital with the farmers. The value of \( b_4 \) (rainfall) and \( x_4 \) (time element) being 0.034 and 0.005 were found to be non significant showing no influence on the consumption of fertilizer in the
district under study. Value of $b_2$ and $b_3$ in respect with gross irrigated area and area under HYV of crops respectively were observed to be positive and significant being +0.801 and +0.944 respectively indicated their influence on the consumption of fertilizers to a greater extent.

Further the value of coefficient of multiple determination ($R^2$) was observed to be 0.933 indicating 93 per cent of variation in fertilizer consumption was due to the variable taken in the regression equation.

(ii) Optimization of farm resources and maximization of wheat yield

Multiple regression analysis was used as an analytical tool to study the input-output relationship and productivity of various inputs factors involved in the production of wheat. The regression equation of cobb-Douglas function was fitted being

The examination of elastics of production of various input used in the production of wheat for all farms as a whole clearly revealed that production elasticities of all input factors except of seed ($x_3$) and bullock labour ($x_2$) were significant and positive. Highest production elasticity was worked out for manure fertilizer ($x_4$) being 0.7284 followed by irrigation ($x_5$) and human labour ($x_1$) being 0.4954 and 0.3796. The same for bullock labour and seed were observed as non-significant. The coefficient of multiple determination ($R^2$) being 0.815 indicated about 81 per cent variation in the production of wheat on the farms was due to these significant input variables.

The value of marginal physical product and marginal value product of $x_1$, $x_2$, $x_3$, $x_4$ and $x_5$ variable inputs were worked at 0.00891, 0.01505, 0.01129, 0.03683 and 0.05117 and Rs. 2.32, Rs. 3.91, Rs. 2.89, Rs. 9.5758 and Rs. 13.30 respectively. The marginal value productivity of manures fertilizers and irrigation indicated greater opportunity to increase the production of wheat per unit of land. Higher value of marginal value products of manure fertilizer and irrigation is the
indicative of lower level application of these inputs on sample farms. Since, the marginal value products of bullock labour and seed were found non-significant, had any scope to increase these inputs in wheat production. Similarly, the marginal value product of human labour although was found significant but high than its price. Therefore the increase of human labour application is not desired.

As regard to optimum existing level and their difference is concerned, the present indicated the optimum level of \( x_1, x_2, x_3, x_4, \) and \( x_5 \) variables inputs as Rs.593.19, Rs. 389.71, Rs.226.78, Rs. 1138.40 and Rs. 774.29 respectively. The respective existing level were Rs. 1308.61, Rs.507.27, Rs. 400.50, Rs. 607.56 and Rs. 297.43 and their difference came to Rs. 715.42, RS. 118.56, Rs. 173.72, Rs. 530.84 and Rs.476.86 respectively.

The critical analysis of optimum and existing levels of input factors taken into account clearly revealed that since the optimal levels of manures fertilizers and irrigation were found to be significantly higher than that their existing levels, the levels of these inputs be increased. On the other hand, since the existing levels of human labour, bullock labour and seed were higher than their respective optimal levels, the levels of these inputs be decreased by shifting of funds used on human and bullock labour and seed in favour of fertilizer and irrigation may maximum production of wheat per unit of land on the sample farms. In order to find out the extent of production and returns from wheat, regression equation at optimum levels of inputs was developed as

\[
y = a.x_1^{b_1}.x_2^{b_2}.x_3^{b_3}.x_4^{b_4}.x_5^{b_5}
\]

\[
= a.593.19^{0.3796}.388.71^{0.2486}.173.72^{0.1451}.1138.40^{2.07284}
\]

\[
= 41.76 \text{ quintals}
\]

The critical examination of regression equation revealed that the yield of wheat per hectare can be maximized from existing level of 30.72 quintals at existing level of inputs variables to 41.76 quintals at optimum levels under capital
constraints simply by reallocation and shifting of funds from low marginal value product input to the input variables having high marginal value product. Net difference of production of wheat and net additional income was observed to 11.04 quintals and Rs. 2870.40 on an average farm of the present study. Similarly, the farmers of different category of farms can maximized the production and net return by following the same principle of reallocation and shifting of funds. Suppose the wheat yield per hectare maximized on the sample farms as a whole be the same on the farms of different categories of farms, the yield of wheat per hectare can be increased from 36.69, 34.87, 31.75 and 28.75 quintals on marginal, small, medium and large farms at existing level of input to 41.76 quintal per hectare at optimal levels of input in each category of farm. Higher physical and monetary additional gain on large farms and medium farms at existing level of input to 41.76 quintal per hectare at optimal levels of input in each category of farm. Higher physical and monetary additional gain on large farms and medium farms being 13.11 quintal and Rs. 3408.60 and 10.01 quintals and Rs. 2602.66 as compared to marginal and small farms being 5.07 quintal and Rs. 1318.20 and 6.94 quintals and Rs.1804.40 was due to comparatively lower yield of wheat per hectare at existing level of input on large and medium farm as compared to marginal and small farmers. The higher yield of wheat per hectare on marginal and small farms as compared to medium and large farms was mainly due to comparatively higher consumption of fertilizers on the farmer as compared to later. Hence, it is quite clear from discussion that from optimization of farm resource inputs and their reallocation, the yield of wheat per hectare can be maximized significantly from their existing level under capital constraints, resulting into additional income of Rs. 2570.40 per hectare on the sample farms as a whole over and above of existing net profit.

(iii) Optimization of farm resources and maximization of yield of bajra
The regression equation was also developed to express the yield of bajra as a function of various independent variable inputs. The regression equation of Cobb-Douglas function of bajra for all farm in the present study is as follows: -

\[ Y = a \cdot x_1^{b_1} \cdot x_2^{b_2} \cdot x_3^{b_3} \cdot x_4^{b_4} \]

\[ = a \cdot x_1^{0.4768} \cdot x_2^{0.2284} \cdot x_3^{0.0061} \cdot x_4^{0.5273} \]

\[ R^2 = 0.8530 \]

* at 5\% level and
** at 1\% level

The value of coefficient of multiple determination (Rs) being 0.8530 explained about 85 per cent of total observed variation on the yield of bajra on the sample farms was due to human labour and manure fertilizer utilization. It is also perspicuous from above equation that human labour \((x_1)\) and manure fertilizer \((x_4)\) were positive and significant at 5 per cent and 1 per cent level of significance respectively whereas bullock labour and cost of seed \((x_2 \text{ and } x_3)\) were observed to be non significant.

The analysis of marginal physical and value products of various input variables showed that the marginal value product of manure fertilizer was significantly higher than that of its price revealing there by greater opportunity of higher production and return of bajra per hectare by increasing the use of fertilizer. Further, the analysis of optimal levels of various variable inputs and comparison to their existing levels indicated that the optimal levels of manure fertilizer \((x_4)\) was significantly higher than that of its existing level. On the contrary, the existing mean levels of human labour \((x_1)\) and bullock labour \((x_2)\) being Rs.411.22 and 202.26 were found to be significantly higher as compared to their respective optimal levels being Rs. 355.80 and Rs. 163.97. No significant difference between optimal and existing of seed was observed. The study stated that by shifting and reallocation of available funds used on human and bullock labour in favour of manure fertilizer may maximize the production and return of bajra on the sample farms. To wheat extent, the production of bajra per hectare could be
increased by using optimal level of variable inputs on the sample farms, a regression equation was developed as given below.

\[ Y = a \cdot x_1^{b_1} \cdot x_2^{b_2} \cdot x_3^{b_3} \cdot x_4^{b_4} \]

\[ = 0.01506 \cdot 355^{0.4768} \cdot 163^{0.2284} \cdot 40.80^{0.0061} \cdot 415.40^{0.5273} \]

\[ = 19.50 \text{ quintals} \]

The examination of regression equation clearly showed that the production of bajra per hectare could be maximized from its existing levels of variable inputs of 15.81 quintals on the sample farms as a whole to 19.50 quintals at optimum levels of input factors resulting an additional gain of 3.69 quintals valuing Rs. 590.40 over and above the original net profit simply by shifting and reallocation of various variable inputs.

Similarly, the farmers of various categories of farms can increase the yield per hectare of bajra by following the same process under assumption that the yield of bajra per hectare obtained an optimal variable inputs on the farms as a whole is the same on the farms of other categories of farms under their existing levels of 16.56, 15.78, 17.25 and 13.24 quintals to 19.50 quintal on the farms of marginal, small, medium and large farmers resulting a net additional gain of 2.96, 3.72, 2.25 and 6.26 quintals valuing Rs. 470.40, Rs. 595.20, Rs. 360.00 and Rs. 935.60 per hectare respectively on the farms of the above mentioned categories of farms.

Highest physical and monetary additional gain per hectare farm bajra crop being 6.26 quintals and Rs. 935.60 on the farms of large farmers was due to comparatively low level of fertilizer consumption resulting lower yield per hectare as compared to the farms of other categories. On the contrary lowest additional production of bajra and its additional gain per hectare being 2.25 quintals and Rs. 360.00 was observed on medium farms which was due to higher level of fertilizer consumption leading to higher yield of bajra per hectare on the above farms. Thus, the present study clearly indicated that from optimization of variable inputs and their reallocation, the yield of bajra per hectare on the sample farms as a
whole and on the farms of various categories can be enhanced significantly from their existing levels resulting additional of Rs. 590.40 on the farms as a whole, Rs. 470.40 on marginal farms, Rs. 595.20 on small farms, Rs. 360.00 on medium farms and Rs. 935.60 on the large farms over and above of their respective net profit per hectare.